RECLAMATION
Managing Water in the West

Biological Assessment for Bureau of Reclamation Future Operations and Maintenance in the Tualatin River Subbasin

Tualatin Project

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office

March 2009

U. S. DEPARTMENT OF THE INTERIOR

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

BUREAU OF RECLAMATION

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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How to Read This Document

To read this biological assessment more effectively, carefully study this page. We have designed and written this biological assessment to:

- Document analysis of the effects of the proposed actions on Endangered Species Act listed species and designated critical habitat.
- Request concurrence for "not likely to adversely affect" conclusions.
- Request formal consultation for "likely to adversely affect" conclusions.
- Present the effects on essential fish habitat and request consultation as required under the Magnuson-Stevens Fishery Conservation and Management Act as amended by the Sustainable Fisheries Act of 1996.

Part I contains information relevant to the U.S. Fish and Wildlife Service and NOAA's National Marine Fisheries Service.

- **Chapter 1** provides the preliminary information and background on this Endangered Species Act Section 7 consultation that is helpful in reading the rest of the document.
- **Chapter 2** describes the proposed action and action area.
- **Chapter 3** contains hydrologic and water quality information.

Part II contains the chapters for terrestrial animal and plant species relevant to only the U. S. Fish and Wildlife Service.

- **Chapters 4 through 11** provide information and analysis on Endangered Species Act listed species.

Part III contains the chapters for aquatic species relevant to only NOAA's National Marine Fisheries Service.

- **Chapter 12** provides information and analysis on listed salmon and steelhead Evolutionarily Significant Units.
- **Chapter 13** provides information and analysis on essential fish habitat for the salmon and steelhead Evolutionarily Significant Units.

Part IV contains the biological assessment appendices.

Acronyms and Abbreviations

BA	Biological Assessment
BE	Biological Evaluation
BOD	biological oxygen demand
BRT	Biological Review Team
cfs	cubic feet per second
Consultation Handbook	The Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act
Corps	U.S. Army Corps of Engineers
CTWSR	Confederated Tribes of the Warm Springs Reservation
CWS	Clean Water Services
EFH	essential fish habitat
ENSO	El Niño-Southern Oscillation
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESA regulations	Sections 7(a)-(d) of the ESA found at 50 C.F.R. 402
ESUs	Evolutionarily Significant Units
FCRPS	Federal Columbia River Power System
Grand Ronde Tribes	Confederated Tribes of the Grand Ronde Community of Oregon
HUC	hydrologic unit code
IFIM	Instream Flow Incremental Methodology
JWC	Joint Water Commission
M&I	municipal and industrial
mgd	million gallons per day

MSA	Magnuson-Stevens Fishery Conservation and Management Act
NOAA Fisheries	NOAA's National Marine Fisheries Service
NWR	National Wildlife Refuge
O&M	operation and routine maintenance
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OWRD	Oregon Water Resources Department
PCE	Primary Constituent Element
PDO	Pacific Decadal Oscillation
PVPP	Patton Valley Pumping Plant
Reclamation	U.S. Bureau of Reclamation
RM	river mile
RMP	Resource Management Plan
SCA	NOAA Fisheries May 2008 Supplemental Comprehensive Analysis of the FCRPS and Mainstem Effects of the Upper Snake and Other Tributary Actions
Services	USFWS and NOAA Fisheries
SHPP	Spring Hill Pumping Plant
Siletz Tribes	Confederated Tribes of Siletz Indians
TBWSP	Tualatin Basin Water Supply Project
TBWSP Partners	partners cooperating on the Tualatin Basin Water Supply Project
TVID	Tualatin Valley Irrigation District
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WUA	weighted usable area


RECLAMATION
Managing Water in the West
Tualatin Project
Tualatin River Subbasin, Oregon
Point of Interest
TVID Pipeline
Barney Diversion Pipeline
Oswego Canal
TVID Boundary
City Limit Boundary
County
Stream
Tualatin River
Major River or Waterbody
Sources:
Bureau of Reclamation, PN Region
Oregon Geospatial Enterprise Office
Tualatin Valley Irrigation District (TVID)
Area of Interest
OREGON
Prepared by Bureau of Reclamation, PNGIS
on March 22, 2007
Frontispiece
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CLATSOP
COLUMBIA
TILLAMOOK
WASHINGTON
CLARK
MULTNOMAH
YAMHILL
CLACKAMAS
Columbia River
Willamette River
Henry Hagg Lake
Barney Reservoir
Lake Oswego
Haines Falls:
Hillsboro Reservoir
Lee Falls
Patton Valley Pumping Plant
Spring Hill Pumping Plant
Joint Water Commission Water Treatment Plant
Wapato Diversion
CWS Rock Creek Facility
Lake Oswego Corporation Diversion Dam
Willamette Falls
Scappoose
North Plains
Banks
Forest Grove
Cornelius
Hillsboro
Portland
Beaverton
Gaston
Tigard
Lake Oswego
Milwaukie
Gladstone
Tualatin
West Linn
Sherwood
Oregon City
Wilsonville
Newberg
Yamhill
Carlton
TUALATIN R
0 2 4 6 8 Miles

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PART I

INTRODUCTION AND THE PROPOSED ACTION

Chapter 1 OVERVIEW

1.1 Purpose of the Biological Assessment

The Bureau of Reclamation (Reclamation) submits this biological assessment (BA) to the U.S. Fish and Wildlife Service (USFWS) and NOAA's National Marine Fisheries Service (NOAA Fisheries), (collectively, the Services) in compliance with Section 7 of the Endangered Species Act (ESA), the implementing regulations for Sections 7(a)-(d) of the ESA found at 50 C.F.R. 402 (ESA regulations), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended by the Sustainable Fisheries Act of 1996. Reclamation also referred to *The Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act* (Consultation Handbook), published jointly by the Services (1998), in determining what to include in this BA.

Reclamation proposes to undertake this Federal action in the Tualatin River subbasin involving future operation and routine maintenance (O&M) activities for the Federal Tualatin Project. Reclamation is initiating consultation for future O&M of the Tualatin Project as part of Reclamation's overall consultation for Reclamation projects in the Columbia River Basin.

Reclamation submits this BA to document its analysis of the effects of the Proposed Action on ESA-listed species and designated critical habitat, to request concurrence for its "not likely to adversely affect" conclusions, and to request formal consultation for its "likely to adversely affect" conclusions. For those species for which formal consultation is required, this BA fulfills the requirements of 50 C.F.R. 402.14(c), and Reclamation requests the issuance of biological opinions by the Services. If the Services concur with Reclamation's findings of "not likely to adversely affect" for certain listed species, then the letter of concurrence will complete the informal consultation process and no further action by Reclamation will be necessary (see 50 C.F.R. 402.13(a)).

1.2 Proposed Action

The Proposed Action consists of Reclamation's future O&M at features and facilities of the Tualatin Project. Authorized Tualatin Project purposes involve irrigation, municipal and industrial (M&I) water supply, flood control, recreation, fish and wildlife, and water quality. The Proposed Action is described in detail in Chapter 2.

1.3 Action Area

The Tualatin Project is about 30 miles west of the city of Portland and on the east side of the Coast Range about 40 miles inland from the Pacific Ocean. Tualatin Project lands lie primarily within Washington County with the remainder in Yamhill County.

The analyses of ESA-listed species, designated critical habitat, and MSA designated essential fish habitat (EFH) focus on the aquatic and terrestrial environments that Reclamation may affect under the Proposed Action. The action area begins at Henry Hagg Lake, which is impounded behind Scoggins Dam, and continues downstream along Scoggins Creek which is released from Henry Hagg Lake. The action area extends downstream to the confluence of the Tualatin River and Willamette River. The action area features are shown in the frontispiece. Based on the analyses presented in this BA, Reclamation has determined that any effects to ESA-listed species would be negligible in areas downstream from the confluence of the Tualatin River and the Willamette River. As a result, no further evaluation of potential impacts in the Willamette River is contemplated. Similarly, evaluation for this BA indicate that the Proposed Action will not have significant effects on the Tualatin River upstream of its confluence with Scoggins Creek and this area is therefore not included in the Action Area.

1.4 Previous Consultations

Reclamation has informally consulted with NOAA Fisheries since 2000 under Section 7 of the ESA on the O&M of the Tualatin Project action area (Table 1-1). In March 2000, Reclamation submitted a biological evaluation (BE) to NOAA Fisheries on ESA Section 7 Consultation for the Tualatin Project. In the BE, Reclamation concluded that its 2000-2001 Tualatin Project operations may affect, but were not likely to adversely affect anadromous fish species listed as threatened under ESA. In June of 2000, Reclamation received a response from NOAA Fisheries on the BE submitted for Upper Willamette River steelhead (*Oncorhynchus mykiss*). NOAA Fisheries was unable to concur with Reclamation's effect determination and concluded that an interim informal consultation for one year would not be appropriate, because the potential for take of listed fish constitutes an adverse effect that requires formal consultation.

Reclamation has also informally consulted with the USFWS and NOAA Fisheries since 2004 under Section 7 of the ESA on the Henry Hagg Lake Resource Management Plan (RMP).

Table 1-1. Previous Reclamation ESA Section 7 consultations in Tualatin Project action area.

Project Name	Listed Species	Consultation Results	USFWS/NOAA Fisheries
Tualatin O&M (informal consultation requested) BE March 2000	• Upper Willamette River steelhead	May affect, not likely to adversely affect	NOAA Fisheries (June 2000) did not concur, recommended formal consultation
Henry Hagg Lake RMP (final report issued June 2004)	• Bald eagle • Upper Willamette River steelhead • Northern spotted owl • Six plant species	May affect, not likely to adversely affect No effect	NOAA Fisheries concurred (April 8, 2004) USFWS concurred (March 30, 2004
Tualatin O&M (Reclamation requests updated species lists from NOAA Fisheries on September 14, 2007 and from USFWS on September 20, 2007)	• Northern spotted owl • Six plant species • Upper Willamette River steelhead	Consultation ongoing	NOAA Fisheries confirms June 24, 2005 species list (September 17, 2007); USFWS provides updated species lists (October 1, 2007).

1.5 Basis for "May Affect" Determinations

The purpose of a BA is, among other things, to determine whether a Federal agency must enter into formal consultation pursuant to the ESA regulations. In this regard, the ESA regulations require a Federal agency "…to determine whether any action may affect listed species or critical habitat" (see 50 C.F.R. 402.14(a)). If an agency determines that a proposed action "may affect" a listed species or its critical habitat, then it must enter into formal consultation unless it determines, and the Service(s) concur, that the proposed action may affect, but "…is not likely to adversely affect…," such species or habitat (see 50 C.F.R. 402.13(a) and 402.14(b)(1)). The ESA regulations (50 C.F.R. 402.14(c)(4)), in describing the information to be submitted to the Services for formal consultation, state that an agency is to provide "a description of the manner in which the action may affect any listed species or critical habitat and an analysis of cumulative effects…," with "cumulative effects" defined in 50 C.F.R. 402.02.

In determining whether the proposed actions "may affect" listed species or critical habitat, Reclamation considered the range of effects resulting from its proposed actions in accordance with the regulatory definition of "effects of the action" (50 C.F.R. 402.02). The hydrologic analyses and associated species analyses contained in this BA address the combined effects of storing and releasing project water from the project reservoir and of diverting project water at downstream points of delivery.

The "may affect" determinations described herein are based on the Consultation Handbook definitions of the terms "may affect," "is not likely to adversely affect," and "is likely to adversely affect." These terms are not specifically defined in the ESA regulations but are defined in the Consultation Handbook Glossary as follows:

> May affect – the appropriate conclusion when a proposed action may pose any effects on listed species or designated critical habitat. When the Federal agency proposing the action determines that a "may affect" situation exists, then they must either initiate formal consultation or seek written concurrence from the Services that the action "is not likely to adversely affect" listed species.
>
> Is not likely to adversely affect – the appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects or (2) expect discountable effects to occur.
>
> Is likely to adversely affect – the appropriate finding in a BA (or conclusion during informal consultation) if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not: discountable, insignificant, or beneficial (see definition of "is not likely to adversely affect"). In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species. If incidental take is anticipated to occur as a result of the proposed action, an "is likely to adversely affect" determination should be made. An "is likely to adversely affect" determination requires the initiation of formal section 7 consultation.

1.5.1 Subsequent Steps in the Consultation Process

While Federal agencies proposing an action are to describe the manner in which the action "may affect" listed species or critical habitat, the Services are, among other things, to evaluate "the effects of the action and cumulative effects on the listed species or critical habitat" and formulate their "biological opinion as to whether the action, taken together with cumulative effects, is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat" (50 C.F.R. 402.14(g)). Furthermore, 50 C.F.R. 402.14(h) states that a biological opinion shall include a "detailed discussion of the effects of the action on listed species or critical habitat…."

Reclamation, in making the "may affect" determinations set forth in this BA, draws no conclusions as to whether the Proposed Action is or is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. Rather, the sole purpose of the "may affect" determinations is to determine whether or not formal consultation is required. Reclamation will not reach a decision as to whether the Proposed Action which is the subject of this BA complies with the requirements of Section 7(a)(2) of the ESA until it receives and considers the biological opinions (if any) to be rendered by the Services.

1.6 Environmental Baseline

Regulations implementing the ESA (50 CFR 402.2) define the environmental baseline as including "the past and present impacts of all Federal, State, or private actions and other human activities in the action area." Also included in the baseline are the "anticipated impacts of all proposed Federal projects in the action area that have undergone formal or early Section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process."

In the case of an ongoing Federal action under consultation, additional guidance is provided by the Consultation Handbook (1998). This document identifies that the total effects of all past activities, including the effects of the past operation of the project, current non-Federal activities, and Federal projects with completed Section 7 consultation, form the environmental baseline.

Based on the guidance referenced above, the environmental baseline for consultation on continued operation of the Tualatin Project includes the structures and facilities associated with the Tualatin Project and their past O&M, up to the point of this consultation. The environmental baseline does not include future effects of the proposed Federal action. The future O&M of the Tualatin Project is the proposed Federal action.

1.7 Summary of Species Effects

Appendix A contains a complete list of the ten species the USFWS has listed in the action area and the three salmon and steelhead Evolutionarily Significant Units (ESUs) that NOAA Fisheries has listed or proposed for listing in the action area. Two ESUs have designated critical habitat in the action area.

Reclamation is submitting this BA to the USFWS and NOAA Fisheries as part of the interagency consultation process for two purposes:

- Reclamation seeks the Services' concurrence for those species that Reclamation has determined the Proposed Action is not likely to adversely affect.
- Reclamation seeks the Services' issuance of biological opinion for those species that Reclamation has determined the Proposed Action is likely to adversely affect.

1.7.1 Species within the Jurisdiction of the USFWS

Based on the Proposed Action as described in Chapter 2 and the seven species-specific analyses presented in subsequent chapters, Reclamation has determined that the Proposed Action will have no effect on the following species: northern spotted owl, Willamette daisy, Howellia, Bradshaw's lomatium, Kincaid's lupine, Nelson's checker-mallow, and golden paintbrush.

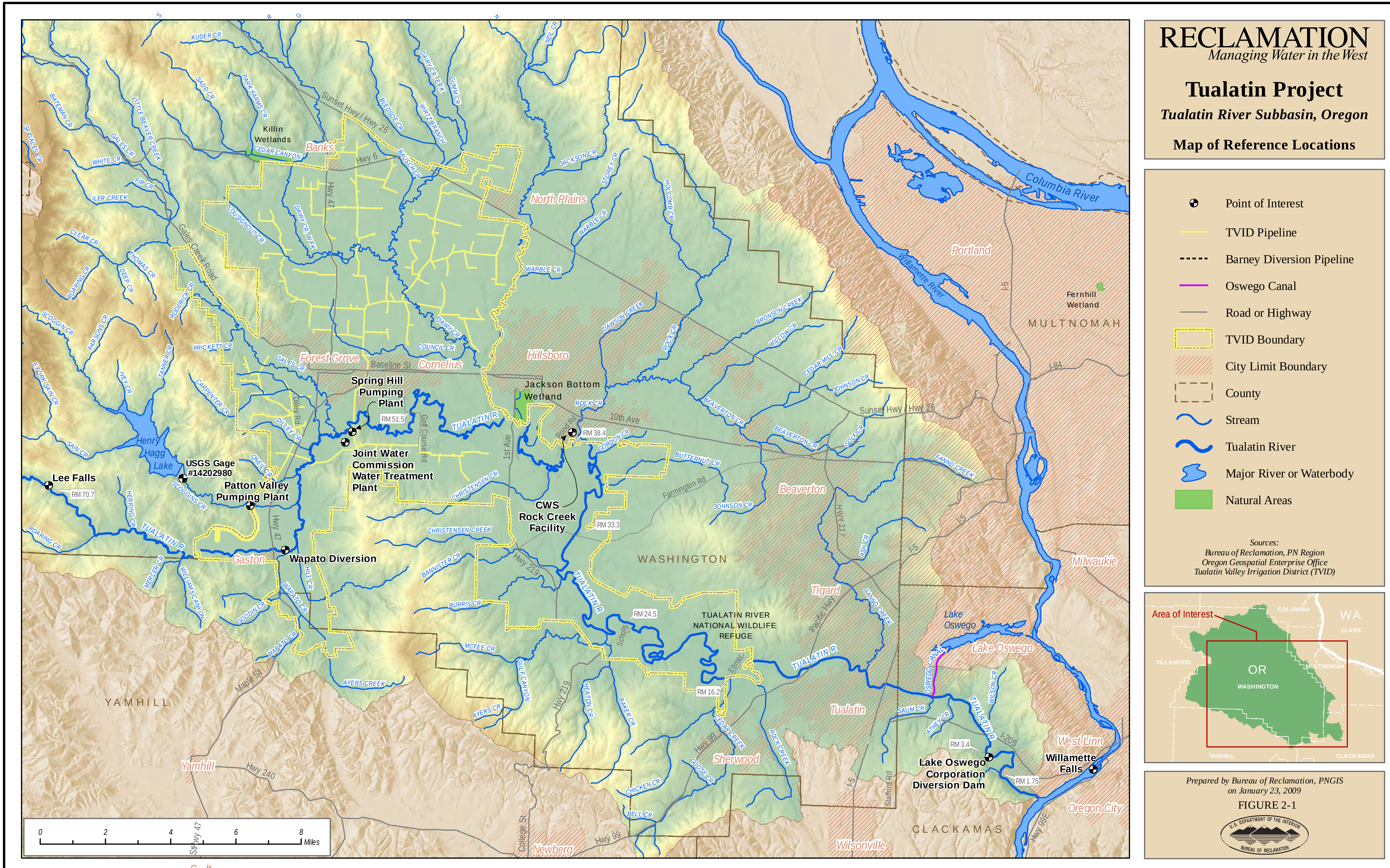
1.7.2 Species within the Jurisdiction of NOAA Fisheries

Reclamation has determined that the Proposed Action is likely to adversely affect Upper Willamette River steelhead. Reclamation submits this BA to request formal consultation with NOAA Fisheries.

In compliance with the MSA, Reclamation has determined that the Proposed Action is likely to adversely affect EFH for Chinook salmon (*Oncorhynchus tshawytscha*). Reclamation has determined that the Proposed Action will adversely affect EFH for coho salmon (*Oncorhynchus kisutch*). Reclamation requests MSA consultation with NOAA Fisheries on this effects analysis for designated EFH.

1.8 Literature Cited

Parenthetical Reference	Bibliographic Citation
NOAA Fisheries and USFWS 1998	National Marine Fisheries Service and the U.S. Fish and Wildlife Service. 1998. *The Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.*



RECLAMATION
Managing Water in the West
Tualatin Project
Tualatin River Subbasin, Oregon
Map of Reference Locations
Point of Interest
TVID Pipeline
Barney Diversion Pipeline
Oswego Canal
Road or Highway
TVID Boundary
City Limit Boundary
County
Stream
Tualatin River
Major River or Waterbody
Natural Areas
Sources:
Bureau of Reclamation, PN Region
Oregon Geospatial Enterprise Office
Tualatin Valley Irrigation District (TVID)
Area of Interest
OR
WA
WASHINGTON
COLUMBIA
CLARK
TILLAMOOK
MULTNOMAH
YAMHILL
CLACKAMAS
Prepared by Bureau of Reclamation, PNGIS
on January 23, 2009
FIGURE 2-1
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
0 2 4 6 8 Miles
Killin Wetlands
Banks
North Plains
Portland
Fernhill Wetland
MULTNOMAH
Forest Grove
Cornelius
Hillsboro
Spring Hill Pumping Plant
Jackson Bottom Wetland
Henry Hagg Lake
USGS Gage #14202980
Lee Falls
Patton Valley Pumping Plant
Joint Water Commission Water Treatment Plant
CWS Rock Creek Facility
Beaverton
Wapato Diversion
Gaston
WASHINGTON
Milwaukie
Tigard
TUALATIN RIVER NATIONAL WILDLIFE REFUGE
Lake Oswego
YAMHILL
Tualatin
West Linn
Willamette Falls
Lake Oswego Corporation Diversion Dam
Sherwood
Yamhill
Oregon City
CLACKAMAS
Newberg
Wilsonville
Columbia River
Willamette River
TUALATIN R
OSWEGO CANAL
RM 70.7
RM 51.5
RM 38.4
RM 33.3
RM 24.5
RM 16.2
RM 3.4
RM 1.75
Sunset Hwy / Hwy 26
Hwy 6
Hwy 47
Baseline St
10th Ave
Farmington Rd
Hwy 219
Hwy 217
Hwy 99
Hwy 240
I-5
I-84
I-205

Chapter 2 DESCRIPTION OF THE PROPOSED ACTION

2.1 Introduction

The Proposed Action described here is authorized, funded, or carried out by Reclamation subject to Federal and State laws. Specific elements of the Proposed Action are summarized below, followed by discussion of interrelated and interdependent activities and activities that are not included in the Proposed Action. The frontispiece shows Tualatin Project feature locations; specific locations referenced in the report are shown in more detail in Figure 2-1.

2.1.1 Proposed Action Elements

The Proposed Action is Reclamation's future O&M for the Tualatin Project, including projected uses of project water through the year 2020 and beyond. The agricultural community has indicated that it believes the need for water to supply container nursery operations will increase as farming practices shift locally to more profitable nursery operations. Nurseries, especially container nursery operations, use more water than many other crops. This trend is expected to lead to an increased demand for irrigation water supply from the Tualatin Project. In addition, it is projected that water needs for municipal and industrial use will increase substantially as populations increase. These future conditions are incorporated in hydrologic modeling assumptions described in Chapter 3. The discussions below identify and describe specific elements of the Proposed Action.

Operation and Maintenance Activities

The Tualatin Project O&M activities are defined in the Reclamation 2002 report *Facilities and Operation and Maintenance, Tualatin Project, Oregon*. Appendix B to this BA includes a listing of specific O&M activities that are performed on a regular basis. General categories of O&M activities include the following:

- **Operate and maintain Scoggins Dam:** The dam is a federally owned facility, with O&M performed by the Tualatin Valley Irrigation District (TVID) since 1983 under a contract with Reclamation. Reclamation also has ownership and/or O&M interests in four Hydromet stream gages in the Tualatin basin.
- **Operate and maintain Patton Valley Pumping Plant (PVPP):** The PVPP and associated fish screens are federally owned facilities, with O&M by TVID under a contract with Reclamation since completion of Tualatin Project construction.

- **Operate and maintain Spring Hill Pumping Plant (SHPP):** The SHPP is a federally owned structure, which includes both federally owned pumps and non-Federal pumps owned by the Joint Water Commission (JWC). TVID and JWC perform Spring Hill O&M in accordance with contracts involving those parties and Reclamation. Funding arrangements for potential fish screen improvements at Spring Hill have not been finalized pending resolution of questions involving the scope, cost, authority, and responsibility for necessary upgrades. In addition, a partnership of local water supply agencies and Clean Water Services (CWS) are currently studying the Tualatin Basin Water Supply Project (TBWSP) that could involve significant modifications to the pumping plant's function and facilities. As a result, Reclamation intends to continue operations at SHPP pending final decisions about possible modifications to the facility and related design parameters. It is anticipated that these decisions and related design information will be available within three or four years. At that time, Reclamation will coordinate with TVID, JWC, NOAA Fisheries, and USFWS regarding appropriate long-term measures for O&M at the SHPP.
- **Operate and maintain the federally owned pipeline distribution systems:** TVID operates and maintains the pipeline distribution systems originating at Patton Valley and Spring Hill pumping plants.
- **Activities for fish and wildlife objectives:** Reclamation and TVID are responsible for maintaining minimum streamflows in Scoggins Creek downstream from Henry Hagg Lake (20 cubic feet per second (cfs) in October/November, 10 cfs at other times); funding habitat projects for fisheries benefits as mitigation for the original construction of Scoggins Dam; and managing elk grazing meadows as mitigation for lost habitat in the Henry Hagg Lake area.

Water Storage and Release

- **Store and release project water at Scoggins Dam:** Project water is stored in Henry Hagg Lake and released for use by TVID, JWC, CWS, and Lake Oswego Corporation. The Proposed Action involves storing and releasing water to these Tualatin Project contractors at annual volumes equal to or less than their respective contract storage amounts.
- **Store and release water at Scoggins Dam for flood control operations:** Water is stored and released to meet project flood control objectives in accordance with the U.S. Army Corps of Engineers' (Corps) flood control plan for Scoggins Dam.

Water Delivery

- **Deliver project water to TVID lands through Patton Valley and Spring Hill pipeline systems:** Project water is delivered to TVID lands via federally owned pipeline systems originating at the Patton Valley and Spring Hill pumping plants.

- **Deliver project water to TVID individual points of diversion:** Project water is delivered to TVID via the Tualatin River and relevant tributaries for diversion at multiple, privately owned diversion points along the mainstem Tualatin River. These diversions also divert non-project water.
- **Deliver project water to JWC for M&I water supply:** Project water is delivered via Scoggins Creek and the Tualatin River to non-Federal pumps at SHPP. JWC pumps project water from SHPP to its treatment plant for subsequent M&I uses.
- **Deliver project water to the Lake Oswego Corporation canal diversion:** Project water is delivered via the Tualatin River to the Lake Oswego Corporation's point of diversion into the Lake Oswego Canal.
- **Deliver project water to CWS for water quality in mainstem Tualatin River:** Project water is delivered via the Tualatin River to address CWS water quality objectives for the mainstem Tualatin River.
- **Deliver contracted water to individual users:** Project water is delivered, on an interruptible basis, to the Reserve Vineyards and Golf Course, the Pumpkin Ridge Golf Course, and the Stimson Lumber Company per contractual arrangements among TVID, Reclamation, and the individual water users. Additional similar contracts are anticipated in the future.

2.1.2 Interrelated and Interdependent Activities

The following activities are not part of the proposed Federal action, but are considered interrelated and interdependent to the proposed Federal action. The effects of these activities will be considered during this consultation.

- **Operate and maintain non-Federal pumps at SHPP:** JWC owns and operates four pumps at the SHPP for delivering project water and non-project water to JWC's water treatment facility.
- **Divert non-project water at Wapato Canal:** Natural flows are diverted at the Wapato Canal to serve 1,740 acres of TVID lands that would otherwise be served by diversion at the PVPP. These diversions are offset by releases from Scoggins Dam.
- **Operate and maintain the fish ladder at Lake Oswego Diversion Dam:** Reclamation originally provided funds to the Oregon State Fish Commission to construct the fish ladder as one element of mitigation for the original construction of Scoggins Dam. Lake Oswego Diversion Dam is currently owned by the Lake Oswego Corporation. Fish ladder O&M is funded and performed by the Oregon Department of Fish and Wildlife (ODFW).

2.1.3 Activities Not Addressed through this Consultation

The following activities are not part of the proposed Federal action, nor are they interrelated or interdependent to that action. These activities, while not inclusive of all activities not addressed by the Proposed Action, are identified here to help clarify the scope of this consultation.

Maintain Henry Hagg Lake recreation facilities: O&M for recreation facilities has been addressed under the June 2004 RMP consultation. No project water is used to maintain a minimum pool for recreation; Washington County maintains recreation facilities.

Maintain perimeter roadway and Reclamation lands around reservoir: O&M for the perimeter road and Reclamation lands is performed by Washington County in accordance with agreements between the County and Reclamation.

Store non-project Trask River water in Barney Reservoir: The storage of Trask River water in Barney Reservoir for eventual routing to SHPP and the Tualatin River at Farmington Bridge for water quality purposes is not a Reclamation action; storage at Barney Reservoir would occur with or without the Tualatin Project.

Divert Trask River water from Barney Reservoir to the Tualatin subbasin: The diversion of Trask River water from Barney Reservoir for use by JWC and CWS in the Tualatin subbasin is not a Reclamation action.

Divert non-project natural flows at Cherry Grove intake for City of Hillsboro: These diversions began prior to the Tualatin Project and are not a Reclamation action.

Divert non-project water at SHPP: JWC pumps non-project natural flows and Trask River water at the SHPP. This pumping is not a Reclamation action and would likely occur in some form with or without the Tualatin Project.

Divert water at privately owned TVID individual points of diversion: Privately owned points of diversion along the mainstem Tualatin River are used to divert both pre-Tualatin Project natural flow rights and project water. These diversions are not a Reclamation action, and the relevant private facilities would likely be present and operating with or without the Tualatin Project. The consultation will consider the hydrologic effects of project water withdrawals, but will not consider private O&M activities at these individual, privately owned facilities.

Divert non-project natural flows to Lake Oswego via canal: These diversions are not a Reclamation action and would occur with or without the Tualatin Project.

Operate and maintain Wapato Improvement District's distribution system: The Wapato Canal and associated distribution system serve the Wapato Improvement District. This system, and the associated O&M by the Wapato Improvement District, would be present and occurring with or without the Wapato Canal diversions that serve TVID lands. Section 12.1.7 of this BA describes USFWS plans for the Wapato Lake Unit of the Tualatin River National Wildlife Refuge (NWR), which includes areas served by the Wapato Improvement District distribution system.

Deliver return flows to Tualatin River from CWS treatment plants: Both project and non-project water used by JWC is, in part, returned to the Tualatin River as discharge from four CWS wastewater treatment plants. Although these return flows are considered in hydrologic modeling, delivery of these flows is not a Reclamation action; wastewater treatment would occur with or without the Tualatin Project.

Implement agricultural and other land use practices in action area: Land use practices are not funded, authorized, or carried out by Reclamation.

Propose additional storage capacity at Scoggins Dam: The partners cooperating on the Tualatin Basin Water Supply Project (TBWSP Partners), described in section 2.1.1, are evaluating alternatives for meeting future water supply needs in the basin. Alternatives being assessed involve raising Scoggins Dam to provide additional storage. This potential action is not included in the Proposed Action for continued and future Tualatin Project operations and will be addressed in a separate consultation process, if it is identified as a federally preferred alternative.

2.2 Duration of Proposed Action

The Proposed Action involves future O&M of the Tualatin Project; this action is projected to continue indefinitely into the future. For purposes of analysis in this BA, future O&M has been projected forward approximately through the year 2020. However, the intent is that the Proposed Action and associated consultation will remain in effect until such time as reconsultation may be required (50 CFR 402.16).

2.3 Framework for Proposed Action

Reclamation's Tualatin Project operates within a framework influenced by factors including state water law and water rights, contracts, and tribal interests. The Proposed Action of future Tualatin Project O&M will also be influenced by these factors outlined in the following sections.

Reclamation secures state water rights for its projects that are consistent with the authorized project purposes. Section 8 of the Reclamation Act of 1902, requires the Secretary of the Interior to proceed in conformity with state water laws in carrying out the provisions of

Reclamation law. Water rights are secured in accordance with state water law, and water rights granted by the state are defined in terms of the type of water use, period of use, the source of the water, the location of the point of diversion and place of use, and the rate and total volume that may be diverted, if applicable. Any changes in water use from those described in the water right must generally be authorized by the state through an approval of a transfer of a water right. Watermasters, as officers of the state, oversee the diversion and use of water to ensure compliance with water rights of record.

Federal law provides that Reclamation obtain water rights for its projects and administer its projects pursuant to state law relating to the control, appropriation, use, or distribution of water, unless the state laws are inconsistent with expressed or clearly implied Congressional directives [43 U.S.C. 383; *California v. United States*, 438 U.S. 645, 678 (1978); appeal on remand, 694 F.2d 117 (1982)]. Water can only be stored and delivered by a project for authorized purposes for which Reclamation has asserted or obtained a water right in accordance with section 8 of the Reclamation Act of 1902, and applicable Federal law. Reclamation must operate projects in a manner that does not impair senior or prior water rights. Reclamation has an obligation to deliver water in accordance with the project water rights and contracts between Reclamation and its contractors.

The Oregon State Water Code was adopted on February 24, 1909, and water rights are evidenced by permits issued by the Oregon Water Resources Department (OWRD). In the Tualatin River subbasin, the State Circuit Court Decree of February 13, 1939, adjudicated six pre-1909 water rights on Harris Creek and the State Circuit Court Decree of September 9, 1939, adjudicated the remaining 117 pre-1909 water rights. These water rights were assigned priority dates back to 1850.

One of the larger subbasin water rights on the Tualatin River is that of the Oregon Iron and Steel Company (now held by the Lake Oswego Corporation) to deliver 57.5 cfs from the Tualatin River through Oswego Canal (River Mile (RM) 6.70) for the production of hydroelectric power. This water right, with a priority date of January 25, 1906, was confirmed by the State Circuit Court Decree of August 21, 1961, and subsequently upheld upon appeal by the Oregon State Supreme Court on November 15, 1967.

Three applications for water rights were filed by Reclamation with OWRD in February 1963. These filings cover appropriations of water and storage in the then proposed Scoggins and Gaston reservoirs (construction of Gaston dam was not pursued). OWRD issued two permits for the Tualatin Project on May 1, 1972:

- Permit R-5777 for the right to store water at Scoggins Dam (in Henry Hagg Lake).
- Permit S-35792 (priority date February 20, 1963) authorizes use of stored water and natural flow for full and supplemental irrigation (228.8 cfs), municipal (70 cfs), and quality control (74 cfs) purposes.

TVID and some individual members of TVID have rights for the use of water from the Tualatin River and tributaries such as Gales Creek. These rights are supplemented by stored water from the Tualatin Project. TVID has a water right to divert cleaned wastewater discharged from the CWS Rock Creek facility for use on 2,001.8 acres. This permit has priority dates of January 4, 1984, for 21.6 cfs and December 18, 1986, for 3.4 cfs.

There are approximately 336 individual Tualatin River water rights extending from river mile (RM) 0.05 to RM 73.3. Some of these rights are held by individual pumpers irrigating lands within the TVID who also receive stored water from the Tualatin Project.

The Oregon Water Policy Review Board adopted resolutions on April 15, 1970, and April 19, 1975, specifying desirable minimum flows which effectively withdrew the Tualatin River subbasin from further appropriation during the irrigation season. The Tualatin River instream water right at the Farmington gaging station (RM 33.3) is 100 cfs year-round and has a priority date of August 5, 1993. This makes the instream flow right junior to most other Tualatin River water rights.

OWRD established minimum perennial streamflows in the Tualatin River and some of its tributaries. Most of these have been converted to instream water rights established in 1993, and held by Oregon Department of Environmental Quality (ODEQ).

2.3.1 Contracts

In accordance with Federal Reclamation law, a party who wishes to receive project water from a Reclamation project for irrigation or M&I purposes must first enter into a contract with the United States pursuant to which they agree, among other things, to pay to the United States the costs of project construction that are allocable to irrigation and/or M&I purposes. In addition, project water users are generally required to bear all costs of annual O&M in the year in which those costs are incurred.

In consideration of this repayment obligation, the United States agrees to deliver project water to contractors in accordance with the terms and conditions set forth in the contract. Reclamation’s discretion in carrying out the Proposed Action is substantially circumscribed by its contractual obligations.

2.3.2 Tribal Interests

The United States has entered into numerous treaties and agreements with tribes in the region. The Proposed Action is consistent with these treaties and agreements.

The tribes that comprise the modern Confederated Tribes of the Grand Ronde Community of Oregon (Grand Ronde Tribes) and Confederated Tribes of Siletz Indians (Siletz Tribes) lived throughout western Oregon. Historically, these tribes and their ancestors have hunted, fished, and gathered along the rivers and wetlands of the Willamette River basin. Scoggins Dam and Henry Hagg Lake are within a hunting and fishing area set forth in a 1986 consent decree between the Grand Ronde Tribes, the state of Oregon, and the United States ("Agreement among the State of Oregon, the United States of America, and the Confederated Tribes of the Grand Ronde Community of Oregon to Permanently Define Tribal Hunting, Fishing, Trapping, and Animal Gathering Rights of the Confederated Tribes of Grand Ronde"). The Confederated Tribes of the Warm Springs Reservation (CTWSR) reserved the right to fish, hunt, and gather roots and berries at all usual and accustomed places through the June 25, 1855, Treaty with the Tribes of Middle Oregon. These usual and accustomed places include the lower Willamette River valley. The Proposed Action would not diminish the hunting, fishing, trapping, and gathering rights set forth in the consent decree with the Grand Ronde Tribes or the treaty rights of the CTWSR to hunt, fish, and gather at usual and accustomed places in common with other citizens of the United States.

2.4 Literature Cited

Parenthetical Reference	Bibliographic Citation
Reclamation 2002	Bureau of Reclamation. 2002. *Facilities and Operation and Maintenance, Tualatin Project, Oregon*. Prepared by Larry Vinsonhaler for Lower Columbia Area Office. Portland, Oregon.

Chapter 3 HYDROLOGIC SETTING AND WATER QUALITY

The frontispiece provides an overview of Tualatin River subbasin and Tualatin Project feature locations; Figure 2-1 shows additional detailed location information for specific features referenced in this document.

3.1 Tualatin River Subbasin Overview

The drainage subbasin of the Tualatin River and tributaries is an oval-shaped area of about 712 square miles located in the northwestern part of the Willamette Valley, Oregon. The western boundary of the river basin is formed by the Coast Range, and the north and east boundaries are formed by a range of high hills bordering the Columbia and Willamette Rivers. On the south, the Tualatin River and Yamhill River subbasins are separated by the Chehalem and Parrott Mountains and the adjoining low hills.

The drainage area consists of a central plain ranging in elevation from about 100 to 300 feet above sea level, surrounded by hills or mountains that rise to much higher elevations. The Coast Range has a general elevation from 2000 to 3000 feet. The hills to the north and east have elevations ranging up to 1000 feet. In the south, the Chehalem and Parrott Mountains reach maximum elevations of 1630 and 1240 feet, respectively.

The Tualatin River originates on the east slope of the Coast Range and flows southeasterly 80 miles to confluence with the Willamette River upstream from Willamette Falls in Clackamas County about 2 miles above Oregon City. Topography of the upper reaches of the Tualatin River and tributaries is characterized by narrow valleys and steep ridges. Slopes of the streams are quite steep, and as they emerge from the foothills, the topography changes rather abruptly to comparatively flat valleys with fairly wide flood plains.

The Tualatin River has eight large tributaries. Wapato Creek drains from the Chehalem Mountains; Scoggins and Gales Creeks drain part of the Coast Range; Dairy and Rock Creeks drain the Tualatin Mountains; McFee and Chicken Creeks drain the northeast slope of the Chehalem Mountains; and Fanno Creek drains the valley floor and Portland west hills.

The climate of the subbasin is characterized by mild, wet winters and warm, dry summers. Temperature and precipitation are directly affected by air masses moving in from the Pacific Ocean. Rainfall ranges from 110 inches on the western slope of the Cascade Range to 37 inches in the southeastern area. The peak months for rainfall are November through February while the driest months, based on the percentage of precipitation occurring, are generally June through October. The area which includes the Tualatin Project has an average annual rainfall of about 45 inches and experiences little, if any, snow accumulation. The average length of the growing season for general crops is about 164 days and about 200 days for hay and forage crops. The area is conducive to the production of a wide variety of crops. However, irrigation is needed for maximum agricultural production.

3.1.1 Tualatin River Runoff

The drainage area of the Tualatin River upstream from its confluence with the Willamette River is about 712 square miles. Records of streamflow for the Tualatin River near its mouth at the West Linn gaging station (RM 1.75) have been kept since 1928.

Maximum and minimum daily discharges of the Tualatin River at West Linn for the period 1929 through 1973, preceding construction of the Tualatin Project, were 29,300 cfs on December 23, 1933, and 10 cfs on September 5 and 6, 1967. Average annual runoff at the mouth during this same period was about 1.1 million acre feet. The average annual flow was about 1,500 cfs; the high monthly average of 4,100 cfs was in January and the low of about 65 cfs was in August.

For the post-construction period, 1977 through 2005, maximum and minimum daily discharges at West Linn were 25,900 cfs on February 10, 1996 and 18 cfs on July 1, 1977. Average annual water year runoff for this 29-year period was 1.02 million acre feet. The annual high was 2.02 million acre feet in water year 1999 and the annual low was 0.20 million acre feet in water year 1977. The high average monthly discharge during the same 29-year period was about 3,540 cfs in February and the low was about 160 cfs in August (Figure 3-1 and Figure 3-2).

3.1.2 Water Storage

The Tualatin River was unregulated prior to construction of the Tualatin Project by Reclamation in the mid-1970s. Scoggins Dam and Henry Hagg Lake with a total capacity of 62,216 acre feet regulates Scoggins Creek, a major tributary entering the Tualatin River at RM 60.0. Scoggins Dam is operated and maintained by TVID pursuant its contract with Reclamation.

Barney Reservoir is a non-Federal storage facility. Although not part of the Proposed Action as described in Section 2.1.3, Barney Reservoir operations have been considered in hydrologic modeling presented in this chapter because they are interconnected with modeled uses of water from other sources (see Section 3.3.1). Barney Reservoir is an impoundment formed by Eldon Mills Dam, constructed in the mid-1970s. This non-Federal storage facility is on the Trask River which flows on the west side of the Coast Range. An aqueduct transports water from Barney Reservoir for discharge into the Tualatin River near its headwaters at RM 78.

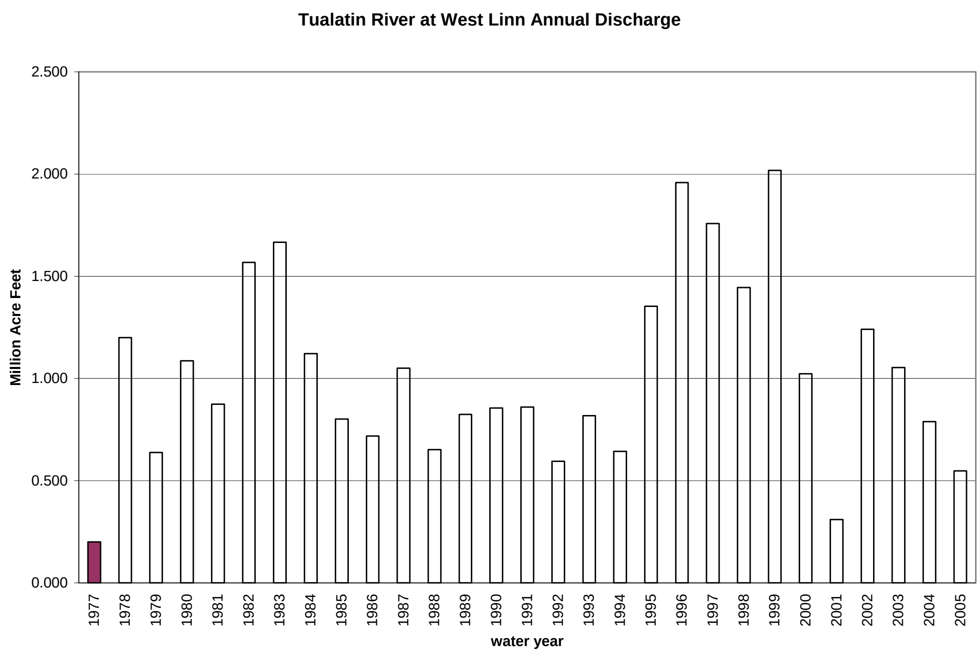


Figure 3-1. Tualatin River at West Linn annual discharge

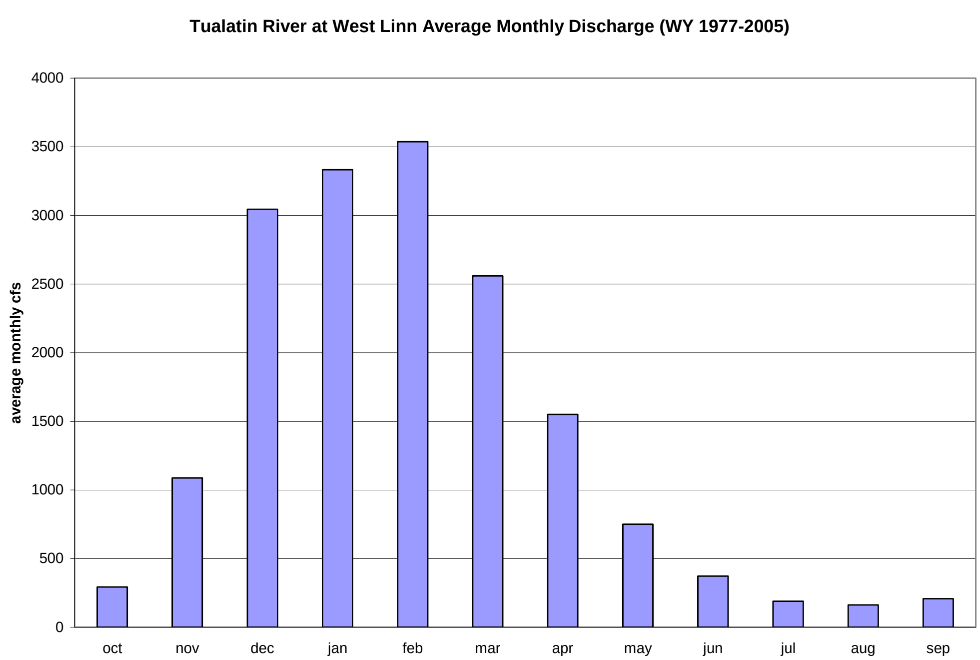


Figure 3-2. Tualatin River at West Linn average monthly discharge (WY 1977-2005).

The initial capacity of Barney Reservoir was 4,000 acre feet but was subsequently enlarged to 15,710 acre feet. Eldon Mills Dam is operated by the city of Hillsboro on behalf of the five entities with interest in the facility.

3.1.3 Large-scale Environmental Variation

The following information contained in Section 3.1.3 is from the 2008 NOAA Fisheries Supplemental Comprehensive Analysis (SCA) for the FCRPS remand consultation[1] (NOAA Fisheries 2008).

Salmonid population abundance is substantially affected by large-scale changes in the freshwater and marine environments. Much of the Pacific Coast was subject to a series of very dry years during the early the 1990s. More recently, severe flooding has adversely affected some stocks. For example, the low return of Lewis River bright fall Chinook salmon in 1999 is attributed to flood events during 1995 and 1996.

Among the variations in ocean conditions suspected of affecting salmon and steelhead populations are the short-term phenomena termed El Niño-Southern Oscillation or ENSO and the longer-term Pacific Decadal Oscillation or PDO. These phenomena have the potential to grossly affect salmonids survival over their entire range and multiple life stages, and are an area of substantial scientific investigation.

El Niño-Southern Oscillation

ENSO is a disruption of the ocean-atmosphere system in the tropical Pacific Ocean having important consequences for weather around the globe and near-shore eastern Pacific Ocean productivity. ENSO events typically last 6 to 18 months. Among the consequences are warmer near-surface ocean water temperatures along the U.S. west coast and generally warmer, drier weather in the Pacific Northwest, particularly during the winter. This warmer ocean surface layer reduces thermodynamic upwelling off the U.S. west coast, reducing nutrient inputs to the euphotic zone, thus reducing near-shore ocean productivity. This reduction in productivity has been shown to reduce juvenile salmon growth and survival. Warmer surface waters can also change the spatial distribution of marine fishes with potential predator-prey effects on juvenile salmon. The warmer, drier weather in the Pacific Northwest often associated with ENSO events can also cause or increase the severity of regional droughts. Droughts reduce streamflows through the Columbia and Snake River migration corridors, increase water temperatures, and reduce the extent of suitable salmonid habitat in some drainages. Each of these physical effects is shown to adversely affect salmon survival. Thus, ENSO events can have negative effects on anadromous fish populations.

[1] The Supplemental Comprehensive Analysis is a reference document for three Biological Opinions that affect the same listed species of the Columbia River salmon and steelhead. Those Biological Opinions cover (1) the FCRPS and 11 Reclamaiton projects, (2) Reclamation's Upper Snake projects, and (3) the 2008-2017 US. V. Oregon Management Agreement.

Pacific Decadal Oscillation

The PDO is a long-term cyclic pattern of Pacific climate variability. While it and the ENSO have similar spatial climate fingerprints, they have very different behavior in time. The term was first used in 1996 in describing connections between Alaska salmon production cycles and Pacific climate.

Two main characteristics distinguish the PDO from ENSO: first, 20th century PDO "events" persist for 20-to-30 years, while typical ENSO events persist for 6 to 18 months; second, the climatic fingerprints of the PDO are most visible in the North Pacific/North American sector, while secondary signatures exist in the tropics – the opposite is true for ENSO. Several independent studies find evidence for just two full PDO cycles in the past century: "cool" PDO regimes prevailed from 1890-1924 and again from 1947-1976, while "warm" PDO regimes dominated from 1925-1946 and from 1977 through (at least) the mid-1990s. Shoshiro Minobe (1997) has shown that 20th century PDO fluctuations were most energetic in two general periodicities, one from 15-to-25 years, and the other from 50-to-70 years.

Major changes in northeast Pacific Ocean marine ecosystems have been correlated with phase changes in the PDO; warm periods have seen enhanced coastal ocean biological productivity in Alaska and reduced productivity off the west coast of the contiguous United States, while cold PDO periods have exhibited the opposite north-south pattern of marine ecosystem productivity.

Causes for the PDO are currently unknown. Likewise, the potential predictability for this climate oscillation is not known. Some climate simulation models produce PDO-like oscillations. The mechanisms giving rise to PDO will determine whether reliable decades-long PDO climate predictions are possible. For example, if PDO arises from definable air-sea interactions that require 10-year ocean adjustment times, then aspects of the phenomenon will (in theory) be predictable at lead times of up to 10 years. Even in the absence of a theoretical understanding of mechanisms, PDO climate information improves the season-to-season and year-to-year climate forecasts for North America because of its strong tendency for multi-season and multi-year persistence. Recognition of the PDO is important because it shows that "normal" climate conditions can vary over time periods comparable to the length of a human's lifetime.

Recent evidence suggests that marine survival of salmonids fluctuates in response to the PDO’s 20- to 30-year cycles of climatic conditions and ocean productivity (Cramer et al. 1999). Ocean conditions that affect the productivity of Northwest salmonid populations appear to have been in a low phase of the cycle for some time and to have been an important contributor to the decline of many stocks, such as during the warm phase from 1977 to about the mid 1990s. The survival and recovery of these species will depend on their ability to persist through periods of low natural survival mediated in part by PDO periodicity.

Global Climate Change

Ongoing global climate change has implications for the current and likely future status of anadromous fish in the Pacific Northwest (ISAB 2007, Zabel et al. 2006, Crozier and Zabel 2006). Average annual Northwest air temperatures have increased by about 1.0° C since 1900 or about 50% more than the global average warming over the same period. The latest climate models project a warming of 0.1 to 0.6° C per decade over the next century. This rate of warming has the potential in itself to alter the hydrology and water quality conditions of the Columbia River Basin. In a basin reliant on cooler winter temperatures to store much of the impending water supply in the snowpack, warmer air temperatures could have the following physical impacts:

- Warmer air temperatures will result in a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a shift to more rain and less snow, the snowpack will diminish in those areas that typically accumulate and store water until the spring freshet.
- With a smaller snowpack, these watersheds will see their runoff diminished and exhausted earlier in the season, resulting in lower streamflows in the June through September period.
- River flows in general and peak river flows are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures will continue to rise, especially during the summer months when lower streamflow and warmer air temperatures will contribute to the warming regional waters.

Such responses to warming air temperatures will not be spatially homogenous across the entire Columbia River Basin. Following anticipated air temperature increases, the distribution and duration of snowpack in those portions of the basin at elevations high enough to maintain temperatures well below freezing for most of the winter and early spring would not be substantially affected. Low-lying areas that historically have received scant precipitation contribute little to total streamflow. This condition would also be relatively unaffected. The most noticeable changes will occur in the “transient snow” watersheds where the threshold between freezing and non-freezing temperatures will be much more sensitive to warming (e.g., the Willamette Basin). Such physical changes in the environment of the Pacific Northwest have implications for the habitat, populations, and spatial distributions of Pacific salmonids (Zabel et al 2006, Crozier and Zabel 2006). Behavioral changes, such as migration timing, could also occur (ISAB 2007). These effects are generally considered adverse and models predict that over the next century the portion of the Columbia Basin occupied by anadromous salmonids will likely decrease (ISAB 2007). Furthermore, to the extent that climate change alters ocean productivity parameters (e.g., PDO and coastal upwelling) population volatility and the likelihood of extinction of some ESUs or populations within ESUs would also likely increase (Zabel et al. 2006, Scheuerell and Williams 2005).

It is unknown at this time what the specific effects of these short- and long-term environmental variations would have on the hydrology and ecology of the Tualatin River basin, including its anadromous salmonids, other than the broadly stated effects described above. The Tualatin Basin is a tributary of the Willamette and as such is part of the "transient snow" watersheds where effects of these environmental variations are expected to be most manifest or sensitive to warming. It is likely, however, that in response to the several large-scale environmental variations, the Tualatin Basin will experience some of the effects experienced by the larger Willamette watershed.

3.2 Tualatin Project Description

3.2.1 Location

The Tualatin Project is located about 30 miles west of the city of Portland and on the east side of the Coast Range, about 40 miles inland from the Pacific Ocean. Lands served by the Tualatin Project lie primarily within Washington County. The current population of Washington County is 450,000 (2000 Census). Hillsboro was founded as the county seat in 1843.

3.2.2 Authorization

Reclamation received authorization for the Tualatin Project from the Secretary of the Interior, who was authorized to construct, operate, and maintain the Tualatin Project by the Act of September 20, 1966 (Public Law 89-596, 80 Stat. 822). The Secretarial authorization states the purposes to be served by each project. The primary purposes of the Tualatin Project are to supply irrigation water to approximately 17,000 acres of land in the Tualatin River Valley, Oregon, to develop municipal and industrial water supplies, to provide facilities for river regulation and control of floods, to enhance recreation opportunities, to provide for the conservation and development of fish and wildlife resources, and for other purposes (Act of September 20, 1966, Public Law 89-596, 80 Stat. 822). Water quality was approved for inclusion as a project purpose for public health considerations by the Commissioner of Reclamation on March 7, 1969.

The principal facilities authorized for construction were a dam and reservoir on Scoggins Creek, pumping plants, and distribution systems. Power required for irrigation water pumping was authorized to be made available from the Federal Columbia River Power System (FCRPS) at charges to be determined by the Secretary of the Interior.

3.2.3 Facilities and Operations

Tualatin Project facilities and operations are described for the Proposed Action in Section 2.1. Facility locations are shown on the frontispiece and in Figure 2-1. A detailed description of Tualatin Project facilities is found in *Facilities and Operation and Maintenance, Tualatin Project, Oregon* (Reclamation 2002). Specific facilities and operations relevant to analyses presented in this BA are presented below in Sections 3.2.4, 3.2.5, and 3.2.6.

3.2.4 Mitigation Measures

As part of the original development of the Tualatin Project, Reclamation funded improvements to the fish ladder at the Lake Oswego Diversion Dam as one element of mitigation efforts to address effects of Tualatin Project construction and operations. In addition, fish collection facilities were constructed and mitigation measures implemented as part of the Tualatin Project. These mitigation measures involved adult anadromous fish collection facilities below Scoggins Dam and annual funding of a steelhead and coho salmon hatchery stocking program in the Tualatin subbasin. The fish collection facility was closed by ODFW in the mid-1980s and the anadromous fish stocking program was terminated in 1998, when it was determined that fish habitat restoration efforts would better achieve the original mitigation objectives. Since 1998, Reclamation mitigation funds have been used to: produce an assessment of restoration project opportunities in the Gales Creek watershed; develop and implement an outreach program to identify willing landowner participants; and complete studies of geomorphology, large woody debris, knotwood/ivy distribution, and monitoring/education approaches. Reclamation continues to work with the Tualatin River Watershed Council and other stakeholders to implement specific habitat improvement projects relative to Tualatin Project mitigation goals.

3.2.5 Patton Valley Pumping Plant

PVPP, located on the right bank of Scoggins Creek about 2.5 miles downstream from Scoggins Dam, was constructed with a Rexnor [brand] traveling screen. This traveling screen was designed to remove debris from the water entering the pumping plant so it would not accumulate in the pump intakes. It was also designed to eliminate entrance of adult and juvenile fish to the pumping plant.

A fishery technical committee, comprised of State and Federal personnel, was formed to review the PVPP in 1998. The committee concluded that the screens were inadequate and did not meet current standards for protecting juvenile anadromous fish. Proposed fish screen improvements included removing and replacing the existing belt screen with a narrow, woven-wire screen ensuring openings would not exceed 3/32 inch in the narrow direction; installing new seals along the bottom and sides of the new screen; and modifying the fish bypass. These fish protective improvements became operational in 2001 and currently meet NOAA Fisheries and ODFW criteria established to effectively and safely screen juvenile fish from entering water delivery systems. The design criteria for the fish screens was based upon current pumping needs, and Reclamation and TVID have committed to operating PVPP at a capacity of 11 cfs or less in the future by using only the two small (3.22 and 6.44 cfs) pumping units.

3.2.6 Spring Hill Pumping Plant

SHPP was constructed on the right bank of the Tualatin River at RM 56. Water was first delivered through the Spring Hill system in 1978. SHPP was constructed with vertical traveling screens in front of the pumps to prevent debris from accumulating in the pump intakes. These screens were to also function to eliminate juvenile and adult fish from entering the pump intakes.

During the initial operation of SHPP it was determined that river sediment consisting of fine sand-sized material was building up in the intake of the pumping bays. In an attempt to remedy this situation, a new channel was constructed in 1983 to divert flows across the sharp bend in the river. An embankment dike upstream of the pumping plant was constructed to block flows to the pumping plant, and a fish screen was installed at the downstream confluence of the original channel and the new bypass channel.

The fish screen consisted of 1/8-inch slotted flat plate screens designed to be placed into stands. Once operation of the new bypass channel and fish screens began in the mid-1980s, TVID encountered many operational problems. Sedimentation upstream from the fish screen required removal of 30 to 45 cubic yards of material at the beginning of each irrigation season to maintain sufficient flows. In addition, the fish screens were overtopped much of the year and required frequent manual debris removal. Consequently, TVID does not use the in-river fish screens but instead uses and closely monitors the original traveling water screens, which provide for exclusion of adult fish and larger juveniles.

In 1994, Reclamation studied fish protective needs at SHPP since the existing traveling water screens do not meet current NOAA Fisheries and ODFW criteria for effective passage of juvenile anadromous fish. This study involved field observations and data collection and was conducted in cooperation with State and Federal fishery agencies. Based on this study, Reclamation programmed funds to design and construct fish screen improvements in fiscal years 1999 and 2000. In 1999, ODFW with funding from Reclamation, conducted mark-recapture studies using steelhead smolts in the vicinity of SHPP. The ODFW (Leader and Ward 2000) released 21 smolts on April 6 about 1 mile above the intake canal to the SHPP. The ODFW reported that 2 out of the 21 fish actually migrated into the canal forebay as far as the boat ramp area. These 2 fish only stayed in the canal about 1 hour before moving downstream. In a second release of 25 smolts, none of the 25 fish entered “deep” into the canal.

In 1999, Reclamation initiated predesign activities to upgrade the fish screens at SHPP. Following review and evaluation of three options, the Committee proposed construction of a flat plate screen at the face of the pumping plant, involving restoration of the original river channel alignment to pass “sweeping flow” in front of the plant. The construction cost was estimated at $6 million, considerably more than previously programmed for construction due to the complexity and magnitude of the channel restoration element. Reclamation deferred further work pending completion of a Tualatin Project operations BA and the associated consultation process.

Studies currently underway to assess water supply alternatives for the TBWSP propose significant modifications to the SHPP. The TBWSP alternatives would use a modified SHPP in both its current mode (to pump water for irrigation and M&I deliveries) and in a pump-back mode (to pump water up to Henry Hagg Lake to store flows from the mainstem Tualatin River). The TBWSP includes preliminary plans for modifying SHPP fish screens in accordance with the proposed changes to the pumping plant facility and operations. Because the timeframe is uncertain for reaching a final decision on implementation of the TBWSP, Reclamation plans to defer decisions about SHPP fish screen upgrades for 10 years. In the meantime, Reclamation remains committed to working with NOAA Fisheries and USFWS to discuss ongoing operations, to plan for related investigations and/or interim steps, and to consider possible funding for related programs if appropriate.

3.3 Modeled Hydrologic Conditions Analysis

The Tualatin Project MODSIM[2] model was developed to perform simulation studies to support the Tualatin BA. Tualatin Project hydrology and operations were simulated for the Current Scenario by applying estimated present levels of development and operational practices to historic unregulated monthly streamflows for water years 1929 through 2001 (the most recent available data at the time of model development). The modeling incorporates variability as included in the available historical streamflow data and does not attempt to specifically project future conditions as potentially affected by large-scale environmental variation. The most recent available data at the time of model development was through 2001.

The physical scope of the model is from the Tualatin River below Lee Falls at RM 70.7 of the Tualatin River and Henry Hagg Lake and Scoggins Dam at RM 4.8 on Scoggins Creek to the Tualatin River at West Linn at RM 1.75.

Documentation for the Tualatin Project MODSIM model is included in Appendix C.

3.3.1 Modeling Current Operations and Proposed Action

Two scenarios were developed for the Tualatin BA modeling studies: Current Conditions, based on 2005 operating practices, and the Proposed Action representing future O&M.

[2] MODSIM was developed by Colorado State University and the Bureau of Reclamation.

Observed flows and reservoir contents can not describe the effects of current irrigation practices, water quality decisions and reservoir operations. Scoggins Dam (Henry Hagg Lake Reservoir) was not in place before 1975 and operational practices have changed through time. Therefore, a reference scenario was developed to determine hydrologic changes related to the Proposed Action. The reference scenario for the Tualatin BA modeling studies is the Current Conditions scenario based on 2005 operating practices. Comparison of modeled flows and reservoir contents for the Proposed Action to the modeled flows and reservoir contents for Current Conditions yields the assessed hydrologic changes related to the Proposed Action.

Current Conditions

The Current Conditions scenario is based on 2005 operating practices and historic traces for diversions adjusted to 2005 levels. Although many assumptions were applied to simulate 2005 operating practices, the following assumptions are significant:

- TVID diversion requests, as modeled, are at historic levels, since TVID annual diversions and diversion patterns have not changed significantly since 1978[3].
- TVID leases water to CWS up to 6,000 acre feet; if the reservoir does not fill the following year, shortage criteria are applied to distribute the shortage among the water service contract holders[4].
- JWC diversions have increased nearly linearly from 1977 through 2004[5]. Therefore, JWC diversion requests are modeled to reflect 2004 levels plus additional requests, up to 4 million gallons per day (mgd), to simulate 2005 conditions[6].
- JWC balances their diversion of Tualatin Project and Barney water based on a 70/30 split through July. At the beginning of August, the proportion is adjusted to maximize the use of project water.
- CWS requests 36 cfs from Tualatin Project storage during July and August regardless of the flow conditions at Farmington. If this 36 cfs does not bring Farmington flows up to the minimum flow requirement of 150 cfs in July and August, additional water is requested. Minimum flow requirements are listed in Table 3-1.
- CWS imports Barney water based on need. Imports are limited by assigned storage space and transbasin diversion capacity.

[3] Refer to the section “TVID diversion requests at Spring Hill”, Appendic C.
[4] Refer to the section “Shortage Criteria”, Appendix C.
[5] Refer to the section “JWC diversion requests at Spring Hill”, Appendix C.
[6] Tigard’s 2003 partnership with JWC for 1.5 mgd and TVWD’s use of 7000 AF of Barney water (available since the dam raise in 2000) are included when historic diversion data are normalized to 2004 levels. The 5-year lease with JWC for 3800 AF of Barney and/or Scoggins water is approximated by an additional 2-4 mgd, which was the anticipated difference between JWC’s 2004 and 2005 operations at the time the modeling studies were completed.

Proposed Action

The Proposed Action scenario simulates anticipated future operating practices. The Proposed Action scenario differs from the Current Conditions 2005 scenario in that:

- JWC diversion requests are increased to 2020 levels.
- TVID converts 1,900 acres of currently irrigated lands to sprinkler irrigated container nursery crops.
- TVID leases water to JWC to mitigate JWC shortages.
- Target flows below Farmington are increased to the estimated future values described in the *Tualatin Basin Water Supply Project, Draft Surface Water Hydrology Technical Report*, Clean Water Services, December 19, 2005. Target flows may not be met if there is not enough water available from CWS' natural flow and storage sources.

No changes were made to waste water treatment plant discharges to the Tualatin River.

Table 3-1. CWS's flow targets below Farmington.

	Current 2005		Proposed Action	
	cfs	ac ft	cfs	ac ft
Oct	180	11,067	350	21,520
Nov	-	-	230	14,142
Dec	-	-	230	14,142
Jan	-	-	230	14,142
Feb	-	-	230	14,142
Mar	-	-	230	14,142
Apr	-	-	230	14,142
May	120	7,378	230	14,142
Jun	120	7,140	230	14,142
Jul	150	9,223	290	17,831
Aug	150	9,223	290	17,831
Sep	180	10,710	350	21,520

3.3.2 Modeled Analysis

The effects of the Proposed Action on streamflows can be evaluated by comparing the modeled average monthly flows for the Proposed Action to the flows for the Current Conditions 2005 scenario. Figure 3-3 through Figure 3-12 show exceedance value curves, also called duration curves, of modeled average monthly flows for each scenario.

A percentile exceedance is the probability that the value shown is equaled or exceeded. For example, in Figure 3-3, Current Conditions 2005 modeled average monthly flows in Scoggins Creek below Scoggins Dam, there is a 10 percent probability that average monthly October flows would equal or exceed 128 cfs; there is a 50 percent probability that average monthly October flows would equal or exceed 71 cfs; and there is a 90 percent probability that average monthly October flows would equal or exceed 10 cfs.

Flows at the 10th percentile are considered to be high flows; 90th percentile flows are low flows; and 50th percentile flows are median flows. Low flows are not limited to dry years. Low flows may occur in wet years, especially in reaches where streamflows are regulated by upstream storage. Similarly, 10th percentile flows do not necessarily represent wet year conditions.

Although evaluating flow effects using exceedance values does not distinguish flow differences on a year by year basis, it can be used to evaluate the magnitude and trends of the Proposed Action effects.

3.3.3 Pisces

The scenario models produce considerably more output than can be discussed practically in these chapters. Therefore, Appendix C contains a CD-ROM with Pisces, a data viewing tool developed by Reclamation, which provides access to model output in graph and table formats.

3.3.4 Flow Effects in Scoggins Creek Below Scoggins Dam

Modeled streamflows in Scoggins Creek below Scoggins Dam (Henry Hagg Lake Reservoir) are influenced by reservoir operations. The Proposed Action decreases late fall and winter flows and increases late summer flows (Figure 3-3 and Figure 3-4). Late fall and winter flows are decreased with the Proposed Action because the reservoir fills while recovering from greater year round withdrawals. Late summer flows are increased with the Proposed Action because the spaceholders' requirements are greater year-round and, consequently, their reliance on Tualatin Project stored flows is greater.

3.3.5 Flow Effects in the Tualatin River Below Spring Hill Pumping Plant

The Proposed Action decreases modeled streamflows in the Tualatin River below SHPP in all months except June and July because diversion requests at SHPP for TVID and JWC are greater (Figure 3-5 and Figure 3-6). In June and July, flows are increased due to CWS' requests to meet minimum streamflows downstream at Farmington. After July, CWS may require additional flows, but their assigned storage space is more frequently depleted in the Proposed Action and, therefore, cannot contribute to flows below SHPP.

3.3.6 Flow Effects in the Tualatin River Below Farmington

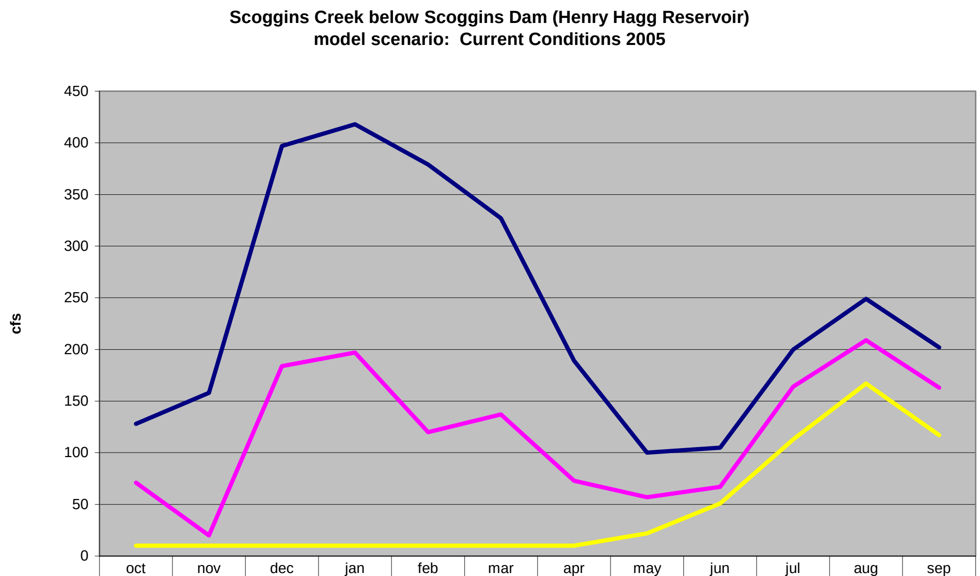
The effects of the Proposed Action on streamflows in the Tualatin River below Farmington are similar to the flow effects below SHPP (Figure 3-7 and Figure 3-8). In the Proposed Action, increased withdrawals from CWS space are needed throughout the year to meet the larger target flows below Farmington (Table 3-1). This factor, along with the overall reduction in the reservoir's ability to recover; lead to inability to meet Proposed Action target flows below Farmington during late summer months.

3.3.7 Flow Effects in the Tualatin River at West Linn near the Mouth

The effects of the Proposed Action on streamflows in the Tualatin River at West Linn near the mouth are similar to the flow effects below SHPP and Farmington (Figure 3-9 and Figure 3-10).

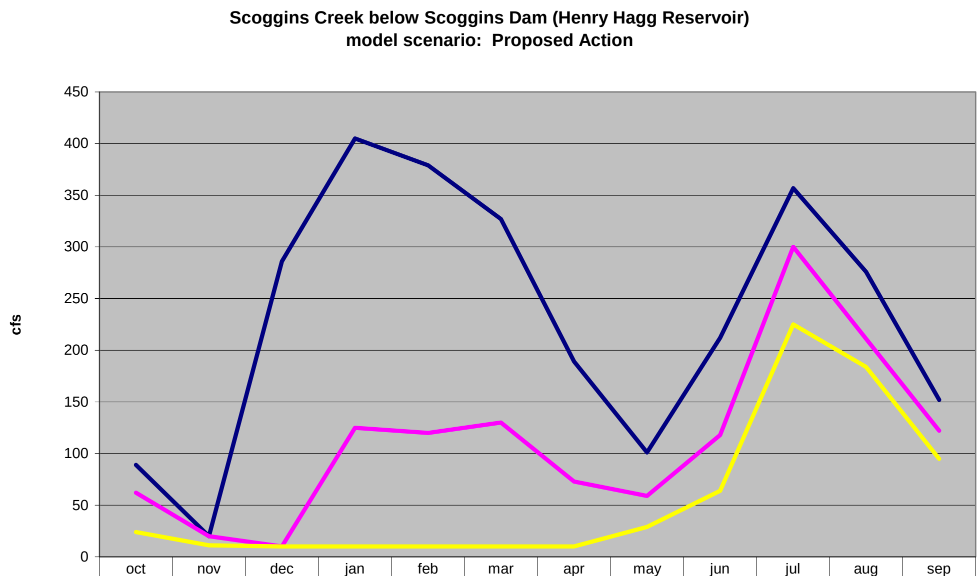
3.3.8 Effects on Henry Hagg Lake Reservoir Contents

The Proposed Action somewhat reduces the ability of Henry Hagg Lake Reservoir to recover fully from the increased withdrawals. The probability of refill for the Current Conditions 2005 scenario is 90 percent and for the Proposed Action the probability of refill is 85 percent. Reservoir levels are considerably lower at the end of the irrigation season (Figure 3-11 and Figure 3-12).



	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	128	158	397	418	379	327	189	100	105	200	249	202
50%	71	20	184	197	120	137	73	57	67	164	209	163
90%	10	10	10	10	10	10	10	22	51	113	167	117

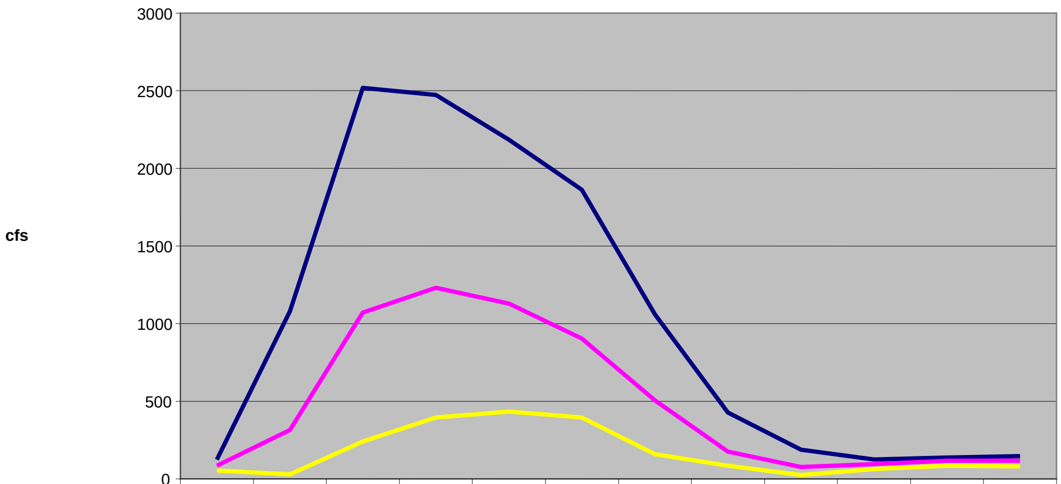
Figure 3-3. Current Conditions 2005 modeled average monthly flows in Scoggins Creek below Scoggins Dam (Henry Hagg Reservoir) at the 10, 50, and 90 percent exceedance levels for each month.



	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	89	20	286	405	379	327	189	101	212	357	276	152
50%	62	20	10	125	120	130	73	59	118	300	211	122
90%	24	11	10	10	10	10	10	29	64	225	184	95

Figure 3-4. Proposed Action modeled average monthly flows in Scoggins Creek below Scoggins Dam (Henry Hagg Reservoir) at the 10, 50, and 90 percent exceedance levels for each month.

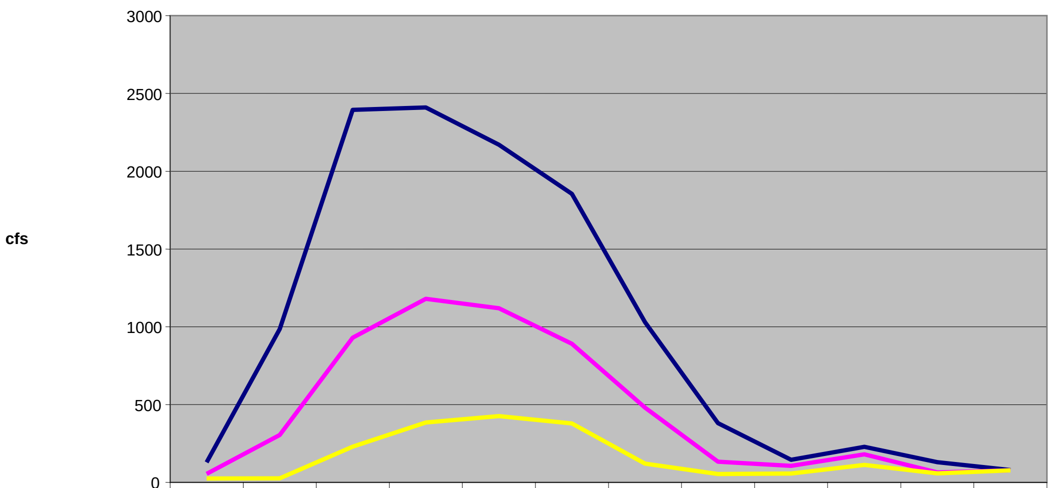
Tualatin River below SHPP
model scenario: Current Conditions 2005



	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	124	1079	2518	2473	2184	1862	1059	427	187	125	138	147
50%	85	315	1072	1231	1128	905	506	176	77	96	117	117
90%	53	28	241	395	434	395	159	84	25	62	84	81

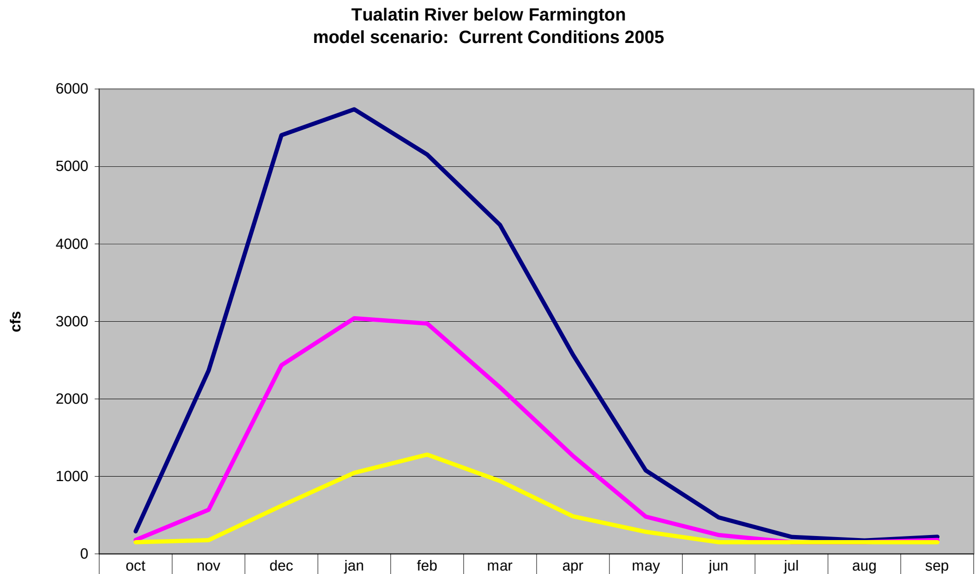
Figure 3-5. Current Conditions 2005 modeled average monthly flows in Tualatin River below SHPP at the 10, 50, and 90 percent exceedance levels for each month.

Tualatin River below SHPP
model scenario: Proposed Action



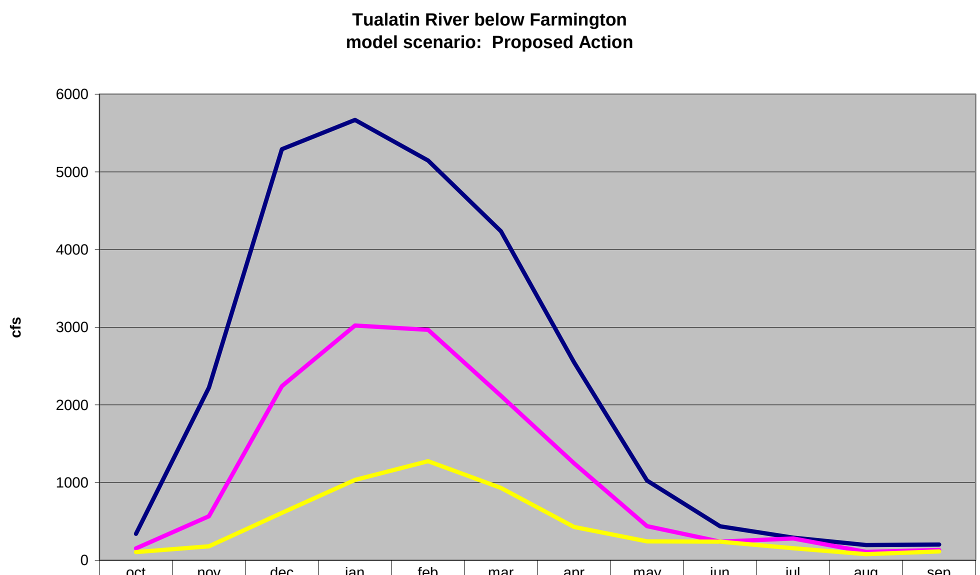
	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	128	985	2394	2410	2170	1855	1029	381	146	228	129	79
50%	55	304	930	1180	1119	891	481	133	106	180	64	77
90%	25	26	230	385	426	378	120	53	57	113	58	77

Figure 3-6. Proposed Action modeled average monthly flows in Tualatin River below SHPP at the 10, 50, and 90 percent exceedance levels for each month.



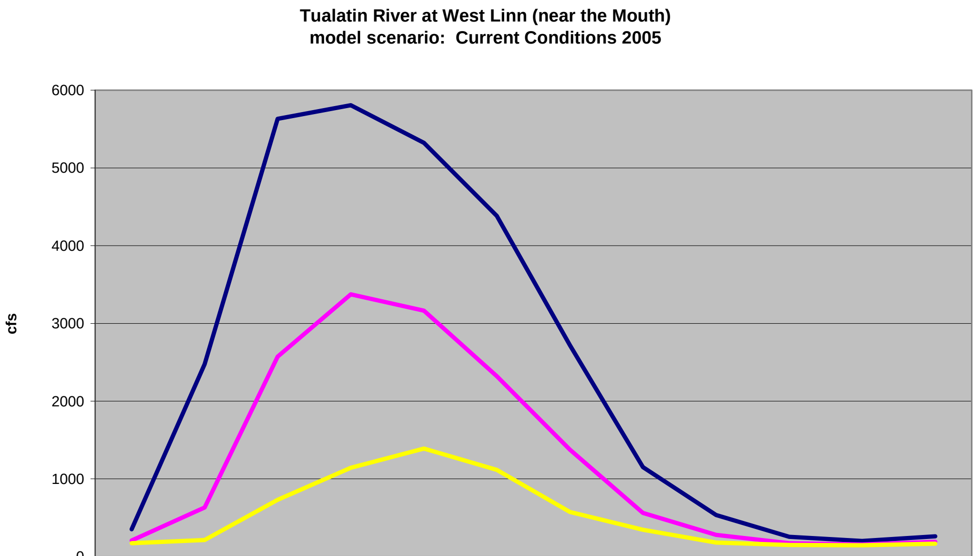
	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	292	2367	5405	5739	5155	4246	2571	1078	470	218	172	221
50%	180	571	2433	3040	2972	2151	1267	482	243	150	150	180
90%	149	178	621	1045	1282	942	484	283	149	150	150	149

Figure 3-7. Current Conditions 2005 modeled average monthly flows in Tualatin River below Farmington at the 10, 50, and 90 percent exceedance levels for each month.



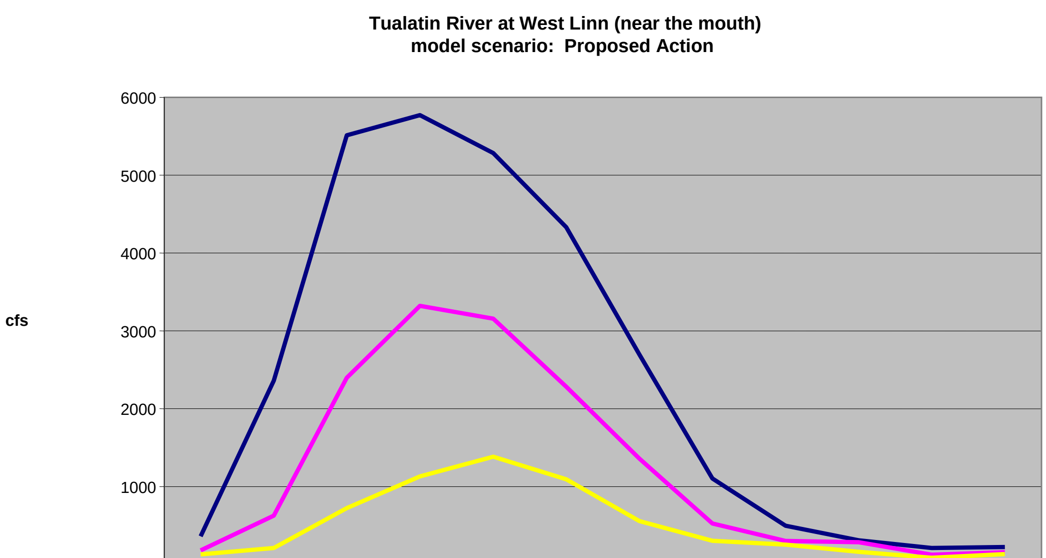
	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	338	2223	5292	5669	5146	4235	2547	1026	436	290	196	202
50%	153	565	2240	3023	2965	2119	1248	439	238	280	107	132
90%	104	179	609	1033	1274	932	427	243	238	154	78	114

Figure 3-8. Proposed Action modeled average monthly flows in Tualatin River below Farmington at the 10, 50, and 90 percent exceedance levels for each month.



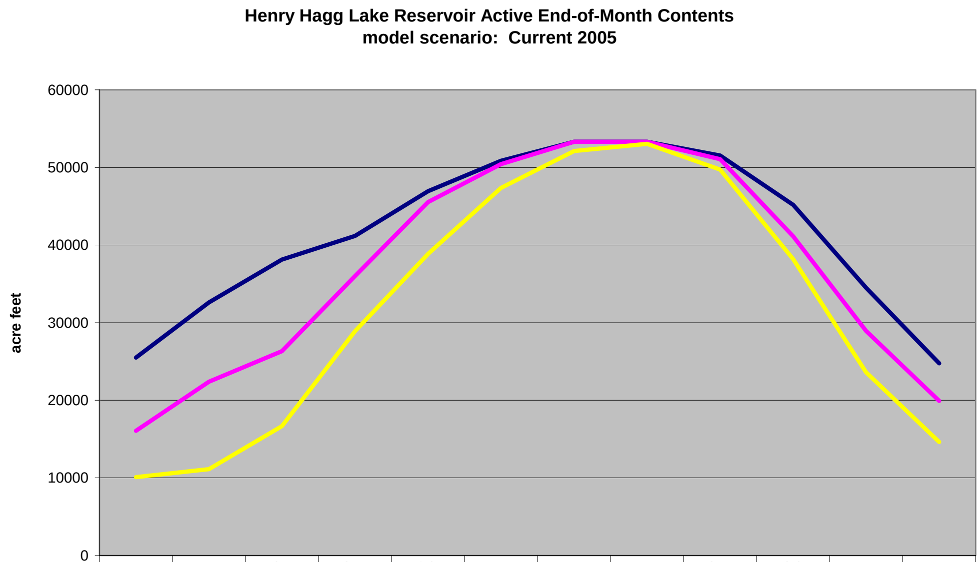
	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	353	2475	5632	5807	5322	4383	2718	1153	536	255	202	261
50%	207	631	2573	3374	3163	2320	1374	561	280	173	157	190
90%	173	213	732	1143	1391	1116	575	346	181	149	146	166

Figure 3-9. Current Conditions 2005 modeled monthly flows in Tualatin River at West Linn near the mouth at the 10, 50, and 90 percent exceedance levels for each month.



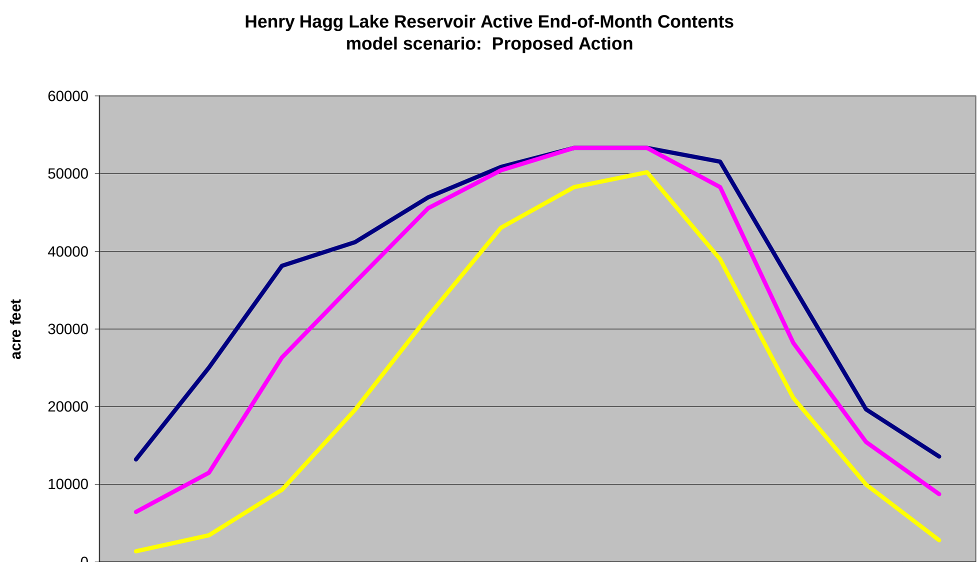
	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	362	2361	5514	5773	5284	4331	2695	1105	498	310	211	222
50%	180	626	2397	3320	3157	2282	1359	524	299	283	122	156
90%	129	211	723	1132	1383	1094	556	305	255	162	86	134

Figure 3-10. Proposed Action modeled average monthly flows in Tualatin River at West Linn near the mouth at the 10, 50, and 90 percent exceedance levels for each month.



	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	25493	32615	38130	41182	46960	50864	53323	53323	51545	45182	34508	24748
50%	16073	22380	26307	35991	45554	50433	53323	53323	51066	41125	28936	19913
90%	10100	11116	16660	28913	38859	47374	52106	53051	49724	38150	23607	14609

Figure 3-11. Current Conditions 2005 modeled end-of-month active contents of Henry Hagg Lake Reservoir at the 10, 50, and 90 percent exceedance levels for each month.



	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
10%	13202	25017	38130	41182	46960	50864	53323	53323	51545	35492	19662	13571
50%	6464	11510	26307	35991	45554	50433	53323	53323	48279	28233	15465	8720
90%	1396	3428	9296	19597	31636	43014	48264	50173	38974	21131	9969	2801

Figure 3-12. Proposed Action modeled end-of-month active contents of Henry Hagg Lake Reservoir at the 10, 50, and 90 percent exceedance levels for each month.

3.4 Water Quality

3.4.1 Current Conditions

A significant amount of data from Scoggins Creek and the Tualatin River below Henry Hagg Lake were used to characterize current water quality conditions. The data were collected through long-term monitoring programs by a variety of agencies, including the U.S. Geological Survey (USGS), Reclamation, and ODEQ, which constitute the major data sources used in this analysis. The effects of Henry Hagg Lake releases on water quality in Scoggins Creek and the Tualatin River are included in this analysis; as are related effects of fluctuations in reservoir levels. However, specific analysis of water quality in Henry Hagg Lake is not included in this BA because there are no known threatened or endangered species residing within the lake itself (Appendix A). Due to their direct influence on the health of aquatic organisms (primarily fish), and because these parameters are expected to experience the greatest amount of change, this water quality analysis focuses on water temperature and dissolved oxygen as the primary parameters of concern. Turbidity is also discussed, but in less detail.

Scoggins Creek

Water temperatures in Scoggins Creek are influenced by Scoggins Dam. The presence of the dam has shifted the temperature regime such that maximum water temperatures occur in late September and into October, whereas above the dam maximum water temperatures occur in late July. This timing shift in the thermal peak is primarily due to cool water releases that occur from Henry Hagg Lake in the spring and early summer, followed by warm water releases in the fall as the pool elevation becomes lower. Figure 3-13 shows a typical summer through fall thermograph below the dam. The data are from USGS station #14202980 near Gaston.

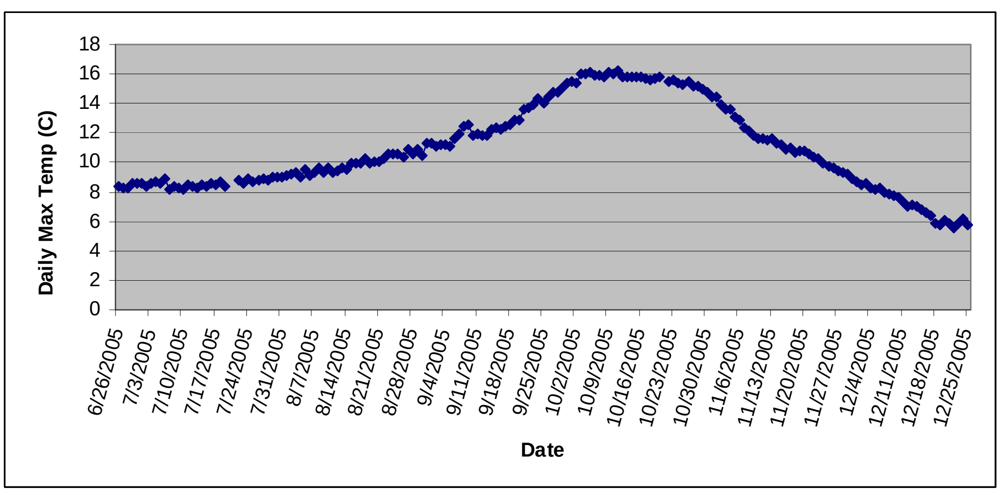


Figure 3-13. Typical summer through fall daily maximum water temperatures in Scoggins Creek below Scoggins Dam (USGS #14202980).

The ODEQ's salmon and trout spawning, rearing, and migration beneficial use designation in Scoggins Creek is accompanied by a water temperature criterion of a 7-day average maximum temperature not to exceed 13°C from October 15 through May 15. During the remainder of the year, the 7-day average maximum temperature may not exceed 18°C. Figure 3-14 shows the October 2005 through May 2006 water temperatures in Scoggins Creek as compared to the 13°C criterion. The criterion is exceeded during the second half of October. Figure 3-13 suggests that during the remainder of the year the 18°C criterion is not exceeded.

Dissolved oxygen concentrations in Scoggins Creek below Scoggins Dam are largely influenced by the Scoggins Dam release (Sullivan and Rounds 2005). Initially, the concentration in Scoggins Creek is a function of the forebay concentration in Henry Hagg Lake. Concentrations in Henry Hagg Lake commonly fall below 6.0 mg/L in the epilimnion and hypolimnion during the summer (when the reservoir is stratified), particularly during the months of August through October. During these months, the layers of deoxygenated water are at the same elevation as the outlet works.

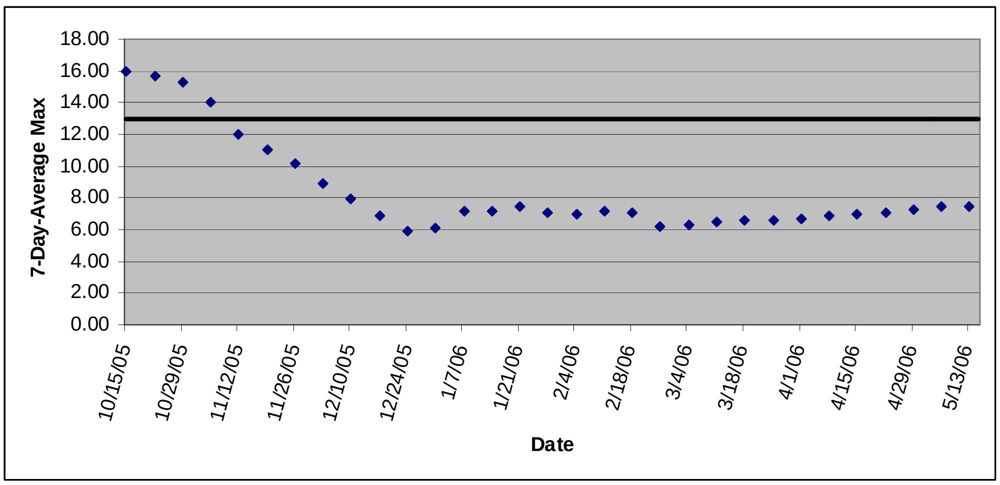


Figure 3-14. Seven-day average maximum water temperatures in Scoggins Creek below Scoggins Dam (USGS #14202980).

Thus, the water released through the reservoir is already typified by low dissolved oxygen. However, as water from the reservoir is passed through the outlet works, turbulence-induced entrainment of air occurs, causing concentrations to increase. The net effect is that dissolved oxygen concentrations directly below the dam will increase in proportion to the initial concentration in the lake. Levels near saturation in Scoggins Creek are normal, but do not always reach 11.0 mg/L (the standard). This phenomenon occurs at both high and low flows. For example, on August 20, 2005, when release flows were 212 cfs, the dissolved oxygen concentration in Scoggins Creek was 11.16 mg/L. On October 30, 2005, when release flows were 59 cfs, the dissolved oxygen concentration in Scoggins Creek was 10.53 mg/L. The difference being that on August 20, 2005, the initial concentration in the lake was likely 1.0 to 2.0 mg/L higher.

The salmon and trout spawning, rearing, and migration beneficial use designation in Scoggins Creek is accompanied by a dissolved oxygen criterion similar to the temperature criterion. The criterion says that from October 15 through May 15 the concentration should exceed 11.0 mg/L, unless the minimum intergravel concentration is 8.0 mg/L, in which case the water column criterion is 9.0 mg/L. Furthermore, in situations where barometric pressure, altitude, and temperature preclude attainment of 11.0 mg/L or 9.0 mg/L, the percent saturation may not be less than 95 percent. During the remainder of the year the concentration shall exceed 8.0 mg/L as a 30-day mean minimum, 6.5 mg/L as a 7-day mean minimum, and be no lower than 6.0 mg/L at any time. Figure 3-15 illustrates the dissolved oxygen concentration in Scoggins Creek from October 15 through May 15.

With regard to the October 15 through May 15 time period, Figure 3-15 shows that dissolved oxygen concentrations in Scoggins Creek are typically below the 11.0 mg/L criterion from mid-October until mid-November, after which they increase above 11.0 mg/L.

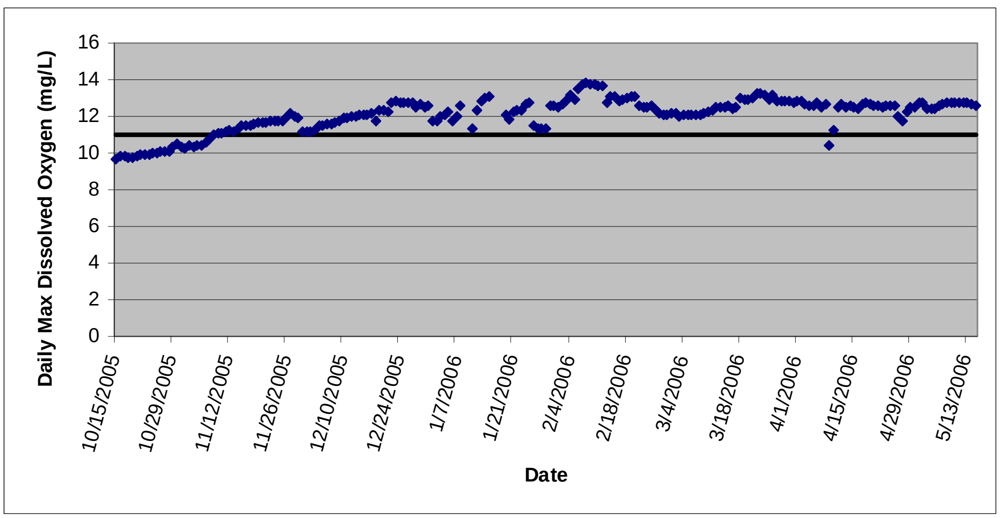


Figure 3-15. Dissolved oxygen concentrations in Scoggins Creek below Scoggins Dam (USGS #14202980).

Mid-November is also the time of year when the reservoir normally becomes isothermal and dissolved oxygen levels increase. This explains why Scoggins Creek dissolved oxygen levels increase as well.

A fully continuous data set is not available to evaluate dissolved oxygen concentrations in Scoggins Creek during the May 16 through October 14 time period (when the standard is a minimum of 6.0 mg/L). However, minimum dissolved oxygen concentration data from June 26, 2005 through October 14, 2005 and May 16, 2006 through June 22, 2006 display a mean of 11.2 mg/L. This indicates that even though the reservoir is stratified and releasing oxygen depleted water, the turbulence-induced entrainment of air at the outlet works is sufficient enough to reaerate the water.

Tualatin River

Water temperatures in the Tualatin River below Scoggins Creek vary seasonally. Temperatures are typically coolest in the winter and spring (December – April), and then gradually increase through the summer and fall months. Temperatures normally reach their peak around mid to late August. The peak water temperatures in August correspond to periods of extended solar radiation, warm ambient air temperatures, low flow conditions, and decreased groundwater contribution (ODEQ 2001). Figure 3-16 illustrates the seasonal variation in Tualatin River water temperature at Rood Road (RM 38.4) and near Elsner (RM 16.2).

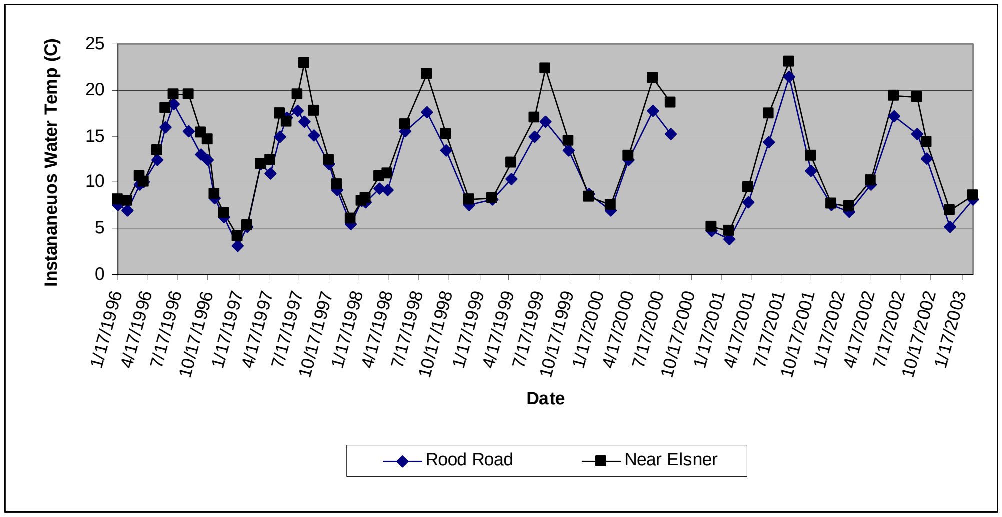


Figure 3-16. Seasonal variation in Tualatin River water temperature at Rood Road (RM 38.4) and near Elsner (RM 16.2).

In addition to the seasonal variation in water temperature shown in Figure 3-16, the Tualatin River also displays diurnal temperature variability. Maximum water temperatures occur in the late afternoon and minimum temperatures occur in the early morning hours. Figure 3-17 shows diurnal temperature profiles at several locations in the river.

Scoggins Dam releases have a cooling effect on the Tualatin River. Data presented in the 2001 Tualatin subbasin Total Maximum Daily Load (ODEQ 2001) show that in 1997 the annual maximum 7-day average temperature decreased from approximately 22.2°C above the Scoggins Creek confluence to approximately 17.2°C below the confluence (5.0°C decrease). In 1998, the maximum 7-day average decreased from approximately 21.6°C above the Scoggins Creek confluence to approximately 18.3°C below the confluence (3.3°C decrease). The river gradually increases in temperature from the confluence of Scoggins Creek to the Willamette River. Figure 3-18 illustrates this longitudinal thermal dynamic.

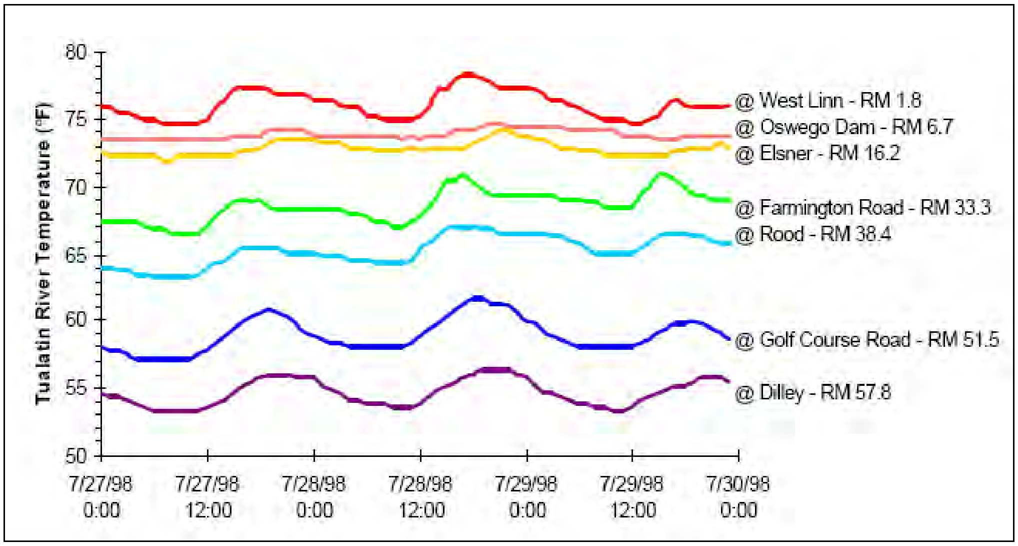


Figure 3-17. Diurnal temperature profiles downstream from Scoggins Creek (Source: ODEQ 2001).

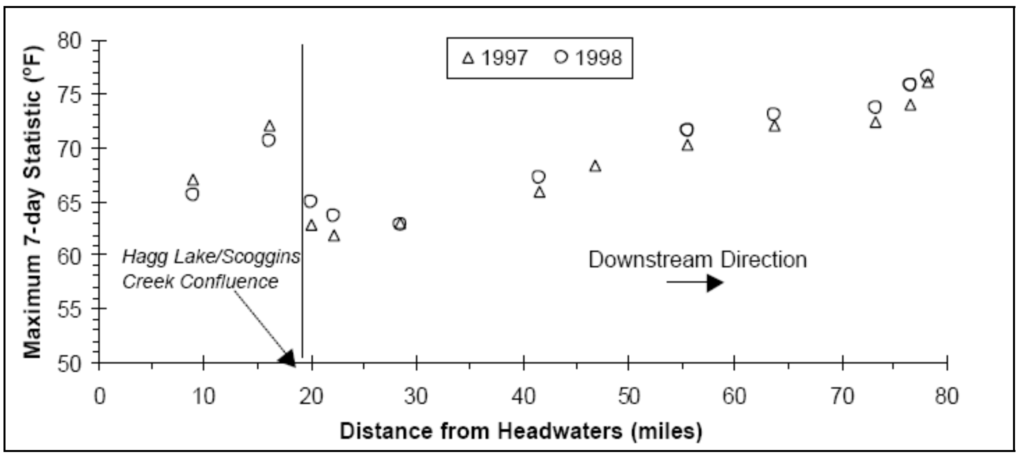


Figure 3-18. Annual maximum 7-day average in the Tualatin River in 1997 and 1998 (Source: ODEQ 2001).

The ODEQ's salmon and trout rearing and migration beneficial use designation in the Tualatin River is accompanied by a water temperature criterion of a 7-day average maximum of 18°C. This criterion is less stringent than the Scoggins Creek criterion because ODEQ does not list spawning as a designated use in the Tualatin River.

Figure 3-19 shows the 7-day average water temperatures in the Tualatin River near Scholls (RM 24.5) and at Oswego Diversion (RM 3.4). Temperatures exceed the criterion in the hot summer months (July through September). The data at these sites allows for the calculation of the 7-day average, whereas the data at Rood Road and Elsner do not. Above Scholls, ODEQ found that the 18°C criterion is largely met between the Golf Course Road (RM 51.5) and the confluence with Scoggins Creek (RM 60.0) (ODEQ 2001).

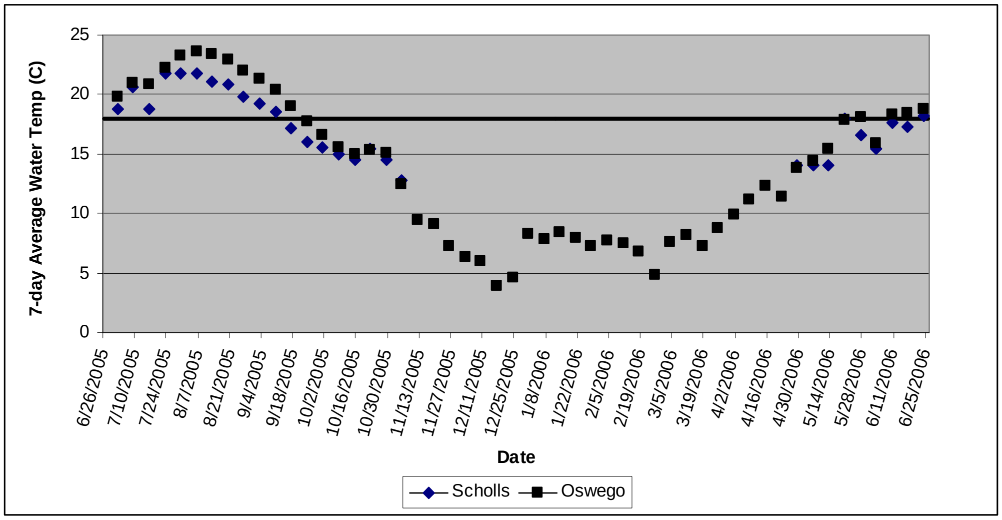


Figure 3-19. Seven-day average water temperatures at Scholls (RM 24.5) and Oswego Diversion (RM 3.4).

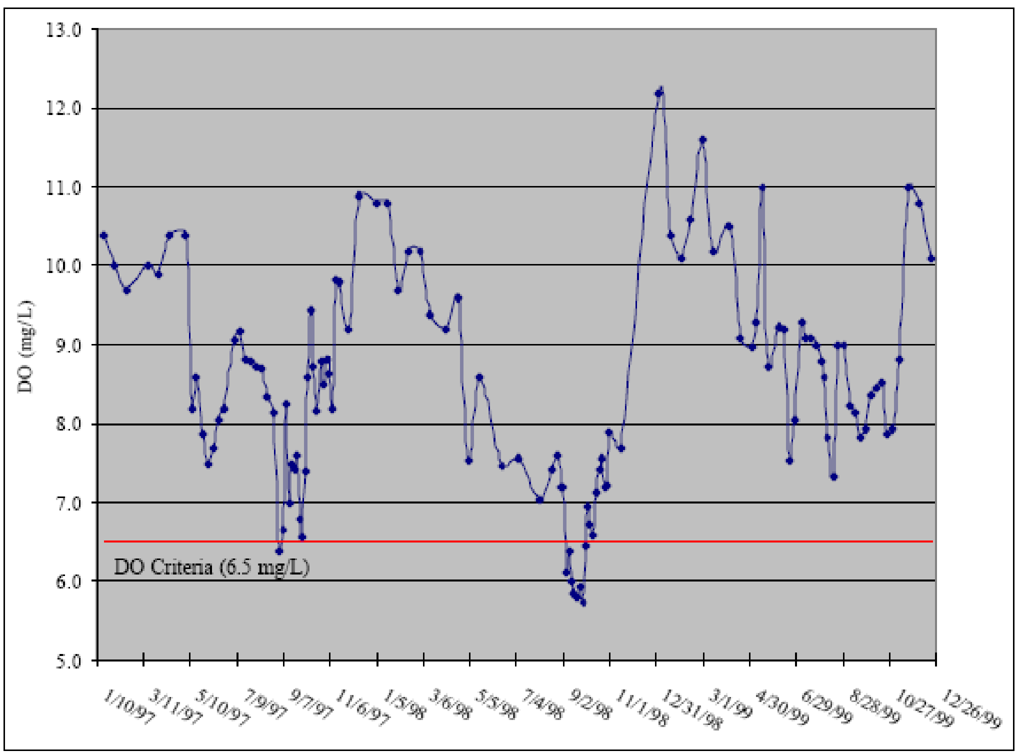


Figure 3-20. Dissolved oxygen concentration in the Tualatin River at Stafford (Source: ODEQ 2001).

The Tualatin River near Stafford (RM 5.4) has historically been the most critical location for low dissolved oxygen concentrations (ODEQ 2001). Figure 3-20 shows dissolved oxygen concentrations at Stafford for the years 1997 through 1999. Figure 3-20 also shows the 6.5

mg/L criterion that accompanies the salmon and trout rearing and migration beneficial use designation in the Tualatin River. Other than brief excursions below the criterion in late August 1997 and early September 1998, the criterion is met. These excursions are likely due to a combination of increased nitrification and sediment oxygen demand. It should be noted that the line connecting the data points in Figure 3-20 is not meant to represent actual data, but rather to help clarify the seasonal variability in dissolved oxygen concentration.

While not an ideal measure of water column sediment (due to other suspended material that may exist in the water column), the Environmental Protection Agency (EPA) has indicated that turbidity is a suitable endpoint for determining the effects of sediment on aquatic life (EPA 1999). Figure 3-21 shows turbidity levels in the Tualatin River at Rood Road (RM 38.4) and Elsner (RM 16.2) for the years 1997 through 2005. Turbidity levels increase notably between the months of November and March.

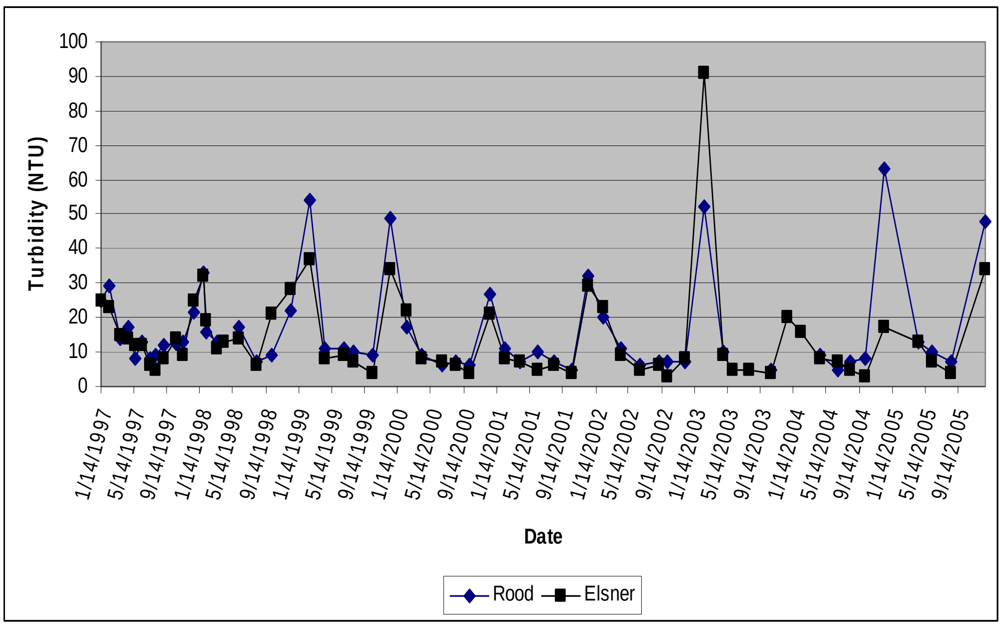


Figure 3-21. Turbidity levels in the Tualatin River at Rood Road (RM 38.4) and Elsner (RM 16.2).

3.4.2 Water Quality Effects

The primary water quality concerns associated with the Tualatin Project are water temperature and dissolved oxygen. As described in more detail in this analysis, most of the effects are realized in Scoggins Creek and the Tualatin River above Dilley. Below Dilley, the change in river flow as a result of future Tualatin Project operation is negligible; therefore, the effects on water quality are negligible. Section 3.3 of this BA describes the flow regimes in more detail.

Scoggins Creek

Water temperatures in Scoggins Creek are largely influenced by Scoggins Dam (Sullivan and Rounds 2004). The presence of the dam has shifted the temperature regime such that maximum water temperatures in Scoggins Creek occur in late September and into October, whereas above the dam, maximum water temperatures occur in late July. Below the dam, the water temperatures are, in any given year, largely a function of the thermal regime in Henry Hagg Lake forebay. The reservoir is typically isothermal from January through early-April. From mid-April through October the reservoir is stratified, with the most distinct layering occurring from July through October. Figure 3-22 shows modeled water temperatures near the dam in 2002.

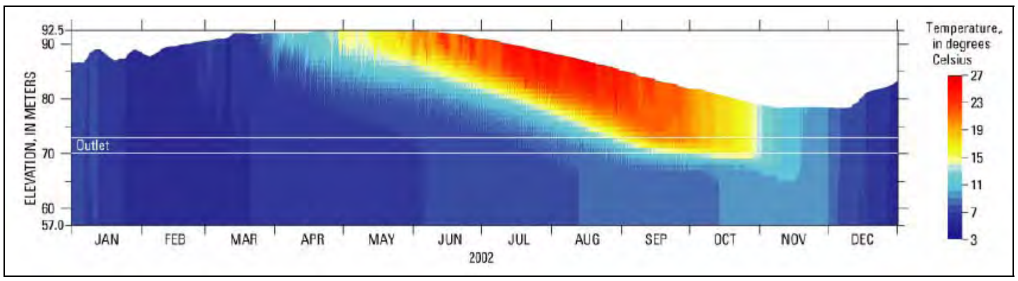


Figure 3-22. Modeled water temperatures in Henry Hagg Lake near the dam in 2002 (Source: Sullivan and Rounds 2004).

As shown in Figure 3-22, Henry Hagg Lake experiences annual stratification. However, unlike many reservoirs where water surface elevation dictates the depths of stratification, water surface elevation does not dictate stratification depths in Henry Hagg Lake. Sullivan and Rounds (2006) found that in Henry Hagg Lake the lowest elevation of the outlet coincided with the lower limit of the thermocline regardless of water surface elevation thus, it is the outlet elevation that dictates stratification depth not the water surface elevation. This phenomenon was also identified in reservoir modeling performed by Casamitjana et al. (2003), where summer inflow rates were minor in comparison to withdrawal rates. Since Henry Hagg Lake inflow rates are only a fraction of withdrawal rates during the summer months (Figure 3-23), the findings of Sullivan and Rounds are consistent with the findings of Casamitjana.

The effect of the lowest elevation of the outlet coinciding with the lower limit of the thermocline, regardless of water surface elevation, is that water temperatures in Scoggins Creek will not be highly dependent on water surface elevation in the lake. Therefore, even though the Proposed Action will notably change the water surface elevations in Henry Hagg Lake (Figure 3-24), the resulting water temperatures in Scoggins Creek are expected to remain essentially unchanged.

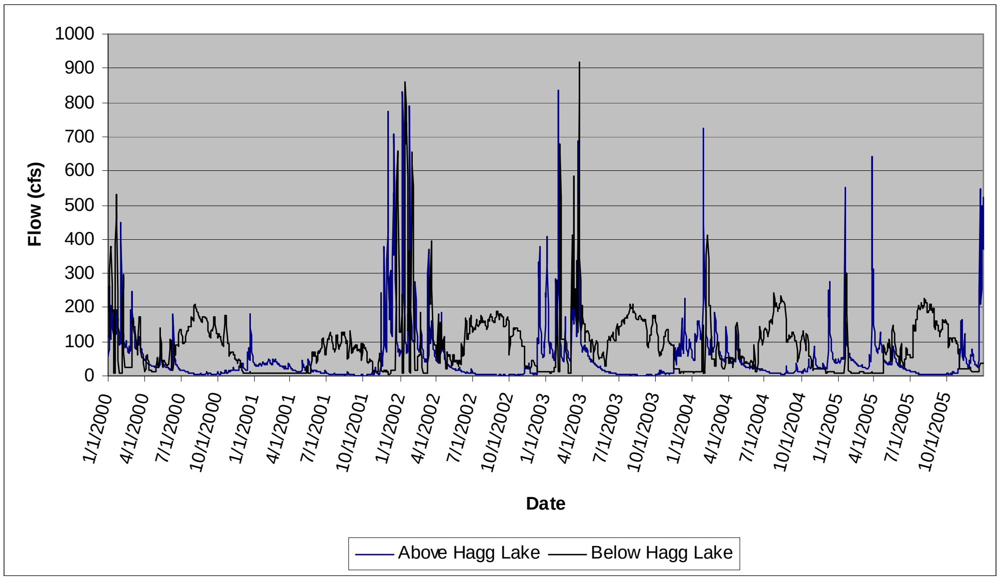


Figure 3-23. Comparison of flows in Scoggins Creek above and below Henry Hagg Lake.

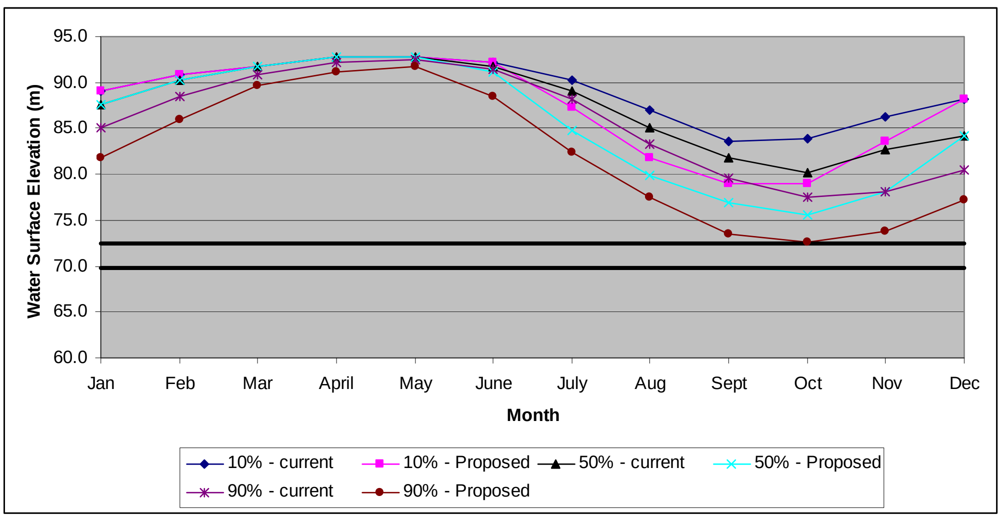


Figure 3-24. Modeled water surface elevations in Henry Hagg Lake at the 10, 50, and 90 percent exceedance levels.

To illustrate the expected daily maximum water temperature in Scoggins Creek at the Proposed Action 50 and 90 percent exceedance flows, data from the final year of a three-year dry period that fall within those flows, and for which temperature data are available, are plotted in Figure 3-25 and Figure 3-26. Temperature data were not available at the 10 percent exceedance flows. Daily maximum temperatures at the 10 percent exceedance flows are expected to be similar to temperatures at the 90 and 50 percent exceedance flows in the 16°C

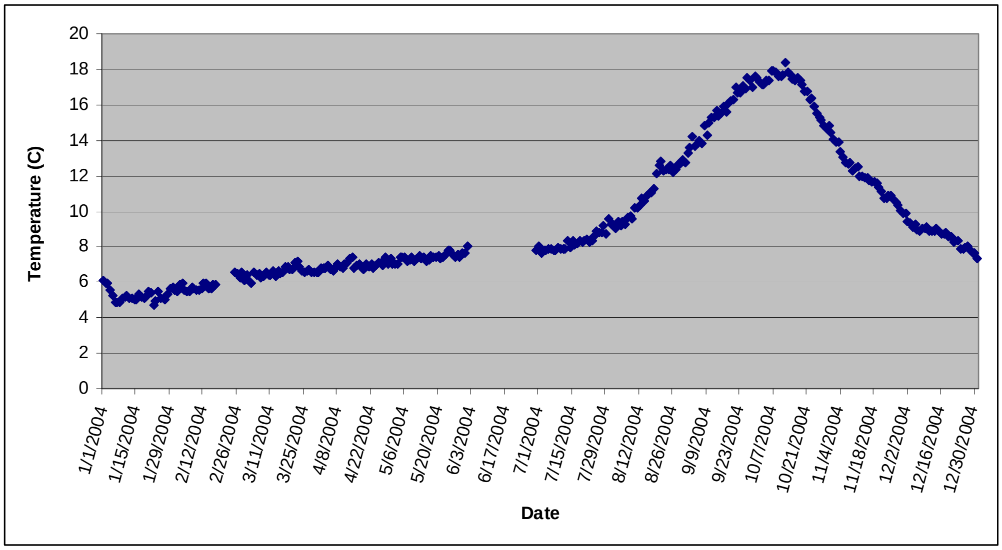


Figure 3-25. Water temperatures in Scoggins Creek below Scoggins Dam representative of modeled Proposed Action 50 percent exceedance flows (some data missing).

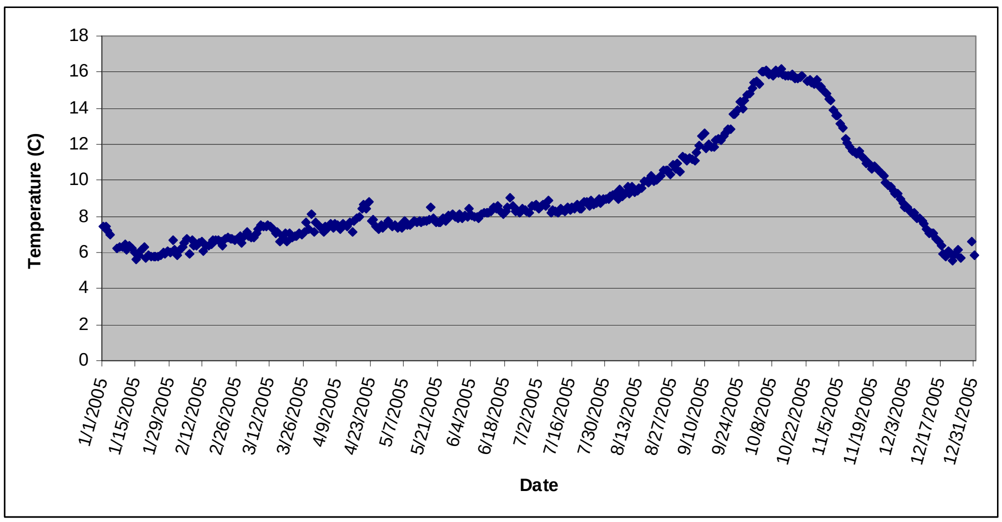


Figure 3-26. Water temperatures in Scoggins Creek representative of proposed 90 percent exceedance flows.

to 18°C range. This is because as described above, the water temperature in Scoggins Creek is not highly dependent on water surface elevation in the lake. Note that the data shown in Figure 3-25 and Figure 3-26 are not modeled data; they are actual measured temperatures in Scoggins Creek for the given year.

Dissolved oxygen concentrations in Scoggins Creek below Scoggins Dam are largely influenced by the Scoggins Dam release (Sullivan and Rounds 2004). As water is passed through the outlet works it becomes aerated due to the turbulence-induced entrainment of air, thereby increasing the dissolved oxygen concentrations. This increase occurs in proportion to the initial concentration in the forebay.

Dissolved oxygen concentrations in the reservoir are lower in the deeper portions of the reservoir when the reservoir is stratified. Figure 3-27 shows modeled dissolved oxygen concentrations near the dam in 2002. Note the drastic change in concentration from July to November when most of the stratification occurs.

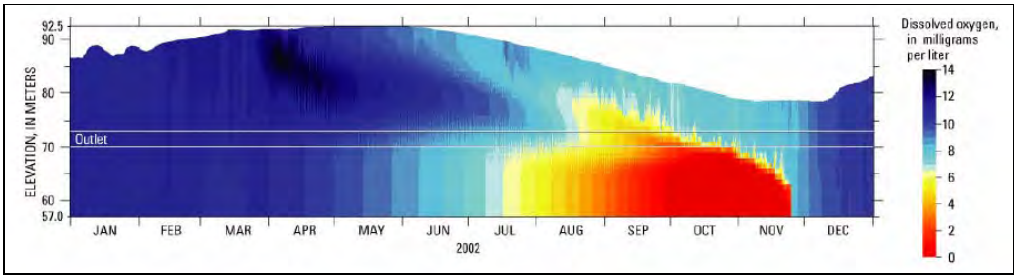


Figure 3-27. Modeled dissolved oxygen concentrations in Henry Hagg Lake near the dam in 2002 (Source: Sullivan and Rounds 2004).

Since dissolved oxygen concentrations in the reservoir are lower in the deeper portions of the reservoir when it is stratified, the effects of future operations under all exceedance flows are expected to slightly increase dissolved oxygen concentrations in Scoggins Creek. This outcome is expected because as the water surface elevation drops (Figure 3-24) the top layers of oxygenated water (due to wind mixing and photosynthesis) will drop in elevation as well, placing them closer to the outlet elevation. While layers of deoxygenated waters will still exist, they will be lower in the reservoir and less available to be released through the outlet.

The effects of low dissolved oxygen levels (3 to 6 mg/L) on prespawning migrating adult salmon are not well understood (ODEQ 1995) but may include, depending upon the exposure to these conditions, negative impacts such as avoidance, delayed migration, reduced swimming speeds, reduced spawning success, and death. The effects of low dissolved oxygen levels on early life history stages of salmonids are well known (Bjornn and Reiser 1991). Below 8 mg/L, the size of fish at emergence is reduced, and survival of juveniles declines (Bjornn and Reiser 1991). Below 5 to 6 mg/L dissolved oxygen, survival of embryos is often low (ODEQ 1995). Bjornn and Reiser (1991) recommended that dissolved oxygen concentrations should be at or near saturation for successful egg incubation.

Tualatin River

Under current conditions, water temperatures in Scoggins Creek have an initial cooling effect on the Tualatin River (Figure 3-18). However, as the Tualatin River flows toward its confluence with the Willamette River it gradually increases in temperature. Under the

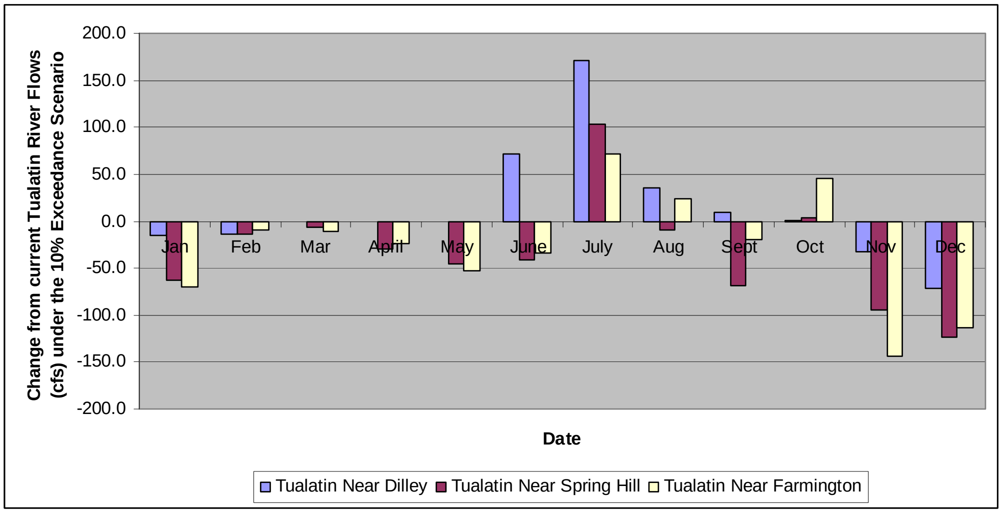


Figure 3-28. Change from Current Conditions flows in the Tualatin River near Dilley, Spring Hill, and Farmington at the 10 percent exceedance flow.

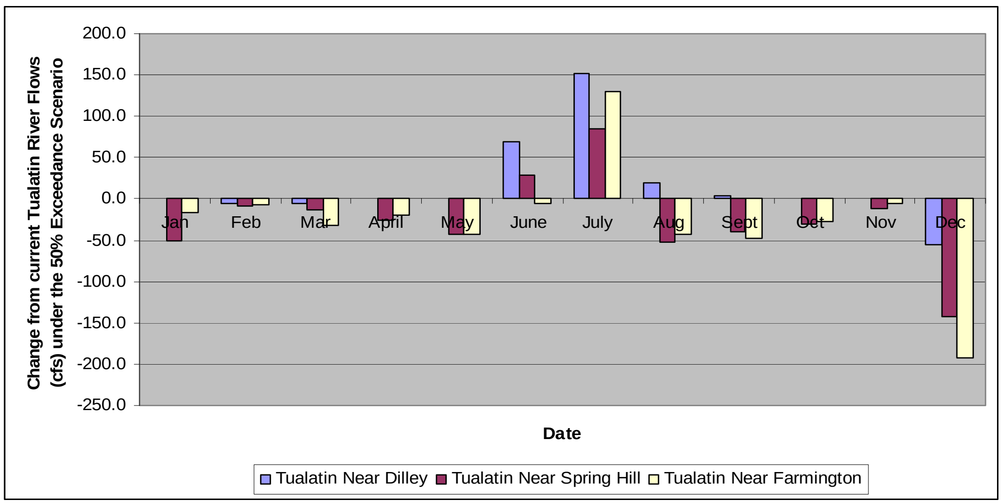


Figure 3-29. Change from Current Conditions flows in the Tualatin River near Dilley, Spring Hill, and Farmington at the 50 percent exceedance flow.

Proposed Action this general tendency is expected to continue. However, the magnitude of thermal loading associated with the trend is expected to be slightly different because the net change in river flow at each river location is different under each exceedance flow. The applied assumption is that more water in the river at any given location equates to less thermal loading potential from the atmosphere and other sources (point and nonpoint), thereby resulting in less overall heat load in the river. Another assumption is that sources decreasing the overall heat load are negligible. Figure 3-28, Figure 3-29, and Figure 3-30 show the change in flows in the Tualatin River near Dilley, Spring Hill, and Farmington under the 10, 50, and 90 percent exceedance flows. If the bar for a particular location is not shown, that means there is no net change in flow during that month.

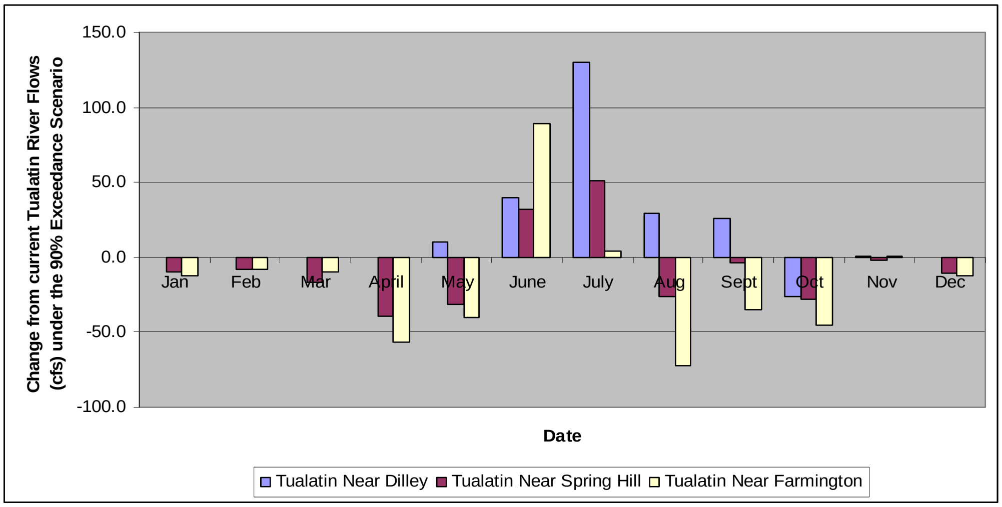


Figure 3-30. Change from Current Conditions flows in the Tualatin River near Dilley, Spring Hill, and Farmington at the 90 percent exceedance flow.

The available data cannot be used to quantify the expected increase or decrease in water temperature in the Tualatin River under the three exceedance flows. To provide some additional insight into the magnitude of temperature change that might occur, the information provided in Table 3-2 shows the change in flows (from Figure 3-28 through Figure 3-30) as a percent of the total current flow. The table also shows whether there is an increase (+) or decrease (-) in flow as compared to the current flow. Where there is an increase in the percentage (+), there is a decreased potential for thermal loading. The larger the increase, the higher the expected decrease in thermal loading potential. Where there is a decrease in the percentage (-), there is an increased potential for thermal loading. The larger the decrease, the higher the expected increase in thermal loading potential. As an example, the percent increase (+) in flow at Dilley in July under the 10 percent exceedance flow is 77.7 percent, whereas in August it is 14.8 percent. While flows at Dilley will increase during both months there will be more water in the river in July than in August, thereby making the river less susceptible to thermal loading in July. It should be noted that in general the large decreases in flows typically occur during the cold winter months, when warm water temperatures are less of an issue for aquatic life. The exception is August and September flows near Spring Hill and Farmington. Flows during these months at these locations tend to be lower than current flows, indicating that additional thermal loading is likely to occur.

Table 3-2. Change in flows at Dilley, Spring Hill, and Farmington as a percent of the total Current Conditions flow.

	Dilley			Spring Hill			Farmington		
	10%	50%	90%	10%	50%	90%	10%	50%	90%
Jan	- 1.0	NC	NC	- 2.5	- 4.1	- 2.5	- 1.2	- 0.6	- 1.1
Feb	- 1.0	- 0.9	NC	- 0.6	- 0.8	- 1.8	- 0.2	- 0.2	- 0.6
Mar	NC	- 0.9	NC	- 0.4	- 1.5	- 4.3	- 0.3	- 1.5	- 1.1
Apr	NC	NC	NC	- 2.8	- 4.9	- 24.5	- 0.9	- 1.5	-11.8
May	NC	NC	+10.6	-10.8	-24.4	- 25.0	- 4.8	- 8.9	-14.1
Jun	+40.2	+60.5	+47.1	-21.9	+37.7	+128.0	- 7.2	-2.1	+59.7
Jul	+77.7	+84.4	+95.6	+82.4	+87.5	+82.3	+33.0	+86.7	+ 2.7
Aug	+14.8	+ 9.4	+17.2	- 6.5	-45.3	- 31.0	+14.0	+28.7	-48.0
Sep	+ 4.0	+ 2.1	+19.3	-46.3	-34.2	- 4.9	- 8.6	-26.7	-23.5
Oct	+ 0.6	NC	-34.7	+ 3.2	-35.3	- 52.8	+15.8	+15.0	-30.2
Nov	- 5.2	NC	1.6	- 8.7	- 3.5	- 7.1	- 6.1	-1.1	+0.6
Dec	- 4.7	- 9.1	NC	- 4.9	-13.2	- 4.6	- 2.1	-7.9	-1.9

NC = no change in flow between Current Conditions and Proposed Action, + = increase in flow form current Conditions, - = decrease in flow from Current Conditions

Dissolved oxygen concentrations in the Tualatin River are a function of many factors, including water temperature. In the upper portions of the river (above the major municipalities) water temperature plays a greater role in dissolved oxygen concentration than in the lower portions of the river, where factors such as biological oxygen demand (BOD) and algal productivity are increasingly significant. This is illustrated in Figure 3-31 and Figure 3-32, which show dissolved oxygen as a function of water temperature at Rood Road (RM 38.4) and near Oswego Diversion (RM 3.4). Note that at Oswego Diversion, the dissolved oxygen concentration in the late spring and early summer months are less of a function of temperature, indicating that other factors are playing a role.

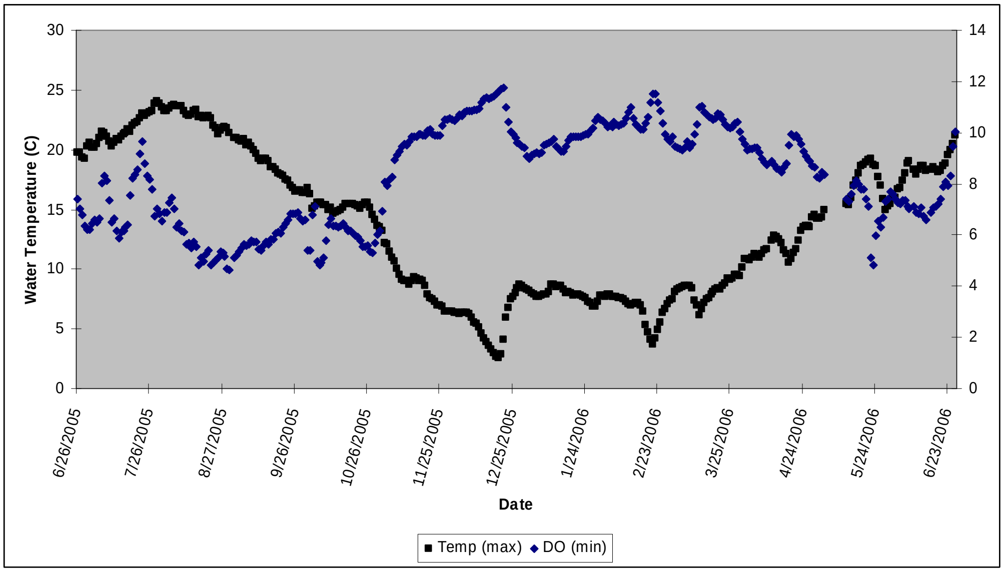


Figure 3-31. Dissolved oxygen concentrations as compared to water temperature at Oswego Diversion.

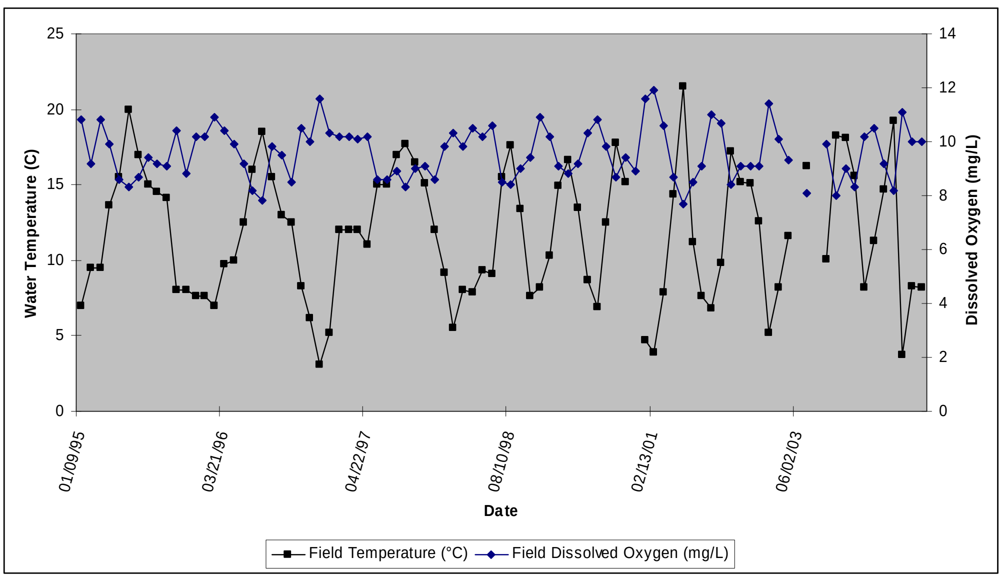


Figure 3-32. Dissolved oxygen concentrations as compared to water temperature at Rood Road (lines do not represent actual data).

At the three exceedance flows, dissolved oxygen levels in the Tualatin River would likely display small shifts in concentration, corresponding to water temperature. These shifts would be most noticeable near Dilley, where changes in river temperature due to future operations are most prevalent. As the Tualatin River flows toward the Willamette River the changes in dissolved oxygen due to future operations would become less prevalent, primarily because flows change less. Any change in dissolved oxygen concentration due to future operations would not be expected to substantially affect dissolved oxygen as it compares to the State of Oregon water quality criteria. The Tualatin River near Stafford (RM 5.4) has historically been the most critical location for low dissolved oxygen concentrations (ODEQ 2001). However, the Stafford area, 5.4 RMs downstream from Henry Hagg Lake would show negligible affects from the Proposed Action.

3.5 Literature Cited

Parenthetical Reference	Bibliographic Citation
Bjornn and Reiser 1991	Bjornn, T.C., and D.W. Reiser. 1991. "Habitat Requirements of Salmonids in Stream." *American Fisheries Society Special Publication* 19:83-138.
Casamitjana et al. 2003	Casamitjana, X., Serra, T., Colomer, J., Baserba, C. and Perez-Losada, J. 2003. Effects of the water withdrawals in the stratification patterns of a reservoir: Hydrobiologia, v. 504, p. 21-28.
EPA 1999	EPA. 1999. Protocol for developing nutrient TMDLs. EPA 841-B-99-007. Office of Water (4503F), US EPA, Washington DC: 135 p.
Leader and Ward 2000	ODFW. 2000. Effect of Spring Hill Pumping Plant on juvenile salmonids in the Tualatin River. Columbia River Investigations Program. Clackamas, Oregon. 11p.
NOAA Fisheries 2008	NOAA Fisheries. May 2008. Supplemental Comprehensive Analysis of the FCRPS and Mainstem Effects of the Upper Snake and Other Tributary Actions. Portland, OR.
ODEQ 1995	Oregon Department of Environmental Quality (ODEQ). 1995. 1992-1994 Water Quality Standards Review.
ODEQ 2001	Oregon Department of Environmental Quality. 2001. Tualatin Subbasin Total Maximum Daily Load (TMDL). August 2001.
ODEQ 2003	Oregon Department of Environmental Quality. 2003. Oregon Administrative Rules-Chapter 340, Division 041. Water Quality Standards: Beneficial Uses, Policies, and Criteria for Oregon.
Reclamation 2002	Bureau of Reclamation. 2002. *Facilities and Operation and Maintenance, Tualatin Project, Oregon*. Prepared by Larry Vinsonhaler for Lower Columbia Area Office. Portland, Oregon.
Sullivan and Rounds 2004	Sullivan , A.B. and S.A Rounds. 2004. Modeling hydrodynamics, temperature and water quality in Henry Hagg Lake, Oregon, 2000-2003. US Geological Survey Investigations Report 2004-5261.
Sullivan and Rounds 2005	Sullivan , A.B. and S.A Rounds. 2005. Modeling hydrodynamics, temperature and water quality in Henry Hagg Lake, Oregon, 2000-2003. US Geological Survey Investigations Report 2004-5261, 38 p.
Sullivan and Rounds 2006	Sullivan , A.B. and S.A Rounds. 2006. Modeling water quality effects of structural and operational changes to Scoggins Dam and Henry Hagg Lake, Oregon. US Geological Survey Investigations Report 2006-5060.

PART II

CHAPTERS FOR USFWS

For counties associated with the Proposed Action, listed species within the jurisdiction of the USFWS have been identified as described in Appendix A and are as follows:

Birds – marbled murrelet (*Brachyramphus marmoratus*); northern spotted owl (*Strix occidentalis caurina*)

Invertebrates – Fender's blue butterfly (*Icaricia icarioides fenderi*); Oregon silverspot butterfly (*Speyeria zerene hippolyta*)

Plants – Willamette daisy (*Erigeron decumbens* var. *decumbens*); Howellia (*Howellia aquatilis*); Bradshaw's lomatium (*Lomatium bradshawii*); Kincaid's lupine (*Lupinus sulphureus* var. *kincaidii*); Nelson's checker-mallow (*Sidalcea nelsoniana*); golden paintbrush (*Castilleja levisecta*)

Reclamation has determined that because Tualatin Project O&M does not impact near-coastal habitat relevant to the marbled murrelet, no further analysis is necessary to conclude that the marbled murrelet would not be affected by the Proposed Action. Similarly, because the Fender's blue butterfly and Oregon silverspot butterfly are listed only for Yamhill County while relevant Tualatin Project O&M activities occur predominantly in Washington County, Reclamation has determined that no further analysis is necessary to conclude that the listed invertebrate species would not be affected by the Proposed Action.

Based on the Proposed Action as described in Chapter 2, Reclamation has completed evaluations of effects on the remaining seven listed species within the jurisdiction of the USFWS. These species specific analyses are presented in chapters 4 through 10. Chapter 11 presents the conclusions of these evaluations.

As indicated in Chapter 11, Reclamation has determined that the Proposed Action will have no effect on the following species: northern spotted owl, Willamette daisy, Howellia, Bradshaw's lomatium, Kincaid's lupine, Nelson's checker-mallow, and golden paintbrush.

Chapter 4 NORTHERN SPOTTED OWL

4.1 Status

Northern spotted owl was listed as threatened by the USFWS on June 26, 1990 (55 FR 26114). The spotted owl is currently designated as threatened across its entire range. The current range of the northern spotted owl is southwestern British Columbia, western Washington, western Oregon, and the coast range area of northwestern California south to San Francisco Bay. The majority of spotted owls are found in the Cascades of Oregon and the Klamath Mountains in southwestern Oregon and northwestern California.

4.2 Habitat and Distribution

Spotted owls prefer stands of mature old growth forests, multi-layered canopies/structures, and the presence of snags and down woody debris in relatively contiguous blocks of habitat (57 FR 1796, USFS and BLM 1994). Their habitat occurs on the western fringes of the Tualatin Project area (USFS 1994). There are no designated critical habitat units in the Tualatin Project area (57 FR 1796).

4.3 Effects Conclusion

Routine Tualatin Project O&M (Appendix B) is not expected to remove or degrade existing old-growth forest or existing multi-layered canopies upon which the spotted owl depends. The Proposed Action is not likely to result in the removal or degradation of dispersal habitat or alter critical habitat units. Consequently, the Proposed Action would have no effect on the northern spotted owl.

4.4 Literature Cited

Parenthetical Reference	Bibliographic Citation
55 FR 26114	Federal Register. 1990. Final rule for the determination of threatened status for the northern spotted owl. Department of the Interior, USFWS. pp26114-26194. http://www.fws.gov/arcata/es/birds/ns_owl.html
57 FR 1796	Federal Register. 1992. Endangered and Threatened Wildlife and Plants; Determination of Critical habitat for the northern spotted owl. Final Rule. USFWS. pp.1796-1839.

USFS and BLM 1994	USDA, Forest Service; USDI, Bureau of Land Management. 1994. Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. http://www.reo.gov/monitoring/10yr-report/northern-spotted-owl/final-report.html

Chapter 5 WILLAMETTE DAISY

5.1 Status

The Willamette daisy was federally listed as endangered under the ESA on January 25, 2000. The published range of this species includes Oregon (65 FR 3875). There is no federally designated critical habitat and a recovery plan has not yet been published for this species. However, the USFWS is actively pursuing a proposal to designate critical habitat in Polk, Benton, Yamhill, Lane, Marion, Linn, and Douglas Counties, Oregon and Lewis County within Washington State (70 FR 66491).

5.2 Distribution

5.2.1 Historical Distribution

The Willamette daisy is endemic to Oregon's Willamette Valley and is most commonly associated with native wetland prairie that occurs in the low flat areas within the valley. Historic collections, from Willamette Valley herbaria, between 1881 and 1934 indicated the species was widespread. No records, herbaria samples, or observations were reported after 1934 until 1980 (USFWS 2002). Historic data indicates that two observations of the daisy were made in Washington and Yamhill counties in 1881 and 1882, respectively; however, no sightings in these two counties have been made since that time (ONHP 2002). The species is known to have been extirpated (destroyed or no longer surviving) from 19 historic locations within the Willamette Valley (USFWS 2002).

5.2.2 Current Distribution

The Willamette daisy was rediscovered in 1980 in Lane County, Oregon, and has since been identified at a total of 32 sites in Polk, Marion, Linn, Benton, and Lane Counties, Oregon. These occurrences occupy habitat of 1,193 acres (483 hectares). The daisy is found in heavy soils in the seasonally wet prairie; however, two populations have been found on top of a dry, stony butte in an upland prairie within the Willamette Valley

(65 FR 3875; 70 FR 66491). Most sites are small and privately owned and few sites are in protective ownership (USFWS 2002).

5.3 Life History

Willamette daisy is a perennial in the composite family (*Asteraceae*). It grows to 6 to 24 inches (15 to 60 centimeters) tall, with one reference stating as tall as 54 inches (135 centimeters). The stems are erect, bushy, red tinted in appearance and somewhat woody at the base. Basal leaves are 2 to 10 inches (5 to 25 centimeters) long and less than a half an inch (1.2 centimeter) wide, becoming gradually shorter along the stem. Most of the lower leaves have three distinct veins on the upper surface. The flowering stems (peduncles), which are taller than the vegetative stems, produce single up to groups of 20 flower heads (groups of 2 to 5 flower heads is probably most common). The flowers are daisy-like, with yellow centers and 25 to 50 pinkish to blue/lilac ray flowers, often fading to white with age. These ray flowers are .25 to .5 inches (.6 to 1.2 centimeters) long and the center yellow disk, of tiny tubular flowers, is .38 to .6 inches (.8 to 1.5 centimeters) across. Flowering typically occurs during June through early to mid-July (USFWS 2002; Guard 1995).

5.4 Habitat Requirements

This species occurs on alluvial soils (deposited by flowing waters). The Willamette daisy occurs on soils in the Wapato, Bashaw, and Mcalpin Series (NRCS mapped soil unit STATSGO 81). This habitat is characterized by the seasonally wet tufted hairgrass (*Deschampsia cespitosa*) community that occurs in low, flat regions of the Willamette Valley where flooding creates anaerobic and strongly reducing soil conditions. This wet prairie community includes rush (*Juncus spp.*) and California oatgrass (*Danthonia californica*) as co-dominant native species, as well as the introduced species of tall fescue (*Festuca arundinaceae*), Japanese brome (*Bromus japonicus*), and sweet vernal grass (*Anthoxanthum odoratum*).

Willamette daisy populations are known to establish in seasonally wet bottomlands. However, one or two populations have been found in an upland prairie remnant having drier conditions (USFWS 2002; 65 FR 3875).

5.5 Factors Contributing to Species Decline

Prior to European settlement, prairie habitat was maintained by fire, which prevented the establishment of woody species. Willamette Valley prairie is considered to be among the rarest habitats in western Oregon and is threatened by fragmentation, agriculture, and urban growth (Meinke 1982). The Kalapooya Indians were known to annually burn large areas of the Willamette Valley for hunting and gathering purposes. These burn areas within the valley extended from its northern end at the falls of the Willamette River to its southern extremities near Eugene, Oregon. Fire suppression management practiced currently causes prairie habitat to be lost through the natural succession of plant communities. Agricultural development changed much of the native prairie into monoculture crops and urbanization quickly followed.

5.5.1 Invasive Species

Because of fire suppression, encroachment by such aggressive species as Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), Himalayan blackberry (*Rubus discolor*), Scotch broom (*Cytisus scoparius*), and poison oak (*Rhus diversiloba*) has become common in many areas of the Willamette Valley. Further succession of the plant community is represented by the establishment of a forest canopy with species such as fir, oak, cottonwood, and maple.

5.6 Current Conditions in the Action Area

Six sites within the action area were inspected for the Willamette daisy. The sites were selected based on areas potentially affected by reported O&M procedures (Rutledge 2005) and are listed according to natural river flow, with the first site being the most upstream of the sites. The survey was conducted July 25-28, 2005 which coincides with the flowering period. The Willamette daisy would have been in the late flowering stages during the survey period so seed pods would have been used for identification as well. All of the inspected sites are located in Washington County, Oregon.

5.6.1 Face of Scoggins Dam at Henry Hagg Lake

The face of the dam is well maintained by mowing and spraying as is the case with most earthen dams. No trees are allowed to establish and vegetation on the face of the dam is not allowed to grow tall. Grasses dominate the steep, sloped face of the dam with some common herbaceous plants such as Canada thistle, tansy (*Tanacetum vulgare*), wild carrot (*Daucus carota*), hairy cat's ear (*Hypochaeris radicata*), and salsify (*Tragopogon dubius*). Many of these herbaceous species showed physical characteristics of herbicide treatment.

The face of the dam is not suitable for the establishment of the Willamette daisy because of its steep slope and dry conditions. The earthen face of Scoggins Dam does not represent or mimic conditions similar to the Willamette Valley wet prairie. Maintenance practices favor the establishment of grasses on this steep slope and prevent most herbaceous plant species from establishing on the face of the dam. No Willamette daisy was observed at this site.

5.6.2 New Channel of Scoggins Creek (Outlet Works to Confluence with Old Channel)

This area is open with few trees; it is a flat meadow with steep-sided slopes down to the creek's edge. The meadow area is routinely mowed.

The old channel of Scoggins Creek is filled with water from springs and seeps as well as with water that backs up from the new channel of Scoggins Creek, approximately ¼ mile below the dam. Some sections of the old channel were inaccessible because of dense shrubs along the creek's edge. Mowing and spraying maintains the area between the old and new Scoggins Creek channels. This area is well vegetated with grasses. The open area between the old and new channels of Scoggins Creek could be suitable habitat for the Willamette daisy, although this area is routinely mowed making it an unlikely area for the establishment of the daisy. This area has been maintained as part of the Tualatin Project since the completion of Scoggins Dam in 1975. Soils in this area may not be suitable for the Willamette daisy because this area was part of the dam construction site from 1972 to 1975.

5.6.3 Patton Valley Pumping Plant

This is a small pumping plant that is approximately ½ acre in size. It consists of a graveled yard surrounded by a chain link fence that is, in turn, surrounded by densely growing tall trees, mostly conifers. The trees, as well as the hill to the south of the facility, shade much of the pumping plant. The facility grounds are mowed and treated with herbicide which has almost eliminated all vegetation within the fenced portion of the facility. Few grasses or forbs were found within the pumping plant yard and those that were present appeared stunted. This possibly is the result of shading and vehicle traffic entering and leaving the pumping plant. An approximate 5-foot perimeter out from the fence is maintained by pruning and spraying. No suitable habitat for Willamette daisy was found at the PVPP.

5.6.4 Spring Hill Pumping Plant

SHPP is located on high ground and is approximately 8 to 15 feet higher than the surrounding agricultural area. Much of the area immediately adjacent to the pumping plant is covered with concrete, asphalt, or gravel. The area surveyed covered approximately 6 acres and measured approximately 580 feet from north to south and 450 feet from east to west. This area included the pumping plant house, driveways and parking areas, a road leading northwest to a private picnic ground, and the area to the north end of the property ending at the Tualatin River. The picnic ground and other open areas are mowed approximately monthly during the growing season (Rutledge 2005). The property elevation is approximately 180 feet above sea level and is flat. Only the picnic area is lower, approximately 10 to 15 feet below the rest of the facility, similar to the surrounding agricultural area and river corridor.

A side channel from the Tualatin River is where water is withdrawn by pumps and sent uphill to water storage tanks approximately ½ mile to the east and 320 feet higher than the pumping plant. This side channel is 3 to 5 feet deep and no pumping activity was observed at the time of inspection.

The area is generally dry and cannot be considered wetland prairie because it is above the surrounding farmland or fields and will not flood during wet seasons. Standing water is not expected to prevail for more than a few days, except possibly in the picnic area.

The sloped areas that border the river and the water channel that feeds the pumping facility are steep, approximately 1:1 slopes. These sloped areas are saturated only at the waters edge.

Habitat for Willamette daisy does not appear to be available at the SHPP because it is higher than the surrounding fields and farmland. Because of this higher ground, it is unlikely to have enough moisture to represent wet prairie habitat. Only the picnic area has an elevation similar to the surrounding agricultural land and therefore may provide habitat.

The area is sprayed to control broadleaf plants around the immediate area of the pumping plant and mowed in other areas to maintain access to the facility. These maintenance activities help to keep the area open and free of encroaching shrubs and trees.

No Willamette daisy was found at the SHPP area.

5.6.5 Spring Hill Pipeline Systems

The TVID pipeline distribution system originates at the SHPP and extends to serve members within the District (Figure 2-1). The pipeline system is buried and is routed generally along roadways and within or adjacent to agricultural lands. Accordingly, there are no specific O&M activities for this pipeline that would affect habitat relevant to listed plant species.

Two additional pipeline corridors exist from the road areas just east and south of the SHPP to two water tanks that are located on a hill approximately ½ mile to the east of the pumping plant. These two pipeline corridors are referred to as the north and south pipeline corridors. The pipeline corridors have an elevation gain from the pumping plant to the water tank on the hill to the east of approximately 320 feet.

South Pipeline Corridor

The south pipeline corridor is approximately 1500 feet in length and 200 feet wide. The pipeline corridor is lined with conifers as well as deciduous trees producing a border canopy 20 to 60 feet high on each side of the corridor. The understory vegetation was sparse, composed of Oregon grape (*Berberis aquifolium*), poison oak, and ferns with much open ground covered by deciduous leaf and conifer needle litter. The corridor is covered with large leaf lupine (*Lupinus polyphyllus*), Canada thistle, bull thistle, Himalayan blackberry, and Scotch broom. The corridor is kept open only by routine mowing and spraying, which occurs on a yearly basis or as needed (Rutledge 2005). Although open, this corridor is on a hillside with gradual to steep slopes (2:1) and it is dry and does not represent wet prairie habitat.

One wet seep was located in an open area in the center of the south pipeline corridor approximately halfway between the top and the bottom of the corridor.

No Willamette daisy was found. The seep area would likely provide the most likely spot for suitable habitat.

North Pipeline Corridor

The north pipeline corridor is similar in width and length to the south corridor; although it is steeper (1:1 slopes are common). The north corridor was less maintained than the south corridor when surveyed in 2005. This could be a reflection of the steepness of this corridor and the difficulty of providing maintenance. The corridor is dominated by Himalayan blackberry, Scotch broom, and poison oak, all of which are very dense, making passage along the corridor very difficult. If further maintenance is not provided, this corridor may become impassable. This difference between the south and the north corridors confirms the speedy encroachment by shrubs and trees without Tualatin Project maintenance. Because of the establishment of many shrubs within the north pipeline corridor, shading of the understory has begun. The hillside was also dry. Both of these factors discourage the establishment of the Willamette daisy because of undesirable habitat. No Willamette daisy was found.

5.7 Effects Analysis

The effects analysis is based on future O&M of the Tualatin Project and routine O&M activities as described in Appendix B, which include routine inspection of all discharge features, periodic testing of mechanical equipment, routine maintenance, vegetation control, rodent control, roadway maintenance, and maintenance of instrumentation.

The six sites within the action area that were inspected for the Willamette daisy should change very little with future operations. The effects upon the individual sites are listed according to natural river flow with the first site being the most upstream of the sites. All of the inspected sites are located in Washington County, Oregon.

5.7.1 Face of Scoggins Dam at Henry Hagg Lake

With future operation of the Tualatin Project the face of Scoggins Dam will remain clear of shrubs and trees. Continued vegetation control on the steep face of the dam will favor grass establishment, as it does now, and not forbs.

5.7.2 New Channel of Scoggins Creek (Outlet Works to Confluence with Old Channel)

Future Tualatin Project O&M in the area between Scoggins Dam and the old channel of Scoggins Creek is likely to keep this area in open meadow as it is now. Habitat for Willamette daisy might be provided in this area, although the soils at the base of the dam may not be representative of the heavy soils originally found in the seasonally wet prairie of the Willamette Valley. The area between the new channel and the old channel might remain open meadow without the presence of the Tualatin Project.

5.7.3 Patton Valley Pumping Plant

Habitat for the Willamette daisy does not exist in this area. The PVPP yard is gravelly and the area is completely surrounded by forest, other than the driveway into the facility. Without future operation of the Tualatin Project, this area would soon reestablish with trees similar to those surrounding the pumping plant, after first being overgrown by weedy and aggressive species such as Himalayan blackberry and snowberry (*Symphoricarpos sp.*).

5.7.4 Spring Hill Pumping Plant

This area is well maintained by mowing and spraying and this will continue with future Tualatin Project operations. A large portion of the area immediately adjacent to the pumping plant is graveled, paved, or covered with concrete. This vegetation control and routine maintenance of the facility will continue with Tualatin Project O&M. Habitat for the Willamette daisy does not appear to be available at the SHPP.

5.7.5 Spring Hill Pipeline Systems

As described in section 5.6.5, the TVID pipeline distribution system does not affect habitat relevant to listed plant species. Two additional buried pipeline rights-of-way connect the SHPP with two water tanks approximately ¼ mile away. The Tualatin Project will continue to maintain these rights-of-way as in the past.

South Pipeline Corridor

This pipeline corridor will continue to be mowed and sprayed with herbicide. Habitat for the Willamette daisy is unlikely because of the dry hillside and continual encroachment of shrubs; seep approximately halfway down the corridor might offer the required moisture for the Willamette daisy.

North Pipeline Corridor

With future Tualatin Project O&M this pipeline corridor will also be mowed and sprayed. No habitat for Willamette daisy was observed within this pipeline corridor. The hillside is dry, steep, and continually encroached upon by shrubs.

5.8 Effects Conclusion

Inspection surveys of the action area did not identify occurrences of Willamette daisy. Future operation of Scoggins Dam and the water operations by Reclamation, TVID, JWC, and CWS should have no negative effect upon any current habitat where the Willamette daisy might be found. No Willamette daisy is known to exist within Washington County, the site of nearly all of the action area, and the site of all of the plant inspections. It is concluded that the Proposed Action would have no effect on the Willamette daisy.

5.9 Literature Cited

Parenthetical Reference	Bibliographic Citation
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Rutledge 2005 — Rutledge, J. 2005. District Manager, Tualatin Valley Irrigation District. Forest Grove, Oregon. Personal communication.

USFWS 2002 — Oregon Fish and Wildlife Office, U.S. Fish and Wildlife Service. March 2002. Willamette Daisy (*Erigeron decumbens var. decumbens*). Endangered Species Fact Sheet.

Chapter 6 HOWELLIA

6.1 Status

Water Howellia, or simply Howellia, was federally listed as threatened without critical habitat on July 14, 1994 (59 FR 35860). A recovery plan has not yet been published for this species (USFWS 2005).

6.2 Distribution

6.2.1 Historical Distribution

Water Howellia was first described by Grey in 1879 from specimens collected in Multnomah County near Portland, Oregon, a state in which Howellia has since become extirpated (59 FR 35860).

The species has historically been collected (voucher specimens in herbaria) from at least four different places in Oregon. It was first collected in 1879 from Sauvie Island, Multnomah County. It was collected again from Sauvie Island in 1886, but has not been collected from this location since then. It was also collected from Lake Oswego in Clackamas County in 1892 and from two locations in the Salem area, most recently in 1977. Numerous attempts to relocate these sites have been unsuccessful. The historic Oregon sites were all located within the Columbia River floodplain or in the broad valley of the Willamette River (USFWS 2005).

6.2.2 Current Distribution

Howellia is known to occur sporadically in: the Puget Trough and Columbia Basin, Washington; Latah County, Idaho; the Swan River drainage, Montana; and Mendocino County, California. Most sites containing Howellia are less than one acre in size. There are approximately 160 known sites (59 FR 35860). No records could be found of Howellia in Washington or Yamhill Counties of Oregon (ONHP 2002). It is believed that Howellia has been extirpated from Oregon since the 1970's (Guard 1995).

6.3 Life History

Howellia is an annual aquatic species in the bellflower family (*Campanulaceae*) and the only member of its genus. Individuals are mostly submerged and rooted in bottom sediments. Stems branch near the soil surface and are 16 to 28 inches (40 to 70 centimeters) long. The leaves are numerous and linear, measuring 0.4 to 2 inches (1.0 to 5.0 centimeters) long, with an entire margin or with a few teeth. The flowers are both emergent and submergent, 0.8 to 1.1 inches (2 to 2.7 millimeters) long, and a corolla is present (in emergent flowers). The corolla is white to pale lavender and is deeply cleft on one side. The seeds number from one to five. This species typically blooms May through August. Due to the predominance of self pollination, Howellia has an extremely uniform genetic makeup throughout its entire range (USFWS 2005).

6.4 Habitat Requirements

Habitat consists of shallow ponds in shaded woods, small, vernal, freshwater wetlands, glacial pothole ponds, or former river oxbows. These water areas must have cyclic spring filling, followed by drying during the summer months. These habitats are generally small, less than 2.5 acres and shallow, about 3 feet deep. Bottom surfaces are reported as firm, consolidated clay, and organic sediments. Most locations were surrounded by deciduous trees. Associated species include duckweed (*Lemna spp.*), water starworts (*Callitriche spp.*), water buttercup (*Ranunculus aquatilis*), yellow water-lily (*Nuphar polysepalum*), bladderwort (*Utricularia vulgaris*), and pondweeds (*Potamogeton spp.*) (USFWS 2005). Howellia reproduces entirely from seed and germination only occurs when ponds dry out and the seeds are exposed to air. The size of a population is affected by the extent of drying the previous growing season. As a result, populations vary annually and exceedingly wet or dry seasons can have a detrimental effect on plant numbers the following year. The length of time seeds remain viable is unknown. However, seeds that remain in the soil longer than 8 months have shown decreased rates of germination and vigor (Lesica 1992).

6.5 Factors Contributing to Species Decline

In Oregon, sites where Howellia were historically found are now within developed urban areas. Channelization and construction of dams along the Columbia, Willamette, and other rivers has led to loss of suitable wetland habitats. The historical California population may have been eliminated by cattle grazing and trampling. Idaho bottomland habitats have been altered by roads, development, and conversion to agriculture and pasture lands. Timber harvest and wetland succession have also contributed to the decline in Howellia (USWS 2005).

6.5.1 Invasive species

Howellia is most abundant in areas with little or no other aquatic plant growth. Howellia cannot compete with aggressive, nonnative species like reed canary grass (*Phalaris arundinacea*) and purple loosestrife (*Lythrum salicaria*) which pose a major threat to Howellia (59 FR 35860).

6.6 Current Conditions in the Action Area

Six sites within the action area were inspected for Howellia. The sites were selected based on areas potentially affected by reported O&M procedures (Rutledge 2005) and are listed according to natural river flow with the first site being the most upstream of the sites. The survey was conducted July 25-28, 2005 which coincides with the flowering period. All of the inspected sites are located in Washington County, Oregon.

6.6.1 Face of Scoggins Dam at Henry Hagg Lake

The face of the dam is well maintained by mowing and spraying as is the case with most earthen dams. No trees are allowed to establish and vegetation on the face of the dam is not allowed to grow tall. Grasses dominate the steep-sloped face of the dam with some common herbaceous plants such as Canada thistle, tansy, wild carrot, hairy cat's ear, and salsify. Many of these herbaceous species showed physical characteristics of herbicide treatment.

The face of the dam is not suitable for the establishment of the Howellia because there is no standing water, the slope is steep, and conditions are dry.

6.6.2 New Channel of Scoggins Creek (Outlet Works to Confluence with Old Channel)

The new channel of Scoggins Creek, from the outlet works at the base of the dam to the confluence with the old Scoggins Creek channel, is a fast moving section of the creek with flows observed at approximately 3 cfs at the time of the field survey. Because of the swiftness of the water and water releases from Henry Hagg Lake, the water is cold within this section. As a result, this area is not suitable for Howellia. The area between the channels is an open meadow area with few trees and steep-sided slopes down to the creek's edge. The meadow area is routinely mowed.

The old channel of Scoggins Creek is filled with water from springs and seeps as well as with water that backs up from Scoggins Creek, approximately ¼ mile below the dam. Some sections of the old channel were inaccessible because of dense shrubs along the channel's edge. Mowing and spraying maintains the area between the old and new Scoggins Creek channels. This area is well vegetated with grasses. The old channel of Scoggins Creek could offer habitat for Howellia if the seeps and springs tend to dry up in late summer exposing some channel edge. However, it appears that water from the new channel might keep the old channel filled regardless of the seeps and springs; therefore, habitat availability is unlikely.

No Howellia was found. This area has changed since 1972 when construction began on Scoggins Dam. The old channel was once the main part of Scoggins Creek and would not have provided appropriate habitat for Howellia.

6.6.3 Patton Valley Pumping Plant

This is a small pumping plant that is approximately ½ acre in size. It consists of a graveled yard surrounded by a chain link fence that is, in turn, surrounded by densely growing tall trees (mostly conifers). The trees, as well as the hill to the south of the facility, shade much of the pumping plant. Scoggins Creek below the facility is fast moving and would not provide habitat for Howellia.

6.6.4 Spring Hill Pumping Plant

SHPP is on high ground, approximately 8 to 15 feet higher than the surrounding agricultural area. Much of the area immediately adjacent to the pumping plant is covered with concrete, asphalt, or gravel. The area inspected for Howellia covered approximately 6 acres and measured approximately 580 feet from north to south and 450 feet from east to west. This area included the pumping plant house, driveways and parking areas, a road leading northwest to a private picnic ground, and the area to the north end of the property ending at the Tualatin River. The picnic ground and other open areas are mowed approximately monthly during the growing season (Rutledge 2005). The property elevation is approximately 180 feet above sea level and is flat. Only the picnic area is lower, approximately 10 to 15 feet below the rest of the facility, similar to the surrounding agricultural area and river corridor.

A side channel from the Tualatin River is where water is withdrawn by pumps and sent uphill to water storage tanks approximately ½ mile to the east and 320 feet higher than the pumping plant. The side channel is 3 to 5 feet deep and no pumping was observed at the time of inspection. This channel would not provide habitat for Howellia because it does not dry out in late summer and water flow would be sporadic depending on pumping activities.

6.6.5 Spring Hill Pipeline Systems

The TVID pipeline distribution system originates at the SHPP and extends to serve members within the District (Figure 2-1). The pipeline system is buried and is routed generally along roadways and within or adjacent to agricultural lands. Accordingly, there are no specific O&M activities for this pipeline that would affect habitat relevant to listed plant species.

Two additional pipeline corridors exist from the road areas just east and south of the SHPP to two water tanks located on a hill approximately ½ mile east of the pumping plant. These two pipeline corridors have steep to gentle slopes and no ponded water occurs on either slope. The pipeline corridors have an elevation gain from the pumping plant to the water tank on the hill to the east of approximately 320 feet. There is no habitat for Howellia in either of these pipeline corridors.

6.7 Effects Analysis

The effects analysis is based on future O&M of the Tualatin Project and routine O&M activities as described in Appendix B, which includes routine inspection of all discharge features, periodic testing of mechanical equipment, routine maintenance, vegetation control, rodent control, roadway maintenance, and instrumentation maintenance.

The six sites within the action area were inspected for Howellia and none was found. No change should be seen at the sites within the action area with future operation of the Tualatin Project. The effects on the individual sites are listed according to natural river flow with the first site being the most upstream of the sites. All of the inspected sites are located in Washington County, Oregon.

6.7.1 Face of Scoggins Dam at Henry Hagg Lake

With future operation of the Tualatin Project, the face of Scoggins Dam will remain clear of shrubs and trees. Continued vegetation control on the steep face of the dam will favor grass establishment as it does now.

6.7.2 New Channel of Scoggins Creek (Outlet Works to Confluence with Old Channel)

The future Tualatin Project O&M in the area between Scoggins Dam and the old channel of Scoggins Creek is likely to keep this area in open meadow as it is now. Operation of the dam, seeps and springs from the dam, and water within the old and new channels of Scoggins Creek will not provide habitat for Howellia in the old channel area unless it were to dry out in late summer.

6.7.3 Patton Valley Pumping Plant

Future operation of the pumping plant will keep this area open. Habitat for the Howellia does not exist in this area. The PVPP yard is gravelly and the area is completely surrounded by forest, other than the driveway into the facility. Without future operation of the Tualatin Project, this area would soon reestablish with trees similar to those surrounding the pumping plant, after first being overgrown by weedy and aggressive species such as Himalayan blackberry and snowberry.

6.7.4 Spring Hill Pumping Plant

This area is well maintained by mowing and spraying and this will continue with future Tualatin Project operations. A large portion of the area immediately adjacent to the pumping plant is graveled, paved, or covered with concrete. This vegetation control and routine maintenance of the facility will continue with future Tualatin Project O&M. Habitat for Howellia is not available at the SHPP. The water channel supplying water to the pumping plant does not provide suitable habitat for Howellia.

6.7.5 Spring Hill Pipeline Systems

As described in section 6.6.5, the TVID pipeline distribution system does not affect habitat relevant to listed plant species. Two additional buried pipeline rights-of-way connect the SHPP with two water tanks approximately ¼ mile away. These rights-of-way will be maintained as in the past, keeping them open and free from encroachment by aggressive shrubs.

6.8 Effects Conclusion

Future operation of Scoggins Dam and the water operations by Reclamation, TVID, JWC, and CWS in accordance with the Proposed Action would have no effect on Howellia. No Howellia was found and no habitat for Howellia was identified.

6.9 Literature Cited

Parenthetic Reference	Bibliographic Citation
59 FR 35860	Federal Register. 1994. U.S. Fish and Wildlife Service: The Plant, Water Howellia (*Howellia Aquatilis*), Determined To Be a Threatened Species. July 14, 1994, Volume 59, pp. 35860-35864.
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Rutledge 2005	Rutledge, J. 2005. District Manager, Tualatin Valley Irrigation District. Forest Grove, Oregon. Personal communication.
USFWS 2005	Oregon Fish and Wildlife Office, U.S. Fish and Wildlife Service. November 2005. Water Howellia (*Howellia aquatilis*) Endangered Species Fact Sheet.

Chapter 7 BRADSHAW'S LOMATIUM

7.1 Status

Bradshaw's lomatium was federally listed as endangered without critical habitat in September 30, 1988 (53 FR 38448). A recovery plan was published in 1993 (USFWS 2003).

Thirty-eight element occurrences (Oregon Natural Heritage Database) had been identified in three population centers as of 1992. Reported populations are generally small, from fewer than 10 to about 1,000 individuals. One large site contains 30,000 individuals (ONHP 2002).

7.2 Distribution

7.2.1 Historical Distribution

Bradshaw's lomatium was once thought to be endemic to the Willamette Valley in Oregon. It was first collected in 1916 in Salem, Oregon (53 FR 38448).

7.2.2 Current Distribution

Today, less than one percent of the Willamette Valley remains undisturbed. Bradshaw's lomatium was believed to be extinct until a graduate student at the University of Oregon rediscovered it while jogging in 1979. Since its rediscovery, it has been found in Benton, Lane, Linn, and Marion Counties of the Willamette Valley and extensive research has been done to understand the ecology of this species. A majority of the populations in Oregon are within a 10-mile radius of the city of Eugene. In Washington in 1994, two sites were found to contain as many plants as are found in all of Oregon. However, both sites are on private land and are not subject to legal protection (CPC 2003). Records indicate that Bradshaw's lomatium has not been found within Washington or Yamhill Counties, Oregon (ONHP 2002).

7.3 Life History

Bradshaw's lomatium is a perennial herb in the parsley family (*Apiaceae*) and is also known as Bradshaw's desert parsley. It can reach 8 to 20 inches (20 to 50 centimeters) in height, with mature plants having only 2 to 6 leaves. Leaves are all from the base and are divided into very fine, highly dissected segments. The yellow flowers are small, 0.05 inches long and 0.025 inches across, and are grouped into compound umbels. Each umbel is composed of 5 to 14 umbellets, which are subtended by green bracts divided into sets of three. This bract arrangement differentiates Bradshaw's from other lomatiums. Bradshaw's lomatium blooms during April and mid-May, with fruits appearing in late May and June. Seeds set quickly and the flowers soon fade. This plant reproduces entirely from seed. Insects observed to pollinate this plant include a number of beetles, ants, and some small native bees (USFWS 2003, Guard 1995)

7.4 Habitat Requirements

The majority of Bradshaw's lomatium populations occur on seasonally saturated or flooded prairies, adjacent to creeks and small rivers in the southern Willamette Valley. Soils at these sites are dense, heavy clays, with a slowly permeable clay layer. This clay layer results in a perched water table during winter and spring, and is critical to the wetland character of these grasslands, known as tufted hair-grass prairies. Bradshaw's lomatium occurs on alluvial (deposited by flowing water) soils. The species occurs on soils in the Wapato, Bashaw, and Mcalpin Series (NRCS mapped soil unit STATSGO 81), as does the Willamette daisy (USFWS 2003).

7.5 Factors Contributing to Species Decline

Once endemic to the Willamette Valley, Bradshaw’s lomatium was widespread in the wet, open areas of the valley. Bradshaw’s lomatium is limited now to a few sites in Lane, Linn, Marion, and Benton Counties. Most of its habitat has been destroyed by land development for agriculture, industry, and housing. In addition, water diversions and flood control structures have changed historic flooding patterns, which may be critical to seedling establishment. Reductions in natural flooding and fire cycles also permit invasion of trees and shrubs, and eventual conversion of wet prairies to woodlands (USFWS 2003). The Kalapooya Indians were known to annually burn large areas of the Willamette Valley for hunting and gathering purposes. These burn areas within the valley extended from its northern end at the falls of the Willamette River to its southern extremities near Eugene, Oregon (65 FR 3875).

7.5.1 Invasive species

Bradshaw’s lomatium has declined because of fire suppression and encroachment by such aggressive species as Canada thistle, bull thistle, Himalayan blackberry, Scotch broom, and poison oak.

7.6 Current Conditions in the Action Area

Six sites within the action area were inspected for Bradshaw's lomatium. The sites were selected based on areas potentially affected by reported O&M procedures (Rutledge 2005) and are listed according to natural river flow, with the first site being the most upstream of the sites. The survey was conducted July 25-28, 2005. Though the survey was outside the typical flowering period, the Bradshaw's lomatium would have been identified by seed pods. All of the inspected sites are located in Washington County, Oregon.

7.6.1 Face of Scoggins Dam at Henry Hagg Lake

The face of the dam is well maintained by mowing and spraying as is the case with most earthen dams. No trees are allowed to establish and vegetation on the face of the dam is not allowed to grow tall. Grasses dominate the steep-sloped face of the dam with some common herbaceous plants such as Canada thistle, tansy, wild carrot, hairy cat's ear, and salsify. Many of these herbaceous species showed physical characteristics of herbicide treatment.

The face of the dam is not suitable for the establishment of the Bradshaw's lomatium because of its steep slope and dry conditions. The earthen face of Scoggins Dam does not represent or mimic conditions similar to the Willamette Valley wet prairie. Maintenance practices favor the establishment of grasses on this steep slope and prevent most herbaceous plant species from establishing on the face of the dam. No Bradshaw's lomatium was observed at this site.

7.6.2 New Channel of Scoggins Creek (Outlet Works to Confluence with Old Channel)

This area is open with few trees; it is a flat meadow with steep-sided slopes down to the creek's edge. The meadow area is routinely mowed.

The old Scoggins Creek channel is filled with water from springs and seeps, as well as with water that backs up from the new Scoggins Creek channel, approximately ¼ mile below the dam. Some sections of the old channel were inaccessible because of dense shrubs along the channel's edge. Mowing and spraying maintains the area between the old and new Scoggins Creek channels. This area is well vegetated with grasses. The open area between the old and new Scoggins Creek channels could be suitable habitat for Bradshaw's lomatium, although this area is routinely mowed making it an unlikely area for the establishment of Bradshaw's lomatium. This area has been maintained by the Tualatin Project since the completion of Scoggins Dam in 1975. The soils in this area may not be suitable for Bradshaw's lomatium because this area was part of the dam construction site from 1972 to 1975. No Bradshaw's lomatium was observed at this site.

7.6.3 Patton Valley Pumping Plant

This is a small pumping plant that is approximately ½ acre in size. It consists of a graveled yard surrounded by a chain link fence that is, in turn, surrounded by densely growing tall trees, mostly conifers. The trees, as well as the hill to the south of the facility, shade much of the pumping plant. The facility grounds are mowed and treated with herbicide which has almost eliminated all vegetation within the fenced portion of the facility. Few grasses or forbs were found within the pumping plant yard and those that were present appeared stunted. This possibly is the result of shading and vehicle traffic entering and leaving the pumping plant. An approximate 5-foot perimeter out from the fence is maintained by pruning and spraying. No suitable habitat for Bradshaw's lomatium was found at the PVPP.

7.6.4 Spring Hill Pumping Plant

SHPP is located on ground approximately 8 to 15 feet higher than the surrounding agricultural area. Much of the area immediately adjacent to the pumping plant is covered with concrete, asphalt, or gravel. The surveyed area covered approximately 6 acres and measured approximately 580 feet from north to south and 450 feet from east to west. This area included the pumping plant house, driveways and parking areas, a road leading northwest to a private picnic ground and the north end of the property ending at the Tualatin River. The picnic ground and other open areas are mowed approximately monthly during the growing season (Rutledge 2005). The property elevation is approximately 180 feet above sea level and is flat. Only the picnic area is lower, approximately 10 to 15 feet below the rest of the facility, similar to the surrounding agricultural and river corridor.

A side channel from the Tualatin River is where water is withdrawn by pumps and sent uphill to the water storage tanks approximately ½ mile to the east and 320 feet higher than the pumping plant. At the time of inspection, the water channel was 3 to 5 feet deep and the water did not appear to be stagnant.

The area is generally dry and cannot be considered wetland prairie because it is above the surrounding farmland or fields and will not flood during wet springs. Standing water is not expected to prevail for more than a few days, except possibly in the picnic area.

The sloped areas that border the river and the water channel feeding the pumping facility are steep, approximately 1:1 slopes. These sloped areas are saturated only at the water's edge.

Habitat for Bradshaw's lomatium is not available at the SHPP because it is higher than the surrounding fields and farmland. Because of this higher ground, it is unlikely to have enough moisture to represent wet prairie habitat. Only the picnic area has an elevation similar to the surrounding agricultural land and, therefore, may provide habitat.

The area is sprayed to control broadleaf plants around the immediate area of the pumping plant and mowed in other areas to maintain access to the facility. These maintenance activities help keep the area open and free of encroaching shrubs and trees.

No Bradshaw's lomatium was found at the SHPP area.

7.6.5 Spring Hill Pipeline Systems

The TVID pipeline distribution system originates at the SHPP and extends to serve members within the District (Figure 2-1). The pipeline system is buried and is routed generally along roadways and within or adjacent to agricultural lands. Accordingly, there are no specific O&M activities for this pipeline that would affect habitat relevant to listed plant species.

Two additional pipeline corridors exist from the road areas just east and south of the SHPP to two water tanks located on a hill approximately ½ mile to the east of the pumping plant. These two pipeline corridors are referred to as the north and south pipeline corridors. The pipeline corridors have an elevation gain from the pumping plant to the water tank on the hill to the east of approximately 320 feet.

South Pipeline Corridor

The south pipeline corridor is approximately 1500 feet long by 200 feet wide. The pipeline corridor is lined with conifers and deciduous trees producing a border canopy 20 to 60 feet high on each side of the corridor. The understory vegetation was sparse, composed of Oregon grape, poison oak, and ferns with much open ground covered by deciduous-leaf and conifer-needle litter. The corridor is covered with large leaf lupine, Canada thistle, bull thistle, Himalayan blackberry, and Scotch broom. The corridor is kept open by routine mowing and spraying, which occurs on a yearly basis or as needed (Rutledge 2005). Although open, this corridor is on a hillside with gradual to steep slopes (2:1); it is dry and does not represent wet prairie habitat. One wet seep was located in an open area in the center of the south pipeline corridor approximately halfway between the top and the bottom of the corridor.

No Bradshaw's lomatium was found, although the seep would likely provide the most likely spot for suitable habitat.

North Pipeline Corridor

The north pipeline corridor is similar in width and length to the south corridor but steeper; 1:1 slopes are common. The north corridor was less maintained than the south corridor when surveyed in 2005. This could be a reflection of the steepness of this corridor and the difficulty of providing maintenance. The corridor is dominated by Himalayan blackberry, Scotch broom, and poison oak—all of which are very dense and make passage along the corridor very difficult. If further maintenance is not provided, this corridor will become impassable. This difference between the south and the north corridors confirms the speedy encroachment by shrubs and trees without Tualatin Project maintenance. Because of the establishment of many shrubs within the north pipeline corridor, shading of the understory has begun and the hillside was dry. Both of these factors discourage the establishment of Bradshaw's lomatium because of undesirable habitat. No Bradshaw's lomatium was found.

7.7 Effects Analysis

The effects analysis is based on future O&M of the Tualatin Project and routine O&M activities, as described in Appendix B, which include routine inspection of all discharge features, periodic testing of mechanical equipment, routine maintenance, vegetation control, rodent control, roadway maintenance, and instrument maintenance.

The six sites within the action area that were inspected for Bradshaw's lomatium should change very little with future operation of the Tualatin Project. The effects to the individual sites are listed according to natural river flow with the first site being the most upstream of the sites. All of the inspected sites are in Washington County, Oregon.

7.7.1 Face of Scoggins Dam at Henry Hagg Lake

With future operation of the Tualatin Project the face of Scoggins Dam will remain clear of shrubs and trees. Future vegetation control on the steep face of the dam will favor grass establishment, as it does now, and not forbs.

7.7.2 New Scoggins Creek Channel (Outlet Works to Confluence with Old Channel)

Future Tualatin Project O&M in the area between Scoggins Dam and the old Scoggins Creek channels is likely to keep this area as it is now, in open meadow. Habitat for Bradshaw's lomatium might be provided in this area; however, the soils at the base of the dam may not be representative of the heavy soils originally found in the seasonally wet prairie of the Willamette Valley. The area between the new channel and the old channel might remain open meadow without the presence of the Tualatin Project.

7.7.3 Patton Valley Pumping Plant

Habitat for Bradshaw's lomatium does not exist in this area. The PVPP yard is gravelly and the area (other than the facility driveway) is completely surrounded by forest. Without future operation of the Tualatin Project, this area would soon reestablish with weedy and aggressive species such as Himalayan blackberry and snowberry followed by trees similar to those surrounding the pumping plant.

7.7.4 Spring Hill Pumping Plant

This area is well maintained by mowing and spraying. A large portion of the area immediately adjacent to the pumping plant is graveled, paved, or covered with concrete. Vegetation control and routine maintenance of the facility will continue with the future operation of the Tualatin Project. Habitat for Bradshaw's lomatium does not appear to be available at the SHPP.

7.7.5 Spring Hill Pipeline Systems

As described in section 7.6.5, the TVID pipeline distribution system does not affect habitat relevant to listed plant species. Two additional buried pipeline rights-of-way connect the SHPP with two water tanks approximately ¼ mile away. These rights-of-way will be maintained as in the past.

South Pipeline Corridor

Under future operations, this pipeline corridor will continue to be mowed and sprayed with herbicide. Habitat for the Bradshaw's lomatium is unlikely because of the dry hillside and continual encroachment of shrubs; a seep approximately halfway down the corridor might offer the required moisture for Bradshaw's lomatium.

North Pipeline Corridor

With future operation of the Tualatin Project, this pipeline corridor will also be mowed and sprayed. No habitat for Bradshaw's lomatium was observed within this pipeline corridor. The hillside is dry, steep, and continually encroached upon by shrubs.

7.8 Effects Conclusion

Inspection surveys of the action area did not identify occurrences of Bradshaw's lomatium. Future operation of Scoggins Dam and the water operations by Reclamation, TVID, JWC, and CWS should have no negative effect upon any current habitat where Bradshaw's lomatium might be found. No Bradshaw's lomatium is known to exist within Washington County, the site of nearly all of the action area, and the site of all of the plant inspections. No record of Bradshaw's lomatium is known for Yamhill County. It is concluded that the Proposed Action would have no effect on Bradshaw's lomatium.

7.9 Literature Cited

Parenthetical Reference	Bibliographic Citation
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65 FR 3875	Federal Register. 2000. U.S. Fish and Wildlife Service: Endangered Status for *Erigeron decumbens var. decumbens* (Willamette Daisy) and Fender's Blue Butterfly (*Icaricia icarioides fenderi*) and Threatened Status for *Lupinus sulphureus ssp. kincaidii* (Kincaid's Lupine). January 25, 2000, Volume 65, pp. 3875-3890.
CPC 2003	Center for Plant Conservation. 2003. National Collection Plant Profile. *Lomatium bradshawii* (Bradshaw's lomatium). CPC Number 2658.
Guard 1995	Guard, B. Jennifer. 1991. Wetland Plants of Oregon and Washington. Lone Pine Publishing. Renton, Washington.
ONHP 2002	Oregon Natural Heritage Program November 15, 2002. Data systems search for rare, threatened and endangered plants and animals in Washington and Yamhill Counties, Oregon.
Rutledge 2005	Rutledge, J. 2005. District Manager, Tualatin Valley Irrigation District. Forest Grove, Oregon. Personal communication.
USFWS 2003	Oregon Fish and Wildlife Office, U.S. Fish and Wildlife Service. September 2003. Bradshaw's lomatium (*Lomatium bradshawii*) Endangered Species Fact Sheet.

Chapter 8 KINCAID'S LUPINE

8.1 Status

Kincaid's lupine was federally listed as threatened under the ESA on January 25, 2000. The published range of this species includes Oregon. There is no federally designated critical habitat and a recovery plan has not yet been published for this species (65 FR 3875). However, the USFWS is actively pursuing a proposal to designate critical habitat in Polk, Benton, Yamhill, Lane, Marion, Linn, and Douglas Counties, Oregon, and in Lewis County, Washington (70 FR 66491).

8.2 Distribution

8.2.1 Historical Distribution

In 1924, C.P. Smith first described Kincaid's lupine as (*Lupinus oreganus* var. *kincaidii*) from a collection made in Corvallis, Oregon. This plant's designation was changed to its current name in 1955 (65 FR 3875).

In the recent past, Kincaid's lupine has been found in the action area or close by according to records received from the Oregon Natural Heritage Program. It was seen on one site in 1989 and on two sites in 1992 within an area of the Fairdale USGS quadrangle, Yamhill County. In 1991, it was also observed in an area of the Gaston USGS quadrangle, Yamhill County. Fender's blue butterfly, an endangered species, is associated with Kincaid's lupine. It was observed near the action area between 1990 and 2000 within an area of the Fairdale USGS quadrangle, Yamhill County. No records of Kincaid's lupine or the Fender's butterfly were indicated for Washington County, Oregon (ONHP 2002).

8.2.2 Current Distribution

Kincaid's lupine occupies 48 sites throughout the Willamette Valley. Four sites are in the Umpqua Valley of Douglas County, Oregon, and two sites are in southern Washington. The range of the 54 total sites of Kincaid's lupine, spans from Lewis County, Washington south to Douglas County, Oregon, a distance of 320 miles (400 kilometers) (65 FR 3875).

8.3 Life History

Kincaid's lupine is an herbaceous perennial species in the pea or legume family (*Fabaceae*). With its low growing habit and unbranched flower stalk, Kincaid's lupine is easily distinguished from other species of lupine. Its aromatic flowers have a slightly reflexed, distinctly ruffled banner and are yellowish-cream colored, often showing shades of blue or violet on the keel. Kincaid's lupine is one of the few host plants of the endangered Fender's blue butterfly. The leaflets are deep green with a smooth upper surface. The plants are low growing, 12 to 32 inches (30 to 80 centimeters), with flowering stems that exceed the height of the branched crown. Flowering typically occurs in May to late June or early July. Fruits are a flattened pod, approximately 1 inch long (2 to 3 centimeters), pinkish brown, and generally hairy. Seeds are dispersed from fruits that open explosively upon drying. Individuals also spread by rhizomes, producing clumps of plants many feet across. (65 FR 3875, USFWS 2002, WDOT 2001).

8.4 Habitat Requirements

Kincaid's lupine is found mainly in the Willamette Valley, Oregon, where it occupies native grassland habitats. Kincaid's lupine is typically found in native upland prairie sites that are characterized by heavier soils with mesic to slightly xeric soil moisture levels (65 FR 3875). Some common indicator species are: red fescue (*Festuca rubra*), Idaho fescue (*Festuca idahoensis*), Tolmie's mariposa (*Calochortus tolmiei*), Hooker's catchfly (*Silene hookeri*), broadpetal strawberry (*Fragaria virginiana*), rose checker-mallow (*Sidalcea virgata*), and common lomatium (*Lomatium* sp.). Kincaid's lupine is occasionally found on steep, south-facing slopes and barren rocky cliffs, if soil moisture is adequate. At the southern limit of its range, this species occurs on well-developed soils adjacent to serpentine outcrops (high in magnesium, iron and certain toxic metals) where it is often found under scattered oaks (65 FR 3875, USFWS 2003).

8.5 Factors Contributing to Species Decline

Native prairie habitat has been eliminated from the Willamette Valley as a result of urban and other development and conversion to agriculture. It is estimated that less than 1 percent of the natural prairie remains. The Willamette Valley grasslands are a transient community which require disturbance to prevent transition to forest. The vast majority of Willamette Valley grasslands would be forested if left undisturbed. Native Americans, the Kalapooya Indians, maintained Willamette Valley prairies by fire prior to European settlement. With extensive changes in the fire regime, disturbance forces that maintained native prairies were substantially altered allowing tree and shrub species to invade many remaining native prairie areas not put into agriculture or development (USFWS 2002).

8.5.1 Invasive species

Many of the areas within the action area become overgrown with native and nonnative weeds and shrubs within a few years if not controlled. Areas around facilities are mowed routinely and sprayed with herbicides to keep them clear and to reduce encroachment by such aggressive species as Canada thistle, bull thistle, Himalayan blackberry, Scotch broom, and poison oak. A later successional plant community is represented by the establishment of forest areas with species such as fir, oak, cottonwood, and maple.

8.6 Current Conditions in the Action Area

Six sites within the action area were inspected for Kincaid's lupine. The sites were selected based on areas potentially affected by reported O&M procedures (Rutledge 2005) and are listed according to natural river flow, with the first site being the most upstream of the sites. The survey was conducted July 25-28, 2005 which coincides with the flowering period. The Kincaid's lupine would have been in the late flowering stages during the survey period so seed pods and/or senescent plants would have been used for identification. All of the inspected sites are located in Washington County, Oregon.

8.6.1 Face of Scoggins Dam at Henry Hagg Lake

The face of the dam is well maintained by mowing and spraying as is the case with most earthen dams. No trees are allowed to establish and vegetation on the face of the dam is not allowed to grow tall. Grasses dominate the steep-sloped dam face with some common herbaceous plants such as Canada thistle, tansy, wild carrot, hairy cat's ear, and salsify. Many of these herbaceous species showed physical characteristics of herbicide treatment.

The earthen face of Scoggins Dam might be suitable for the establishment of the Kincaid's lupine; although it is a steep slope, the conditions are dry and may simulate upland prairie conditions. However, maintenance practices favor the establishment of grasses on this steep slope and prevent most herbaceous plant species from establishing on the face of the dam. Vegetative control on this site has been practiced since the completion of the dam in 1975. No Kincaid's lupine was observed at this site.

8.6.2 New Scoggins Creek Channel (Outlet Works to Confluence with Old Channel)

This area is a flat meadow with steep-sided slopes down to the channel's edge and is open with few trees. The meadow area is routinely mowed.

The old Scoggins Creek channel is filled with water from springs and seeps originating at the base of the dam and from water that backs up from the new Scoggins Creek channel, approximately ¼ mile downstream from the dam. Some sections of the old channel were inaccessible because of dense shrubs along the channel's edge. Mowing and spraying maintains the area between the old and new Scoggins Creek channels. This area is well vegetated with grasses. The open area between the old and new channels of Scoggins Creek could be suitable habitat for the Kincaid's lupine, although this area is routinely mowed making it an unlikely area for the establishment of Kincaid's lupine. This area has been maintained by the Tualatin Project since the completion of Scoggins Dam in 1975. The soils in this area may not be suitable for the Kincaid's lupine because this area was part of the dam construction site from 1972 to 1975. No Kincaid's lupine was observed at this site.

8.6.3 Patton Valley Pumping Plant

This is a small pumping plant that is approximately ½ acre in size. It consists of a graveled yard surrounded by a chain link fence that is, in turn, surrounded by densely growing tall trees, mostly conifers. The trees and the hill to the south of the facility shade much of the pumping plant. The facility grounds are mowed and treated with herbicide which has eliminated almost all vegetation within the fenced portion of the facility. Few grasses or forbs were found within the pumping plant yard and those that were present appeared stunted. This possibly is the result of shading as well as vehicle traffic entering and leaving the pumping plant. An approximate 5-foot perimeter out from the fence is maintained by pruning and spraying. No suitable habitat for Kincaid's lupine was found at the PVPP.

8.6.4 Spring Hill Pumping Plant

SHPP is approximately 8 to 15 feet higher than the surrounding agricultural area. Much of the area immediately adjacent to the pumping plant is covered with concrete, asphalt, or gravel. The surveyed area covered approximately 6 acres and measured approximately 580 feet from north to south and 450 feet from east to west. This area included the pumping plant house, driveways and parking areas, a road leading northwest to a private picnic ground, and the area to the north end of the property ending at the Tualatin River. The picnic ground and other open areas are mowed approximately monthly during the growing season (Rutledge 2005). The property elevation is approximately 180 feet above sea level and is flat. Only the picnic area is lower, approximately 10 to 15 feet below the rest of the facility, similar to the surrounding agricultural area and river corridor.

A side channel from the Tualatin River is where water is withdrawn by pumps and sent uphill to the water storage tanks approximately ½ mile to the east and 320 feet higher than the pumping plant. At the time of inspection, the water channel was 3 to 5 feet deep and the water did not appear to be stagnant.

The area is generally dry and might be considered upland prairie because it is above the surrounding farmland or fields and does not flood during wet springs. Standing water is not expected to prevail for more than a few days, except for possibly in the picnic area.

The sloped areas that border the river and the channel that feeds the pumping facility are steep, approximately 1:1 slopes. These sloped areas are saturated only at the water's edge.

Habitat for the Kincaid's lupine might be available at the SHPP because it is higher than the surrounding fields and farmland and can provide drier conditions represented by upland prairie habitat. Only the picnic area has an elevation similar to the surrounding agricultural land and, therefore, represents a potentially wetter area.

The site is sprayed to control broadleaf plants around the immediate area of the pumping plant and is mowed in other areas to maintain access to the facility. These maintenance activities help to keep the area open and free of encroaching shrubs and trees. No Kincaid's lupine was found at the SHPP area.

8.6.5 Spring Hill Pipeline Systems

The TVID pipeline distribution system originates at the SHPP and extends to serve members within the District (Figure 2-1). The pipeline system is buried and is routed generally along roadways and within or adjacent to agricultural lands. Accordingly, there are no specific O&M activities for this pipeline that would affect habitat relevant to listed plant species.

Two additional pipeline corridors exist from the road areas just east and south of the SHPP to two water tanks located on a hill approximately ½ mile to the east of the pumping plant. These two pipeline corridors are referred to as the north and south pipeline corridors. The pipeline corridors have an elevation gain of approximately 320 feet from the pumping plant to the water tank on the hill to the east.

South Pipeline Corridor

The south pipeline corridor is approximately 1500 feet long by 200 feet wide. The pipeline corridor is lined on both sides with conifers and deciduous trees producing a border canopy 20 to 60 feet high. The understory vegetation beneath this tree canopy was sparse, composed of Oregon grape, poison oak, and ferns with much open ground covered by deciduous-leaf and conifer-needle litter. The corridor is covered with large leaf lupine, Canada thistle, bull thistle, Himalayan blackberry, and Scotch broom. The corridor is kept open only by routine mowing and spraying, which occurs on a yearly basis or as needed (Rutledge 2005). This open corridor is on a hillside with gradual to steep slopes (2:1), and it is dry and may substitute for upland wet prairie habitat. One wet seep which provides moisture for local plants was found in an open area in the center of the south pipeline corridor approximately halfway between the top and the bottom of the corridor. No Kincaid's lupine was found, although the seep and some areas in the corridor might provide suitable habitat.

North Pipeline Corridor

The north pipeline corridor is similar in width and length to the south corridor, although it is steeper; 1:1 slopes are common. When surveyed in 2005, the north corridor was either less maintained than the south corridor or it had been longer since maintenance had been done. This could be a reflection of the steepness of this corridor and the difficulty of providing maintenance. The corridor is dominated by Himalayan blackberry, Scotch broom, and poison oak all of which are very dense, making passage along the corridor very difficult. If further maintenance is not accomplished, this corridor will become impassable within a year or two. This difference between the south and the north corridors confirms the speedy encroachment by shrubs and trees without Tualatin Project maintenance. The understory within the corridor was shaded because of the establishment of many shrubs. These shrubs would discourage the establishment of Kincaid's lupine. This area may also be too dry for Kincaid's lupine. No Kincaid's lupine was found.

8.7 Effects Analysis

The effects analysis is based on future O&M of the Tualatin Project and routine O&M activities as described in Appendix B, which include routine inspection of all discharge features, periodic testing of mechanical equipment, routine maintenance, vegetation control, rodent control, roadway maintenance, and instrument maintenance.

The six sites within the action area that were inspected for Kincaid's lupine should not change with future operation of the Tualatin Project. The effects on the individual sites are listed according to natural river flow, with the first site being the most upstream of the sites. All of the inspected sites are located in Washington County, Oregon.

8.7.1 Face of Scoggins Dam at Henry Hagg Lake

With future operation of the Tualatin Project the face of Scoggins Dam will remain clear of shrubs and trees. Vegetation control on the steep face of the dam will favor grass establishment and not forbs.

8.7.2 New Scoggins Creek Channel (Outlet Works to Confluence with Old Channel)

Future operation and maintenance of the Tualatin Project in the area between Scoggins Dam and the old channel is likely to keep this area in open meadow. Habitat for Kincaid's lupine might be provided in this area; however, the soils at the base of the dam may not be representative of upland prairie soils of the Willamette Valley. The area between the new channel and the old channel might remain open meadow without the presence of the Tualatin Project.

8.7.3 Patton Valley Pumping Plant

Habitat for the Kincaid’s lupine does not exist in this area. The PVPP yard is gravelly and the area is completely surrounded by forest (other than the driveway into the facility). Without future operation of the Tualatin Project, this area would soon reestablish with trees similar to those surrounding the pumping plant, after first being established by weedy and aggressive species such as Himalayan blackberry and snowberry.

8.7.4 Spring Hill Pumping Plant

This area is well maintained by mowing and spraying. A large portion of the area immediately adjacent to the pumping plant is graveled, paved, or covered with concrete. This vegetation control and routine maintenance of the facility will continue with the future operation of the Tualatin Project.

8.7.5 Spring Hill Pipeline Systems

The TVID pipeline distribution system originates at the SHPP and extends to serve members within the District (Figure 2-1). The pipeline system is buried and is routed generally along roadways and within or adjacent to agricultural lands. Accordingly, there are no specific future O&M activities for this pipeline that would affect habitat relevant to listed plant species.

Two additional buried pipeline rights-of-way connect the SHPP with two water tanks approximately ¼ mile away. These rights-of-way will be maintained as in the past.

South Pipeline Corridor

With future operation of the Tualatin Project, mowing and spraying of herbicides will keep this corridor open as in the past. Habitat for Kincaid’s lupine might be available on the dry open hillside; however, without spraying and mowing, encroachment of shrubs and subsequent establishment of trees within the corridor would soon shade out any possible habitat. A seep approximately halfway down the corridor might offer required moisture for Kincaid’s lupine if the rest of the corridor proved too dry.

North Pipeline Corridor

With future operation of the Tualatin Project this pipeline corridor will also be mowed and sprayed. No habitat for Kincaid’s lupine was observed within this pipeline corridor. The hillside is steep and, at the time of inspection, encroachment by shrubs was shading much of the understory.

8.8 Effects Conclusion

Inspection surveys of the action area did not identify occurrences of Kincaid's lupine. Future operation of Scoggins Dam and the water operations by Reclamation, TVID, JWC, and CWS in accordance with the Proposed Action would have no effect on Kincaid's lupine. Many of the inspected areas are open hillside or prairie only because of maintenance and vegetation control provided by the Tualatin Project. Without future operation of the Tualatin Project, most of the areas would be overgrown with shrubs or forested. No Kincaid's lupine is known to exist within Washington County, the site of nearly all of the action area, and the site of all the plant inspections. It is concluded that the Proposed Action would have no effect on Kincaid's lupine.

8.9 Literature Cited

Parenthetic Reference	Bibliographic Citation
65 FR 3875	Federal Register. 2000. U.S. Fish and Wildlife Service: Endangered Status for Erigeron decumbens var. decumbens (Willamette Daisy) and Fender's Blue Butterfly (Icaricia icarioides fenderi) and Threatened Status for Lupinus sulphureus ssp. kincaidii (Kincaid's Lupine). January 25, 2000, Volume 65, pp. 3875-3890.
70 FR 66491	Federal Register. 2005. U.S. Fish and Wildlife Service: Designation of Critical Habitat for the Fender's Blue Butterfly (Icaricia icarioides fenderi), Lupinus sulphureus ssp. kincaidii (Kincaid's Lupine), and Erigeron decumbens var. decumbens (Willamette Daisy). Proposed Rule. November 2, 2005, Volume 70, pp. 66491-66540.
ONHP 2002	Oregon Natural Heritage Program. November 15, 2002. Data systems search for rare, threatened and endangered plants and animals in Washington and Yamhill counties, Oregon.
Rutledge 2005	Rutledge, J. 2005. District Manager, Tualatin Valley Irrigation District. Forest Grove, Oregon. Personal communication.
USFWS 2002	Oregon Fish and Wildlife Office, U.S. Fish and Wildlife Service. March 2002. Willamette Daisy (Erigeron decumbens var. decumbens). Endangered Species Fact Sheet.
USFWS 2003	Oregon Fish and Wildlife Office, U.S. Fish and Wildlife Service. July 2003. Kincaid's Lupine (Lupinus sulphureus ssp. Kincaidii) Endangered Species Fact Sheet.
WDOT 2001	Washington State Department of Transportation. 2001. Environmental Services.

Chapter 9 NELSON'S CHECKER-MALLOW

9.1 Status

Nelson's checker-mallow was federally listed as threatened without critical habitat in February 12, 1993 (58 FR 8235). A recovery plan was published in 1998 (USFWS 2003).

9.2 Distribution

9.2.1 Historical Distribution

Nelson's checker-mallow was first collected by Elichu Hall in 1871. Botanically it was described by Charles Pipe in 1919 based on plant material collected by J.C. Nelson near the town of Salem, Oregon (58 FR 8235).

9.2.2 Current Distribution

The majority of sites are in the Willamette Valley, Oregon; the plant is also found at several sites in the Coast Range of Oregon and at two sites in the Puget Trough of southwestern Washington. The range of the plant extends from southern Benton County, Oregon, north to Cowlitz County, Washington, and from central Linn County, Oregon, west to the crest of the Coast Range. The species is known to occur in 62 patches within five relict population centers in Oregon and at two sites in Washington (USFWS 2003).

Two records for Nelson's checker-mallow were found for Washington County in 1995 and 1997 and one record in Yamhill County in 1995. These recorded sightings were in different USGS quadrangles than the inspected action area sites which were located in the Laurelwood and Gaston quadrangles, Washington County (ONHP 2002).

9.3 Life History

Nelson's checker-mallow is a perennial herb in the mallow family (*Malvaceae*). It has tall, lavender to deep pink flowers. The flowers are borne in clusters 1.6 to 5 feet (50 to 150 centimeters) tall at the end of short stalks. These flower clusters are usually spike-like, elongate, and somewhat open. The plant can reproduce vegetatively by rhizomes and by seeds which drop near the parent plant. The seed coats are extremely hard and require scarification to germinate. Flowering can occur as early as mid-May and extend into September in the Willamette Valley. Fruits have been observed as early as mid-June and as late as mid-October (USFWS 2003).

9.4 Habitat Requirements

Within the Willamette Valley, Nelson's checker-mallow most frequently occurs in Oregon ash (*Fraxinus latifolia*) swales and meadows with wet depressions or along streams. It is also tolerant of drier areas associated with yarrow (*Achillea* spp.) (USFWS 2003, CPC 2001). The species also grows in wetlands within remnant prairie grasslands. Some populations occur along roadsides at stream crossings where nonnative plants, such as reed canary grass, blackberry, and wild carrot are also present. Nelson's checker-mallow primarily occurs in open areas with little or no shade and will not tolerate encroachment of woody species.

In the Willamette Valley, Nelson's checker-mallow occurs on soils in the Wapato, Bashaw, and Mcalpin Series (NRCS mapped soil unit STATSGO 81) and Malabon, Coburg, and Salem Series (NRCS mapped soil unit STATSGO 91) (USFWS 2003).

9.5 Factors Contributing to Species Decline

Prior to European colonization of the Willamette Valley, naturally occurring fires and fires set by Native Americans maintained suitable Nelson's checker-mallow habitat. Current fire suppression practices allow succession by introduced and native trees and shrubs. Remnant prairie patches in the Willamette Valley have been modified by livestock grazing, fire suppression, or agricultural land conversion. Herbicide spraying and mowing are also contributing factors to Nelson’s checker-mallow decline (USFWS 2003).

9.5.1 Invasive Species

Efforts are typically made to control shrubs invading open areas, such as Himalayan blackberry, Scotch broom, and poison oak which can eliminate habitat. Later succession of the plant community is represented by the establishment of a forest canopy with species such as fir, oak, cottonwood, and maple. Shading by both shrubs and trees increase habitat decline.

9.6 Current Conditions in the Action Area

Six sites within the action area were inspected for Nelson's checker-mallow. The sites were selected based on areas potentially affected by reported O&M procedures (Rutledge 2005) and are listed according to natural river flow, with the first site being the most upstream of the sites. The survey was conducted July 25-28, 2005 which coincides with the flowering period. All of the inspected sites are located in Washington County, Oregon.

9.6.1 Face of Scoggins Dam at Henry Hagg Lake

The face of the dam is well maintained by mowing and spraying as is the case with most earthen dams. No trees are allowed to establish and vegetation on the face of the dam is not allowed to grow tall. Grasses dominate the steep-sloped face of the dam with some common herbaceous plants such as Canada thistle, tansy, wild carrot, hairy cat's ear, and salsify. Many of these herbaceous species showed physical characteristics of herbicide treatment.

The earthen face of Scoggins Dam might be suitable for the establishment of the Nelson's checker-mallow even though it is a steep slope; the conditions are dry and may simulate upland prairie conditions. However, maintenance practices favor the establishment of grasses on this steep slope and prevent most herbaceous plant species from establishing on the face of the dam. Vegetative control on this site has been practiced since the completion of the dam in 1975. No Nelson's checker-mallow was observed at this site.

9.6.2 New Scoggins Creek Channel (Outlet Works to Confluence with Old Channel)

This area is an open, flat meadow with few trees. Steep-sided slopes run down to the creek's edge. The meadow area is routinely mowed.

The old Scoggins Creek channel is filled with water originating from springs and seeps at the base of the dam and water that backs up from the new Scoggins Creek channel, approximately ¼ mile below the dam. Some sections of the old channel were inaccessible because of dense shrubs along the creek's edge. Mowing and spraying maintains the area between the old and new Scoggins Creek channels. This area is well vegetated with grasses. The open area between the old and new channels could be suitable habitat for the Nelson's checker-mallow but this area is routinely mowed, making establishment unlikely. This area has been maintained by the Tualatin Project since the completion of Scoggins Dam in 1975. The soils in this area may not be suitable because this area was part of the dam construction site from 1972 to 1975. No Nelson's checker-mallow was observed at this site.

9.6.3 Patton Valley Pumping Plant

This is a small pumping plant that is approximately ½ acre in size. It consists of a graveled yard surrounded by a chain link fence that is surrounded by densely growing tall trees, mostly conifers. The trees, as well as the hill to the south of the facility, shade much of the pumping plant. The facility grounds are mowed and treated with herbicide which has almost eliminated all vegetation within the fenced portion of the facility. Few grasses or forbs were found within the pumping plant yard and those that were present appeared stunted. This possibly is the result of shading, vehicle traffic entering and leaving the pumping plant, and maintenance activities. An approximately 5-foot perimeter out from the fence is maintained by pruning and spraying. No suitable habitat for Nelson's checker-mallow was found at the PVPP.

9.6.4 Spring Hill Pumping Plant

SHPP is located approximately 8 to15 feet higher than the surrounding agricultural area. Much of the area immediately adjacent to the pumping plant is covered with concrete, asphalt, or gravel. The surveyed area covered approximately 6 acres and measured approximately 580 feet from north to south and 450 feet from east to west. This area included the pumping plant house, driveways and parking areas, a road leading northwest to a private picnic ground and the area to the north end of the property ending at the Tualatin River. The picnic ground and other open areas are mowed approximately monthly during the growing season (Rutledge 2005). The property elevation is approximately 180 feet above sea level and is flat. Only the picnic area is lower, approximately 10 to 15 feet below the rest of the facility, similar to the surrounding agricultural land and river corridor.

A side channel from the Tualatin River is where water is withdrawn by pumps and sent uphill to water storage tanks approximately ½ mile to the east and 320 feet higher than the pumping plant. At the time of inspection, the water channel was 3 to 5 feet deep and the water did not appear to be stagnant.

The area is generally dry and might be considered upland prairie because it is above the surrounding farmland or fields and does not flood during wet seasons. Standing water is not expected to prevail for more than a few days, except for possibly in the picnic area.

The sloped areas that border the river and the water channel that feeds the pumping facility are steep, approximately 1:1 slopes. These sloped areas are saturated only at the water's edge.

Habitat for the Nelson's checker-mallow might be available at the SHPP because it is higher than the surrounding fields and farmland and may provide drier conditions represented by upland prairie habitat. Only the picnic area has an elevation similar to the surrounding agricultural land and therefore represents a potentially wetter area.

The site is sprayed to control broadleaf plants around the immediate area of the pumping plant and mowed in other areas to maintain access to the facility. These maintenance activities help to keep the area open and free of encroaching shrubs and trees. No Nelson's checker-mallow was found at the SHPP area.

9.6.5 Spring Hill Pipeline Systems

The TVID pipeline distribution system originates at the SHPP and extends to serve members within the District (Figure 2-1). The pipeline system is buried and is routed generally along roadways and within or adjacent to agricultural lands. Accordingly, there are no specific O&M activities for this pipeline that would affect habitat relevant to listed plant species.

Two additional pipeline corridors exist from the road areas just east and south of the SHPP to two water tanks that are located on a hill approximately ½ mile to the east of the pumping plant. These two pipeline corridors are referred to as the north and south pipeline corridors. The pipeline corridors have an elevation gain of about 320 feet from the pumping plant to the water tank on the hill to the east.

South Pipeline Corridor

The south pipeline corridor is approximately 1500 feet long by 200 feet wide. The pipeline corridor is lined with conifers as well as deciduous trees producing a border canopy 20 to 60 feet high on each side of the corridor. The understory vegetation beneath this tree canopy was sparse, composed of Oregon grape, poison oak, and ferns with much open ground covered by deciduous-leaf and conifer-needle litter. The corridor is covered with large leaf lupine, Canada thistle, bull thistle, Himalayan blackberry, and Scotch broom. The corridor is kept open only by routine mowing and spraying, which occurs on a yearly basis or as needed (Rutledge 2005). This open corridor is on a hillside with gradual to steep slopes (2:1) and it is dry and may substitute for upland wet prairie habitat. One wet seep, which provides moisture for local plants, was located in an open area in the center of the south pipeline corridor approximately halfway between the top and the bottom of the corridor.

No Nelson’s checker-mallow was found, although the seep and some of the south pipeline corridor might provide suitable habitat.

North Pipeline Corridor

The north pipeline corridor is similar in width and length to the south corridor, although it is steeper (1:1 slopes are common). The north corridor was less maintained than the south corridor when surveyed in 2005 or it has been longer since maintenance has been done. This could be a reflection of the steepness of this corridor and the difficulty of providing maintenance. The corridor is dominated by Himalayan blackberry, Scotch broom, and poison oak, all of which are very dense and make passage along the corridor very difficult. If further maintenance is not accomplished, this corridor will become impassable.

This difference between the south and the north corridors confirms the speedy encroachment by shrubs and trees without Tualatin Project maintenance. Because of the establishment of many shrubs within the north pipeline corridor, shading of the understory has begun. These shrubs would discourage the establishment of Nelson's checker-mallow. No Nelson's checker-mallow was found.

9.7 Effects Analysis

The effects analysis is based on future O&M of the Tualatin Project and routine O&M activities as described in Appendix B, which include routine inspection of all discharge features, periodic testing of mechanical equipment, routine maintenance, vegetation control, rodent control, roadway maintenance, and instrument maintenance.

The six sites within the action area inspected for Nelson's checker-mallow should not change with future operation of the Tualatin Project. The effects upon the individual sites are listed in sequence according to natural river flow, with the first site being the most upstream of the sites. All of the inspected sites are located in Washington County, Oregon.

9.7.1 Face of Scoggins Dam at Henry Hagg Lake

With future operation of the Tualatin Project the face of Scoggins Dam will remain clear of shrubs and trees. Continued vegetation control on the steep face of the dam will favor establishment of grasses over forbs.

9.7.2 New Scoggins Creek Channel (Outlet Works to Confluence with Old Channel)

Future operation and maintenance of the Tualatin Project in the area between Scoggins Dam and the old channel is likely to keep this area in open meadow as it is now. Habitat for Nelson's checker-mallow might be provided in this area; however, the soils at the base of the dam may not be representative of upland prairie soils of the Willamette Valley. The area between the new channel and the old channel might remain open meadow without the presence of the Tualatin Project.

9.7.3 Patton Valley Pumping Plant

Habitat for the Nelson's checker-mallow does not exist in this area. The PVPP yard is gravelly and the area is completely surrounded by forest, other than the driveway into the facility. Without future operation of the Tualatin Project this area would soon reestablish with trees similar to those surrounding the pumping plant, after first being established by weedy and aggressive species such as Himalayan blackberry and snowberry.

9.7.4 Spring Hill Pumping Plant

This area is well maintained by mowing and spraying. A large portion of the area immediately adjacent to the pumping plant is graveled, paved, or covered with concrete. This vegetation control and routine maintenance of the facility will continue with the future operation of the Tualatin Project.

9.7.5 Spring Hill Pipeline Systems

As described in section 9.6.5, the TVID pipeline distribution system does not affect habitat relevant to listed plant species. Two additional buried pipeline rights-of-way connect the SHPP with two water tanks approximately ¼ mile away. These rights-of-way will be maintained as in the past.

South Pipeline Corridor

With future operation of the Tualatin Project, mowing and spraying of herbicides will keep this corridor open as in the past. Habitat for Nelson's checker-mallow might be available on the dry open hillside; however, without spraying and mowing, encroachment of shrubs and subsequent establishment of trees within the corridor would soon shade out any possible habitat. A seep approximately halfway down the corridor might offer required moisture for Nelson's checker-mallow if the rest of the corridor proved too dry.

North Pipeline Corridor

With future operation of the Tualatin Project, the north pipeline corridor will also be mowed and sprayed. No habitat for Nelson's checker-mallow was observed within this pipeline corridor. The hillside is steep and encroachment by shrubs was shading much of the understory at the time of inspection.

9.8 Effects Conclusion

Inspection surveys of the action area did not identify occurrences of Nelson's checker-mallow. Future operation of Scoggins Dam and the water operations by Reclamation, TVID, JWC, and CWS in accordance with the Proposed Action would have no effect upon Nelson's checker-mallow. Many of the inspected areas are open, hillside or prairie, only because of maintenance and vegetation control provided by the Tualatin Project. Without the Tualatin Project, most of the areas would be overgrown with shrubs or forested. No Nelson's checker-mallow was found and no records were located of it existing within the USGS quadrangles of the inspected sites (Laurelwood and Gaston), although it has been found in quadrangles nearby (Forest Grove) within Washington County (ONHP 2002). It is concluded that the Proposed Action would have no effect on Nelson's checker-mallow.

9.9 Literature Cited

Parenthetical Reference	Bibliographic Citation
58 FR 8235	Federal Register. 1993. U.S. Fish and Wildlife Service: Determination of Threatened Status of the Plant *Sidalcea nelsoniana* (Nelson's checker-mallow) February 12, 1993, Volume 58, pp. 8235-8243.
CPC 2001	Center for Plant Conservation. 2001. National Collection Plant Profile. *Sidalcea nelsoniana* (Nelson's checker-mallow). CPC Number 3980.
ONHP 2002	Oregon Natural Heritage Program. November 15, 2002. Data systems search for rare, threatened and endangered plants and animals in Washington and Yamhill counties, Oregon.
Rutledge 2005	Rutledge, J. 2005. District Manager, Tualatin Valley Irrigation District. Forest Grove, Oregon. Personal communication.
USFWS 2003	Oregon Fish and Wildlife Office, U.S. Fish and Wildlife Service. September 2003. Nelson's checker-mallow (*Sidalcea nelsoniana*) Endangered Species Fact Sheet.

Chapter 10 Golden Paintbrush

10.1 Status

Golden paintbrush, also known as golden Indian paintbrush, (*Castilleja levisecta*) was federally listed as threatened on June 11, 1997 (62 FR 31740). On July 6, 2005, a 5-year review of 33 species, which included golden paintbrush, was initiated by the U.S. Fish and Wildlife Service. The purpose of a 5-year review is to ensure that the classification of a species as threatened or endangered on the List of Endangered and Threatened Wildlife and Plants is accurate and consistent with the best scientific and commercial data available at the time of the review (70 FR 38972). Golden paintbrush is currently listed as endangered on the Oregon and Washington State lists.

10.2 Distribution

10.2.1 Historical Distribution

Golden paintbrush was first collected near Mill Plain, Washington, by Thomas Jefferson Howell in 1880 and was described by Jesse More Greenman in 1898. Over 30 sites of golden paintbrush were once known in the Puget Trough of Washington and British Columbia. It was found from Victoria Island south to the Willamette Valley (FR62:31740). Records for golden paintbrush (herbaria samples) indicate that it was once found in the Willamette Valley in Linn County in 1938, in Marion County in 1916 and in Multnomah County in 1905. No records of golden paintbrush were found for Washington or Yamhill Counties, Oregon (Vrilakas 2007 and ONHP 2002). Golden paintbrush has not been seen in Oregon for over 40 years (CPC 2002).

10.2.2 Current Distribution

Golden paintbrush is now known from 10 extant populations. Eight populations occur in Washington, one population south of Olympia in Thurston County, five populations on Whidbey Island in Island County, one population on San Juan Island in San Juan County, and one population on Lopez Island, Island County. In British Columbia, Canada, two populations exist on islands off of the southern coast of Vancouver Island (FR62:31740).

10.3 Life History

Golden paintbrush is a multi-stemmed perennial in the figwort family (*Scrophulariaceae*). It is a short-lived perennial herb. Individual plants generally do not survive more than 5-6 years. Golden paintbrush is easily identified by its showy inflorescences consisting of whorls of conspicuous golden-yellow leaf bracts surrounding less-conspicuous greenish flowers. Plants emerge in early March and flower from April to July. Bumblebees are frequently observed foraging on the flowers of golden paintbrush and are suspected of being a primary pollinator. Seed production is rather prolific, and cold stratification is required for germination. It does not seem to spread vegetatively, like many species within the family Scrophulariaceae. Golden paintbrush is considered to be a facultative root parasite. Fruits mature from June to mid-July and capsules persist into August. Flowering seems to occur about the same time throughout the species range (Wentworth J. 1998 and CPC 2002).

10.4 Habitat Requirements

Golden paintbrush inhabits low elevation prairies and grasslands within the Puget Trough region. It often occurs in gravelly soils on glacial outwash near bedrock outcrops, and on clayey glacio-lacustrine and alluvial soils (Gamon 2000). Associated species include Idaho fescue (*Festuca idahoensis*), red fescue (*Festuca rubra*), common camas (*Camassia quamash*), common velvetgrass (*Holcus lanatus*), common yarrow (*Achillea millefolium*), bracken fern (*Pteridium aquilinum*), vetches (*Vicia spp.*), and brome grasses (*Bromus spp*). Frequent, low intensity fires can be important in maintaining habitat for plant species such as golden paintbrush (FR 62:31740).

10.5 Factors Contributing to Species Decline

The conversion of habitat to agricultural, residential, and other uses has been the primary cause of the decline in the number of populations of golden paintbrush. Loss of suitable habitat is also due to the invasion of grassland habitat by native species such as Douglas fir (*Pseudotsuga menziesii*), bracken fern, Pacific blackberry (*Rubus ursinus*), and snowberry (*Symphoricarpos albus*). Historically, periodic fires in the Puget Trough were instrumental in maintaining native grassland habitat by limiting successional encroachment of trees and shrubs (FR 62:31740). Trampling and collecting by humans may threaten populations to a lesser degree. Although herbivory does not appear to pose a significant threat to the large population at Rocky Prairie, Washington, herbivory by deer, rabbits, or other mammals could potentially have a severe impact on the smaller populations (Wentworth J. 1998).

10.5.1 Invasive species

Golden paintbrush is not a successful competitor and it cannot survive under a closed canopy. Threats to the extant populations include loss of suitable habitat due to the invasion of grassland habitat by non-native species such as the raspberry clan (*Rubus spp.*), Scotch broom (*Cytisus scoparius*), and thistles (*Cirsium spp.*) (Wentworth J. 1998).

10.6 Current Conditions in the Action Area

Six sites within the action area were inspected. The sites are listed according to natural river flow with the first site being the most upstream of the sites. The survey was conducted July 25-28, 2005. Though the survey was outside the typical flowering period, the golden paintbrush would have been identified by seed pods. All of the inspected sites are located in Washington County, Oregon.

10.6.1 Face of Scoggins Dam at Henry Hagg Lake

The face of the dam is well maintained by mowing and spraying as is the case with most earthen dams. No trees are allowed to establish and the vegetation on the face of the dam is not allowed to grow tall. Grasses dominate the steep sloped face of the dam with some common herbaceous plants such as Canada thistle (*Cirsium arvense*), tansy (*Tanacetum vulgare*), wild carrot (*Daucus carota*), hairy cat's ear (*Hypochaeris radicata*), and salsify (*Tragopogon dubius*). Many of these herbaceous species showed physical characteristics of herbicide treatment.

The earthen face of Scoggins Dam might be suitable for the establishment of the golden paintbrush. The face of the dam is a steep slope; the conditions are dry and may simulate upland prairie conditions. However, maintenance practices favor the establishment of grasses on the face of the dam and prevent most herbaceous plant species from establishing on the slope. Vegetative control on this site has been practiced since the completion of the dam in 1975. It is unlikely that golden paintbrush would survive or establish on the site. This site does not mimic an environment of gravelly soils or rocky outcroppings.

10.6.2 New Scoggins Creek Channel (Outlet Works to Confluence with the Old Channel)

This area is open with few trees; it is a flat meadow with steep-sided slopes down to the creek's edge. The meadow area is routinely mowed.

The old channel of Scoggins Creek is filled with water from springs and seeps as well as with water that backs up from the new channel of Scoggins Creek, approximately ¼ mile below the dam. Some sections of the old channel were inaccessible because of dense shrubs along the creek's edge. Mowing and spraying maintains the area between the old and new Scoggins Creek channels. This area is well vegetated with grasses. The open area between the old and new channels of Scoggins Creek could be suitable habitat for golden paintbrush, although this area is routinely mowed making it an unlikely area for establishment. This area has been maintained as part of the Tualatin Project since the completion of Scoggins Dam in 1975. The soils in this area may not be suitable for golden paintbrush because this area was part of the dam construction site from 1972 to 1975.

10.6.3 Patton Valley Pumping Plant

This is a small pumping plant that is approximately ½ acre in size. It consists of a graveled yard surrounded by a chain link fence that is, in turn, surrounded by densely growing tall trees, mostly conifers. The trees, as well as the hill to the south of the facility, shade much of the pumping plant. The facility grounds are mowed and treated with herbicide which has eliminated almost all vegetation within the fenced portion of the facility. Few grasses or forbs were found within the pumping plant yard and those that were present appeared stunted. This possibly is the result of shading and vehicle traffic entering and leaving the pumping plant. An approximate five feet perimeter out from the fence is maintained by pruning and spraying. No suitable habitat for golden paintbrush was found at the Patton Valley Pumping Plant.

10.6.4 Spring Hill Pumping Plant

SHPP is located on high ground and is approximately 8 to15 feet higher than the surrounding agricultural area. Much of the area immediately adjacent to the pumping plant is covered with concrete, asphalt, or gravel. The area surveyed covered approximately 6 acres and measured approximately 580 feet from north to south and 450 feet from east to west. This area included the pumping plant house, driveways and parking areas, a road leading northwest to a private picnic ground, and the area to the north end of the property ending at the Tualatin River. The picnic ground and other open areas are mowed approximately monthly during the growing season (Rutledge 2005). The property elevation is approximately 180 feet above sea level and is flat. Only the picnic area is lower, approximately 10 to 15 feet below the rest of the facility, similar to the surrounding agricultural area and river corridor.

A side channel from the Tualatin River is where water is withdrawn by pumps and sent uphill to water storage tanks approximately ½ mile to the east and 320 feet higher than the pumping plant. This side channel is 3 to 5 feet deep and no pumping activity was observed at the time of inspection.

The area is generally dry and might be considered upland prairie because it is above the surrounding farmland or fields and will not flood during wet springs. Standing water is not expected to prevail for more than a few days, except for possibly in the picnic area.

The sloped areas that border the river and the water channel that feeds the pumping facility are steep, approximately 1:1 slopes. These sloped areas are saturated only at the waters edges.

Habitat for the golden paintbrush does not appear to be available at the SHPP, even though it is higher than the surrounding fields and farmland. Golden paintbrush can tolerate drier conditions represented by upland prairie habitat, but this area is very fragmented with both graveled and paved roads.

The area is sprayed to control broadleaf plants around the immediate area of the pumping plant and mowed in other areas to maintain access to the facility. These maintenance activities help to keep the area open and free of encroaching shrubs and trees.

10.6.5 Spring Hill Pipeline Systems

Two pipeline corridors exist from the road areas just east and south of the Spring Hill Pumping Plant to two water tanks that are located on a hill approximately ½ mile to the east of the pumping plant. These two pipeline corridors are referred to as the north and south pipeline corridors. The pipeline corridors have an elevation gain from the pumping plant to the water tanks on the hill to the east of approximately 320 feet.

South Pipeline Corridor

The south pipeline corridor is approximately 1,500 feet in length and 200 feet wide. The pipeline corridor is lined with conifers as well as deciduous trees producing a border canopy twenty feet to sixty feet high on each side of the corridor. The understory vegetation beneath this tree canopy was sparse, composed of Oregon grape (*Berberis aquifolium*), poison oak (*Rhus diversiloba*), and ferns with much open ground covered by deciduous leaf and conifer needle litter. The corridor is covered with large leaf lupine (*Lupinus polyphyllus*), Canada thistle, bull thistle (*Cirsium vugare*) Himalayan blackberry, and Scotch broom. The corridor is kept open only by routine mowing and spraying, which occurs on a yearly basis or as needed (Rutledge 2005). This open corridor is on a hillside with gradual to steep slopes (2:1) and is dry, possibly substituting for upland wet prairie habitat. One wet seep was located in an open area in the center of the south pipeline corridor approximately halfway between the top and the bottom of the corridor.

This corridor might provide temporary habitat for golden paintbrush. However, much of the corridor is grass-covered and shrubs are beginning to encroach into the corridor. Shading within the corridor will occur if the shrubs are not mowed or sprayed. If the corridor is mowed or sprayed this also may prohibit golden paintbrush from establishing. Therefore, it is unlikely that the corridor would provide suitable habitat for golden paintbrush.

North Pipeline Corridor

The north pipeline corridor is similar in width and length to the south corridor; although it is steeper (1:1 slopes are common). The north corridor was less maintained than the south corridor, when surveyed in 2005. This could be a reflection of the steepness of this corridor and the difficulty of providing maintenance. The corridor is dominated by Himalayan blackberry, Scotch broom, and poison oak, all of which are very dense, making passage along the corridor very difficult. If further maintenance is not accomplished this corridor will become impassable. This difference between the south and the north corridors confirms the speedy encroachment by shrubs and trees without Tualatin Project maintenance. Because of the establishment of many shrubs within the North pipeline corridor, shading of the understory has begun. Golden paintbrush would not survive in the shaded understory of the north pipeline corridor.

10.7 Effects Analysis

The effects analysis is based on future O&M of the Tualatin Project and routine O&M activities as described in Appendix B, which include routine inspection of all discharge features, periodic testing of mechanical equipment, routine maintenance, vegetation control, rodent control, roadway maintenance, and instrument maintenance.

The six sites within the action area were inspected and should not change with future operation of the Tualatin Project. The effects upon the individual sites are listed in sequence according to natural river flow with the first site being the most upstream of the sites. All of the inspected sites are located in Washington County, Oregon.

10.7.1 Face of Scoggins Dam at Henry Hagg Lake

With future operation of the Tualatin Project the face of Scoggins Dam will remain clear of shrubs and trees. Continued vegetation control on the steep face of the dam will favor grass establishment, as it does now, and not forbs.

10.7.2 New Scoggins Creek Channel (Outlet Works to Confluence with Old Channel)

Future Tualatin Project O&M in the area between Scoggins Dam and the old and the new channels of Scoggins Creek are likely to keep this area in open meadow as it is now. Habitat for golden paintbrush might be provided in this area; however, the soils at the base of the dam may not be representative of soils suitable for golden paintbrush, which are commonly gravelly glacial soils and rocky outcrops. Vegetation control, mostly mowing, is likely to keep golden paintbrush from establishing in this area. The area between the new channel and the old channel might remain open meadow without the presence of the Tualatin Project.

10.7.3 Patton Valley Pumping Plant

Habitat for the golden paintbrush does not exist in this area. The Patton Valley Pumping Plant yard is graveled, and the area is completely surrounded by forest and therefore mostly shaded. Without future operation of the Tualatin Project, this area would soon reestablish with shrubs and trees similar to those surrounding the pumping plant, after first being overgrown by weedy and aggressive species such as Himalayan blackberry and snowberry.

10.7.4 Spring Hill Pumping Plant

This area is well maintained by mowing and spraying and this will continue with future Tualatin Project operations. A large portion of the area immediately adjacent to the pumping plant is graveled, paved, or covered with concrete. This vegetation control and routine maintenance of the facility will continue with future Tualatin Project O&M. It is unlikely that habitat for golden paintbrush would exist at this site other than a few small areas which are separated by buildings, roads, and other well used areas. The SHPP would be maintained in the future by mowing and spraying that would most likely prevent establishment of golden paintbrush.

10.7.5 Spring Hill Pipeline Systems

As described in Section 10.6.5, the TVID pipeline distribution system does not affect habitat relevant to listed plant species. Two additional buried pipeline rights-of-way connect the SHPP with two water tanks approximately ½ mile away. Future Tualatin Project O&M will continue to maintain these rights-of-way as they have in the past.

South Pipeline Corridor

With future Tualatin Project O&M, mowing and spraying of herbicides will keep this corridor open as it is now. Although habitat for golden paintbrush might be available on the dry open hillside, without spraying and mowing encroachment of shrubs and subsequent establishment of trees within the corridor would soon shade out any possible habitat. A seep approximately halfway down the corridor offers more moisture for plants but along with this moisture are tall grasses which shade nearby forbs; this seep would probably provide too much moisture for golden paintbrush.

North Pipeline Corridor

With future Tualatin Project O&M, the north pipeline corridor will also be mowed and sprayed. No habitat for golden paintbrush was observed within this pipeline corridor. The hillside is steep, and encroachment by shrubs at the time of inspection was shading much of the understory.

10.8 Effects Conclusion

Future operation of Scoggins Dam and the water operations by Reclamation, TVID, JWC, and CWS should have no negative effect on any current habitat where the golden paintbrush might be found. Although golden paintbrush was not specifically one of the plants of concern during the July 2005 field inspections, no paintbrush of any kind (*Castilleja spp.*) was observed during the inspection and evaluation of Tualatin Project areas. No records were located of golden paintbrush existing within Washington or Yamhill counties. It is concluded that the Proposed Action would have no effect on golden paintbrush.

10.9 Literature Cited

Parenthetical Reference	Bibliographic Citation
CPC 2002	Center for Plant Conservation. 2002. National Collection Plant Profile. *Castilleja levisecta* (golden paintbrush). CPC Number 824.
62 FR 31740	Federal Register. 1993. U.S. Fish and Wildlife Service: Determination of Threatened Status for the Plant *Castilleja levisecta* (Golden Paintbrush) June 11, 1997, Volume 62, pp. 31740-31748.
70 FR 38972	Federal Register. 2005. U.S. Fish and Wildlife Service: Initiantion of a 5-year review on the classification of 33 species under section 4(c)(2)(B) of the Endangered Species Act (Act). July 6, 2005, Volume 70, pp. 38972-38975.
Gamon 2000	Gamon, J., P.W. Dunwiddie, T. Thomas, and T. Rush. 2000. Assessing the Viability of Golden Paintbrush (*Castilleja levisecta*). Washington Natural Heritage Program, Washington Department of Natural Resources.
ONHP 2002	Oregon Natural Heritage Program. November 15, 2002. Data systems search for rare, threatened and endangered plants and animals in Washington and Yamhill counties, Oregon.
Rutledge 2005	Rutledge, J. 2005. District Manager, Tualatin Valley Irrigation District. Forest Grove, Oregon. Personal communication.
Vrilakas 2007	Vrilakas, S. 2007. Botanist/Data Manager, Oregon Natural Heritage Information Center – OSU. Personal communication.
Wentworth 1998	Wentworth, J. 1998. *Castilleja levisecta*, A Threatened South Puget Sound Prairie Species. Natural Heritage Program, Washington Department of Natural Resources. pp. 101-105.

Chapter 11 CONCLUSIONS

Activities that are not part of the Proposed Action but which are considered interrelated and interdependent to the Proposed Action have been considered in the effects analyses presented in this BA. These interrelated and interdependent activities include: operation and maintenance of non-Federal pumps at SHPP, diversion of non-project water at Wapato Canal, and operation and maintenance of the fish ladder at Lake Oswego Diversion Dam. These interrelated/interdependent activities are described in more detail in section 2.1.

Based on the Proposed Action as described in Chapter 2 and the species-specific analyses presented in the preceding chapters, Reclamation has determined that the Proposed Action will have no effect on the following species: northern spotted owl; Willamette daisy; Howellia; Bradshaw's lomatium; Kincaid's lupine; Nelson's checker-mallow, and golden paintbrush.

PART III

CHAPTERS FOR NOAA FISHERIES

Based on the Proposed Action as described in Chapter 2, Reclamation has completed evaluations of effects of the Proposed Action on listed species within the jurisdiction of NOAA Fisheries as identified in Appendix A. These species-specific analyses are presented in Chapter 12. Chapter 13 presents Reclamation's evaluation of effects on EFH under the MSA.

Reclamation has determined that the Proposed Action is likely to adversely affect Upper Willamette River steelhead and not likely to adversely affect Upper Willamette River Chinook salmon. Reclamation submits this BA to request formal consultation with NOAA Fisheries on Upper Willamette River steelhead.

In compliance with the MSA, Reclamation has determined that the Proposed Action will likely adversely affect EFH for Upper Willamette River Chinook salmon. Coho salmon are present in Scoggins Creek and the Tualatin River, but are only federally listed below Willamette Falls, thus there is no effect on ESA listed coho. Reclamation has determined that the Proposed Action will adversely affect EFH for Lower Columbia River coho salmon. Reclamation submits this BA to request that NOAA Fisheries recommend conservation measures to offset potential adverse effects to EFH pursuant section 305(b)(4)(A) of the MSA.

Chapter 12 SALMON AND STEELHEAD

The following sections address the potential effects of Reclamation's Proposed Action on listed Upper Willamette Steelhead and Upper Willamette River Spring Chinook salmon ESUs in the action area. An ESU is a distinct group of Pacific salmon or steelhead distinguished by genetics, meristics, life history characteristics, behavior, and geographical area occupied that can be considered a species for purposes of the ESA.

The action area for the Proposed Action as it relates to anadromous fish is the area immediately downstream from Scoggins Dam on Scoggins Creek, continuing downstream to the Tualatin River, and down the Tualatin River to the confluence of the Tualatin and Willamette Rivers.

Sections 8.13 and 8.14 of the NOAA Fisheries May 2008 SCA of the FCRPS and Mainstem Effects of the Upper Snake and Other Tributary Actions describes in detail the life histories, factors for decline, and range-wide status of these listed ESUs to that point in time. This assessment provides additional and updated information regarding these ESUs, including recent changes in population abundance.

Critical habitat was designated for Upper Willamette River steelhead and Chinook salmon September 2005 (70 FR 52630). Willamette River Steelhead critical habitat was designated in the Tualatin Project action area from Gales Creek to Dairy Creek. No Lower Columbia River coho and upper Willamette River Chinook salmon critical habitat was designated within the Action area.

Table 12-1. Listed anadromous salmonid species and ESUs considered.

Evolutionarily Significant Unit	Status	Critical Habitat Designation
Upper Willamette River Chinook salmon (*O. tshawytscha*)	Threatened March 24, 1999 (64 FR 14308)	September 2, 2005 (70 FR 52630)
Upper Willamette River steelhead (*O. mykiss*)	Threatened March 25, 1999, Reaffirmed January 5, 2006 (64 FR 14517)	September 2, 2005 (70 FR 52630)

12.1 Upper Willamette River Steelhead

12.1.1 Status

NOAA Fisheries listed the Upper Willamette River steelhead ESU as threatened on March 25, 1999, and reaffirmed this listing on January 5, 2006 (Table 12-1). This ESU includes all naturally spawned winter-run steelhead populations in the Willamette River and its tributaries upstream from Willamette Falls to (and including) the Calapooia River. Steelhead in this ESU must pass Willamette Falls. Resident populations of steelhead below impassible barriers (natural and manmade) that co-occur with anadromous populations are included in this ESU (Figure 12-1).

There is no artificial propagation of this ESU (WRI 2004). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 4,872 square miles in the Willamette River basin. Busby et al. (1996) and section 8.14 of the SCA (NOAA Fisheries 2008) contain additional information on life history, habitat requirements, and factors for decline.

The Biological Review Team (BRT) found moderate risks for each of the four Viable Salmonid Populations categories (WRI 2004). The BRT (2003) designated four demographically independent populations for this ESU: Molalla River, South Santiam River, North Santiam River, and the Calapooia River. There was some question about the existence of an historical population in westside tributaries of the Willamette valley that drain the east side of the coast range mountains.

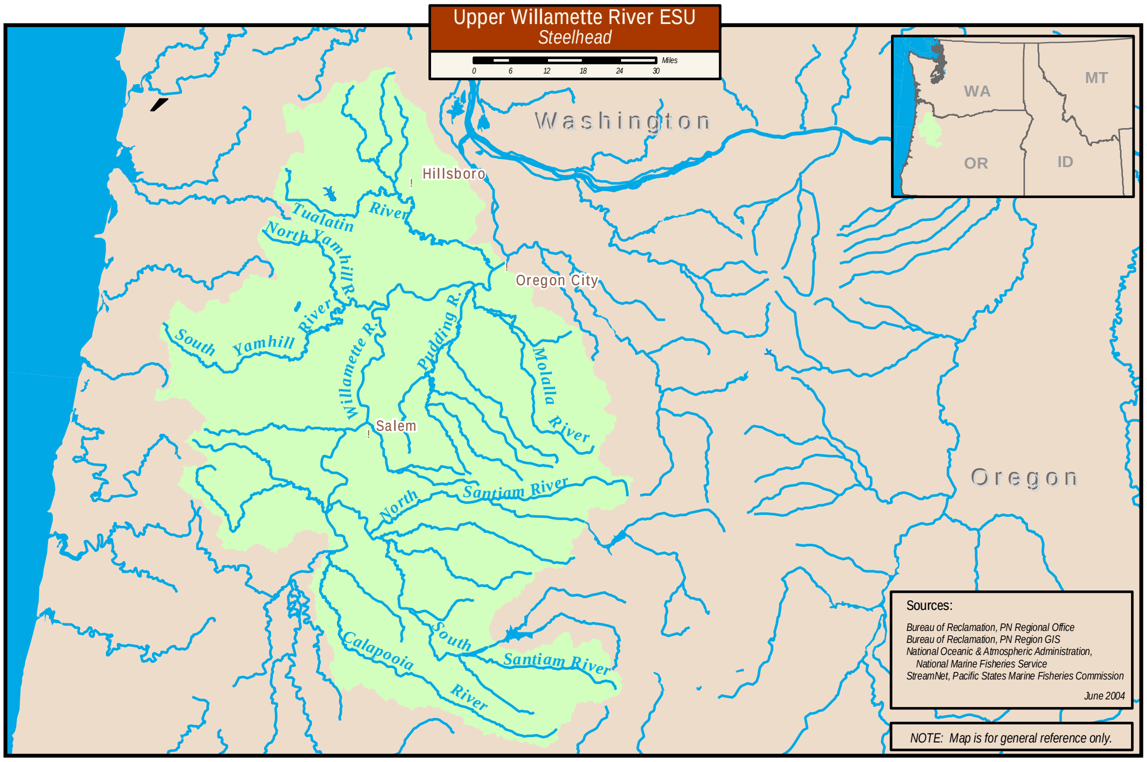

Figure 12-1. Geographic range of the Upper Willamette River steelhead ESU.

There are two groups of winter steelhead in the upper Willamette River. Late-run winter steelhead exhibit the historical phenotype adapted to passing the seasonal barrier at Willamette Falls; early-run winter steelhead were derived from steelhead outside the Willamette River basin and are considered nonnative. Early-run winter steelhead apparently require a ladder to pass Willamette Falls. The ESU’s geographical range for spawning, incubation, and rearing is within the action area.

12.1.2 Distribution and Abundance

Steelhead from the Upper Willamette River are genetically distinct from those in the lower river (Busby et al. 1996). Reproductive isolation from lower river populations may have been facilitated by Willamette Falls, which is known to be a migration barrier to some anadromous salmonids. For example, winter steelhead and spring Chinook salmon occurred historically above the falls, but summer steelhead, fall Chinook salmon, and coho salmon did not (PGE 1994). Fish ladders were constructed at Willamette Falls in the late 1800s to aid the passage of anadromous fish. The ladders have been modified and rebuilt as fish passage technology has improved, most recently in 1971 (Bennett 1988; PGE 1994). These fishways facilitated the successful introduction of Skamania stock summer steelhead and early-migrating Big Creek stock winter steelhead to the upper basin. Steelhead habitat in tributaries was not historically used by these introduced species (BRT 2003).

The native late-run winter steelhead are distinguished from nonnative fall-run steelhead by the date of passage at Willamette Falls—February 15. Those fish ascending the falls prior to February 15 are considered introduced nonnative early-run steelhead; and those ascending after February 15 are considered native late-run steelhead (WRI 2004).

Resident rainbow trout are abundant in the Upper Willamette River basin, particularly in the McKenzie River and Middle Fork Willamette River where they support popular trout fisheries. Recent genetic data from resident trout in the McKenzie and Middle Fork Willamette River basin showed that these fish have no genetic continuity with known hatchery trout (Cape Cod stock) or any Willamette River steelhead populations (WRI 2004).

Historically, spawning by Upper Willamette River steelhead was concentrated in the north and middle Santiam River subbasins, and extended only up to the Calapooia River watershed (WRI 2004). Steelhead are not thought to have been present historically in the McKenzie and Middle Fork Willamette River subbasins, but resident rainbow trout were abundant there (WRI 2004). At most, they may have had a limited distribution in the McKenzie River and Middle Fork Willamette River subbasins. Naturally spawning steelhead are present in westside tributaries draining the Coast Range, although there is considerable debate as to whether the existing fish are native or derived from introduced stocks (WRI 2004). Winter steelhead have been observed spawning in the Tualatin (Gales Creek), the Luckiamute, Rickreall Creek, and the Yamhill River. With the exception of Gales Creek in the Tualatin subbasin, Parkhurst et al. (1950) did not report the presence of any salmon or steelhead in westside tributaries. Numerous introductions of early-run winter steelhead (Big Creek Hatchery stock) and late-run (North Santiam stock) winter steelhead have been made into the Tualatin River; this makes it difficult to determine whether the existing fish represent native or introduced lineages. Based on hatchery records, large numbers of early-run winter steelhead were stocked in the Yamhill and Luckiamute rivers (WRI 2004). ODFW observations suggest that late-run winter steelhead may have recently colonized the Yamhill River (WRI 2004). With the exception of the Tualatin River, there is little evidence to suggest that self-sustaining spawning aggregations of winter steelhead existed historically in the Westside tributaries (WRI 2004).

Present spawning and rearing distributions of native steelhead have been determined from redd counts performed by ODFW. Most principal spawning sites are located upstream from the confluence of the Tualatin River and the Willamette River. These sites include the Little North Fork, Rock Creek, and Mad Creek watersheds in the North Santiam, and in the South Santiam, Thomas Creek, Crabtree Creek, Wiley Creek, Canyon Creek, and Moose Creek watersheds (WRI 2004). Wevers et al. (1992) reported that principal spawning areas in the Molalla River were in the North Fork, Table Rock Fork, Milk Creek, and Copper Creek; and in the Pudding River, Butte, and Abiqua Creeks.

In the Tualatin River subbasin, ODFW assumes that most adult natural spawning and juvenile rearing and the highest quality spawning and rearing habitat occur in Gales Creek and the upper mainstem Tualatin River above Scoggins Creek (WRI 2004). In addition, McKay Creek and the East and West Forks of Dairy Creek in the Tualatin River subbasin reportedly also have suitable spawning and rearing habitat (WRI 2004). Some biologists believe it is likely that most of the Tualatin subbasin tributaries once sustained naturally reproducing steelhead populations. Figure 12-2 shows a map of known steelhead streams in the Tualatin River subbasin.

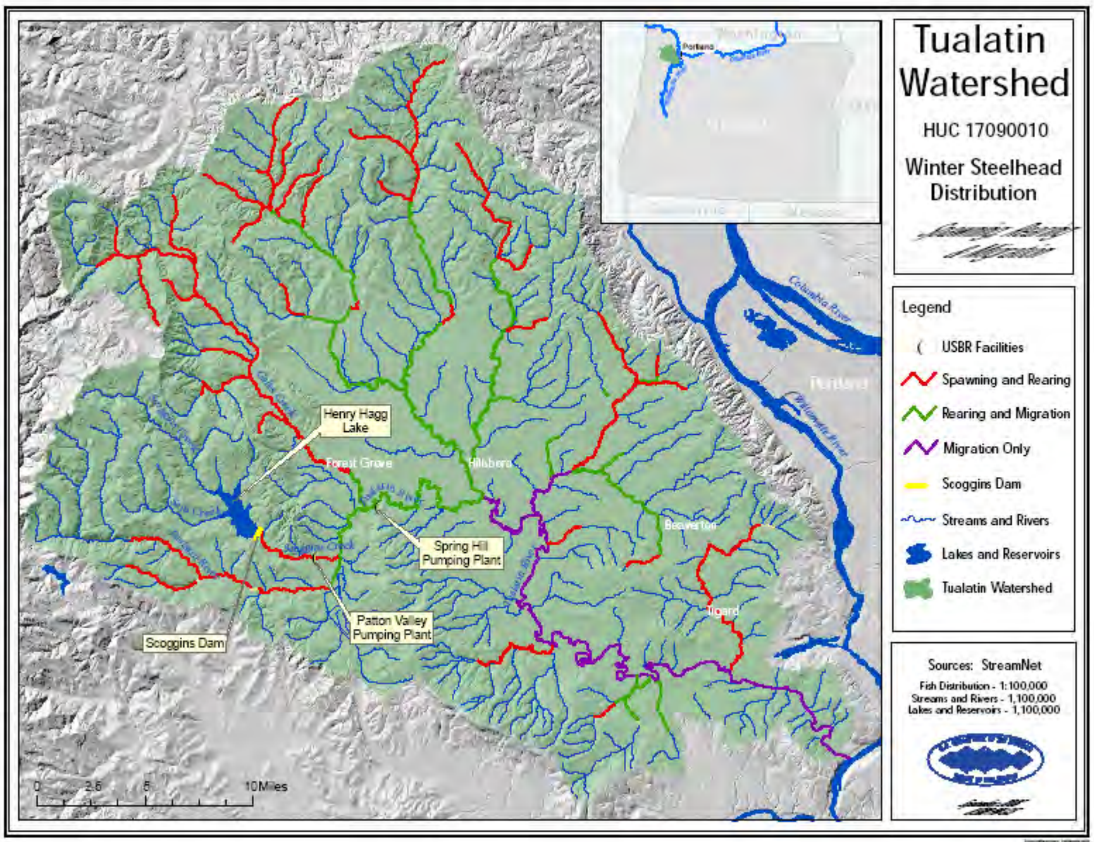

Figure 12-2. Known steelhead streams in the Tualatin River subbasin.

The ODFW stocked hatchery steelhead in the upper Tualatin River and Scoggins Creek between 1976 and 1998 to mitigate for loss of steelhead habitat from construction of Scoggins Dam. Approximately 10,000 smolts were planted each year. ODFW discontinued release of hatchery steelhead into the system in 1999 in response to the federal listing of Upper Willamette steelhead as a threatened species (BLM 2000).

It remains unclear whether any steelhead currently use Scoggins Creek. An extensive study of flow and habitat associated with the Tualatin Basin Water Supply Project found about 1000 feet of gravel at the outlet channel of the dam. Field surveys conducted in 2003 in Scoggins Creek below the dam and in an unnamed tributary to lower Scoggins Creek found no steelhead or redds (White 2003). According to Oregon's Streamnet database, suitable rearing or spawning habitat for steelhead in lower Scoggins Creek is low.

The current number of steelhead that use Scoggins Creek below Scoggins Dam is unknown (Tom Murtaugh, ODFW, pers. Comm. 9/26/07). ODFW (WRI 2004) also indicated that prior to construction of Scoggins Dam, most steelhead spawning in the Scoggins Creek basin likely occurred upstream of where Hagg Lake is now located.

Steelhead juvenile rearing in Scoggins Creek has not been documented. There is the possibility that juvenile steelhead from the Tualatin River may move into Scoggins Creek, but there is no available information to support this.

Determining population trends is difficult for this ESU because of its limited historic distribution, the influence of hatchery summer-run fish, and the limited amount of available information. This is especially true for the Tualatin River subbasin, where little information on run size, angler harvest, and magnitude of production exists.

Total Willamette River basin run size or escapement estimates appear to indicate a declining population (WRI 2004). Of the three winter steelhead subpopulations that have adequate adult escapement information to compute trends, the populations range from a 4.9 percent annual decline to a 2.4 percent annual increase (WRI 2004). None of these winter steelhead population trends are significantly different from zero, indicating that these stocks are not presently recovering (WRI 2004). The ODFW (2003) has determined that the South Santiam winter steelhead subpopulation is close to being unable to sustain itself.

Native winter steelhead abundance is determined from counts of fish passing the fish ladders at Willamette Falls (RM 26). Abundance of winter steelhead returning to Willamette River tributaries has been determined primarily from redd counts in April and May (WRI 2004). The difference in run timing between native winter steelhead and introduced Big Creek and Skamania stocks has been used as a means of estimating run size of native steelhead passing Willamette Falls. Steelhead passing the falls between February 15 and May 15 are counted as being native stock, earlier passing fish are counted as Big Creek winter-run, and later passing fish are regarded as Skamania summer-run stock (WRI 2004) (Table 12-2).

Total abundance of natural late-migrating winter steelhead ascending the Willamette Falls fish ladder has fluctuated the past several decades over a range of approximately 5,000 to 20,000 spawners. The last run exceeding 15,000 occurred in 1988. Abundance during 1991 to 1998 was below 5,000 fish, and the run in 1992 was the lowest in 30 years. Estimates of the proportion of hatchery fish in natural spawning escapements range from 5 to 25 percent (WRI 2004). NOAA Fisheries commented that it was possible that population sizes were never large above Willamette Falls, and that the winter steelhead in this ESU are capable of persisting at relatively low abundance (WRI 2004).

No estimates of pre-1960s abundance are available for this ESU. Based on 1989 to 1993 counts at Willamette Falls, the native late-run winter steelhead average run size was approximately 4,200 while early-run winter and summer steelhead averaged 1,900 and 9,700 respectively.

Table 12-2. . Big Creek winter steelhead run size estimates for the Tualatin, Molalla, and Coast Range subbasins.

Subbasin	Area	Year									
Estimated harvest from salmon steelhead angler catch records:											
Tualatin		1981-1982	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987	1987-1988	1988-1989	1989-1990	1990-1991
	Tualatin River	99	31	44	77	50	80	53	16	31	3
	Gales Creek	193	221	289	388	285	217	262	79	90	58
	Total	292	252	333	465	335	297	315	95	121	61
Molalla											
	Molalla River	341	265	470	459	439	593	697	578	263	220
Coast Range											
	Total	104	62	77	118	111	125	221	141	120	72
Willamette Falls “early run” winter steelhead counts:											
Passage		6,117	4,596	6,664	4,549	8,475	8,543	8,371	4,211	1,878	2,221
Run size estimates:											
Tualatin		2,424	2,000	2,522	1,981	3,208	2,500	2,139	492	451	384
Molalla		2,830	2,104	3,559	2,043	4,204	4,991	4,732	2,990	980	1,384
Coast Range		863	492	583	525	1,063	1,052	1,500	729	447	453

Winter run steelhead are indigenous to the Tualatin River subbasin, but information on historic run size is unknown. Total subbasin population size for native spawning fish is difficult to estimate as well. The ODFW has generated an abundance estimate using Big Creek winter steelhead which were introduced to the subbasin in the early 1970s and now accounts for some of the natural production in the subbasin (WRI 2004). The ODFW has generated a time-series based upon punch-card data and early winter steelhead counts passing the Willamette Falls fish ladder. There are currently no fish counting stations located in the Tualatin River subbasin. Based upon ODFW punch card data, the Big Creek winter steelhead run is estimated to be quite small, averaging 1,810 fish from 1981 to 1991 (WRI 2004) (Table 12-2). The peak year for returns was an estimated 3,208 steelhead in 1985 to 1986.

Busby et al. (1996) described trends in abundance up to the mid-1990s and environmental factors that affected this late-run winter steelhead ESU (the adults that migrate upstream in March and April). The average run size of the adult late-run winter steelhead in the Willamette River, as counted at Willamette Falls, was about 5,819 fish, ranging from 2,735 to 12,208 fish for the period 1971 to 2002 (Busby et al. 1996), although the ODFW (Murtagh 2009) reported 16,658 winter-run steelhead counted at Willamette Falls in 2002 (Table 12-3), and decreased counts since 2002.

The BRT (2003) reported that it could not conclusively identify a single population in the Upper Willamette River steelhead ESU that was self-sustaining. All the populations are small, with a recent mean abundance less than 6,000 returning adults. However, as reported for most other salmon and steelhead ESUs in the Columbia and Snake River basins, there was a notable increase in adult returns in 2001, most likely resulting from improved ocean conditions (BRT 2003). Counts at Willamette Falls show an approximately 26 percent increase in total steelhead numbers from 2001 to 2002, and then a decline in total steelhead numbers from 2003 to 2006 of approximately 60 percent.

Table 12-3. Willamette Falls steelhead counts from 2001 to 2006 (Murtagh 2009).

Year	Winter Steelhead	Summer Steelhead
2001	12,289	26,418
2002	16,658	34,291
2003	9,092	15,834
2004	11,842	33,440
2005	5,963	14,063
2006	6,404	19,373
2007	5,494	13,924

12.1.3 Life History

Winter steelhead are native to the Tualatin River and are part of the Willamette River ESU. These fish are typically a late returning stock, enter fresh water in the Columbia River sometime in early-mid winter and, move upstream in response to temperature and flow. Tualatin winter steelhead migrate above Willamette Falls and into the Tualatin basin primarily in March and April to spawn. Natural production of Willamette ESU winter steelhead, including the Tualatin River stock, occurs almost exclusively in tributary streams and rivers. However, the mainstem Willamette River is an important rearing and migration corridor.

Big Creek stock hatchery winter steelhead were also released in the Tualatin River as partial mitigation for the construction and use of Scoggins Dam, completed in the early 1970s. This is an early returning stock and provided a significant sport fishery in December and January for anglers in the upper Tualatin River (Murtagh 2007). All winter steelhead hatchery releases were terminated in the late 1990s, however, for conservation reasons, and currently, there is no sport harvest allowed for winter steelhead in the Tualatin.

Spawning

Some data are available to characterize the return timing of Upper Willamette steelhead, including fish ladder counts at Willamette Falls, and sport angler harvest in the tributaries. Passage over Willamette Falls begins in early February, typically peaks throughout the month of March, and ceases in late May.

In the Tualatin River, ODFW punch card data show winter steelhead catches once occurred from December to June, with most fish harvested by anglers from January to March (WRI 2004). Based on some tag-recapture studies, the Big Creek Hatchery adult steelhead migration occurred from about mid-October through February (WRI 2004). Presently, however, Big Creek Hatchery stock is not released in the Tualatin basin, and subsequently no angling is allowed for winter steelhead in the Tualatin River (Murtagh 2007). Table 12-4 summarizes life history timing for naturally produced winter steelhead in the upper Tualatin River basin.

Spawning activity typically peaks in April in tributaries to the west side, and in May in tributaries draining the Cascade Range to the east (WRI 2004). Steelhead in the Upper Willamette ESU generally spawn once or twice in their lifetimes, but infrequently spawn more than that. A few fish may spawn three times based on patterns found in the Lower Columbia ESU. Repeat spawners are predominantly female and generally account for less than 10 percent of the total run size (WRI 2004). Spawning occurs primarily high in the upper steeper gradient tributaries (WRI 2004) that have good water quality and access.

Table 12-4. Life history timing for winter steelhead - Upper Tualatin Basin (actual months are shaded) (Alsbury 2006).

Species	Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead (winter)	Adult Migration												
	Spawning												
	Incubation												
	Rearing												
Juvenile out-migration													

Incubation rates vary with water temperature with eggs hatching anywhere between 18 and 101 days (WRI 2004). Fry emergence of naturally produced Willamette winter steelhead is thought to occur predominantly in late May and June (WRI 2004).

Juvenile Rearing and Outmigration

Data on juvenile rearing distributions are limited, but indicate that juvenile steelhead reside both within their native tributaries and in the mainstem Willamette River. Seining studies conducted by ODFW between 1991 and 1998 have found that juvenile steelhead in the mainstem Willamette River are mostly distributed during the late summer between RM 133 near Corvallis and the mouth of the McKenzie River. Water quality and temperatures are typically not favorable in the lower Willamette for steelhead rearing in summer.

Emigration of native steelhead smolts usually occurs from late March to late May, generally after their second winter in freshwater (WRI 2004). The ODFW reports that juvenile steelhead tend to out-migrate from the Tualatin River subbasin primarily in the spring (April through June) of each year. Smolt migration of Willamette winter steelhead past Willamette Falls begins in early April and extends through early June, with peak migration occurring in early to mid-May.

Ocean Stage

Most, if not all, Upper Willamette River steelhead spend 2 years (2-ocean) in the ocean before returning to freshwater to spawn (WRI 2004). Most coastal steelhead in Washington and Oregon have a modal total age maturity of 4 years (2-freshwater/2-ocean); some fish reach 5 years of age (WRI 2004). About 65 percent of adults in the Upper Willamette ESU are 2-ocean (WRI 2004). Scale samples from the 1957 to 1959 broods on the North Santiam River indicated all had spent 2 years in the ocean. On the South Santiam, scales from adults produced by the 1977 and 1978 smolt years showed that 92 percent were ocean age 2, and the remainder age 3 (WRI 2004). Though specific age data for Tualatin steelhead has not been collected, it is believed that this stock is similar to other Willamette basin winter steelhead runs (Murtagh 2007).

Distribution of winter steelhead in the ocean is not well understood, but some studies show that adult steelhead move widely throughout the northern Pacific Ocean, including the Gulf of Alaska, to forage and grow.

12.1.4 Habitat Requirements

To best describe the environmental baseline in a way that facilitates the assessment of the potential effects on salmonids, Reclamation will use the NOAA Fisheries Matrix of Pathways and Indicators to identify important components of suitable aquatic habitat. The matrix (Table 12-5) consists of six pathways: water quality, habitat access, habitat elements, channel conditions and dynamics, flow/hydrology, and watershed conditions. Each pathway is comprised of a number of quantitative and qualitative indicators that are assigned one of three condition levels: properly functioning, at risk, or not properly functioning (NMFS 1996) based on available information.

Table 12-5. NOAA Fisheries matrix of watershed pathways and indicators.

Pathway	Indicator
Water quality	Temperature Sediment/Turbidity Chemical contaminants/Nutrients
Habitat Access	Physical barriers
Habitat Elements	Substrate Large woody debris Pool frequency Pool quality Off-channel habitat Refugia (remnant habitat)
Channel Conditions and Dynamics	Width/Depth ratio Streambank condition Floodplain connectivity
Flow/Hydrology	Change in peak/base flow Increase in drainage network
Watershed conditions	Road density and location Disturbance history Riparian reserves

The following discussion describes the environmental baseline for Upper Willamette River winter steelhead in terms of pathways and indicators for Scoggins Creek below Scoggins Dam and the Tualatin River. An analysis of the current system compared with winter steelhead proper functioning condition can be used to help understand the relative significance of potential impacts from the Proposed Action.

Water Quality

The water quality of the Tualatin River has been degraded over time due to water withdrawals, wetland conversion, introduction of waste, and chemical effects associated with urbanization and other watershed management activities. Although improvements have occurred over the past three decades, conditions in the mainstem river and Scoggins Creek are considered impaired for several parameters. Primary water quality problems identified in the Tualatin River between Scoggins Creek and the Willamette River include water temperature, bacteria, dissolved oxygen, and phosphorous (ODEQ 2001).

Temperature tolerances and preferences of steelhead vary among seasons, life stages, and stock characteristics. The NOAA Fisheries “properly functioning” temperature range for salmonids is 50° to 57°F; above this level fish become “at risk” for adverse effects and above 60°F a water body is “not properly functioning” (NMFS 1996). Further information for Scoggins Creek and the Tualatin River are described in Section 3.4.1.

Sediment/Turbidity

Sediment and turbidity can affect salmonids at all life stages. The most significant impact may be inundation of spawning, rearing, and incubation habitats by deposited sediments. Sediments and turbidity may also damage fish gills, and decrease salmonids abilities to visually locate prey. Decreases in light can also directly impact salmonids by reducing algae and plant production, which impact food availability and habitat structure (Spence et al. 1996).

Steep slopes in the upper reaches of the Tualatin-Scoggins watershed, soil characteristics, mass wasting events (landslides) and human activities, including agriculture and forestry, place the watershed at risk of instream sedimentation and turbidity (BLM 2000). An analysis in 1992 found that Scoggins Creek watershed contributed the majority of summer suspended solids to the Tualatin River in the summer due to high flow contributions. The study determined that about half of the 1991 summer suspended solids came from Scoggins Creek below the dam.

Chemical Contamination/Nutrients

Scoggins Creek below Scoggins Dam was listed in 1998 under section 303(d) of Clean Water Act as being limited for ammonia, dissolved oxygen, pH, phosphorus, E. coli, chlorophyll-a, and temperature. The Tualatin River is listed for 303(d) violations in ammonia, dissolved oxygen, pH, phosphorus, E. coli, chlorophyll-a, temperature, copper, zinc, sediments, and a variety of organics (ODEQ 2004).

The effects of low dissolved oxygen levels (3 to 6 mg/L) on prespawning migrating adult salmon are not well understood (ODEQ 2004) but may include, depending upon the exposure to these conditions, negative impacts such as avoidance, delayed migration, reduced swimming speeds, reduced spawning success, and death. The effects of low dissolved oxygen levels on early life history stages of salmonids are well known (Bjornn and Reiser 1991). Similarly, below 5 to 6 mg/L, the size of fish at emergence is reduced, and survival of juveniles decline (ODEQ 1995). Similarly, below 5 to 6 mg/L dissolved oxygen, survival of embryos is often low (ODEQ 1995). Bjornn and Reiser (1991) recommended that dissolved oxygen concentrations should be at or near saturation for successful egg incubation.

Dissolved oxygen concentrations in Scoggins Creek below Scoggins Dam are largely influenced by the Scoggins Dam release (Sullivan and Rounds 2005). Initially, the concentration in Scoggins Creek is a function of the forebay concentration in Henry Hagg Lake. Concentrations in Henry Hagg Lake commonly fall below 6.0 mg/L during the summer (when the reservoir is stratified), particularly during the months of August to October. During these months the layers of deoxygenated water are at the same elevation as the outlet works. Thus, the water released through the reservoir is already typified by low dissolved oxygen. However, as water from the reservoir is passed through the outlet works, turbulence-induced entrainment of air occurs, causing the concentrations to increase. The net effect is that dissolved oxygen concentrations directly below the dam will increase in proportion to the initial concentration in the lake. Levels near saturation in Scoggins Creek are normal, but do not always reach 11.0 mg/L (the standard). This phenomenon occurs at both high and low flows. For example, on August 20, 2005, when release flows were 212 cfs the dissolved oxygen concentration in Scoggins Creek was 11.16 mg/L. On October 30, 2005, when release flows were 59 cfs, the dissolved oxygen concentration in Scoggins Creek was 10.53 mg/L. The difference being that on August 20, 2005, the initial concentration in the lake was likely 1.0 to 2.0 mg/L higher. The difference is due to a 1 to 2 mg/L higher initial concentration in the lake on August 20, 2005.

The salmon and trout spawning, rearing, and migration beneficial use designation in Scoggins Creek is accompanied by a dissolved oxygen criterion similar to the temperature criterion. The criterion states from October 15 through May 15 the concentration should exceed 11.0 mg/L, unless the minimum intergravel concentration is 8.0 mg/L, in which case, the water column criterion is 9.0 mg/L. Furthermore, in situations where barometric pressure, altitude, and temperature preclude attainment of 11.0 mg/L or 9.0 mg/L, the percent saturation may not be less than 95 percent. During the remainder of the year the concentration shall exceed 8.0 mg/L as a 30-day mean minimum, 6.5 mg/L as a 7-day mean minimum, and be no lower than 6.0 mg/L at any time. Figure 3-15 illustrates the dissolved oxygen concentration in Scoggins Creek from October 15 through May 15.

With regard to the October 15 through May 15 time period, Figure 3-15 shows that dissolved oxygen concentrations in Scoggins Creek are typically below the 11.0 mg/L criterion until mid-November, after which they increase above 11.0 mg/L. Mid-November is also the time of year when the reservoir normally becomes isothermal and dissolved oxygen levels increase. This explains why Scoggins Creek dissolved oxygen levels increase as well.

A fully continuous data set is not available to evaluate dissolved oxygen concentrations in Scoggins Creek during the May 16 through October 14 time period (when the standard is a minimum of 6.0 mg/L). However, minimum dissolved oxygen concentration data from June 26 to October 14, 2005, and May 16 to June 22, 2006, display a mean of 11.2 mg/L. This indicates that even though the reservoir is stratified and releasing oxygen depleted water, the turbulence-induced entrainment of air at the outlet works is sufficient enough to reaerate the water.

The Oregon Department of Environmental Quality (ODEQ) has listed Scoggins Creek below the dam as being in violation of oxygen criteria for salmonid spawning between November 1 and April 30 (ODEQ 2001). However, the current criteria of 11 mg/L may be reduced in the future.

The Tualatin River near Stafford (RM 5.4) has historically been the most critical location for low dissolved oxygen concentrations (ODEQ 2001). Figure 3-20 shows dissolved oxygen concentrations at Stafford for the years 1997 to 1999. Figure 3-20 also shows the 6.5 mg/L criterion that accompanies the salmon and trout rearing and migration" designation in the Tualatin River. Other than brief excursions below the criterion in late August 1997 and early September 1998, the criterion is met. These excursions are likely due to a combination of increased nitrification and sediment oxygen demand. It should be noted that the line in Figure 3-8 is not meant to represent actual data, but rather to help clarify the seasonal variability in dissolved oxygen concentration.

Habitat Access

There are several manmade and natural barriers to fish passage within the action area. In addition, low summer flows and subsequent impaired water quality in the lower Tualatin mainstem may impede habitat access for migratory fishes.

Physical Barriers

The Lake Oswego Corporation Diversion Dam, located at RM 3.45 of the Tualatin River, has been identified as a partial barrier to migratory fishes in the Tualatin River Basin (WRI 2004). Scoggins Dam also acts as a physical barrier to fish. The dam blocks migratory fishes from passing between the lower Scoggins Creek above the mainstem of the Tualatin River and the upstream reaches of Scoggins Creek and its tributaries.

Habitat Elements

With the exception of habitat that was analyzed as part of the TBWSP study (and subsequently identified in section 12.1.6) limited habitat data are available for the Tualatin River and Scoggins Creek. Recent data for habitat elements other than those described below were not available.

Substrate

Steelhead salmon require gravel beds for spawning, with optimal gravel diameter between 0.6 and 10.2 cm. (Bjornn and Reiser 1991). The degree of substrate embeddedness by sand or silt greatly reduces the value of the streambed for spawning and incubation. The 1996 NMFS properly functioning standard for embeddedness is less than 20percent.

In the upper Tualatin (outside Tualatin Project area), gravel substrates dominate from the headwaters to the Wapato Valley at approximately RM 61 (BLM 2000). No data on embeddedness are available for this reach. Fine substrates such as sand and silt predominate until below the Lake Oswego dam at RM 3.4 (BLM 2000). Lower Scoggins Creek is dominated by sand and silt with only two visible gravel beds (BLM 2000).

Large Wood

Large wood is considered a desirable habitat element, providing instream structure, fish cover and shade.

No qualitative data were available for the mainstem Tualatin River, however, visual observations during 2006 boat tours of the Tualatin River between Scoggins Creek and upstream of the Lake Oswego Diversion showed significant wood debris. Field surveys of Scoggins Creek below Scoggins Dam demonstrated that both the existing large wood in the stream channel and large wood recruitment potential were limited (White 2003).

Pool Frequency/Quality/Refugia

Diversity of aquatic habitat is important for fish spawning, feeding, cover and resting. Poor habitat diversity such as in entrenched and channelized stream reaches degrades reach habitat value for all fish species. Habitat diversity provided by numerous and varied pools supports different fish life stages and activities. For example, undercut banks and overhanging riparian vegetation are important for protection from predators, while deep pools are critical for adult holding during the spawning migration.

The general lack of salmonid species in the mainstem reaches of the Tualatin River is likely related in part to the physical habitat characteristics of the stream channel. According to ODFW (2003) the majority of mainstem reaches are gently sloping and nearly flat resulting in long slow moving segments of river. As a result, the substrates within the mainstem river are largely comprised of silts and sands; gravels suitable for salmonid spawning are generally absent.

The results of a remote sensing based habitat mapping exercise completed on the reach of the Tualatin River extending from Farmington upstream to the mouth of Scoggins Creek, and within Scoggins Creek upstream to the dam indicated that the mainstem Tualatin River was comprised essentially of glide/run habitats with no discernible riffles, a function of its low gradient (about 0.04 percent) (R2 Resource Consultants 2006). Scoggins Creek was likewise dominated by glide/run habitats, except for the reach of stream just downstream from the dam, which appeared to contain a few riffles.

Following analysis of an Instream Flow Incremental Methodology (IFIM) study conducted by R2 Resource Consultants in 2006 for TBWSP Partners, the report characterized Scoggins Creek and the Tualatin River as having approximately 90 percent run/glide habitat. Based on field tours and other fish habitat studies (White 2003), it was evident that there are limited control structures in Scoggins and the main Tualatin River below the mouth of Scoggins Creek. R2 Resource Consultants (2006) stated "the majority of the Tualatin River is a channel control due to having a U-shape channel for most of its length."

The channelized section of Scoggins Creek below the dam also has very poor habitat diversity with glide habitat accounting for over 90 percent of this reach. The channel is generally U-shaped with few or no side channels, backwaters, or pools. The report found that about 1,000 feet of spawning gravel, suitable for Coho salmon, was located at the outlet channel of Scoggins Dam.

Channel Conditions and Dynamics

Due to the predominance of silt and clay in channel banks, most unchannelized streams in the lower reaches of the Tualatin subbasin tend to exhibit high sinuosity, which results in a low width to depth ratio (BLM 2000). Both lower Scoggins Creek and the Tualatin River are highly channelized. In some sections, the river has become deeply entrenched (BLM 2000, White 2003). Subsequently, in many areas the Tualatin River and Scoggins Creek have become disconnected from the riparian and floodplain habitats.

Flow/Hydrology

Peak/Base Flows

Properly functioning watersheds have a hydrograph that is comparable to an undisturbed watershed of similar size, geology, and geography (NMFS 1996). Since 1977, the flow patterns in lower Scoggins Creek (below the dam) and the Tualatin River downstream of Scoggins Creek have been altered with respect to both peak and base flows (BLM 2000). As compared to natural flow conditions, current flows are higher in the summer and lower in the winter due to winter water storage and summer flow augmentation.

Watershed Conditions

Road Density/Location

Roads are a source of pollution (petroleum and other chemicals) and sedimentation of the aquatic environment. The road network of a watershed consists of paved and unpaved primary transportation routes and unpaved secondary roads and trails used for recreation or logging. The density of the road network, proximity to lakes and streams, the value of buffer areas between roads and water bodies (i.e., width of buffer, density and type of vegetative ground cover), and volume of traffic are all factors in determining potential impacts on aquatic habitats from roads. Cedarholm et al. (1981) found that fine sediment in salmon spawning gravels increased significantly in watersheds with more than 3 miles of roads per square mile of land area.

Road density in the Upper Tualatin-Scoggins Creek watershed is generally greater than 3 miles/square mile (BLM 2000). Only reaches of Scoggins Creek, more than 1.5 miles above Hagg Lake and a 2.5-mile reach of the Tualatin River above Gaston have road densities of less than 3 miles/square mile. These densities are sufficient to adversely impact aquatic habitat throughout the watershed.

Disturbance History

The Tualatin subbasin has experienced significant human disturbance. About half of the land area in the Tualatin basin is forested. Nearly all of these forestlands are second growth (TRWC 1999). The area above Hagg Lake along Scoggins Creek and its tributaries is primarily forestlands that have been extensively logged in the past.

At lower elevations, the basin has been converted to agricultural and urban uses. Urbanized areas comprise approximately 21 percent of the Tualatin subbasin. About 13 percent of Washington County lies within the Urban Growth Boundary (TRWC 1999). Urban growth has continued since 1999 with a heavy center of development in the lower and middle Tualatin subbasin. Approximately 23 percent of the watershed area has been converted to agriculture. Agricultural practices adjacent to streams were unregulated prior to 1996. More recently the Oregon Department of Agriculture has begun implementing regulations requiring some increases in riparian vegetative buffers. It is currently unclear how effective these new measures have been implemented (BLM 2000).

Riparian Reserves

Riparian buffers in the Tualatin basin have been extensively altered by human activities. This has resulted in stream bank erosion and downstream deposition of sediments, which in turn can alter stream morphology and substrate composition. Aquatic species, particularly salmonids and lamprey, can be impacted by the resulting gravel embeddedness, filling of pools, and loss of large woody debris (BLM 2000).

In the mountainous reaches of the Tualatin subbasin, riparian buffer strips often exceed 75 feet. For most of the Tualatin River, buffers are generally less than 75 feet wide, and in many areas with extensive agricultural or urban development stream buffers may be minimal (TRWC 1999).

Riparian areas of Scoggins Creek below the dam are generally poor, consisting primarily of grasses with some non-native shrubs (Himalayan blackberry). Further downstream, the riparian zone improves somewhat with some young and mature deciduous trees providing canopy cover of approximately 40 to 60 percent. Above Hagg Lake, however, these creeks have better defined riparian zones with a mix of native shrubs, trees, and some potential for recruitment of large woody debris (White 2003).

12.1.5 Current Conditions in Action Area

IFIM Baseline Analysis

As part of the TBWSP study, an IFIM study was conducted to more thoroughly characterize the inchannel condition in Scoggins Creek downstream from Scoggins Dam, and in the middle and lower Tualatin River. A total of nine transects were used to characterize the available spawning and rearing habitat in Scoggins Creek. A total of three transects were used to characterize the inchannel habitat for the middle and lower Tualatin River. Transect locations are shown on figures included in Appendix D.

Natural flow scenarios were not examined as a result of changes in habitat conditions in Scoggins Creek and the Tualatin River following construction of Scoggins Dam. The IFIM analysis incorporates existing habitat conditions that compared the weighted usable area (WUA) values versus current and projected flow conditions. Physical Habitat Simulation software was used by R2 Resource Consultants to determine habitat versus flow relationships for steelhead spawning and incubation as well as juvenile rearing habitat in Scoggins Creek and the Tualatin River. Not all life stages were modeled in all habitats. Spawning, incubation, and juvenile rearing habitat was modeled only for Scoggins Creek due to limited suitable substrate. R2 Resource Consultants also assumed that Scoggins Creek did not support sufficient adult holding habitat for steelhead. However, the TBWSP Fishery Technical Workgroup came to a consensus that adult holding habitat could be represented with juvenile rearing habitat given the nature of Scoggins Creek.

Habitat versus flow relationships for steelhead were examined, with subsequent WUA versus flow curves developed. The model generated outputs of WUA that were completed over time and under varying flow scenarios. Results of the analysis will indicate whether adequate flows for steelhead are being provided at various times of the year given existing habitat conditions. Tables 12-12, 12-13, and 12-14 were created from WUA vs. flow curves developed by R2 Resource Consultants. Reclamation used modeled monthly exceedance flows and determined through interpolation and from R2 Resource Consultants WUA vs. flow curves, the resulting WUAs.

Juvenile Rearing Habitat in Scoggins Creek and the Tualatin River

R2 Resource Consultants (2006) modeled juvenile rearing and adult holding habitat for the upper Scoggins Creek IFIM site. Curves depicting the relationship between WUA and flows for juvenile steelhead rearing habitat in upper Scoggins Creek are displayed in Figure 12-3. At upper Scoggins Creek, the WUA increases dramatically with increased flows from 10 to 50 cfs with a peak at 400 cfs. The range of WUA varies over the months when juveniles are rearing, from a low in November of 4,686 sq ft/1000 ft stream to a high of 14,507 sq ft/1000 ft stream in May (Table 12-12). For adult steelhead, WUA peaked at approximately 70 cfs, and then declined to zero WUA at flows greater than 325 cfs.

R2 Resource Consultants (2006) modeled together juvenile and adult steelhead habitat in the Tualatin River. Composite curves depicting the relationship between WUA and flows for the three Tualatin IFIM sites were very similar. The composite curve developed for the upper Tualatin River site is shown in Figure 12-4. The WUA for adult and juvenile habitat at these three Tualatin River sites peak with around 40,000 to 50,000 sq ft/1000 ft stream at approximately 200 cfs for the upper and middle site and from 250 to 350 cfs for the lower site. The WUA declines slowly with increasing flows but remains greater than 30,000 sq ft/1000 ft stream even at highest modeled Current Operation flows. This explains why flow is not an issue for migrating juveniles and adults in the Tualatin River.

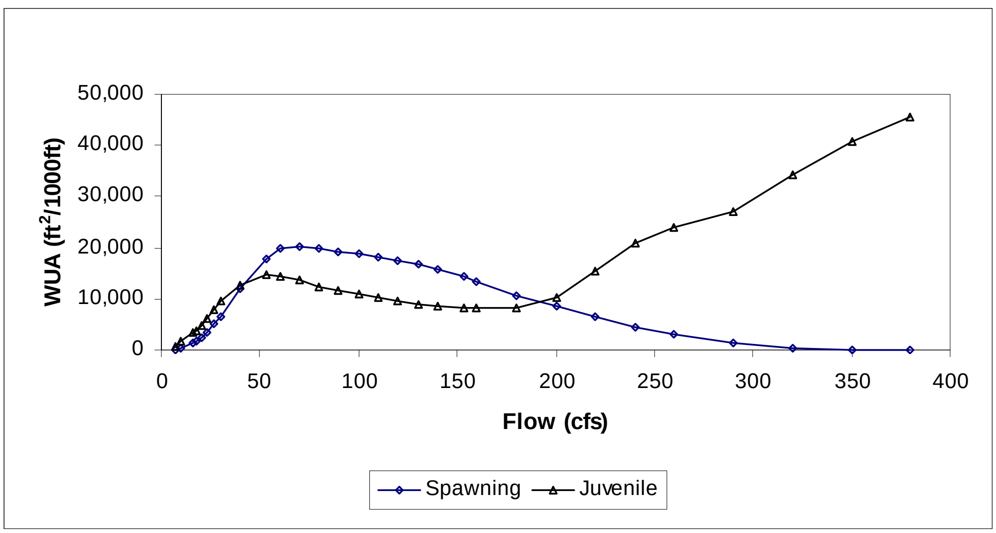

Figure 12-3. WUA curves for steelhead spawning and incubation and juvenile rearing at the upper site in Scoggins Creek (R2 Resource Consultants 2006).

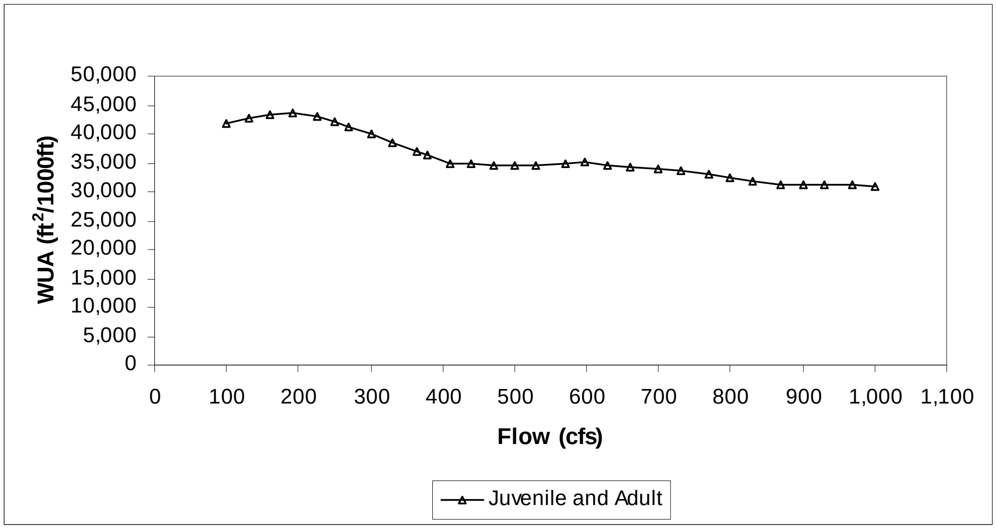

Figure 12-4. WUA curves for steelhead juvenile and adult habitat on the Tualatin River at the upper site.

Critical Habitat

NOAA Fisheries designated critical habitat for Upper Willamette River steelhead on March 25, 1999 (Table 12-1), and revised this designation on September 2, 2005. The original critical habitat designation by NOAA Fisheries in 1999 included lower Scoggins Creek and the upper Tualatin River upstream of Scoggins Creek. The redesignation of critical habitat in September of 2005 excluded most of these stream reaches based mainly on economic analyses. Critical habitat that was designated in the action area includes the reach of the Tualatin River from Gales Creek (RM 57) downstream to Dairy Creek (RM 45).

Based on information provided in previous sections of Chapter 12, we have determined that this reach of the Tualatin River contains the Primary Constituent Element (PCE) of critical habitat for juvenile rearing and adult migrations life stages. Based on descriptions in the Federal Register Notice from NOAA Fisheries, these PCEs are required to have; 1) Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; and 2) Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

12.1.6 Effects Analysis

This section describes potential effects of Reclamation's Proposed Action on the ESA-listed steelhead ESU in the action area downstream from Scoggins Dam. The area of analysis for the ESU includes those river and stream reaches where the ESUs occupied geographic area overlaps the action area of Reclamation's Proposed Action. The effects discussion considers the combined hydrologic effects of the Proposed Action. The potential for adverse effects on ESA listed fish and critical habitat varies depending on site specific features such as physical setting, project operations and activities, other anthropogenic influences, and species life stages of listed fish that may be present.

The analysis of effects from Reclamation's Proposed Action on listed steelhead is complicated by factors including inflows from wastewater treatment plants between Reclamation's projects and the action area for listed steelhead. It is expected that any measurable effect from Reclamation's Proposed Action on listed steelhead would be most pronounced in Scoggins Creek downstream from Scoggins Dam and near the SHPP, and would diminish with distance downstream from the SHPP due to tributary inflow and an array of other environmental and anthropogenic factors.

General Effects to Pathways and Indicators in the Action Area

The NOAA Fisheries habitat matrix was used as a general guide to describe and discuss habitat features as part of the environmental baseline for the Upper Willamette River steelhead in the Tualatin River from Gales Creek downstream to Dairy Creek. Table 12.6 summarizes these conditions where we had sufficient data (discussed in section 12.1.4) and notes the effects of the Proposed Action on steelhead critical habitat. In general, the Proposed Action appears to result in little to no change from existing conditions for steelhead habitat in Scoggins Creek and the Tualatin River.

Table 12-6. NOAA Fisheries matrix checklist documenting environmental baseline and general effects of Reclamation's operations on Upper Willamette River steelhead critical habitat in lower Scoggins Creek and the Tualatin River.

	Environmental Baseline			Effects of Actions		
Pathways Indicators	Properly Functioning	At Risk	Not Properly Functioning	Restore	Maintain	Degrade
Water Quality Temperature		X				X
Sediment/Turbidity		X			X	
Contaminants/Nutrients		X			X	
Habitat Access Physical Barriers			X		X	
Habitat Elements Substrate			X		X	
Large Wood		X			X	
Pool Frequency			X		X	
Pool Quality		X			X	
Off-Channel habitat			X		X	
Refugia		X			X	
Channel Conditions Width/Depth Ratio		X			X	
Streambank Condition		X			X	
Floodplain Connectivity			X		X	
Flow/Hydrology Change in Peak/Base Flows			X		X	
Increase in Drainage Network			X		X	
Watershed Conditions Road Density and Location			X		X	
Disturbance History			X		X	
Riparian Reserves			X		X	

The projected minor decreases in flows generally will occur during the cold winter months, when warm temperatures are less of an issue for aquatic life. The exception is for August and September flows near Spring Hill and Farmington. Flows during these months at those locations tend to be lower under the Proposed Action than at current conditions, indicating that additional thermal loading is likely to occur.

Table 12-7. Monthly average flows (cfs) for Scoggins Creek. Values represent the 10, 50, and 90 percent exceedance flow values of all modeled flows for that month.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10 percent Exceedance Flow (High)												
Current Conditions	128	158	397	418	379	327	189	100	105	200	249	202
Proposed Action	89	20	286	405	379	327	189	101	212	357	276	152
Percent change in flow	-30	-87	-28	-3	0	0	0	+1	+102	+79	+11	-25
50 percent Exceedance Flow (Median)												
Current Conditions	71	20	184	197	120	137	73	57	67	164	209	163
Proposed Action	62	20	10	125	120	130	73	59	118	300	211	122
Percent change in flow	-13	0	-95	-37	0	-5	0	+4	+76	+83	+1	-25
90 percent Exceedance Flow (Low)												
Current Conditions	10	10	10	10	10	10	10	22	51	113	167	117
Proposed Action	24	11	10	10	10	10	10	29	64	225	184	95
Percent change in flow	+140	+10	0	0	0	0	0	+32	+25	+99	+10	-19

Table 12-8. Monthly average flows (cfs) for the Tualatin River at Dilley. Values represent the 10, 50, and 90 percent exceedance flow values of all modeled flows for that month.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10 percent Exceedance Flow (High)												
Current Conditions	166	637	1547	1551	1288	1068	653	294	179	220	244	224
Proposed Action	167	604	1475	1536	1275	1068	653	294	251	391	280	215
Percent change in flow	+1	-5	-5	-1	-1	0	0	0	+40	+78	+15	-4
50 percent Exceedance Flow (Median)												
Current Conditions	128	204	617	732	653	570	312	145	114	180	212	190
Proposed Action	128	204	561	732	647	565	312	145	183	332	232	194
Percent change in flow	0	0	-9	0	-1	-1	0	0	+61	+84	+9	+2
90 percent Exceedance Flow (Low)												
Current Conditions	75	62	152	205	270	216	117	94	85	136	169	135
Proposed Action	49	63	152	205	270	216	117	104	125	266	198	161
Percent change in flow	-35	+2	0	0	0	0	0	+11	+47	+96	+17	+19

Table 12-9. Monthly average flows (cfs) for the Tualatin River below SHPP. Values represent the 10, 50, and 90 percent exceedance flow values of all modeled flows for that month.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10 percent Exceedance Flow (High)												
Current Conditions	124	1079	2518	2473	2184	1862	1059	427	187	125	138	147
Proposed Action	128	985	2394	2410	2170	1855	1029	381	146	228	129	79
Percent change in flow	+3	-8	-5	-3	-1	-1	-3	-11	-22	+82	-7	-46
50 percent Exceedance Flow (Median)												
Current Conditions	85	315	1072	1231	1128	905	506	176	77	96	117	117
Proposed Action	55	304	930	1180	1119	891	481	133	106	180	64	77
Percent change in flow	-35	-3	-13	-4	-1	-2	-5	-24	+38	+88	-45	-34
90 percent Exceedance Flow (Low)												
Current Conditions	53	28	241	395	434	395	159	84	25	62	84	81
Proposed Action	25	26	230	385	426	378	120	53	57	113	58	77
Percent change in flow	-53	-7	-5	-3	-2	-4	-25	-37	+128	+82	-31	-5

Table 12-10. Monthly average flows (cfs) for the Tualatin River below Farmington. Values represent the 10, 50, and 90 percent exceedance flow values of all modeled flows for that month.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10 percent Exceedance Flow (High)												
Current Conditions	292	2367	5405	5739	5155	4246	2571	1078	470	218	172	221
Proposed Action	338	2223	5292	5669	5146	4235	2547	1026	436	290	196	202
Percent change in flow	+16	-6	-2	-2	-1	-1	-1	-5	-7	+33	+14	-9
50 percent Exceedance Flow (Median)												
Current Conditions	180	571	2433	3040	2972	2151	1267	482	243	150	150	180
Proposed Action	153	565	2240	3023	2965	2119	1248	439	238	280	107	132
Percent change in flow	-15	-1	-8	-1	-1	-1	-1	-9	-2	+87	-29	-27
90 percent Exceedance Flow (Low)												
Current Conditions	149	178	621	1045	1282	942	484	283	149	150	150	149
Proposed Action	104	179	609	1033	1274	932	427	243	238	154	78	114
Percent change in flow	-30	+1	-2	-1	-1	-1	-12	-14	+60	+2	-48	-23

Table 12-11. Monthly average flows (cfs) for the Tualatin River at West Linn. Values represent the 10, 50, and 90 percent exceedance flow values of all modeled flows for that month.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10 percent Exceedance Flow (High)												
Current Conditions	353	2475	5632	5807	5322	4383	2718	1153	536	255	202	261
Proposed Action	362	2361	5514	5773	5284	4331	2695	1105	498	310	211	222
Percent change in flow	+3	-5	-2	-1	-1	-1	-1	-4	-7	+22	+4	-15
50 percent Exceedance Flow (Median)												
Current Conditions	207	631	2573	3374	3163	2320	1374	561	280	173	157	190
Proposed Action	180	626	2397	3320	3157	2282	1359	524	299	283	122	156
Percent change in flow	-13	-1	-7	-2	-1	-2	-1	-7	+7	+64	-22	-18
90 percent Exceedance Flow (Low)												
Current Conditions	173	213	732	1143	1391	1116	575	346	181	149	146	166
Proposed Action	129	211	723	1132	1383	1094	556	305	255	162	86	134
Percent change in flow	-25	-1	-1	-1	-1	-2	-3	-12	+41	+9	-41	-19

Effects to Juvenile Rearing Habitat in Scoggins Creek and the Tualatin River

Scoggins Creek

Modeling results predicted at the high, 10 percent exceedance flows for the upper Scoggins site (Table 12-12), WUA for rearing steelhead increased for the months of June through August and declined slightly for the months of September, November, and January. While the month of December showed a substantial decline in WUA, there was still adequate habitat available of about 26,674 sq ft/1000 ft stream.

The WUA estimates at the median, 50 percent exceedance flow condition (Table 12-12) showed gains in WUA for the months of July through October and March. The WUAs either remained the same or decreased slightly during the months of January, February, April, May, and November. December and June had substantial declines of WUA, where a reduction in flow of 95percent for the month of December under the Proposed Action explains the reduction of available habitat for rearing steelhead. The decline in WUA for the month of June is associated with a near doubling of flows associated with increased releases from Scoggins Dam.

The WUA estimates at the low, 90 percent exceedance flow conditions (Table 12-12) slightly declined in June, with the remainder of the months staying the same or increasing.

Overall impacts to juvenile rearing steelhead appear minor under all flow scenarios, with the exception for the month of December at the 50 percent exceedance flow condition, where the Proposed Action results in only 10 cfs being released from Scoggins Dam, thereby decreasing available habitat.

Tualatin River

The WUA projections for juvenile rearing/adult holding steelhead habitat on the upper (Dilley) and middle (below SHPP) site of the Tualatin River (Table 12-13) for nearly all months and all exceedance flow conditions remained high (even when the WUA declined under the Proposed Action), with the exception of the month of October (juvenile rearing) (85 percent decrease) at the 90 percent exceedance flow below the SHPP. That month showed a modeled decrease in flow (Table 12-9) from 53 cfs to 25 cfs under the Proposed Action.

The WUA projections for the Tualatin River at Farmington (Table 12-14) were high at the 10, 50, and 90 percent exceedance flows for the period that downstream migrating juveniles and upstream migratory adult steelhead would be passing through during February through April. The Proposed Action resulted in very little change in WUA when compared to Current Conditions.

Table 12-12. Steelhead - Scoggins Creek - Difference in WUA[9] (square feet per 1000 feet) between Current Conditions and Proposed Action.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Spawning and Incubation – Upper Scoggins below Scoggins Dam												
10 percent Exceedance Flow (High)												
Current Conditions						203	9707	18873	18563			
Proposed Action						0.0	0.0	-62	-11525			
50 percent Exceedance Flow (Median)												
Current Conditions					17509	16030	20146	19010	20138			
Proposed Action					0.0	+702	0.0	+516	-2480			
90 percent Exceedance Flow (Low)												
Current Conditions					450	450	450	3091	17099			
Proposed Action					0.0	0.0	0.0	+3060	+2887			
Juvenile Rearing/Adult Holding – Upper Scoggins below Scoggins Dam												
10 percent Exceedance Flow (High)												
Current Conditions	9133	8113	47404	49883	45226	35770	9129	10885	10527	10339	22136	10854
Proposed Action	+2613	-3427	-20730	-1493	0.0	0.0	0.0	-72	+2905	+31565	+3446	-2562
50 percent Exceedance Flow (Median)												
Current Conditions	13464	4686	8579	10009	9552	8759	13247	14507	13837	8070	12659	8066
Proposed Action	+812	0.0	-6896	-719	0.0	+269	0.0	-37	-4162	+21413	+515	+1381
90 percent Exceedance Flow (Low)												
Current Conditions	1683	1683	1683	1683	1683	1683	1683	5594	14331	9983	8083	9737
Proposed Action	+4819	+288	0.0	0.0	0.0	0.0	0.0	+3429	-230	+6825	+496	+1537

[9] The WUA numbers were developed from WUA vs flow curves by R2 Resource Consultants in 2006. Reclamation used modeled monthly exceedance flows to generate the WUAs.

Table 12-13. Steelhead - Tualatin River - Difference in WUA between Current Conditions and Proposed Action.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Juvenile Rearing/Adult Holding – Tualatin River Near Dilley												
10 percent Exceedance Flow (High)												
Current Conditions	42297	34579	47570	>45000	>45000	32809	34376	40151	42603	43012	42321	43027
Proposed Action	+24	+478	-2277	0.0	0.0	0.0	0.0	0.0	-547	-7203	-1572	-33
50 percent Exceedance Flow (Median)												
Current Conditions	41027	42953	34863	33666	34376	34773	39357	41641	40340	42647	42983	42862
Proposed Action	0.0	0.0	-973	0.0	+76	-29	0.0	0.0	+2357	-4159	-209	+55
90 percent Exceedance Flow (Low)												
Current Conditions	37779	36691	41881	42957	41256	42997	40487	39217	38562	41331	42368	41297
Proposed Action	-3041	+84	0.0	0.0	0.0	0.0	0.0	-637	-2318	+109	+563	+882
Juvenile Rearing/Adult Holding – Tualatin River below SHPP												
10 percent Exceedance Flow (High)												
Current Conditions	49704	30453	38031	37282	33059	29266	30785	45956	53432	49767	50597	51171
Proposed Action	+255	+1658	-2081	-832	-38	-85	+503	+2087	-2325	+5410	-574	-8233
50 percent Exceedance Flow (Median)												
Current Conditions	44663	52490	30572	28562	29662	33838	42919	52848	42362	46771	49114	49114
Proposed Action	-8703	+820	+2730	+294	+139	+351	+995	-2570	+5525	+6289	-10491	-6752
90 percent Exceedance Flow (Low)												
Current Conditions	33905	8219	55667	47214	45700	47214	51936	44376	5137	38048	44376	43513
Proposed Action	-28768	-2054	-415	+592	+292	+1066	-2488	-10471	+31472	+10619	-7479	-1151

Table 12-14. Steelhead - Tualatin River - Difference in WUA between Current Conditions and Proposed Action.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Juvenile/Adult Migration – Tualatin River at Farmington												
10 percent Exceedance Flow (High)												
Current Conditions					91828	75760	45750	40963	49381	52022	51424	52046
Proposed Action					-98	-410	-335	+1402	+869	+444	+394	-155
50 percent Exceedance Flow (Median)												
Current Conditions					52972	38339	37912	49176	52219	51081	51081	51566
Proposed Action					-125	-571	+298	+943	-39	+1337	-1239	-791
90 percent Exceedance Flow (Low)												
Current Conditions					37739	44265	49135	52433	51064	51081	51081	51064
Proposed Action					0	+196	+1298	-214	+1116	-68	-3378	-830

Effects to Critical Habitat

Section 3(5)(A)(i) of the ESA defines critical habitat as specific areas that possess those physical or biological features essential to the species' conservation. Essential features of Upper Willamette River steelhead spawning areas are outside of the area designated as critical habitat in the Tualatin River subbasin. The essential features of the juvenile migration corridor are met since these fish are actively migrating in the spring when adequate flows are available for the reach of the Tualatin River designated as critical habitat (see Tables 12-9, 12-10, and 12-11). The essential features of the adult migration corridor are met since adult steelhead are actively migrating in late fall/early winter when adequate flows are available in the Tualatin River.

The PCE of freshwater rearing sites (identified previously in Chapter 12.1.5), with the exception of water temperature, will remain the same (functioning at risk and not properly functioning). Water temperature near Spring Hill and Farmington during the months of August and September are expected to increase slightly as a result of decreased flows. However, the limited available data cannot be used to quantify the expected increase in water temperature.

The PCE of freshwater migration corridors will essentially remain the same (at risk to not functioning) under the Proposed Action.

12.1.7 Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the Proposed Action are not analyzed for cumulative effects because they require separate consultation.

A large number of activities occur in the action area, such as agriculture, sewage treatment, forestry activities, construction, and commercial and residential development. These activities will continue into the future, and their effects will contribute to cumulative effects. The specific impacts of these activities are unknown at this time. A Recovery Plan for Willamette River steelhead is in progress and expected to be completed within a year.

CWS and JWC are Tualatin Project water users who are also participating in a partnership of local agencies interested in developing additional water supplies primarily for municipal, industrial, and water quality purposes. The TBWSP contemplates the potential raising of Scoggins Dam for additional water storage, in conjunction with modifying the SHPP to operate in a pump-back mode to transfer water from the Tualatin River up to Hagg Lake during periods of high winter flows. A separate BA specific to the TBWSP is planned to be submitted by Reclamation to the Services at a later date (see Section 2.1.1).

In April 2006, the USFWS issued an environmental assessment for the proposed Wapato Lake Unit of the Tualatin River NWR. The Wapato Lake Unit is intended to provide wildlife and habitat protection and is located along the mainstem of the Tualatin River, including locations from the river's confluence with Scoggins Creek downstream to areas just east of the city of Forest Grove. The USFWS has now documented its decision to establish the Wapato Lake Unit in a Finding of No Significant Impact. A land acquisition program has been initiated for the USFWS to acquire lands or interest in lands from willing sellers.

Reclamation has determined that the cumulative effects of the above actions and the Proposed Action will result in the same effects on listed species as summarized in section 12.4.

12.1.8 Interrelated and Interdependent Activities

Activities that are not part of the Proposed Action but which are considered interrelated and interdependent to the Proposed Action have been considered in the effects analyses presented in this BA. These interrelated and interdependent activities include: operation and maintenance of non-Federal pumps at SHPP, diversion of non-project water at Wapato Canal, and operation and maintenance of the fish ladder at Lake Oswego Corporation Diversion Dam. These activities are described in more detail in section 2.1. Reclamation has included the effects of interrelated and interdependent activities in its assessment of effects on listed species as summarized in section 12.4.

12.2 Effects Conclusion

Overall, the availability of steelhead rearing habitat in Scoggins Creek is expected to remain the same or increase the majority of the time under the Proposed Action. However, the months of June and December show a decline in WUA for rearing steelhead for all exceedance flows (94 percent decline at the 50 percent level) as a result of releases from Scoggins Dam under the Proposed Action. It is unknown to what extent these flows will have on rearing steelhead.

From SHPP downstream to Farmington, fish screening criteria not being met at SHPP will impact rearing steelhead, as well as low flow during the months of August and September, resulting in elevated water temperature.

Table 12-15 - Summary of effects on Upper Willamette River steelhead.

Stream Segment	Spawning (Feb – June 7)/ Incubation (Feb – July 7)	Juvenile Rearing (year-round)	Juvenile/Adult Migration (Feb – May)	Feb – May Adult Holding	Water Temperature
Scoggins Creek	The best available information does not support the presence of adult steelhead in Scoggins Creek.	Potential negative effect from low flow in December and high flow in June at median exceedance. At low flow exceedance, no change. Insignificant changes at high exceedance.	Generally no changes.	Generally no changes.	Not expected to change substantially from current conditions.
Tualatin River near Dilley	No spawning habitat.	Generally minor rearing habitat changes (gains and losses) should not adversely affect steelhead. Insignificant changes at high, median, and low flow levels.	Generally no changes.	Generally minor adult holding habitat changes (gains and losses) should not adversely affect steelhead. Insignificant changes at high, median, and low flow levels.	Not expected to change substantially from current conditions.
Tualatin River below SHPP	No spawning habitat.	Potential negative effects from decreased flows October – November at low flow exceedance. Fish screening criteria not met at SHPP may adversely affect juvenile rearing. Insignificant changes at median and high flow exceedance.	Only minor changes.	No adult holding habitat.	August & September flows will be less under Proposed Action.
Tualatin River below Farmington	No spawning habitat.	No juvenile rearing habitat.	Minor to no changes in juvenile and adult migratory habitat.	No adult holding habitat.	

12.3 Upper Willamette River Spring Chinook Salmon

12.3.1 Status

NOAA Fisheries listed the Upper Willamette River Chinook salmon ESU as threatened on March 24, 1999 (Table 12-1). This ESU includes all naturally spawned spring-run Chinook salmon populations in the Clackamas River and in the Willamette River and its tributaries above Willamette Falls, Oregon. Figure 12-5 shows the geographic range of this ESU. Seven artificial propagation programs are considered to be part of this ESU (WRI 2004). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 8,575 square miles. The Willamette /Lower Columbia Technical Recovery Team (WLCTRT 2003) identified seven populations in this ESU: the Clackamas River, Molalla River, North Santiam River, South Santiam River, Calapooia River, McKenzie River, and the Middle Fork Willamette River. The ODFW (2003) reports that spring Chinook salmon may have historically accessed Upper Gales Creek prior to 1940, but they do not return to the Tualatin subbasin at this time. According to NOAA Fisheries (Turner 2006), juvenile Upper Willamette River Chinook salmon do occupy the Tualatin River at the confluence with the Willamette River.

Section 8.13 of the SCA (NOAA Fisheries 2008) contains additional information on life history, habitat requirements, and factors for decline. This ESU's geographical range for spawning and incubation is outside the action area; juveniles enter the action area in the lower Tualatin River when they are migrating in the Willamette River.

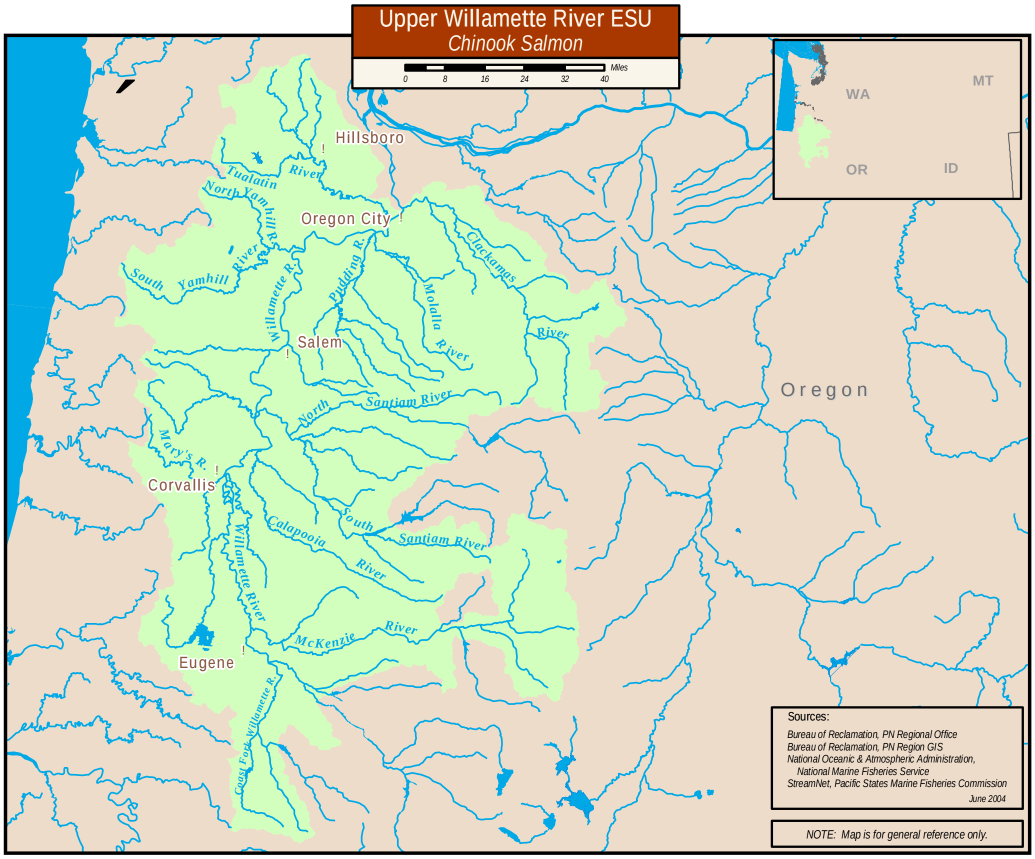

Figure 12-5. Geographic range of the Upper Willamette River Chinook salmon ESU.

12.3.2 Distribution and Abundance

Myers et al. (1998) note that the total abundance of this ESU has been relatively stable at about 20,000 to 30,000 fish, although recent escapement has been declining. The BRT (2003) estimated an abundance of 1,787 natural spawners for this ESU, concluding that many of the returning adults are of hatchery origin. Figure A.2.6.2 of the BRT (2003) shows some higher returns in the late 1980s and early 1990s. Table 12-16 shows recent counts at Willamette Falls Fishway. Risks to this ESU include habitat blockage and habitat degradation.

Table 12-16. Willamette Falls spring Chinook salmon counts (Murtagh 2009).

Year	Adults	Jacks
2001	52,685	1,288
2002	82,111	1,025
2003	85,898	1,851
2004	96,319	757
2005	35,453	1,180
2006	36,851	190
2007	22,818	280

Murtagh (2006) speculates that spring Chinook may have historically strayed into the Tualatin River, but there was never a healthy robust return to this system, primarily because water quality and flow were more attractive in the east-side tributaries such as the Molalla, Santiam, and upper Willamette River. As mentioned previously by NOAA, it appears that only juvenile Upper Willamette River Chinook salmon occupy the Tualatin River at the confluence with the Willamette River. These are migratory smolts moving down the Willamette River that enter the lower Tualatin River near the confluence, possibly seeking improved water quality and quantity conditions, better forage conditions, etc.

12.3.3 Life History

There are two races of Chinook salmon found in Oregon streams; spring Chinook salmon and fall Chinook salmon. Spring-run Chinook salmon generally enter the Upper Willamette River from March through mid-August, while fall Chinook salmon entry peaks in September. Variations in freshwater entry and run timing exist in local populations and occur in response to the local temperature and water flow regimes (Myers et al. 1998). For example, Upper Willamette River spring Chinook salmon exhibit an early entry into freshwater compared to other Columbia River stocks. Upper Willamette River spring Chinook salmon are unique among other Columbia River stocks based on genetic differences and distinct life history patterns.

Spawning

Chinook salmon mature and begin their spawning migration at ages 3 to 6 years, with most spawning adults at ages 4 or 5 (WRI 2004). Spring Chinook salmon spawn primarily from September through November, and fall Chinook salmon spawn predominantly during October and December. Females may deposit somewhere between 3,000 and 6,000 eggs depending on age and body size (WRI 2004).

Juvenile Rearing and Outmigration

Similar to all salmon, Chinook salmon egg incubation varies with temperature. Chinook salmon eggs hatch in about 159 days at 3˚C, and in 32 days at 16˚C (WRI 2004). Prior to emerging, the young remain in the gravel for two to three weeks after hatching (WRI 2004). Many variations in juvenile life history stage are possible. Some juvenile fish may move into the ocean quickly, while others depend on extended rearing in the streams or estuaries (WRI 2004). In the Willamette River basin, most Chinook salmon exhibit a yearling strategy where juveniles will rear in natal streams for a full year before migrating downstream to estuarine habitats (WRI 2004). Although some fish may move throughout the year, juvenile Chinook salmon in the Willamette River exhibit a peak in their downstream migration in the fall with the onset of the fall rains in October and November and again in the late winter and spring with freshets.

12.3.4 Critical Habitat

NOAA Fisheries designated critical habitat for Upper Willamette River Chinook salmon on March 24, 1999 (Table 12-1), and reissued this designation on September 2, 2005. No Upper Willamette River Chinook salmon critical habitat was designated within the action area.

12.3.5 Chinook Effects Analysis

Upper Willamette River Chinook salmon (juvenile migratory phase) appear to only occupy the Tualatin River at the confluence with the Willamette River during downstream migrations from the Upper Willamette River. This location is at the end of the Action Area and is affected little by the Proposed Action as evidenced by the percent change in flow at the 10, 50, and 90 percent exceedance levels for monthly average flows for the Tualatin River at West Linn (Table 12-11). Based on these flow conditions, the Proposed Action may affect, but will not adversely affect Upper Willamette River Chinook Salmon in the Action Area.

12.4 Effects Conclusion Summary

Upper Willamette River Steelhead

Juvenile rearing habitat in Scoggins Creek would be expected to see more increases in available habitat than decreases the majority of the time under the Proposed Action at the modeled 50 and 90 percent exceedance flows. The only substantial decrease in WUA for juvenile rearing and adult holding under the Proposed Action would be during the month of December at the 50 percent exceedance flow, when releases are 10 cfs; this decline in streamflow would decrease WUA habitat for juveniles by 80 percent. The impacts associated with the reduction in streamflow would be a lack of adequate rearing habitat and lack of cover. Juvenile steelhead may be forced to other locations (mainstem Tualatin River) where more suitable flows and habitat conditions prevail. Availability of adult and juvenile habitat in the Tualatin River would either remain similar to the Current Conditions, or retain a high WUA, even after a decline of WUA under the Proposed Action, again indicating either similar or positive impacts associated with the Proposed Action. The only substantial decrease in WUA for adult and juvenile habitat was for the months of October and November (90 percent exceedance flows) in the Tualatin River below the SHPP, when flows drop to 25 to 26 cfs.

Both water temperature and dissolved oxygen for Scoggins Creek are not expected to change significantly from current conditions, therefore not having impacts on fish. In the Tualatin River below SHPP during the months of August and September, flows will be less under the Proposed Action, which has the potential for increased water temperature which may affect rearing steelhead.

Overall, Reclamation's Proposed Action is likely to adversely affect juvenile rearing habitat in Scoggins Creek for the month of December as a result of decreased releases. In the Tualatin River below the SHPP, adult and juvenile habitat would be adversely affected during the months of October and November under low flow modeled conditions. Table 12-15 summarizes effects of the Proposed Action on Upper Willamette River steelhead in Scoggins Creek and the Tualatin River.

Upper Willamette River Steelhead Critical Habitat

The essential features for both the juvenile and adult migration corridor will be met under the Proposed Action. The PCE of freshwater migration corridors will essentially remain the same under the Proposed Action.

Upper Willamette River Spring-run Chinook

Currently, the Tualatin River subbasin is not considered to include Chinook salmon spawning habitat (Alsbury 2006). Any possible Chinook salmon using habitat in the subbasin would have moved into the lower most reaches of the Tualatin River from the Willamette River. The Proposed Action may affect, but will not adversely affect upper Willamette River spring Chinook salmon.

12.4.1 Spring Hill Pumping Plant

Under the Proposed Action, the SHPP existing traveling water screens will remain in place and continue to operate without meeting current NOAA Fisheries and ODFW criteria for effective protection of juvenile anadromous fish. Continued impacts include the potential entrainment of juvenile steelhead. However, the proposed TBWSP includes plans for modifying SHPP fish screens in accordance with the proposed changes to the pumping plant facility and operations (see Section 3.2.6). Because the timeframe is uncertain for reaching a final decision on implementation of the TBWSP, Reclamation plans to defer decisions about SHPP fish screen upgrades for 10 years. In the meantime, Reclamation remains committed to working with NOAA Fisheries and USFWS to discuss ongoing operations, to plan for related investigations and/or interim steps, and to consider possible funding for related programs if appropriate. Reclamation's Proposed Action is likely to adversely affect juvenile steelhead at the SHPP.

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Chapter 13 ESSENTIAL FISH HABITAT

13.1 Background

EFH has been designated for federally managed groundfish, coastal pelagics, Chinook salmon, coho salmon, and Puget Sound pink salmon (*O. gorbuscha*) fisheries within the waters of Washington, Oregon, and California (PFMC 1999).

In previous consultations for Reclamation projects, NOAA Fisheries stated that:

> [d]esignated EFH for groundfish and coastal pelagic species encompasses all waters from the mean high water line, and upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon, and California, seaward to the boundary of the U.S. exclusive economic zone (370.4 km) (PFMC 1998a, 1998b). Detailed descriptions and identification of EFH for the groundfish species are found in the Final Environmental Assessment/Regulatory Impact Review for Amendment 11 to The Pacific Coast Groundfish Management Plan (PFMC 1998a) and NOAA Fisheries EFH for West Coast Groundfish Appendix (Casillas et al. 1998). Detailed descriptions and identifications of EFH for the coastal pelagic species are found in Amendment 8 to the Coastal Pelagic Species Fishery Management Plan (PRMC 1998b).
>
> Freshwater EFH for federally managed Pacific salmon includes all those river, streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, except above the impassable barriers identified by PFMC (1999). Chief Joseph Dam, Dworshak Dam, and the Hells Canyon Complex (Hells Canyon, Oxbow, and Brownlee Dams) are among the listed man-made barriers that represent the upstream extent of the Pacific salmon fishery EFH. Freshwater salmon EFH excludes areas upstream of longstanding, naturally impassable barriers (e.g., natural waterfalls in existence for several hundred years). In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California, north of Point Conception to the Canadian border. Detailed descriptions and identifications of EFH for Pacific salmon are found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999).

Appendix A to Amendment 14 of the Pacific Coast Salmon Plan (PFMC 1999) listed EFH for Chinook salmon and coho salmon in the Tualatin River. EFH was delineated by 4th field hydrologic unit codes (HUCs). EFH for the two salmon species was listed without regard for whether the ESUs of the two species were federally listed under the ESA, and the particular Chinook or coho salmon ESUs that occupied the area were not considered when designating EFH. For this EFH analysis, Reclamation considers both ESA-listed ESUs and nonlisted Chinook and coho salmon stocks that spawn, rear, and/or migrate in the action area.

The objective of this EFH assessment is to describe potential adverse effects to designated EFH for federally-managed fisheries species within the Action area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the Proposed Action.

Reclamation's proposed operation is described in Chapter 2 of the BA for the Tualatin Project. Chapter 12.6.1 briefly describes impacts to upper Willamette River Chinook salmon, although this stock has only recently been documented in the lower reach of the Tualatin River, where the Tualatin Project has little to no impacts on this species of fish.

13.2 Action Area

The action area for this EFH consultation includes the farthest upstream point at which federally managed salmon fisheries smolts enter (or adults exit) the Tualatin River up to and including Scoggins Creek to Scoggins Dam. The action area in Scoggins Creek includes the area immediately downstream of Scoggins Dam, to the confluence of the Tualatin River, and downstream to the confluence of the Willamette River.

This area encompasses one 4th field HUC (17090010). EFH was designated for Chinook and/or coho salmon in this HUC in Appendix A of Amendment 14 (PFMC 1999). Table 13-1 provides summary information for the EFH-designated species, affected ESU, and life history use.

Table 13-1. Tualatin River subbasin HUC with designated Chinook and coho salmon EFH, Chinook ESU, and life history use (from Tables A-1 and A06 in PFMC 1999).

HUC	Hydrologic Unit Name	Species	Current or Historical Distribution	ESU	Life History Use
17090010	Tualatin River	Chinook salmon	Currently accessible but unutilized historic habitat in action area. Juveniles enter the action area in the lower Tualatin River in the spring when they are migrating downstream in the Willamette River	Upper Willamette River Spring Chinook salmon	M
		Coho salmon	Current habitat	None	S, R, M
M=migratory; S=spawning; R=rearing					

In the case of the Tualatin River HUC (17090010), the EFH designation did not differentiate between specific Chinook or coho ESUs, nor consider any ESA listing status (e.g., the coho salmon ESU is outside the Tualatin River subbasin).

13.3 Status, Life History, Habitat Requirements, and Effects Analysis

13.3.1 Upper Willamette River Chinook Salmon

Species Information

General life history information for upper Willamette River Chinook salmon is provided in Chapter 12.3.

13.3.2 Lower Columbia River Coho Salmon

Species Information

Coho salmon are anadromous and reproduce and spend the early portion of their life in freshwater then metamorphose into smolts that migrate to sea for a period of adult growth. Oregon coho salmon return to natal tributaries in November and spawn from November through February (Nickelson et al. 1992). Adult coho salmon require deep holding cover for resting during upstream migration and sufficient discharge for upstream movement into tributaries. Laufle et al. (1986) reported minimum depths of 18 centimeters are needed for upstream migration of coho. For spawning and egg incubation, coho salmon require clean gravel and cool water temperatures (53 to 58°F preferred) (Reiser and Bjornn 1979). Adult coho salmon die after spawning.

The length of incubation for coho salmon ranges from 35 to 101 days (Laufle et al. 1986). Egg mortality occurs at stream temperatures above 13.3°C (Spence et al. 1996). After hatching, larval fish typically spend two to three weeks in the gravel before they emerge in early March to mid-May (Laufle et al. 1986; McMahon 1983), and rear in fresh water for one year before outmigration. Newly emerged fry usually congregate along stream margins and in backwater pools. As juveniles grow, they disperse and aggressively defend their territory, which results in displacement of excess juveniles downstream to potentially less favorable habitat (Wydoski and Whitney 1979).

Once territories are established, individuals typically rear in selected areas of the stream, feeding on drifting benthic organisms and terrestrial insects until the following spring (Hart 1973). During their first winter, juveniles will use a variety of slower water habitats including alcoves, side channels, beaver pools, and dam pools (Nickelson et al. 1992). In the winter, this complex habitat can provide low velocity refuge from high flows. Complex large wood structures and side channels are important habitats for coho salmon during the summer low-flow period (1986). These studies suggest the importance of freshwater habitat diversity, in particular high pool to riffle ratios, and habitat complexity in determining juvenile coho production, a component that is not present in both Scoggins Creek and the Tualatin River (downstream from Scoggins Creek). Juvenile coho salmon rear in freshwater for approximately 15 months prior to migrating downstream to the ocean, but some rear in freshwater up to two years (Sandercock 1991). The smolt outmigration begins in February and may continue into June, with peak migration occurring in May. Smolt migration timing is influenced by timing of spring storms. Coho spend 5 to 20 months in ocean before returning to spawn (Johnson et al. 1991). Table 13-2 summarizes life history timing for coho salmon in the Tualatin River.

Table 13-2. Life history timing for coho salmon - Tualatin River.

Species	Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coho	Adult Migration												
	Spawning												
	Incubation												
	Rearing												

Coho salmon are not considered native to the Tualatin River subbasin. Stocking of coho salmon by ODFW in the early 1900s and the construction of a fish ladder at Willamette Falls has resulted in some natural production of coho salmon in this subbasin (BLM 2000). ODFW also extensively stocked coho in the Tualatin subbasin between 1962 and 1999. Over 3.5 million coho fry were planted in the upper Tualatin River between 1962 and 1982. Approximately 2,400 adult coho salmon were also planted in the upper Tualatin between 1962 and 1972. ODFW began stocking coho smolts in the Tualatin River and Scoggins Creek in 1973. Over 1.7 million individuals were planted prior to discontinuing the practice in 1999 in response to the Federal listing of Upper Willamette River steelhead. Some natural production of coho salmon currently occurs in Gales Creek and other tributaries in the Tualatin River (White 2003). The ODFW observed what they thought were coho salmon spawning in Scoggins Creek downstream from Scoggins Dam in December 2005 (Alsbury 2006). In November 2006 and 2007, ODFW conducted a coho spawning survey in the Scoggins Creek channel below the Henry Hagg spillway and found 19 redds, 7 dead (spawned out) coho, and 3 live coho in 2006, and 18 redds and 1 dead coho in 2007 (Murtagh 2006 and 2007).

Although some natural reproduction of coho salmon occurs in Gales Creek and other tributaries of the Tualatin River, it is the result of past introductions and successful reproduction by hatchery fish.

13.4 Potential Adverse Effects of Proposed Action - Chinook and Coho Salmon

By virtue of the various life stages of coho and Chinook salmon present, the Proposed Action may adversely affect Chinook and coho salmon by decreasing current survival levels and abundance of several freshwater life history stages of coho and Chinook salmon, including adults, fry, juveniles, and outmigrating smolts. The magnitude of these affects cannot be quantified at this time.

Coho - Scoggins Creek

During August through December, the Proposed Action could adversely affect the EFH function of providing passage conditions for upstream migrating coho salmon and their spawning success in Scoggins Creek. The Proposed Action will reduce flows by 95 percent (184 to 10 cfs) at the 50 percent exceedance level (Table 12-7) for the month of December. This reduction in flow could prevent coho salmon from accessing the limited amount of spawning habitat located below Scoggins Dam.

During October through February, the Proposed Action could adversely affect the EFH function of providing spawning habitat conditions for coho salmon in Scoggins Creek below Scoggins Dam. At the 10 percent exceedance level (Table 12-7), the Proposed Action will reduce flows during the month of November by 87 percent to 20 cfs, and at the 50 percent exceedance flow, for the month of December, flow will be reduced 95 percent to 10 cfs. These reductions in flow under the Proposed Action will likely reduce the amount of limited spawning substrate available for coho salmon in Scoggins Creek below Scoggins Dam.

During October through May, the Proposed Action could adversely affect the EFH function of providing incubation habitat conditions for coho salmon in Scoggins Creek below Scoggins Dam. The months of impact would be similar as identified in the previous paragraph. These reductions in flow under the Proposed Action could expose coho salmon redds, resulting in desiccation of eggs and newly hatched fry.

During the entire year, the Proposed Action could adversely affect the EFH function of providing rearing habitat conditions for coho salmon in Scoggins Creek below Scoggins Dam. The amount of coho rearing habitat would likely decrease as a result of flow reductions under the Proposed Action during the months of November, December, and January (Table 12-7), and would again decrease as a result of increased releases from Scoggins Dam in June and July. Flow reductions may result in the stranding of rearing coho salmon, elevated water temperatures which could force rearing coho to seek more suitable rearing habitat (mainstem Tualatin River), or could result in increased levels of predation due to lack of hiding cover.

During the migratory period of February through June, the Proposed Action will likely not affect the EFH function of coho smolt migration, based on either existing conditions not changing, or flows increasing under the Proposed Action during the months of May and June (Table 12-7).

Coho - Tualatin River

The Proposed Action will not adversely affect the EFH function of providing passage, rearing, and juvenile migratory conditions for coho salmon in the Tualatin River. Modeled streamflows (Tables 12-8, 12-9, and 12-10) at Dilley, SHPP, and Farmington would, for the most part, remain at or above normal parameters under the Proposed Action for coho salmon in the Tualatin River. The only exception would be for the month of October below the SHPP, where monthly average flow would drop 53 percent to 25 cfs at the 90 percent exceedance flow. This reduction in flow could potentially delay migratory adult coho moving up the Tualatin River.

Chinook salmon - Scoggins Creek

During March through mid-August, the Proposed Action will not affect the EFH function of providing passage conditions for upstream migrating Chinook salmon and their potential spawning success in Scoggins Creek. The Proposed Action will either maintain or increase flow (Table 12-7) in Scoggins Creek during the period migratory Chinook salmon would be present.

During September through November, the Proposed Action could adversely affect the EFH function of providing spawning habitat conditions for Chinook salmon in Scoggins Creek below Scoggins Dam. At the 10 percent exceedance level (Table 12-7), the Proposed Action will reduce flows during the month of November by 87 percent to 20 cfs, This reduction in flow under the Proposed Action will likely reduce the amount of existing limited spawning substrate available for coho salmon in Scoggins Creek below Scoggins Dam.

During November through April, the Proposed Action could adversely affect the EFH function of providing incubation habitat conditions for Chinook salmon in Scoggins Creek below Scoggins Dam. At the 10 percent exceedance level (Table 12-7), the Proposed Action will reduce flows during the month of November by 87 percent to 20 cfs, and at the 50 percent exceedance flow, for the month of December, flow will be reduced 95 percent to 10 cfs. These reductions in flow under the Proposed Action could expose Chinook salmon redds, resulting in desiccation of eggs and newly hatched fry.

During the entire year, the Proposed Action could adversely affect the EFH function of providing rearing habitat conditions for Chinook salmon in Scoggins Creek below Scoggins Dam. The amount of Chinook rearing habitat would likely decrease as a result of flow reductions under the Proposed Action during the months of November, December, and

January (Table 12-7), and would again decrease as a result of increased releases from Scoggins Dam in June and July. Flow reductions may result in the stranding of rearing coho salmon, elevated water temperatures which could force rearing coho to seek more suitable rearing habitat (mainstem Tualatin River), or could result in increased levels of predation due to lack of hiding cover. Flow increases might reduce available rearing habitat due to high water velocity which might flush rearing fish downstream to unsuitable habitat.

The SHPP, which currently does not meet NOAA Fisheries and ODFW criteria for effective passage of juvenile anadromous fish would continue to adversely affect the survival of juvenile Chinook and coho salmon.

13.5 Essential Fish Habitat Conservation Measures

Increased releases from Scoggins Dam during previously identified low flow periods, water conservation, and habitat improvement projects (described in section 3.2.4) will contribute towards improving EFH in the Action area. In addition, streamflow requirements of coho salmon, and, to a lesser extent, Chinook salmon, need to be quantified in Scoggins Creek allowing for a better estimation of the effects of Federal water operations on stream fish habitat.

Because the TBWSP is currently being studied and proposes significant modification to the SHPP (section 2.1.1), Reclamation plans to defer decisions about SHPP fish screen upgrades for 10 years. In the meantime, Reclamation remains committed to working with NOAA Fisheries and USFWS to discuss ongoing operations, to plan for related investigations and/or interim steps, and to consider possible funding for related programs, if appropriate.

13.6 Conclusion

Upon review of the effects, Reclamation's continued operation and maintenance under the Proposed Action will adversely affect all of the EFH functions for Pacific salmon currently or previously managed under the MSA in Scoggins Creek. The Proposed Action would result in a continued decline in conditions in Scoggins Creek over time, and thereby, preclude rebuilding the Lower Columbia Coho and Willamette River Chinook salmon population. Minimal impacts to Chinook salmon EFH in the Tualatin River are expected to occur based on adequate flows.

13.7 Literature Cited

Parenthetical Reference	Bibliographic Citation
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PART IV

APPENDICES

Appendix A

List of Species

ENCLOSURE A

FEDERALLY LISTED THREATENED, ENDANGERED, PROPOSED, CANDIDATE SPECIES AND SPECIES OF CONCERN WHICH MAY OCCUR WITHIN WASHINGTON COUNTY, OREGON

LISTED SPECIES[1/]

Birds		
Marbled murrelet[2/]	*Brachyramphus marmoratus*	CH T
Northern spotted owl[3/]	*Strix occidentalis caurina*	CH T
Fish		
Steelhead (Upper Willamette River)[4/]	*Oncorhynchus mykiss* ssp.	T*
Chinook salmon (Upper Willamette River)[5/]	*Oncorhynchus tshawytscha*	T*
Plants		
Golden Indian paintbrush[6/]	*Castilleja levisecta*	T
Willamette daisy[7/]	*Erigeron decumbens* var. *decumbens*	E
Howellia	*Howellia aquatilis*	T
Bradshaw's lomatium	*Lomatium bradshawii*	E
Kincaid's lupine[8/]	*Lupinus sulphureus* var. *kincaidii*	T
Nelson's checker-mallow	*Sidalcea nelsoniana*	T

PROPOSED SPECIES

None

CANDIDATE SPECIES[9/]

Mammals	
Pacific fisher[10/]	*Martes pennanti pacifica*
Birds	
Yellow-billed cuckoo	*Coccyzus americanus*
Streaked horned lark	*Eremophila alpestris strigata*
Amphibians and Reptiles	
Oregon spotted frog	*Rana pretiosa*

SPECIES OF CONCERN

Mammals	
White-footed vole	*Arborimus albipes*
Red tree vole	*Arborimus longicaudus*
Pacific western big-eared bat	*Corynorhinus townsendii townsendii*
Silver-haired bat	*Lasionycteris noctivagans*
Long-eared myotis (bat)	*Myotis evotis*
Fringed myotis (bat)	*Myotis thysanodes*
Long-legged myotis (bat)	*Myotis volans*
Yuma myotis (bat)	*Myotis yumanensis*
Camas pocket gopher	*Thomomys bulbivorus*
Birds	
Band-tailed pigeon	*Columba fasciata*
Olive-sided flycatcher	*Contopus cooperi*
Yellow-breasted chat	*Icteria virens*

Acorn woodpecker	*Melanerpes formicivorus*
Lewis' woodpecker	*Melanerpes lewis*
Mountain quail	*Oreortyx pictus*
Oregon vesper sparrow	*Pooecetes gramineus affinis*
Purple martin	*Progne subis*

<u>Amphibians and Reptiles</u>

Tailed frog	*Ascaphus truei*
Northwestern pond turtle	*Emys marmorata marmorata*
Northern red-legged frog	*Rana aurora aurora*

<u>Fishes</u>

Pacific lamprey	*Lampetra tridentata*	
Coastal cutthroat trout (Lower Columbia R.)	*Oncorhynchus clarki clarki*	
Coastal cutthroat trout (Oregon Coast)	*Oncorhynchus clarki clarki*	
Coastal cutthroat trout (Upper Willamette)	*Oncorhynchus clarki clarki*	
Steelhead (Oregon Coast)	*Oncorhynchus mykiss* ssp.	*

<u>Plants</u>

White top aster (Curtus)	*Aster curtus*
Pale larkspur	*Delphinium leucophaeum*
Willamette Valley larkspur	*Delphinium oreganum*
Peacock larkspur	*Delphinium pavonaceum*
Shaggy horkelia	*Horkelia congesta* ssp. *congesta*
Thin-leaved peavine	*Lathyrus holochlorus*

(E) - Listed Endangered *(T) - Listed Threatened* *(CH) - Critical Habitat has been designated for this species*
(PE) - Proposed Endangered *(PT) - Proposed Threatened* *(PCH) - Critical Habitat has been proposed for this species*

Species of Concern - Taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

* *Consultation with NOAA's National Marine Fisheries Service may be required.*

[1/] *U.S. Department of Interior, Fish and Wildlife Service, October 31, 2000, <u>Endangered and Threatened</u> <u>Wildlife and Plants</u>, 50 CFR 17.11 and 17.12*
[2/] *Federal Register Vol. 57, No. 45328, October 1, 1992, Final Rule - Marbled Murrelet*
[3/] *Federal Register Vol. 57, No. 10, January 15, 1992, Final Rule - Critical Habitat for the Northern Spotted Owl*
[4/] *Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Middle Columbia and Upper Willamette River Steelhead*
[5/] *Federal Register Vol. 64, No. 56, March 24, 1999, Final Rule - West Coast Chinook Salmon*
[6/] *Federal Register Vol. 62, No. 112, June 11, 1997, Final Rule - Castilleja levisecta*
[7/] *Federal Register Vol. 65, No. 16, January 25, 2000, Final Rule - Erigeron decumbens var. decumbens, Lupinus sulphureus ssp. kincaidii, and Fender's blue butterfly*
[8/] *Federal Register Vol. 65, No. 16, January 25, 2000, Final Rule - Erigeron decumbens var. decumbens, Lupinus sulphureus ssp. kincaidii, and Fender's blue butterfly*
[9/] *Federal Register Vol. 69, No. 86, May 4, 2004, Notice of Review - Candidate or Proposed Animals and Plants*
[10/] *Federal Register Vol. 69, No. 68, April 8, 2004, 12-Month Finding for a Petition to List the West Coast Distinct Population Segment of the Fisher*

ENCLOSURE A

FEDERALLY LISTED THREATENED, ENDANGERED, PROPOSED, CANDIDATE SPECIES AND SPECIES OF CONCERN WHICH MAY OCCUR WITHIN YAMHILL COUNTY, OREGON

LISTED SPECIES[1/]

Birds		
Marbled murrelet[2/]	*Brachyramphus marmoratus*	CH T
Northern spotted owl[3/]	*Strix occidentalis caurina*	CH T
Fish		
Steelhead (Upper Willamette River)[4/]	*Oncorhynchus mykiss* ssp.	T*
Chinook salmon (Upper Willamette River)[5/]	*Oncorhynchus tshawytscha*	T*
Invertebrates		
Fender's blue butterfly[6/]	*Icaricia icarioides fenderi*	CH E
Oregon silverspot butterfly	*Speyeria zerene hippolyta*	T
Plants		
Golden Indian paintbrush[7/]	*Castilleja levisecta*	T
Willamette daisy[8/]	*Erigeron decumbens* var. *decumbens*	E
Howellia	*Howellia aquatilis*	T
Bradshaw's lomatium	*Lomatium bradshawii*	E
Kincaid's lupine[9/]	*Lupinus sulphureus* var. *kincaidii*	CH T
Nelson's checker-mallow	*Sidalcea nelsoniana*	T

PROPOSED SPECIES

None

CANDIDATE SPECIES[10/]

Mammals	
Pacific fisher[11/]	*Martes pennanti pacifica*
Birds	
Yellow-billed cuckoo	*Coccyzus americanus*
Streaked horned lark	*Eremophila alpestris strigata*
Amphibians and Reptiles	
Oregon spotted frog	*Rana pretiosa*

SPECIES OF CONCERN

Mammals	
White-footed vole	*Arborimus albipes*
Red tree vole	*Arborimus longicaudus*
Pacific western big-eared bat	*Corynorhinus townsendii townsendii*
Silver-haired bat	*Lasionycteris noctivagans*
Long-eared myotis (bat)	*Myotis evotis*
Fringed myotis (bat)	*Myotis thysanodes*
Long-legged myotis (bat)	*Myotis volans*
Yuma myotis (bat)	*Myotis yumanensis*
Camas pocket gopher	*Thomomys bulbivorus*

<u>Birds</u>		
Band-tailed pigeon	*Columba fasciata*	
Olive-sided flycatcher	*Contopus cooperi*	
Yellow-breasted chat	*Icteria virens*	
Acorn woodpecker	*Melanerpes formicivorus*	
Lewis' woodpecker	*Melanerpes lewis*	
Mountain quail	*Oreortyx pictus*	
Oregon vesper sparrow	*Pooecetes gramineus affinis*	
Purple martin	*Progne subis*	
<u>Amphibians and Reptiles</u>		
Tailed frog	*Ascaphus truei*	
Northwestern pond turtle	*Emys marmorata marmorata*	
Northern red-legged frog	*Rana aurora aurora*	
Southern torrent (seep) salamander	*Rhyacotriton variegatus*	
<u>Fishes</u>		
Pacific lamprey	*Lampetra tridentata*	
Coastal cutthroat trout (Oregon Coast)	*Oncorhynchus clarki clarki*	
Coastal cutthroat trout (Upper Willamette)	*Oncorhynchus clarki clarki*	
Steelhead (Oregon Coast)	*Oncorhynchus mykiss* ssp.	*
<u>Invertebrates</u>		
American acetropis grass bug	*Acetropis americana*	
Oregon giant earthworm	*Megascolides (=Driloleirus) macelfreshi*	
<u>Plants</u>		
Bog anemone	*Anemone oregana* var. *felix*	
White top aster (Curtus)	*Aster curtus*	
Pale larkspur	*Delphinium leucophaeum*	
Willamette Valley larkspur	*Delphinium oreganum*	
Peacock larkspur	*Delphinium pavonaceum*	
Coast Range fawn-lily	*Erythronium elegans*	
Queen-of-the-forest	*Filipendula occidentalis*	
Henderson's horkelia	*Horkelia hendersonii*	
Thin-leaved peavine	*Lathyrus holochlorus*	

(E) - Listed Endangered *(T) - Listed Threatened* *(CH) - Critical Habitat has been designated for this species*
(PE) - Proposed Endangered *(PT) - Proposed Threatened* *(PCH) - Critical Habitat has been proposed for this species*

Species of Concern - Taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

* *Consultation with NOAA's National Marine Fisheries Service may be required.*

[1/] *U.S. Department of Interior, Fish and Wildlife Service, October 31, 2000, <u>Endangered and Threatened</u> <u>Wildlife and Plants</u>, 50 CFR 17.11 and 17.12*
[2/] *Federal Register Vol. 57, No. 45328, October 1, 1992, Final Rule - Marbled Murrelet*
[3/] *Federal Register Vol. 57, No. 10, January 15, 1992, Final Rule - Critical Habitat for the Northern Spotted Owl*
[4/] *Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Middle Columbia and Upper Willamette River Steelhead*
[5/] *Federal Register Vol. 64, No. 56, March 24, 1999, Final Rule - West Coast Chinook Salmon*
[6/] *Federal Register Vol. 65, No. 16, January 25, 2000, Final Rule - Erigeron decumbens var. decumbens, Lupinus sulphureus ssp. kincaidii, and Fender's blue butterfly*
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[8] *Federal Register Vol. 65, No. 16, January 25, 2000, Final Rule - Erigeron decumbens var. decumbens, Lupinus sulphureus ssp. kincaidii, and Fender's blue butterfly*

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[10] *Federal Register Vol. 69, No. 86, May 4, 2004, Notice of Review - Candidate or Proposed Animals and Plants*

[11] *Federal Register Vol. 69, No. 68, April 8, 2004, 12-Month Finding for a Petition to List the West Coast Distinct Population Segment of the Fisher*

ENCLOSURE B

FEDERAL AGENCIES RESPONSIBILITIES UNDER SECTION 7(a) and (c) OF THE ENDANGERED SPECIES ACT

SECTION 7(a)-Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;

2) Consultation with FWS when a Federal action may affect a listed endangered or Threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of Critical Habitat. The process is initiated by the Federal agency after they have determined if their action may affect (adversely or beneficially) a listed species; and

3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed Critical Habitat.

SECTION 7(c)-Biological Assessment for Major Construction Projects[1]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify proposed and/or listed species which are/is likely to be affected by a construction project. The process is initiated by a Federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct an on-site inspection of the area to be affected by the proposal which may include a detailed survey of the area to determine if any species are present and whether suitable habitat exists for either expanding existing populations or for potential reintroduction of species; (2) review literature and scientific data to determine species distribution(s), habitat needs, and other biological requirements; (3) interview experts including those within FWS, National Marine Fisheries Service, State conservation departments, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species present in terms of effects to individuals and populations, including consideration of cumulative effects to the species and habitat; (5) analyze alternative actions that may provide conservation measures and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not any listed species will be affected. Upon completion, the report should be forwarded to our Portland Office at 2600 SE 98th Ave., Suite 100, Portland, Oregon, 97266.

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[1] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332. (2)c). On projects other that construction, it is suggested that a biological evaluation similar to the biological assessment be undertaken to conserve species influenced by the Endangered Species Act.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Oregon Fish and Wildlife Office
2600 SE 98th Avenue, Suite 100
Portland, Oregon 97266
Phone: (503)231-6179 FAX: (503)231-6195

Reply To: 8330.SP10(08)

October 2, 2007

Michael Relf
U.S. Bureau of Reclaimation, PNW Regional Office
PN-3823, 1150 N Curtis Rd. Suite 100
Boise, ID 83706-1234

Subject: Tualatin Project
USFWS Reference # 3DF004E276C0F84888257368007C9215

Dear Mr. Michael Relf:

This is in response to your request, dated October 2, 2007, requesting information on listed and proposed endangered and threatened species that may be present within the area of the Tualatin Project in Washington, Yamhill County(s). The Fish and Wildlife Service (Service) received your correspondence on October 2, 2007.

We have attached a list (Enclosure A) of threatened and endangered species that may occur within the area of the Tualatin Project. The list fulfills the requirement of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). U.S. Bureau of Reclamation requirements under the Act are outlined in Enclosure B.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems on which they depend may be conserved. Under section 7(a)(1) and 7(a)(2) of the Act and pursuant to 50 CFR 402 *et seq*., the U.S. Bureau of Reclamation is required to utilize their authorities to carry out programs which further species conservation and to determine whether projects may affect threatened and endangered species, and/or critical habitat. A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) which are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (NEPA) (42 U.S.C. 4332 (2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to the Biological Assessment be prepared to determine whether they may affect listed and proposed species. Recommended contents of a Biological Assessment are described in Enclosure B, as well as 50 CFR 402.12.

If the U.S. Bureau of Reclamation determines, based on the Biological Assessment or evaluation, that threatened and endangered species and/or critical habitat may be affected by the project, the U.S. Bureau of Reclamation is required to consult with the Service following the requirements of 50 CFR 402 which implement the Act.

Enclosure A includes a list of candidate species under review for listing. The list reflects changes to the candidate species list published September 12, 2006, in the Federal Register (Vol. 71, No. 176, 53756) and the addition of "species of concern." Candidate species have no protection under the Act but are included for consideration as it is possible candidates could be listed prior to project completion. Species of concern are those taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

If a proposed project may affect only candidate species or species of concern, the U.S. Bureau of Reclamation is not required to perform a Biological Assessment or evaluation or consult with the Service. However, the Service recommends minimizing impacts to these species to the extent possible in order to prevent potential future conflicts. Therefore, if early evaluation of the project indicates that it is likely to adversely impact a candidate species or species of concern, the U.S. Bureau of Reclamation may wish to request technical assistance from this office.

Your interest in endangered species is appreciated. The Service encourages the U.S. Bureau of Reclamation to investigate opportunities for incorporating conservation of threatened and endangered species into project planning processes as a means of complying with the Act. If you have questions regarding your responsibilities under the Act, please contact Kevin Maurice at (503) 231-6179. All correspondence should include the above referenced file number. For questions regarding salmon and steelhead trout, please contact NOAA Fisheries Service, 525 NE Oregon Street, Suite 500, Portland, Oregon 97232, (503) 230-5400.

For future species list requests, please visit our website (http://www.fws.gov/oregonfwo/Species/default.asp) for instructions on how to make requests.

Enclosures
EnclosureA: Washington.PDF, Yamhill COUNTY.PDF
EnclosureB: EnclosureB_Federal_Agencies_Responsibilities.PDF

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
PORTLAND OFFICE
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

June 24, 2005

Karen Blakney
Bureau of Reclamation
Pacific Northwest Region - Lower Columbia
1201 NE Lloyd Blvd, Suite 750
Portland, Oregon 97232

Re: Request for List of Species Which May Be Affected by the Operation and Maintenance of the Tualatin Project in the Tualatin River, Washington and Yamhill Counties

Dear Ms. Blakney:

The National Marine Fisheries Service (NMFS) received your May 16, 2005, letter requesting an updated list of threatened and endangered anadromous fish species which may be affected by the proposed Tualatin Project. We enclose a list of those anadromous fish species that are listed as endangered or threatened under the Endangered Species Act (ESA) in Oregon, those that are proposed for listing, and those that are candidates for listing (Enclosure 1). This inventory only includes species under NMFS' jurisdiction that occur in the Pacific Northwest. The U.S. Fish and Wildlife Service should be contacted regarding the presence of species falling under its jurisdiction.

Available information indicates that ESA-listed anadromous fish species may be present near the proposed action area including Upper Willamette River (UWR) spring-run Chinook salmon (*Oncorhynchus tshawytscha*) and UWR steelhead (*O. mykiss*). This letter constitutes the required notification of the presence of a Federally-listed threatened or endangered species under NMFS' jurisdiction in the permit area that may be affected by the proposed project (Appendix A to Part 330, Section C.13(5)(I).

Additional information on ESA-listed species' distribution, copies of Federal Register documents designating listed species' status, and links to various ESA consultation policies and tools may be found on our web site at: www.nwr.noaa.gov. For information on the ESA Section 7 consultation process, please refer to the ESA Section 7 implementing regulations, 50 CFR Part 402.

In addition, please be aware that consultation under the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-297), requires Federal agencies to consult with NMFS on activities that may adversely affect designated essential fish habitat (EFH). All habitat in this project area is designated as EFH for Chinook and coho salmon (*O. kisutch*). Additional information addressing EFH may be found on our website, above.

Questions regarding this letter should be directed to Jim Turner of my staff in the Oregon State Habitat Office at 503.231.6894.

Sincerely,

Michael P. Tehan

Michael P. Tehan
Director, Oregon State Habitat Office
Habitat Conservation Division

Enclosure (1): Endangered, Threatened, Proposed, and Candidate Species Occurring under National Marine Fisheries Service's Jurisdiction in Oregon

Enclosure 1.

Endangered, Threatened, and Candidate Pacific Salmon and Steelhead under NMFS' Jurisdiction in Oregon.

Federal Register Notices for Final Rules that list species, designate critical habitat, or apply protective regulations to ESUs considered in this consultation are included. (Listing status 'T' means listed as threatened, 'E' means listed as endangered, and 'P' means proposed for listing).

Species ESU	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (*Oncorhynchus tshawytscha*)			
Lower Columbia River	T 3/24/99; 64 FR 14308	P 12/14/04; 69 FR 74572	7/10/00; 65 FR 42422
Upper Willamette River	T 3/24/99; 64 FR 14308	P 12/14/04; 69 FR 74572	7/10/00; 65 FR 42422
Upper Columbia River spring-run	E 3/27/99; 64 FR 14308	P 12/14/04/ 69 FR 74572	ESA section 9 applies
Snake River spring / summer run	T 4/22/92; 57 FR 14653	10/25/99; 64 FR 57399	7/10/00; 65 FR 42422
Snake River fall-run	T 6/3/92; 57 FR 23458	12/28/93; 58 FR 68543	7/10/00; 65 FR 42422
Chum salmon (*O. keta*)			
Columbia River	T 3/25/99; 64 FR 14508	P 12/14/04; 69 FR 74572	7/10/00; 65 FR 42422
Coho salmon (*O. kisutch*)			
Lower Columbia River	P 6/14/04; 69 FR 33102	P 12/14/04; 69 FR 74572	Not applicable
Southern Oregon/Northern California	T 5/6/97; 62 FR 24588	P 12/14/04; 69 FR 74572	7/18/97; 62FR 38479
Oregon Coast	P 6/14/04; 69 FR 33102	P 12/14/04; 69 FR 74572	Not applicable
Sockeye salmon (*O. nerka*)			
Snake River	E 11/20/91; 56 FR 58619	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 3/19/98; 63 FR 13347	P 12/14/04; 69 FR 74572	7/10/00; 65 FR 42422
Upper Willamette River	T 3/25/99; 64 FR 14517	P 12/14/04; 69 FR 74572	7/10/00; 65 FR 42422
Middle Columbia River	T 3/25/99; 64 FR 14517	P 12/14/04; 69 FR 74572	7/10/00; 65 FR 42422
Upper Columbia River	E 8/18/97; 62 FR 43937	P 12/14/04; 69 FR 74572	ESA section 9 applies
Snake River Basin	T 8/18/97; 62 FR 43937	P 12/14/04; 69 FR 74572	7/10/00; 65 FR 42422

Appendix B

O&M ADDENDUM

Appendix B
Summary of Routine O&M Activities

DRAFT

Biological Assessment, Tualatin Project Future O&M

Water conveyance and control facilities require periodic inspection, maintenance, and repair. Those proposed actions that include routine maintenance, inspection, and repair activities are limited to those associated features and facilities. Reclamation (with TVID, the operating entity, where applicable) also inspects the major features described in this document every three to six years. Inspection reports are developed and recommendations are incorporated into the yearly routine maintenance programs where applicable.

Reclamation (or TVID, the operating entity) will periodically take advantage of low reservoir elevations when possible to accomplish repairs or inspections so that there is little or no affect on normal operations. In some cases, however these activities may require reducing or temporarily suspending river flows.

Scheduled maintenance and inspections usually occur during lower flows in the late summer, fall, or winter. If possible, Reclamation (or TVID, the operating entity) reroutes river or waterway flows around the work area. Where this is not possible, river flows may be temporarily suspended for the duration of the work.

The following eight subsections summarize the categories of routine maintenance activities that are part of the proposed actions. In addition, Reclamation has analyzed the potential effects of specific O&M activities on listed species where relevant, as described in Chapters 4 through 12 of this BA.

<u>Routine Inspection of all Discharge Features</u> – Reclamation inspects spillway, canal headworks, river outlet works, pumping plant equipment, and associated equipment at least every six years. These inspections are typically performed under dewatered conditions but can be performed by divers, climbers, and other specially trained personnel. Whenever possible, inspections are scheduled to minimize effects to water deliveries and environmental and other interests. The inspection of these features may require temporary suspension or diversion of flow via another discharge feature for minutes or hours to ensure the safety of inspection personnel.

<u>Periodic Testing of All Mechanical Equipment</u> – Reclamation strives to operate each gate through a least one complete cycle each year. Gate and valve operation under both balanced (operation in dry conditions or equal head on both sides of the gate or valve) and unbalanced head is critical to ensure the reliability of the equipment. In many cases, spillway gate testing is limited to operation during dewatered conditions or a portion of the full operation cycle due to potential impacts downstream. The testing of gates and valves typically results in minor fluctuations in the downstream waterway. Periodic

testing of other mechanical equipment such as emergency backup generators and pumps is required to ensure that the equipment is operating satisfactorily.

Routine Maintenance of Discharge Features and Associated Equipment – This work includes concrete repairs, protective coatings repairs and maintenance of mechanical equipment. Whenever possible, Reclamation schedules maintenance such that impacts to streamflows, water deliveries, or environmental or other interests are minimal. Maintenance activities may require dewatering, temporary suspension of rerouting of flow via another discharge feature to allow access to the pertinent feature, curing of repaired material such as concrete and protective coatings, or to ensure the safety of maintenance personnel.

Vegetative Control – Reclamation must prevent the growth of trees and other deep-rooted vegetation on and adjacent to all embankments, concrete structures and other appurtenant features, and along the alignment of buried features. This work is necessary to reduce the risk of structural problems associated with vegetative root systems and rodent burrows. In addition, vegetation control is needed such that visual inspection of the facilities is not compromised. Methods of vegetation control are needed such that visual inspection of the facilities is not compromised. Methods of vegetation control include pulling, burning, cutting, or herbicide application, which is employed in accordance with EPA label and other applicable rules and regulations.

Rodent Control – Reclamation must prevent or minimize rodent population on and near embankments because of the risk of structural problems associated with burrows. Methods of rodent control include shooting, poisoning, and trapping and relocation, which are employed in accordance with EPA label and other applicable rules and regulations.

Crest Roadway Maintenance – The roadway surface across the top of the embankment dam requires periodic maintenance to ensure roadway integrity and proper surface drainage to protect dam embankment slopes, both upstream and downstream.

Debris Removal – Debris carried into the reservoir must be removed to avoid complications related to controlled discharges. Methods for debris removal include manual collection and disposal and flushing the debris via spillway discharges. Manually collected debris is: disposed of through burning; stockpiled in an appropriate area; or removed by another party through a mutual agreement.

Maintenance of Instrumentation Devices – Reclamation must maintain the instrumentation installed in and near the dam to ensure the quality of the data collected. This work may entail: removal of moss, algae, or beaver dams adjacent to a seepage measurement device; vegetation control adjacent to an instrument; or repair of vandalism damage.

Appendix C

HYDROLOGIC DATA

RECLAMATION
Managing Water in the West

DRAFT

Tualatin Project
MODSIM Model Users Manual

MODEL VERSION: Reclamation MODSIM 30Jun06

prepared by Leslie Stillwater
U.S. Bureau of Reclamation
Pacific Northwest Region
Boise, Idaho

August, 2006

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Tualatin Project MODSIM Model Users Manual

MODEL VERSION: Reclamation MODSIM 30Jun06

1. Background and Purpose

The Tualatin Project MODSIM[1] model was developed to perform simulation studies to support the Tualatin Biological Assessment. This document describes the scope, assumptions and simulation methods used in the development of the Tualatin Project MODSIM model. A description of the physical Project and Project operations are described in the Facilities and Operation and Maintenance Report[2].

2. How to use this Manual

Information on general modeling assumptions and data development is provided in each section. Technical details of interest to modelers are described in text boxes, like the one shown below.

Text boxes provide information for modelers who want to review or reproduce Tualatin Project MODSIM model runs. Model nodes and links are printed in bold italics, for example, ***TVID_SpHill*** and ***JWC_SpHill*** are demand nodes at Spring Hill Pumping Plant.

1 MODSIM was developed by Colorado State University and the U.S. Bureau of Reclamation.
2 'Tualatin Project, Oregon, Facilities and Operation and Maintenance', prepared for the U.S. Department of the Interior by Larry Vinsonhaler, August, 2002.

3. How to Run the Model

The files necessary to run the Tualatin Project MODSIM Model are available from lstillwater@pn.usbr.gov.

To run the Tualatin Project MODSIM Model:

Copy these files to your working directory:

```
\Water Distribution Model
    \Tualatin Modsim
        \Tualatin.exe
        \libsim.dll
        \ModsimModel.dll
        \NetworkUtils.dll
        \XYFile.dll
```

Open a command window (cmd.exe) and go to your working directory. Enter the command:

Tualatin.exe scenario.xy

where scenario.xy is the MODSIM input file for a given scenario (For the Tualatin BA, the input files are either current2005.xy or ProposedAction.xy).

To view model output using Pisces:

Copy 'pisces30Jun06 for distribution.zip' to your hard drive; extract all and run pisces.exe. Use the help button on the toolbar for assistance.

Pisces is configured here to view model output from the current2005 and ProposedAction scenarios. New scenarios can be added by editing data\tree.csv, creating the corresponding directory data\scenario and moving Modsim output files to that directory.

Install MODSIM-DSS (optional):

If you want to use the MODSIM GUI to view and edit MODSIM input files and as another option to view model results, follow these instructions to install and run MODSIM-DSS.

Download MODSIM and the MODSIM GUI from http://modsim.engr.colostate.edu and install.

Once installed, double click the MODSIM.exe icon and open the MODSIM input file (either current2005.xy or ProposedAction.xy) from the tool bar using *File/Open.* The input file can be edited and viewed from this interface and the results can be viewed and graphed. However, the Tualatin model requires additional basin code and therefore can not be run from this interface—it must be run from the command line as described above.

View MODSIM-DSS Documentation:

MODSIM-DSS documentation can be downloaded from http://modsim.engr.colostate.edu.

4. Scope

Tualatin Project hydrology and operations were simulated by applying estimated levels of development and operational practices to unregulated monthly streamflows for water years 1929 through 2001.

The physical scope of the model is from the Tualatin River below Lee Falls at RM 70.7 of the Tualatin River and Henry Hagg Lake and Scoggins Dam at RM 4.8 on Scoggins Creek to the Tualatin River at West Linn at RM 1.8 (See schematic in Figure 1).

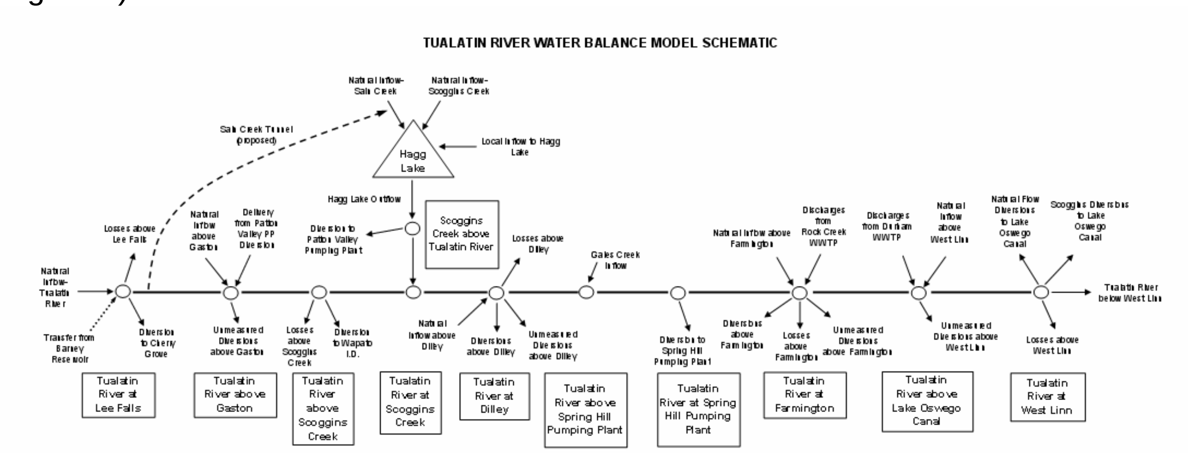

Figure 1. Schematic of Tualatin River and scope of model (Reference: Tualatin Hydrologic Modeling TM-12.15.03, MWH 2003)

5. River System Unregulated Flows (System Gains and Losses)

The unregulated flows (system gains and losses) were developed by MWH[3]. In the development of unregulated flows, mass balance calculations were performed at:

1. Tualatin River below Lee Falls (RM 70.7)
2. Tualatin River at Gaston (RM 63.9)
3. Tualatin River above Scoggins Creek
4. Hagg Lake (RM 4.8)
5. Scoggins Creek above Tualatin River
6. Tualatin River at Scoggins Creek
7. Tualatin River near Dilley (RM 58.8)
8. Tualatin River above Spring Hill Pumping Plant
9. Tualatin River at Spring Hill Pumping Plant
10. Tualatin River at Farmington (RM 33.3)
11. Tualatin River above Lake Oswego Canal
12. Tualatin River at West Linn (below Lake Oswego Diversion Dam) (RM 1.8)

3 '2003 Tualatin River Hydrologic Analysis', MWH Technical Memorandum and '2004 Adjustments to Hydrologic Analysis', memorandum from Steven M. Thurin, MWH, to Lisa Obermeyer, MWH, November 30, 2004.

Changes in basin morphology, unmeasured inflows and diversions, estimation errors and gage errors contribute to error and uncertainty in the calculation of system gains and losses. Therefore, unregulated flows are not natural flows, but are as close as the data limitations allow to describing the system without the impacts of storage, diversion, and irrigation. Since the same unregulated streamflows are applied in each modeled scenario, the system gains and losses, and error and uncertainty are identically repeated in each scenario. Therefore, model output only makes sense in context: each modeled scenario must be compared to a 'reference' or 'baseline' modeled scenario. For the Tualatin BA, the reference scenario selected was Current Conditions based on 2005 operating criteria.

6. Shared MODSIM model structure

The shared MODSIM model structure of the Tualatin Project consists of the physical structure of the system, the monthly gains and losses for water years 1929 through 2001, natural flow rights, Project contracts and the invariable operating rules and guidelines practiced. Each scenario, including those used for calibration, were built starting with the shared model structure. A schematic of the shared model structure is shown in Figure 2 and continued in Figure 3.

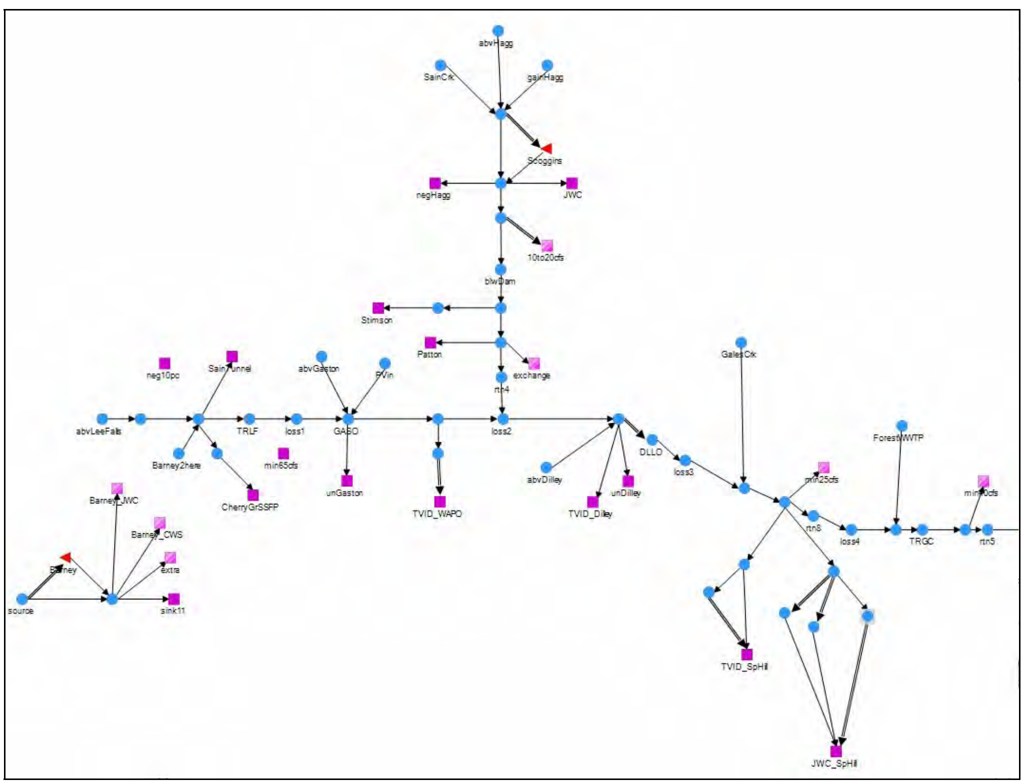

Figure 2. Shared MODSIM model structure of the Tualatin Project, upstream portion.

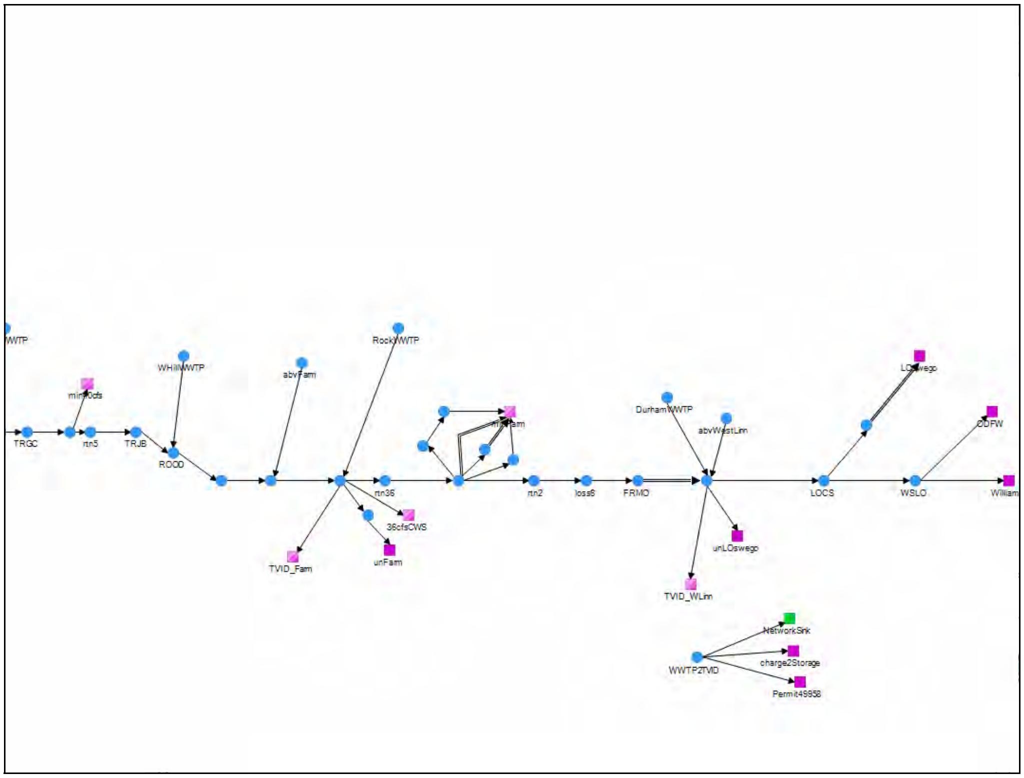

Figure 3. Shared MODSIM model structure of the Tualatin Project, downstream portion.

The following sections describe components of the shared model structure starting from the most upstream nodes and moving downstream.

6.1. Trask River Basin Imports

Imported water from Barney Reservoir on the Trask River enters the modeled system upstream of the Tualatin River below Lee Falls (RM 70.7). Barney imports are requested as needed and limited by the water remaining in the individual contractor's space. Barney contract spaceholders are the Joint Water Commission (JWC) and Clean Water Services (CWS).

As modeled, JWC holds 11,061 acre-feet of space in Barney reservoir and CWS holds 1,229 acre-feet of space, which corresponds to a 97% reliability of fill. In most scenarios, as JWC and CWS request water at their points of diversion and instream use, Barney water is imported to the Tualatin River. For each spaceholder, the quantity of the Barney water diverted and a carriage loss is subtracted from their starting account balance at the beginning of the time step. The carriage loss for JWC is 4.5% and for CWS it is 9%.

Issue: Barney Reservoir water enters the Tualatin River based on the amount of water that is being requested downstream by contract spaceholders. The water which enters the Tualatin from Barney is slightly inflated over diverted water to account for travel losses. Barney imports are limited to channel capacity (68.7 cfs) and the quantity of water remaining in the spaceholders' accounts in Barney Reservoir.

Method: Barney Reservoir is modeled as a reservoir node separate from the main network. Since insufficient data were available for a balance on Barney, the spaceholders in Barney start each year with the quantity of water in their accounts corresponding to a 97% reliability. Water enters the Tualatin River from Barney Reservoir through three flow-through demands , ***Barney_JWC***, ***Barney_CWS***, and ***extra***. These demand nodes watch the Barney Storage Contract links in the main network (see entries under the 'Watch Links' tab). The storage contract links are ***Barney owned by JWC***, ***Barney owned by CWS***, and ***Scoggins Exchange for TVID***. The flow-through demand nodes then request an amount of water depending on how much water is delivered through the Storage Contract links. The requested amount is slightly greater than the watched flow to compensate for the physical channel losses which will be accumulated along the way to JWC and CWS diversions (see the entry in the 'Factors' box of the flow-through demands under the 'Watch Links' tab).

An additional link from Barney reservoir entering the sink should show zero flow after convergence, but is required to start the iteration sequence.

Issue: JWC and CWS divert transbasin water from Barney Reservoir.

Method: Barney contracts are modeled by entering the following data of the storage contract links (formerly called ownership links) ***Barney owned by JWC*** and ***Barney owned by CWS***:

- 'Ownership Amount' is the 97% reliability space (which is always available because Barney is modeled as an unlimited source, but spaceholder's are limited to using only the space which fills to 97% reliability).
- 'Right Name' (formerly called 'Parent Link') equal to 'accrual Barney', points to the accrual link which represents the pseudo water right used to fill Barney.
- 'Storage Channel Loss Link' points to a channel loss link so that the spaceholder's account is reduced by a carriage loss from the dam to the point of diversion. The channel loss link is separate from the main network; it doesn't flow any water and it's only purpose is to provide a channel loss percentage.

6.2. Cherry Grove Slow Sand Filter Plant

As modeled, Cherry Grove Slow Sand Filter Plant requests about 1.5 cfs throughout the year[4], relying on a portion of the 1930, 9 cfs, water right (shared with Spring Hill Pumping Plant) and, when necessary, Barney imports.

Cherry Grove Slow Sand Filter Plant is represented in the model by demand node ***CherryGRSSFP*** and the natural flow link ***WR 1.5 of 9 cfs 1930 Hillsboro w SpringH*** .

6.3. Wapato Canal

The modeled Wapato diversion request[5] is based on historic observed and estimated diversions and is met by natural flow, using the most senior natural flow right in the system. If there is not enough natural flow in the system above Lee Falls, the Wapato diversion request may not be fully satisfied. The natural flow diverted is exchanged for Scoggins water, so that an amount equal to the water diverted at Wapato must enter the Tualatin River from Scoggins Creek, in addition to natural flow and the flows released from Scoggins to meet other downstream requests.

In the field, about 1,497 acres served by the Wapato Canal are Tualatin Valley Irrigation District (TVID) lands. The modeled Wapato diversion request is about 800 acre-feet at the median and, for the purposes of this modeling study, represents the TVID water diverted at Wapato. Other unmeasured Wapato diversions are implicit in the gains data set.

6.4. Unmeasured diversions--not TVID

Modeled unmeasured diversions near Gaston, Dilley, Farmington and West Linn were estimated by MWH and were included in the calculation of the gains[6]. Unmeasured non-TVID diversions in the MODSIM model scenarios are never allowed to experience shortage. This assumptions implies that the water sources which serve these diversions are not subject to or affected by the changes applied in the scenarios.

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4 Observed and estimated diversions were developed by MWH and Reclamation. Refer to '2003 Tualatin River Hydrologic Analysis', MWH Technical Memorandum and '2004 Adjustments to Hydrologic Analysis', memorandum from Steven M. Thurin, MWH, to Lisa Obermeyer, MWH, November 30, 2004.
5 Ibid.
6 Ibid.

Issue: Unmeasured diversions, not belonging to TVID, must always be met.

Method: Unmeasured diversions, not belonging to TVID, are represented by the demand nodes ***unGaston***, ***unDilley***, ***unFarm***, and ***unLOswego*** and are served by links with high priority costs of about -90,000. These links are open in both the natural flow and storage steps and are negative enough to draw stored flow out of Scoggins during the storage step, which is unlikely, but occurs when there is not enough natural flow in the system. This use of stored water is prorated as a loss across all accounts proportionately.

6.5. Unmeasured diversions—TVID

Modeled unmeasured diversion requests for TVID at locations near Dilley, Farmington and West Linn were estimated by MWH[7]. These diversion requests are met with stored Project water from TVID's contract space in Scoggins and water rights associated with the discharge from the waste water treatment plants (25 cfs for 2,000 acres). A carriage loss of 1% is charged for water delivered from Scoggins to TVID lands near Dilley and 8% for water delivered to TVID lands near Farmington. If there is not sufficient water in TVID's account, unmeasured diversion requests for TVID may not be fully satisfied.

Issue: TVID unmeasured diversions are served by Scoggins stored flows and discharge from the waste water treatment plants.

Methods: Unmeasured diversions for TVID are represented by the demand nodes ***TVID_Dilley***, ***TVID_Farm***, ***TVID_WLinn***. ***TVID_Dilley*** is served by the Storage Group Contract link ***Scoggins owned by TVID Dilley***. The storage contract is a group contract because it is shared with other TVID diversions. The 1% carriage loss from Scoggins Dam to the point of diversion is entered in the 'Storage Channel Loss Link'.

7 Ibid.

Issue: TVID lands below waste water treatment plants probably divert most of their flows from the plant discharge, although only 25 cfs is allowed as natural flow diversion. The remaining diversion, even though it is plant discharge, is accounted as Project stored flows.

TVID_Farm and ***TVID_WLinn*** are served by very high priority links which watch the treatment plant discharges into the Tualatin River at Durham and Rock Creek so that they can divert plant discharge. Watching is accomplished by identifying an Exchange Limit Link. These two demands flow through to the node **WWTP2TVID** for accounting purposes. 25 cfs of the water diverted is then removed by the demand node **Permit49958** to represent the natural flow right for waste water treatment plant flows and the remainder is drawn to demand **charge2Storage** which is served by the Storage Group Contract Link **Scoggins owned by Farm and WLinn** thereby accounting the remainder of the diverted plant flows as Project storage.

6.6. TVID diversion requests at Spring Hill

TVID serves about 17,000 acres from Spring Hill Pumping Plant. The modeled TVID diversion requests at Spring Hill are either current conditions or projected conditions. The water required for projected conditions was estimated by assuming about 2,000 acres of currently irrigated land are converted to sprinkler irrigated container nursery crops[8]. Projected conditions were used for the Proposed Action.

Observed TVID pumping values at Spring Hill are available from May 1991 through May 2004. Power consumption records were used to estimate pumping prior to May 1991 (refer to Appendix A).

The resulting June 1983 through May 2004 trace, shown in Figure 4, does not demonstrate an increasing trend in pumping during the 22 years of observed and estimated record. Therefore, current conditions pumping for TVID at Spring Hill, based on WY2004 operating criteria, was assumed to be the same as the observed and estimated TVID pumping at Spring Hill for the period of record. The trace was extended back through water year 1929 by comparisons to precipitation data and natural streamflow discharge. The entire modeled trace, used for TVID diversion requests at Spring Hill Pumping Plant for current conditions based on 2004 operations, is shown in Figure 5.

TVID's service contract is for 37,000 acre-feet per water year. Of that 37,000 acre-feet, 26,849 acre-feet is attributed to storage in Scoggins Reservoir (with no carryover) and the remainder to Project natural flow. Shortage criteria apply (see Section 6.7 on Shortage Criteria).

8 Projected Tualatin Valley Irrigation District Water Requirements, Draft Technical Memorandum to Karen Blakney from Leslie Stillwater, June 8, 2006.

The modeled TVID diversion request is first served by the 90 cfs Project natural flow right (priority date 2/21/1963) and then by stored flows from Scoggins. A carriage loss of 4% is charged on stored flows from Scoggins Dam to TVID at Spring Hill Pumping Plan. If there is insufficient water in TVID's storage account, the diversion request may not be satisfied.

Issue: TVID at Spring Hill is served by Project natural flows and Project stored flows.

Method: TVID diversion requests at Spring Hill are represented by the demand node ***TVID_SpHill***. The 90 cfs Project natural flow right is represented by the natural flow link serving ***TVID_SpHill***.

Two Storage Contract links serve the demand node ***TVID_SpHill***. The first link, ***Scoggins owned by TVID***, is a Storage Group Contract and is associated with the first 85% of TVID's share of the Project storage right. The second link, ***Scoggins 15% owned by TVID***, is a Storage Contract link associated with the remaining 15% (see Section 6.7 on Shortage Criteria).

Storage contracts are modeled by entering the following data in the Storage Contract links:

- 'Ownership Amount' is the contract space; if the reservoir fills to the full contract space, this is the amount of water available at the beginning of the irrigation season, otherwise it is determined by the Shortage Criteria.
- 'Right Name' equal to either 'accrual R5777' or 'accrual fifteen%', points to the accrual link which represents the water right used to fill Scoggins.
- 'Storage Channel Loss Link' points to a channel loss link so that TVID's account is reduced by a carriage loss from the dam to the point of diversion. The channel loss link is separate from the main network; it does not flow any water; and it's only purpose is to provide a channel loss percentage.

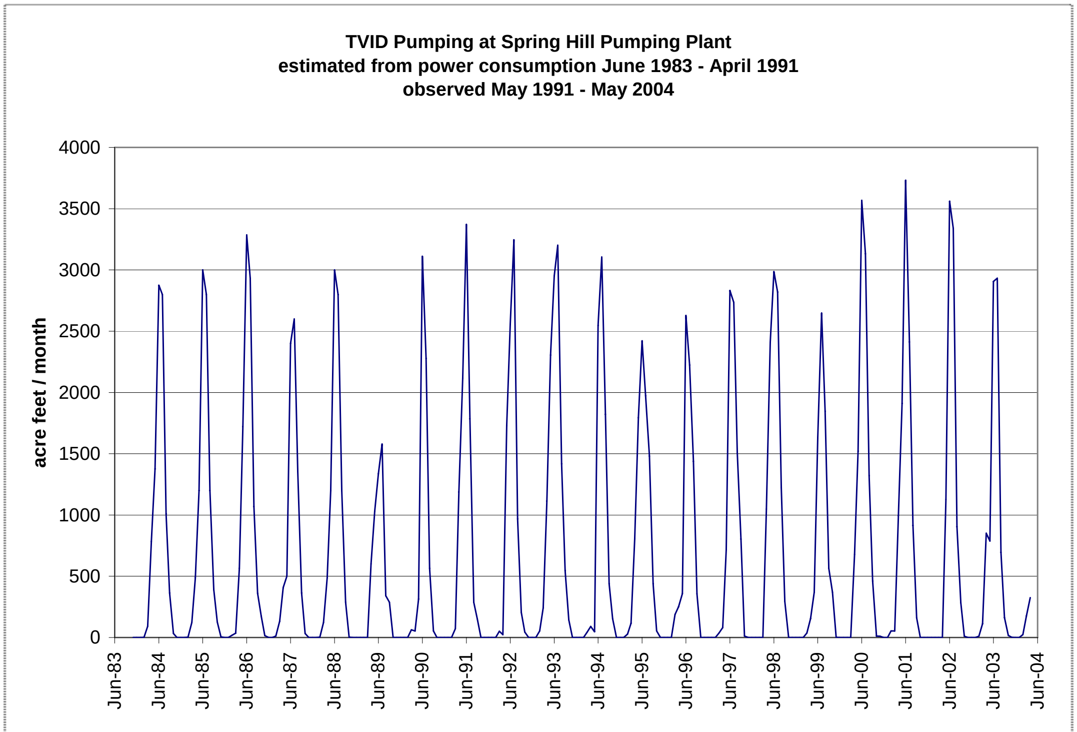


Figure 4. Observed and Estimated Monthly TVID Pumping at Spring Hill Pumping Plant (acre-feet/month).

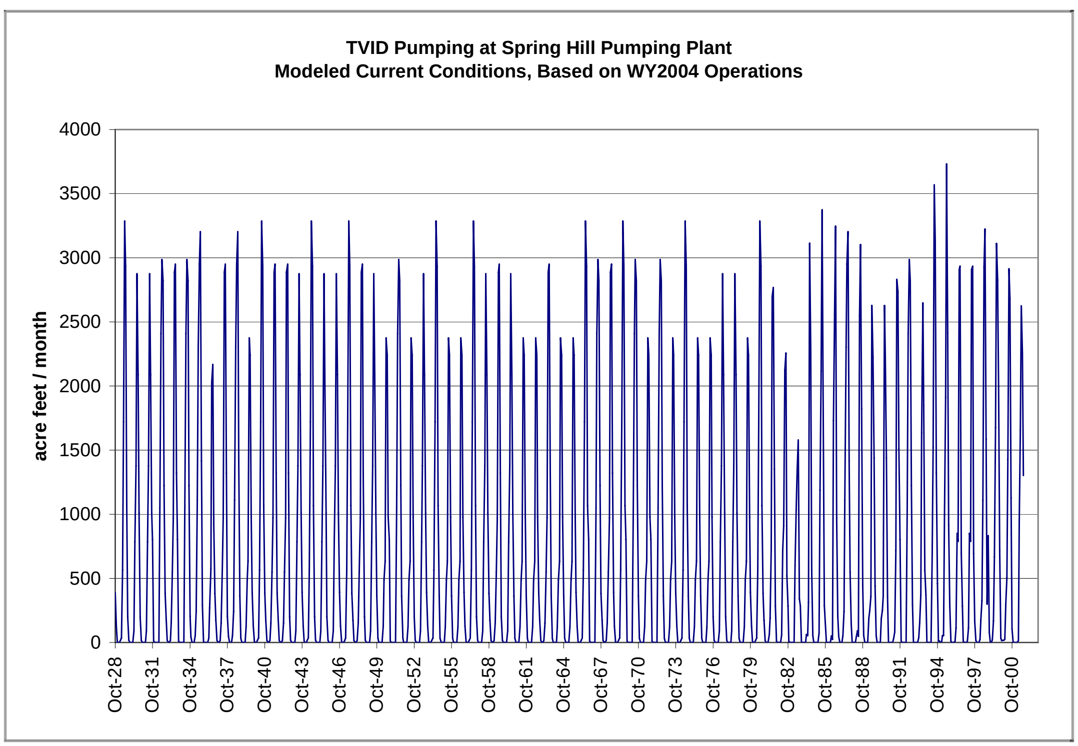


Figure 5. Modeled Monthly TVID Diversion Request at Spring Hill Pumping Plant for Current Conditions, based on WY2004 Operating Criteria (acre-feet/month).

6.7. Shortage Criteria

The shortage to Project water supply is the amount by which Scoggins Reservoir fails to fill, usually determined in early April. To distribute the shortage among the water service contract holders, the shortage is reduced by applying it to the first 15% of TVID's and CWS's service contract amounts, respectively. Any remaining shortage is distributed among all service contractor holders according to the ratio of their respective contract to the total of all contract amounts.

Issue: Modeling shortage criteria

Method: MODSIM's scripting capabilities, using C#, were used to write the shortage criteria in the basin model code (see file Tualatin.cs), which is dynamically linked to the MODSIM libraries.

Scoggins reservoir fills with two accrual links, ***accrual R5777*** which fills the first 85% of the active space with a priority date of 2/20/1963, and ***accrual fifteen%*** which fills the remaining 15% of the active space with a later priority date of 2/21/1963.

In the basin model code, if the reservoir fills by April, all accounts are whole. If the reservoir fills between 85% and full, the TVID and CWS accounts which share the accrual link ***accrual fifteen%***, share the shortage proportionately. If the reservoir fills to less than 85%, no water is available through the accrual link ***accrual fifteen%***, and the water available through the primary accrual link ***accrual R5777*** is distributed proportionately. The table below shows the space associated with each accrual link.

Accrual Link	Service Contract holders	Storage Space (AF)
R5777	TVID CWS JWC Lake Oswego	21299 10004 13437 498
accrual fifteen%	TVID CWS	5550 2535
Total Active Space		53323

6.8. JWC diversion requests at Spring Hill

Observed JWC pumping at Spring Hill Pumping Plant for water years 1977 through 2003 shows an increasing linear trend and an increasing spread between summer and winter values through time (see Figure 6).

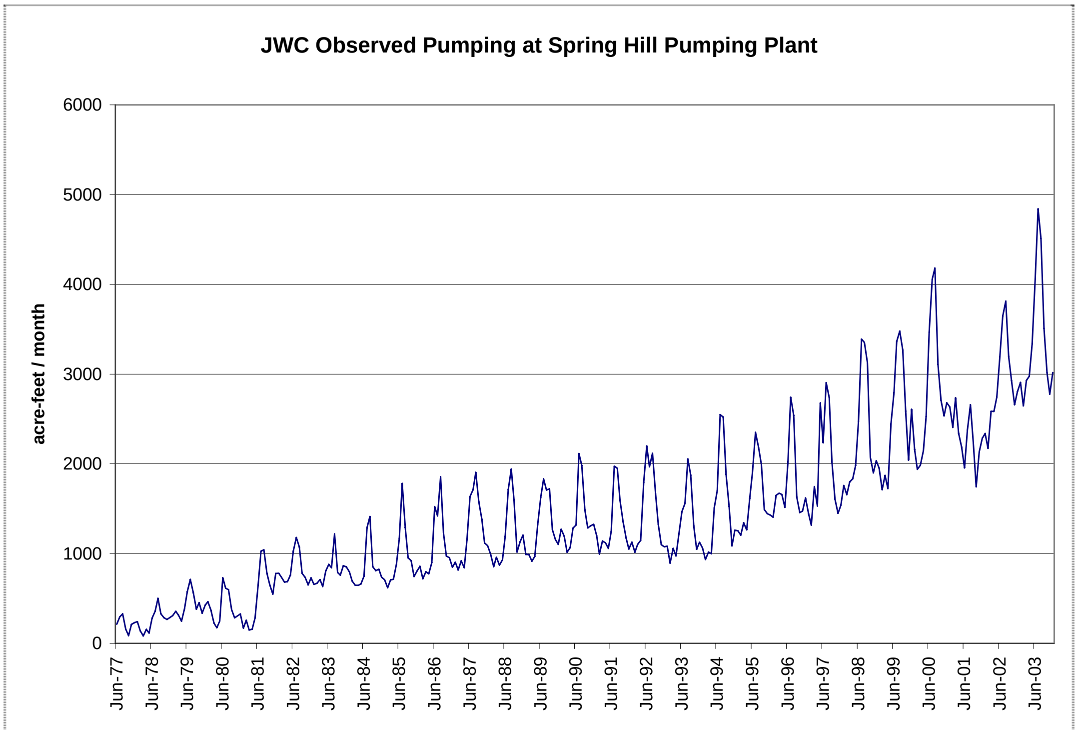


Figure 6. JWC Observed Pumping at Spring Hill Pumping Plant (acre-feet/month).

The modeled request for current conditions JWC pumping was developed by translating and rotating the data about the June 2004 pumping value to create a flat trend. Then the amplitudes between winter and summer values were expanded to simulate 2004 conditions and the trace was extended backwards to water year 1929 by comparisons to natural stream discharges and precipitation. The resulting diversion request for Current Conditions, based on 2004 operating criteria, is shown in Figure 7.

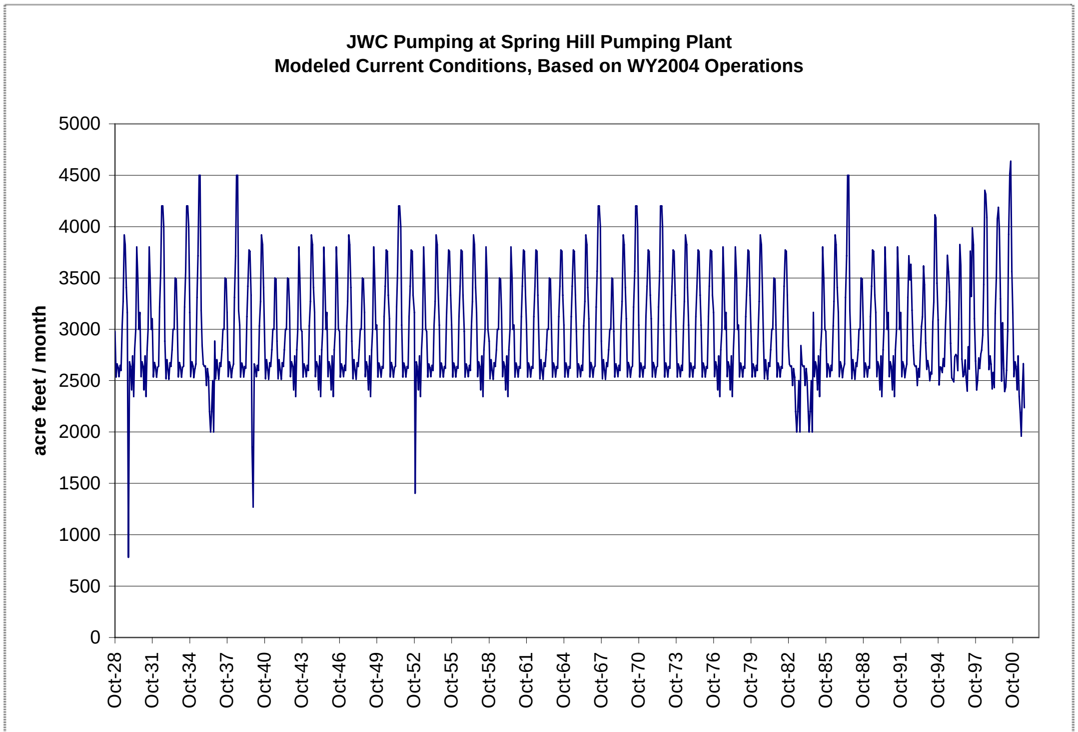


Figure 7. Modeled monthly JWC Pumping Request at Spring Hill Pumping Plant for Current Conditions, based on 2004 operating criteria (acre-feet/month).

The scenarios developed for the Tualatin BA use Current Conditions based on 2005 operating criteria, which is the 2004 request shown in Figure 7 plus 4 mgd. Projected Conditions used for the Proposed Action Scenario are based levels of depletion which inflate the 2004 request so that annual values are consistent with the water year 2020 value extrapolated from observed conditions[9].

The modeled request for JWC pumping at Spring Hill is satisfied first by natural flow rights and then by Scoggins and Barney flows based on a 70/30 split through August 1. After August 1, the split may change in order to maximize draw down in Scoggins. A carriage loss of 15% is charged on Scoggins flows from the dam to the pumping plant. This is used to describe reach losses from the dam to the pumping plant and JWC's difficulty in pumping all the water delivered. If there is insufficient water in either JWC's Barney or Scoggins accounts, the request may not be satisfied. Modeled natural flow rights which serve the JWC diversion request are shown in Table 1.

JWC's service contract in Scoggins is for 13,4370 acre-feet per water year. Their Barney contract space is modeled at 97% reliability, or, 11,061 acre-feet per water year.

9 MWH report, 'Integrated Water Resources Management Strategy', August, 2001.

Table 1. Modeled Natural Flow Rights serving JWC Diversion Request at Spring Hill Pumping Plant.

Date	Rate	Description
1/22/1912	3 cfs	Hillsboro, Sain Creek
5/1/1915	2 cfs	Hillsboro, Sain Creek
2/14/1947	7 cfs	Forest Grove
4/28/1976	33 + 6 cfs	Forest Grove
7/15/1980	25 cfs	Beaverton

Issue: JWC relies on Scoggins and Barney water based on a 70/30 split.

Method: The 70/30 split could have been managed using MODSIM's scripting capabilities, but it was easier, although less intuitive, to model the split using node and watch constructs. The 70/30 split is directed by the detached network centering on the round node ***JWC_SpHill2***. The inflow to node ***JWC_SpHill2*** is identical to the demand at ***JWC_SpHill***. The link ***watches natrlQ JWC*** which exits the node ***JWC_SpHill2*** watches the total natural flow serving the ***JWC_SpHill*** demand node using an exchange limit link (see the entry in the 'Exchange Limit Link' box under the 'Advanced' tab). This construct is used to calculate the remaining demand, not met by natural flow, which must be met by stored flows from Barney and Scoggins (through the link entering the node ***shortage***). The water that the flow through demand node ***shortage*** receives is split 70/30 and flows through to the round nodes ***30pc*** and ***70pc***. The links which exit ***30pc*** and ***70pc*** are watched by links serving the ***JWC_SpHill*** demand node, called ***watches 70pc*** and ***watches 30pc*** (see the 'Exchange Limit Link' entries). These links are therefore opened up to just 70% and 30% of the required flow in all months, but are supplemented by neighboring links that are only open August through November (these links are called ***unlimited Aug thru Nov*** and ***unlimited Aug thru Nov 2***). This effectively limits the flow to a 70/30 split until August 1, but is unlimited after that (at least through this portion of the network). Scoggins and Barney deliveries to the ***JWC_SpHill*** demand, however, are still limited by contract space remaining in the respective accounts.

6.9. Physical Reach and Accounting Losses

Physical reach losses are applied along the network at the following locations:

- above Lee Falls (2.0%)
- Lee Falls to Scoggins Creek (1.0 %)
- Scoggins Creek to Dilley (1.0%)
- Dilley to Spring Hill (3.0 %)
- below Spring Hill and above Forest Grove WWTP discharge (5.0%)
  below Farmington and above Durham WWTP discharge (9.0%)

All water flowing in these reaches is reduced by the percentage shown.

Accounting losses are also charged to service contract storage accounts:

- TVID, Scoggins to Spring Hill (4.0%)
- JWC, Barney to Spring Hill (4.5%)
- JWC, Scoggins to Spring Hill (15%)
- CWS, Scoggins to Farmington (8%)
- CWS, Barney to Farmington (9%)

Accounting losses differ from reach losses in that reach losses are applied to the physical water flowing in the reaches specified, and accounting losses are charges applied to the service contract holder's storage account. For example, when Scoggins water is delivered to TVID at Spring Hill, that water must flow through the reaches Scoggins Creek to Dilley (1.0%) and Dilley to Spring Hill (3.0 %), so the physical water is depleted by 1.0% (with 99% remaining) plus 3.0% of the 99% remaining, for a total physical loss of 3.97%. TVID is responsible for paying for that loss, so the accounting loss charged to TVID depletes TVID's account by about 4%. The Scoggins storage account for JWC at Spring Hill Pumping Plant is depleted by 15%, not only to account for the 3.97% physical loss from Scoggins to Spring Hill, but also to simulate JWC's inability to pump the quantity of water ordered from the dam.

Issue: Reach losses and accounting losses are modeled differently. Method: Reach losses are entered under the 'Channel Loss' for the individual reach links. Accounting losses are entered in the 'Storage Channel Loss Link' of the Storage Contract link. 'Storage Channel Loss Link' points to another link in the system with the required 'Channel Loss'.

6.10. Instream Flow Requests below Farmington

Depending on the scenario modeled, instream flow requests below Farmington are either the 'Current Conditions' or 'Baseline' flow levels used by MWH (refer to Table

2.) If the water flowing in the Farmington reach for other uses downstream is not sufficient to satisfy the instream flow requests, additional water can be drawn from the following sources in priority:

- o 8/5/1993 100 cfs natural flow right
- o Scoggins stored flows (if available in the CWS Scoggins account)
- o Barney stored flows (if available in CWS Barney account)
- o leased Scoggins water from TVID, up to 6,000 AF/year (if available in TVID's account)

Table 2. Model Input: Instream Flow Requirements Below Farmington.

	MWH 'Current Conditions'		MWH 'Baseline'	
Month	**cfs**	**ac-ft**	**cfs**	**ac-ft**
oct	180	11,067	350	21,520
nov	--	--	230	14,142
dec	--	--	230	14,142
jan	--	--	230	14,142
feb	--	--	230	14,142
mar	--	--	230	14,142
apr	--	--	230	14,142
may	120	7,378	230	14,142
jun	120	7,140	230	14,142
jul	150	9,223	290	17,831
aug	150	9,223	290	17,831
sep	180	10,710	350	21,520

6.11. Other Instream Flow Requests

Other instream flow requests are modeled to simulate authority, instream water rights and accepted operations.

- o Scoggins Creek below Scoggins Dam,10 cfs December through September, 20 cfs in October and November. The 10 cfs is met as an authorized flow, the remainder is met with a 1966 Sain Creek water right in priority, if water flowing in this reach for other purposes is not sufficient.
- o Tualatin River below Spring Hill Pumping Plant, 25 cfs is an operational guideline year round, met with the highest priority natural flow and stored flows, if water flowing in this reach for other purposes is not sufficient.
- o Tualatin River below Golf Course gage, 40 cfs is an operational guideline and is met with stored flows (Barney or Scoggins) May through October, if water flowing in this reach for other purposes is not sufficient.

6.12. Scoggins Reservoir Operations

The active capacity of Henry Hagg Lake (Scoggins Dam and Reservoir) is 53,323 acre-feet.

Scoggins Reservoir (Henry Hagg Lake), as modeled, uses a natural flow right with a priority date of 2/20/1963 to fill. Physical fill is not allowed to exceed fill guidelines which are modeled as a function of precipitation forecasts. Flood control rule curves from November 1 to May 1 are observed, but some flexibility is applied based on observed historic response in similar water years and months.

From May through October, reservoir drawdown is primarily determined by requests from TVID, CWS and JWC, although guidelines, based on precipitation forecasts, provide an upper limit for reservoir contents.

Issue: Scoggins Reservoir operations rely on precipitation forecasts and storage guidelines.

Method: Scoggins Reservoir operations are governed by targets in the model using hydrologic states. The hydrologic states represent seven levels of water year type and water month type, from wet to dry, and were developed using cumulative precipitation at Forest Grove, Oregon, starting in October (represented in the model by reservoir node ***cumPrecip***). Time series of historic reservoir contents for December through April and May through September were grouped visually by shape and magnitude and visually correlated with cumulative precipitation records. Reservoir targets, based on hydrologic state, were developed from these visual correlations (see ‘Target Storage’ under the ‘Reservoir Data’ tab for the reservoir node ***Scoggins***). During simulation, hydrologic state, and therefore reservoir targets, may change from month to month (a dry April may be followed by a normal May, etc). On the toolbar, select ‘Settings/System State’ to view the ‘Boundary Factors’ which define Hydrologic State. The use of Hydrologic States is explained in greater detail in the MODSIM documentation, included on the CD which accompanies this document.

6.13. Project Accounting

Water supplied by Reclamation’s Tualatin Project is from three sources: storage in Scoggins Reservoir, natural flow, and return flow (although return flow is negligible). Reclamation provides Project water through water service contracts with the Tualatin Valley Irrigation District (TVID), the three municipalities of the Joint Water Commission (JWC), Clean Water Services (CWS), and Lake Oswego Corporation. There is no accounting carryover of unused water from one year to the next.

Although not specified in the contracts, Reclamation has traditionally assigned reservoir space to each contract, so that a constant percentage of the contract volume is attributable to storage space in Scoggins Reservoir, and the remainder to Project natural flow. Table 3 shows the water service contracts for the Tualatin Project and the space attributed to storage

As Scoggins Reservoir fills, space belonging to water service contract holders accrue water in proportion to their attributed storage space. This is the basis of the paper storage accounting performed in the model. Total accrual may exceed the active capacity of the reservoir. Both CWS and JWC may be drawing on their accounts during the fill period. On April 1, Shortage Criteria may be applied to the water service contract holders' accounts (see Section 6.7 on Shortage Criteria).

Table 3. Water Service Contracts and Storage Space in Scoggins Reservoir

	Water Service Contract Volume (acre-feet)	Contract Volume attributed to Storage[10] (acre-feet)
TVID	37,000	26,849
JWC	13,500	13,437
CWS	16,900	12,539
Lake Oswego	500	498
Total	**67,900**	**53,323**

Issue: Accounting is performed on Project water service contracts.

Method. Accrual links ***accrual R5777*** and ***accrual fifteen%*** serve the reservoir node ***Scoggins*** with water rights dates 2/20/1963 and 2/21/1963. Storage Contract links serving TVID, JWC, CWS and Lake Oswego demand nodes point to these accrual links to facilitate accounting for the volume of each contract attributable to storage space. TVID Storage Contract links are Group Storage Contract links because TVID diverts at multiple locations which share the same storage space.

The no carryover rule is managed in the same basin model code in 'Tualatin.cs' that manages the Shortage Criteria (see Section 6.7).

Project natural flow deliveries are modeled as serving TVID at Spring Hill Pumping Plant (link ***WR 90 cfs Project*** which serves demand node ***TVID_SpHill***) and CWS below Farmington (link ***WR Project natrlQ CWS*** which serves flow-through demand node ***minFarm***).

10 revised by May, 2001, Area-Capacity tables.

6.14. Waste Water Treatment Plant Inflows

Four waste water treatment plants (WWTP) discharge into the Tualatin River at separate locations: Forest Grove, Hillsboro, Rock Creek, and Durham. For the most part, water diverted at Spring Hill by the JWC returns through these four plants, in addition to considerably more water from basins outside the Tualatin. The model uses present-level WWTP discharge rates based on recent observed rates (Refer to Appendix B).

7. Model Calibration

Model calibration was performed by comparing historic reservoir contents and river discharge to model results. Calibration points are locations with sufficient observed data: Scoggins Reservoir contents and discharges for Scoggins Creek below Scoggins Dam, Tualatin River at Lee Falls, Tualatin River at/near Gaston, Tualatin River at Dilley, Tualatin River at Farmington, and Tualatin River at West Linn.

Several calibration scenarios were developed. The ‘Hydrology and Water Rights Calibration’ Scenario applies observed and estimated historic traces for Scoggins Reservoir contents, JWC pumping at Spring Hill and TVID pumping at Spring Hill to the common MODSIM model structure. This scenario is tightly controlled by using these historic traces, so that it can be used to examine the simulation of water rights and accounting, reach losses, and system gains and losses.

The ‘Current Conditions 2004 Calibration’ Scenario uses 2004 operating practices applied to the common MODSIM model structure to investigate the modeled behavior of reservoir contents, transbasin diversions and diversions at Spring Hill Pumping Plant and compares the results to observed (historic) values.

> Issue: For the ‘Hydrology and Water Rights Calibration Scenario’, apply observed and estimated historic traces for Scoggins Reservoir contents, JWC pumping at Spring Hill and TVID pumping at Spring Hill.
>
> Method: ‘Settings/Run Type/Explicit Targets’ is set from the MODSIM toolbar and observed data is imported to nodes ***Scoggins*** and ***JWC_SpHill***. ***TVID_SpHill*** demand data is already observed and estimated historic in the common MODSIM model structure.

7.1. Hydrology and Water Rights Calibration Scenario Results

Hydrology and Water Rights Calibration Scenario results for streamflows and storage accounting are compared to observed values in Figure 9 through Figure 17. End of month reservoir contents are compared to observed values in Figure 8.

Modeled streamflows represent the physical water in the system. Modeled streamflows for the Calibration Scenario for all streamflow locations compare favorably to observed streamflows (see examples in Figure 9 through Figure), except for the Tualatin River at/near Gaston in the later years (Figure 10). Possible explanations for the less than perfect calibration are that two gages with different periods of record are modeled at a single location, or Barney imports and/or Cherry Creek Slow Sand Filter diversions were changed or updated after the original gains data set (naturalized streamflows) was developed. The lack of calibration here is inconsequential, since the system corrects itself downstream of Gaston, which is high in the system anyway and modeled scenarios are always be compared back to a reference or baseline.

Modeled ‘use of Project water’ represents the paper accounting performed by the dam tender at Scoggins Dam. This is a more difficult calibration, and the comparison of modeled values is made to values which have been calculated and adjusted in the field for many reasons. By definition, in the Calibration Scenario, the quantity of water physically diverted at Spring Hill Pumping Plant is identical to the estimated historic and observed diversion. So the differences are only in the paper accounting which identifies the water diverted as either natural flow or Project stored and natural flows. Given these considerations, the magnitude of the modeled accounting values for ‘use of Project stored water’ for TVID and CWS are reasonable (Figure 15 and Figure 16). CWS ‘use of Project natural and Project stored flows’ to meet instream flow requests below Farmington (Figure 17) does not calibrate nearly as well, for several reasons: the historic demands for instream flows below Farmington are not known and were highly variable and discharge from waste water treatment plants and a multitude of flow rights contribute to flows in that reach. One source of flow in the that reach which is modeled, but may not be observed in the field before CWS calls for stored flow, is a 1993 water right for instream flow further downstream. It is possible that, in the field, some of that natural flow is identified as Scoggins stored flow. Even so, the model calibrates well to the physical water flowing in the reach.

7.2. Current Conditions 2004 Calibration Scenario Results

Current Condtions Calibration Scenario results for streamflows and storage accounting are compared to observed values Figure 18 and Figure 19.

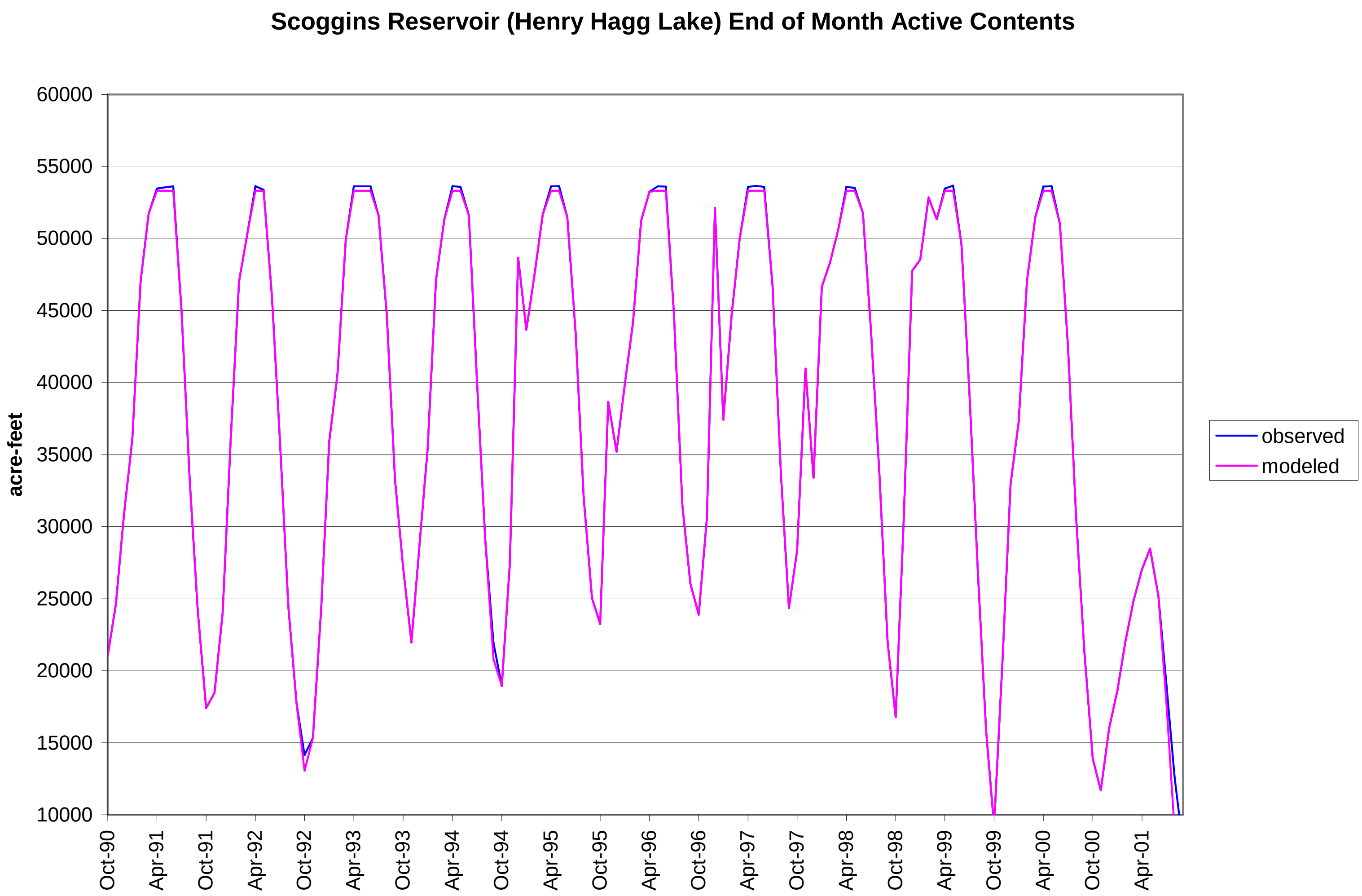


Figure 8. Scoggins Reservoir observed and 'Hydrology and Water Rights Calibration' modeled end of month active contents, water years 1981 – 1991. In the Calibration scenario, Scoggins Reservoir was forced to behave as it did historically, so the two lines can not be distinguished.

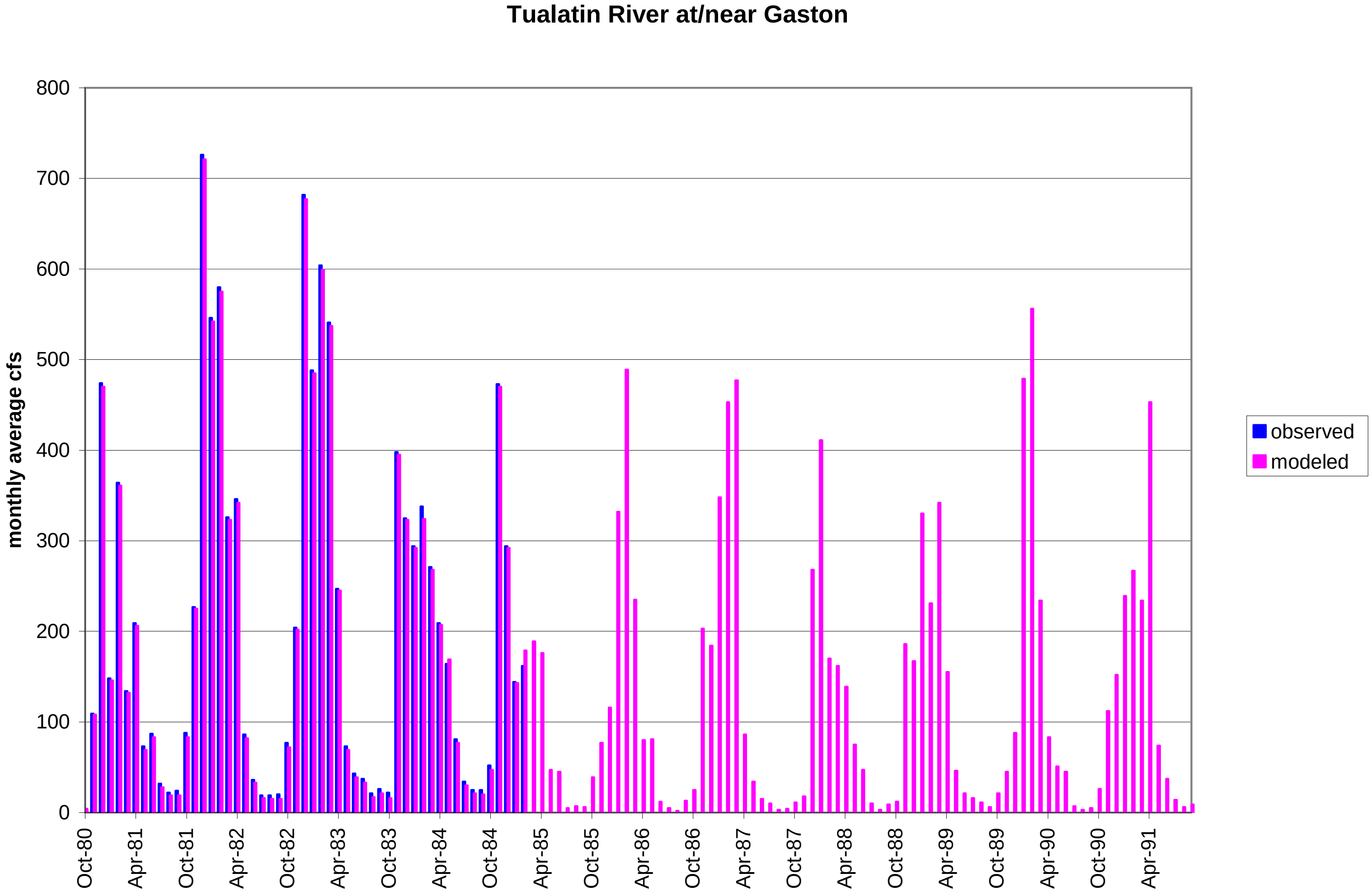


Figure 9. Tualatin River at/near Gaston, observed and modeled 'Hydrology and Water Rights Calibration' discharge, water years 1981 - 1991

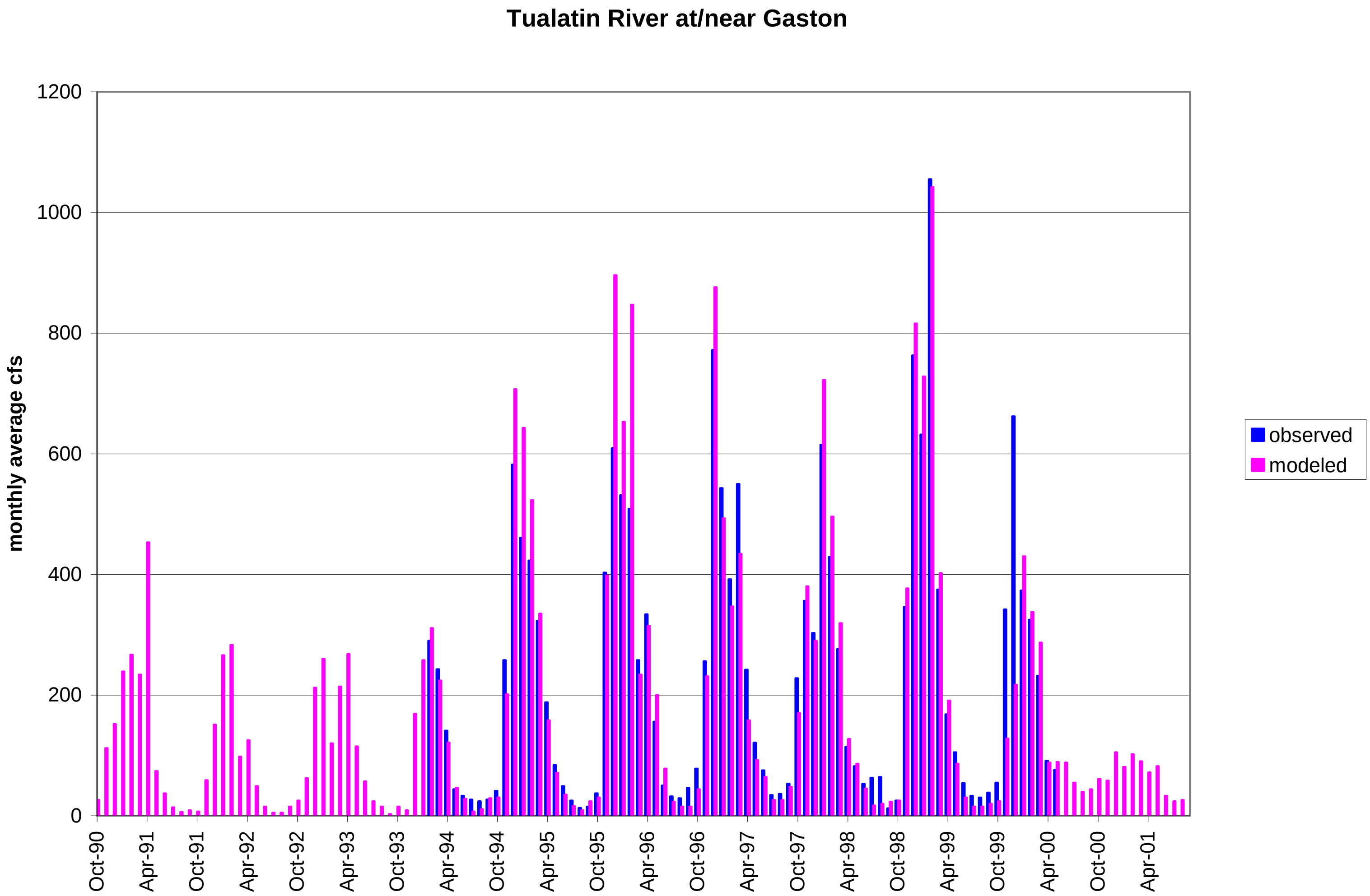


Figure 10. Tualatin River at/near Gaston, observed and modeled 'Hydrology and Water Rights Calibration' discharge, water years 1991-2001.

Tualatin River at Dilley

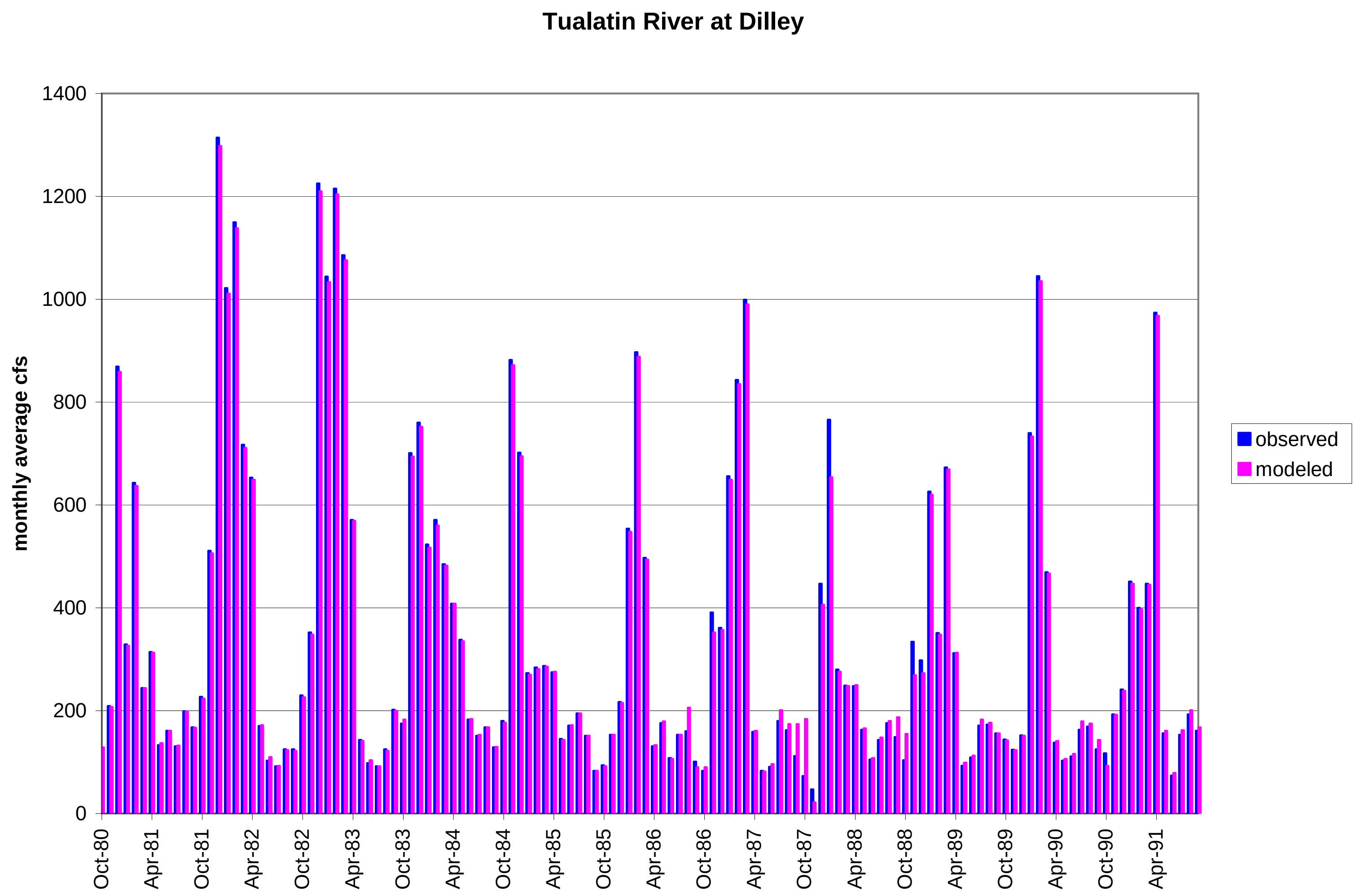


Figure 11. Tualatin River at Dilley, observed and modeled 'Hydrology and Water Rights Calibration' discharge, water years 1981-1991.

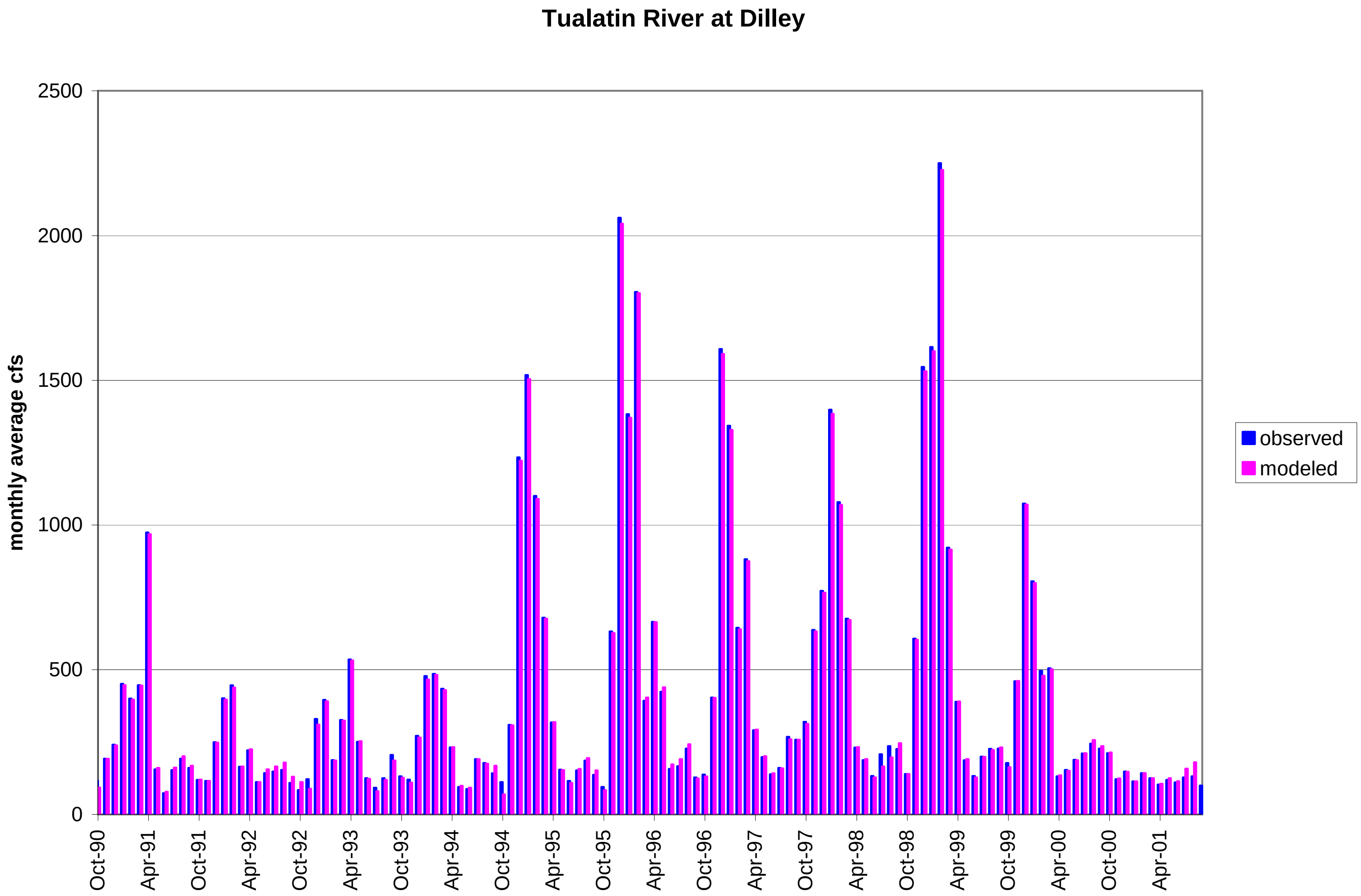


Figure 12. Tualatin River at Dilley, observed and modeled 'Calibration' discharge, water years 1991-2001.

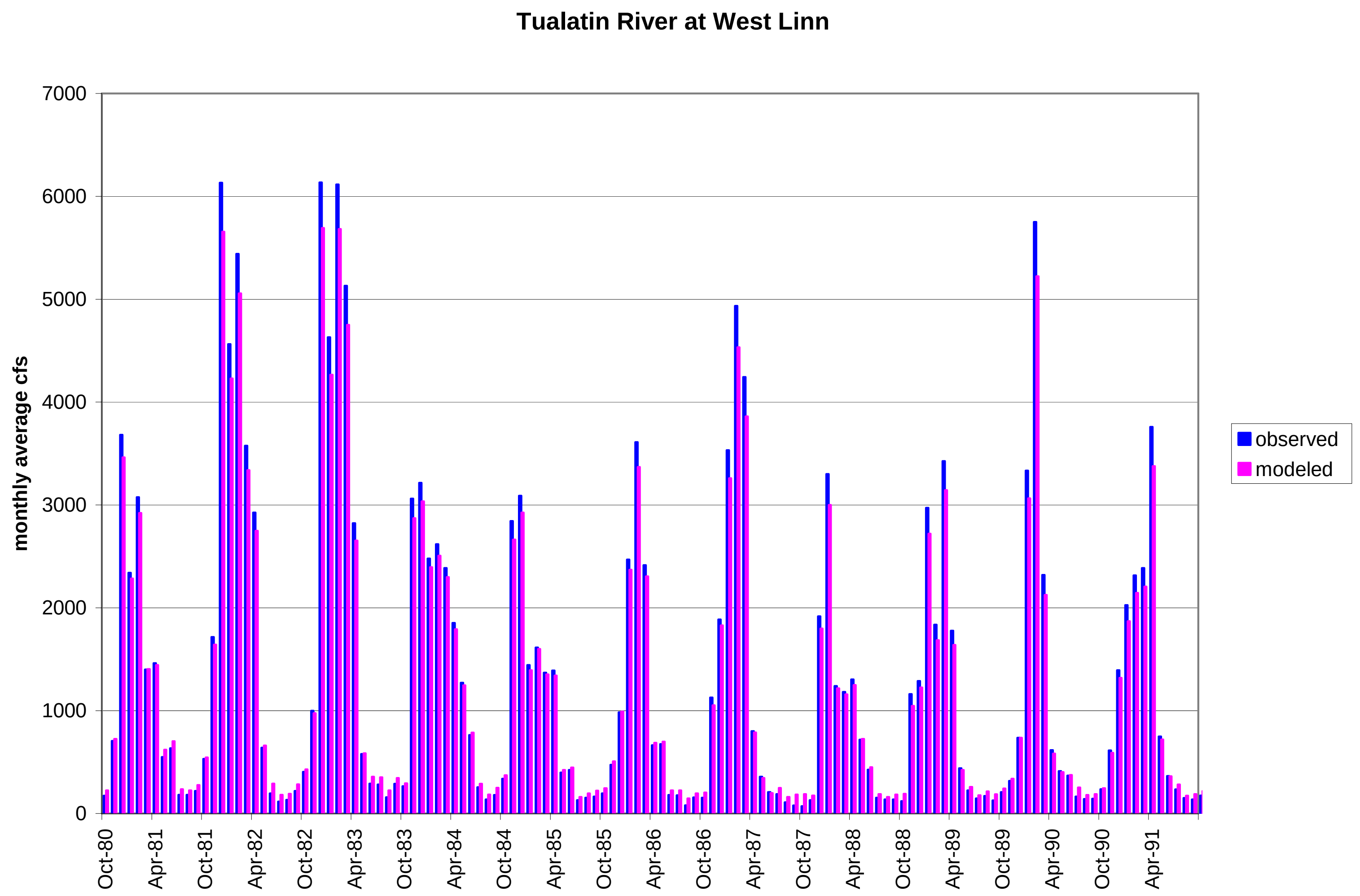


Figure 13. Tualatin River at West Linn, observed and modeled 'Hydrology and Water Rights Calibration' discharge, water years 1981-1991.

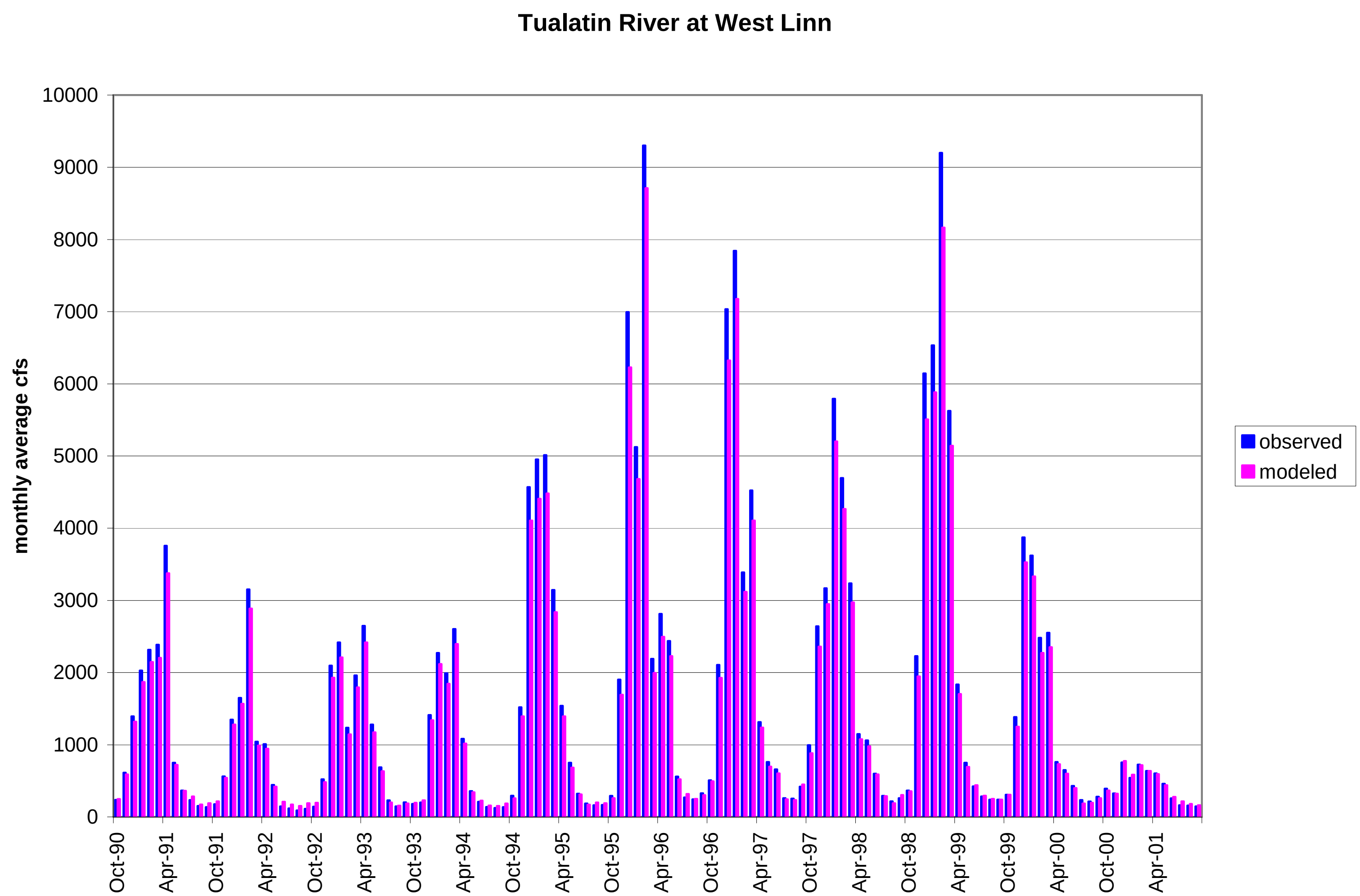


Figure 14. Tualatin River at West Linn, observed and modeled 'Hydrology and Water Rights Calibration' discharge, water years 1991-2001.

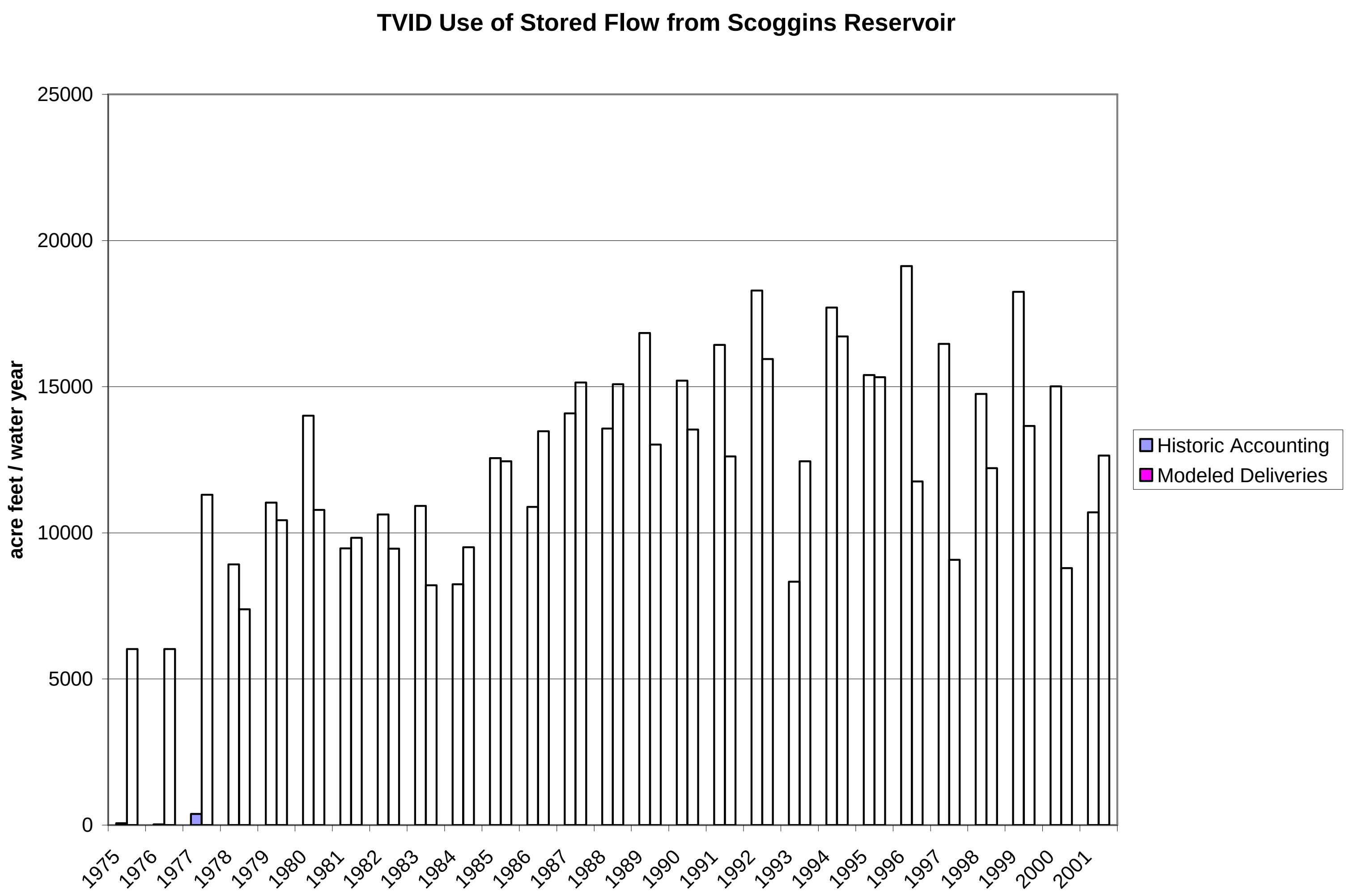


Figure 15. TVID use of Project stored flows, accounted at Scoggins Dam, for the Hydrology and Water Rights Calibration Scenario and Historic records.

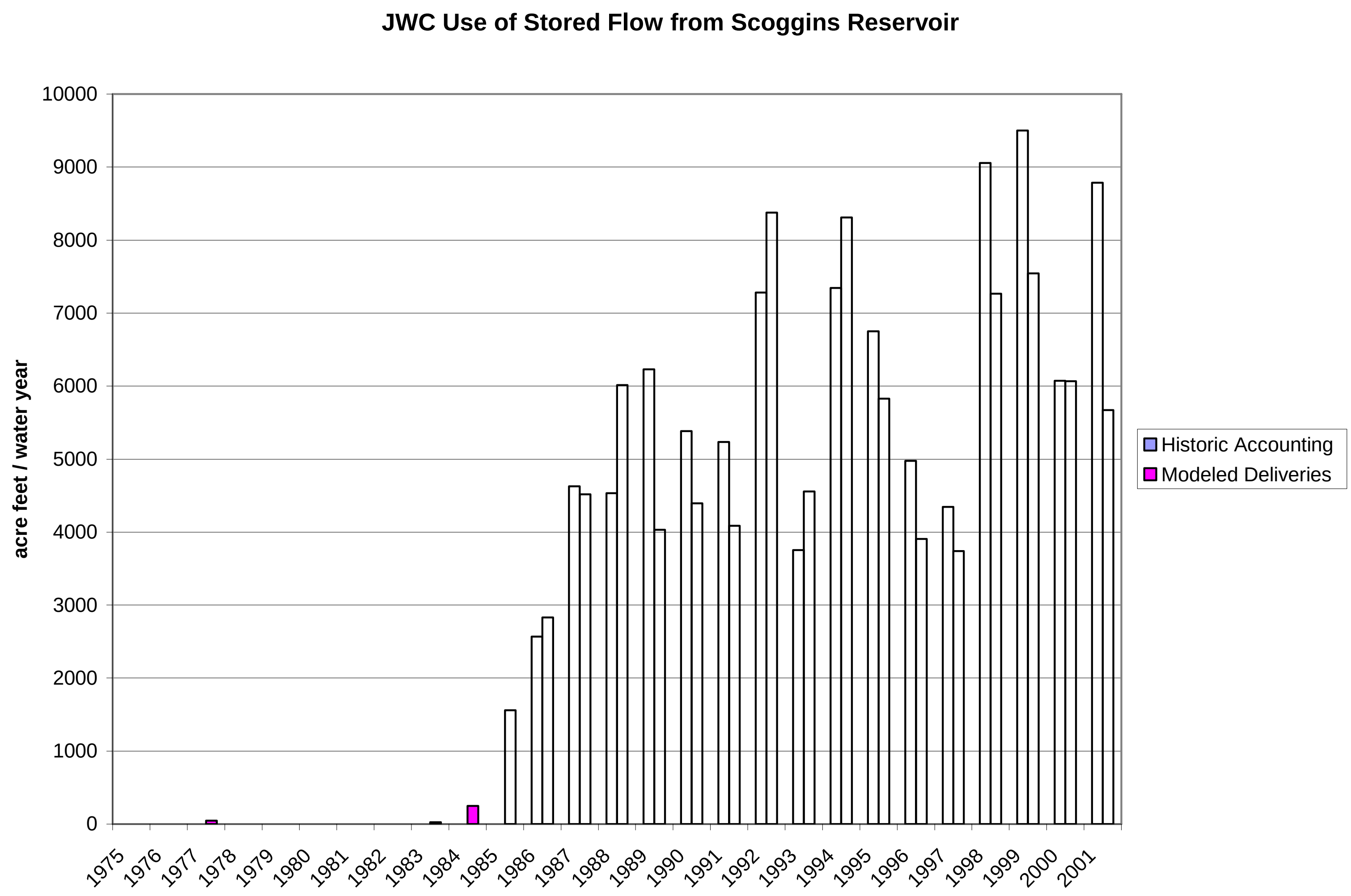


Figure 16. JWC use of Project stored flows, accounted at Scoggins, for the Hydrology and Water Rights Calibration Scenario and Historic records..

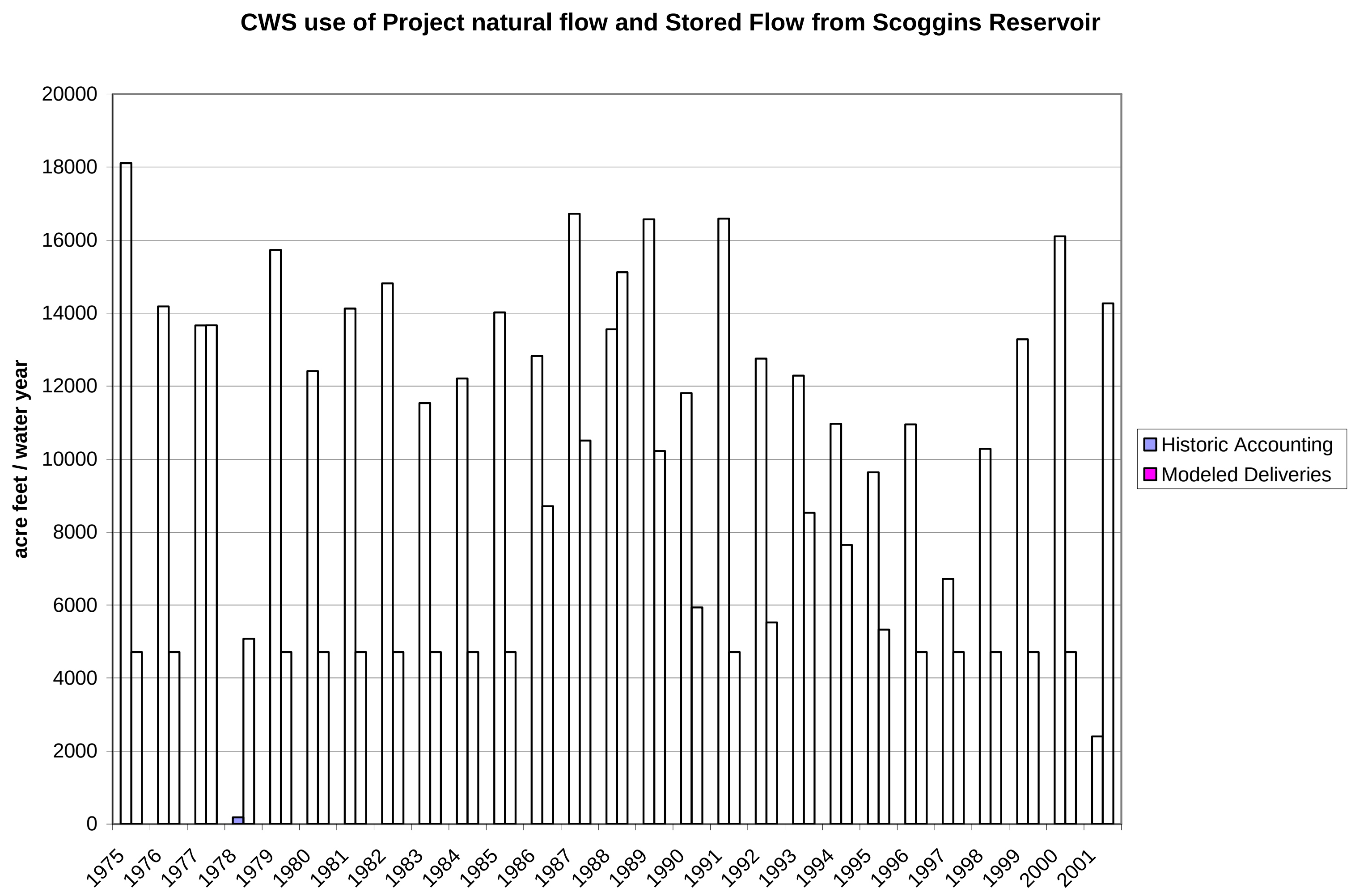


Figure 17. CWS use of Project natural and stored flows, accounted at Scoggins, for the Hydrology and Water Rights Calibration Scenario and Historic records..

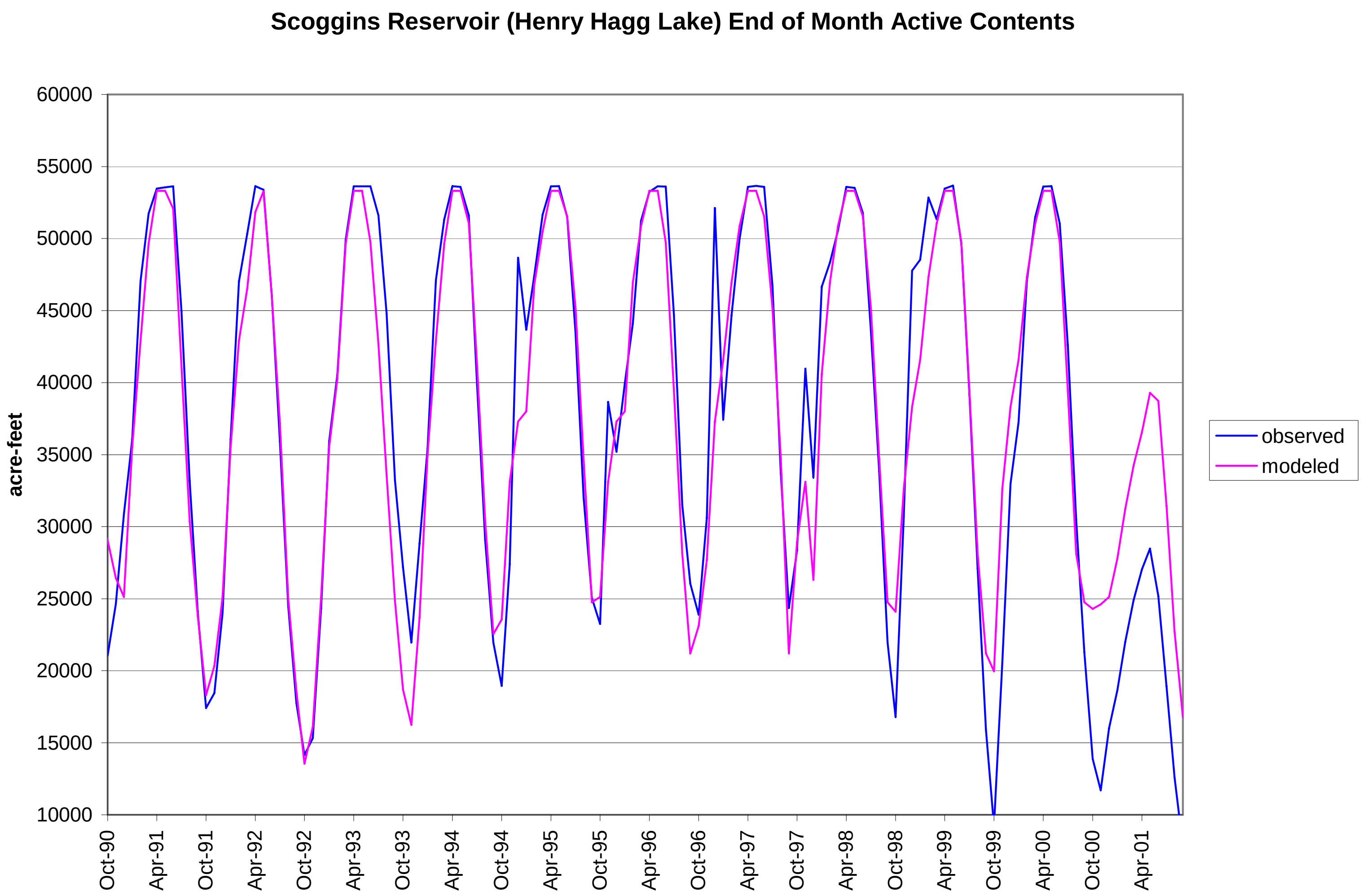


Figure 18. Scoggins Reservoir observed and 'Current Conditions 2004' modeled end of month active contents.

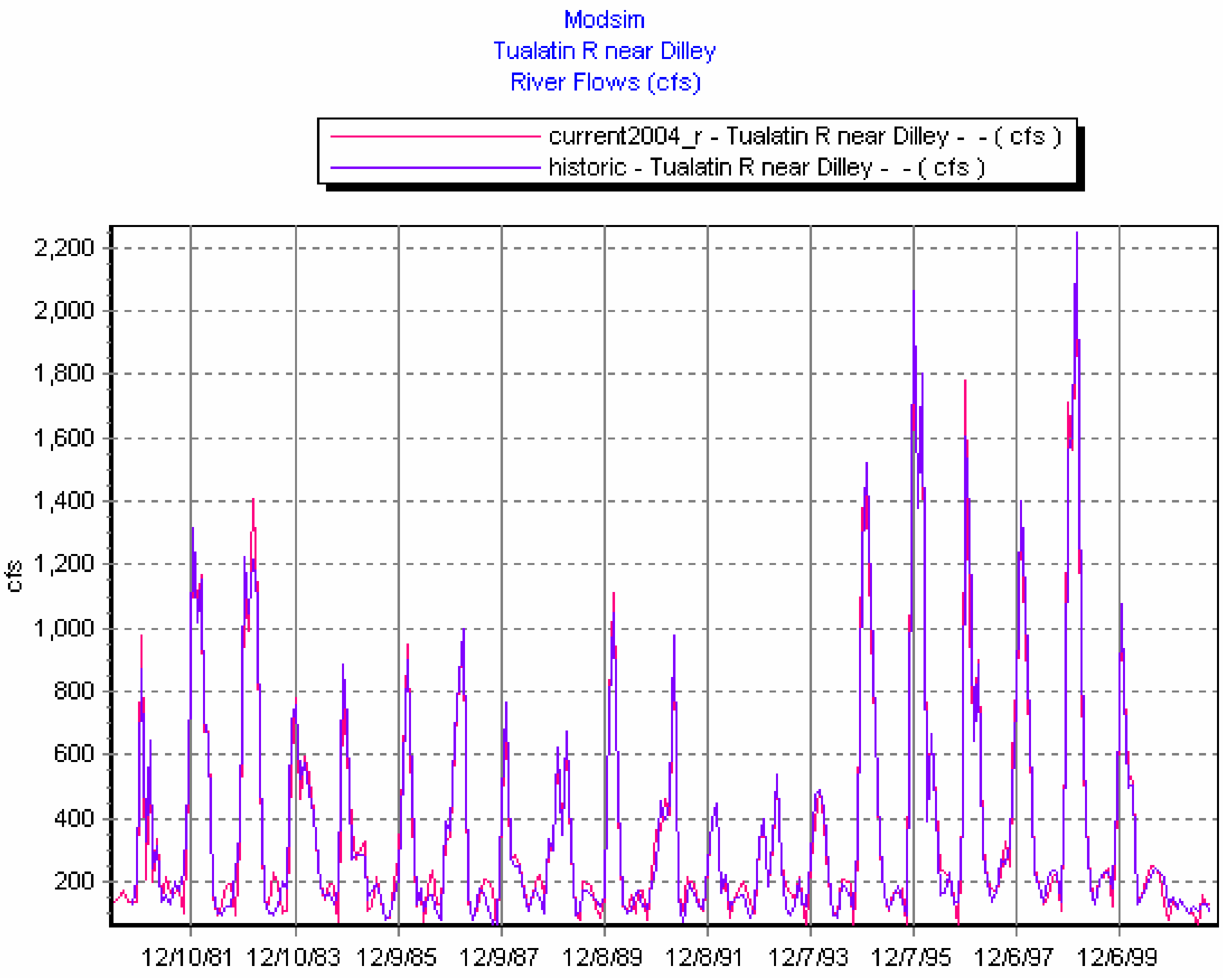


Figure 19. Comparison of Current Conditions 2004 Calibration Scenario to Observed (historic) streamflows for the Tualatin River near Dilley.

8. Glossary

Accrual – Credit for natural flow runoff in a storage priority; an accrual link is a link into a reservoir that at least one other network link, to a demand, has the accrual link specified as its parent link.

Bypass Credit Link – A link (usually immediately downstream from a diversion point) specified by a flow through demand that the flow is taken as partial satisfaction of the demand. In a network where water rights and storage contracts are simulated, instream flow demands are placed off-stream and connected to the river with appropriate entitlement links. The demand, in many cases, wants to divert water only if water is not already available at the point of the instream demand due to meeting other downstream demands. Credit is taken for the flow in the bypass credit link and effectively reduces the flow through demand.

Bypass Outflow Link – A link that represents flow through a reservoir that is not accrued under an accrual link.

Demand Node – Square purple node on the MODSIM GUI that represents a consumptive or non-consumptive demand

Exchange Limit Link – A specified link in the network whose flow is used to set the upper bounds of another link in the network for the time step.

Flow Through Demand – MODSIM demand construct to represent non-consumptive demands.

Storage Group Contract Link – A storage contract that is shared among two or more demands.

Hydrologic State – An index number between 1 and from 3 to 7; the index number is determined each time step of MODSIM simulation based on input forecast data and dynamically computed reservoir contents through a computation and table lookup; a MODSIM network may have several hydrologic states defined for a given network; the index number is used to specify reservoir and demand priorities, reservoir guide levels, and rent pool contribution / subscription amounts.

Natural Flow Link – MODSIM link representing a natural flow right; a link to a demand node with a negative cost

Natural Flow Right – A permit granted by the State Water Resources Department allowing the water right holder to divert water at a specified rate as long as all senior rights are satisfied that have physical access to the water to be diverted. Seniority is based on the priority date associated with the natural flow right specified on the permit.

Storage Contract Link – A link to a demand that represents a storage contract and has an accrual link as its parent link.

Reservoir Node – Red triangular node on the MODSIM GUI representing dams / reservoirs

Storage Contract – An agreement between a water user (irrigation district) and Reclamation that states a specified amount of space in a storage priority is administered by Reclamation to store runoff and deliver the water to the contract holder when needed; in return, the contract holder agrees to a repayment schedule for construction, operation, and maintenance of the dam, reservoir, and delivery works.

Target Storage – Maximum desired storage in a reservoir for a given time step.

Appendix A. Spring Hill Pumping Plant Data Completion

J. Charles

September, 2005

TVID

Available Data

- USGS flow data at the pumping plant (gage # 14204650) May1991 – May 2004
- PGE power data (power required to run pumps) Jan 1983 – May 2004
- Western Region Climate Research Institute precipitation data Jan 1978 – May 2004

Calculations

TVID began pumping water at Spring Hill pumping plant in 1978. The data set calculated in this document is to represent the historical pumping from January 1978 to May 2004.

The first attempt to calculate the dataset utilized the power data provided by PGE. PGE provided data for the power required to run the TVID pumps at the plant from January 1983 to May 2004 (PGE contact: Carroll Verback, Carroll_Verbeck@pgn.com). The flow data was a 0.97 correlation to the power data. Using the physical relationship

$$P = fh \qquad \text{Eq. 1}$$

where, P is power, is the unit weight of water, f is the flow and h is the head, the relationship

$$0.000897*P=f \qquad \text{Eq. 2}$$

was developed and used to calculate flow data from the PGE power data. The resulting flow data was compared to the USGS flow data for the overlapping dates. The difference between the calculated and the USGS datasets was negligible.

The remaining years of data, 1978 to 1983, were calculated using precipitation data from the Western climate research Institute (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?orfore). A correlation was developed between the precipitation data and the existing flow data for the over lapping years. This correlation was used to calculate the flow data for the remaining years.

Figure 1 shows the USGS data set, the data calculated from PGE data and the data calculated using the precipitation correlation.

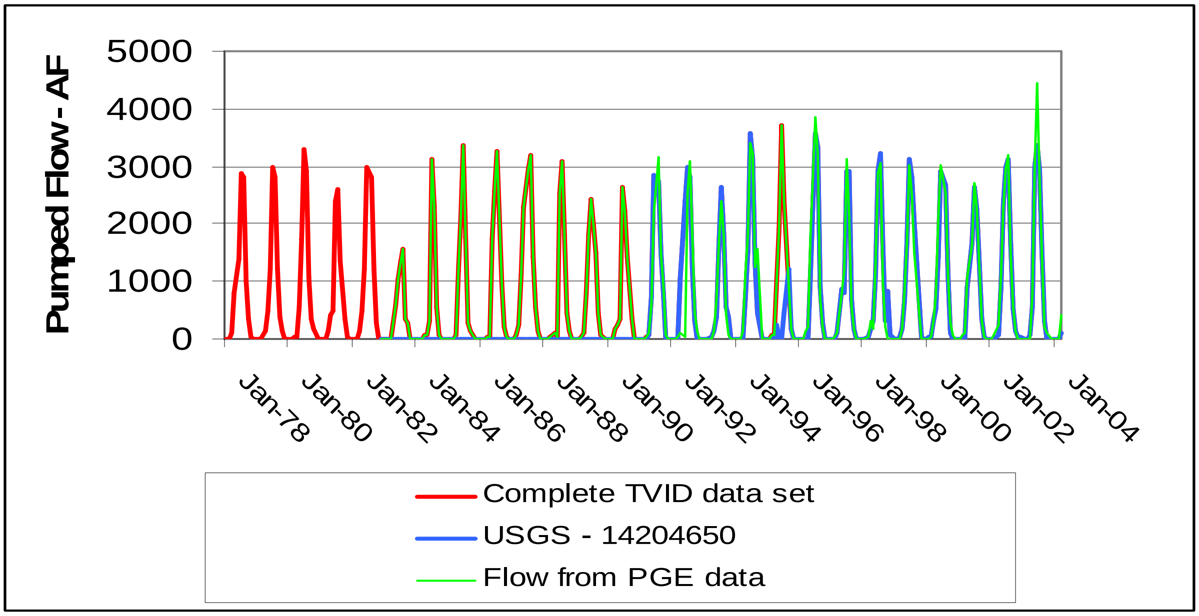


Figure 1: Calculated and actual flow data. Data is missing for USGS year 1995.

JWC

The Joint Water Commission supplied data for January 1977 to December 2003. It is assumed that the increasing trend in the data is due to population increase in the area. It is also assumed that winter pumping is relatively constant. Using income tax data from the Washington County, OR, for years 1992-2003 it can be observed that the increase in population corresponds with the increase in winter usage.

It is assumed that the years 2000 to 2003 are the most representative of the current pumping activity. The winter months (November through March) are assumed to be consistent throughout the period of record with the only changes being due to population growth. Using an average of the winter months for the years 2000-2003, the curve was normalized to a "straight line" approximation of the winter months. The normalized curve indicates that more pumping occurs in the summer months of low water supply years and less pumping occurs during high water supply years. Figure 2 shows historical data as given by Jean Woll. Figure 3 shows current conditions data as calculated by removing the trend from the historical data.

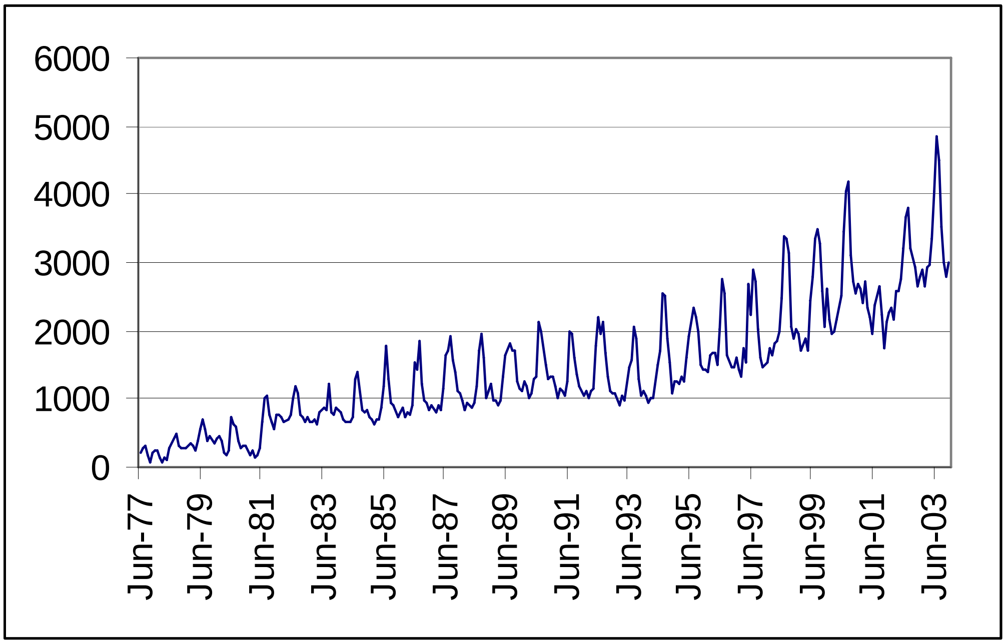


Figure 2: Joint Water Commision historical pumping at Spring Hill Pumping Plant in Acre-feet.

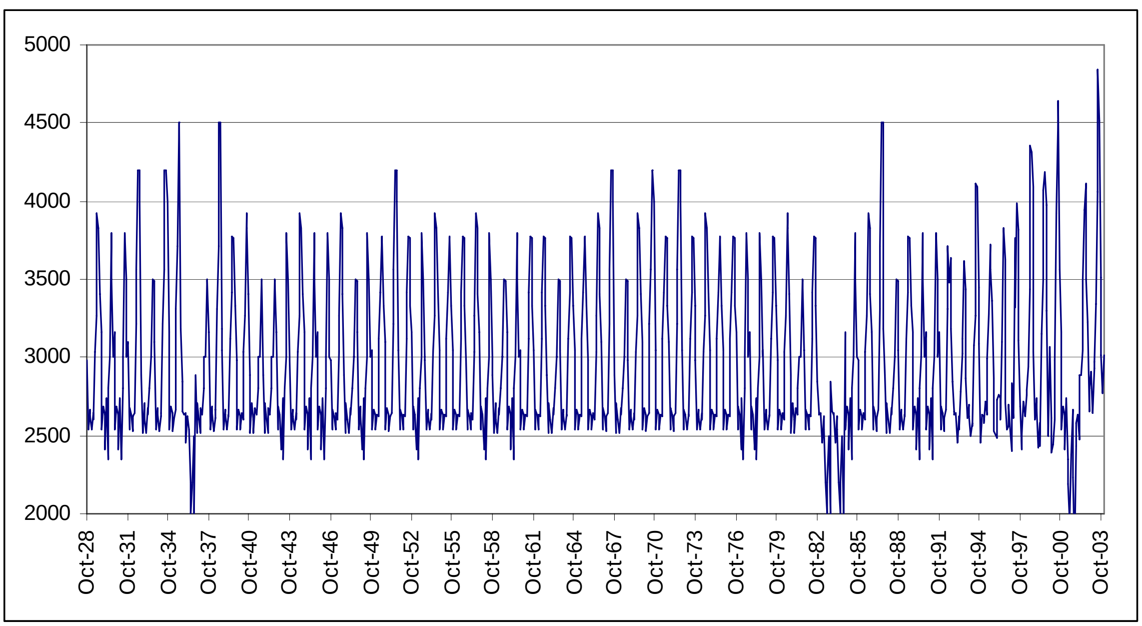


Figure 3: Calculated current condition pumping at Spring Hill Pumping Plant.

Appendix B. Waste Water Treatment Plant Flows Analysis

L. Stillwater
June 4, 2004

These notes are based conversations with Jan Miller (CWS) and on data and analyses in file WWTPs.xls.

Chronology

- Durham WWTP came on line in 1976.
- Rock Creek WWTP came on line in 1977 or 1978.
- Hillsboro and Forest Grove WWTPs came on line sometime in the 1960's.
- Durham and Rock Creek WWTPs replaced 22 small WWTPs throughout the basin.

Forest Grove WWTP and Hillsboro WWTP Operations

- Forest Grove WWTP and Hillsboro WWTP turn off in the summer (May 1 - Oct 31) and the summer water goes through Rock Creek WWTP.
- CWS can ask for a waiver to run these plants beyond May 1, but they must turn off when the Farmington gage gets down to 250 cfs.
- CWS often shuts the plants down earlier than May 1 if Farmington is low.
- The plants can start up again for winter once the Farmington gage shows a 7 day average of 350 cfs or an average daily flow of 1000 cfs.

Forest Grove WWTP

year	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	sum
2002	511	330	360	19								129	1348
2003	517	414	526	129								391	1976
2004	471	447	328	81									
median->	511	414	360	81								260	1662

Hillsboro WWTP

year	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	sum
1989			375	264							216	240	1095
1990	393	355	285	210							203	243	1689
1991	271	274	284	321	238						306	413	2108
1992	453	457	392	384	202						318	451	2656
1993	466	335	436	475	395	235					67	410	2820
1994	476	446	379	240	93					54	319	671	2679
1995	590	479	468	341	134						408	685	3107
1996	709	778	403	470	430	120					470	900	4281
1997	746	427	613	314	196						293	431	3020
1998	742	560	507	359	467	199					528	775	4137
1999	791	870	636	439							332	556	3623
2000	623	492	495	351								343	2304
2001	355	329	348	266							263	709	2269
2002	715	417	527	355									2014
2003												510	
2004	657	551	465	283									1956
median->	607	451	436	341	220	199				54	312	480	2656

Rock Creek WWTP

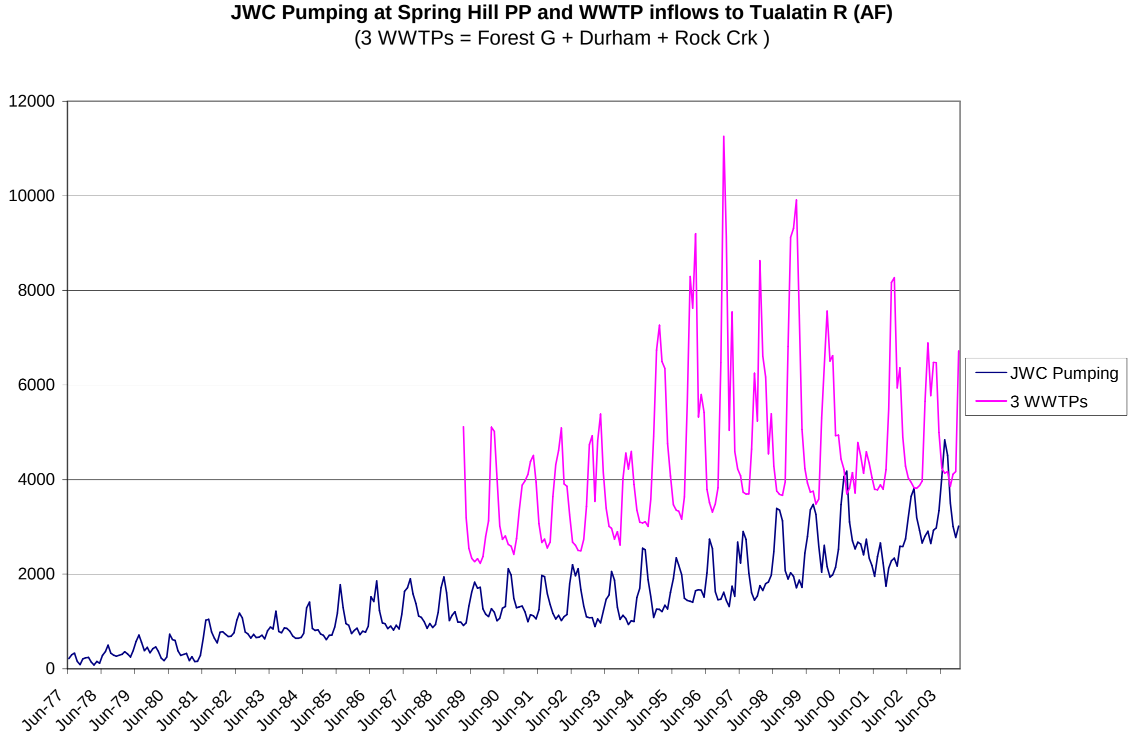
year	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	sum
1989	1884	1769	2541	1495	1312	1172	1147	1198	1190	1218	1385	1522	17833
1990	2701	2671	2111	1535	1485	1393	1370	1303	1164	1309	1560	1780	20381
1991	1808	1929	2257	2143	1836	1507	1311	1377	1275	1324	1698	2029	20494
1992	2180	2403	1824	1778	1575	1367	1382	1338	1276	1419	1586	2242	20370
1993	2349	1720	2329	2557	1776	1653	1488	1455	1334	1399	1270	1770	21099
1994	2081	1966	2147	1858	1753	1678	1682	1688	1583	1779	2351	3308	23873
1995	3862	3287	3369	2254	1989	1755	1739	1701	1613	1796	2648	4445	30458
1996	3698	4607	2375	2803	2582	1987	1913	1788	1809	1906	3013	5874	34357
1997	4460	2410	3658	2172	2137	2227	2088	2070	2023	2642	3711	2559	32158
1998	4613	3447	3025	2232	2641	2279	2123	2091	2071	2136	3350	4772	34779
1999	4824	5241	3746	2401	2341	2226	2100	2115	1921	1896	2721	3335	34867
2000	4130	3522	3614	2657	3020	2713	2558	2165	2293	2513	2089	2544	33816
2001	2390	2222	2455	2364	2407	2266	2299	2375	2336	2613	3194	4587	31508
2002	4678	3309	3428	2672	2641	2491	2433	2357	2373	2409	2448	3442	34682
2003	4218	3481	3846	4014	3068	2704	2691	2701	2435	2563	2495	3550	37765
2004	4178	3429	2787	1702									
median->	3780	2979	2664	2243	2137	1987	1913	1788	1809	1896	2448	3308	31508

Durham WWTP

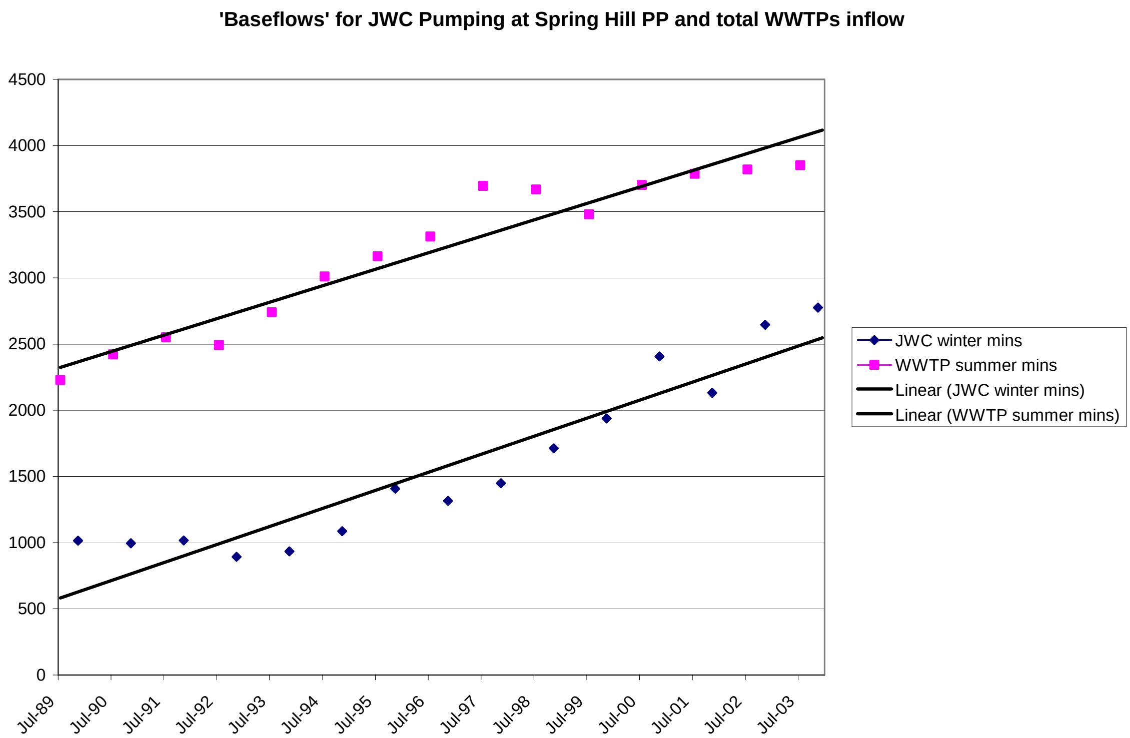
year	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	sum
1989	1747	1494	2205	1431	1237	1164	1117	1129	1038	1156	1195	1363	16277
1990	2012	1996	1628	1279	1250	1415	1259	1289	1258	1447	1589	1858	18279
1991	1894	1906	1843	2049	1874	1561	1358	1364	1277	1356	1635	1872	19988
1992	1984	2229	1694	1695	1473	1312	1231	1162	1215	1320	1530	2046	18892
1993	2116	1488	2054	2350	1984	1509	1522	1513	1407	1502	1283	1838	20566
1994	2003	1814	2072	1800	1512	1423	1402	1423	1427	1749	2249	2761	21634
1995	2816	2730	2511	2166	1954	1714	1612	1629	1551	1837	2562	3167	26249
1996	3219	3815	2547	2532	2411	1686	1597	1525	1678	1915	2987	4485	30396
1997	3924	2203	3274	2107	1893	1855	1645	1624	1677	2005	2243	2249	26699
1998	3274	2609	2630	1956	2288	1813	1637	1597	1597	1813	2938	3574	27728
1999	3699	3801	3094	2225	1891	1702	1638	1642	1560	1697	2255	2492	27696
2000	2806	2493	2515	1920	1919	1721	1664	1536	1527	1635	1627	1900	23264
2001	1752	1586	1785	1715	1642	1527	1487	1511	1462	1595	2039	2871	20971
2002	2877	2213	2410	1871	1643	1544	1512	1471	1447	1464	1519	2216	22188
2003	2672	2293	2632	2458	1929	1536	1444	1468	1418	1553	1673	2660	23737
2004	2845	2357	2034	1209									
median->	2739	2221	2308	1938	1891	1544	1512	1511	1447	1595	1673	2249	22188

•

JWC pumping and WWTP flows have increased over the years. (See graph below).



The increase in both JWC pumping and WWTP flows has occurred at about the same rate. (See graph below.)



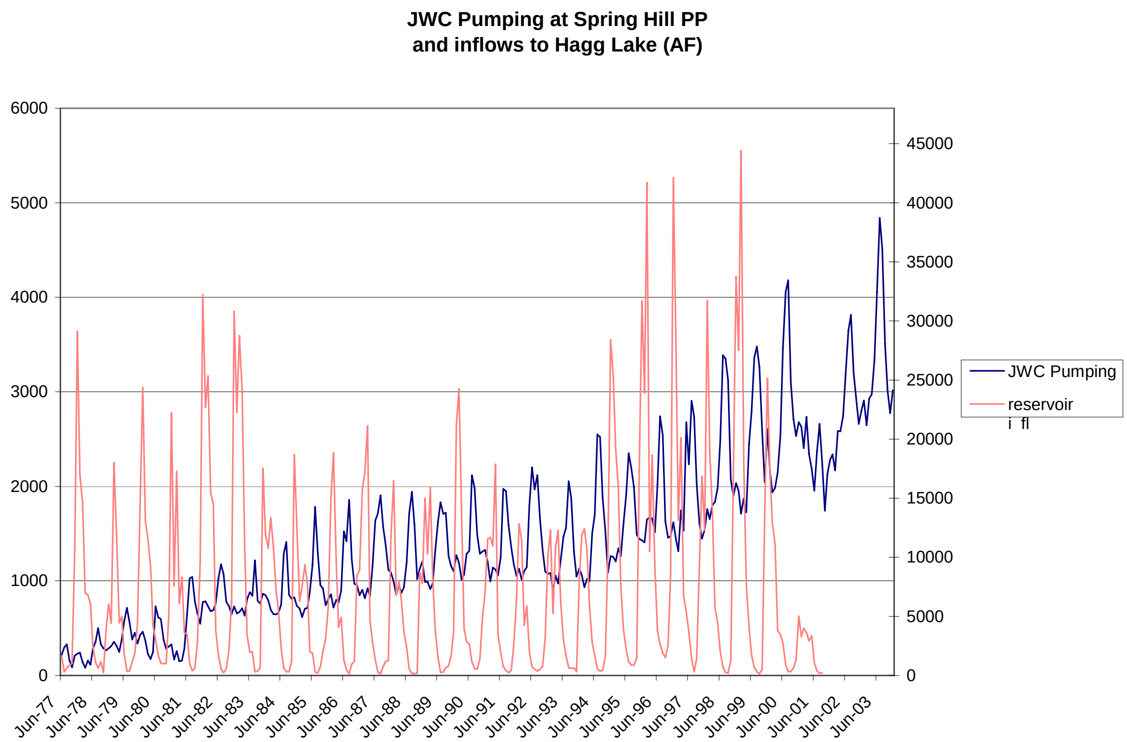
The rate of increase for JWC pumping was determined by looking at the low winter flows. This removes summer lawn and golf course irrigation from the analysis. The rate of increase for WWTP flows was determined by looking at low summer flows. This removes flows due to winter storms from the analysis.

Because both JWC pumping and WWTP flows have increased at about the same rate, we can conclude the increase in WWTP flows is primarily due to the increase in JWC pumping, and is not due to an increased reliance on other basins for municipal water.

The increase in WWTP flows appears to be due to Rock Creek and Durham WWTPs. Hillsboro WWTP does not contribute to the increase and, although there's very little data, Forest Grove WWTP appears not to contribute to the increase.

'Current Conditions' JWC Pumping and WWTP Flows

JWC pumping is somewhat constant during 1987-1994 and starts to increase after 1994. Reservoir inflows also increase after 1994, indicating a generally wetter period. (See graph below.)



The JWC pumping increase after 1994 is at least partially due to the operators' response to having more water in the basin (more inflows to Hagg Lake). The JWC pumping data for 1987 through 2004, then, reflect different JWC pumping responses to water supply in addition to an increased demand. [Is it then reasonable, then, to model JWC pumping requests and WWTP flows for Current Conditions based on water year type (wet to dry) and calibrated to 1987-2004 data?]

Percentage of JWC Pumping that returns through the WWTPs

If all JWC pumping is assumed to return to the Tualatin River within the same month through the WWTPs, then:

- about 28% of JWC pumping returns in the winter months via Hillsboro WWTP (see table below)
- about 10% of JWC pumping returns in the winter months via Forest Grove WWTP (see table below)
- about 77% of the remainder of JWC pumping (winter) or 77% of all JWC pumping (summer) returns to Rock Creek WWTP, and
- about 23% of the remainder of JWC pumping (summer) or 23% of all JWC pumping (summer) returns to Durham WWTP.

The 77% and 23% remainder values for Rock Creek and Durham WWTPs are based on the relative increase of these flows over time compared to the total WWTP flow increase.

Hillsboro WWTP / JWC Pumping at Spring Hill

	year	jan	feb	mar	apr	May	...	nov	dec	average
	1989			0.41	0.27	0.00		0.19	0.22	
	1990	0.31	0.30	0.28	0.20	0.00		0.16	0.18	
	1991	0.23	0.28	0.25	0.29	0.23		0.26	0.39	
	1992	0.40	0.45	0.36	0.33	0.11		0.29	0.42	
	1993	0.43	0.37	0.41	0.49	0.32		0.06	0.36	
	1994	0.45	0.48	0.37	0.24	0.06		0.29	0.53	
	1995	0.47	0.40	0.35	0.27	0.08		0.28	0.48	
	1996	0.50	0.47	0.24	0.28	0.28		0.32	0.56	
	1997	0.52	0.32	0.35	0.21	0.07		0.20	0.28	
	1998	0.42	0.34	0.28	0.20	0.24		0.28	0.38	
	1999	0.41	0.51	0.34	0.25	0.00		0.16	0.21	
	2000	0.29	0.25	0.25	0.16	0.00			0.13	
	2001	0.13	0.14	0.13	0.11	0.00		0.12	0.31	
	2002	0.31	0.19	0.20	0.14	0.00				
	2003					0.00			0.17	
median->		0.41	0.34	0.31	0.25	0.06		0.23	0.34	0.28

Forest Grove WWTP / JWC Pumping at Spring Hill

	year	jan	feb	mar	apr	May	...	nov	dec	average
	2002	0.22	0.15	0.14	0.01			0.00	0.05	
	2003	0.18	0.16	0.18	0.04			0.00	0.13	
median->		0.20	0.15	0.16	0.03			0.00	0.09	0.10

TECHNICAL MEMORANDUM

Projected Tualatin Valley Irrigation District Water Requirements

PREPARED FOR: Karen Blakney

PREPARED BY: Leslie Stillwater

DATE: June 8, 2006

This memo describes the projected water requirements of Tualatin Valley Irrigation District (TVID).

Summary

TVID's contract provides for the irrigation of 17,000 acres with Project natural and stored flows each year. By 2005, nursery crops were estimated to account for more than 25% of the 17,000 acres. If the trend towards converting land to nursery crops continues, TVID will require its full contract entitlement in the near future.

During the past 10 years, deliveries from Project storage in Henry Hagg Lake Reservoir to TVID Project lands have averaged about 16,200 acre-feet annually. If an additional 1,900 acres were to convert to sprinkler irrigated container crops, TVID's annual water requirement from Project storage would likely increase by about 10,800 acre-feet, which would increase TVID's average reliance on Project stored flows to 27,000 acre-feet.

Method

The quantity of water required for an acre of a non-nursery crop was compared to the quantity of water required for an acre of sprinkler irrigated container nursery crop. The difference (Δ) times the number of acres which convert to container crops is the quantity of additional water required from Project storage.

The application efficiency (eff_A) is the crop evapotranspiration (ET) divided by the applied water (AW). Applied water is the quantity of water delivered to the farm from natural flow and stored flow sources. Therefore,

$$AW = ET / eff_A$$
$$\Delta = AW_{nursery} - AW_{non\text{-}nursery}$$

where,

Δ is the quantity of additional water required for a sprinkler irrigated container nursery crop.

A 4% loss was then added to the additional water required (Δ) to account for transmission losses from the dam to the point of application.

The values assumed for evapotranspiration (ET) and application efficiency (eff_A), and the calculated values for applied water (AW) and additional water required (Δ) are shown in Table 1.

Table 1. Assumed values for evapotranspiration (ET) and application efficiency (eff_A), and the calculated values for applied water (AW) and additional water required (Δ).

	evapotranspiration ET (acre-feet/acre)	application efficiency eff_A	applied water AW (acre-feet/acre)
non-nursery	1.9	0.85	2.2
nursery	3.88	0.5	7.8
difference Δ			5.5
Δ + 4%			5.7

Therefore, for every acre of land which converts from commonly grown crops to sprinkler irrigated container nursery crops, 5.7 acre-feet of additional water from storage is required.

Trend in Increasing Nursery Acreage

TVID's contract provides for the irrigation of 17,000 acres with Project natural and stored flows each year. By 2005, nursery crops were estimated to account for more than 25% of the 17,000 acres. The increasing trend towards nursery crops is shown in Table 2 and Figure 1.

Total nursery acreage was estimated by TVID from data supplied in the Crop and Water Data (Crop Census) Reports[1] and GIS coverage. Since all irrigators did not consistently report nursery acres each year, it was assumed that once land was reported as planted in nursery crops, it remained in nursery crops.

One third of total nursery acreage is assumed to be in container nurseries.

Table 2. Estimated Total and Container Nursery Acreage

Year	total nursery (acres)	container nursery (acres)
1998	724	241
1999	2040	680
2000	3138	1046
2001	3355	1118
2002	3547	1182
2003	3683	1228
2004	4023	1341
2005	4271	1424

1 required, through 2002, as a result of the Reclamation Reform Act.

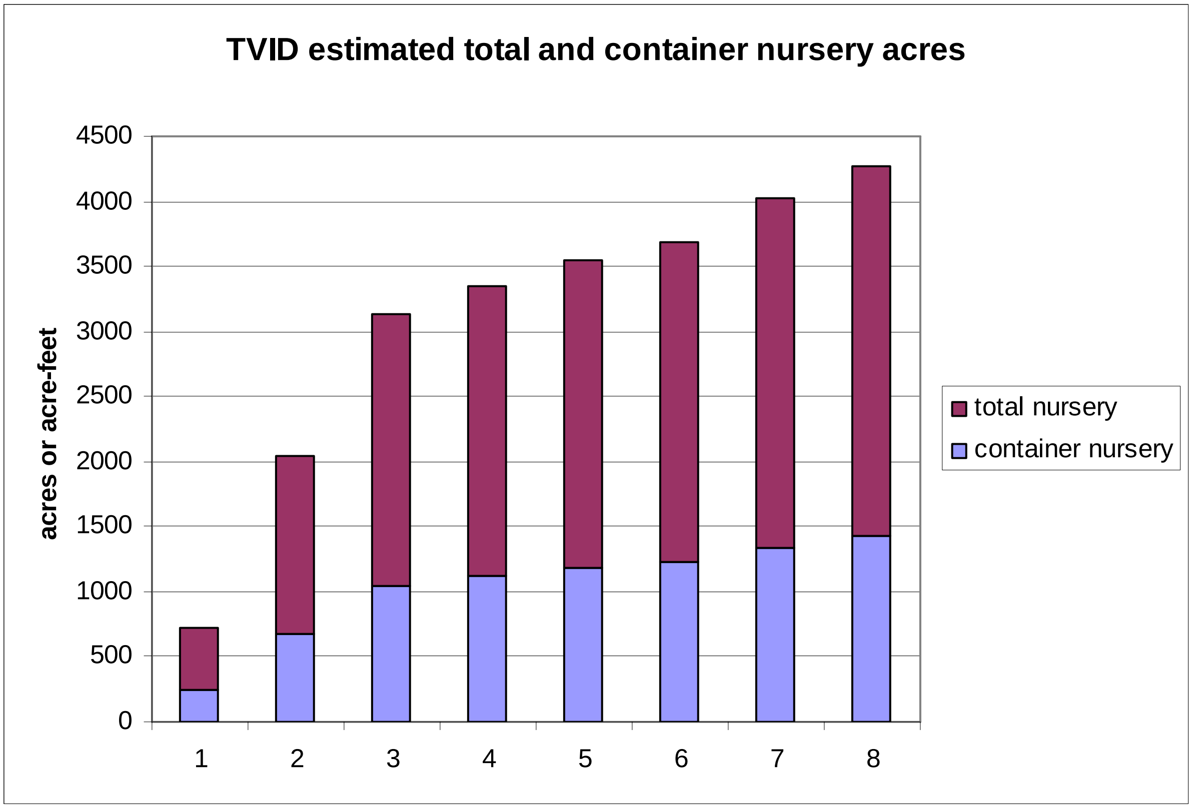


Figure 1. Estimated Total and Container TVID Nursery Acreage.

Crop Water Use

Non-nursery crop water use. TVID crop water use was calculated from the acreages supplied in the Crop Census Reports, crop evapotranspiration from the Agrimet Forest Grove station (http://www.usbr.gov/pn/agrimet), and evapotranspiration estimates from other sources:

$$\text{Crop Water Use} = \sum \text{acres}_i * \text{ET}_i$$

where, the summation is taken over each crop i.

Three years of complete acreage data are available from the Crop and Water Data Reports: 1999, 2000, and 2002.

Table 3. Average non-nursery crop water use.

year	average non-nursery crop water use (acre-feet/acre)
1999	1.88
2000	2.06
2002	2.15

Container nursery crop water use. Sprinkler irrigated container nursery crop water use was estimated from several sources. Crop coefficients for selected ornamentals were obtained from the Texas Water Resources Institute[2] and were then multiplied by the reference evapotranspiration (ET) from Agrimet for Forest Grove to obtain container nursery crop water use.

Application Efficiency

Non-nursery application efficiency. Application efficiency is the crop water use divided by the applied water. Most TVID lands are irrigated by sprinkler. The application efficiency for sprinkler irrigation is generally assumed to be .85 to .95.

Nursery application efficiency. Sprinkler irrigated container nursery crops require more water than other crops because applied water falls outside of the container. The Oregon Association of Nurseries reports initial application efficiencies for 6-inch diameter containers of .10 to .20[3]. Low application efficiencies usually imply drainage which could eventually discharge to the river, but Oregon nurseries capture and reuse the drainage. The resulting application efficiency from reuse is highly variable due to losses, mixing of drainage with other sources, and evaporation, and is not well understood. So the final application efficiency for container irrigation must lie somewhere between .10 (initial application) and .95 (sprinkler application). A compromise value of .50 was used.

Historic Water Deliveries from Project Storage

The median annual delivery of Project stored water to TVID lands over the last 10 years is about 16,400 acre-feet. TVID's agreement with Reclamation allows for 27,000 acre-feet of water from storage to meet their full contract entitlement of 37,000 acre-feet (the difference is supplied by Project natural flows). The accounted releases of Project stored flows from Henry Hagg Reservoir are shown in Table 4.

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2 Niu, Genhua, Raul Cabrera, Cynthia McKenney, and Wayne Mackay, 2006. *Determining Plant Water Use and Crop Coefficients of Selected Nursery and landscape Plants*. Texas Agricultural Experiment Station – El Paso, TX. (http://twri.tamu.edu)
3 Regan, Richard, 2005. *Every drop, and drip, counts.* Far West Edition, Digger Magazine. August, 2005. (http://www.oan.org/)

Table 4. Historic releases for TVID from Scoggins Dam (Henry Hagg Reservoir).

	Reservoir Deliveries (acre-feet)
1995	15398
1996	19126
1997	16463
1998	14756
1999	18248
2000	15012
2001	10704
2002	19093
2003	19633
2004	16371
2005	13483
average	16207

The trend towards increasing water requirements as lands convert to sprinkler irrigated container crops is not apparent in the record of stored water deliveries due to differences in the availability of natural flow and changes in water conservation practices, especially in dry years. Releases in 2001 were low because it was a very dry year and irrigators were offered incentives to cut back. Releases in 2005 were low because, even though it was a very dry year overall, natural flow was available through June and releases did not start until July.

Conclusions

Sprinkler irrigated container nursery acreage within TVID boundaries is estimated to have increased by more than 1,200 acres since 1998 (refer to Table 2). Annual water requirements increase by about 5.7 acre feet for each acre of land which converts to sprinkler irrigated container nursery crops from other commonly grown TVID crops (refer to Table 1). Therefore, TVID water requirements have increased correspondingly by more than 6,800 acre-feet per year since 1998. TVID predicts the trend is likely to continue.

If an additional 1,900 acres were to convert to sprinkler irrigated container crops, TVID's annual water requirement from Project storage increase by 10,800 acre-feet (1,900 x 5.7, refer to Table 1) which would increase TVID's average reliance on Project stored flows to 27,000 acre-feet (10,800 added to the historic average release of about 16,200 yields about 27,000).

Limitations of the Analysis

The analysis described in this document is very sensitive to:

1) crop coefficients for container irrigated nursery ornamentals,
2) percentage of TVID land converting to sprinkler irrigated container nursery crops, and
3) re-use of applied water.

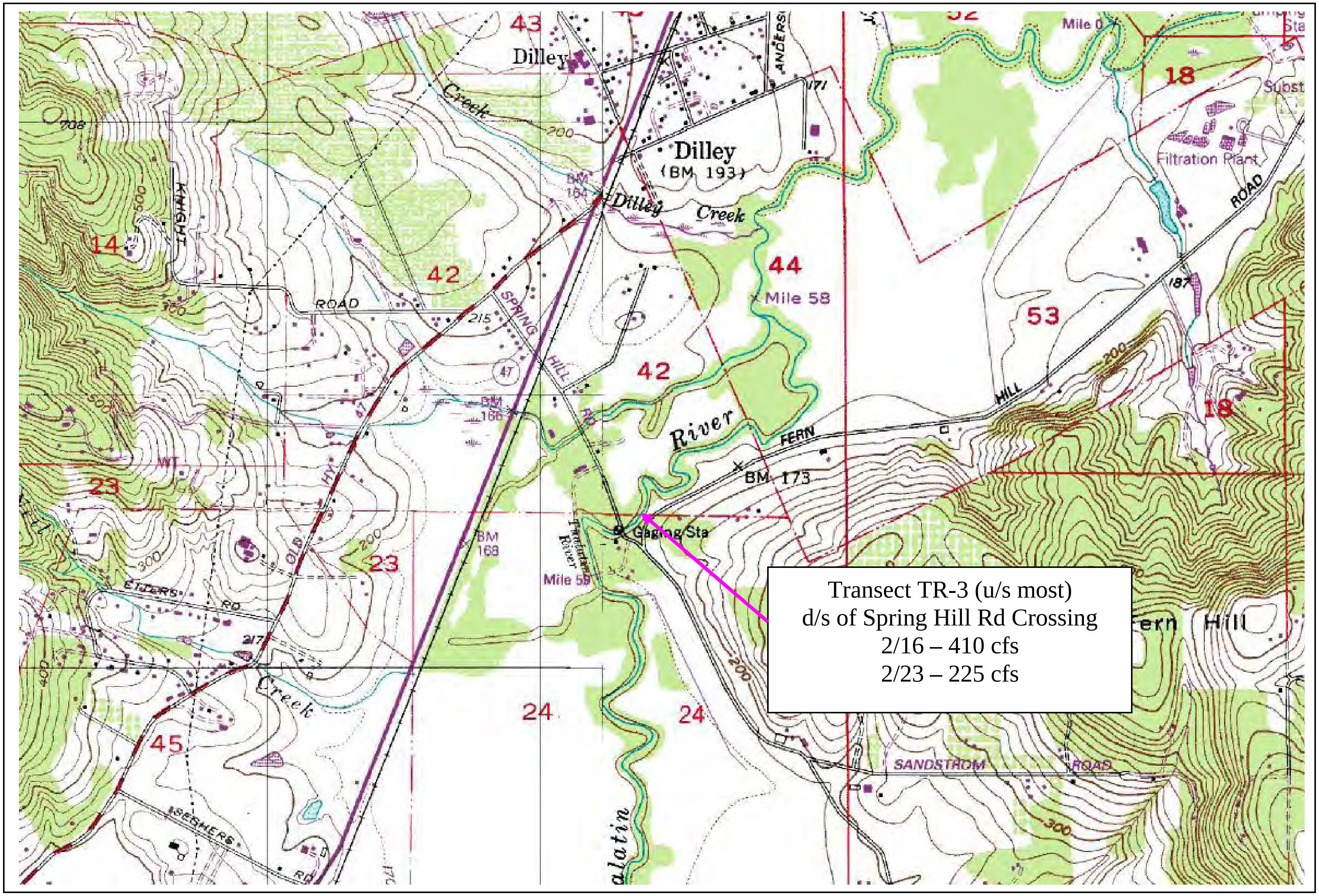
Little research is available for crop coefficients of container irrigated nursery ornamentals. The values applied in this analysis, obtained from the Texas Water Resources Institute, seem unusually high.

The percentage of land converting to sprinkler irrigated container nursery crops can only be estimated. Although a trend can be demonstrated for increasing acres planted in nursery crops, the fraction of those acres planted in *sprinkler irrigated container* nursery crops is unknown.

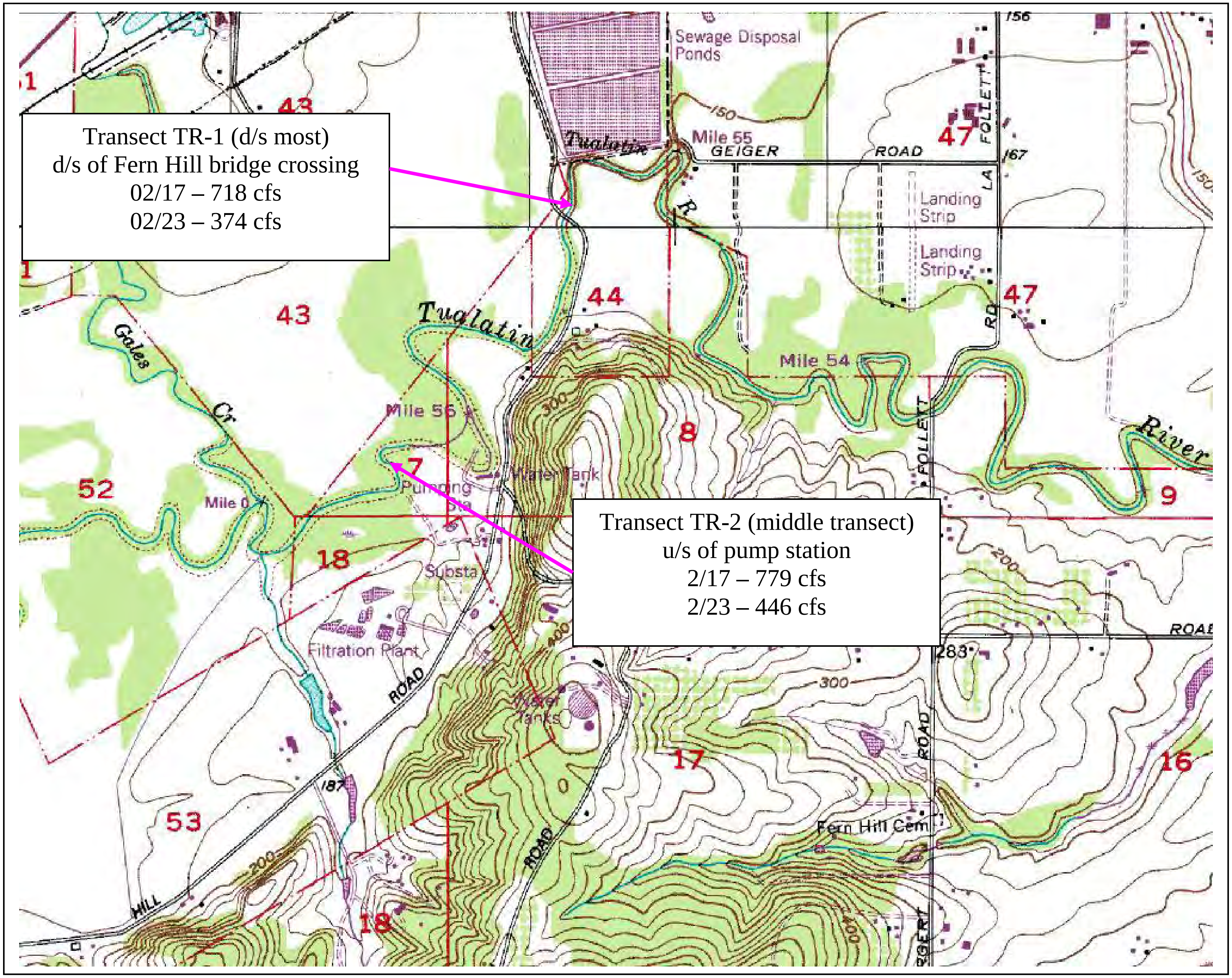
The re-use of water for sprinkler irrigated container nursery crops is unknown, although conversations with growers indicate an attempt towards high levels of reuse. An estimate which was half way between the highest and the lowest reasonable values was used in this analysis.

Appendix D

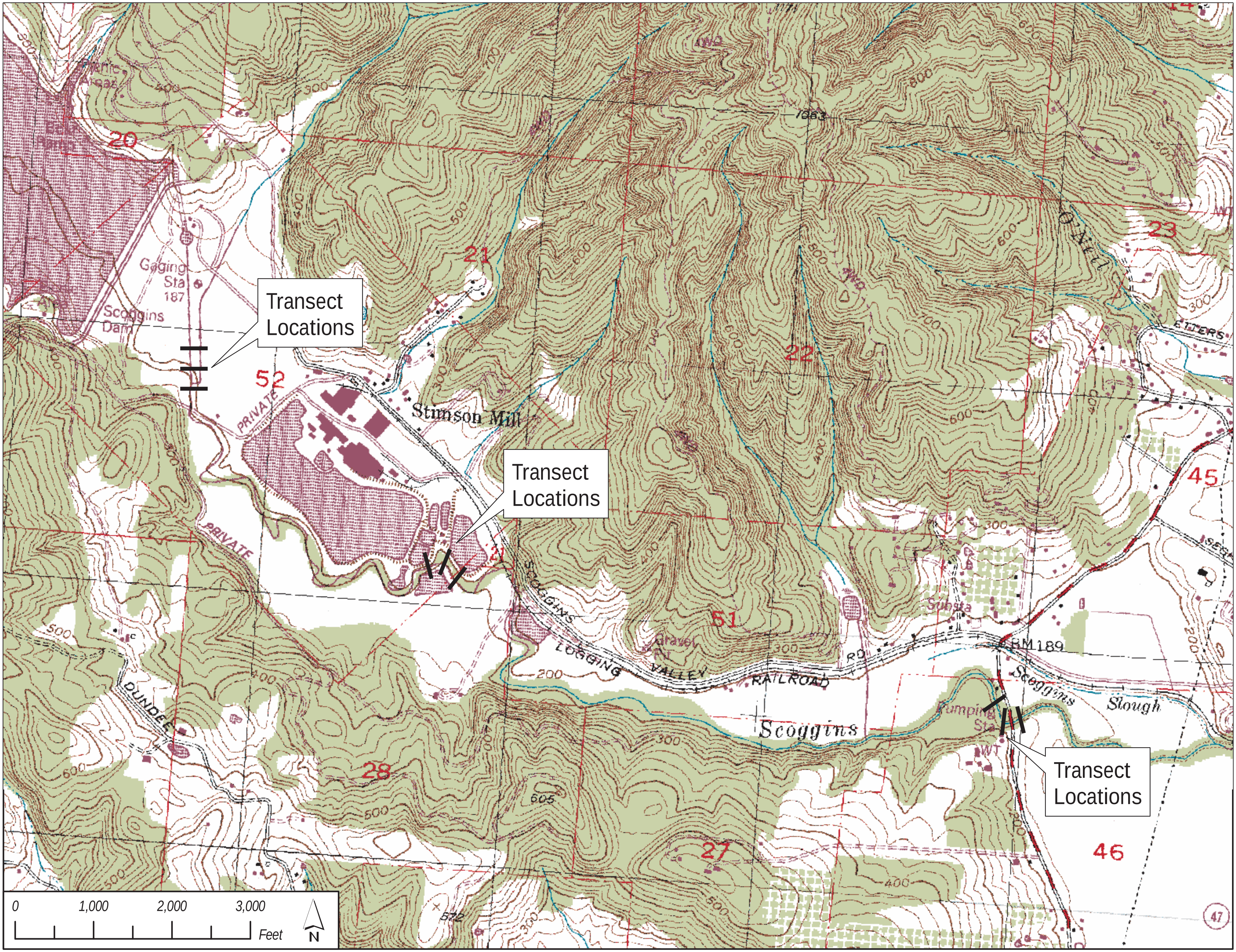
IFIM STUDY WITH TRANSECT LOCATIONS



Transect TR-3 (u/s most)
d/s of Spring Hill Rd Crossing
2/16 – 410 cfs
2/23 – 225 cfs
Dilley
Dilley
(BM 193)
Dilley Creek
Creek
River
Fern Hill
Filtration Plant
Mile 58
Mile 0
Gaging Sta
SPRING HILL RD
FERN HILL ROAD
KNIGHT ROAD
SANDSTROM ROAD
SEGHERS RD
BM 173



Transect TR-1 (d/s most)
d/s of Fern Hill bridge crossing
02/17 – 718 cfs
02/23 – 374 cfs
Transect TR-2 (middle transect)
u/s of pump station
2/17 – 779 cfs
2/23 – 446 cfs
Sewage Disposal Ponds
Tualatin
Mile 55
GEIGER
ROAD
FOLLETT
Landing Strip
Landing Strip
Mile 54
Mile 56
Gales Cr
Mile 0
River
Water Tank
Pumping Sta
Substa
Filtration Plant
Water Tanks
Fern Hill Cem
HILL


Transect Locations
Transect Locations
Transect Locations
Scoggins Dam
Gaging Sta 187
Stimson Mill
PRIVATE
PRIVATE
SCOGGINS
LOGGING VALLEY RAILROAD
RD
Scoggins
Scoggins Slough
BM189
O'Neil
DUNDEE
Pumping Sta
20
21
22
23
27
28
45
46
51
52
0
1,000
2,000
3,000
Feet
N