Quality Assurance Project Plan

South Fork Palouse River Dissolved Oxygen and pH Total Maximum Daily Load Study

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2004 303(d) Listings Addressed in this Study

Listing ID	Waterbody	New Waterbody ID	Old Waterbody ID
Dissolved Oxygen			
11137	South Fork Palouse River	ZXB2FM	WA-34-1020
8142	South Fork Palouse River	ZXB2FM	WA-34-1020
8105	South Fork Palouse River	ZXB2FM	WA-34-1020
pH			
6729	South Fork Palouse River	ZXB2FM	WA-34-1020

Project Code: 05-008-05

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Abstract

The South Fork Palouse River has been listed by the state of Washington under Section 303(d) of the Clean Water Act for non-attainment of Washington State dissolved oxygen (DO) and pH criteria. The listings are based on sampling done by the Washington State Department of Ecology in 1987, 1991, and 1994-2001. Additional 303(d) listings exist within the South Fork Palouse River watershed for temperature, fecal coliform bacteria, and ammonia.

EPA requires states to set priorities for cleaning up 303(d) listed waters and to establish a Total Maximum Daily Load (TMDL) for each. A TMDL entails an analysis of how much of a pollutant load a waterbody can assimilate without violating water quality standards. The South Fork Palouse River TMDL Study will address the 303(d) listings within the watershed with three separate Quality Assurance (QA) Project Plans: one for bacteria, one for temperature, and one for DO and pH.

This QA Project Plan describes the technical study that will monitor DO and pH in the South Fork Palouse River Watershed, and will form the basis for a proposal to allocate contaminant waste loads to sources. The study will be conducted by Ecology's Environmental Assessment Program.

What is a Total Maximum Daily Load, or TMDL?

Federal Clean Water Act Requirements

The Clean Water Act established a process to identify and clean up polluted waters. Under the Clean Water Act, each state is required to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards are set to protect designated uses such as cold water biota and drinking water supply.

Every two years, states are required to prepare a list of waterbodies—lakes, rivers, streams or marine waters—that do not meet water quality standards. This list is called the 303 (d) list. To develop the list, the Washington State Department of Ecology (Ecology) compiles its own water quality data along with data submitted by local, state and federal governments, tribes, industries, and citizen monitoring groups. All data are reviewed to ensure that they were collected using appropriate scientific methods before they are used to develop the 303(d) list.

Water Quality Assessment/Categories 1-5

The 303(d) list is part of the larger Water Quality Assessment. The Water Quality Assessment is a list that tells a more complete story about the condition of Washington's water. This list divides waterbodies into one of five categories:

Category 1 – Meets standards for parameter(s) for which it has been tested

Category 2 – Waters of concern

Category 3 – Waters with no data available

Category 4 – Polluted waters that do not require a TMDL because:

- 4a. - Has a TMDL approved and its being implemented
- 4b. – Has a pollution control plan in place that should solve the problem
- 4c. – Impaired by a non-pollutant such as low water flow, dams, culverts

Category 5 – Polluted waters that require a TMDL – or also known as the 303d list

TMDL Process Overview

The Clean Water Act requires that a Total Maximum Daily Load (TMDL) be developed for each of the waterbodies on the 303 (d) list. A TMDL identifies how much pollution needs to be reduced or eliminated to achieve clean water. Then Ecology works with the local community to develop a strategy to control the pollution and a monitoring plan to assess effectiveness of the water quality improvement activities.

Elements Required in a TMDL

The goal of a TMDL is to ensure the impaired water will attain water quality standards. A TMDL includes a written, quantitative assessment of water quality problems and of the pollutant sources that cause the problem. The TMDL determines the amount of a given pollutant that can be discharged to the waterbody and still meet standards (the loading capacity) and allocates that load among the various sources.

If the pollutant comes from a discrete source (referred to as a point source) such as a municipal or industrial facility's discharge pipe, that facility's share of the loading capacity is called a wasteload allocation. If it comes from a set of diffuse sources (referred to as a nonpoint source) such as general urban, residential, or farm runoff, the cumulative share is called a load allocation.

The TMDL must also consider seasonal variations and include a margin of safety that takes into account any lack of knowledge about the causes of the water quality problem or its loading capacity. A reserve capacity for future loads from growth pressures is sometimes included as well. The sum of the wasteload and load allocations, the margin of safety, and any reserve capacity must be equal to or less than the loading capacity.

Total Maximum Daily Load Analyses: Loading Capacity

Identification of the contaminant loading capacity for a waterbody is an important step in developing a TMDL. EPA defines the loading capacity as "the greatest amount of loading that a waterbody can receive without violating water quality standards." (EPA, 2001) The loading capacity provides a reference for calculating the amount of pollution reduction needed to bring a waterbody into compliance with standards. The portion of the receiving water's loading capacity assigned to a particular source is a load or wasteload allocation. By definition, a TMDL is the sum of the allocations, which must not exceed the loading capacity.

Introduction

Water quality monitoring has identified reaches of the South Fork Palouse River (SFPR) that do not meet state or federal water quality standards. As a result, these reaches have been included on Washington State's 303(d) list for 2004 (Figures 1a/1b and Table 1). Additional 303(d) listings exist within the South Fork Palouse River watershed for temperature, fecal coliform bacteria, and ammonia. The South Fork Palouse River TMDL Study will address the 303(d) listings within the watershed with three separate Quality Assurance (QA) Project Plans: one for bacteria, one for temperature, and one for DO, pH.

This QA Project Plan describes the technical study that will develop DO and pH TMDLs for the South Fork Palouse River. These TMDLs will set water quality targets to meet DO and pH water quality standards, identify key reaches for source reduction, and allocate pollutant loads to point and nonpoint sources. The study will be conducted by Ecology's Environmental Assessment (EA) Program in cooperation with the Ecology Water Quality Program at the Eastern Regional Office, Palouse Conservation District, and other local governments. The Idaho Department of Environmental Quality (DEQ) has completed a TMDL for Paradise Creek and several North Fork Palouse River tributaries and is in the early stages of developing a TMDL for the SFPR in Idaho. Ecology recently completed a TMDL for fecal coliform in 2004 on the North Fork Palouse River based on monitoring conducted by the Palouse Conservation District (CD) and Ecology (Ahmed, 2004). Ecology's TMDL efforts will now focus on the Washington segment of the SFPR watershed.

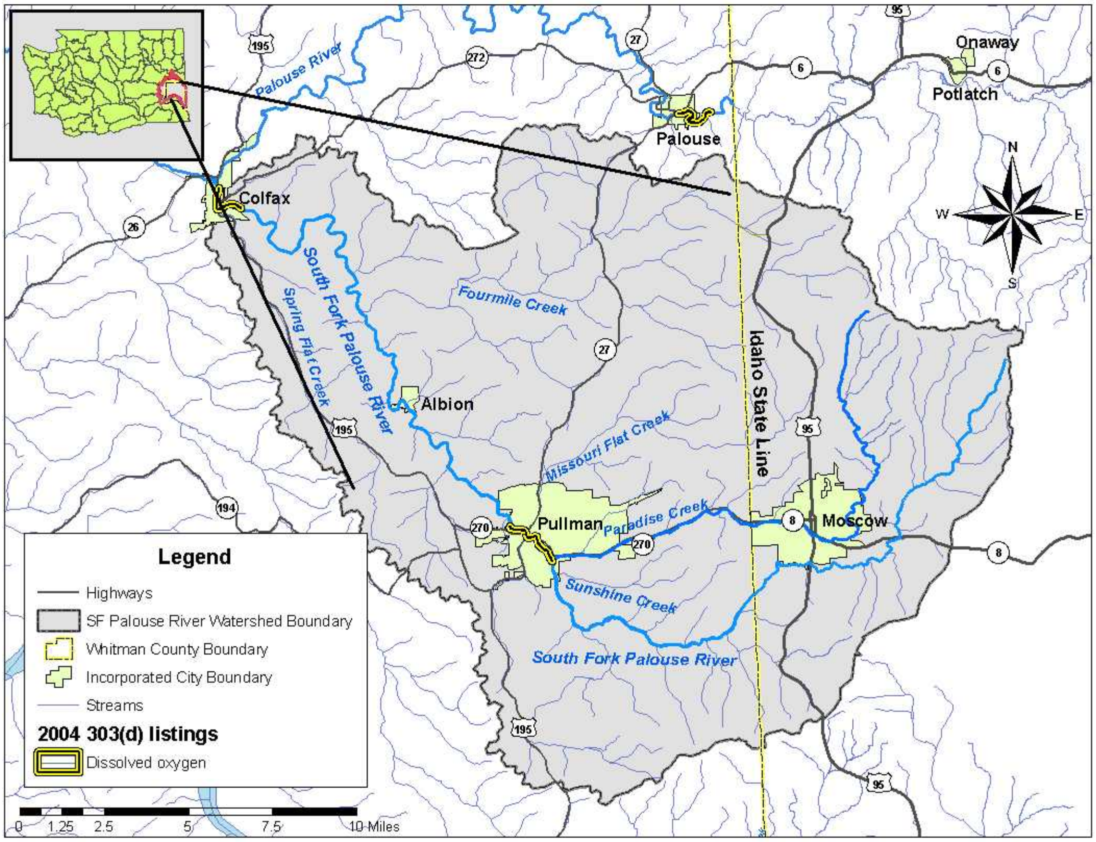

Figure 1a. Study Area with 303(d) listed segments for dissolved oxygen.

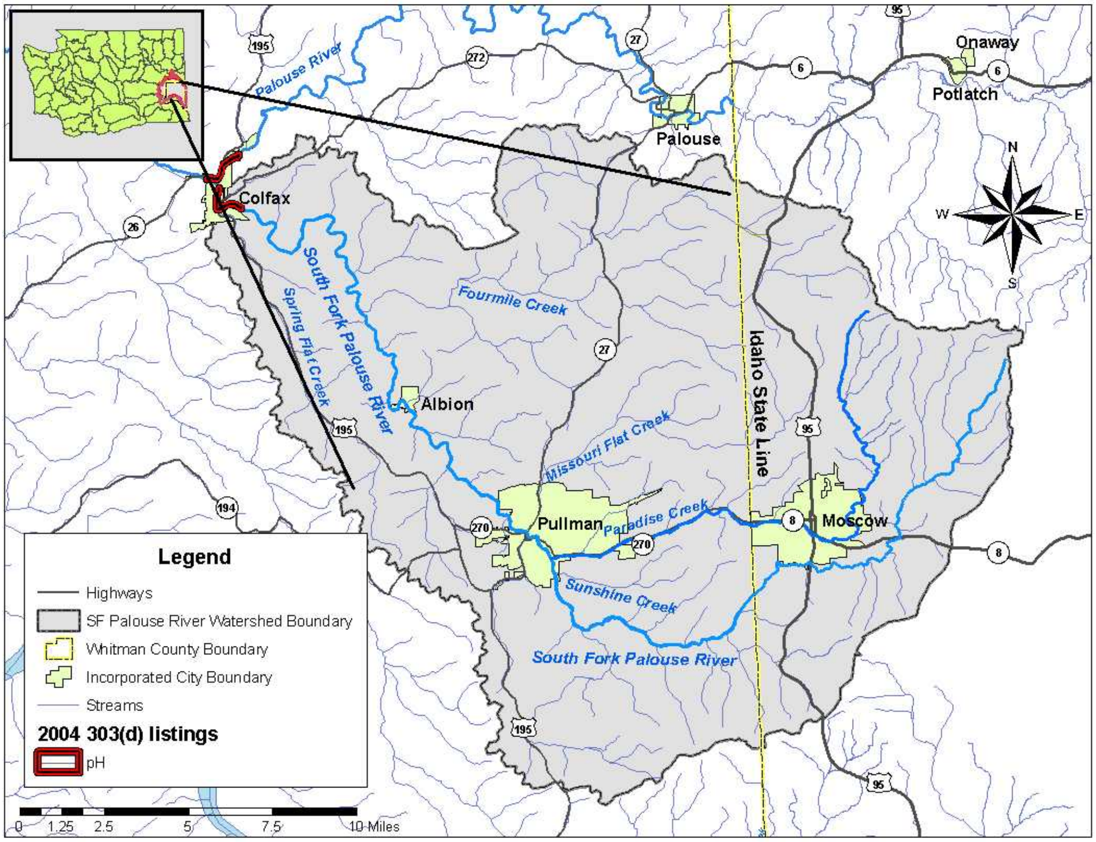

Figure 1b. Study area with 303(d) listed segments for pH.

Table 1. Reaches of the South Fork Palouse River with Clean Water Act Section 303(d) listings (2004 list) due to not meeting dissolved oxygen or pH water quality standards. These will be addressed in the South Fork Palouse River TMDL study for dissolved oxygen and pH.

Waterbody	Parameter	Township	Range	Section	2004 Listing ID
South Fork Palouse River	Dissolved Oxygen	15N 14N 16N	45E 45E 43E	06 05 14	11137 8142 8105
South Fork Palouse River	pH	16N	43E	14	6729

There are additional DO and pH listings in the Palouse River watershed outside of this year's project area. These listings are on the mainstem Palouse River, Rebel Flat Creek, Cow Creek, and Pleasant Valley Creek and will be addressed by a separate TMDL study in the near future. Other listed parameters in the SFPR are addressed in separate QA Project Plans (Matheiu & Carroll, 2006; Bilhimier et. al. 2006).

Project Objectives

Objectives of the proposed study are as follows:

- Characterize processes governing DO and pH in Paradise Creek and the South Fork Palouse River including the influence of tributaries, nonpoint sources, point sources, and groundwater.
- Develop a model to simulate biochemical oxygen demand (BOD) and productivity in Paradise Creek and the South Fork Palouse River. Using critical conditions in the model, determine the capacity to assimilate BOD and nutrients.
- The calibrated model will be used to evaluate future water quality management decisions in the SFPR basin.

Water Quality Standards and Beneficial Uses

The Washington State Water Quality Standards, set forth in Chapter 173-201A of the Washington Administrative Code (WAC), include designated beneficial uses, waterbody classifications, and numeric and narrative water quality criteria for surface waters of the state. The South Fork Palouse River is classified as Class A (excellent).

Freshwater waterbodies are required to meet water quality standards to protect the designated beneficial uses of the waterbody. For Class A waters, characteristic uses include water supply (domestic, industrial, agricultural), stock watering, fish and shellfish (salmonid and other fish migration, rearing, spawning, harvesting), wildlife habitat, recreation (primary contact recreation, sport fishing, boating, aesthetic enjoyment), and commerce and navigation.

In July 2003, Ecology made revisions to the state's surface water quality standards. These changes included eliminating the classification system the state had used for decades to designate uses to be protected by water quality criteria (e.g., temperature, DO, turbidity, bacteria). Ecology also revised the numeric temperature criteria that were to be assigned to waters to protect specific types of aquatic life uses (e.g., native char, trout and salmon spawning and rearing, warm water fish habitat).

The revised water quality standards' regulation was submitted to the EPA for federal approval. EPA was not satisfied that Ecology's 2003 standards met the requirements of the federal Clean Water Act and the federal Endangered Species Act. Their main concerns were over the temperature criteria applied to waters that support endangered fish species (e.g., bull trout, salmon, and steelhead). As a consequence, EPA has formally disapproved portions of the revised standards.

Ecology has agreed to initiate state rule revision proceedings that will make the changes EPA has highlighted as necessary. The result of the corrective state rulemaking will be that a number of streams and stream segments would receive more stringent temperature and DO criteria.

The state expects to conclude its corrective rulemaking proceedings in October 2006 and have approved state standards in early 2007. Until that time, TMDLs must be based on the 1997 version of the state water quality standards, rather than the 2003 version that was disapproved by EPA.

TMDLs will be designed during this uncertain transition period with formal allocations that meet the existing (1997) approved standards. In all TMDL technical studies completed during this transition period, the analysis must include a scenario evaluating what would be required to meet the EPA required standards in the corrective rule. Proposed revisions to the existing standards can be found online at Ecology's water quality standards website www.ecy.wa.gov/programs/wq/swqs.

Table 2 provides a general structure for understanding the expected changes for Class A waters including the South Fork Palouse River.

Table 2: Water Quality Standards and expected changes for temperature, dissolved oxygen, pH, and turbidity in Class A waters.

1997 Standards Classification	Water Quality Parameter	1997 Criteria[2]	2003 Use Revision	2003/2007 Criteria[2]
Class A[1]	Temperature	18°C 1-Dmax[3]	"Non-core" Salmon/Trout	17.5°C 7-DADMax[4]
	Dissolved Oxygen	8.0 mg/L	"Non-core" Salmon/Trout	8.0 mg/L[5]
	pH	6.5 to 8.5 units	"Non-core" Salmon/Trout	6.5 to 8.5 units
	Turbidity	5 NTU and 10%[6]	"Non-core" Salmon/Trout	5 NTU and 10%[6]

1. Class A waters were subcategorized into "native char" and "salmon/trout non-core rearing" designated use types during the 2003 revision to the water quality standards regulation. There are no native char in the SFPR.
2. Criteria have been established in the existing water quality standards for specific waterbodies that differ from the general criteria shown in the above table. These special conditions can be found in WAC 173-201A-130 of the 1997 version, and WAC 173-201A-602 of the 2003 version of the standards.
3. 1-DMax means the highest annual daily maximum temperature occurring in the waterbody.
4. 7-DADMax means the highest annual running 7-day average of daily maximum temperatures.
5. When a waterbody classified as "excellent quality" (formerly Class A) has a DO lower than 8.0 mg/L and that condition is due to natural conditions, then cumulative human actions may not cause the DO to decrease more than 0.2 mg/L.
6. Turbidity criteria are based on an allowable increase from background concentrations. The allowance changes from # NTU to a percent NTU as background increases above 50 NTU.

Nitrogen and phosphorus are essential nutrients for plant growth and aquatic community health. However, when there is an overabundance of nutrients, aquatic plant growth can become over-stimulated—a process called eutrophication. If natural reaeration processes cannot compensate for plant respiration and production in areas affected by eutrophication, DO becomes under-saturated at night and over-saturated during the day, and hydrogen ion (pH) concentrations become over-saturated at night and under-saturated during the day. These diel (i.e., day to night) swings can be harmful to macroinvertebrates and fish. Washington State water quality standards do not have numeric nutrient (nitrogen and phosphorus) criteria for streams. However, Chapter 173-201A contains a narrative criterion that applies to nitrogen and phosphorus:

"Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department."

Natural Conditions

Water quality criteria are set at levels that fully protect designated uses. This ensures that these uses will be fully protected wherever doing so is an attainable condition. However, setting fully protective criteria means that under natural conditions some waterbodies will fail to meet the criteria for some water quality parameters, especially temperature and DO. To account for this condition, the standards contain both narrative provisions and numeric allowances for considering the effect of natural conditions. A general narrative provision in the state standards is that when and where, under natural conditions, a waterbody would fail to meet the assigned numeric criteria, those measured or estimated natural conditions are used as alternate water quality criteria. In some cases, such as with the DO and temperature criteria, a small additional cumulative allowance for degradation beyond naturally poor conditions is provided for human activities (0.3° C for temperature and 0.2 mg/L for DO).

In assessing what is and is not natural, Ecology will use historic data and water quality modeling as appropriate to ascertain what the water quality conditions would be without human sources of degradation. Using this approach does not infer that Ecology believes that systems can or should be returned to pre-historic conditions. Some sources of human degradation cannot be remedied due to both technical and/or social (legal) limitations. The water quality standards and the federal regulations governing those standards contain numerous provisions and tools for setting water quality-based limitations. These provisions, when followed, allow states to identify and protect the highest attainable uses. Thus while an assessment of natural conditions may demonstrate what was once attainable, it may not represent what can be attained given the changes that have occurred over more than a century.

Background

Study Area

The South Fork Palouse River (SFPR) drains 295 square miles from its headwaters in Idaho to its confluence with the mainstem Palouse River at Colfax, Washington. The mainstem then drains into the Snake River at the convergence of Whitman, Franklin, Columbia, and Walla Walla counties. The SFPR sub-watershed is located in Whitman county of Eastern Washington and Latah County of North Idaho, within the larger Palouse River watershed. The portion of the Palouse Watershed within Washington is known as Water Resource Inventory Area (WRIA) 34. Major tributaries to the SFPR include Paradise Creek, Missouri Flat Creek, Four Mile Creek, and Spring Flat Creek. Other smaller tributaries of interest within the study area include Sunshine Creek, Airport Road Creek, Dry Fork Creek, Parvin Creek, Rose Creek, and Staley Creek.

Paradise Creek drains about 35 square miles from its headwaters at Moscow Mountain in Idaho to its confluence with the SFPR near the eastern Pullman city limits. The creek serves as the receiving waters for the Moscow Publicly Owned Treatment Works (POTW), located approximately 0.5 miles east of the state line. During low flow periods (June to October), the POTW discharge can account for up to 87 percent of the flow in Paradise Creek at the state line (Hallock, 1993).

Missouri Flat Creek originates north of Moscow in Idaho and flows west across the state border where it bends south, travels through Pullman along Highway 27/Grand Avenue and converges with the SFPR near downtown Pullman. The 27 square mile drainage area is influenced primarily by nonpoint agricultural runoff; however, the stretch of the creek within the Pullman city limits receives residential and commercial runoff from 26 separate storm drains.

Land use within the study area is dominated by dryland agriculture (Table 3) and interspersed with several clusters of urban population. The majority of population is concentrated around Washington State University in the city of Pullman and the University of Idaho in Moscow. Smaller communities include the towns of Colfax, at the mouth of the SFPR and Albion, located along the SFPR between Pullman and Colfax (Figure 1). Major crops include spring and winter wheat, barley, peas, and lentils. These crops are produced without irrigation, thus the term “dryland agriculture” (RPU, Inc., 2002).

Table 3. Land use in SFPR watershed (RPU, Inc., 2002).

Land Use	Acres	% of Watershed
Cropland	154,764	82%
Urban Use (including roadways)	15,100	8%
Forestland	11,324	6%
Rangeland	3,774	2%
Riparian/Wetland	3,774	2%
Total		188,736 acres

Annual precipitation in this watershed can range from 15-25 inches of rain per year. A drought was declared in 2001 and the climatic condition has continued for the last several years. Summer daily maximum air temperatures can be in a range from mid-80ºF to mid-90ºF (around 29ºC to 35ºC) and occasionally over 100ºF (37.8ºC). There is a weather monitoring station at the Pullman/Moscow regional airport collecting data on: air and dewpoint temperatures, wind speed and direction, barometric pressure, and weather observations.

The bedrock geology of this area is derived from the Priest Rapids member of the Wanapum Formation with the exception of a quartzite outcrop of the Kamiak Butte near the town of Albion. Holocene era alluvium and colluvium deposits occur along the SFPR valley (Bush and Garwood, 2005a and 2005b). Groundwater recharge and discharge are affected by geologic formations such as a syncline that was identified by Bush & Garwood (2005a and 2005b) with an axis longitudinal to the SFPR between Pullman and Albion, and two monoclines on the North and South within one-to-two miles of the SFPR. The soils are primarily loess deposits that are well drained, moderately permeable silt loams of the Palouse-Athena association (Donaldson, 1980).

Potential Sources of Biochemical Oxygen Demand and Nutrients

Point Sources/Permit Holders

Two facilities in Washington State and one facility in Idaho have individual National Pollutant Discharge Elimination System (NPDES) permits for discharge within the SFPR basin. Effluent from the following facilities will be sampled for this TMDL study:

- Moscow Wastewater Treatment Plant (POTW)
- Pullman POTW
- Albion POTW

Treatment from the Moscow POTW occurs in Idaho approximately 0.5 miles east of the state line. Effluent is discharged at creek mile (CM) 6.9 of Paradise Creek. During periods of low flow, the Moscow POTW comprises nearly the entire flow of Paradise Creek and the SFPR until confluence with the Pullman POTW discharge (Pelletier, 1993). The Moscow POTW received a number of upgrades in 2001 to address a TMDL on the Idaho-portion of Paradise Creek.

The Pullman POTW is a secondary treatment plant that provides year-round nitrification and discharges to the SFPR at river mile (RM) 21.3. Wastewater is treated for pathogens using a chlorine gas and then dechlorinated using sulfur dioxide (Heffner, 1987).

The Albion POTW consists of two facultative lagoons which drain to a chlorinator and effluent control structure before discharge to the SFPR at RM 14.1. The permit allows the POTW to discharge year round; however, discharges typically occur between January and May (Koch, 2006).

Wildlife and Background Sources

A wide variety of perching birds, upland game birds, raptors, and waterfowl are found within the SFPR watershed. Birds, elk, deer, moose, beaver, muskrat, and other wildlife in rural areas are potential sources of nutrients. Open fields and riparian areas lacking vegetation are attractive feeding and roosting grounds for some birds whose presence can increase BOD and nutrients in runoff.

Usually these sources are dispersed and do not affect DO and pH in streams significantly enough to violate the state criteria. Sometimes birds and animals are locally concentrated and such cases will be noted during sampling surveys.

Nonpoint Sources

Nonpoint sources and practices are dispersed and not readily controlled by discharge permits. Several types of potential nonpoint sources are present in the study area. BOD and nutrients from nonpoint sources are transported to the creeks by direct and indirect means. Manure that is spread over fields during certain times of the year can enter streams via surface runoff or fluctuating water levels. Often livestock have direct access to water. Manure is deposited in the riparian area of the access points where fluctuating water levels, surface runoff, or constant trampling can bring the manure into the water. Some residences may have wastewater piped directly to waterways or may have malfunctioning on-site septic systems where effluent seeps to nearby waterways. Pet waste concentrated in public parks or private residences can be a source of contamination, particularly in urban areas. Swales, sub-surface drains, and flooding through pastures and near homes can carry BOD and nutrients from sources to waterways.

Groundwater discharging to the SFPR and its tributaries also affects DO levels and nutrient concentrations. Groundwater discharges to the river or creeks in some reaches, and is recharged by the stream in other reaches. In the SFPR basin, background groundwater flow and BOD/nutrient concentrations may be elevated due to upland practices such as agricultural field fertilizing and wastewater discharge to groundwater from on-site septic systems.

Stormwater Sources

During precipitation events, rainwater washes the surface of the landscape, pavement, rooftops, and other impervious surfaces. This stormwater runoff can accumulate and transport pollutants and contaminants via stormwater drains to receiving waters and potentially degrade water quality.

NPDES Phase II stormwater regulations require stormwater permits for all municipalities located in urbanized areas or cities outside of urbanized areas that have a population of greater than 10,000. Ecology has completed a formal draft Phase II Municipal Stormwater Permit for Eastern Washington and is currently soliciting public comments. After reviewing all public comments, the permit will be revised and then a final permit will be issued in late September 2006 at the earliest.

Pullman is not located within an urbanized area but does have a population of greater than 10,000 and is likely to be regulated as a small municipal separate storm sewer system (MS4) under the permit. Washington State University may be required to be a secondary permittee to the city of Pullman permit.

Stormwater will be evaluated as part of the Fecal Coliform Bacteria TMDL (Mathieu and Carroll, 2006). The project team will attempt to capture one storm event during the summer, low-flow season in order to characterize the impact of these events. Limited BOD and nutrient and other water quality parameters may be sampled depending on budget. This data may be used to assign a WLA to the city of Pullman under the new Phase II permit.

Historical Data Review

Hydrology

The US Geological Survey (USGS) currently operates one streamflow gage on the SFPR in the town of Pullman (#13348000) with a 34 year record. This gage is downstream of Paradise Creek at the State Street crossing of the SFPR. Figure 2 summarizes mean monthly flow data at this station. There is also a USGS gage currently operating on Paradise Creek at the University of Idaho (#13346800) with a 27-year record.

There were six historical streamflow gages located on the SFPR and major tributaries. One historical station (SFPR at Colfax #13349200) contains flow data from a short period of record that the SFPR gage at Pullman was not in service. A gage on Missouri Flat Creek at Pullman (#13348500) operated from 1934-1979. Mean monthly flow data for Missouri Flat Creek at Pullman is summarized in Figure 3.

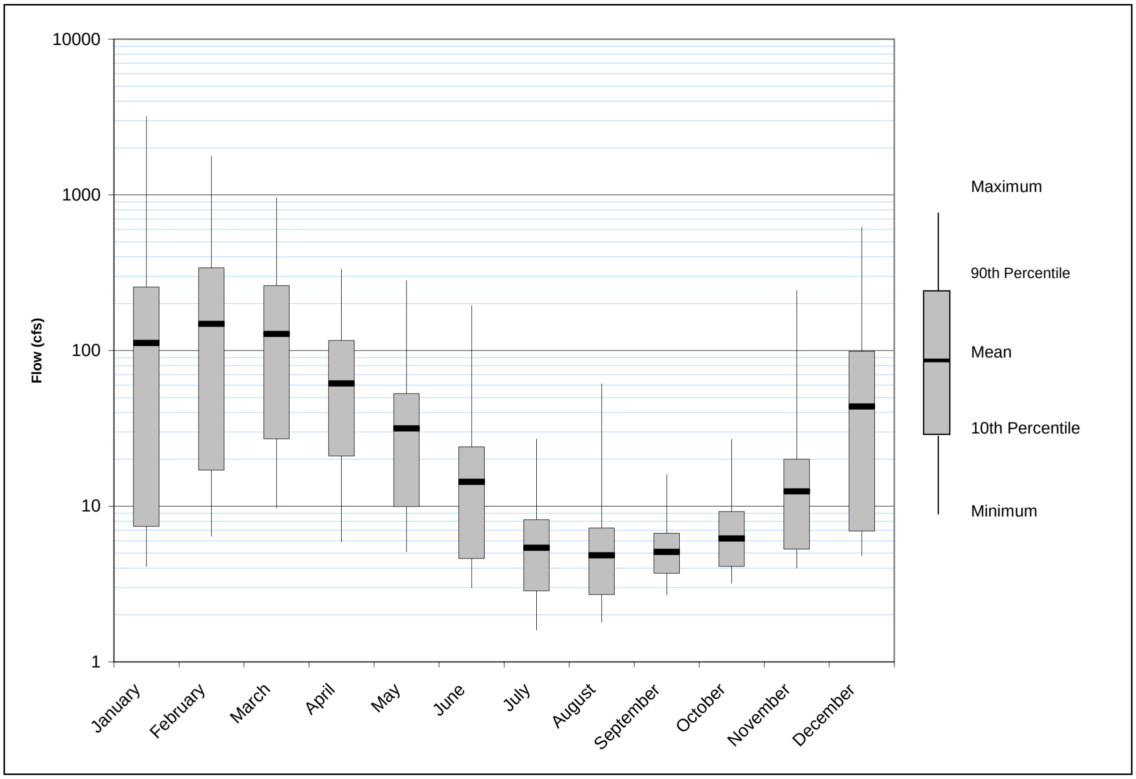

Figure 2. USGS stream gage mean monthly flows for the SFPR at Pullman from 1970 - 2004.

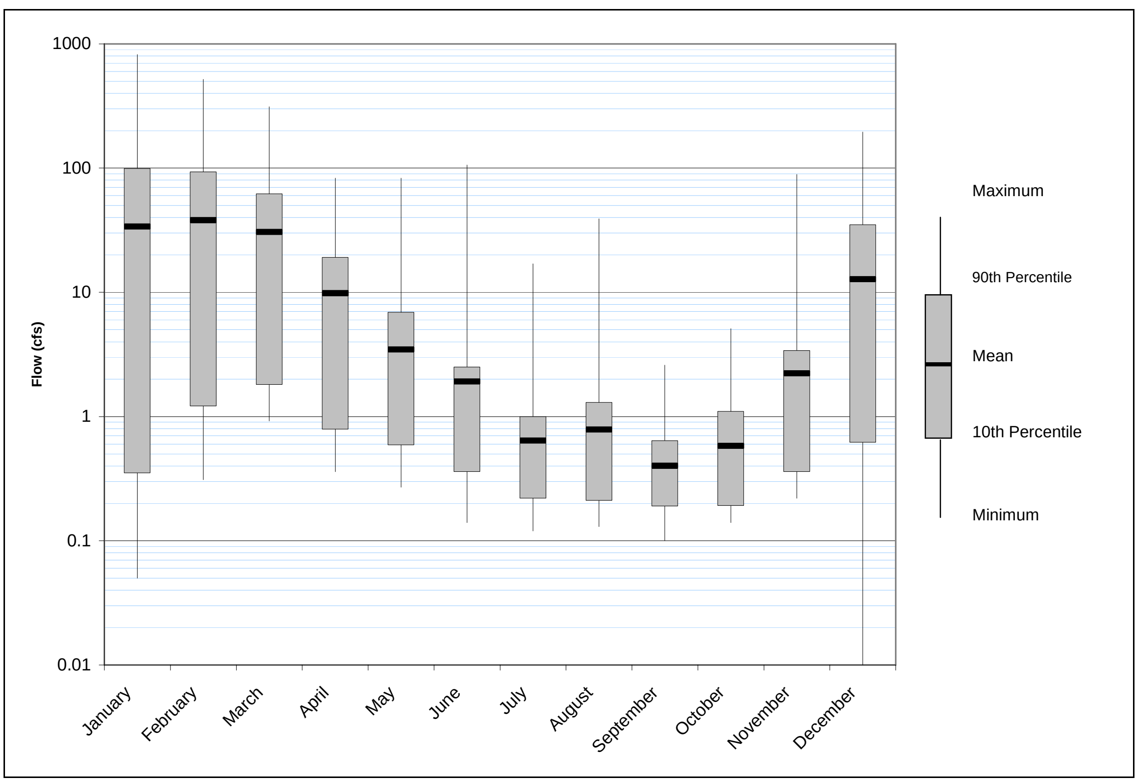

Figure 3. USGS stream gage mean monthly flows for Missouri Flat Creek at Pullman from 1970 - 1979.

Daily and seasonal variation in SFPR streamflows can be affected by the discharge of the Pullman POTW. In turn, the magnitude of the Pullman POTW discharge can be greatly affected by the Washington State University (WSU) school schedule. Norm Glenn (1992) examined two weekly influent flow charts from the Pullman POTW as part of a Class II inspection and found that the difference in peak influent flow, of approximately 2.5 mgd, between a week in July and a week in early October was attributed to the large increase in the number of students in the fall. The influent flow exhibit a bimodal pattern in daily inflow volumes as the result of patterns of human water consumption. The dual daily-peak patterns (Figure 4) in the streamflow gage record at Colfax suggest that daily fluctuations may be controlled to a greater extent by patterns of human waste water discharge to the river during periods of low streamflow.

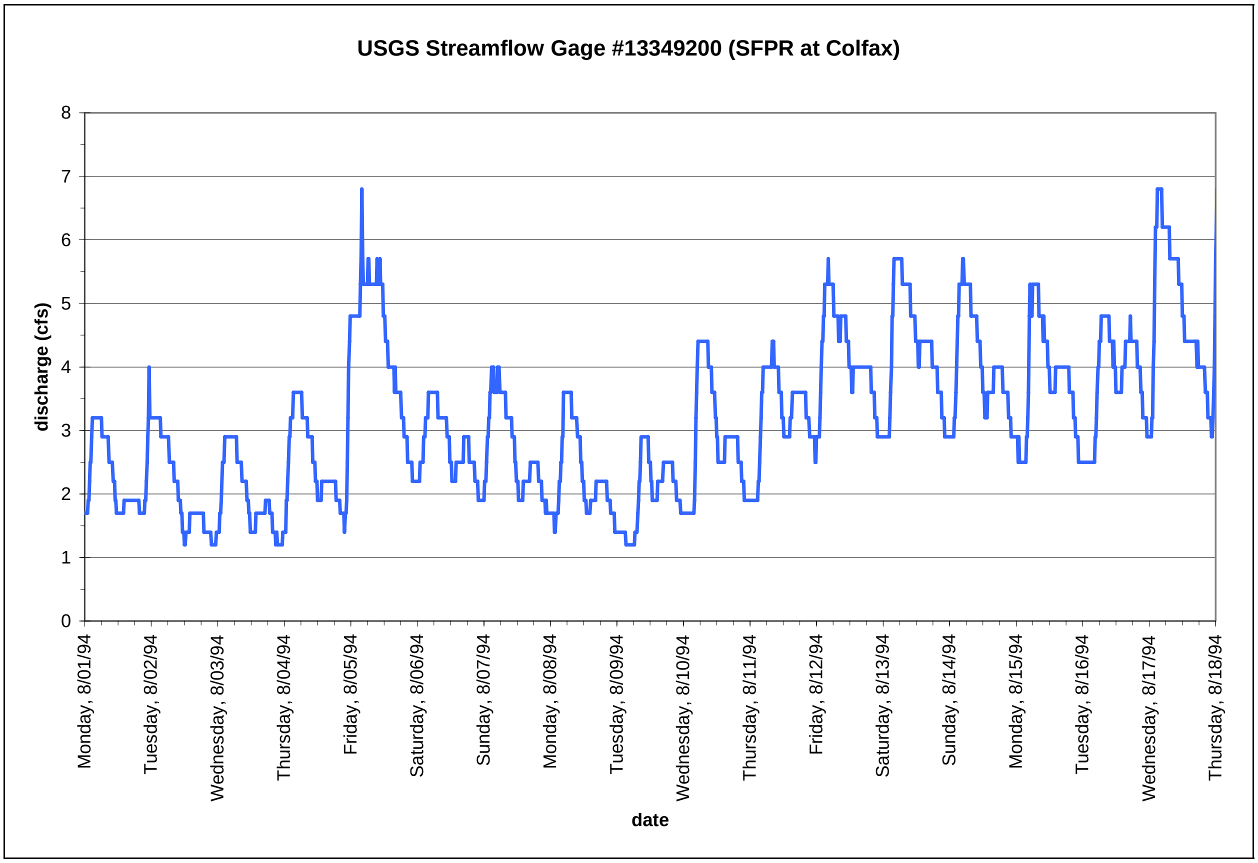

Figure 4: A closer look at a two and one half week continuous streamflow record for the SFPR at Colfax showing the daily fluctuation in stream stage resulting from upstream point discharges.

Pelletier (1993) showed that the fraction of POTW effluent in the SFPR during critical flow is high. Moscow POTW and Pullman POTW are estimated to comprise the majority of the river flow during July–November for a typical year (Figure 5).

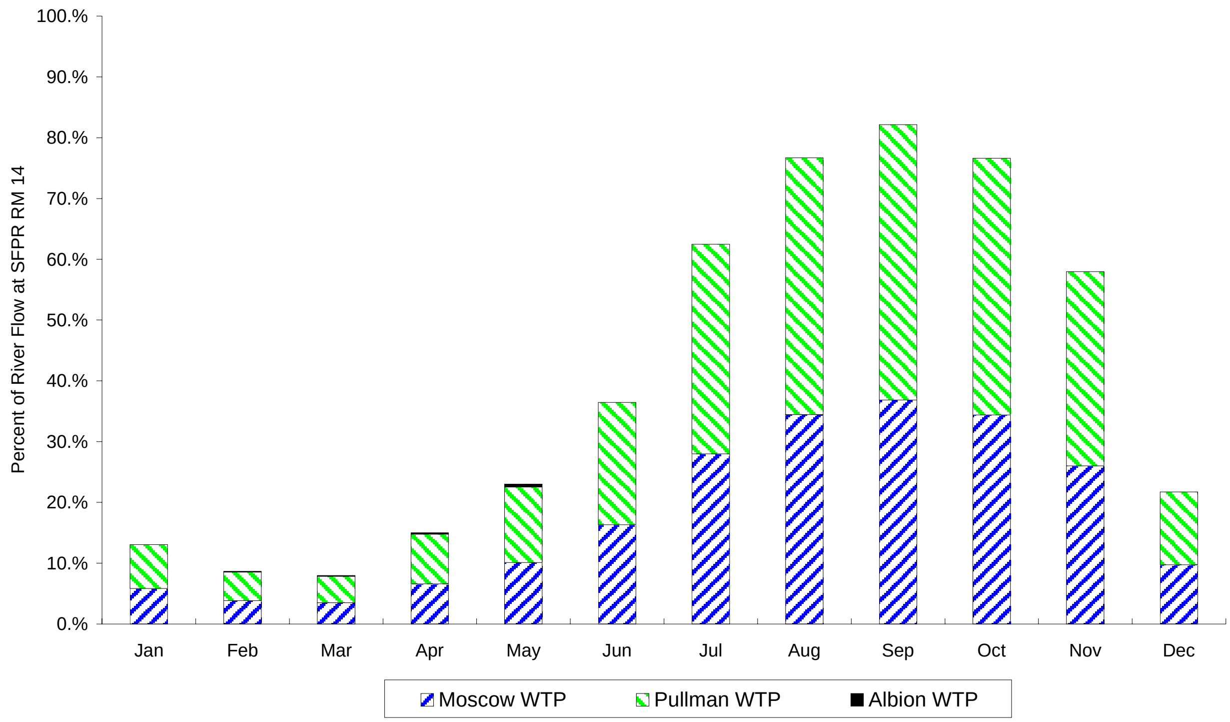

Figure 5: Estimated monthly fraction of POTW effluent in the South Fork Palouse River for a median flow year. Adapted from Pelletier (1993).

USGS Water Quality Study

As part of the USGS National Water-Quality Assessment Program, the cumulative downstream effects from point and nonpoint discharges of nutrients were assessed during low-flow discharge in 1994 throughout the Palouse River Basin (Greene et. al., 1997). Diel and instantaneous data were collected at three sites on the SFPR and three sites on Paradise Creek. The six stations in the SFPR watershed had the highest nutrient levels, largest diel swings in DO, and highest growth of benthic algae when compared to other stations in the rest of the Palouse River watershed. Growth of benthic algae in the SFPR and Paradise Creek was not significantly correlated with nutrient loading, indicating nutrient loading exceeded the algal nutrient requirements. Most of the nutrient load in the SFPR during the low-flow discharge was attributed to both the Moscow POTW and Pullman POTW.

Idaho Department of Environmental Quality

In 1997 the Idaho DEQ completed a waterbody assessment and TMDL for Paradise Creek (IDEQ, 1997). The TMDL set waste-load allocations (for point sources) and load allocations (for non-point sources) for total suspended solids, water temperature, total phosphorus, fecal coliform bacteria, and ammonia. Allocations were set to meet the Washington State Class A Water Quality Standards for temperature and fecal coliform bacteria at the state line. Allocations for ammonia were based on the state line ammonia limits established by Washington in Pelletier

(1993). A seasonal (May to October) total phosphorus allocation of 0.136 mg/L was established based on upper watershed data deemed to represent a "natural background" level. This was expressed as an interim target concentration subject to change as more data was made available.

Idaho DEQ is currently developing a TMDL for total suspended solids, water temperature, total phosphorus, and E-coli bacteria in the Idaho portion of the SFPR.

Washington State Department of Ecology

Washington State Department of Ecology Ambient Monitoring

Ecology has collected ambient monitoring data from the SFPR at Pullman (Station 34B110) since 1974 (Ecology, 2006c). Data was not collected from this station from October 1974 to September 1977 and from October 1992 to September 1994.

An analysis of the ambient monitoring data was conducted by Hallock (1993). Hallock found that the SFPR exhibited extremely poor water quality due to high concentrations of bacteria, nutrients, turbidity, and suspended solids. Temperature, DO, and pH all exceeded standards even though samples were not collected at the time of day most likely to detect violations. The SFPR scored poorly using a state-wide water quality index.

Figure 6 shows box plots of monthly instantaneous DO samples for the SFPR at Pullman (above Pullman POTW). The instantaneous DO measurements did not necessarily capture the daily minimum because they were made during daylight hours when photosynthesis is increasing water column DO. Monthly data from this site indicate DO levels are not in compliance with water quality standards in the months of May through October. This season encompasses the growing season when light is more available and water temperatures are high in the SFPR.

Figure 7 shows box plots of monthly pH measurements for the SFPR at Pullman. Like the DO measurements, the instantaneous pH measurements did not necessarily capture the daily maximum or minimum because measurements were made at different times of the day. A clear season of excursions occurred between April and October. This season encompasses the growing season when light is more available and water temperatures are warmer in the SFPR. Diel high pH levels may result from periphyton growth (i.e., algae attached to the substrate consume inorganic carbon forms during productivity affecting the pH balance).

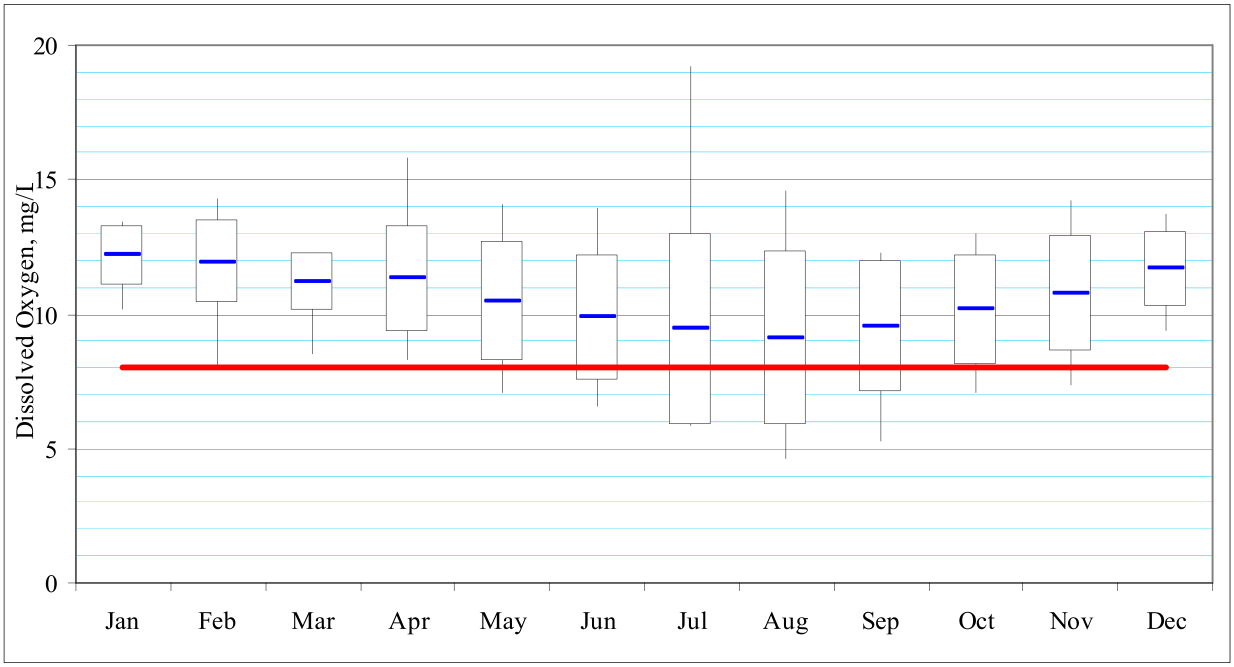

Figure 6. Distribution of monthly dissolved oxygen concentrations measured at the SFPR at Pullman ambient monitoring station (34B110) from 1973 to 2004 (n=27-30 per month). Box plots represent the 90th percentile, mean, and 10th percentile of the measurements. Whiskers on boxes represent the maximum and minimum measurements. The red line represents the minimum instantaneous dissolved oxygen standard of 8 mg/L.

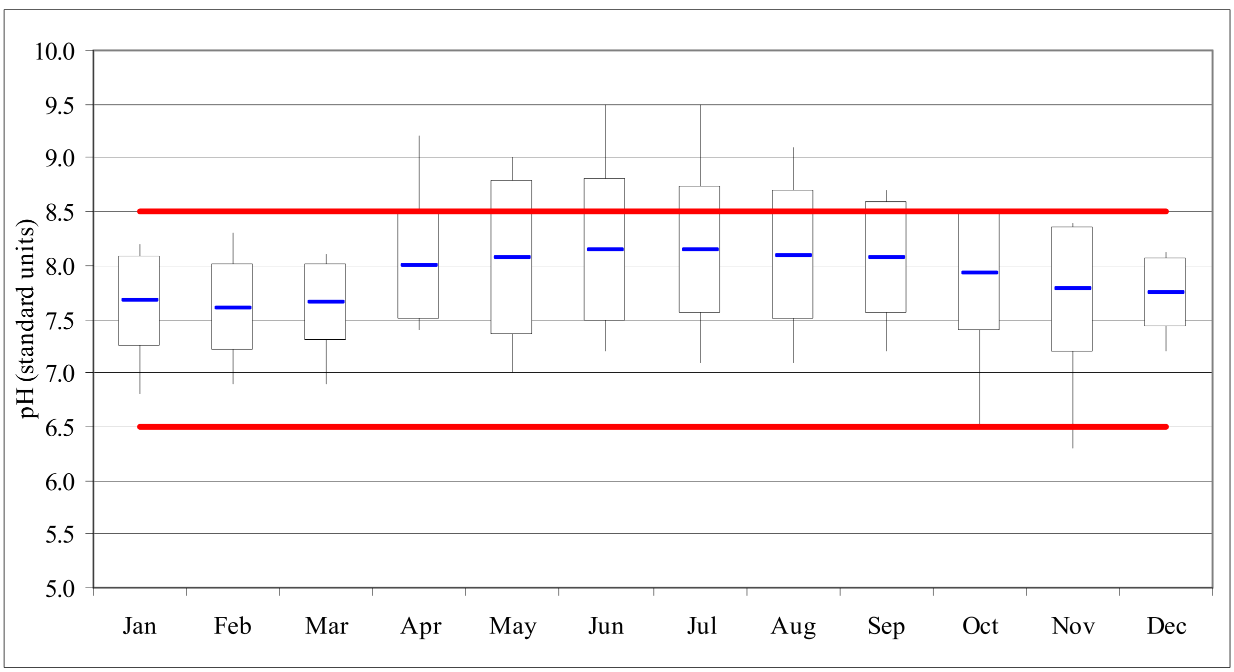

Figure 7. Distribution of monthly pH levels measured at the SFPR at Pullman ambient monitoring station (34B110) from 1973 to 2004 (n= 27-30 per month). Box plots represent the 90th percentile, mean, and 10th percentile of the measurements. Whiskers on boxes represent the maximum and minimum measurements. Red lines denote the maximum and minimum pH water quality criteria of 8.5 and 6.5 pH.

Washington State Department of Ecology Ammonia TMDL

Ecology completed a TMDL for ammonia in the SFPR to address un-ionized ammonia concentrations that exceeded state water quality standards (Pelletier, 1993; addendum in 1995). Sampling data were collected for the project during two intensive surveys in July and October of 1991, which coincided with Class II inspections of the Pullman and Albion POTW (Glenn, 1992). Supplemental ambient monitoring data from additional Ecology stations were also collected during the 1992 water year.

Semi-annual ammonia limits were recommended for critical points in the SFPR and in Paradise Creek at the Washington-Idaho state line. Waste load allocations for Pullman POTW, Albion POTW, and Paradise Creek at the state line were not expected to change significantly by reducing nonpoint sources because of the relatively minor load contribution from nonpoint sources.

Moscow POTW has since added nitrification upgrades (which converts ammonia to nitrate) to their facility. Recently, an effectiveness monitoring project in Paradise Creek and the SFPR has shown that un-ionized ammonia concentrations are in compliance with the water quality standards (Ross, 2006-in progress).

Pelletier (1993) also modeled DO concentrations at critical points below the Moscow, Pullman, and Albion POTWs during critical conditions. Pelletier found that the Class A minimum DO standard of 8 mg/L was not attainable due to low DO solubility in the high-temperature water and, therefore, there was no capacity for further BOD or nutrient load discharge. Pelletier acknowledged that improvements for water temperatures (e.g., increased shading) would increase minimum DO concentrations but probably not enough to meet the water quality standards, even if all POTW effluent loads were eliminated.

Using the recommended ammonia limits and year-round BOD_5 limits of 10 mg/L for the POTWs, Pelletier (1993) predicted an attainable minimum instantaneous DO concentration of 4 mg/L during summer critical conditions. Pelletier (1993) recommended BOD_5 WLAs of 10 mg/L, acknowledging that the DO water quality standard would not be met and that a special condition for DO may need to be adopted to continue discharging effluent; however, a DO TMDL was not completed.

Stormwater Monitoring

In 2005 and 2006 Ecology collected stormwater data for the South Fork Palouse River Pesticide, PCB, and Fecal Coliform Stormwater Pilot Study (Lubliner, 2005). The QAPP and sampling have been completed; however, the sampling results have not yet been verified or analyzed. Limited nutrient sampling was conducted for characterization of the stormwater. The final report is scheduled to be available in fall 2006.

Project Description

Study Design

The project objectives (page 9) will be met by developing a numerical model of hydrodynamics and water quality for the SFPR from the USGS gage station on Paradise Creek in Moscow, Idaho, to the downstream end of the SFPR in Colfax. The model will rely on data collected during the project by Ecology as well as existing data collected by Ecology, Whitman County, cities of Pullman and Moscow, Idaho DEQ, Washington State University, USGS, and others.

The model will be calibrated to field data. The calibrated model will then be used to evaluate the water quality in the SFPR in response to various alternative scenarios of pollutant loading. The loading capacity of the SFPR will be evaluated and waste load allocations for point sources and load allocations for nonpoint sources will be evaluated. The model will be used to determine how much nutrients and BOD need to be reduced to meet the DO and pH water quality standards.

Data will be collected for the SFPR DO and pH TMDL from a fixed network of stations sampled synoptically (all stations sampled over a short period of time). Sampling at each station will be conducted twice daily. Synoptic surveys will be conducted at least two times throughout the course of the project to provide calibration and corroboration data sets. The fixed-network synoptic sampling will occur during the summer low-flow months (June to October 2006) to capture critical conditions. The locations of the fixed-network water quality stations are listed in Table 4 and can be seen in Figures 8 and 9. Major tributaries of the SFPR will be sampled as close to their confluence with the mainstem as possible.

Synoptic sampling will include grab samples of chloride, total suspended solids, total non-volatile suspended solids, turbidity, ammonia, nitrite/nitrate, orthophosphate, total phosphorous, total persulfate nitrogen, dissolved and total organic carbon, and alkalinity. Ultimate carbonaceous biochemical oxygen demand sampling will be done on the POTW final effluents.

Continuous diel monitoring for pH, DO, conductivity, and temperature will be conducted at several sites with Hydrolab DataSonde® (listed in Table 4). Phytoplankton and periphyton sampling will be conducted at the same sites to determine biomass and chlorophyll levels.

Continuous streamflow data will be obtained from seven stream gaging stations:

- SFPR at State Street crossing in Pullman, United States Geological Survey (USGS)
- SFPR at Albion, Ecology, Stream Hydrology Unit (SHU)
- SFPR below Parvin Creek confluence, Ecology, SHU
- SFPR just upstream of Colfax city limits, Ecology, SHU
- Paradise Creek at the University of Idaho, USGS
- Paradise Creek at the Washington-Idaho border, Ecology, SHU
- Paradise Creek at the mouth, Ecology, SHU

Ecology's SHU will also install staff gages at other sites to develop discharge rating curves based on stage. Flows in Paradise Creek and the SFPR will be estimated from a flow routing model application, such as HEC-RAS (www.hec.usace.army.mil) or GEMSS (www.jeeai.com).

Reaeration field studies may be performed to provide calibration data for the reaeration model utilized in the water quality modeling. Reaeration field studies would follow protocols outlined by Kilpatrick et al. (1989).

Sites may be added or removed from the sampling plan depending upon access and new information provided during the QA Project Plan review, field observations, and preliminary data analysis.

Table 4. Fixed-network stations for synoptic surveys in the SFPR watershed.

Waterbody/ Source	Road Crossing or Access	Reason for Site	Data-logger Site
SF Palouse River	Sand Road near state line	Washington-Idaho Border	X
SF Palouse River	Off Johnson Rd.	Just outside Pullman city limits	
SF Palouse River	Entrance to Pro. Mall Plaza	Ambient site, below Sunshine Ck. confluence	X
SF Palouse River	South Street bridge	Good access	
SF Palouse River	Kamiaken Street bridge	Good access	
SF Palouse River	State Street bridge	Ambient site; Good access;	X
SF Palouse River	Below Hayward Road	Just downstream of Pullman POTW outfall	X
SF Palouse River	Armstrong Road	West of Pullman city limits	
SF Palouse River	Albion Rd./D Street bridge	Within Albion city limits	X
SF Palouse River	Shawnee Road	Upstream of Four Mile Creek confluence	
SF Palouse River	Parvin Road bridge	Downstream of Parvin Creek confluence	X
SF Palouse River	Access TBD	Just outside Colfax city limits	
SF Palouse River	End of B Ave.	Mouth of SFPR	X
Paradise Creek	Perimeter Dr. in Moscow, ID	Surface flow- background above POTW	X
Paradise Creek	Off Moscow-Pullman Hwy.	Washington-Idaho Border	X
Paradise Creek	Sunshine Creek Rd. bridge	Large gap between stations	
Paradise Creek	Airport Rd. bridge	Upstream of Airport Rd. Creek confluence	
Paradise Creek	Bishop Boulevard	Mouth of Paradise Creek	X
Missouri Flat Creek	Kitzmiller Road	Just outside Pullman city limits	
Missouri Flat Creek	Stadium Way	Upstream of storm drain outfall	
Missouri Flat Creek	Grand Ave. near Whitman St.	Mouth of Missouri Flat Creek	
Dry Fork Creek	Fairmount Road	Just outside Pullman city limits	
Dry Fork Creek	Crestview Rd. and Grand Ave.	Identify sources	
Dry Fork Creek	Gas Station at 500 Grand Ave.	Good access; Identify FC sources	
Dry Fork Creek	Off Grand at SFPR confluence	Dry Creek at its mouth	
Storm Drain WSU#1 to SFPR	Benewah St.	Identify sources	
Storm Drain WSU#2 to SFPR	Main St. just E. of Dilke Rd.	Identify sources	
Storm Drain #120 to Mo. Flat Ck	Off Stadium Way	Identify sources	
Pullman POTW Outfall	1025 Guy St.	Treated wastewater effluent discharge	X
Four Mile Creek	Shawnee-Parvin Road	Mouth of Four Mile Creek	
Spring Flat Creek	Off Hwy 195 near city limits	Just upstream of Colfax city limits	
Moscow POTW Outfall	Moscow-Pullman Hwy	Treated wastewater effluent discharge	X
Albion POTW Outfall	Shawnee-Parvin Rd.	Seasonal wastewater effluent discharge	
Airport Road Creek	Off Main St. or Airport Rd.	Mouth of Airport Rd. Creek	
Staley Creek	Off Johnson Rd;south of Busby	Mouth of Staley Creek	
Sunshine Creek	Old Moscow Highway	Mouth of Sunshine Creek	

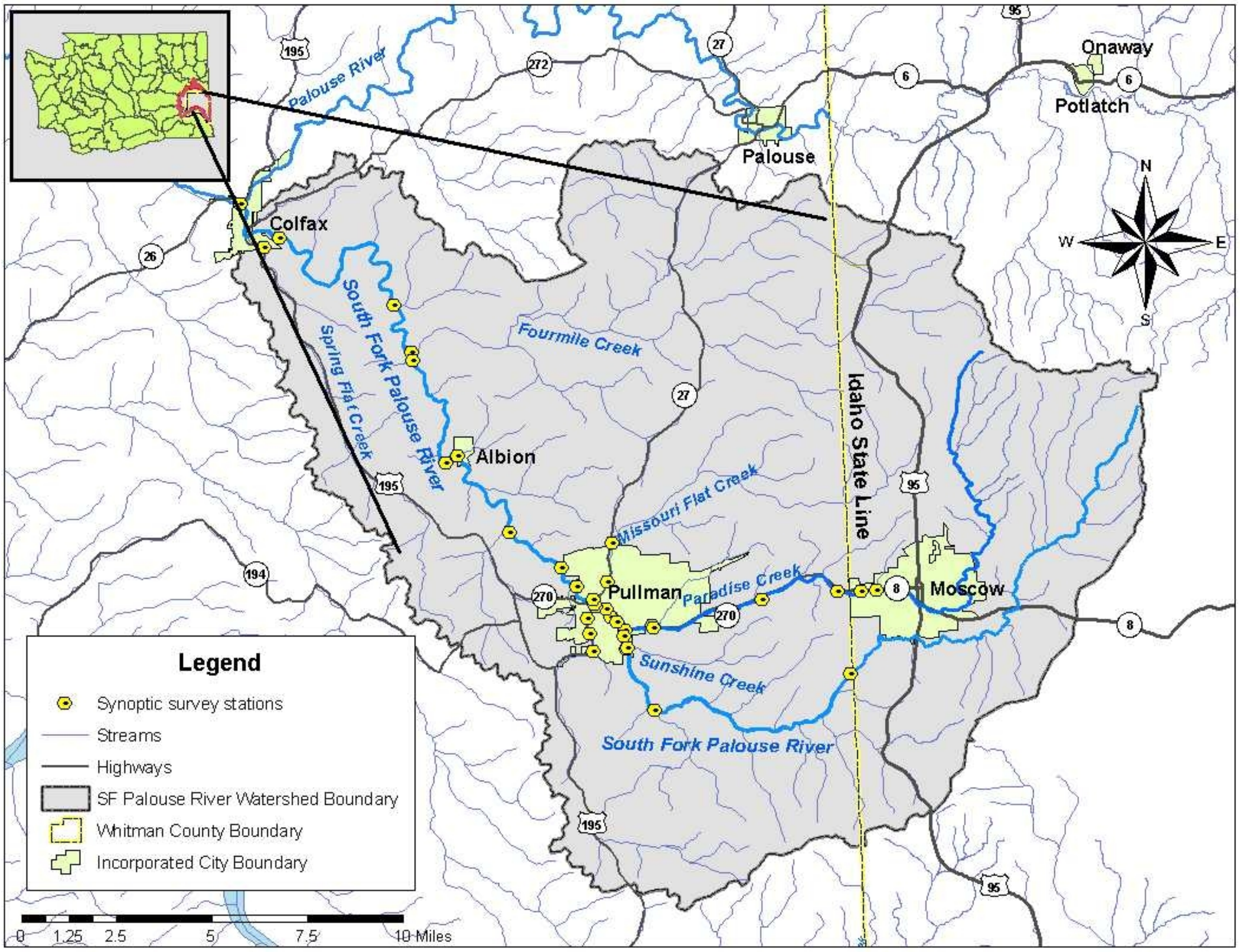

Figure 8. Map of the SFPR Watershed showing proposed TMDL sampling sites. The Pullman area is shown in more detail in Figure 9.

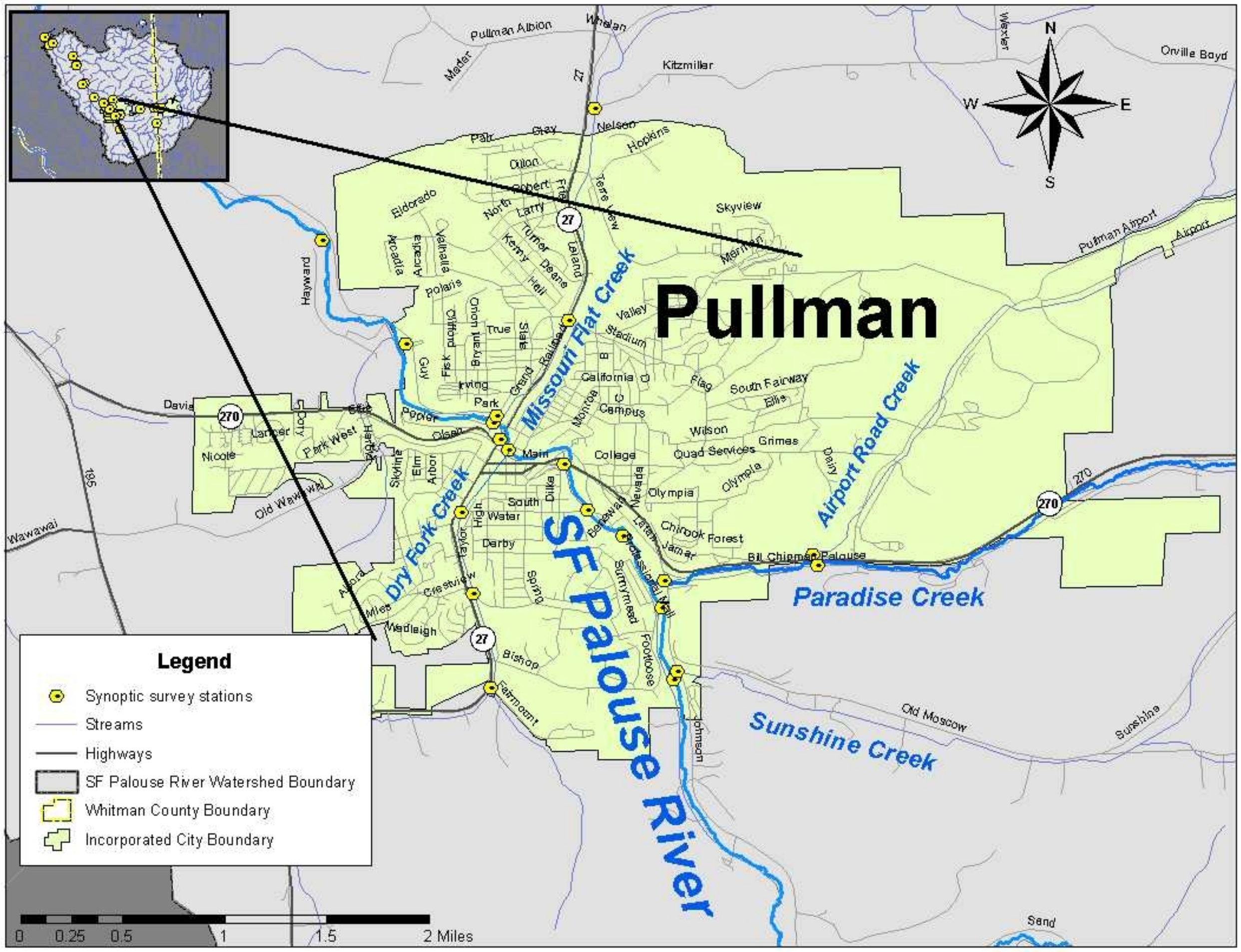

Figure 9. Map of the Pullman area showing proposed TMDL sampling sites.

Groundwater monitoring

Geologic Setting
The SFPR watershed lies near the eastern edge of the Columbia Plateau Aquifer System (Drost and others, 1990). The western two-thirds of the watershed is contained within Washington State and is underlain largely by Miocene age basalts and associated sediments of the Columbia River Basalt group. The Columbia River basalts, which contain the areas primary water supply aquifers, were extruded upon and overlie an assemblage of igneous intrusive and metasedimentary rocks of Cretaceous to Pre-Cambrian Age. These older rocks are widely distributed at land surface east of the Washington-Idaho border and locally within the Washington Palouse drainage, where they are not obscured beneath later basalt flows. The Palouse uplands in Washington State are generally mantled by thick accumulations of loess (wind blown sand, silt, and clay). Where stream valleys bisect the uplands, the loess typically grades laterally into coarser deposits of alluvium and colluvium derived from reworked loess, basalt, and granatoid fragments (Bush and others, 1998).

Evaluation of Groundwater and Surface Water Interactions
For this study, groundwater and surface-water interactions will be assessed via a combination of common field techniques. In-stream piezometers will be installed beginning in May 2006 at selected points along the SFPR to enable monitoring of surface water and groundwater head relationships, streambed water temperatures, and groundwater quality at discrete points along the river. The piezometers will be distributed to provide point measurements along the length of the river and, where possible, will be co-located with previously deployed instream thermistors.

The piezometers for this study will consist of a five-foot length of 1.5-inch diameter galvanized pipe, one end of which is crimped and slotted. The upper end of each piezometer will be fitted with a standard pipe coupler to provide a robust strike surface for piezometer installation and to enable the piezometers to be securely capped between sampling events. The piezometers will be driven into the stream bed (within a few feet of the shoreline) to a maximum depth of approximately five feet. Following installation, the piezometers will be developed using standard surge and pump techniques to assure a good hydraulic connection with the streambed sediments.

Each piezometer will be instrumented with up to three thermistors for continuous monitoring of streambed water temperatures. In a typical installation, one thermistor will be located near the bottom of the piezometer, one will be located at a depth of approximately 0.5 feet below the streambed, and one will be located roughly equidistant between the upper and lower thermistors. The piezometers will be accessed monthly to download thermistors and to make spot measurements of stream and groundwater temperature for later comparison against and validation of the thermistor data. The monthly spot measurements will be made with properly maintained and calibrated field meters in accordance with standard Watershed Ecology Section (WES) methodology.

During the monthly site visits, surface water stage and instream piezometer water levels will be measured using a calibrated electric well probe, a steel tape, or a manometer board (as appropriate) in accordance with standard USGS methodology (Stallman, 1983). The water level (head) difference between the internal piezometer water level and the external river stage provides an indication of the vertical hydraulic gradient and the direction of flow between the river and groundwater. When the piezometer head exceeds the river stage, groundwater discharge into the river is inferred. Similarly, when river stage exceeds the head in the piezometer, loss of water from the river to groundwater storage can be inferred.

To help define the potential nutrient load that discharging groundwater contributes to the river those piezometers that exhibit positive hydraulic gradients (groundwater discharge conditions) will be sampled in June, August, and October 2006 for the following parameters: conductivity, temperature, pH, DO, total dissolved solids, alkalinity, chloride, dissolved nutrients (ammonia, nitrate-nitrite, total nitrogen, orthophosphate and total phosphorus), and total and dissolved organic carbon. All water quality samples will be collected, processed, and transported to the laboratory in accordance with standard WES methodology.

To provide a secondary confirmation of the instream piezometer dataset, we will also attempt to arrange access to a tandem network of shallow off-stream domestic wells which will be used to monitor "regional" groundwater levels, temperatures, and groundwater quality. When selecting wells preference will be given to shallow properly documented wells in close proximity to the SFPR. Wells selected for monitoring will be visited monthly between May and November, 2006, to measure groundwater levels. Where owner permission is granted and site conditions allow, recording thermistors and water level transducers will be deployed. A subset of the off-stream wells will be sampled in August 2006 for the above listed parameters.

In addition to the above work, Ecology is currently evaluating a method for the direct measurement of streambed sediment permeability using constant head injection tests. The field methods and analytical techniques are based on procedures outlined in Cardenas and Zlotnik (2003). To support the development of this procedure for future EA Program studies, injection tests are proposed for a subset of the piezometers installed during this study. If successful, the test results will be used to augment thermal profiling and gradient measurements for estimation of groundwater/surface water exchange.

Storm Monitoring

Stormwater monitoring will be conducted for the Fecal Coliform Bacteria TMDL (Mathieu and Carroll, 2006) to better characterize potential sources of fecal coliform loading to the study area stream. The Bacteria TMDL will attempt to capture one storm event during the summer, low-flow season in order to characterize the impact of these events. Limited nutrient and other water quality parameters may be sampled depending on budget.

Representativeness

The study was designed to have enough sampling sites and sufficient sampling frequency to adequately characterize water quality spatial and temporal patterns (during the synoptic survey) in the watershed. Representative sampling variability can be somewhat controlled by strictly following standard procedures and collecting quality control samples, but natural spatial and temporal variability can contribute greatly to the overall variability in a parameter value.

Resources limit the number of samples that can be taken at one site spatially or over various intervals of time; however, an attempt will be made to take water quality grab samples at least twice at all stations during the synoptic survey: preferably one in the morning and one in the afternoon.

Comparability

Samples collected at the Pullman and Moscow POTW will be collected, when possible, in conjunction with the routine samples collected by the POTW operators. Ecology results will be compared to the results from each POTW. Similarly, if possible, samples collected on the SFPR at the Washington-Idaho border, will be collected in conjunction with samples collected by the Idaho DEQ for the TMDL on the SFPR in Idaho.

Completeness

The Environmental Protection Agency (EPA) has defined completeness as a measure of the amount of valid data needed to be obtained from a measurement system (EPA, 2002). The goal for the SFPR TMDL is to correctly collect and analyze 100% of the samples for each of the sites. However, problems occasionally arise during sample collection that cannot be controlled such as flooding, inadequate rain for storm sampling, or site access problems that can interfere with this goal. A lower limit of one grab sample per synoptic survey per site will be required for comparison to state criteria and model input. Investigatory samples may be collected at sites not included in this QA Project Plan; or, if necessary, a site may be added to further characterize water quality problems in an area.

Laboratory Budget

The estimated laboratory budgets and lab sample loads are presented in Table 5.

Table 5. Projected sample loads and lab costs for nutrient sampling on the SFPR.

	Nutrients	Reps.	TOC	Reps	DOC	Reps.	Alkalinity	Reps.	Cost
Synoptic survey #1	75	10	75	10	75	10	75	10	$ 12,070
Synoptic survey #2	75	10	75	10	75	10	75	10	$ 12,070
Periphyton sampling	25	2							$ 1,728
Totals	175	22	150	20	150	20	150	20	$ 25,868

Reps. = replicates about 10% of the preceding column; **Nutrients** = Ammonia (NH3), Nitrite/Nitrate (NO2/NO3), Orthophosphate (OP), Total Phosphorous (TP), and Total Persulfate Nitrogen (TPN); **TOC** = Total Organic Carbon; **DOC** = Dissolved Organic Carbon.
Projected lab costs include a 50% discount for services at Manchester Laboratory (the remaining 50% is paid through base funding).

Sampling Procedures

Field sampling and measurement protocols will follow those listed in the WES (previously the Watershed Assessment Section) protocols manual (Ecology, 1993). Grab samples will be collected directly into pre-cleaned containers supplied by Manchester Environmental Laboratory (MEL) and described in the MEL User's Manual (2005). Sample parameters, containers, volumes, preservation requirements, and holding times are listed in Table 6. All samples for laboratory analysis will be stored on ice and delivered to MEL within 24 hours of collection via Horizon Air and Ecology courier.

Ten-to-twenty percent of the samples will be duplicated in the field in a side-by-side manner to assess field and lab variability. Samples will be collected in the thalweg and just under the water's surface.

Periphyton field sampling protocols are adapted from the USGS protocols (Porter et al., 1993).

Table 6. Containers, preservation requirements, and holding times for samples collected during the SFPR TMDL Study (MEL, 2005).

Parameter	Sample Matrix	Container	Preservative	Holding Time
Fecal Coliform	Surface water, POTW effluent, & runoff	250 or 500 mL glass/poly autoclaved	Cool to 4ºC	24 hours
Chloride	Surface water, POTW effluent, & runoff	500 mL poly	Cool to 4ºC	28 days
Total Suspended Solids; TNVSS	Surface water, POTW effluent, & runoff	1000 mL poly	Cool to 4ºC	7 days
Turbidity	Surface water, POTW effluent, & runoff	500 mL poly	Cool to 4ºC	48 hours
Alkalinity	Surface water, POTW effluent, & runoff	500 mL poly – NO Headspace	Cool to 4°C; Fill bottle completely; Don't agitate sample	14 days
Ammonia	Surface water, POTW effluent, & runoff	125 mL clear poly	H_2SO_4 to pH<2; Cool to 4ºC	28 days
Dissolved Organic Carbon	Surface water, POTW effluent, & runoff	60 mL poly with: Whatman Puradisc™ 25PP 0.45um pore size filters	Filter in field with 0.45um pore size filter; 1:1 HCl to pH<2; Cool to 4°C	28 days
Nitrate/Nitrite	Surface water, POTW effluent, & runoff	125 mL clear poly	H_2SO_4 to pH<2; Cool to 4ºC	28 days
Total Persulfate Nitrogen	Surface water, POTW effluent, & runoff	125 mL clear poly	H_2SO_4 to pH<2; Cool to 4ºC	28 days
Orthophosphate	Surface water, POTW effluent, & runoff	125 mL amber poly w/ Whatman Puradisc™ 25PP 0.45um pore size filters	Filter in field with 0.45um pore size filter; Cool to 4°C	48 hours
Total Phosphorous	Surface water, POTW effluent, & runoff	60 mL clear poly	1:1 HCl to pH<2; Cool to 4°C	28 days
Total Organic Carbon	Surface water, POTW effluent, & runoff	60 mL clear poly	1:1 HCl to pH<2; Cool to 4°C	28 days
Biochemical Oxygen Demand (ultimate)	Surface water, POTW effluent	1 gallon cubitainer	Cool to 4ºC in dark	48 hours
Chlorophyll a	Surface water, periphyton	1000 mL amber poly	Cool to 4ºC; 24 hrs to filtration	28 days after filtering

Measurement Procedures

Field measurements in the SFPR and its tributaries will include conductivity, temperature, pH, and DO using a calibrated Hydrolab DataSonde® or MiniSonde®. DO will also be collected and analyzed using the Winkler titration method (Ecology, 1993).

Estimation of instantaneous flow measurements will follow the SHU protocols manual (Ecology, 2000). Flow volumes will be calculated from continuous stage height records and rating curves developed prior to, and during, the project. Stage height will be measured by pressure transducer and recorded by a data logger every 15 minutes. All data loggers will be downloaded monthly. Staff gages will be installed at other selected sites. During the field surveys, streamflow will be measured at selected stations and/or staff gage readings will be recorded. A flow rating curve will be developed for sites with a staff gage.

Measurement Quality Objectives

Field sampling procedures and laboratory analysis inherently have associated error. Measurement quality objectives state the allowable error for a project. Precision and bias are data quality criteria used to indicate conformance with measurement quality objectives.

Precision is defined as the measure of variability in the results of replicate measurements due to random error. Random error is imparted by the variation in concentrations of samples from the environment as well as other introduced sources of variation (e.g., field and laboratory procedures). Precision for replicates will be expressed as percent relative standard deviation (%RSD).

Bias is defined as the difference between the population mean and true value of the parameter being measured. Bias affecting measurement procedures can be inferred from the results of QC procedures involving the use of blanks, check standards, and spiked samples. Bias in field measurements will be minimized by strictly following sampling and handling protocols, and will be assessed by submitting field blanks.

Analytical methods, expected precision of sample replicates, and method reporting limits and/or resolution are given in Table 7. The targets for analytical precision of laboratory analyses are based on historical performance by MEL for environmental samples taken around the state by the WES Section (Mathieu, 2005a). The reporting limits of the methods listed in the table are appropriate for the expected range of results, and the required level of sensitivity to meet project objectives. The laboratory's measurement quality objectives and quality control procedures are documented in the MEL Lab Users Manual (MEL, 2005).

Table 7. Targets for precision and reporting limits for the measurement systems.

Analysis	Method	Duplicate Samples Relative Standard Deviation (RSD)	Method Reporting Limits and/or Resolution
Field Measurements			
Velocity[1]	Marsh McBirney Flow-Mate Flowmeter	0.1 ft/s	0.01 ft/s
Water Temperature[1]	Hydrolab MiniSonde®	+/- 0.1° C	0.01° C
Specific Conductivity[2]	Hydrolab MiniSonde®	+/- 0.5%	0.1 umhos/cm
pH[1]	Hydrolab MiniSonde®	0.05 SU	1 to 14 SU
Dissolved Oxygen[1]	Hydrolab MiniSonde®	5% RSD	0.1 - 15 mg/L
Dissolved Oxygen[1]	Winkler Titration	+/- 0.1 mg/L	0.01 mg/L
Laboratory Analyses			
Fecal Coliform – MF	SM 9222D	30% RSD[3]	1 cfu/100 mL
Chloride	EPA 300.0	5% RSD[4]	0.1 mg/L
Total Suspended Solids	SM 2540D	10% RSD[4]	1 mg/L
Turbidity	SM 2130	10% RSD[4]	1 NTU
Alkalinity	SM 2320	10% RSD[4]	10 mg/L
Ammonia	SM 4500-NH_3^-H	10% RSD[4]	0.01 mg/L
Dissolved Organic Carbon	EPA 415.1	10% RSD[4]	1 mg/L
Nitrate/Nitrite	4500-NO_3^- I	10% RSD[4]	0.01 mg/L
Total Persulfate Nitrogen	SM 4500-NO_3^-B	10% RSD[4]	0.025 mg/L
Orthophosphate	SM 4500-P G	10% RSD[4]	0.003 mg/L
Total Phosphorous	EPA 200.8 modified	10% RSD[4]	0.001 mg/L
Total Organic Carbon	EPA 415.1	10% RSD[4]	1 mg/L

[1] as units of measurement, not percentages.
[2] as percentage of reading, not RSD.
[3] replicate results with a mean of less than or equal 20 cfu/100mL will be evaluated separately.
[4] replicate results with a mean of less than or equal to 5X the reporting limit will be evaluated separately.

SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition (APHA, AWWA and WEF, 1998)
EPA = EPA Method Code.

Quality Control Procedures

Total variability for field sampling and laboratory procedures will be assessed by collecting replicate samples. Sample precision will be assessed by collecting replicates for 10-20% of samples in each survey. MEL routinely performs duplicate sample analyses to measure bias in lab analytical methods. The difference between total variability and laboratory variability is an estimate of the error introduced by the sampling process.

All samples will be analyzed at MEL. The laboratory's measurement quality objectives and quality control procedures are documented in the MEL Lab Users Manual (MEL, 2005). MEL will follow standard quality control procedures (MEL, 2005). Field sampling and measurements will follow quality control protocols described in Ecology (1993). If any of these quality control criteria are not met, the associated results will be qualified and used with caution, or not used at all.

Data Management Procedures

Field measurement data will be entered into a field book with waterproof paper in the field and then entered into EXCEL® spreadsheets (Microsoft, 2001) as soon as practical after returning from the field. This database will be used for preliminary analysis and to create a table to upload data into Ecology's Environmental Information Management (EIM) System.

Sample result data received from MEL by Ecology's Laboratory Information Management System (LIMS) will be exported prior to entry into EIM and added to a cumulative spreadsheet for laboratory results. This spreadsheet will be used to informally review and analyze data during the course of the project.

An EIM user study (JICA0000) has been created for this TMDL study and all monitoring data will be available via the internet once the project data has been validated. The URL address for this geospatial database is: www.ecy.wa.gov/eim/index.htm. All data will be uploaded to EIM by the EIM data engineer once it has been reviewed for quality assurance and finalized.

All spreadsheet files, paper field notes, and GIS products created as part of the data analysis and model building will be kept with the project data files.

Audits and Reports

The project manager will be responsible for submitting quarterly reports and the final technical study report to the Water Quality Program TMDL coordinator for this project according to the project schedule.

Data Verification and Validation

Laboratory-generated data reduction, review, and reporting will follow the procedures outlined in the MEL Users Manual (MEL, 2005). Lab results will be checked for missing and/or improbable data. Variability in lab duplicates will be quantified using the procedures outlined in the MEL Users Manual (MEL, 2005). Any estimated results will be qualified and their use restricted as appropriate. A standard case narrative of laboratory QA/QC results will be sent to the project manager for each set of samples.

Field notebooks will be checked for missing or improbable measurements before leaving each site. The EXCEL® Workbook file containing field data will be labeled "DRAFT" until data verification and validity are completed. Data entry will be checked by the field assistant against the field notebook data for errors and omissions. Missing or unusual data will be brought to the attention of the project manager for consultation. Valid data will be moved to a separate file labeled "FINAL."

Data received from LIMS will be checked for omissions against the "Request for Analysis" forms by the field lead. Data can be in EXCEL® spreadsheets (Microsoft, 2001) or downloaded tables from EIM. These tables and spreadsheets will be located in a file labeled "DRAFT" until data validity is completed. Field replicate sample results will be compared to quality objectives in Table 7. Data requiring additional qualifiers will be reviewed by the project manager. After data validity and data entry tasks are completed, all field, laboratory, and flow data will be entered into a file labeled "FINAL," and then into the EIM system. EIM data will be independently reviewed by another EA Program field assistant for errors at an initial 10% frequency. If significant entry errors are discovered, a more intensive review will be undertaken. At the end of the field collection phase of the study, the data will be compiled in a data summary.

Data Analysis and Water Quality Modeling Procedures

Data analysis will include evaluation of data distribution characteristics and, if necessary, appropriate distribution of transformed data. Estimation of univariate statistical parameters and graphical presentation of the data (box plots, time series, and regressions) will be made using WQHYDRO (Aroner, 2003) and EXCEL® (Microsoft, 2001) software.

Means, maximums, minimums, and 90th percentiles will be determined from the raw data collected at each monitoring location. Estimates of groundwater inflow will be calculated by constructing a water mass balance from continuous and instantaneous stream flow data and piezometer studies.

A model will be developed for observed and critical conditions. Critical conditions for DO are characterized by a period of low-flow and high-water temperatures. Sensitivity analysis will be run to assess the variability of the model results. Model resolution and performance will be measured using the root-mean-square-error (RMSE), a commonly used measure of model variability (Reckhow, 1986). The RMSE is defined as the square root of the mean of the squared difference between the observed and simulated values.

Water quality modeling will be conducted using QUAL2Kw (Pelletier and Chapra, 2003), GEMSS (www.jeeai.com), or a similar biogeochemical modeling framework. The specific modeling framework is expected to be QUAL2Kw, although an alternative framework may be used instead depending on a review of available frameworks at the time when modeling tasks will be conducted. The water quality model will use kinetic formulations for simulating DO and pH in the water column similar to those shown in Figure 10 and Table 8. Both GEMSS and QUAL2K have similar kinetic processes and one of these, or a similar model (e.g. WASP EUTRO), will be used to analyze the fate and transport of water quality variables relating to nutrients, periphyton, DO, and pH interactions in the water column. The water quality model will be developed to simulate dynamic variations in water quality of the SFPR and Paradise Creek. The water quality model will be calibrated and corroborated using data collected during the synoptic surveys and any other historical data collected to the extent possible.

QUAL2K will be applied by assuming that flow remains constant (i.e., steady flows) for a given condition such as a 7-day or 1-day period (using daily average flows), but key variables other than flow will be allowed to vary with time over the course of a day. For QUAL2K temperature simulation, the solar radiation, air temperature, relative humidity, headwater temperature, and tributary water temperatures are specified or simulated as diurnally varying functions. If model resolution using QUAL2K is insufficient, then GEMSS will be applied using variable flow over the course of a day (i.e., unsteady flow).

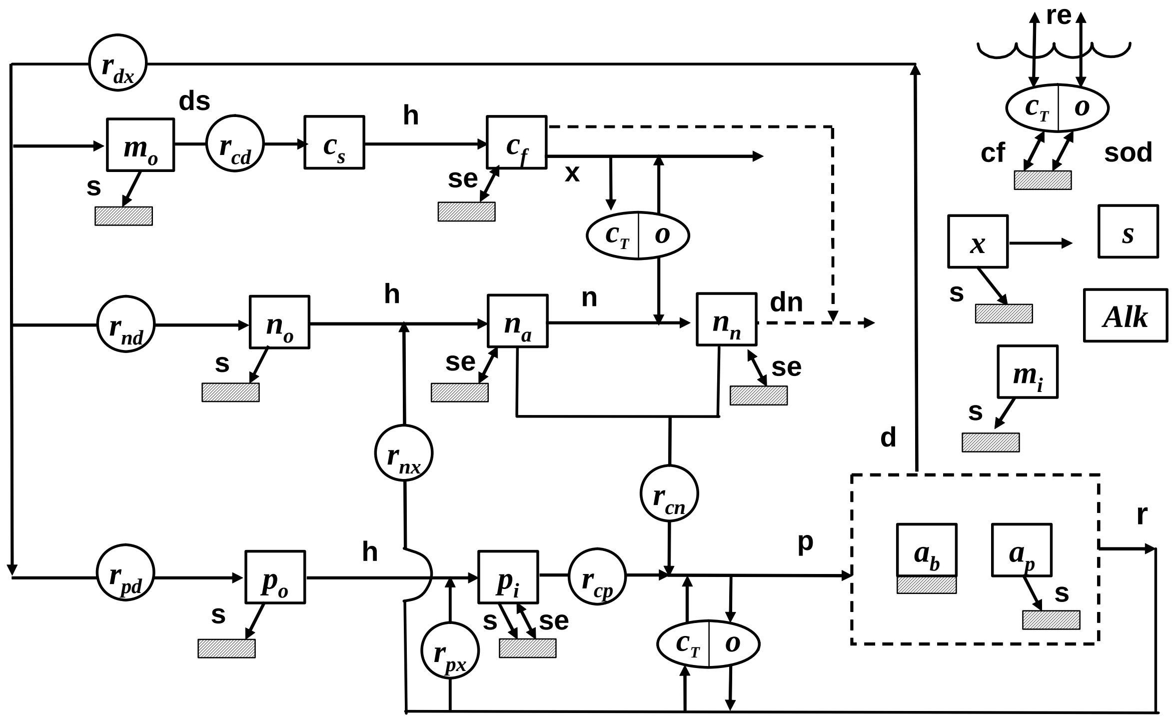

Figure 10: Model kinetics and mass transfer processes in QUAL2Kw and GEMSS. The state variables are defined in Table 8. Kinetic processes are dissolution (ds), hydrolysis (h), oxidation (x), nitrification (n), denitrification (dn), photosynthesis (p), death (d), and respiration/excretion (r). Mass transfer processes are reaeration (re), settling (s), sediment oxygen demand (SOD), sediment exchange (se), and sediment inorganic carbon flux (cf). Note that the subscript x for the stoichiometric conversions stands for chlorophyll a (a) and dry weight (d) for phytoplankton and bottom algae, respectively. For example: r_{px} and r_{nx} are the ratio of P and N to chlorophyll a for phytoplankton, or the ratio of P and N to dry weight for bottom algae; rdx is the ratio of dry weight to chlorophyll a for phytoplankton or unity for bottom algae; r_{nd}, r_{pd}, and r_{cd} are the ratios of N, P, and C to dry weight.

Table 8. Model state variables.

Variable	Symbol	Units*	Measured as
Conductivity	s	μmhos	COND
Inorganic suspended solids	m_i	mgD/L	TSS-VSS
Dissolved oxygen	o	mgO_2/L	DO
Slow-reacting CBOD	c_s	mg O_2/L	-
Fast-reacting CBOD	$c_{f,}$	mg O_2/L	r_{oc} * DOC or CBODU
Organic nitrogen	n_o	μgN/L	TN – NO3N NO2N– NH4N
Ammonia nitrogen	n_a	μgN/L	NH4N
Nitrate nitrogen	n_n	μgN/L	NO3N+NO2N
Organic phosphorus	p_o	μgP/L	TP - SRP
Inorganic phosphorus	p_i	μgP/L	SRP
Phytoplankton	a_p	μgA/L	CHLA
Detritus	m_o	mgD/L	r_{dc} (TOC – DOC)
Alkalinity	Alk	$mgCaCO_3/L$	ALK
Total inorganic carbon	c_T	mole/L	Calculation from pH and alkalinity
Bottom algae biomass	a_b	gD/m^2	Periphyton biomass dry weight
Bottom algae nitrogen	IN_b	mgN/m^2	Periphyton biomass N
Bottom algae phosphorus	IP_b	mgP/m^2	Periphyton biomass P

* mg/L ≡ g/m^3, D=dry weight, A=chlorophyll a, roc = stoichiometric ratio of oxygen for hypothetical complete carbon oxidation (2.69).

The following are measurements that are needed for comparison with model output:

TEMP = temperature (^oC)
TKN = total kjeldahl nitrogen (μgN/L) or TN = total nitrogen (μgN/L)
NH4N = ammonium nitrogen (μgN/L)
NO2N = nitrite nitrogen (μgN/L)
NO3N = nitrate nitrogen (μgN/L)
CHLA = chlorophyll *a* (μgA/L)
TP = total phosphorus (μgP/L)
SRP = soluble reactive phosphorus (μgP/L)
TSS = total suspended solids (mgD/L)
VSS = volatile suspended solids (mgD/L)
TOC = total organic carbon (mgC/L)
DOC = dissolved organic carbon (mgC/L)
DO = dissolved oxygen (mgO_2/L)
PH = pH
ALK = alkalinity ($mgCaCO_3/L$)
COND = specific conductance (μmhos/cm)

The model state variables can then be related to these measurements as follows:

s = COND

m_i = TSS – VSS or TSS – r_{dc} (TOC – DOC)

o = DO

n_o = TKN – NH4 – r_{na} CHLA or n_o = TN – NO2 – NO3 – NH4 – r_{na} CHLA

n_a = NH4

n_n = NO2 + NO3

p_o = TP – SRP – r_{pa} CHLA

p_i = SRP

a_p = CHLA

m_o = VSS – r_{da} CHLA or r_{dc} (TOC – DOC) – r_{da} CHLA

pH = PH

Alk = ALK

Data Quality (Usability) Assessment

The field lead will verify that all measurement and data quality objectives have been met for each monitoring station. If the objectives have not been met (e.g. percent RSD for sample replicates exceeds the MQO or a Hydrolab was recording bad data), then the field lead and project manager will decide how to qualify the data and how it should be used in the analysis or whether it should be rejected.

Project Organization

The roles and responsibilities of Ecology staff are as follows:

Environmental Assessment Program

- *Jim Carroll, Project Manager, Water Quality Studies Unit*: Responsible for overall project management. Defines project objectives, scope, and study design. Author of the QA Project Plan for DO, pH, and Nutrients. Responsible for development of TMDLs for temperature, bacteria and other conventional parameters, including model development and writing the technical report. Manages the data collection program. Coordinates field surveys with ERO staff. Responsible for data collection and data quality review.

- *Nuri Mathieu, Conventionals Field Investigator, Water Quality Studies Unit*: Manages the data collection program. Coordinates intensive field surveys once a month with ERO staff. Responsible for data collection, entering project data into the EIM system, and data quality review.

- *Brenda Nipp, Conventionals Field Investigator*, *Water Quality Studies Unit, Eastern Regional Office:* Coordinates and conducts field surveys twice a month. Responsible for data collection in the field.

- *Chuck Springer, Hydrogeologist, Stream Hydrology Unit*: Responsible for deploying and maintaining continuous flow gages and staff gages. Responsible for producing records of streamflow data at sites selected for this study.

- *Scott Tarbutton, Field Assistant, Nonpoint Studies Unit*: Assists staff in field preparations, data collection, and sample processing.

- *Karol Erickson, Unit Supervisor, Water Quality Studies Unit*: Reviews and approves the QA Project Plan, TMDL report, and the project budget.

- *Will Kendra, Section Manager, Watershed Ecology Section*: Responsible for approval of the QA Project Plan and final TMDL report.

- *Stuart Magoon, Leon Weiks, and Pam Covey, Ecology Manchester Laboratory Staff*: Provide laboratory staff and resources, sample processing, analytical results, laboratory contract services, and QA/QC data. Review sections of the QA Project Plan relating to laboratory analysis.

- *Bill Kammin, Ecology Quality Assurance Officer*: Reviews the QA Project Plan and all Ecology quality assurance programs. Provides technical assistance on QA/QC issues during the implementation and assessment of the project.

Water Quality Program

- *Elaine Snouwaert, Overall TMDL Coordinator, Water Quality Program, Eastern Regional Office*: Acts as point of contact between Ecology technical study staff and interested parties. Coordinates information exchange, technical advisory group formation, and organizes meetings. Supports, reviews, and comments on QA Project Plan, and technical report. Is responsible for implementation, planning, and preparation of TMDL document for submittal to EPA.

- *Dave Knight, Watershed Unit Supervisor, Eastern Regional Officer*: Responsible for approval of TMDL submittal to EPA.

- *Jim Bellatty, Section Manager, Eastern Regional Officer*: Responsible for approval of TMDL submittal to EPA.

Project Schedule

Table 15. Project schedule for the South Fork Palouse River Total Maximum Daily Load study.

Environmental Information System (EIM) Data Set	
EIM Data Engineer	Nuri Mathieu
EIM User Study ID	JICA0000
EIM Study Name	South Fork Palouse River Dissolved Oxygen and pH TMDL
EIM Completion Due	September 2007
Quarterly Reports	
Report Author Lead	Jim Carroll
Schedule:	
1st Quarter Report	November 2006
2nd Quarter Report	February 2007
3rd Quarter Report	May 2007
4th Quarter Report	August 2007
Final Report	
Report Author Lead	Jim Carroll
Schedule:	
Report Supervisor Draft Due	January 2008
Report Client/Peer Draft Due	February 2008
Report External Draft Due	March 2008
Report Final Due (original)	June 2008

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Appendix A

Response to Comments on the Draft Quality Assurance Project Plan for the South Fork Palouse River Dissolved Oxygen and pH Total Maximum Daily Load Study

The draft report, *Quality Assurance Project Plan for the South Fork Palouse River Dissolved oxygen and pH TMDL Study*, was distributed to the SFPR Technical Advisory Group (TAG) on July 14, 2006, for a two-week comment period. Comments were due by July 28, 2006. Written review comments were received from the cities of Pullman and Albion; Washington State University; Idaho DEQ; and others. Ecology appreciates all comments received. Minor editorial and grammatical comments were incorporated in the final QA Project Plan. The remaining comments were summarized below (as italicized text) with our response or action following each comment. Changes were incorporated into the final QA Project Plan.

1. Several submitted comments noted that the DO/pH QA Project Plan did not address an allocation plan or inquire how the modeling would be used to establish allocations:

From Tom Dupuis, CH2M Hill for City of Pullman:

> *My overall observation is that the DO QAPP generally does a thorough job of defining the kinds of field studies that will be done, and the QA/QC procedures that will be followed for that particular field work. These field studies, as far as they go, are comprehensive and the data they provide should be defensible for the TMDL process.*
>
> *My general comments in the paragraphs below are more reflective of the need to evaluate how the data ultimately will be used in the TMDL allocations. Perhaps the DO QAPP was not intended for this purpose, although the stated objectives and some of the information provided suggest that that is the intent. In addition, it is not possible to fully evaluate if the studies being proposed will provide all of the information actually needed without answers to the questions I raise below.*
>
> *In particular, there is not enough discussion in the DO QAPP to understand at this point how natural conditions will be defined and quantified in the event that human use allowance of 0.2 mg/L DO under natural conditions (per the 2003 standards revision) turns out to be the operative DO standard for this TMDL. This outcome seems quite possible given the information on page 21 of the QAPP regarding previous studies that assessed the attainability of the DO criterion:*
>
> > *"Pelletier (1993) also modeled dissolved oxygen concentrations at critical points below the Moscow, Pullman, and Albion POTWs during critical conditions. Pelletier found that the Class A minimum dissolved oxygen standard of 8 mg/L was not attainable due to low DO solubility in the high-temperature water and therefore there was no capacity for further BOD or nutrient load discharge. Pelletier acknowledged that improvements for water temperatures (e.g., increased shading) would increase minimum DO concentrations but probably not enough to meet the water quality standards, even if all POTW effluent loads were eliminated.*
> >
> > *Using the recommended ammonia limits and year-round BOD_5 limits of 10 mg/L for the POTWs, Pelletier (1993) predicted an attainable minimum instantaneous DO concentration of 4 mg/L during summer critical conditions. Pelletier (1993)*

recommended BOD_5 WLAs of 10 mg/L, acknowledging that the DO water quality standard would not be met and that a special condition for DO may need to be adopted to continue discharging effluent; however, a DO TMDL was not completed."

This previous analysis strongly suggests that a DO criterion of 8.0 mg/L will not be attainable, even under natural conditions; consequently Ecology is most likely to apply the human use allowance of 0.2 mg/L for all sources of nutrients and oxygen-demanding materials and sediments. Because the SFPR is effluent dominated during the critical summer low flow period, the outcome of this exercise will mostly affect the municipal treatment facilities in the basin.

From Kevin Gardes, City of Pullman:

There was reference to work by Pelletier (1993) that "...predicted an attainable minimum instantaneous DO concentration of 4 mg/l during summer critical conditions." As Tom Dupuis goes into in greater detail, how will this type of "natural condition" be determined? And what potential affect will it have on Pullman and Moscow's POTW? If more, or all, of the effluent was removed from the South Fork, how would this affect DO concentrations? My theory is that they will get significantly worse.

Response: The SFPR DO/pH TMDL QA Project Plan restricted the objectives of this year's efforts to:

- **Characterize processes governing dissolved oxygen and pH in Paradise Creek and the South Fork Palouse River including the influence of tributaries, nonpoint sources, point sources, and groundwater.**
- **Develop a model to simulate biochemical oxygen demand (BOD) and productivity in Paradise Creek and the South Fork Palouse River. Using critical conditions in the model, determine the capacity to assimilate BOD and nutrients.**
- **The calibrated model will be used to evaluate future water quality management decisions in the SFPR basin.**

This year, model development will be completed for Paradise Creek and the SFPR only. Ecology understands that there are challenging issues concerning establishing a dissolved oxygen and pH TMDL in both of these waterbodies, particularly because they are effluent –dominated during critical low-flow conditions. For this reason, Ecology is proposing to delay establishing WLAs and LAs for dissolved oxygen and pH until a thorough understanding of the science is completed. After a calibrated model is developed for the SFPR system, the model will be used to evaluate future water quality management decisions in the SFPR basin.

2. Several comments submitted noted that the classification of the SF Palouse River as a Class A waterbody may be inaccurate.

From Kenneth Smith, City of Albion:

After a quick review, the only comment I have at this time is that the South Fork of the Palouse River was originally mis-classified as a Class A stream, (page 9 of the report), I had discussed this with DOE back in 1997 for Albion's new NPDES permit and it was acknowledge that Ecology agreed with me:

> *(from the 1997 NPDES permit response to comments):*
> *"Comment: The town disputes the classification of the South Fork Palouse River as a Class A stream. The characteristic uses of Class A streams have never applied to the stream and never will.*
>
> *Response: Ecology is in agreement with what appears to be a mis-classification of the S. Fork of the Palouse. Unfortunately, this is the way it is classified in the state's surface water standards; WAC 173-201A-130. Changing a stream's classification requires the implementation of what is called a "Use Attainability Study". Ecology has not adopted a methodology for conducting such a study. Ecology is currently developing an alternative way of classifying surface waters which will be based on use. It is uncertain when this will be completed or implemented."*

It appears that Ecology would need to adopt a " Use Attainability Study" as mentioned in the attachment for use in convincing EPA that the SFPR is indeed a Class B Stream and not a Class A (Palouse Falls?).

Anyway, the material included in the report are factual and do represent the classification that we are all stuck with for the moment.

<u>From Tom Dupuis, CH2M Hill for City of Pullman:</u>

The DO QAPP states that the SFPR was designated Class A under the old rule (still in effect because of EPA's disapproval of the 2003 revisions). Actually, the SFPR was not specifically classified in the standards, only the main stem Palouse River was classified, but the standards say that unclassified waters are Class A by default unless they are tributary to Class AA waters. The mainstem Palouse was designated Class B from its mouth to the SFPR (at Colfax) and Class A from the South Fork to the Idaho State line. Under the 2003 standards, the South Fork was again not specifically designated, only the mainstem Palouse was. The previously reviewed Temperature QAPP stated that Class A waters were designated for "char" and "salmon/trout spawning, noncore rearing and migration" in the 2003 revisions. This DO QAPP does not mention the "char" use designation and associated DO criterion of 9.5 mg/L. Review of the 2003 rule shows that the "char" box was not in fact checked off for the Palouse basin (Table 602, WRIA 34). Thus, Ecology needs to clarify in these QAPPs whether the "char" designation would apply to the SFPR.

The DO QAPP identifies EPA's disapproval of the 2003 water quality standards rule, and notes that Ecology is currently working on revising the rule and expects to have an approved rule in place by 2007. Thus, it would seem that this would be an opportune time to consider if the carry-over use designations from the old Class system are appropriate for the SFPR. The Washington Department of Fish and Wildlife management plan for the river is for a mixed fishery (put-and-take rainbow trout, brown trout, brook trout, largemouth bass and smallmouth bass). The river does not contain native char (bull trout would be the char of *concern), nor is it designated as critical habitat for bull trout, nor are there any management goals for bull trout; thus the "native char" use designation described in the Temperature QAPP seems incorrect. In addition, a Class B designation under the old standards (consistent with the main stem Palouse downstream of the SFPR), and "salmon and trout rearing and migration only" under the 2003 designation system, would seem more appropriate for this system. The DO criterion for this use designation is 6.5 mg/L, which not only would be more appropriate but also more attainable.*

Response: Chapter 173-201A of the Washington Administrative Code (WAC) assigned a classification to all waterbodies throughout the state. Some waterbodies were given specific classifications based on known conditions. These conditions included being located in more pristine areas, draining to a lake, and other considerations. According to WAC 173-201A-120, "All other unclassified surface waters within the state are hereby classified Class A." The SF Palouse River falls under this classification. Changing the SF Palouse River's Class A classification is outside the scope of the QAPP and the technical study. However, the data from this study will lead to a better understanding about what is attainable for this system.

The currently disapproved 2003 water quality standards will likely be revised and approved during the SFPR TMDL timeline. In order to expedite the approval of the new standards, new rulemaking leading to the approval of the new standards will only address EPA's challenges to specific designated uses. (Currently, the only use-changes EPA has requested for the Palouse River watershed are below the falls at the mouth of the Palouse River at the Snake River.) Ecology encourages communities to bring forward their concerns about the designated uses of their water during the triennial review process which will review specific designated uses. The triennial review will begin after the approval of the new water quality standards.

The SFPR is not an assigned water to support a native char fishery and that designation was removed from the final Temperature TMDL QA Project Plan.

3. Several comments were submitted inquiring how Ecology planned to establish what the natural conditions were in the SFPR watershed.

From Tom Dupuis, CH2M Hill for City of Pullman:

The way in which natural conditions will be determined, should that become the operative criterion, has also not been defined in the QAPP. Specifically, the method for estimating the natural flow regime has not been defined. The flows will be a very critical component of the natural condition. Given that the Moscow and Pullman WWTFs are the source of virtually all of the flow in the river during non-storm periods, determining what the natural flows would be without the WWTFs during the critical dry periods in summer will be a major challenge. The QAPP does not identify how diversions, if there are any, will be identified and their flows quantified. Although extensive piezometer data (described in the Temperature QAPP) will help characterize existing groundwater flows, the natural groundwater flows also will need to be quantified. The QAPP does not address this issue at all. Is there an existing groundwater model of the area that will be used to estimate groundwater/surface interactions in the absence of groundwater pumping? If not, how will natural baseflows in the river be estimated? Another *important component of natural conditions is the natural stream/river morphology. The QAPP does not discuss if an attempt will be made to evaluate what a more natural condition would be.*

One additional aspect of a natural conditions determination pertains to background concentrations of parameters that affect DO, such as nutrients, organic matter (e.g., BOD, TOC, etc), ammonia and sediment oxygen demand. The DO QAPP does not identify which surface water monitoring location(s) would be used to develop natural background concentrations, or if groundwater monitoring would be used, in which case the well locations and sampling/analytical protocols need to be identified. Also, reaeration is strongly influenced by flow and morphological characteristics of the river, thus reaeration will be different under natural conditions than at current conditions. This will need to be accounted for in the selection of the reaeration approach to modeling.

<u>From Kevin Gardes, City of Pullman</u>:

As with previous TMDL's I was pleased to see some mention of Natural Conditions and human impacts, some of which you state "cannot be remedied". Again I am wondering how such a statement will be implemented in the TMDL study.

There was reference to work by Pelletier (1993) that "...predicted an attainable minimum instantaneous DO concentration of 4 mg/l during summer critical conditions." As Tom Dupuis goes into in greater detail, how will this type of "natural condition" be determined? And what potential affect will it have on Pullman and Moscow's POTW? If more, or all, of the effluent was removed from the South Fork, how would this affect DO concentrations? My theory is that they will get significantly worse.

<u>Also from Kevin Gardes, City of Pullman:</u>

In general I was wondering how background conditions will be determined. You mentioned that the Idaho TMDL on Paradise Creek had a total phosphorus allocation of 0.136 mg/l. Will something similar be considered for this TMDL? If so, how will the data be collected?

<u>Response</u>: In modeling the natural conditions in the SFPR, Ecology cannot completely mimic the conditions prior to white settlement on the SFPR. By all accounts, the SFPR watershed has been so drastically altered by land use in the last century that there is no reference condition to infer the myriad of conditions that the original landscape might have had such as stream flow; groundwater flow (natural base flow) and water quality; channel morphology; tributary flow and water quality; among others. Ecology believes it is important to first evaluate what is currently attainable in the SFPR watershed.

Primarily, the dissolved oxygen and pH TMDL will rely on establishing what water quality conditions are attainable given the current conditions. Once a calibrated model is developed, sensitivity analyses can be conducted to evaluate how changes to boundary conditions will affect water quality conditions (e.g., stream flow and water chemistry can be changed for headwaters, tributaries, groundwater, or dischargers; channel morphology can be changed; as well as riparian and meteorological conditions). This will allow the

opportunity to evaluate different conditions, some of which may be deemed "natural conditions".

All TMDL studies are required to evaluate critical conditions. Critical flow condition for a low-flow TMDL study (i.e., temperature, dissolved oxygen, pH) is defined as the 7Q10 low-flow. Ecology is aware that a large portion of the flow during the low-flow period in the SFPR is contributed by the WWTPs, thus the calculated 7Q10 based on historical flow records is magnified due to these contributions compared to a "natural" flow regime. A number of critical-flow conditions will be evaluated including the affect to water quality if effluent discharge is removed from Paradise Creek and the SFPR. Again, sensitivity analyses of different critical flows (with an emphasis on what is currently attainable) will allow Ecology and stakeholders to evaluate potential management options.

4. Several comments received thought the historical data presented may not accurately depict current conditions.

From Tom Dupuis, CH2M Hill for City of Pullman:

> *Page 20 – Figures 6 and 7 are reflective of water quality conditions and statistical results in the SFPR all the way back to 1973, which is likely not indicative of current conditions, especially given the recent improvements made at the Moscow plant. Figures developed with data more reflective of current conditions should be used in place of, or in addition to, these figures. This will give participants a much better sense of how far from the DO and pH standards the SFPR is today.*

From Kevin Gardes, City of Pullman:

> *A number of times the QAPP mentions the poor water quality of the South Fork system. A more realistic view would be to consider the water quality data since Moscow's WWTP upgrade 4 or 5 years ago. It seems that water quality has improved considerably.*

Response: The figures in the QAPP were reproduced below to include only data since 1994 (i.e., after the Moscow POTW upgrades). Low dissolved oxygen exceedances are still evident in the SF Palouse River seasonally, from June to October, while pH exceedances are muted. Continuous diel dissolved oxygen data was collected with a water quality data-logger in June 2006 and is presented below. Under-saturated and over-saturated dissolved oxygen concentrations exist due to primary productivity. Dissolved oxygen concentrations below the 8 mg/L water quality criterion were exhibited overnight from 9:00 pm to 6:30 am for both days of the logging.

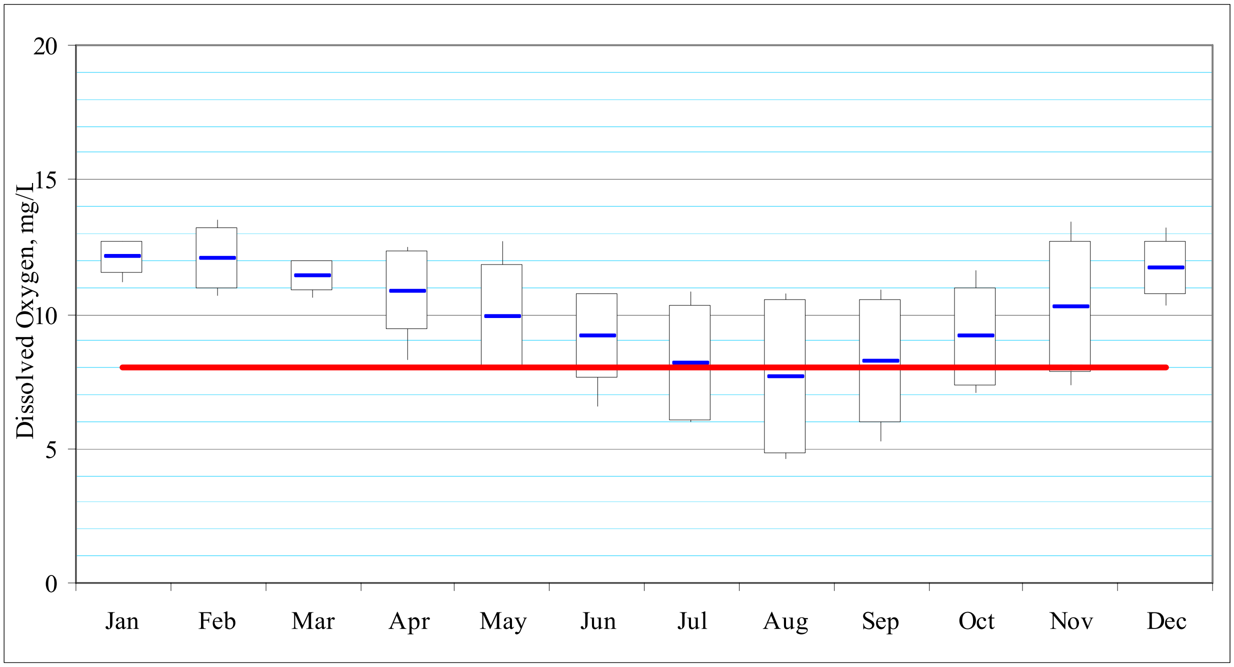

Figure A-1. Distribution of monthly instantaneous dissolved oxygen concentrations measured at the SFPR at Pullman ambient monitoring station (34B110) from 1994 to 2004 (n= 9-12 per month). Box plots represent the 90th percentile, mean, and 10th percentile of the measurements. Whiskers on boxes represent the maximum and minimum measurements. The red line represents the minimum instantaneous dissolved oxygen standard of 8 mg/L.

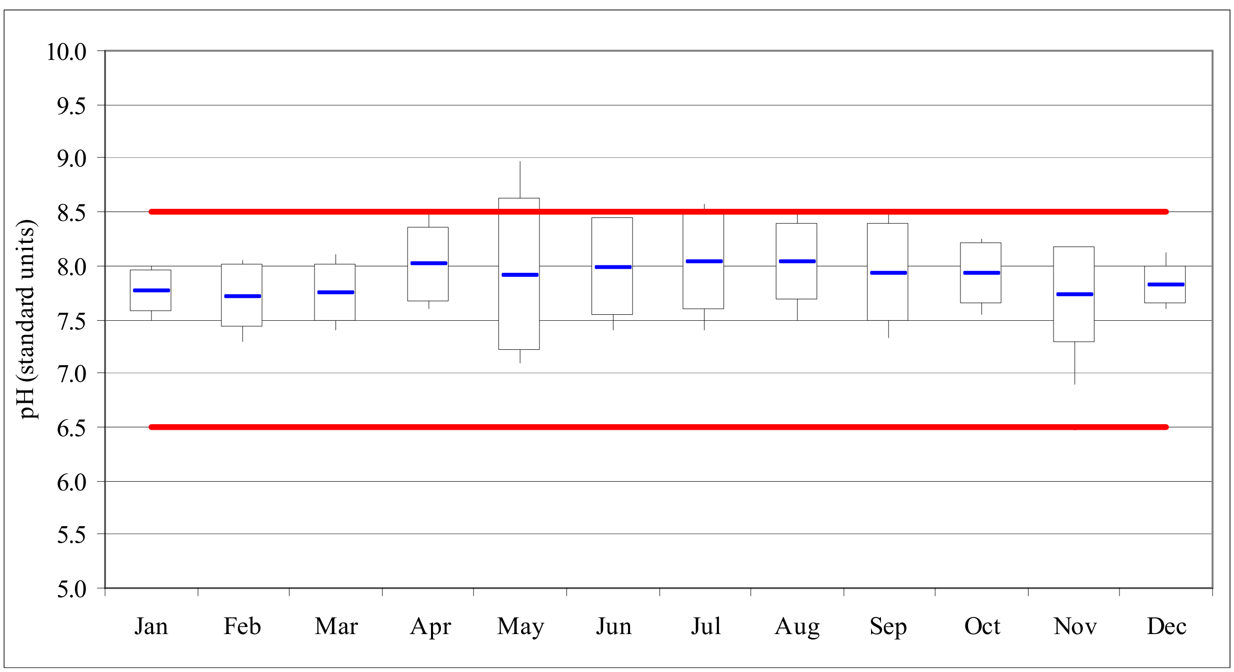

Figure A-2. Distribution of monthly pH levels measured at the SFPR at Pullman ambient monitoring station (34B110) from 1994 to 2004 (n= 9-12 per month). Box plots represent the 90th percentile, mean, and 10th percentile of the measurements. Whiskers on boxes represent the maximum and minimum measurements. Red lines denote the maximum and minimum pH water quality criteria of 8.5 and 6.5 pH.

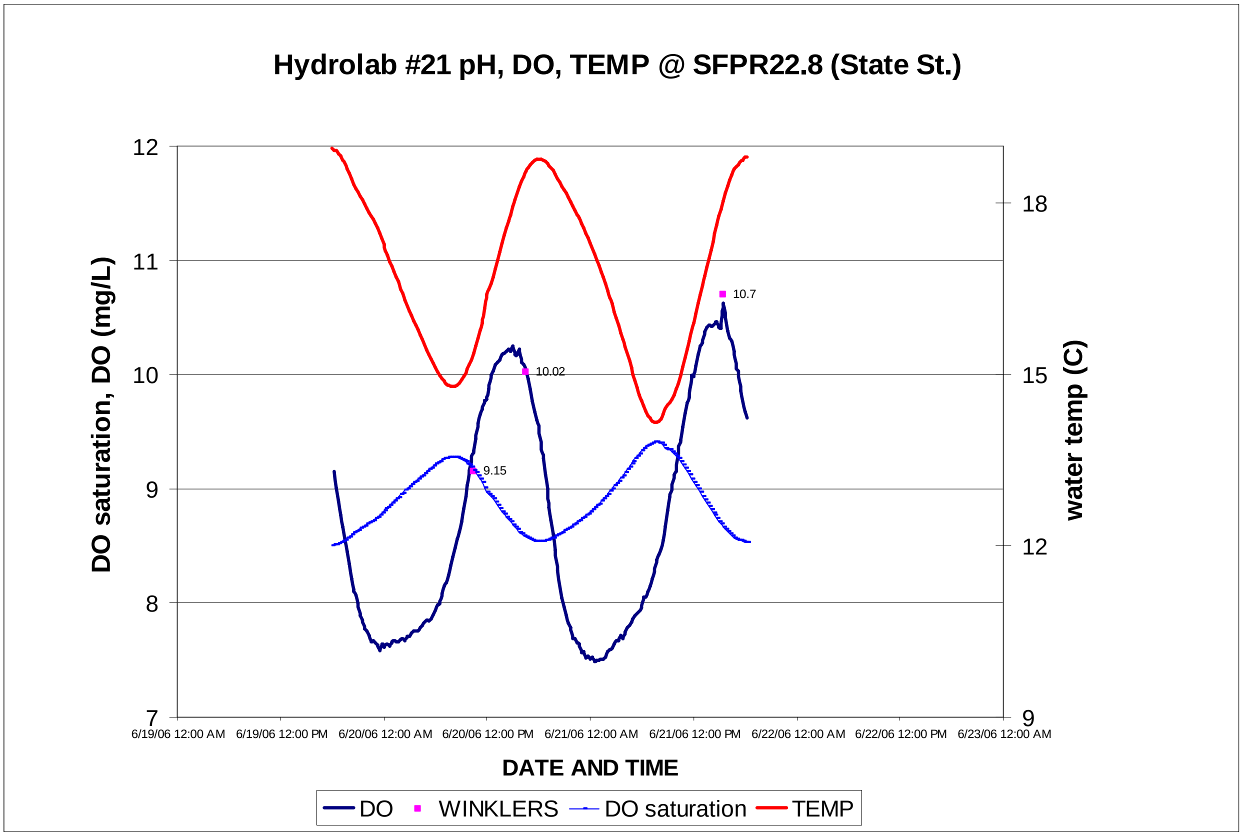

Figure A-3. Time-series plot of dissolved oxygen (mg/L), dissolved oxygen saturation (mg/L), and water temperature (C) in the South Fork Palouse River at State St. in Pullman on June 19-21, 2006.

5. Several comments addressed the on-going Idaho DEQ TMDL on the SF Palouse River:

From Kyle Steel, Idaho Department of Environmental Quality:

> *On page 19 of the DO and pH QAPP, it states that "Idaho DEQ is currently developing a TMDL for total suspended solids, water temperature, total phosphorus, and **fecal coliform** bacteria in the Idaho portion of the SFPR".*
>
> *Please note that IDEQ assesses **E-coli** bacteria data to determine compliance with Idaho water quality standards. That is, waters designated for primary or secondary contact recreation are not to contain E-coli bacteria significant to the public health in concentrations exceeding:*
>
> *A geometric mean of 126 cfu/100 ml based on a minimum of five samples taken every three to five days over a 30-day period. Additionally, we have criterion for a single sample for both uses (406 cfu/100 ml for Primary and 576 for Secondary), but we use the 126 cfu/100 ml criterion to determine compliance; a single sample spike above the criterion triggers additional sampling to determine compliance with the126 criterion. Thanks.*

Response: Page 19 has been updated from fecal coliform to *E-coli.*

From Tom Dupuis, CH2M Hill for City of Pullman:

> *Page 19 – The QAPP notes that Idaho is currently working on TMDLs for the North Fork Palouse River; however, there is no discussion about consistency of sampling, modeling, and data interpretation by the respective states. Is the work being done concurrently with same sampling dates and methods, and will the same modeling approach be used? The work being done by Idaho will be critical to understanding what sources of pollutants are contributing to boundary conditions at the state line, and ultimately how those sources would need to be managed to meet standards in both states.*

Response: Idaho DEQ is currently conducting a TMDL for the South Fork Palouse River. They are conducting a TMDL for temperature, nutrients, sediment, and *E-coli.* bacteria. Washington State is just beginning a TMDL on the SFPR for temperature, dissolved oxygen, pH, and fecal coliform bacteria. Idaho DEQ is conducting a nutrient TMDL to address dissolved oxygen and pH violations, so with the exception of the sediment TMDL in Idaho, the two states are conducting parallel TMDLs. However, the two TMDLs are being conducted on different time frames. Almost all of the field data for the Idaho TMDL was collected from November 2001 to November 2002; however, some *E-coli.* data was collected this year in June and July. Washington State is just beginning data collection this year under the current QA Project Plans. The sampling collection times and methodology, as well as the analysis and modeling are for the most part different for Idaho and Washington. Some of this is due to the two states having different water quality standards. Regardless of the differences in the water quality standards, though, the waters from Idaho must meet the Washington State water quality standards at the state line (or the point of maximum impact downstream, if that is the case) and it will be the responsibility of Idaho to control or manage sources to meet this requirement.

6. Additional comments addressed individually:

From Tom Dupuis, CH2M Hill for City of Pullman:

> *….. the QAPP does not indicate if any of the tributary streams other than Paradise Creek will be directly modeled, or if they will be simple inputs to a mainstem model. If the latter, how will the natural conditions for these tributaries be determined should natural conditions become the operative DO standard?*

And from Marty O'Malley, WSU

> *In considering the project objectives (page 9), developing the model using only information from Paradise Creek and the main stem of the SFPR may be unfairly biasing the model and this may not be truly representative of the basin. I would include Missouri Flat creek, 4 Mile creek and Spring Flat creek in the model development if possible.*

Response: The SF Palouse River will be modeled from the mouth at Colfax to Paradise Creek. Paradise Creek will be modeled from the mouth to the USGS station in Idaho (on the U of I campus above Moscow POTW). The rest of the tributaries to these reaches will be treated as inflows with boundary conditions to the model. Addressing the natural conditions of these tributaries is discussed above.

From Tom Dupuis, CH2M Hill for City of Pullman:

Page 22 – The number and locations for deployment of the DataSondes should be specified in the QAPP. Similarly, the number of sampling locations for periphyton needs to be identified. The DO QAPP notes that only "several" sites will be sampled, which is not sufficient given the importance of periphyton in this system as alluded to a number of times in the QAPP. Table 5 indicates 25 periphyton analyses, but the QAPP does not describe where or when these samples will be collected. If indeed this is a periphyton dominated system, then sufficient samples will need to be collected to determine if periphyton scour is an important process (the proposed QUAL2K model does not simulate periphyton scour, thus have data on the importance of scour will be critical to model selection; for example the Aquatox model does simulate periphyton scour and could be a better choice if this proves to be important). Tables 6 and 7 do not identify methods to be used for periphyton.

Response: The number and locations for diel data collection and periphyton sampling was added to Table 4. The DO and pH TMDL field studies will be conducted during low-flow conditions and the model will simulate low-flow critical conditions. Periphyton scouring should not be present during these low-flow conditions and will not be modeled. References for periphyton field sampling protocols and laboratory analyses were added to the QA Project Plan.

From Tom Dupuis, CH2M Hill for City of Pullman:

Page 22 – The QAPP does not describe how hydraulic parameters (depth and velocity as a function of flow) will be determined for the modeling portion of the TMDL. Although rating curve data will be available for the continuous gage sites, it is not clear how that information will be gathered for the staff gage only sites. Note that HEC-RAS model information is rarely suitable for water quality studies such as these because the low-flow channel is not delineated in flood studies to the level of detail needed for DO modeling.

Response: Due to unsteady diel flow, a routed stream model will likely be developed to develop a water balance (e.g., HEC-RAS, GEMSS). Channel geometry will be developed from existing cross section data, digital terrain model coverage, and stream gage station data (seven continuous recording stream gages are being monitored as part of the Temperature TMDL). In addition, the Temperature TMDL also includes detailed channel surveys (up to 200 cross sections) that will be used. Ortho-rectified aerial photo coverage will provide wetted-width data during a low-flow season. Depth, width, and velocity to flow functions would be developed from a calibrated routed stream model for use in QUAL2K. Daily average flow will be used in QUAL2K.

From Tom Dupuis, CH2M Hill:

Tables 6 and 7 and the text overall do not identify any analyses will be done for BOD (only DOC and TOC). Given that the QUAL2K model is being proposed, the lack of BOD data will be a major data gap. Moreover, the way in which organic matter, including BOD, is represented in the model and sampled in the field is a critical component of the analysis. The QUAL2K manual goes to great lengths to emphasize this and the QAPP must outline which approach will be used in the modeling to ensure that the correct data are collected in the field *study (e.g., see section 5.4.2 in the manual). Similarly, these tables do not identify any analyses will be done for sediment oxygen demand modeling. SOD is a critical modeling parameter, and there are a variety of ways in which it can be modeled; so having the correct field data for SOD is also critical and must be addressed in the QAPP. Will a simple zero-order SOD modeling approach be used, or the more sophisticated diagenesis modeling capability of QUAL2K? Also, the tables and QAPP in general do not identify any direct measurement of reaeration in the field studies. I assume reaeration method used in the modeling will be a part of the calibration process, but this is not identified in the QAPP. Finally, the tables and QAPP in general do not identify any time-of-travel studies will be conducted. These are usually a standard component of DO studies in which modeling will play a central role. This seems to be a major data gap in the proposed field studies.*

<u>Response</u>: Both GEMSS and QUAL2K represent carbonaceous BOD (CBOD) as the oxygen mass equivalency needed to oxidize each gram of dissolved organic carbon (DOC). In the model, 2.69 grams of oxygen is consumed for every gram of DOC oxidized. Oxygen demand from nitrification is represented separately as described in the model kinetic diagram (Figure 10). The best measurement for CBOD for the model is a field measurement of DOC. The DOC will initially be modeled as a single pool (fast CBOD) which is option 1 in the Qual2K manual referred to. Most of the measurements in the SFPR watershed will be DOC; however, there will also be measurements of ultimate CBOD from final effluent at the Pullman and Moscow POTWs. Ultimate CBOD methodology was added to the Table 6 and 7.

Both GEMSS and QUAL2K have an internal sediment diagenesis model which will be applied to SFPR and Paradise Creek. The general framework and rate parameterization for the sediment model is from DiToro (2001)*. The QUAL2K model does not allow rate parameter changes to the sediment model (the sediment model was calibrated to empirical data by DiToro), although prescribed nutrient fluxes and prescribed SOD are permitted. No prescribed conditions (e.g., SOD, nutrient fluxes) will be determined by field measurements for the study. Prescribed conditions (within reasonable ranges) may be applied during the calibration process. Any unaccounted or over-accounted nutrient fluxes or SOD will be part of the residual in the respective nutrient and oxygen mass balances. Residual fluxes and SOD in the mass balances will hopefully be minimized by directly measuring as many of the other sources as possible.**

Published reaeration models are utilized in the GEMSS and QUAL2K models that relate reaeration as a function of flow and channel morphology. Field measurement of reaeration for calibration may be made and was added to the QA Project Plan.

Due to unsteady diel flow, a routed stream model will likely be developed to develop a water balance (e.g., HEC-RAS, GEMSS). Time of travel studies will be conducted. The Temperature TMDL QA Project Plan includes the time of travel study description which will suffice for the DO and pH TMDL.

*****Reference: DiToro, D.M., 2001. Sediment Flux Modeling. John Wiley & Sons, Inc., New York.**

From Kevin Gardes, City of Pullman:

Defining the growing season may be critical for determining potential wastewater treatment plant options depending on the conclusions of the TMDL study. How will this be determined?

Response: The growing season (or a determination of the season of water quality exceedances) is best defined by the long-term monthly ambient data. The one long-term station is on the SFPR in Pullman at State St. Unfortunately, this long-term ambient station does not measure the lowest dissolved oxygen concentrations because it is an instantaneous daytime measurement; and is probably not at the point of compliance (the point of maximum water quality impact) because it is above the Pullman POTW; however, the long-term ambient data suggests that the season of concern for dissolved oxygen is at least from May to November (see Figure A-1 above).

From Kevin Gardes, City of Pullman:

It mentioned that the TMDL study will attempt to sample one storm event with respect to Pullman's Phase II permit. Potentially basing economic and management decisions on one sampling event does not seem appropriate. I would suggest either eliminating this task entirely, or DOE should develop a sufficient sampling program on which to base decisions.

Response: The summer storm event sampling is part of the bacteria TMDL study and will be used in conjunction with other storm sampling events to characterize bacteria loading from stormwater outfalls. Some minimal nutrient and organic carbon measurements may be made to characterize those components of stormwater as well. This was clarified in the QA Project Plan.

From Kevin Gardes, City of Pullman:

It mentions that Pullman's POTW provides "seasonal nitrification". Pullman's POTW provides year-round nitrification. Our NPDES permit has varying discharge limits based on the season, but the plant nitrifies year round.

Response: Change made.

From Kevin Gardes, City of Pullman:

Mention is made of previous data to be used in the model (page 22). Will only data be used that was collected under some kind of QAPP?

Response: The QAPP reference here was generally in regards to the USGS study data, which was collected under a study plan with an appropriate QA/QC plan and analysis. Most of the data was collected as part of the USGS National Water-Quality Assessment Program (NAWQA).

From Ken Clark, Idaho Association of Conservation Districts

Pelletier's (1993) predicted attainable minimum instantaneous DO concentration of 4 mg/L during summer critical conditions seems pretty low; during my monitoring projects on the Idaho side, there were very few instances of the DO in the SFPR or Paradise Creek dropping below 6 mg/L; your own DO data in Figure 6 doesn't show the DO dropping below 6 mg/L).

<u>Response</u>: The data in Figure 6 is from instantaneous daytime DO measurements and would not be expected to reflect the minimum instantaneous DO, however, a minimum DO of less than 5 mg/L in the month of August is shown in Figure 6. Lower DO levels would be expected at night and in the early morning (see Figure A-3).