WASHINGTON STATE DEPARTMENT OF ECOLOGY

Draft

Total Maximum Daily Load To Restore and Maintain Dissolved Oxygen In the Spokane River and Lake Spokane (Long Lake)

Submittal Report

by
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Introduction

Section 303(d) of the federal Clean Water Act mandates that the state of Washington establish Total Maximum Daily Loads (TMDLs) for surface waters that do not meet water quality standards, designed to protect, restore and preserve water quality, after application of technology-based pollution controls. The U.S. Environmental Protection Agency (EPA) has established regulations (40 CFR 130) for setting TMDLs. The Spokane River and the Spokane Valley aquifer are a critical resource to the region and play a major role in the settlement and economic development of the area (Figure 1). The river has had an intricate history of providing the population with a subsistence fishery, hydropower and electivity, irrigation water, recreation, aesthetic enjoyment and serves as the regions major conduit for wastewater disposal from cities and industry. Continued population growth in the area will inevitably demand more of the regions water resources. The river is also an important cultural and natural resource for Native American tribes.

Under the Clean Water Act, every state has its own water quality standards designed to protect, restore, and preserve water quality. The state's water quality standards consist of both (1) designated uses, such as supporting cold-water biota, contact recreation, and providing a drinking water supply, and (2) criteria, usually numeric, required to achieve those uses. When a lake, river or stream fails to meet the water quality standards after application of required technology-based controls, the Clean Water Act requires the state to place the water body on a list of "impaired" water bodies and to prepare an analysis called a Total Maximum Daily Load.

The goal of a TMDL is to ensure that the impaired water will attain water quality standards. A TMDL includes a written, quantitative assessment of water quality problems and of the sources that cause them. The TMDL determines the amount of a given pollutant that can be discharged to the water body and still meet standards; this is called the loading capacity. The TMDL also allocates that load among the various sources, both point and non-point.

The TMDL must also consider seasonal variations and include a margin of safety that takes into account any lack of knowledge about the cause of the water quality problem or its loading capacity. The sum of the individual allocations and the margin of safety must be equal to or less than the loading capacity.

Nutrient enrichment and eutrophication of Lake Spokane has been one of the major water quality concerns for the area over the last 30 years (Cunningham, 1969; Soltero et al., 1973-86; Singelton, 1981; Wagstaff and Soltero, 1982). The discharge of nutrients and organic carbonaceous waste (BOD) both affect dissolved oxygen concentrations. Eutrophication (due to excess nutrients) increases plant growth and decreases dissolved oxygen due to plant respiration and decay of the organic material produced. Direct loading of BOD from point and nonpoint sources also decreases dissolved oxygen through direct decay of the organic waste. The load assessment and modeling work described in a Technical Report by Cusimano (February 2004) uses the new CE-QUAL-2E model to link these impacts on dissolved oxygen and establishes the technical basis for this TMDL. Electronic links to the technical documents are provided on Ecology's Spokane TMDL Web Site at:

> http://www.ecy.wa.gov/programs/wq/tmdl/watershed/spokaneriver/dissolved_oxygen/technical.html.

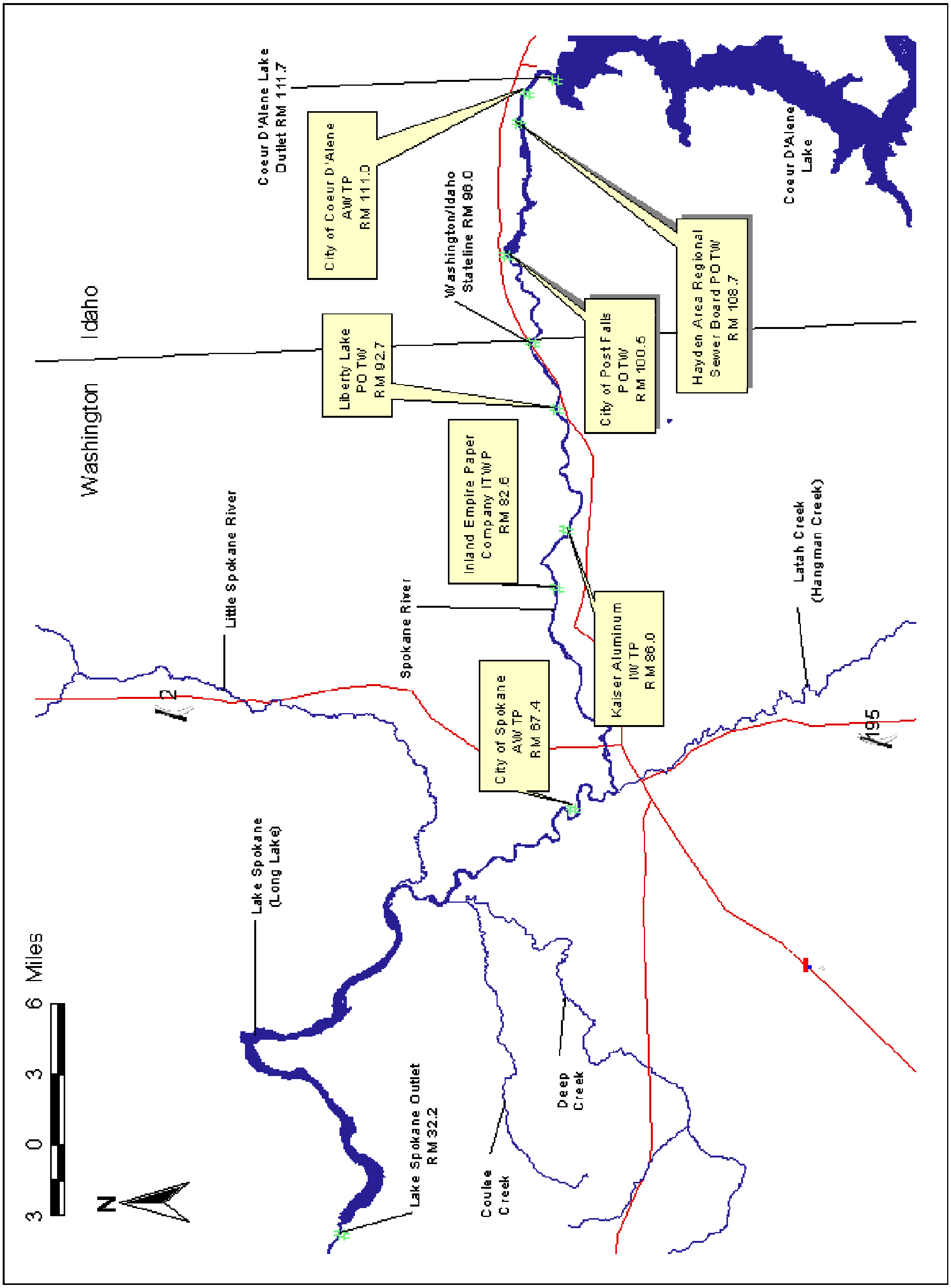


Figure 1. Site Map of Upper Spokane River, Lake Spokane, and Lake Coeur d' Alene with main stem dischargers.

The Spokane TMDL will establish Washington State's plan for future management of organic and nutrient pollutants in the river that affect dissolved oxygen, cause excessive algae blooms and contribute to degradation of downstream water quality on the Spokane Indian Reservation. This TMDL requires much more stringent control of phosphorus loading and will supersede the existing Spokane River Phosphorus TMDL. The existing phosphorus TMDL originally adopted as a Phosphorus Management Plan in 1989 has since been demonstrated as not being adequately protective of water quality. Management of these pollutants according to this TMDL will result in restoration and protection of existing and designated uses stipulated in Washington's water quality standards.

Development of this TMDL began in 1998 with the draft study plan presented to the Spokane River Phosphorus Technical Advisory Committee. An extensive public participation process was employed by Ecology to develop this TMDL. Appendix A lists some of the opportunities provided for input and involvement for interested and affected parties in this watershed to participate in development of this TMDL. In addition to the listing in Appendix A the department has hosted numerous informal meetings and discussion with interested parties to discuss various topics related to this TMDL. Input to the Department from the Spokane River dischargers, environmental groups, Tribal government, local citizens, Idaho Department of Environmental Quality and the Environmental Protection Agency resulted in modification of the original study plan, model design, and this proposed TMDL.

In addition to the mandatory components of a TMDL, the general purposes of this document are to:

- Summarize the results of a technical assessment, which evaluated various loading pollutant scenarios and the resultant impact on dissolved oxygen.
- Summarize actions recommended for meeting water quality standards.
- Summarize monitoring that should be used to track TMDL implementation and determine progress toward attaining water quality standards.

A Detailed Implementation Plan (DIP) will be developed within a year of TMDL approval by EPA, to expand the initial implementation strategy into a working plan. Further public input will be sought to help prepare the DIP, which will identify how, when, and where voluntary restoration activities will be implemented. Details of a monitoring plan to track implementation and measure progress toward improved water quality will be developed. The Washington State Department of Ecology (Ecology) and other entities will provide technical assistance and seek additional funding for these activities.

Components of the TMDL

The five components of a TMDL, as required by the Clean Water Act and applied to this TMDL, are described below:

Total Loading capacity - The total loading capacity is the maximum amount of pollutant that a water body can receive and assimilate without violating water quality standards. The loading capacity is allocated between waste load allocations (WLA) for point sources of pollution, load allocations (LA) for loading from nonpoint pollution sources (NPS) combined with natural background loading, and a margin of safety (MOS). The maximum loading capacity for the upper Spokane River and Lake Spokane was determined by the amount of allowable increase in the nutrient load (phosphorus, carbonaceous biochemical oxygen demand, and ammonia) above the estimated natural conditions without causing a violation of the dissolved oxygen (DO) criteria. The most critical portion of the waterbody was found to be in the deepest segment of Lake Spokane near the dam (segment 188) where the DO criteria stipulated for Washington's Lake Class requires no more than 0.2 mg/L decrease in dissolved oxygen from natural conditions. The CE-Qual-W2 Version 3.1 dynamic model was used as the tool to assess loading capacity under varying conditions and determine the maximum assimilative capacity while meeting the WQ standards.

Total Loading Capacity = LA (natural background loading + nonpoint pollution sources) + WLA (point sources pollution) + MOS

Natural Conditions - Washington water quality standards (WAC 173-201A-020) define "Natural conditions" or "natural background levels" as "*surface water quality that was present before any human-caused pollution. When estimating natural conditions in the headwaters of a disturbed watershed it may be necessary to use the less disturbed conditions of a neighboring or similar watershed as a reference condition*". For this TMDL, "natural conditions" were estimated by making certain assumptions about boundary conditions and man-caused influences on water quality (at the Idaho border and at the mouth of the tributaries). These conditions were then run as the NO SOURCE scenario with the CE-QUAL-W2 model to obtain a reference dissolved oxygen condition for the river and lake (absent pollutant loading from human activities). A more thorough description of these assumption and model output are included in Cusimano (2004). Some of the more important assumptions used in determining the natural condition under the "NO SOURCE" modeling scenario included:

1) Existing dams operating under 2001 hydraulic conditions will not change. After analyzing the period from 1968-2001, Cusimano determined that Spokane River flow in 2001 had a probability of one of the overall driest years to be expected out of ten and therefore used it as the TMDL design year.
2) Estimates of natural background water quality for the tributaries were made using nitrate, phosphorus, and ammonia data collected from the West Branch of the Little Spokane River upstream from Eloika Lake in 1987 (Soltero et al., 1988). Background nutrients for the Spokane River were derived from actual data collected from the outlet of Lake Coeur d' Alene during the Cusimano study and modeled to predict it's change in quality between the lake outlet and the state border using the uncalibrated 2001 Idaho reach CE-Qual-W2 model. Valley Aquifer input to the model used average aquifer water quality as measured during the time of the load assessment study.

The model estimates of natural conditions using the previously described assumptions showed that the river would likely meet the dissolved oxygen criteria (8.0 mg/L) from the state border to Lake Spokane except during hottest part of the year in the water-losing reach upstream of Sullivan Road (RM 88). This river reach has flows dropping below 100 cfs during a dry year in a relatively shallow streambed resulting in the saturation point of oxygen in water to fall near criteria. Natural Conditions estimated for Lake Spokane show that algal productivity would be relatively low and a water column dissolved oxygen profile in the lower stratified end of the reservoir would be characteristic of a meso-oligotrophic (moderately low productivity) lake. In Lake Spokane, and similar to Lake Coeur d' Alene, it's source water, the lake's lowest cold water stratum (hypolimnion) would normally be expected to decline somewhat below 8.0 mg/L depending on the duration of summer stratification and the strength of natural sediment oxygen demand.

Load allocations (LA) – Load allocations are assigned to the Spokane River where it enters Washington from Idaho (boundary condition) and also to the mouths of the tributaries; Hangman Creek (Latah Creek), Coulee Creek, and Little Spokane River. These load allocations are comprised of loading associated with natural conditions plus the nonpoint pollution sources. Load allocations for this TMDL are based on the estimated natural background load and the allowable increase in nonpoint pollution that would not cause an oxygen depletion to exceed 0.2 mg/L from the natural condition. TMDLs for Little Spokane and Hangman (Latah) Creek are under development, which may better differentiate the amount of nutrient loading in these tributaries that is naturally occurring from that which is man-caused. Other sources of direct nonpoint pollutant loading were determined to be insignificant to the dissolved oxygen depletion because of the relatively porous geology of the Spokane Valley allows infiltration and the abnormally dry hydraulic design year meant that there was very little precipitation generated runoff.

Wasteload allocations (WLA) – The wasteload allocation is the amount of receiving water's loading capacity that may be allocated to point sources of pollution. Modeling results indicate that oxygen depletion caused by less than a third of the existing nonpoint pollutant load is enough to cause a 0.2 mg/L decline in DO. As a result, there is no capacity available for point source waste loads that would further contribute to increases in nutrient concentrations during the critical period (April 1 through October 31). A point source discharge would be allowable if the discharge did not contribute to an increase in the river concentration of nutrients under the total loading scenario needed to meet the DO criteria (see below). This might be accomplished by meeting the in-stream target concentrations at end-of pipe during the critical season. Otherwise, other seasonal alternatives to river discharge will be needed.

Margin of safety - Federal regulations require that a TMDL include a margin of safety to account for any lack of knowledge concerning the relationship between loads and water quality. However, because the TMDL requires that point sources not contribute to any change in target instream concentrations, a safety factor subtracted from WLAs of essentially zero appear unnecessary. There is a very small safety factor associated with the proposed tributary LAs since actual DO declines used to establish the LAs were rounded from values ranging between 0.1995 mg/L in the most stringent example to 0.18 mg/L under slightly less critical conditions. This essentially equates in a 0.3% to 10% margin of safety.

Seasonal variation - Seasonal variation, or the changes in loading rates due to changing conditions associated with the annual change in seasons, has been accounted for by sampling seasonal events and using the dynamic model, CE-Qual-W2 Version 3.1 to determine the most critical dissolved oxygen conditions and pollutant loading. Dissolved oxygen in lakes and rivers is typically at greatest concern in the summer when stream flows are lowest, the water is the warmest, gas-holding capacity is reduced, growing conditions for algae are optimal, and thermal stratification of lakes becomes well established. Because the CE-Qual-W2 model can continually simulate the changing hydraulic, climatic, biological and chemical conditions in the river and lake, it is a good tool for evaluating seasonality of dissolved oxygen. Using the model it was determined that water quality plays a role in lake dissolved oxygen beginning at onset of thermal stratification (near April 1st) and ending with the end of the growing season near the end of October.

Background Information

The upper Spokane River, upstream of Long Lake Dam (Lake Spokane Dam) drains over 6,000 square miles of land in Washington and Idaho. Most of the people in the watershed live in the Spokane metropolitan area. However, the incorporated area of Liberty Lake east of Spokane and the cities of Coeur d'Alene and Post Falls in Idaho are rapidly growing in population.

The Spokane River flows west from Lake Coeur d'Alene in Idaho, across the state line to the city of Spokane. From Spokane, the river flows northwesterly to its confluence with the Columbia River at Lake Roosevelt. The focus of the TMDL extends from the Stateline Bridge at approximately river mile[1] (RM) 96.0 to Lake Spokane Dam at RM 33.9.

There are five hydroelectric dams downstream from the outlet of Lake Coeur d' Alene including Post Falls, Idaho (RM 100.8) that regulates the water levels of Lake Coeur d' Alene and significantly influences the hydrodynamics of the river downstream, Upriver Dam (RM 79.9), Monroe Street Dam (RM 73.4), Nine-Mile Dam (RM 57.6), and Lake Spokane Dam (RM 33.9). The Washington dams are run-of-the river types except Lake Spokane Dam (Long Lake dam), which creates Lake Spokane (Long Lake), a 24-mile long reservoir.

There are a seven wastewater discharges to the main stem of the Spokane River between Lake Spokane and Lake Coeur d' Alene discharging a summer average of approximately 75 million gallons per day (116 cfs). In Washington, beginning at Spokane and moving upstream they include the Spokane WWTP, Inland Empire Paper, Kaiser Aluminum, and Liberty Lake Sewer District. Discharges in Idaho include Post Falls, Hayden Sewer District, and the city of Coeur d' Alene.

Water Quality Criteria

The Spokane River water quality classifications and dissolved oxygen criteria are:

Portion Of Study Area	Classification	Dissolved Oxygen Criterion
Lake Spokane or Lake Spokane (from Lake Spokane Dam to Nine Mile Bridge)	Lake Class	No measurable decrease from natural conditions.
Spokane River (from Nine Mile Bridge to the Idaho border)	Class A	Dissolved oxygen shall exceed 8.0 mg/L. If "natural conditions" are less than the criteria, the natural conditions shall constitute the water quality criteria.

In addition, the Spokane River has the following specific water quality criteria (Ch. 173-201A-130 WAC):

Spokane River from Lake Spokane Dam (RM 33.9) to Nine Mile Bridge (RM 58.0).
Special conditions:

(a) The average euphotic zone concentration of total phosphorus (as P) shall not exceed 25 ug/L during the period of June 1 to October 31.

Ecology has recently revised the surface water quality standards (effective August 1, 2003). The class-based system of organizing the standards was changed to a use-base system. However, the changes are not effective for federal Clean Water Act programs (i.e., the TMDL program) until they are approved by the U.S. Environmental Protection Agency (EPA). It is not anticipated that the new aquatic life dissolved oxygen criteria will change the discussion presented in this document. However, the TMDL may be revised if site-specific criteria are developed or uses changed under a use attainability analysis (UAA). Such changes to water quality standards are subject to formal rulemaking procedures established in the Washington's Administrative Procedures Act and in federal regulations.

Water Quality Resource Impairment

The Spokane River and Lake Spokane (Long Lake) has had a long history of water quality problems associated with the discharge of municipal and industrial wastes. Toxic algae blooms occurring in Lake Spokane in the 1970's resulted in a court-ordered establishment of a phosphorus TMDL. The existing phosphorus TMDL focused on preventing excessive blue-green algae blooms by requiring Spokane and others to implement 85 percent phosphorus removal. Subsequent years of excessive algae blooms in the Lake (Figure 2) and depressed oxygen levels measured in the lake and river with more severe conditions predicted by modeling has demonstrated the existing phosphorus TMDL does not adequately protect water quality (Figure 3). Reoccurring violations of water quality standards resulted in some waterbody segments of the Spokane River being included on Ecology's 1998 and proposed 2002/04 303(d) list of impaired waterbodies.

Waterbody Name	Parameter	Old WBID	New WBID	96 List	98 List	2002/04
Lake Spokane (Long Lake)	Dissolved Oxygen	WA-54-1010	QZ45Ue			X
Spokane River	Total Phosphorus	WA-54-1020	QZ45UE	X	X	X
Spokane River	Dissolved Oxygen	WA-54-1010	QZ45UE	X		X
Spokane River	Dissolved Oxygen	WA-57-1010	QZ45UE	X	X	X

The Spokane River downstream of Long Lake Dam also violates state and tribal water quality standards with DO recently reported below 3.0 mg/L near the mouth of the Spokane River attributed to decomposition of summer algal biomass (Lee et al., 2003). Recent continuous monitoring of the river below Long Lake Dam by the Spokane Tribe shows depressed oxygen levels with recurring minimums below 4.0 mg/L (Butler, 2004)

Recent combined point source pollutant loads of carbonaceous organic waste (BOD5) discharged to the Spokane River is about half of what is currently allowable under existing NPDES permits. Phosphorus loading from point sources in recent years has been only about two-thirds of what is currently allowed by NPDES permits based on the existing phosphorus TMDL and Spokane River Phosphorus Management Plan.

Along with the existing problems, several requests for approvals of facility plans to expand wastewater discharge to the river has required Ecology to investigate the causes of water quality violations and establish a TMDL that is protective of all designated beneficial uses. A TMDL for the river and lake was identified as a high priority during the 1998 water quality scoping process for the Spokane Water Quality Management Area (Knight, 1998). Subsequent modeling of the river/reservoir system has confirmed that dissolved oxygen is significantly depleted

Figure 2. Blue-green algae blooms on Lake Spokane in Fall 2001

by anthropogenic (human-caused) pollution sources under existing conditions and that approved/permitted loads would cause dissolved oxygen to approach zero throughout colder water portions of the stratified Lake Spokane (Figure 3). Evaluation of the existing phosphorus TMDL has also shown that it is not effective at adequately protecting beneficial uses in Lake Spokane (Cusimano, 2004).

The Eastern Regional Office requested that the Environmental Assessment Program assess the dissolved oxygen and nutrient loading to Lake Spokane, and if needed, update the phosphorus (P)-attenuation model developed for the river in the mid 1980s (Patmont et al., 1985).

Nutrient enrichment and eutrophication of Lake Spokane has been one of the major water quality concerns for the area. The two project requests were linked because nutrient loading and organic waste (BOD) both affect dissolved oxygen concentrations. Eutrophication (due to excess nutrients) increases plant growth and decreases dissolved oxygen due to plant respiration and decay of the organic material produced. Direct loading of BOD from point and nonpoint sources also decreases dissolved oxygen concentrations. Both of these water quality issues can be exacerbated during periods of low river flow and warm temperatures, especially in the deep, slow-moving water segments of the river system like Lake Spokane. The results of this study and modeling resulted in the proposed allocations for both BOD and nutrients to mitigate the impact of these pollutants on dissolved oxygen.

Seasonal Variation

Dissolved oxygen (DO) and excess productivity are seasonal issues in the Upper Spokane River and Lake Spokane. Dissolved Oxygen declines occur during critical summer conditions when water warms, physical reaeration declines with low stream flows, and growing conditions for primary productivity (plants and algae) are favorable. This seasonality is exhibited in graphical representation of data collected from the Spokane River at the state line and DO in Lake Spokane (Figures 4 and 5). The CE-Qual-W2 model is a dynamic model used to assess seasonal changes in pollutant loading, and many more variables, as it continually predicts changes in various parameters of concern at any given time or place for the modeled period.

The critical season for controlling dissolved oxygen in the reservoir is dependant on timing of lake stratification. Hypolimnion (bottom stratum) becomes isolated from the rest of the reservoir beginning in the spring and lasting for up to 150 days (i.e.: there is no mixing between this bottom layer and upper layers of the lake). This means that the organic loading present in the water at the time of stratification combined with sediment oxygen demand and settling organic detritus cause significant declines in the hypolimnetic DO until it displaced during fall flushing. Algae blooms in the upper reservoir and depressed dissolved oxygen in the metalimnion (middle interflow stratum) of the lower reservoir are directly impacted by pollutant loading that occurs during the growing season typically June-October. The impact of nutrient loading is more pronounced during low flow years because it allows the nutrients to become more concentrated and the travel time through the shallower upstream end of the reservoir is longer, allowing more time to grow algal.

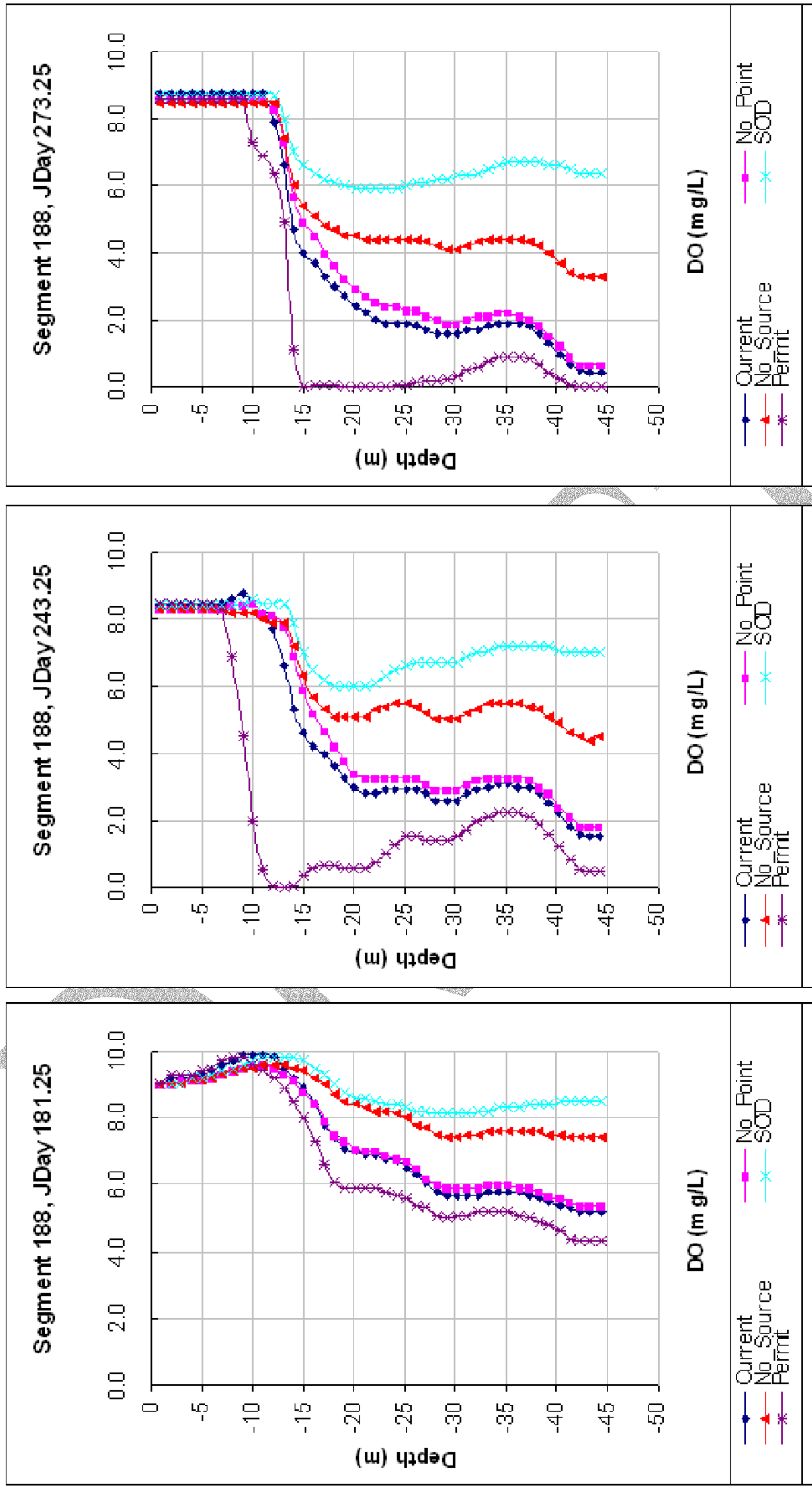


Figure 3. Model predicted dissolved oxygen profiles for Lake Spokane at model segments 188 for the CURRENT, NO-POINT, NO-SOURCE, PERMIT, and SOD scenarios on Julian days 181.25 (Jun 15), 243.25 (Sep 1), 273.25 (Oct 1)

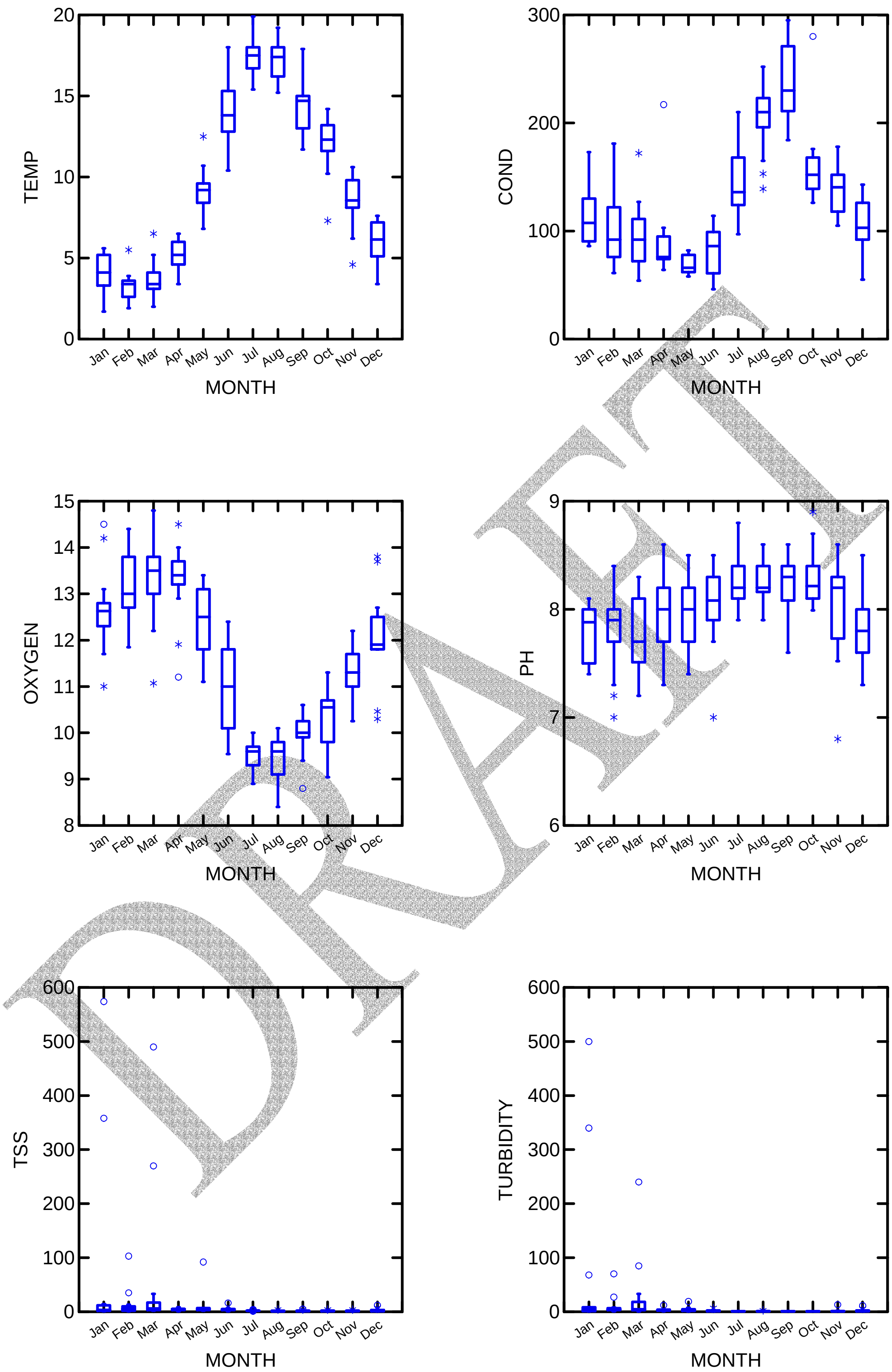


Figure 4. Seasonal trends in Spokane River ambient data at Idaho state line (Cusimano, 2004)

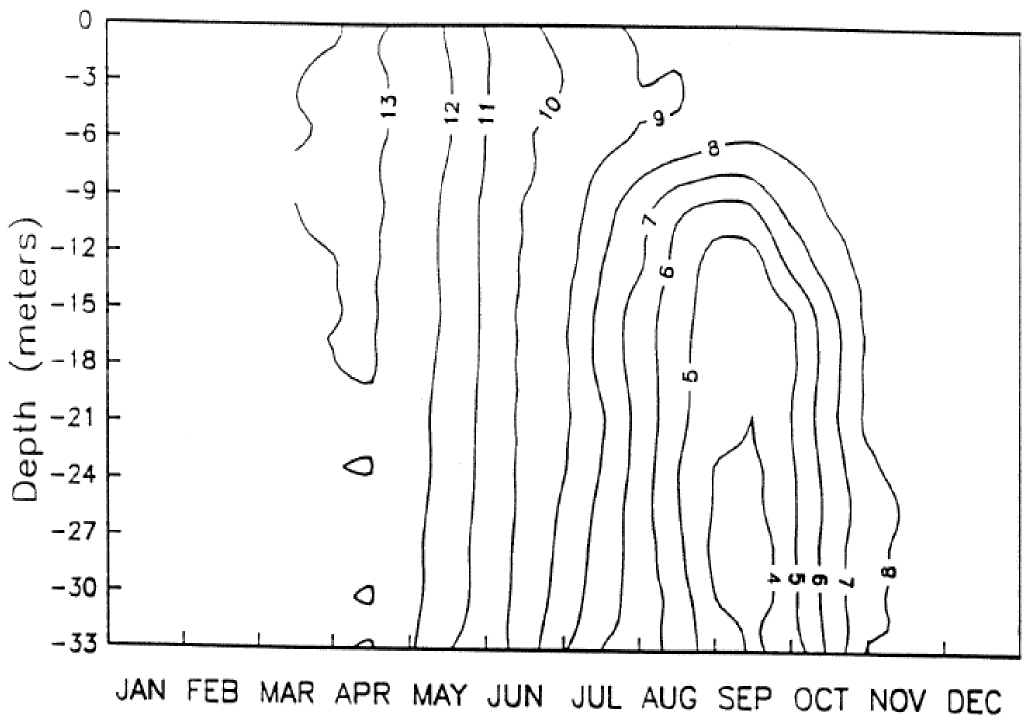


Figure 5. Seasonal trends in dissolved oxygen near Long Lake Dam (model segment 188) during 1991 to 33 meters of the 46 meter water depth (Soltero, 1993)

Technical Analysis

Ecology developed a Quality Assurance Project Plan (Cusimano, 1999) to conduct sampling and modeling of the river/lake system. After doing preliminary modeling and fieldwork, Ecology chose to use the capabilities of the CE-QUAL-W2 Version 2 model developed by the U.S. Army Corps of Engineers. The CE-QUAL-W2 Version 2 model was preferred due to its application in other reservoirs and the available support. During 2000, the model was upgraded to Version 3.0 (now 3.1). The newer version includes modifications that enable simulations of river systems and a number of hydraulic structures (e.g., weirs, spillways, tainter gates, and pipes). In the fall of 2000, Ecology contracted with the U.S. Army Corps of Engineers (through a joint cost share grant) to have Tom Cole, Corps scientist and primary developer of the model, apply the model to the Spokane River and Lake Spokane. The Corps collaborated with Scott Wells, Professor of Engineering at Portland State University to apply the model to 1991 and 2000 conditions. Subsequent to the 1991 and 2000 model calibration, the NPDES permittees collected additional ambient and effluent data during 2001 and contracted directly with Scott Wells to apply the model to 2001 conditions. Subsequent evaluations determined that the 2001 was more characteristic of a 1-in-10 drier year that should be used as the critical TMDL design year and that it should be used it as the final model calibration year.

The CE-Qual-W2 model was created to simulate Lake Spokane and the Upper Spokane River as a tool for assessing different pollutant loading scenarios in development of this TMDL. The model is considered state-of-the-science at this time.

The Cusimano load assessment report analyzed five basic loading scenarios (Figure 3).

1. **CURRENT**: A base case defined as 2001 conditions for the study area from the state line through Lake Spokane. Since this was the calibration year and TMDL critical design year. The model predictions versus actual data are very similar. Dissolved oxygen profiles exhibit marked decline in interflow zone and then a continued decline with each scenario where organic loading from upstream is available.

2. **NO-POINT**: The CURRENT case without point source loads. The associated point source flow was kept in the model, but the loads were reduced to reflect groundwater constituent concentrations. The state line boundary conditions were set at those found in 2001, which were affected by Idaho point source dischargers, i.e., the effects of the Idaho point sources were not removed for the NO-POINT scenario. (See Spokane River Model: Boundary Conditions and Model Setup 2001, Annear et al., 2001.)

3. **NO-SOURCE**: The NO-POINT case with tributary and upstream river boundary concentrations set at estimated natural conditions. Tributaries and upstream river nutrient (nitrate, phosphorus, ammonia) concentrations were set to natural conditions based on data collected by Soltero et al. (1988) at the inlet to Eloika Lake in the Little Spokane and/or data from the outlet of Lake Coeur D'Alene collected as part of this study. The average Lake Coeur D'Alene ultimate CBOD as measured by the dischargers in 2001 of 1.4 mg/L was used to set the maximum CBOD at Latah Creek (Hangman Cr.) and the Little Spokane River. All other constituents were the same as 2001 conditions. The non-calibrated 2001 CE-QUAL-W2 model of the Idaho portion of the river from the outlet of Lake Coeur D'Alene to the state line was used to estimate upstream boundary conditions for the NO-SOURCE scenario (i.e., Idaho point and nonpoint sources were removed). Coulee Creek water quality

constituents were the same as those used for Latah Creek.

4. **SOD**: The NO-SOURCE case with the maximum sediment oxygen demand set 0.25 g O_2 m^{-2} per day, which is a value that has been historically used to define an oligotrophic system (Welch, 1980).

5. **PERMIT**: The CURRENT case with point source daily concentrations increased to provide a monthly average value equal to the monthly average BOD5 permit limits (e.g., The city of Spokane AWTP 2001 monthly average BOD5 calculated from the daily record provided by the city was 5.6 mg/L, and the monthly average permit limit for BOD5 was 30 mg/L. Each 2001 daily model input file value was increased from the reported value plus the difference between the monthly average permit value and the actual monthly average value). Concentrations of soluble reactive phosphorus, ammonia, and nitrate were set at estimated upper 10^{th} percentile effluent values based on the 2001 measured values (i.e., adding the difference between the monthly average and estimated upper 10^{th} percentile value to the data record listed in the model input files). Kaiser Aluminum does not have a BOD5 permit limit, and daily values were set at estimated upper 10^{th} percentile effluent concentrations for BOD5, soluble reactive phosphorus, ammonia, and nitrate.

   In addition, the phosphorus loading for the PERMIT scenario was limited such that the total loading would not exceed the target total phosphorus concentration for Lake Spokane used to establish the original TMDL (i.e., an average euphotic zone total phosphorus concentration of 25 ug/L). The target phosphorus concentration was estimated by a series of trial-and-error model runs based on adjusting the phosphorus stoichiometry associated with the point sources CBOD values and averaging the total predicted phosphorus concentration in the upper 10 meters of the lake for the June-October period. The upper 10 meters of the lake was assumed to approximate the maximum euphotic zone.

Subsequent modeled scenarios were also tested after the Cusimano Report was completed to evaluate effects of different treatment scenarios along with changing trends affected by a higher minimum river flow as follows:

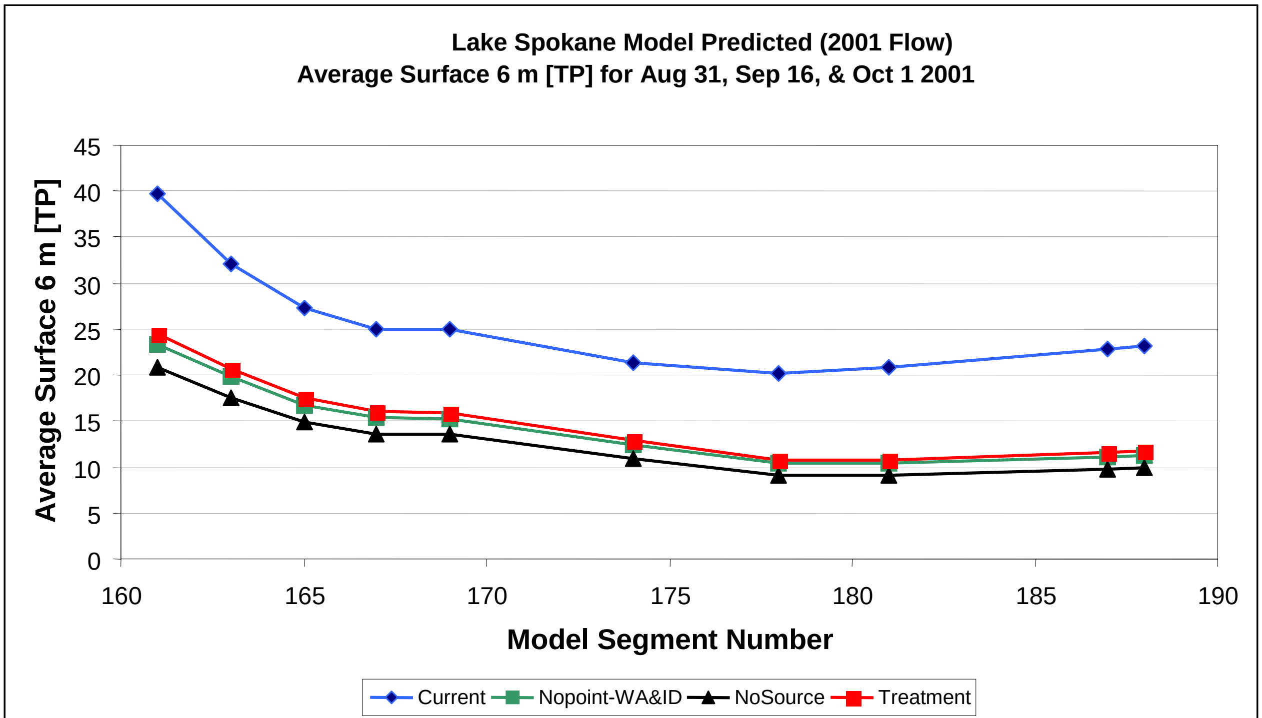
1. **NO-POINT WA&ID** – A scenario where Idaho point sources were also removed along with the WA NO-POINT case. The uncalibrated model for the Idaho reach in conjunction with the Ecology model was used to estimate changes in downstream river quality with loading from all of the WA and ID point sources pollution removed, but no changes to flow. This was performed to try to quantify the effects of the ID dischargers from the WA dischargers.
2. **Treatment** – Used the Current 2001 case except effluent quality was improved for all dischargers so that total phosphorus concentration was 0.020 mg/L TP, 0.1 mg /L NH3 and 2 mg/L CBOD. This was a test that showed that effluents of high quality would still cause more than a 0.2 mg/L decrease in DO from the NO POINT WA&ID scenario with out any change in nonpoint sources.

Flow Augmentation – Based on recommendations made by the 2514 watershed planning group and the FERC Relicensing Fisheries Work Group, the previously analyzed 2001 nutrient loading scenarios were modeled with additional flow added to the 2001 hydraulic conditions below Post Falls Dam. Minimum flow was altered so that it never dropped below 745 cfs at Post Falls gage and then forced to remain there through September (Figures 6, 7, and 8).

a. Current (2001 loads for point sources and Tributaries)
b. No-Point – WA&ID (all point sources removed)
c. No Source – Estimate of natural water quality conditions

d. Treatment – Same as Current except effluent quality was set for all point sources at 0.020 mg/L TP, 2 mg/L CBOD, and 0.1 mg/L NH3

Figure 6. Comparison of model predictions for Lake Spokane total phosphorus over reservoir length during 2001 flows and augmented minimum flows (745 cfs @ Post Falls). (Current = 2001 existing conditions, Nopoint WA&ID =. All point source pollutants removed, NoSource = Natural Background, Treatment = highest level of effluent treatment – 20 ug/L TP).



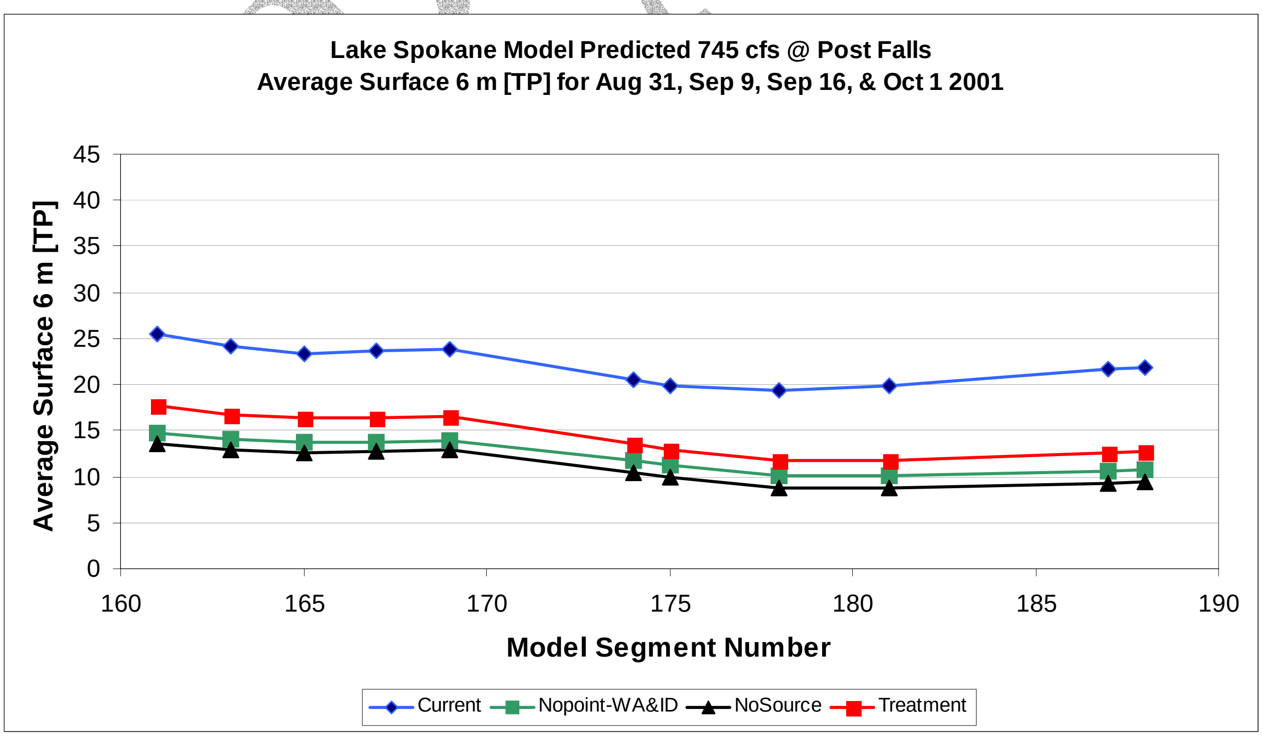
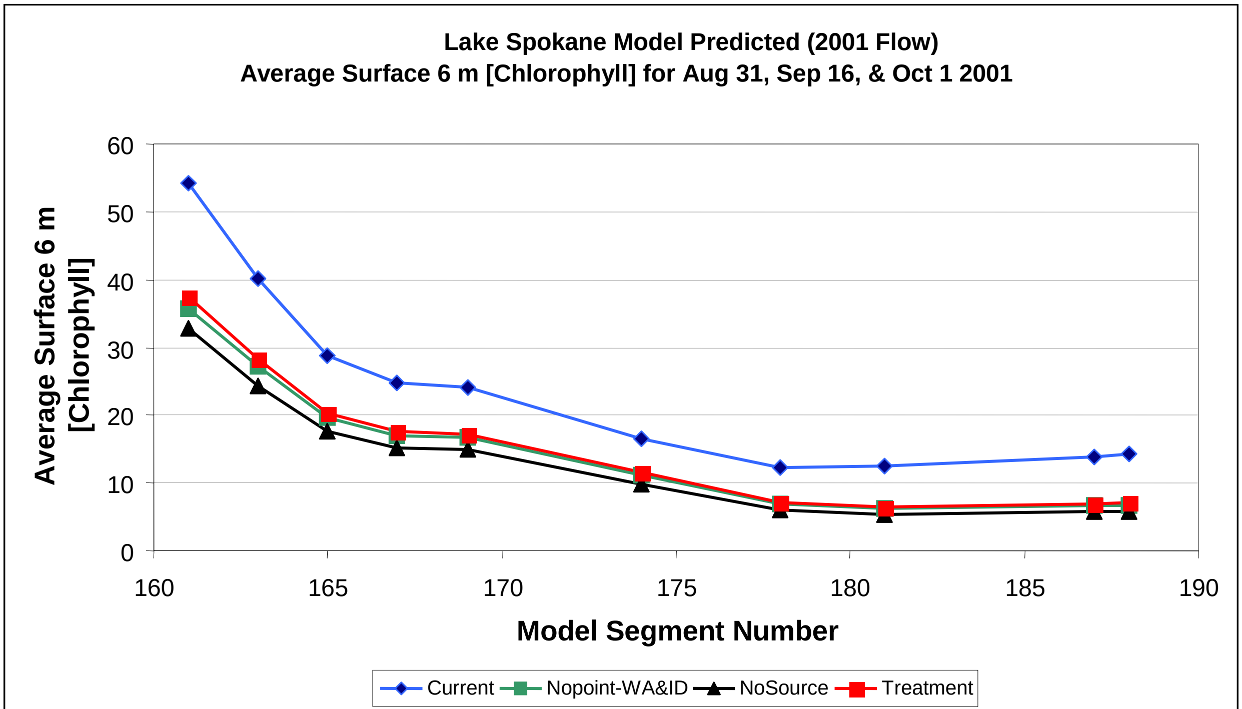


Figure 7. Comparison of model predictions for Lake Spokane algal productivity over reservoir length during 2001 flows and augmented minimum flows (745 cfs @ Post Falls).
(Current = 2001 conditions, Nopoint WA&ID =. All point source pollutants removed, NoSource = Natural Background, Treatment = highest level of effluent treatment – 20 ug/L TP).



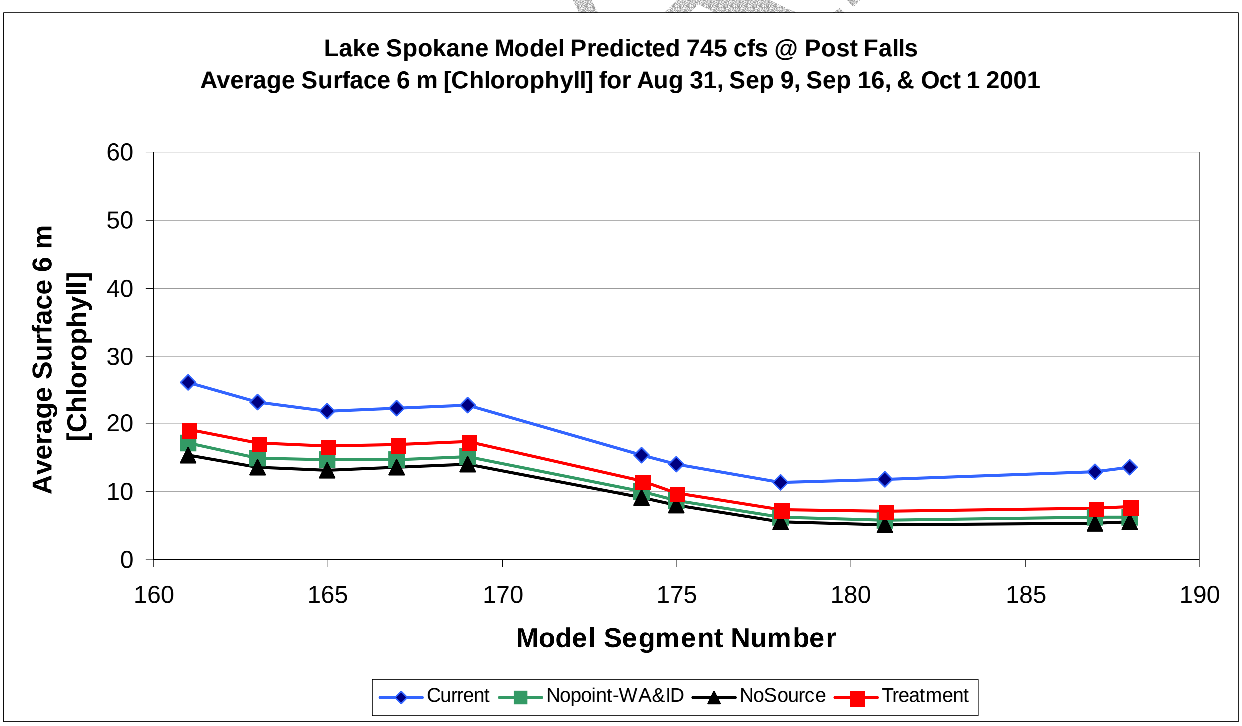
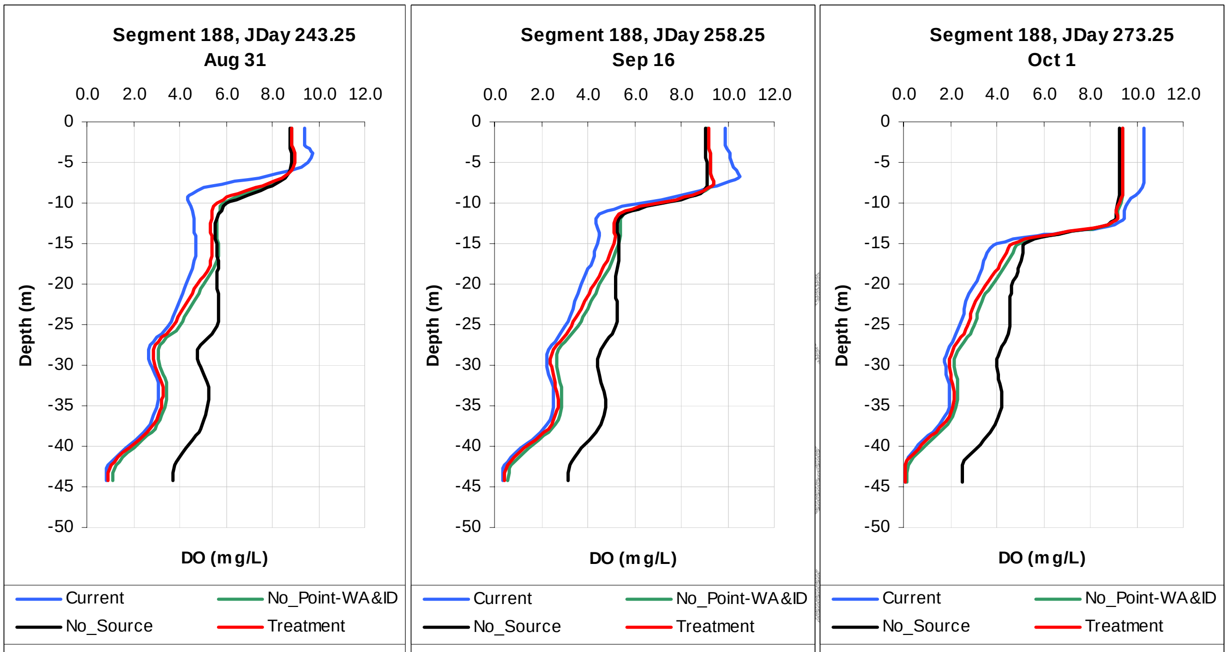
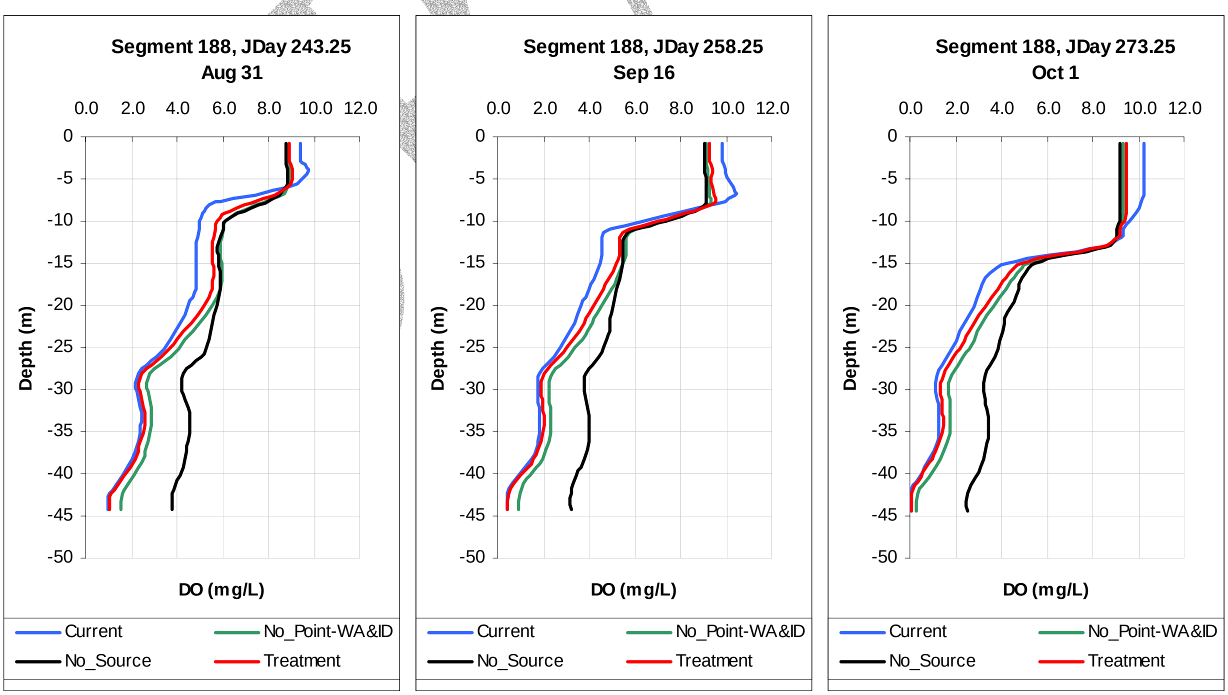


Figure 8. Comparison of model predictions for Lake Spokane dissolved oxygen (DO) near Dam (segment 188) during 2001 flows and augmented minimum flows (745 cfs @ Post Falls).
(Current = 2001 conditions, Nopoint WA&ID =. All point source pollutants removed, NoSource = Natural Background, Treatment = highest level of effluent treatment – 20 ug/L TP).

2001 Flows



Augmented Minimum Flow (745 cfs @ Post Falls)



Supporting Documents

This TMDL relies primarily on the work described in the report entitled, Spokane River and Lake Spokane (Long Lake) Pollutant loading Assessment for Protecting Dissolved Oxygen (Cusimano, 2004). This technical report contains an extensive listing of references, reviews and evaluations that were used to support development of the study and model. These are part of the administrative record for this TMDL. Several documents were also generated in the process of developing and calibrating the model and gathering data. The major supporting documents and their role in the TMDL/model development were as follows: :

1. Annear et al. (2001) and Slominski et al. (2003) provide data used to develop the CE-QUAL-W2 model, background information on the CE-QUAL-W2 model, and model boundary conditions and model setup for simulating the Spokane River system in Washington.
2. Berger et al. (2002 and 2003) discusses the model calibration results.
3. Cusimano (2003) provides information on data sampling stations and locations, methods, data quality objectives and analytical procedures, sample collection and field measurement methods, sampling and quality control procedures, and data quality results for data collected by Ecology
4. Wells et al. (2003) discusses the non-calibrated model set-up for simulating the Idaho portion of the Spokane River.
5. Berger et al. (2004) discusses changes made to the Spokane River model calibration since the original calibration of the model discussed in the model development reports. The results presented in the final load assessment report were based on the final calibrated model completed January 22, 2004.

These reports are available on Ecology's Spokane River TMDL web site at:

http://www.ecy.wa.gov/programs/wq/tmdl/watershed/spokaneriver/dissolved_oxygen/technical.html

Conclusions of Technical Report and TMDL

A summary of the important conclusions identified in the TMDL and supporting technical report are presented below. More in depth discussion can be found in the load assessment report (Cusimano, 2004).

- DO criteria in Lake Spokane and portions of the Spokane River are not met during the critical conditions.
- Lake Spokane suffers from algae blooms during the critical periods of warm weather and low flow. Along with contributing to oxygen demand, algae blooms also adversely affect aesthetics, boating, and other recreational uses of the Lake.
- Low DO conditions in the Lake contribute to violations of the Spokane Indian Tribe's water quality standards.
- Algal production significantly contributes to DO depletions beyond criterion during critical conditions in the River and Lake.
- Phosphorus has the most significant impact on algal production in the Lake and River, but DO is also impacted by BOD and ammonia.

- Both point source and nonpoint sources of pollutant loading contribute to violations of WQ criterion
- DO in the hypolimnion (bottom strata of the lake) is most impacted by nonpoint pollution with some additional impact from point sources
- Point Sources of nutrients cause the majority of the DO depletion in the Lake Spokane interflow zone (metalimnion) during the summer.
- Current nonpoint pollutant loading alone, contributes nutrients in excess of the loading needed to prevent excessive DO depletion (<0.2 mg/L decrease from "natural conditions").
- Managing pollutant loads as proposed to protect Lake DO will also protect the river DO.
- Reducing BOD and phosphorus loads will likely reduce sediment oxygen demand over time allowing for improved DO in the hypolimnion of the lake (currently applied as MOS).
- The Effluent Treatment scenario using effluent quality of 20 ug/L TP resulted in a 0.44 mg/L decrease in DO in the worst spot (segment 188) and an average of 0.22 mg/L decrease from the NoPoint scenario in portions of the water column where DO was already below 8.0 mg/L..
- Maintaining higher minimum flows to around 700 cfs in the river can significantly reduce phosphorus concentrations and phytoplankton productivity in the upper part of Lake Spokane. However, significant immediate changes in same-season dissolved oxygen were not predicted in the lower lake strata (hypolimnion) as previously predicted using regression models developed for Long Lake in the 80's (Patmont et al., 1987). It is anticipated that any DO changes due to reduced productivity will likely be delayed at least a year and exhibited as gradual changes in future SOD and hypolimnetic DO as unoxidized organic matter decrease in the sediment.

Total Loading Capacity

The total allowable loading capacity is based on the amount of CBOD, phosphorus, ammonia that can be assimilated by Lake Spokane without causing greater than a 0.2 mg/L decrease in dissolved oxygen from natural conditions in the most critical portion of the lake. The baseline estimate of natural DO was determined from the NO SOURCE model scenario. The allowable decrease from natural conditions was calculated as an average difference from the natural profile for water column model layers predicted to have natural DO of less than 8.0 mg/L. The natural condition load is comprised of the large volume, but naturally low nutrient concentrations received from Lake Coeur d' Alene, the Spokane Valley – Rathdrum Prairie Aquifer (≈500 cfs) entering the river downstream of Liberty Lake, and the Little Spokane River (over half of the summer flow is from ground water, ≈250 cfs). Natural loading from surface water in the Little Spokane River and Hangman Creek is less significant during a dry year such as 2001 because of the decreased volume. The total load capacity was then determined by performing an incremental addition to each of the surface water tributary "natural condition" loads by a small percentage (NPS Pollution) until the average allowable 0.2 mg/L decrease was achieved.

Lake Spokane's total maximum daily load (TMDL) for each month during the critical period of April 1 through October 31 was then calculated as the sum of the Spokane River load at Nine Mile Dam and the Little Spokane River load near the mouth (Table 1). The river upstream of Nine Mile Dam to the Idaho Stateline will meet the DO criteria when conditions of the TMDL are met.

Load Allocations

The load allocations for this TMDL includes both natural background loading plus the amount of loading from nonpoint pollution sources that will not cause more than 0.2 mg/l decrease from the estimated natural condition dissolved oxygen concentrations. Table 2 below contains the monthly Tributary Load Allocations (LA) in yellow as determined using the natural tributary loading plus an allowable nonpoint source (NPS) pollutant load. The allowable NPS load was modeled as described above by incrementally increasing a percentage of each "natural condition" tributary loading (NO SOURCE) until an average decrease of 0.2 mg/L from natural conditions DO was derived for the hypolimnion of Lake Spokane near the dam (segment 188). This method of calculation showed that during the period June – October only about 8.5 lbs per day of phosphorus can be allowed above the natural background loading. Total tributary loadings (natural condition + nonpoint pollutant source loading) will need to be reduced by approximately 20 percent to comply with the TMDL.

Lake Spokane Total Loading Capacity by Month

(Total Lake Load = 9Mi + LSR based on model estimates)

	NOSOURCE + NPS						Nonpoint Pollution Source (NPS) (9 Mi+LSR)			% Reduction from 2001 Current Load to TMDL (Natural + NPS)		
	TP	CBOD	NH3	TP	CBOD	NH3	TP	CBOD	NH3			
monthly average	mg/L	mg/L	mg/L	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	TP	CBOD	NH3
APR	0.006	0.906	0.011	311.2	46470	562.6	23.6	5093.4	10.6	51%	44%	30%
MAY	0.006	0.897	0.015	635.4	102845	1746.3	41.2	11106.3	19.7	36%	37%	9%
JUN	0.006	0.914	0.016	240.6	37334	644.8	15.3	3358.5	7.7	49%	40%	1%
JUL	0.005	0.719	0.016	105.6	13836	303.5	6.7	943.9	2.5	61%	47%	11%
AUG	0.006	0.594	0.015	71.4	7532	194.7	4.4	446.6	0.9	67%	55%	35%
SEP	0.006	0.759	0.015	85.6	10274	200.4	5.9	727.6	1.6	69%	59%	41%
OCT	0.006	3.16	0.031	130.4	20044	295.6	10.1	1850.8	8.3	70%	53%	35%
Apr-May avg	0.006	0.90	0.013	473.3	74657.7	1154.4	32.4	8099.8	15.1	42%	40%	16%
Jun-Oct avg	0.006	1.23	0.019	126.7	17803.9	327.8	8.5	1465.5	4.2	62%	48%	22%

	CURRENT 2001 CONDITIONS (9Mi+LSR)							Natural Conditions = NOSOURCE (9Mi + LSR)					
	Flow	TP	CBOD	NH3	TP	CBOD	NH3	TP	CBOD	NH3	TP	CBOD	NH3
monthly average	(cfs)	mg/L	mg/L	mg/L	lbs/day	lbs/day	lbs/day	mg/L	mg/L	mg/L	lbs/day	lbs/day	lbs/day
APR	6150	0.012	1.616	0.016	636.2	82876	805.0	0.006	0.807	0.011	287.5	41377	552.0
MAY	13748	0.009	1.434	0.017	988.6	164418	1927.6	0.005	0.800	0.015	594.3	91739	1726.6
JUN	4900	0.011	1.525	0.016	468.1	62310	648.3	0.006	0.831	0.016	225.3	33975	637.1
JUL	2309	0.014	1.346	0.018	272.9	25912	342.1	0.005	0.669	0.016	98.9	12892	301.1
AUG	1519	0.017	1.320	0.024	216.9	16725	301.0	0.005	0.559	0.015	67.0	7085	193.8
SEP	1623	0.021	1.837	0.025	279.0	24871	340.2	0.006	0.705	0.015	79.7	9547	198.8
OCT	2422	0.021	2.108	0.023	429.5	42573	457.2	0.006	0.901	0.014	120.3	18193	287.3
Apr-May avg	9949	0.011	1.525	0.016	812.4	123647	1366.3	0.005	0.80	0.013	440.9	66558	1139.3
Jun-Oct avg	2555	0.017	1.627	0.021	333.3	34478	417.8	0.006	0.73	0.015	118.2	16338	323.6

Table 1. Lake Spokane Total Loading Capacity by month with comparison to estimates of 2001 and Natural Condition loadings. Total Lake load was derived as the sum of natural condition and allowable nonpoint pollution source loads (NPS) for Spokane River near 9 Mile Dam (9Mi) combined with Little Spokane River near the mouth (LSR).

Hangman = CURRENT 2001 CONDITIONS					Current conditions **LOAD**			Hangman = NOSOURCE			Natural conditions **LOAD**			Hangman = NOSOURCE+NPS F			**LOAD Allocat (Natural+NPS)**			% Reduction from current to get to Natural + NPS		
					TP	CBOD	NH3				TP	CBOD	NH3				TP	CBOD	NH3			
LA MONTH	avg Flow	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	TP	CBOD	NH3
APR	135.83	0.1011	3.8	0.040	74.0	2782.2	29.5	0.0204	1.40	0.007	14.9	1025.0	5.4	0.0230	1.64	0.007	16.9	1200.7	5.4	77%	57%	82%
MAY	92.86	0.0788	3.8	0.018	39.4	1902.0	8.8	0.0191	1.40	0.007	9.5	700.7	3.7	0.0217	1.64	0.007	10.9	820.9	3.7	72%	57%	58%
JUN	29.15	0.0760	3.8	0.021	11.9	597.1	3.2	0.0184	1.40	0.007	2.9	220.0	1.2	0.0210	1.64	0.007	3.3	257.7	1.2	72%	57%	65%
JUL	10.52	0.0609	3.4	0.021	3.5	193.8	1.2	0.0184	1.40	0.005	1.0	79.4	0.3	0.0210	1.64	0.005	1.2	93.0	0.3	65%	52%	77%
AUG	6.66	0.0436	2.7	0.005	1.6	98.5	0.2	0.0184	1.40	0.005	0.7	50.3	0.2	0.0210	1.64	0.005	0.8	58.9	0.2	52%	40%	0%
SEP	6.38	0.0456	3.1	0.005	1.6	106.3	0.2	0.0184	1.40	0.005	0.6	48.1	0.2	0.0210	1.64	0.005	0.7	56.4	0.2	54%	47%	0%
OCT	12.74	0.0452	3.2	0.005	3.1	219.8	0.3	0.0191	1.40	0.005	1.3	96.2	0.3	0.0217	1.64	0.005	1.5	112.6	0.3	52%	49%	0%
Apr-May avg	114.35	0.090	3.80	0.029	56.74	2342.07	19.19	0.020	1.40	0.007	12.24	862.87	4.52	0.022	1.64	0.007	13.87	1010.79	4.52	76%	57%	76%
Jun-Oct avg	13.09	0.054	3.25	0.011	4.33	243.08	1.03	0.019	1.40	0.005	1.31	98.79	0.43	0.021	1.64	0.005	1.49	115.73	0.43	65%	52%	59%
Coulee = CURRENT 2001 CONDITIONS								Coulee = NOSOURCE						Coulee = NOSOURCE + NPS								
					TP	CBOD	NH3				TP	CBOD	NH3				TP	CBOD	NH3			
LA MONTH	avg Flow	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day			
APR	35.47	0.1011	3.8	0.040	19.3	726.6	7.7	0.0204	1.40	0.007	3.9	267.7	1.4	0.0230	1.64	0.007	4.4	313.6	1.4	77%	57%	82%
MAY	24.25	0.0788	3.8	0.018	10.3	496.7	2.3	0.0191	1.40	0.007	2.5	183.0	1.0	0.0217	1.64	0.007	2.8	214.4	1.0	72%	57%	58%
JUN	7.62	0.0760	3.8	0.021	3.1	156.0	0.8	0.0184	1.40	0.007	0.8	57.5	0.3	0.0210	1.64	0.007	0.9	67.3	0.3	72%	57%	65%
JUL	2.75	0.0609	3.4	0.021	0.9	50.6	0.3	0.0184	1.40	0.005	0.3	20.7	0.1	0.0210	1.64	0.005	0.3	24.3	0.1	65%	52%	77%
AUG	1.73	0.0436	2.7	0.005	0.4	25.6	0.0	0.0184	1.40	0.005	0.2	13.1	0.0	0.0210	1.64	0.005	0.2	15.3	0.0	52%	40%	0%
SEP	1.66	0.0456	3.1	0.005	0.4	27.6	0.0	0.0184	1.40	0.005	0.2	12.5	0.0	0.0210	1.64	0.005	0.2	14.7	0.0	54%	47%	0%
OCT	3.33	0.0452	3.2	0.005	0.8	57.4	0.1	0.0191	1.40	0.005	0.3	25.1	0.1	0.0217	1.64	0.005	0.4	29.4	0.1	52%	49%	0%
Apr-May avg	29.86	0.090	3.80	0.029	14.82	611.63	5.01	0.020	1.40	0.007	3.20	225.34	1.18	0.022	1.64	0.007	3.62	263.97	1.18	76%	57%	76%
Jun-Oct avg	3.42	0.054	3.25	0.011	1.13	63.46	0.27	0.019	1.40	0.005	0.34	25.79	0.11	0.021	1.64	0.005	0.39	30.21	0.11	65%	52%	59%
Little Spokane = CURRENT 2001 CONDITIONS								Little Spokane = NOSOURCE						Little Spokane = NOSOURCE + NPS								
					TP	CBOD	NH3				TP	CBOD	NH3				TP	CBOD	NH3			
	avg Flow	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day			
APR	590.21	0.0442	2.5	0.050	140.5	7953.1	160.1	0.0271	1.40	0.007	86.1	4453.7	23.3	0.0297	1.64	0.007	94.5	5217.2	23.3	33%	34%	85%
MAY	540.99	0.0408	2.5	0.028	119.1	7289.8	80.7	0.0257	1.40	0.007	75.0	4082.3	21.4	0.0284	1.64	0.007	82.7	4782.1	21.4	31%	34%	73%
JUN	426.06	0.0382	2.5	0.008	87.7	5741.2	19.1	0.0251	1.40	0.007	57.6	3215.1	16.8	0.0277	1.64	0.007	63.6	3766.2	16.8	27%	34%	12%
JUL	372.04	0.0244	1.3	0.005	49.0	2586.8	10.0	0.0172	1.29	0.005	34.5	2586.8	10.0	0.0196	1.51	0.005	39.4	3034.7	10.0	20%	-17%	0%
AUG	353.72	0.0245	1.3	0.009	46.8	2440.4	16.5	0.0152	1.11	0.005	29.1	2122.6	10.2	0.0173	1.30	0.005	33.1	2484.9	10.2	29%	-2%	38%
SEP	352.16	0.0266	1.7	0.006	50.5	3165.2	11.9	0.0180	1.36	0.005	34.1	2586.2	9.5	0.0205	1.60	0.005	39.0	3027.5	9.5	23%	4%	20%
OCT	379.44	0.0273	1.7	0.005	55.8	3476.8	10.2	0.0191	1.40	0.005	39.0	2863.3	10.2	0.0217	1.64	0.005	44.4	3354.1	10.2	20%	4%	0%
Apr-May avg	565.60	0.043	2.50	0.039	129.79	7621.45	120.40	0.026	1.40	0.007	80.57	4268.01	22.36	0.029	1.64	0.007	88.62	4999.67	22.36	32%	34%	81%
Jun-Oct avg	376.68	0.028	1.69	0.007	57.94	3482.08	13.56	0.019	1.31	0.006	38.85	2674.80	11.35	0.021	1.54	0.006	43.89	3133.49	11.35	24%	10%	16%
Stateline = CURRENT 2001 CONDITIONS								Stateline = NOSOURCE						Stateline = NOSOURCE + NPS						Negative reductions caused by differences in very low levels of modeled and measured NH3 at Stateline		
					TP	CBOD	NH3				TP	CBOD	NH3				TP	CBOD	NH3			
	avg Flow	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day			
APR	4777.76	0.0107	1.8	0.007	276.4	46353.8	180.3	0.0070	1.24	0.011	179.1	31910.2	271.5	0.0076	1.44	0.011	194.5	37060.6	271.5	30%	20%	-51%
MAY	10949.88	0.0084	1.8	0.005	495.8	106235.7	295.1	0.0070	1.24	0.010	415.1	73030.3	614.5	0.0076	1.44	0.010	450.4	84816.5	614.5	9%	20%	-108%
JUN	3243.12	0.0084	1.8	0.006	146.8	31464.7	110.7	0.0068	1.28	0.012	119.4	22359.7	207.4	0.0074	1.47	0.012	129.6	25762.0	207.4	12%	18%	-87%
JUL	842.72	0.0095	1.9	0.012	42.9	8596.3	52.2	0.0063	1.33	0.012	28.5	6057.5	53.9	0.0068	1.51	0.012	30.9	6872.4	53.9	28%	20%	-3%
AUG	240.03	0.0132	2.2	0.009	17.0	2813.9	11.3	0.0058	1.44	0.013	7.5	1867.4	16.4	0.0063	1.62	0.013	8.1	2091.9	16.4	52%	26%	-45%
SEP	629.80	0.0113	2.6	0.006	38.4	8859.9	18.7	0.0062	1.64	0.015	20.9	5561.2	52.1	0.0068	1.86	0.015	23.2	6327.9	52.1	39%	29%	-179%
OCT	1681.74	0.0099	2.2	0.005	90.0	19942.1	45.3	0.0070	1.62	0.016	63.5	14728.4	144.4	0.0078	1.87	0.016	70.3	16991.0	144.4	22%	15%	-219%
Apr-May avg	7863.82	0.010	1.80	0.006	386.09	76294.75	237.68	0.007	1.24	0.010	297.07	52470.2	443.0	0.008	1.44	0.010	322.47	60938.57	442.99	16%	20%	-86%
Jun-Oct avg	1327.48	0.010	2.14	0.007	67.05	14335.39	47.65	0.006	1.46	0.014	47.96	10114.8	94.8	0.007	1.67	0.014	52.44	11609.03	94.85	22%	19%	-99%

Table 2. Spokane River and Tributary Load Allocations (LA) for nutrients necessary to prevent violations of the dissolved oxygen criteria in Lake Spokane

Waste Load Allocations

The total nutrient loading capacity of Lake Spokane is consumed by just a portion of the existing nonpoint pollutant source load combined with the natural condition load. There is no reasonable assurance that NPS can or will be reduced to achieve the load allocation. Therefore, no assimilative capacity is left for point source pollutant loading that would cause or contribute to an increase in river concentrations of pollutants during the critical period (April 1 – October 31). Discharges of treated effluent to the river that meet the target river concentrations at end-of-pipe for phosphorus, CBOD, and ammonia, in each of the applicable river reaches will not cause or contribute to violation of applicable water quality standard. Therefore, a concentration-based wasteload allocation is allowable as long as these target instream concentrations are met. The target concentrations for several reaches of the river constitute the WLAs for each reach and were calculated by the model with the Natural Condition + NPS scenario when the DO criteria is met in Lake Spokane.

Instream concentrations as predicted by the model under the NOSOURCE + Nonpoint Source Pollution (NPS) scenario used to develop the Tributary Load Allocations

	NH3	TP	CBOD
Upstream of Liberty Lake	0.014	0.0092	1.99
Upstream of Kaiser	0.020	0.0087	1.76
Upstream of IEPC	0.017	0.0086	1.37
Upstream of Spokane WWTP	0.030	0.0082	1.18

1) The values above represent the average Jun-Oct period from segments upstream of the point source discharges.
2) All other surface sources should receive these concentrations or the average of these concentrations

There are many small direct and indirect discharges to the Spokane River that may occur as the result of rainfall and snowmelt events. These discharges are regulated by NPDES permits for runoff from construction sites greater than one acre, runoff from industrial activities and discharges from the municipal storm sewer system. Typically, significant discharges from these facilities will not occur during the critical period and none did during TMDL monitoring in 2001. However, discharges from these facilities may occur during the critical period in some future year. This TMDL presumes that implementation of the best management practices identified in each of these permits will not cause or contribute to violation of water quality standards during the critical period. Therefore, the WLA for these permittees (during the critical period) is the concentration-based WLA identified above. Monitoring of these discharges and an evaluation of BMP effectiveness over time will determine if this presumption is correct or needs to be modified.

Margin of Safety

Because this TMDL requires that point sources not contribute to any change in target instream concentrations, a safety factor applied to a WLA of essentially zero appear to be unnecessary. There is a very small safety factor associated with the proposed tributary LAs since actual average DO declines used to establish the LAs were rounded from values ranging between 0.1995 mg/L on the most critical day of the summer in the most stringent model segment. Other days in the critical summer months had declines down to 0.18 mg/L. This essentially equates in a 0.3% to 10% margin of safety around the critical summer time.

Summary Implementation Strategy

The Summary Implementation Strategy (SIS) is required with a proposed TMDL under the requirements of a memorandum of agreement with US EPA. The SIS should provide a clear, concise, and sequential presentation of concepts which will meet the allocations of the TMDL.

Schedule

The proposed schedule is targeted at removing the largest controllable sources of Lake Spokane nutrient contributions as quickly as possible (Figure 9) so that significant changes in water quality are realized quickly and allow time to observe Lake DO response while developing reuse projects. The compliance schedule requires interim treatment plant upgrades by the existing wastewater dischargers to meet the state-of-the-science phosphorus removal by achieving average effluent phosphorus concentrations of 50 ug/L or less (Figure 10). The compliance schedule would allow until the end of 2008 for these upgrades to be completed. The interim compliance schedule for treatment plant upgrades need not be delayed while developing a detailed implementation plan and should begin immediately with approval of the TMDL.

Compliance with the final WLAs and LAs will allow the maximum length compliance schedule allowed under state WQ standards (10 years, ending January 2016). The TMDLs being developed for Hangman Creek (Latah Creek) and the Little Spokane River will develop plans to implement best management practices for control of nonpoint sources in those major tributary watersheds by 2006/07. A detailed implementation plan will also be needed by no later then the end of 2005 for developing seasonal alternatives river discharges for point source such as water reclamation and reuse and/or other wastewater treatment techniques to meet the very low end-of-pipe concentrations-based WLA.

Strategies to Achieve TMDL Load Allocations for Nonpoint Sources

The major tributary watersheds of Hangman Creek (Latah Creek) and the Little Spokane River are in the process of developing a TMDL for each. The resulting TMDLs and implementation strategies will be coordinated with the Spokane TMDL.

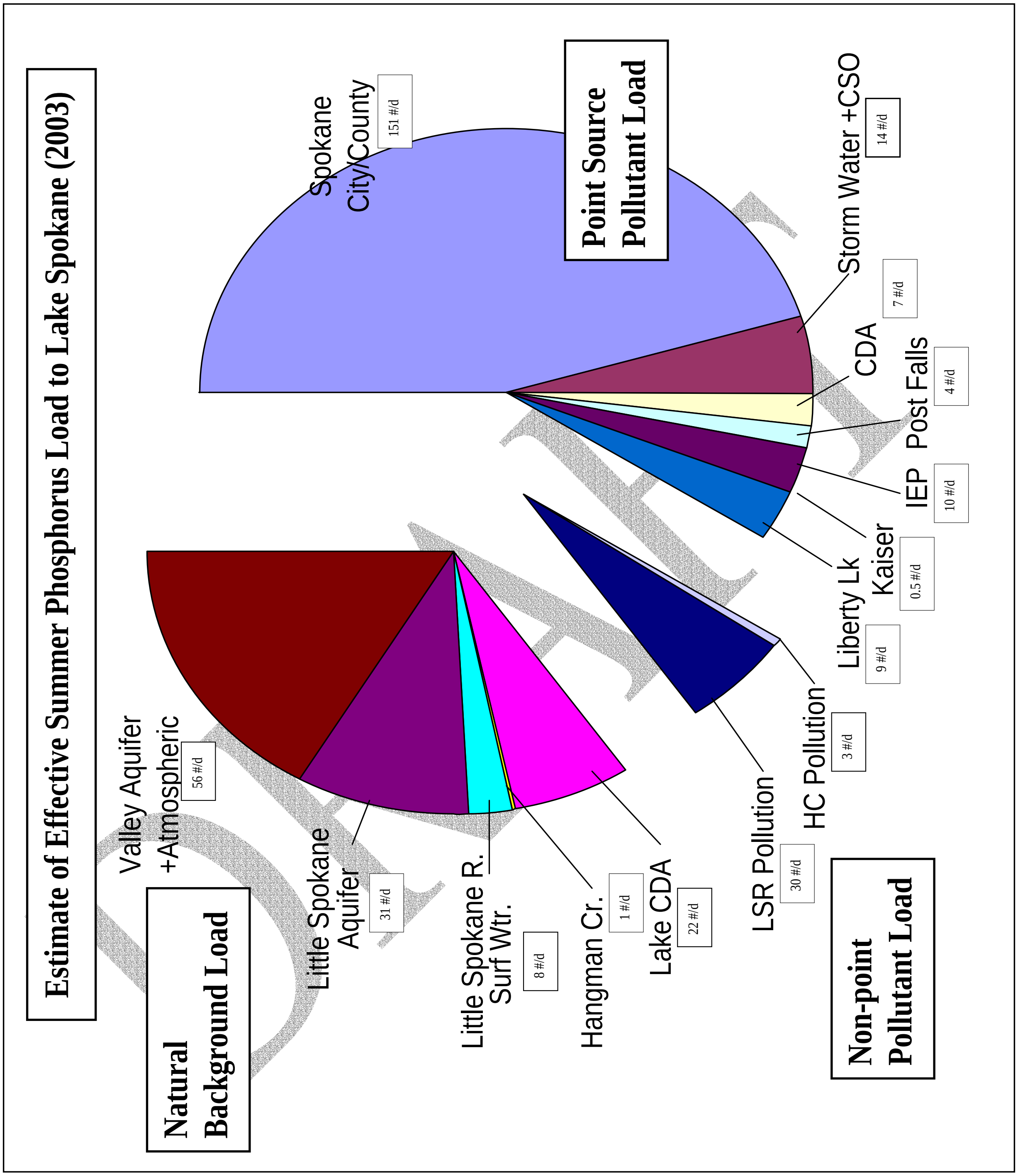
Strategies to Achieve TMDL Wasteload Allocations for Point Sources

It is anticipated that it will take a combination of several strategies described below, to ultimately achieve compliance with the TMDL.

1. Control influent wastewater volume and quality through conservation and waste management

Reduction of the volume and pollution concentration of influent into treatment plants can improve efficiency and lower resulting discharge loading for a given population. Influent flow reduction strategies include I/I (influent & infiltration) control and water conservation. Pollutant reduction strategies vary. Because phosphorous is a pollutant of concern in the Spokane River DO TMDL, control of phosphate content in household and commercial products which reach the sewer can reduce phosphorous treatment requirements. Industrial discharge of high strength organic wastewater without pretreatment or the import of high strength sludges can also affect nutrient loads in the effluent.

Figure 9. Estimate of 2003 effective summer (June – October) phosphorus loading to Lk Spokane using natural condition estimates from CE-Qual-W2 and attenuated point source loadings estimated from the P- attenuation model for a 1-in-10 low flow year.



YR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TMDL Schedule	TMDL Approval	**Phase I - Interim Nutient Removal**				**Phase 2 - Final TMDL Goal - Meet DO Criteria**						
w/ existing WQ criteria						0.2 mg/L DO decrease from natural mostly by phosphorus control						
Point Sources	Planning for Max TP removal and reuse		Construction		MAX TP removal in-place	Meet natural background conc or Imp Reuse - Lake Monitor - Complete UAA						
Nonpoint Sources	Tributary TMDLs completed with Imp Plan			Begin Implement BMPs		Complete implement BMPs w/ monitoring and adaptive approach						

Estimates of Phosphorus Loading Reduction (2003 Pt Src flows)

	Existing Avg TP load Summer 2003			Max TP removal Load @ 50 ug/L- all to river			Load at TP Final goal @ 10 ugL to River	
Discharger	**#/day**	**Flow MGD**		**#/day**	**Flow MGD**		**#/day**	**Flow MGD**
CDA	6.9	3.2		0.4	3.2		0.1	3.2
Hayden	seaonal land app			seaonal land app			early spring P removal?	
Post Falls	4.1	2.1		0.4	2.1	If effluent TP meets instream target conc. - effluent TP loading can increase with effluent flow as long as in-stream conc. does not increase	0.1	2.1
Liberty Lake	9.1	0.7		0.1	0.7		0.0	0.7
Kaiser	0.1	0.1 (Outfall 02+03)		3.2	16*		1.3	16.0
IEP	9.8	4.8*		1.1	4.8		0.2	4.8
Spokane City/Cnty	151.0	36.5		14.5	36.5		2.9	36.5
Spokane CSO&Storm	14.2			CSO elim & SW mgmt plans			Reduce / Elim CSO & SW	
Tot. PS Load**	**195.2**			**19.7**			**4.6**	conc-based limt
Tributary Load (Natural+NPS)	150.8	YR 2001		150.8	YR 2001	≈ 20% reduction in trib loads needed to meet TMDL	127.0	YR 2001
Total Load**	346.0	NA		170.5	NA		127.0	

* Includes all cooling water
** with estimated P attenuation
Point Source compliance schedule implemented via common Administrative Order then rolled into all individual permits within 2 years

Figure 10. Summary - Spokane R. Proposed TMDL and Phosphorus Loading Reduction Strategy (9-20-04)

Strategies:

A. Municipal NPDES permit holders will adopt specific plans with measures to investigate and control inflow and infiltration (I/I) into municipal sewer systems.

B. Municipal NPDES permit holders will conduct water audits and adopt water conservation measures including ordinances and rate structures to induce reductions in household and commercial water use by their customers. Industrial users shall be required to invest in water reuse technology (membrane systems) as is economically achievable to eliminate dilute high-volume discharges.

C. Municipal NPDES permit holders with require commercial/industrial users of their collection system to use phosphate reduced/free products where possible and/or provide on-site pretreatment of high strength phosphorus and organic wastes before disposal to the sewer. There shall be audits of the larger wastewater dischargers to review all waste disposal practices to the sewer. These will include industries such as commercial laundries, hospitals, and metal finishers using phosphoric-based cleaners.

D. To prevent unnecessary pollutant loading to the river, the city of Spokane and Spokane County shall immediately cease the import of domestic septage, municipal sludges, or any other hauled wastewater from outside of Spokane County unless it is to alleviate an immediate emergency.

E. Industrial NPDES permit holders will conduct internal water audits to reduce internal water use, maximize reuse of industrial effluent, and eliminate phosphate-containing products where possible.

F. Spokane County will adopt an ordinance to ban the sale of phosphate containing dishwashing detergent and other phosphorus based cleaning aids designed for disposal to the sewer.

2. <u>Reclamation and Reuse</u>

RCW 90.46.005 states: "[T]he people of the state of Washington have a primary interest in the development of facilities to provide reclaimed water . . . . To the extent reclaimed water is appropriate for beneficial uses, it should be so used . . . ." In the case of the Spokane River, this mandate is also an opportunity.

Reclaimed (or recycled) water is already used extensively at locations across the country, and would provide at least two significant benefits: First, water which is reclaimed for other purposes need not be discharged into the river, reducing the stress on the system.

Second, reclaimed water used locally substitutes for water which would otherwise be drawn from natural sources. Eliminating the need for such withdrawals enhances natural flows, including avoiding negative effects occurring upstream of the current discharge points. As municipalities and holders of state waste discharge permits are among those eligible to obtain water reclamation permits (see, e.g., RCW 90.46.030(4)), this option is available to all point source dischargers on the Spokane River.

Pursuant to RCW 90.46, the Washington State Departments of Health and Ecology issued the *Water Reclamation and Reuse Standards* (publication #97-23, hereafter Standards) (http://www.ecy.wa.gov/programs/wq/reclaim/standards.pdf) in September 1997. These standards identify various uses appropriate for reclaimed water and set the criteria to be met by water used for each such purpose. One significant use is for irrigation, where some of the same substances considered contaminants when dumped in a river serve a beneficial purpose instead. Strategies:

A. Municipal sewage treatment plants shall implement programs to provide reclaimed water of suitable quality for appropriate and available local uses.

B. Municipalities shall implement programs to use reclaimed water for all appropriate beneficial uses.

C. Land use planning shall require all major residential, commercial, industrial, and municipal development projects to include accommodation for appropriate reclaimed water uses.

D. Industrial dischargers shall develop their own reclamation facilities, contract to redirect their discharges into municipal reclamation facilities, or contract to substitute municipal reclaimed wastewater for industrial purposes.

3. Alternative wastewater treatment to meet end-of-pipe WLA with discharge to the river

The proposed interim reduction in point source phosphorus concentrations to 50 ug/L by 2008 was based on existing treatment plant performance at some New York Watershed wastewater treatment plants (Dibble pers com, 2004), existing performance of the Upper Occoquan Sewer Authority treatment plant (WEF, 1998), and a technical report describing proven phosphorus removal efficiency using membrane bioreactors (Lorenz, 2002). These interim reductions are necessary to provide a significant reduction in phosphorus loading to the lake and allow time for monitoring to assess the lake and river responses to the nutrient reductions. The vertical continuously cleaning, dual sand filter systems used in New York appear to be achieving phosphorus concentrations very near to those necessary to meet the final concentration-based WLA (<10 ug/L annual avg TP).

Strategies:

The NPDES permit dischargers shall evaluate new and available technologies for reducing phosphorus and other nutrient pollution including operating pilot projects to determine suitability and cost effectiveness.

4. Combined Sewage Overflow and Stormwater Control

The pollutant loading from combined sewage overflow (CSO) and stormwater was determined to be insignificant during an unusually dry year similar to the TMDL design condition. However, the pollutant loading will continue to be reduced through the exiting requirement in the city of Spokane's NPDES permit to implement the approved CSO elimination plan. The plan requires that all CSO outfalls will be in compliance by 2017 with state CSO regulations (WAC 173- 245) which require no more than an average of one CSO discharge event per outfall per year.

City of Spokane's stormwater discharges are now regulated by the Municipal Stormwater requirements and EPA rules require operators of municipal separate storm sewer systems (**MS4s**) to develop and implement a ***stormwater management program*** that:

- Reduces the discharge of pollutants to the "maximum extent practicable."
- Protects water quality.
- Satisfies appropriate requirements of the Clean Water Act.

5. Flow Augmentation

As previously discussed, increased river flow above the critical design low flows can significantly improve upper lake phosphorus concentrations and algal productivity. A combination of increased flow and reduced nutrient load may result in large improvements in water quality.

Strategies:

Methods for augmenting minimum flows in the Spokane River should be explored by the municipalities, watershed planning units, and Avista Dam relicensing advisory groups. These considerations should include options for altering existing Coeur d' Alene lake level management and the feasibility of actively managing aquifer/river exchanges for maximizing potential aquifer storage and ground water discharge to the river in the summer.

Monitoring

Under WAC § 173-220-210, any discharge authorized by a permit is subject to monitoring requirements as may be reasonably required by Ecology. The MOA, EPA Guidelines, and TMDL Guidance Document require detailed monitoring plans where implementation will be phased in over time. All permits must require effluent and ambient monitoring necessary to show that the effluent limits are being met and re-opener clauses allowing Ecology to modify or revoke the permit if the permit limits or the permittee fail to attain specified targets. 40 CFR § 122.44. *See also* WAC §§ 173-220-180, -190.

Monitoring for the Spokane River dissolved oxygen TMDL shall include the following with the details to be completed in the detailed implementation plan (DIP) for monitoring:

A. An ambient water quality monitoring program of the Spokane River, its tributaries, and Lake Spokane must be established to monitor critical conditions and include collection and analysis of physical, chemical and biological data with quality assurance and control programs to assure scientifically valid data. The monitoring shall be designed to assess the most critical locations and time of year for efficacy of point source nutrient load reductions and nonpoint source cleanup strategies. Reports will be made public through section 305(b) reports.

B. The TMDL Detailed Implementation Plan will establish a series of milestones for the implementation of the strategies identified in Part 3 above. Ecology will develop and circulate a quarterly report that indicates levels of progress for each party that is charged with responsibilities for implementation.

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Appendix A

- **Appendix A – Public Involvement Opportunities - Spokane River TMDL to restore and maintain dissolved oxygen**

- **May 1999**: **Draft Study Plan submitted and discussed with Spokane River Phosphorus Technical Advisory Committee (TAC) for review and comment**. Suggested that Idaho modeling might be integrated with the WA effort and worked with EPA for supplemental funding of Idaho dischargers to finish their effort

- **July 1999**: Final Draft of study plan QAPP again submitted to **Spokane River Phosphorus TAC** with another request for review and comment

- **October 1999**: **Meeting with City of Spokane wastewater staff** discussing many discharge issues including, CSO, stormwater, river monitoring, and DO modeling

- **April - September 2000**: **Public Workshop for presentation of preliminary QUAL2E model** sensitivity test results with agencies and dischargers – continued sampling surveys

- **August 2000**: **Provided written response back to City of Spokane** on the general and technical comments received from them following the workshop.

- **November 2000**: **Public Workshop to provide them an updated TMDL timeline and allow Tom Cole (COE) to present overview of the new CE-Qual-W2 model** and provide opportunities for discussions of WQ issues.

- **Spring 2001: Dischargers request delay in model development to allow for another year** of calibration sampling to be conducted in 2001

- **February 2002**: **Ecology provided CE-Qual-W2 modeling training** to consultants and staff of the dischargers and Ecology.

- **March 2002**: **Public announcement and formal comment period for Ecology's Spokane River Study/Data Summary Report** with appended COE model development report. The reports were made available on website. Draft copy of model made available to public upon request.

- **April 1, 2002**: **Comment period closed on draft data summary report** and initial model development reports.

- **June 2002**: **Public Workshop and formal review of draft interim technical memo** and interim model results for input on potential loading scenarios

- **October 2002**: Water Quality Program Manager and Section Manager **privately meet with City of Spokane Directors of Public Works and Wastewater Management** to discuss local concerns about TMDL process

- **December 2002: Public Workshop to review 2001 data and model WQ predictions**. Discuss previously submitted comments and resolution. Begin discussion about organization of a facilitated TMDL advisory group

- **January 2003: Meeting with City, County, and Liberty Lake, wastewater management and staff to explain potential impacts of new water quality standards, TMDL**, and discuss the process of conducting a use attainability analyses

- **February 2003**: **Public workshop for organization of advisory group**, develop preliminary work agenda, and review UAA process

- **February 2003**: **Meeting with Dischargers Group to review UAA process and discuss scope of work**

- **February 2003**: Municipal wastewater managers meeting organized by Spokane Valley to discuss Spokane regional WW planning. **Ecology presented preliminary WQ model results, discussed implications, and possible solutions in detail with all municipalities present.**

- **March 2003**: Review and comment on UAA scope of work from sponsors

- **March 2003**: Pre-Meeting with the dischargers/UAA sponsors followed by a **Public meeting with interim-Advisory Group and UAA sponsors to discuss TMDL and UAA process**

- **May 2003**: **First official Advisory Group meeting** outline of tasks with incorporation for UAA as appropriate

- **June 2003**: **Conduct Public Workshop and distribute draft Dissolved Oxygen Pollutant Loading Assessment Technical Report for formal public comment**

- **October 2003**: **Distribute formal response to comments on technical report** but, mistakenly omitted City of Spokane comments. Electronically distributed document to Advisory Group and other commenters

- **November 2003**: **UAA forum for dischargers arranged by Ecology** to discuss process for UAA and interaction with TMDL process

- **January 2004**: **Meeting with EPA and Ecology staff** to discuss TMDL for DO and permitting questions

- **February 2004**: **Final Response to Comments on Load Assessment Technical Report** with addendum distributed to Advisory Group and commenters.

- **February 2004**: **Spokane River model with final calibration made available on web site along with PSU technical review report.**

- **February 2004**: **Final Load Assessment Technical Report was published**

- **May 2004**: **Meeting conducted at the Airport Ramada Inn without public notification with dischargers, certain politicians, and EPA** to discuss implications of TMDL and coordination of the UAA process

- **Advisory Group Meetings held** to develop and discuss proposed TMDL submittal report on May 18, 2004, June 22, 2004, July 27, 2004, August 31, 2004, October 5, 2004