APPENDIX D: SUPPORTING DOCUMENTS FOR THE DISSOLVED OXYGEN TMDL

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APPENDIX D-1

Note: The following is a computer-scanned copy of the original and may contain transcription errors.

TMDL Number: 22M-01-004

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Note: This is a computer-scanned copy of the original and is not a legal document due to possible errors in transcription.

TOTAL MAXIMUM DAILY LOAD
WATER QUALITY MANAGEMENT PLAN COMPONENT
Department of Environmental Quality
811 Southwest Sixth Avenue, Portland, OR 97204
Telephone: (503) 229-5696
Developed pursuant to ORS 468.730 and The Federal Clean Water Act

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WATER QUALITY LIMITED SEGMENT:
Tualatin River (RM 4 - 39)

RECEIVING SYSTEM INFORMATION:
Basin: Willamette
Subbasin: Tualatin
County: Washington

WQ STANDARD-NOT ATTAINED:

Dissolved Oxygen

APPLICABLE RULES:

OAR 340-41-442
OAR 340-41-445(2)(a)

TMDL PARAMETER:

Ammonia Nitrogen

OAR 340-41-006
OAR 340-41-470(3)

SOURCES COVERED BY THIS TMDL:

Source Number	Allocation Type	Source Description
001	LA	Tualatin River -(upstream input)
002	LA	Rock Creek
003	WLA	Unified Sewerage Agency Rock Creek WWTP (USA-RCWWTP)
004	LA	Chicken Creek
005	WLA	Unified Sewerage Agency Durham WWTP (USA-Durham)
006	LA	Fanno Creek

WATER QUALITLY MANAGEMENT ACTIVITIES AND IMPLEMENTATION

Until this TMDL is modified, point source permits will be reissued as they are reopened or expire to include limits for complying with the established waste loads. Where new or reduced loads are needed, compliance schedules will be specified for reaching those loads. Nonpoint sources will be addressed through specified schedules for developing and implementing needed control programs. All requirements, limitations, and conditions are set forth in the attached sections as follows:

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SECTION A

Pollutant: Discharge loads not to be Exceeded

1. Pollutant Discharge Loads not to be Exceeded After TMDL Issuance (Interim Loads based on existing conditions prior to implementation of controls).

MONTHLY AVERAGE AMMONIA LOADS
May 1 to November 15
(pounds per day)

Source Number	Source Description	Tualatin River Flow			
		less than 120 cfs	120 to 200 cfs	200 to 300 cfs	greater than 300 cfs
	River Mile 16 - 39 *				
001	Tualatin (upstream)	16	20	40	65
002	Rock Creek	5	8	11	16
003	USA – RCWTP	2500	2500	2500	2500
	TMDL (Interim)	2521	2528	2551	2581
	Loading Capacity	538	646	1076	1614
	River Mile 4 - 16 **				
	Upstream attenuation	-2090	-2010	-1690	-1290
005	Chicken Creek	2	3	4	6
006	USA - Durham	1250	1250	1250	1250
007	Fanno Creek	3	5	6	9
	TMDL (Interim)	1685	1775	2120	2557
	Loading Capacity	538	646	1076	1614

Notes:

* Based on Tualatin River flow measured at Farmington Gauge Station.

** Based on Tualatin River flow measured at Vest Linn Gauge Station plus flow measured at Oswego Canal Gauge Station.

a. The loading capacity for the upper portion (RM 16 - 39) of the segment is based on attaining a monthly median concentration of ammonia_nitrogen equal to 1000 ug/L for the Tualatin River at Farmington. The loading capacity for the lower portion (RM 4 - 16) of the segment is based on attaining a monthly median concentration of Ammonia nitrogen equal to 850 ug/L for the Tualatin River at Stafford Road.

b. Loading capacities are divided into four hydrologic categories based on typical flows observed between May and November in the lower Tualatin River. When flows in the river are below 120 cfs, the design flow for determining the loading capacity is 100 cfs. For the other hydrologic categories, the design flow for determining loading capacity is the low end of the flow range.

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2. Pollutant Discharge Loads not to be Exceeded After Attainment of Operationa Level as Required by Section C of this TMDL(Final Loads).

MONTHLY AVERAGE AMMONIA LOADS
May 1 to November 15
(pounds per day)

		Tualatin River Flow			
Source Number	Source Description.	less than 120 cfs	120 to 200 cfs	200 to 300 cfs	greater than 300 cfs
	River Mile 16 - 39 *				
001	Tualatin (upstream)	16	20	40	65
002	Rock Creek	5	8	11	16
003	USA – RCWTP	516	616	854	854
	TMDL	538	646	908	939
	Loading Capacity	538	646	1076	1614
	River Mile 4 - 16 **				
	Upstream attenuation	-270	-320	-470	-490
005	Chicken Creek	2	3	4	6
006	USA - Durham	265	312	628	854
007	Fanno Creek	3	5	6	9
	TMDL	538	646	1076	1318
	Loading Capacity	538	646	1076	1614

Notes:

* Based on Tualatin River flow measured at Farmington Gauge Station.

** Based on Tualatin River flow measured at Vest Linn Gauge Station plus flow measured at Oswego Canal Gauge Station.

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SECTION B

Minimum Monitoring and Reporting Requirements
(unless otherwise approved in writing by the Department)

1. Ambient Monitoring. The Department and USA shall operate a receiving water monitoring program to evaluate the effectiveness of the TMDL and to guide development of any additional control strategies. The ambient monitoring program shall consist of the following:

Stream	River Mile	Agency	Parameter	Minimum Frequency*	Type of Sample
Tualatin River	38.5	DEQ/USA	Basic/[1] & Solids/[2]	Semimonthly	Grab
		"	Nutrients/[3]	Semimonthly	Grab
		"	Chloro. a	Semimonthly	Grab
Tualatin River	33.3	USA	Flow	Daily	Recording
		"	Basic/[1] & Solids/[2]	Monthly	Grab
		"	Nutrients/[3]	Monthly	Grab
		"	Chloro. a	Monthly	Grab
Tualatin River	27.1	DEQ/USA	Basic/[1] & Solids/[2]	Semimonthly	Grab
		"	Nutrients/[3]	Semimonthly	Grab
		"	Chloro. a	Semimonthly	Grab
Tualatin River	16.2	DEQ/USA	Basic/[1] & Solids/[2]	Semimonthly	Grab
		"	Nutrients/[3]	Semimonthly	Grab
		"	Chloro. a	Semimonthly	Grab
Tualatin River	8.4	DEQ/USA	Basic/[1] & Solids/[2]	Semimonthly	Grab
		"	Nutrients/[3]	Semimonthly	Grab
		"	Chloro. a	Semimonthly	Grab
Tualatin River	5.4	USA	Flow	Daily	Recording
		"	Basic/[1] & Solids/[2]	Monthly	Grab
		"	Nutrients/[3]	Monthly	Grab
		"	Chloro. a	Monthly	Grab

Notes:

* May 1 - November 15, unless otherwise noted.

1. Basic:	Water temperature, dissolved oxygen, conductivity, pH
2. Solids:	Total solids, total suspended solids
3. Nutrients:	NH3-N, N02+NO3-N, Total Kjeldahl Nitrogen, Total Phosphorus Ortho Phosphorus

1. Ambient Monitoring (cont.)

Stream	River Mile	Agency	Parameter	Minimum Frequency*	Type of Sample
Rock Creek	1.2	USA	Basic/[1] & Solids/[2]	Monthly	Grab
		"	Nutrients/[3]	Monthly	Grab
		"	Chloro. a	Monthly	Grab
Fanno Creek	1.2	USA	Basic/[1] & Solids/[2]	Monthly	Grab
		"	Nutrients/[3]	Monthly	Grab
		"	Chloro. a	Monthly	Grab

Notes:

* May 1 - November 15, unless otherwise noted.

1. Basic: Water temperature, dissolved oxygen, conductivity, pH
2. Solids: Total solids, total suspended solids
3. Nutrients: NH3-N, N02+NO3-N, Total Kjeldahl Nitrogen, Total Phosphorus Ortho Phosphorus

2. Source Monitoring. The following source monitoring program will be conducted by USA to describe wasteloads being discharged to the Tualatin River:

Source	Parameter	Minimum Frequencv	Type of Sample
USA - Rock Creek WWTP (Outfall 001)	Total Flow (mgd)	Continuous	Recording
	Ammonia Nitrogen	Daily	Composite
	Total Kjel. Nitrogen	Daily (Jun-Sep)	Composite
	"	Weekly (Oct-May)	"
	N02+NO3-N	Daily (Jun-Sep)	Composite
	"	Weekly (Oct-May)	"
	Total Phosphorus	3 days per week	Composite
USA - Durham (Outfall 001)	Total Flow (mgd)	Continuous	Recording
	Ammonia Nitrogen	Daily	Composite
	Total Kjel. Nitrogen	Daily (Jun-Sep)	Composite
	"	Weekly (Oct-May)	"
	N02+NO3-N	Daily (Jun-Sep)	Composite
	"	Weekly (Oct-May)	"
	Total Phosphorus	3 days per week	Composite

2. Monitoring Procedures. Monitoring must be conducted-according to test procedures approved under 40 CFR Part 136 unless other test procedures have been approved by the Department.

4. Reporting Procedures. Monitoring results shall be reported on approved forms. The reporting period is the calendar month. Reports must be submitted to the Department by the 15th day of the following month.

SECTION C

Compliance Conditions and Schedules

1. Within 30 days after startup of the nitrification facilities at: the USA - Rock Creek facility, but no later than November 1, 1989, Condition 2 of Section A shall apply for the USA - Rock Creek facility.
2. Within one year after startup of the nitrification facilities at the USA - Rock Creek facility, the Unified Sewerage Agency shall submit a final report to the Department based on full scale plant testing that confirm and quantify factors that affect ammonia removal.
3. Within 90 days of adoption of implementation rules for the Tualatin River by the Environmental Quality Commission, the Unified Sewerage Agency shall submit a plan and time schedule to the Department describing how and when the Agency will modify its sewage treatment facilities to comply with this TMDL. This could result in a redistribution of wasteloads between the USA facilities.

SECTION D

Special Conditions

1. A biennial assessment report will be prepared by USA which describes the effectiveness of their control programs towards attaining water quality standards on the Tualatin River. This report will be submitted to the Department by January 1 on even numbered years for incorporation into the state-wide water quality assessment.

2. The Department and USA will use the assessment report and other information from the monitoring program to periodically evaluate the effectiveness of this TMDL. If the data indicates adjustments are needed, the TMDL will be reopened. Wasteload allocations and load allocations may be redistributed, but in no case will the final TMDL exceed the loading capacity defined for the stream.

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SECTION E

General Conditions

1. Definitions:

Loading Capacity (LC): The greatest amount of loading that a water can receive without violating water quality standards.

Load Allocation (LA): The portion of a receiving water's loading capacity that is attributed either to one of its existing or future non-point sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate' techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity that is allocated to one of its existing or future pointsources of pollution. WLAs constitute a type of water quality-based effluent limitation.

Total Maximum Daily Load (TMDL): The sum of the individual WLA's for point sources and LAs for nonpoint sources and background. If a receiving water has only one point source discharger, the TMDL is the sum of that point source WLA plus the LAs for any nonpoint sources of pollution and natural background sources, tributaries, or adjacent segments. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure. If Best Management Practices (BMPs) or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. Thus, the TMDL process provides for nonpoint source control tradeoffs.

WJ1052

APPENDIX D-3: TRIBUTARY DISSOLVED OXYGEN MODELING

TRIBUTARY DISSOLVED OXYGEN MODELING

GALES CREEK WATERSHED

Gales Creek is located at the western edge of the Tualatin Sub-Basin and has its origins in forested portions of the Coast Range (see Figure 1). Land uses in the upper reaches of the watershed are mostly forest (green on the map), while in the lower reaches land uses are mostly agricultural (yellow) and rural residential/urban (purple).

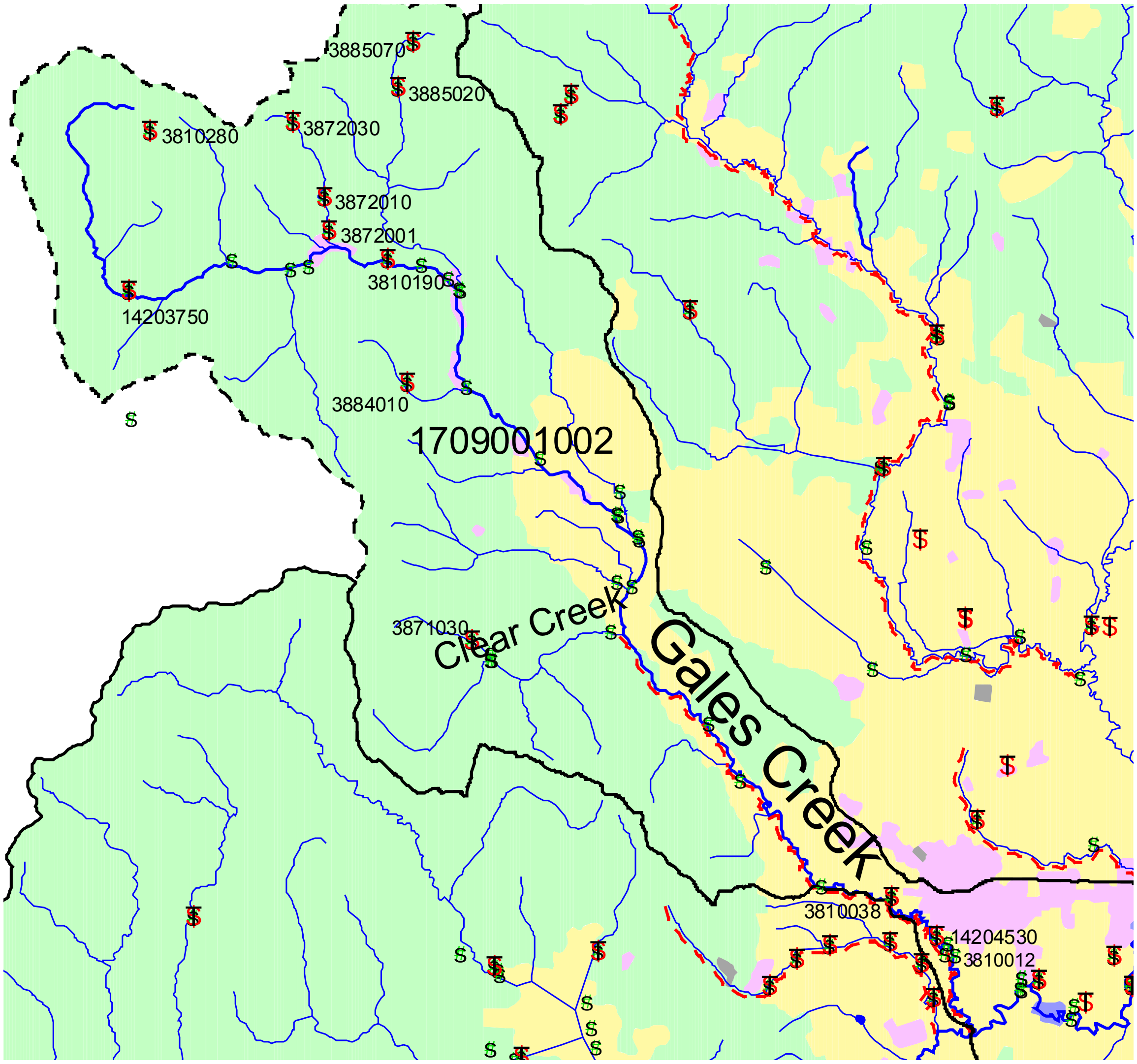

Figure 1 – Gales Creek Watershed

Water Quality Modeling

A steady state water quality model was developed of Gales Creek in order to evaluate the sensitivity of dissolved oxygen concentrations to temperature and sediment oxygen demand. The model was developed using the modeling framework QUAL2E (USEPA 1987). QUAL2E is supported by the U.S. Environmental Protection Agency and has been extensively applied throughout North America. Channel geometry, velocity, flow and temperature inputs to the model were extracted from a Heat Source temperature model of Gales Creek developed by DEQ.

Model Calibration

Model calibration was performed for the same summer, low flow day that Heat Source model was calibrated. Modeled flow rates are presented in Figure 2.

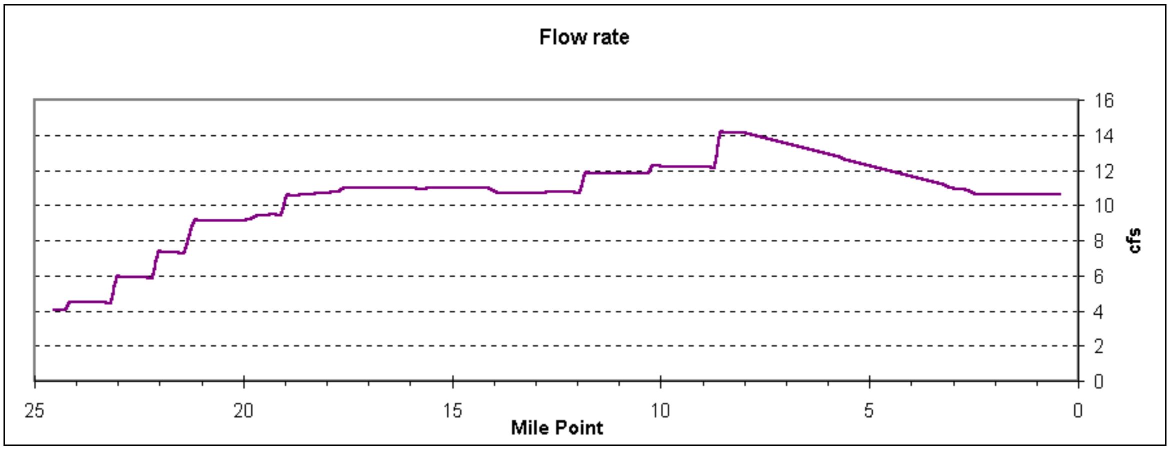

Figure 2. Modeled Flow Rate

Calculated daily average temperatures are presented in Figure 3.

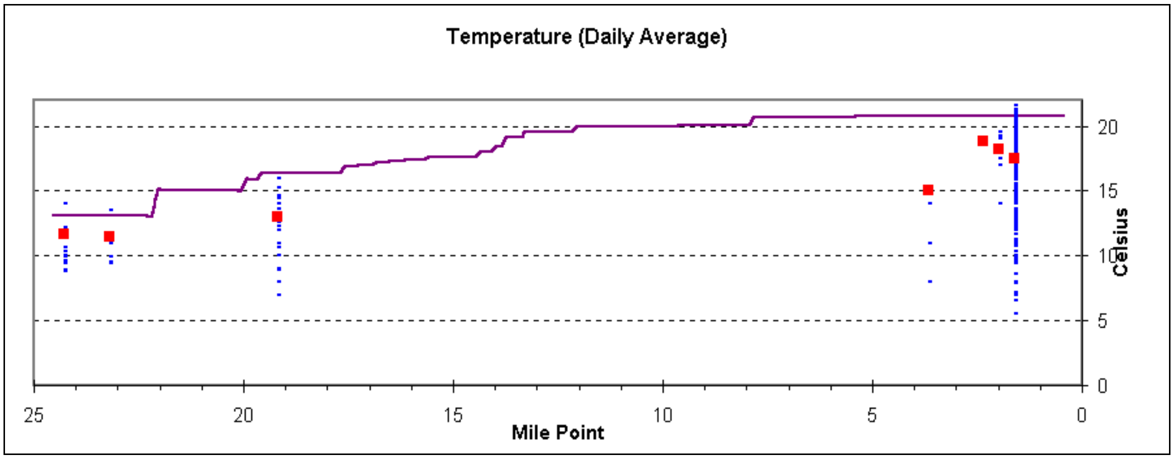

Figure 3. Model Calculated Temperature

Also shown on Figure 3 are the observed summer (June 1 – Sept 30) temperature grabs (small dots) and the medians (large squares) for this data. While comparing calculated daily average temperatures to discrete temperature measurements generally collected in the morning may be akin to comparing apples to oranges, the daily average temperature for day of model calibration does appear to be higher than the median summer temperature. Since dissolved oxygen saturation is inversely related to temperature, the model was calibrated to match dissolved oxygen as a percentage of saturation rather than as an absolute concentration. DO in the system is significantly influenced by SOD. Field observations indicate that upstream from Mile Point 11 benthic sediments are comprised primarily of relatively clean cobble sized rocks. Below MP 11 silt sized sediments prevail. The presence of large quantities of silt indicates that this is a depositional area for solids and likely to have significantly larger SOD rates than the cobble dominated areas. To achieve calibration, SOD below MP 11 was adjusted within the 25th to 75th percentile range of observations for all Tualatin tributaries. An SOD_{20} of 3.0 $g/m^2/day$ was found to produce a good fit to the observed median summer DO (see Figure 4).

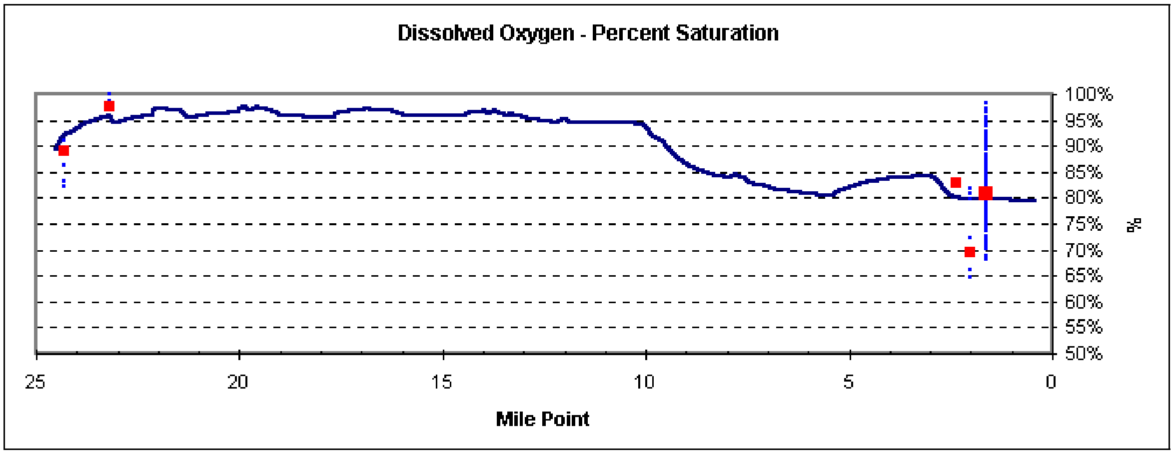

Figure 4. Model Calculated Percent DO Saturation – Calibration vs. Observations

Note that the only station with a large quantity of water quality data is Gales Creek at Hwy 47 Bridge at MP 1.63, so emphasis was placed on insuring that the calculated percent saturation matched the observed percent saturation at this station.

DO calculated by the model below MP 11 was not influenced by the SOD rate above MP 11. Since virtually no data is available for these upper reaches, the SOD rate above MP 11 could not be determined from model calibration. For these reaches SOD was simply set to 50% of the SOD rate of the lower reaches or 1.5 g/m^2/day.

Model calculated dissolved oxygen vs. observed median monthly dissolved oxygen is presented in Figure 5 (upper most curve is DO at saturation, the middle curve is calculated DO, and the bottom curve is the calculated DO deficit, ie, DO at saturation minus the calculated DO).

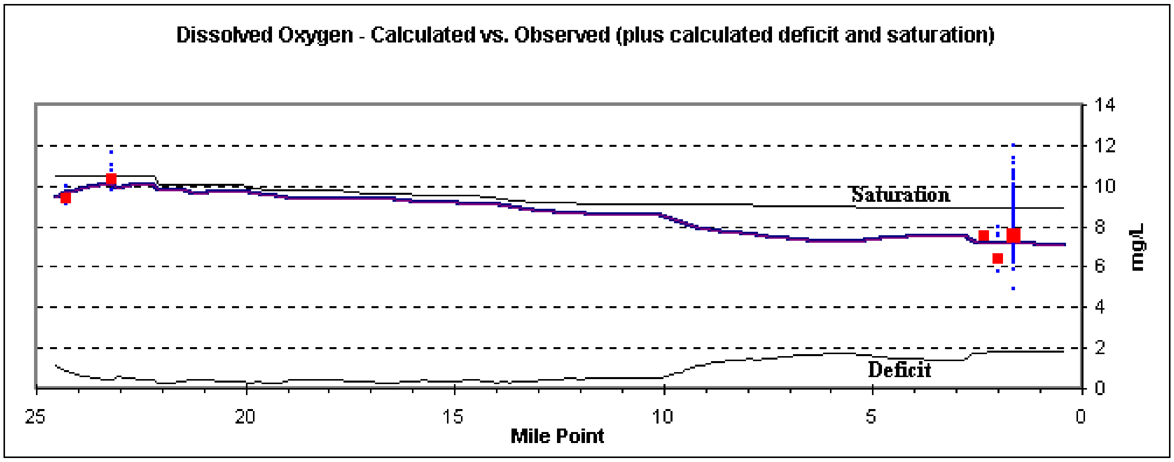

Figure 5. Model Calculated Dissolved Oxygen – Calibration vs. Observations

As shown, the calculated DO deficit is significantly greater in lower reaches than upper reaches.

MODEL SIMULATION 1 – SENSITIVITY TO TEMPERATURE REDUCTION

A simulation was performed to evaluate the impact on DO of the temperature reductions expected for the site potential shade scenario of 100 ft. buffer width, 100 ft. buffer height, and 90% shade density. Heat Source calculated site potential temperature (lower curve) vs. observed calibration temperature (upper curve) is presented in Figure 6.

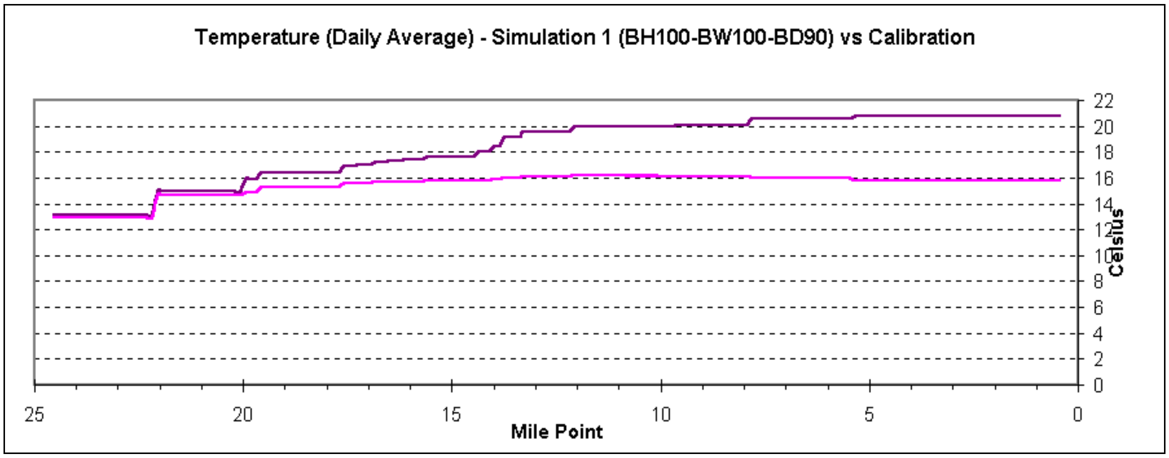

Figure 6. Temperature - Simulation 1 vs. Calibration

As shown, significant temperature reductions are expected for this scenario. QUAL2E calculated DO and percent saturation for this scenario are presented in Figures 7 and 8 (upper curves show site potential shade condition concentrations while lower curves show current calibration condition concentrations).

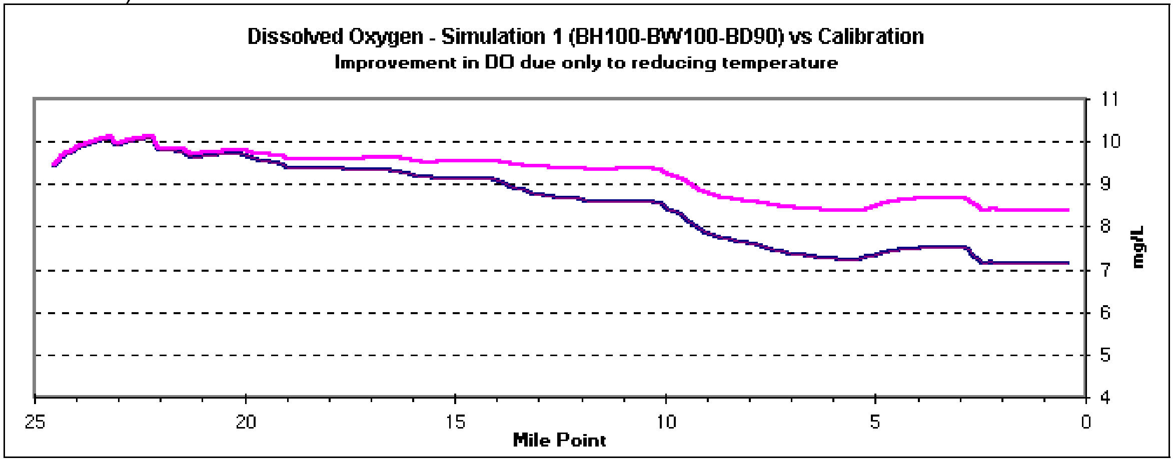

Figure 7. Dissolved Oxygen - Simulation 1 vs. Calibration

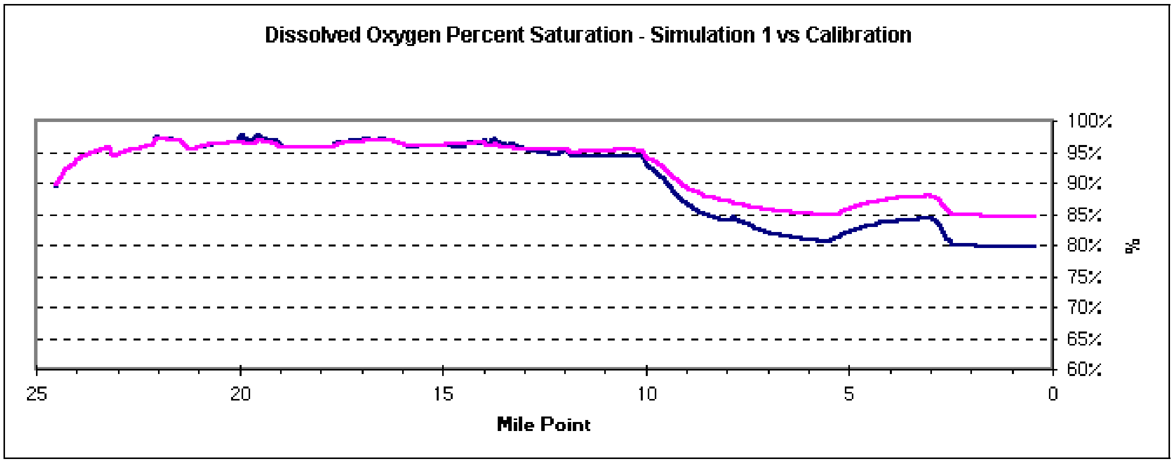

Figure 8. Dissolved Oxygen Percent Saturation - Simulation 1 vs. Calibration

As shown, the model calculates that DO will exceed 8.0 mg/L on a daily average basis for site potential shade scenario. However, the applicable standard for Gales Creek is 8.0 mg/L as an absolute minimum (or where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/L, DO may not be less than 90 percent of saturation). While no data is available on diel DO fluctuation, it is assumed that DO fluctuates somewhat due to temperature fluctuations and their impact on saturation DO. Therefore, a daily average DO of greater than 8.0 mg/L should be targeted.

MODEL SIMULATION 2 – SENSITIVITY TO TEMPERATURE AND SOD REDUCTION

In order to provide a margin of safety to insure that the 8 mg/L dissolved oxygen standard is met at all times, additional model simulations were performed to determine an SOD reduction needed to maintain a daily average DO of 9 mg/L. Upstream from MP 11, Simulation 1 (Figure 8) showed that dissolved oxygen standards should be met simply by reducing temperatures by increasing shade to site potential conditions. Therefore, no SOD reductions are needed in these reaches. Downstream from MP 11, however, SOD reductions are necessary. The model indicates that a 30% reduction in the SOD downstream from MP 11, coupled with site potential shade conditions, will result in a daily average DO of about 9 mg/L or greater throughout the system (see Figure 9, upper curve model simulation vs. lower curve current calibration conditions). In addition, this will result in saturation DO of about 90% or greater (see Figure 10).

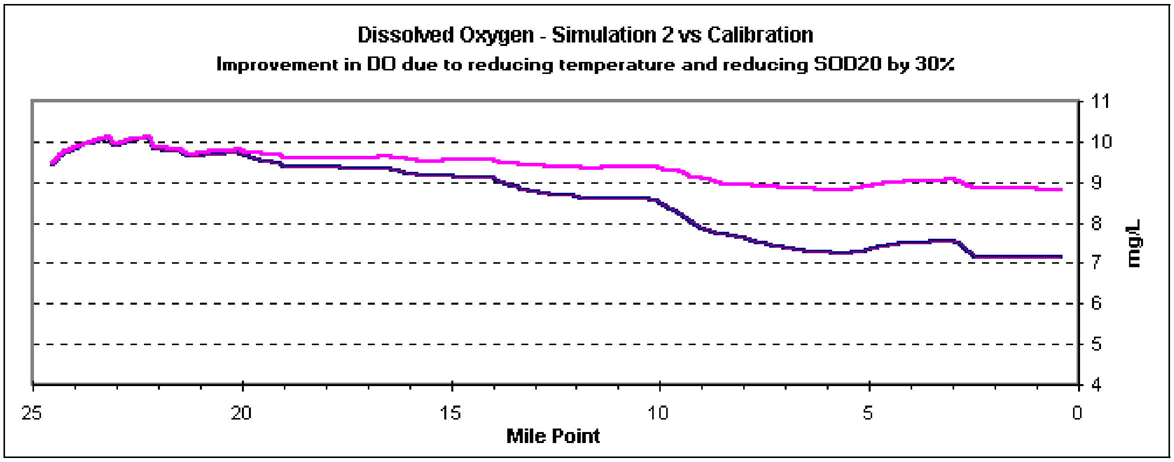

Figure 9. Dissolved Oxygen - Simulation 2 vs. Calibration

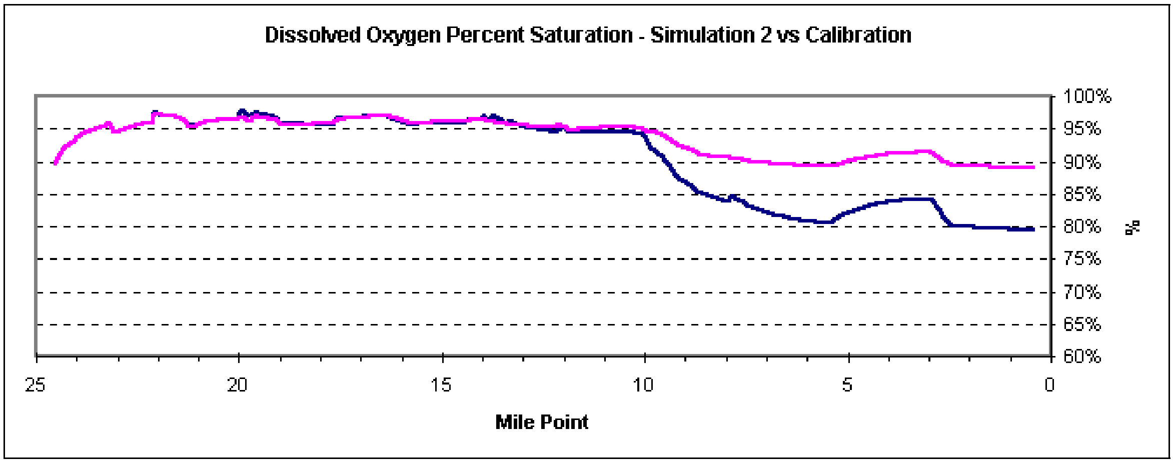

Figure 10. Dissolved Oxygen Saturation - Simulation 2 vs. Calibration

FANNO CREEK WATERSHED

Fanno Creek is located in a heavily urbanized portion of the Tualatin Sub-Basin (see Figure 11). As shown, land uses in the watershed are mostly urban (purple on the map), with limited areas of agriculture (light green) and forestry (dark green).

All reaches of Fanno Creek, as well two of its major tributaries, Ash Creek and Summer Creek, are included on the 303(d) list for failing to meet water quality standards for dissolved oxygen (see dashed red lines on Figure 11).

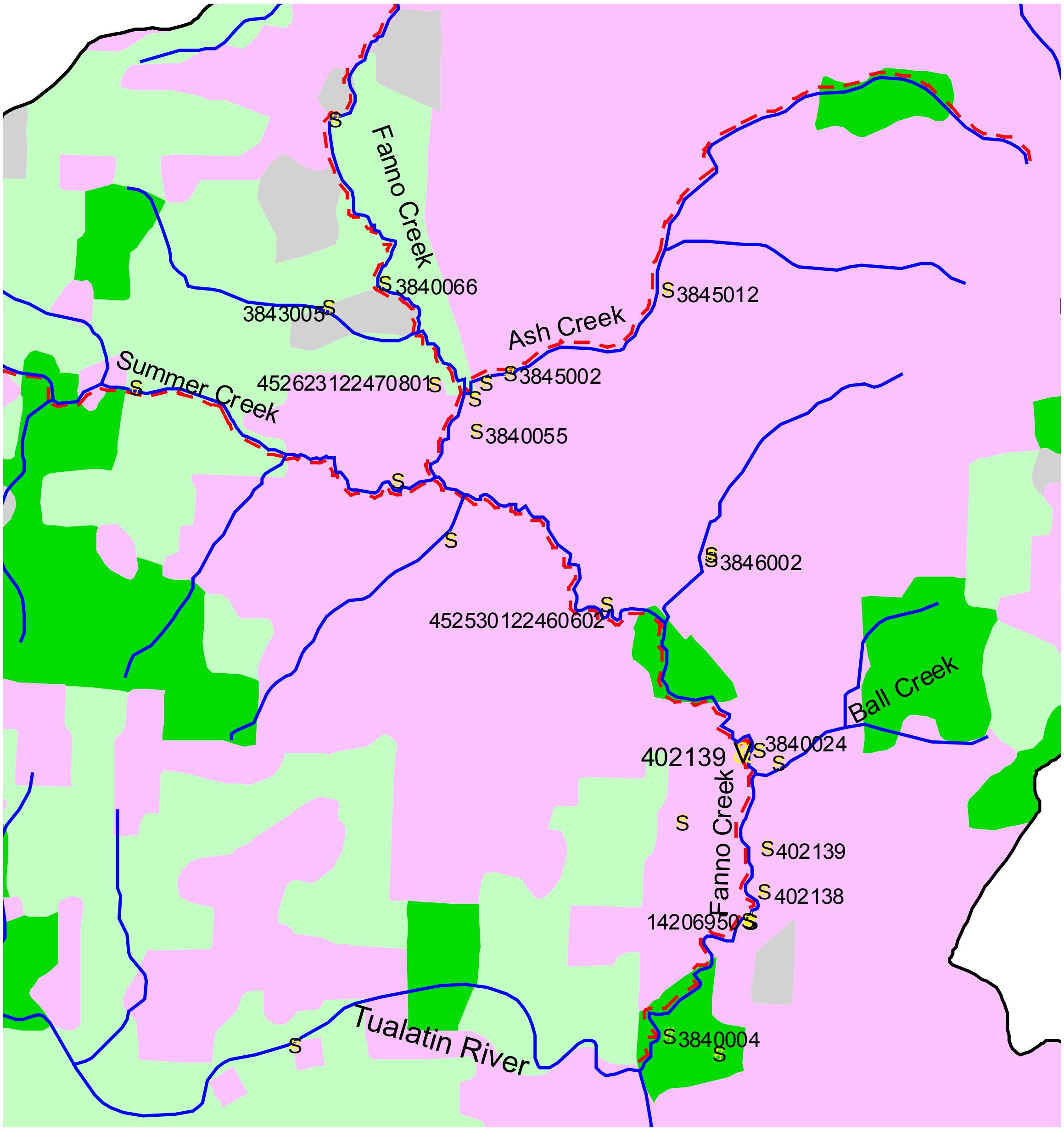

Figure 11. Fannno Creek Watershed

Contributors to Dissolved Oxygen Deficit

Available dissolved oxygen data for Fanno Creek for summer months (July 1 – Sept 30) for the past ten years is presented in Figure 12 (see Appendix D-2 for an explanation of box and whiskers plots). All data is grab sample data, as no continuous DO monitoring data (Hydrolabs, etc.) is available.

Figures 13 through 16 present box plots for DO saturation, chlorophyll a, BOD, and ammonia, respectively.

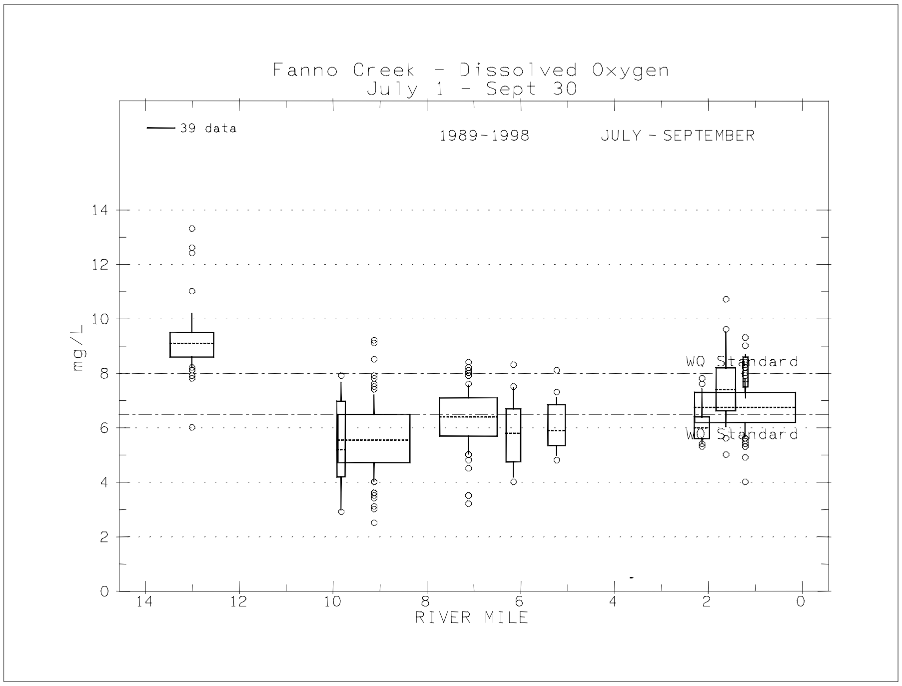

Figure 12. Fanno Creek Dissolved Oxygen

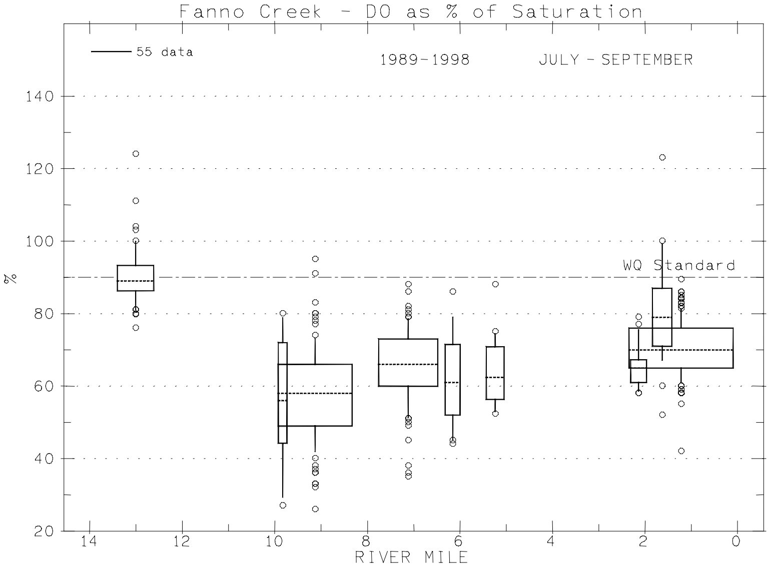

Figure 13. Fanno Creek Dissolved Oxygen - Percent of Saturation

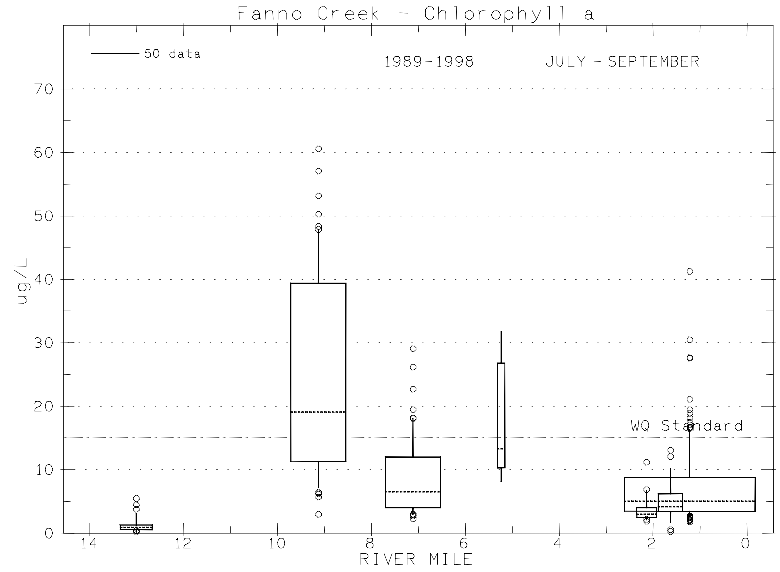

Figure 14. Fanno Creek Chlorophyll a

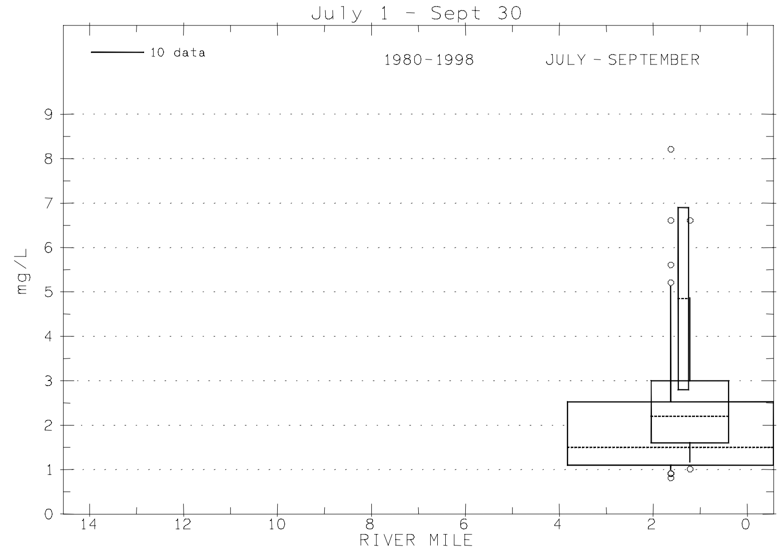

Figure 15. Fanno Creek BOD5

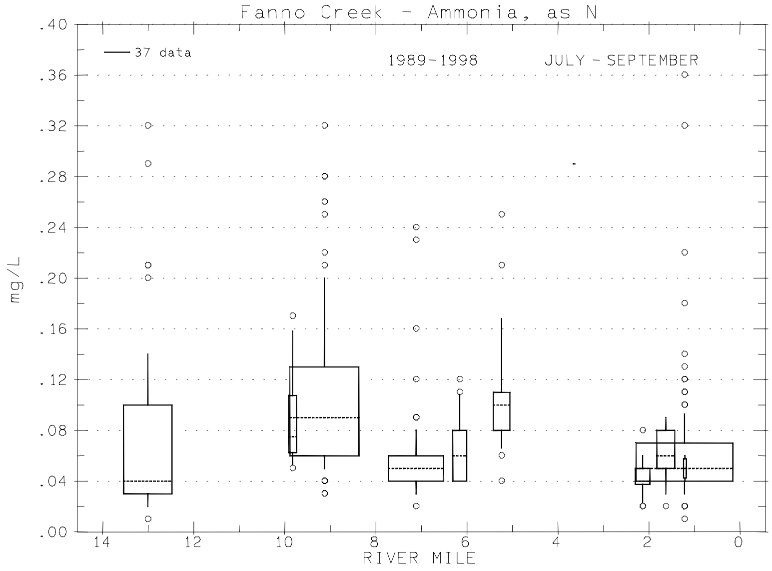

Figure 16. Fanno Creek Ammonia

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Water Quality Modeling

A steady state QUAL2E water quality model was developed of Fanno Creek in order to evaluate the sensitivity of dissolved oxygen concentrations to temperature and sediment oxygen demand. Channel geometry, velocity, flow and temperature inputs to the model were extracted from a temperature model of Fanno Creek developed by DEQ using the modeling framework Heat Source.

MODEL CALIBRATION

Model calibration was performed for the same summer, low flow day that Heat Source model was calibrated. Modeled flow rates are presented in Figure 17.

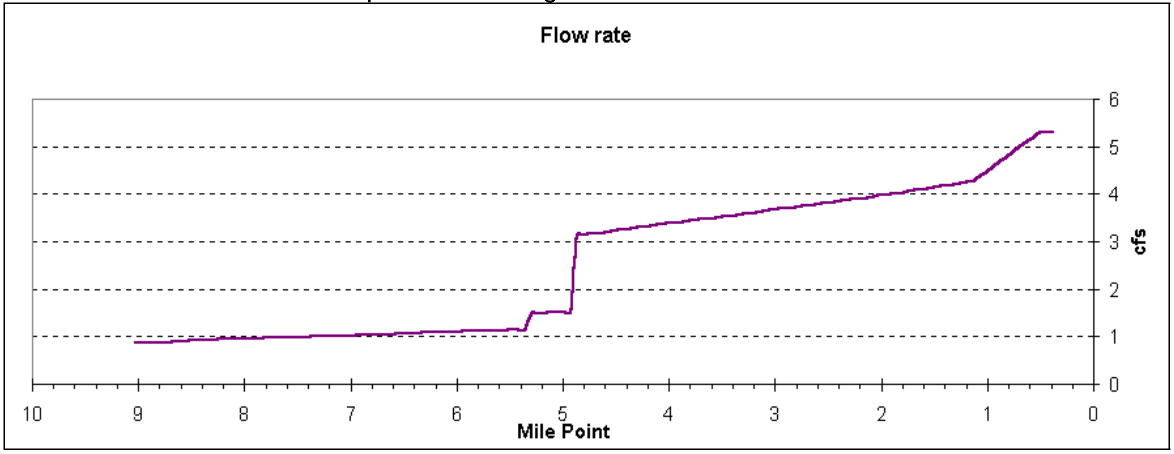


Figure 17. Modeled Flow Rate

Calculated daily average temperatures are presented in Figure 18.

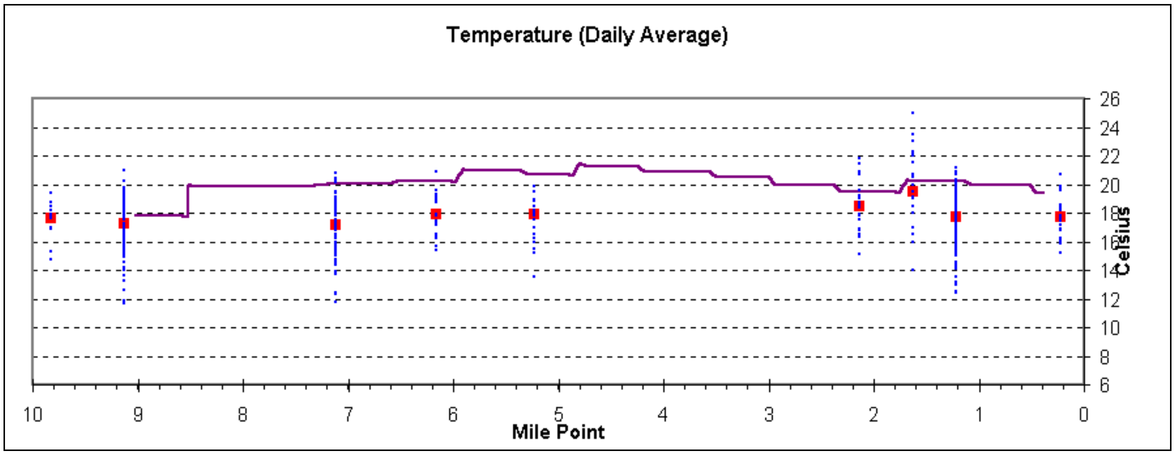


Figure 18. Model Calibration Temperatures

Also shown on Figure 18 are the observed summer (June 1 – Sept 30) temperature grabs (small dots) and the medians (large squares) for this data. As shown, the daily average temperature for day of model calibration may be higher than the median summer temperature. Since dissolved oxygen saturation is inversely related to temperature, the model was calibrated to match dissolved oxygen as a percentage of saturation rather than as an absolute concentration. To achieve calibration, the SOD was adjusted within the 25th to 75th percentile range of observations for all Tualatin tributaries. SOD_{20} rates in the reaches above Ash Creek (MP 7.7) of 2.2 g/m^2/day and below Ash Creek of 3.5 g/m^2/day were found to provide a good fit of saturation DO to the observed median summer values (see Figure 19). The SOD value of 3.5 g/m^2/day is also the median of the observed values at two of three sampling sites on Fanno Creek. The other site, near the mouth of Fanno Creek had SOD values that were below the 10th percentile for all Tualatin tributary SOD data and therefore may not be representative of tributary data.

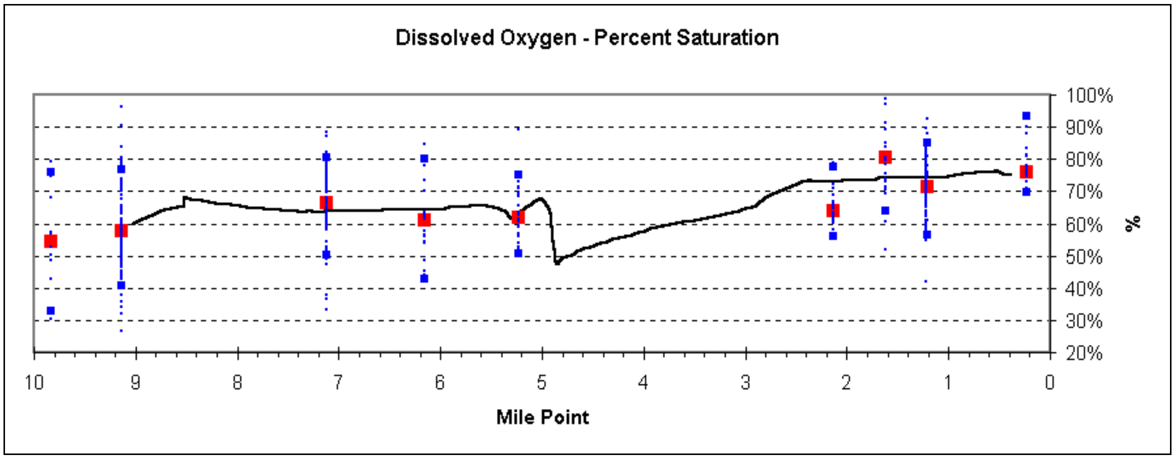


Figure 19. Model Calculated Percent DO Saturation - Calibration vs. Observations

Model calculated dissolved oxygen vs. observed median monthly dissolved oxygen is presented in Figure 20. As shown, the calculated DO matches the observations reasonably well. Also shown on Figure 20 is saturation DO (uppermost curve) and DO deficit. As shown, calculated DO deficits are quite large in the system, ranging from 2 to >4 mg/L.

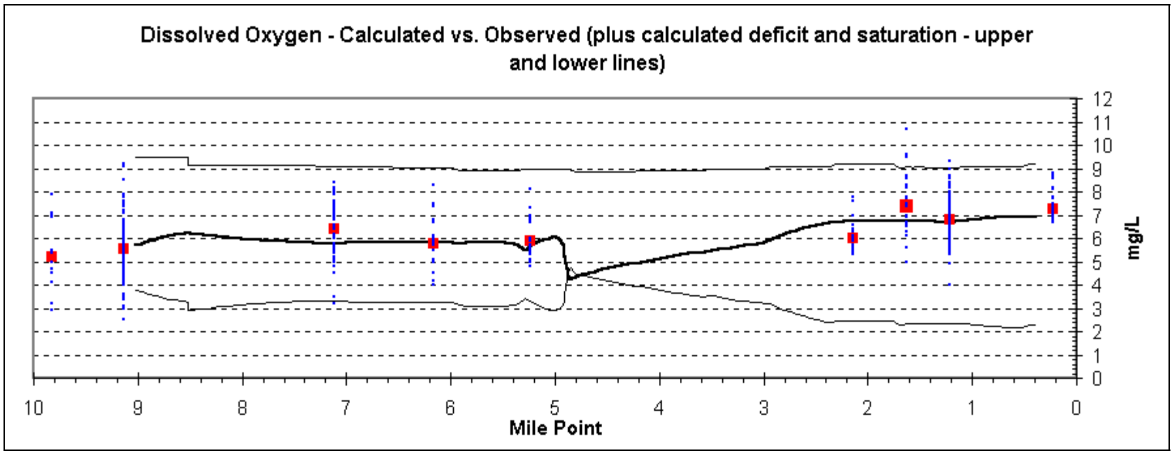


Figure 20. Model Calculated Dissolved Oxygen - Calibration vs. Observations

Since algae is also of potential concern in the system, it was included in the model. Calculated vs. observed chlorophyll a is presented in Figure 21.

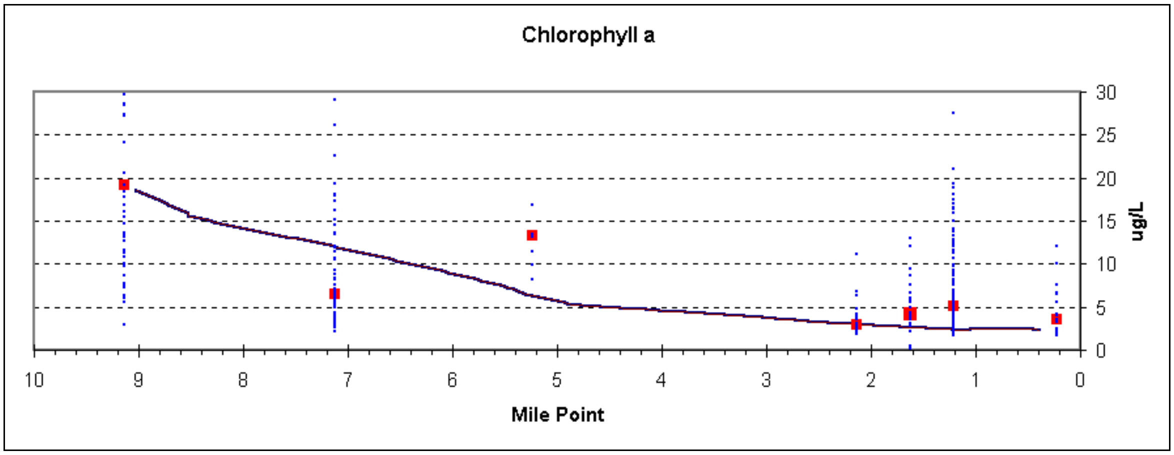


Figure 21. Model Calculated Chlorophyll a (Algae) - Calibration vs. Observations

While chlorophyll a concentrations are large enough in the upper reaches of the stream to be of concern, the model indicated that algae was not a significant contributor to the oxygen balance in the stream. The model indicated that the net daily average quantity of oxygen supplied by algae (photosynthesis minus respiration) equates to less than 10% of the oxygen consumed by sediment oxygen demand.

MODEL SIMULATION – SENSITIVITY TO TEMPERATURE REDUCTION

A simulation was performed to evaluate the impact on DO of the temperature reductions expected for the site potential shade scenario. Heat Source calculated site potential temperature vs. observed calibration temperature is presented in Figure 22.

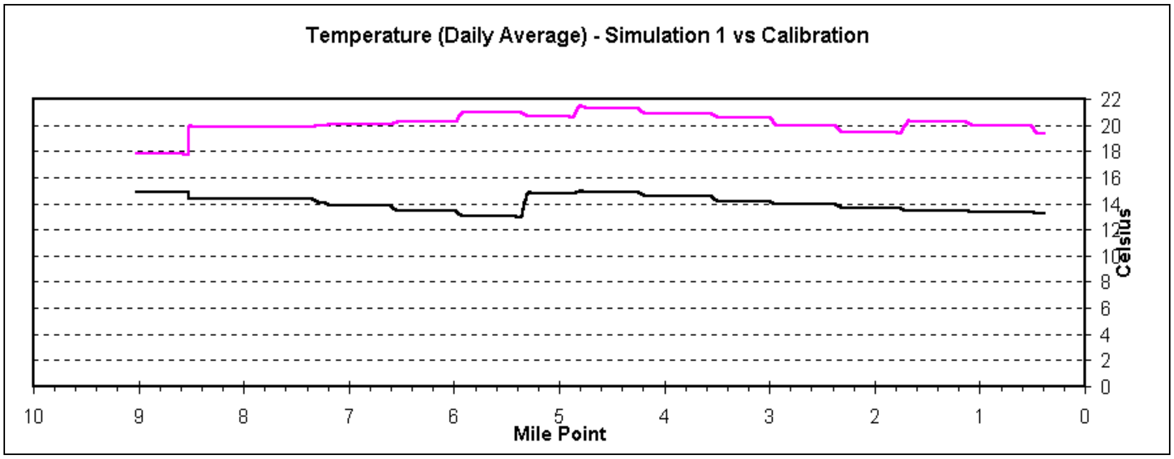


Figure 22. Temperature – Site Potential Shade Scenario vs. Calibration

As shown, significant temperature reductions are expected for this scenario. QUAL2E calculated DO for this scenario is presented in Figures 23 and 24. Three curves are shown on each figure. The lowermost curves show calculated DO and percent saturation for calibration conditions (current conditions). The middle curves show calculated DO and percent saturation for the site potential temperature condition if boundary and tributary DO concentrations are unchanged as percentages of saturation from calibration conditions. The uppermost curve shows calculated DO and percent saturation if boundary and tributary DO concentrations are increased to 75% of saturation.

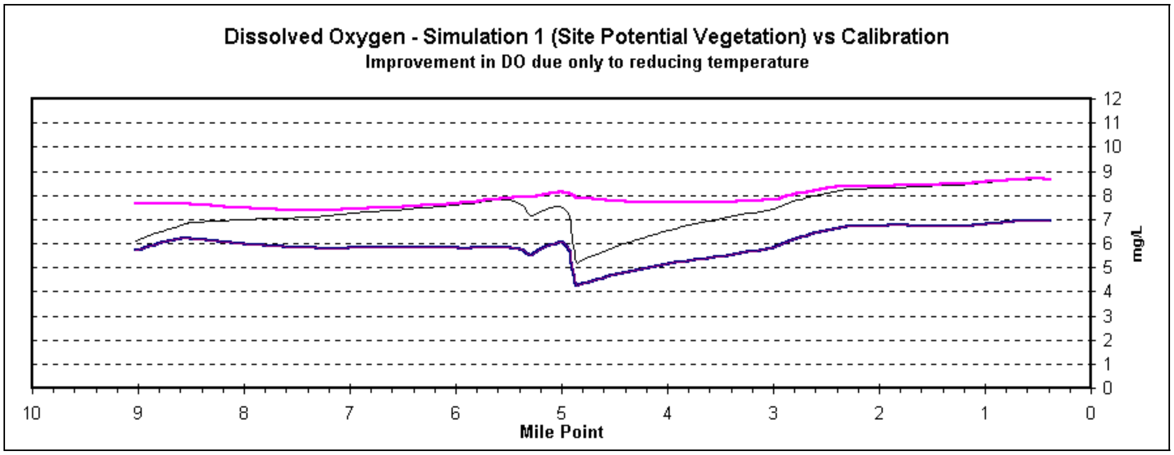


Figure 23. Dissolved Oxygen – Site Potential Shade with No SOD Reduction

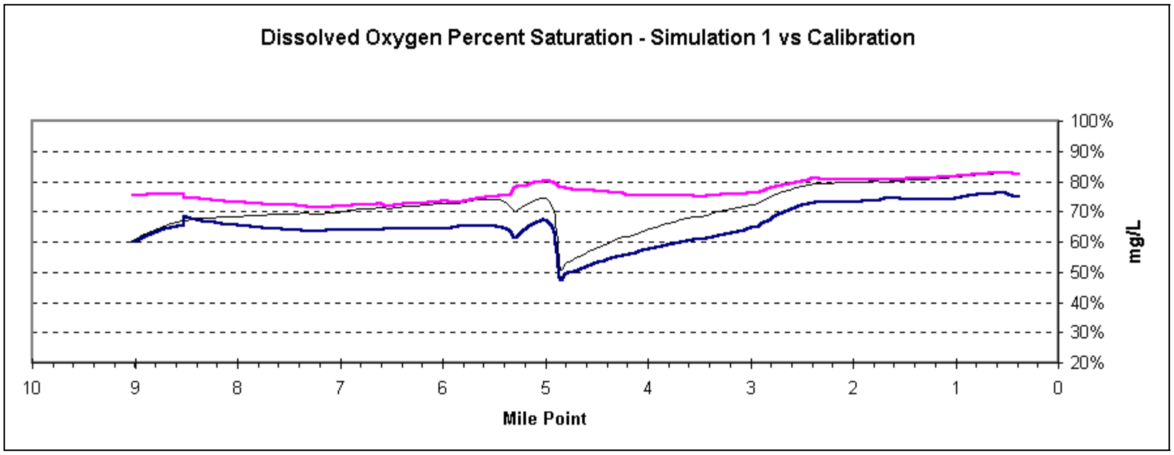


Figure 24. Dissolved Oxygen Saturation – Site Potential Shade with No SOD Reduction

Since the percent shade allocations provide to meet the temperature standard will apply to all reaches of Fanno Creek, as well as Ash and Summer Creeks, it is reasonable to assume that boundary and tributary DO concentrations will be improved by an amount similar to the modeled portions of Fanno Creek. Therefore, the uppermost curves on Figures 23 and 24 are calculated conditions for the site potential scenario. As shown by Figure 23, temperature reductions calculated by Heat Source are expected to improve DO by 1.5 to 2 mg/L. However, the model calculates that the DO standard will still be violated in much of Fanno Creek.

MODEL SIMULATION 2 – SENSITIVITY TO SOD REDUCTION

Additional modeling was performed to determine the percent reduction in SOD needed to maintain a daily average DO of 8.0 mg/L or greater. The model indicated that a 20% reduction in SOD, coupled with site potential shade conditions, will result in daily average DO of 8.0 mg/L or greater in all reaches (see Figures 25 and 26, uppermost curves). Note that for this scenario boundary and tributary DO concentrations were set to 80% of saturation.

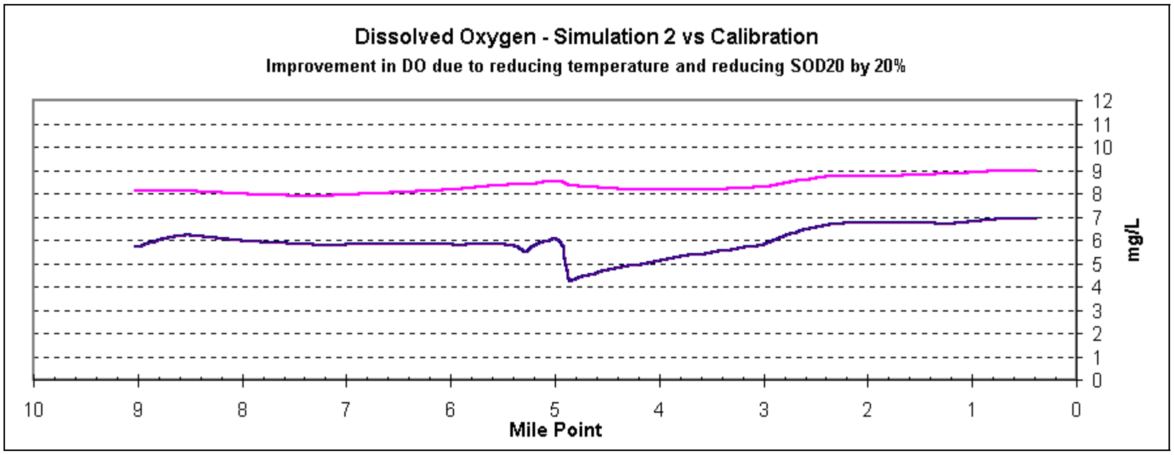


Figure 25. Dissolved Oxygen - Site Potential Shade with 20% SOD Reduction

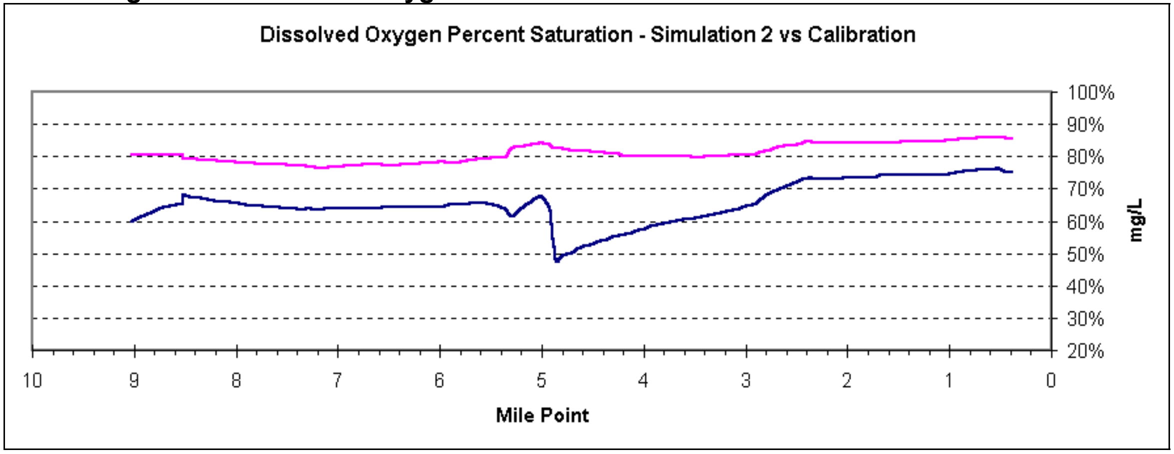


Figure 26. Dissolved Oxygen Percent Saturation - Site Potential Shade with 20% SOD Reduction

While a 20% SOD reduction combined with site potential shade levels will result in a daily average DO of greater than 8.0 mg/L, the applicable standard for Fanno Creek is 8.0 mg/L as an absolute minimum (or where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/L, DO may not be less than 90 percent of saturation). While no data is available on diel DO fluctuation, it is assumed that DO fluctuates somewhat due to temperature fluctuations and their impact on saturation DO, as well as due to algae photosynthesis and respiration. Therefore, a daily average DO of greater than 8.0 mg/L should be targeted.

In order to provide a margin of safety to insure that the DO standard is met at all times, additional model simulations were performed to determine an SOD reduction needed to maintain a daily average DO of 9 mg/L. The model indicates that site potential shade coupled with a 50% reduction in SOD should be sufficient to maintain a daily average DO of about 9 mg/L throughout the system (see Figures 27 and 28, uppermost curves). Note that for this scenario boundary and tributary DO concentrations were set to 90% of saturation for the simulations.

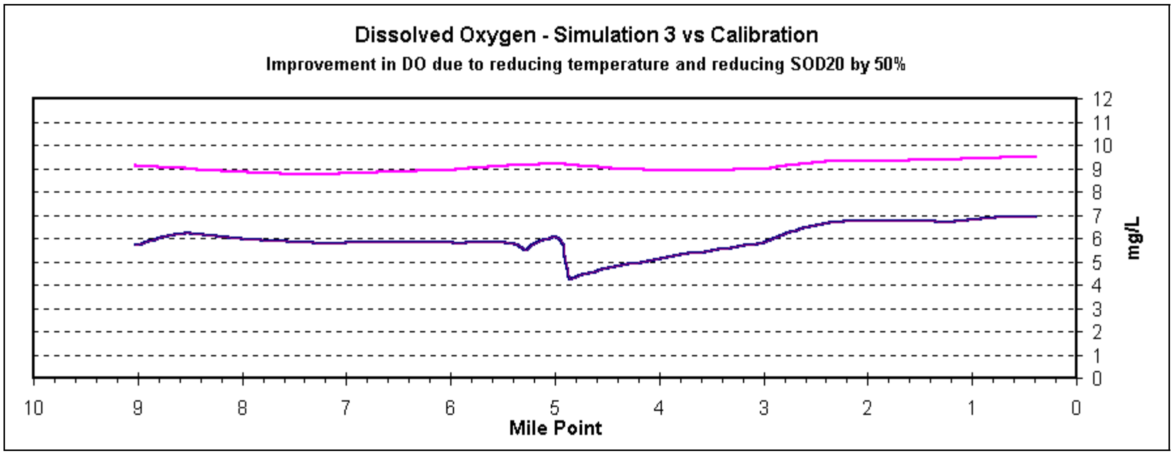


Figure 27. Dissolved Oxygen - Site Potential Shade with 50% SOD Reduction

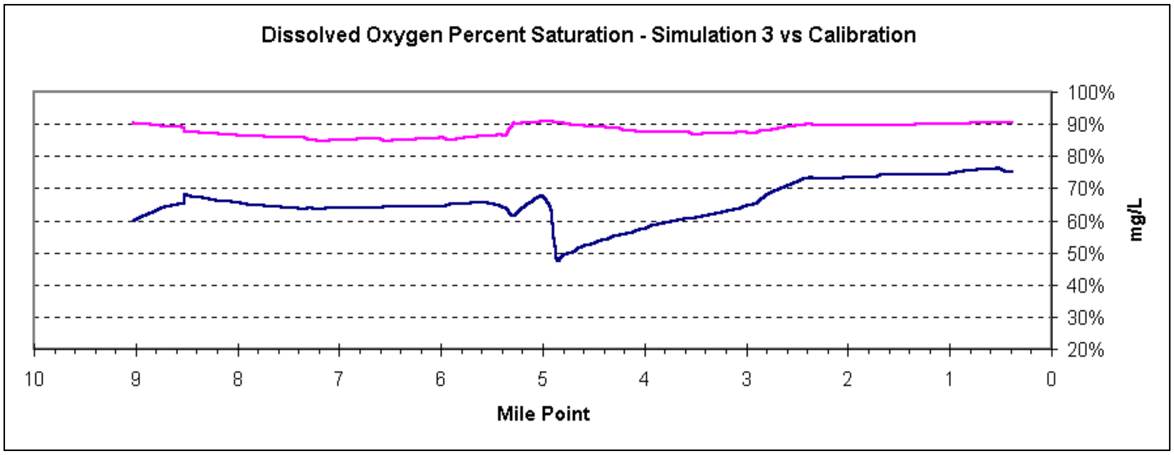


Figure 28. Dissolved Oxygen Percent Saturation – Site Potential Shade with 50% SOD Reduction

LOWER ROCK CREEK AND BEAVERTON CREEK WATERSHED

Rock and Beaverton Creeks are located in the Tualatin Sub-Basin (see Figure 29). Land uses in the watershed are mostly urban (purple on the map) and agricultural (light green), with limited areas of forestry (dark green).

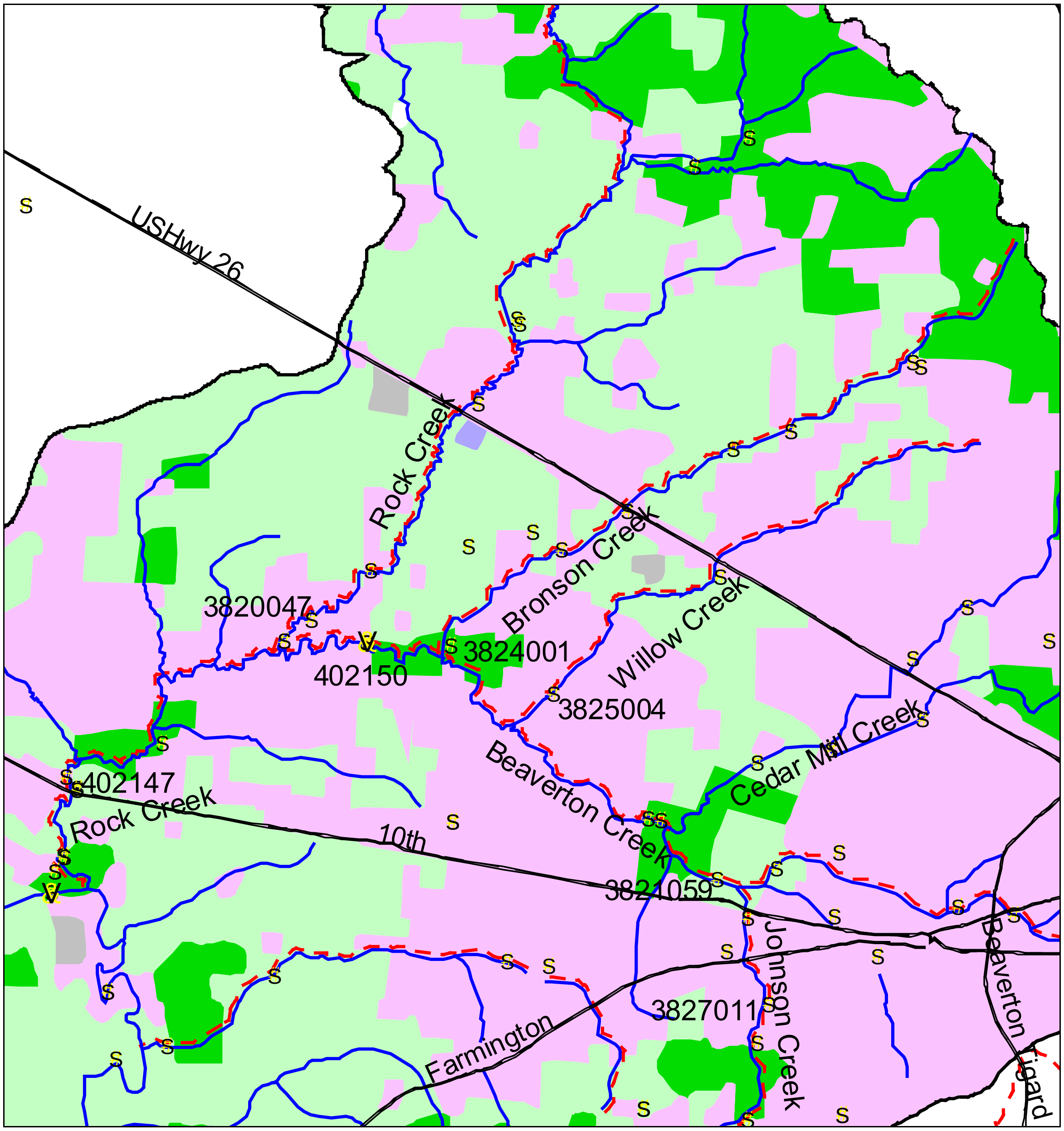


Figure 29. Lower Rock Creek and Beaverton Creek Watershed

Figures 30 through 32 present longitudinal box plots for DO concentration, DO saturation, and chlorophyll a concentration, repectively.

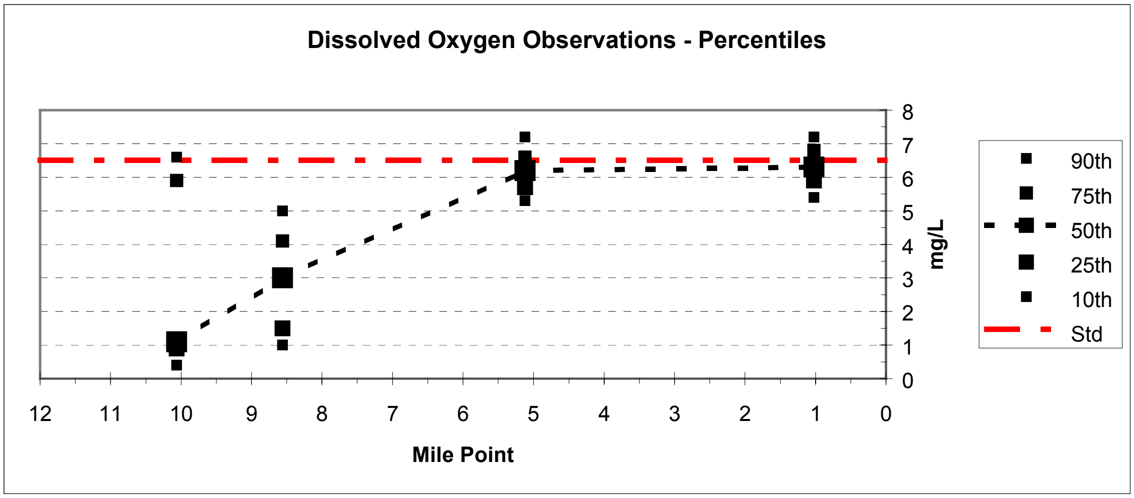


Figure 30. Rock and Beaverton Creek Dissolved Oxygen

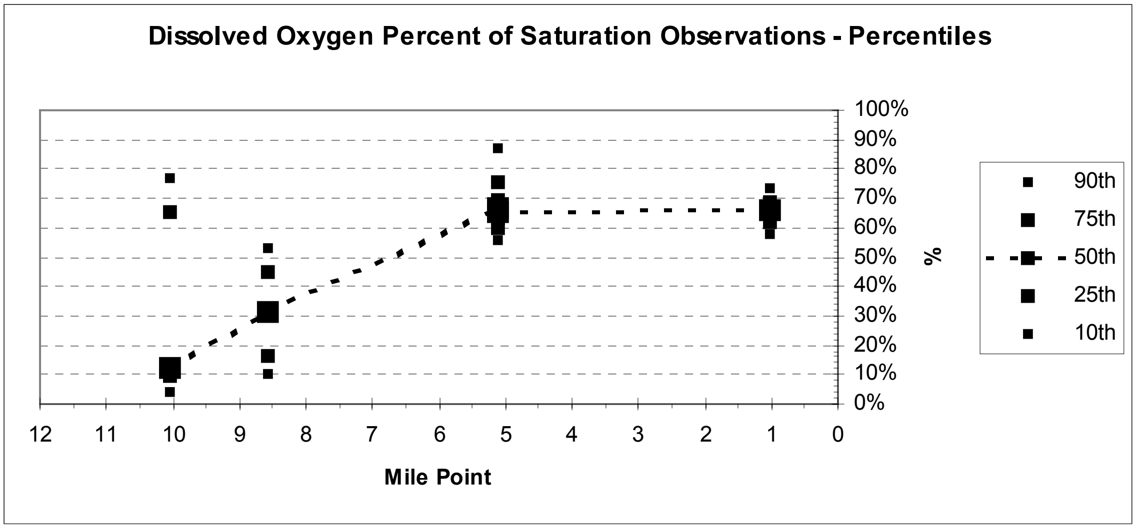


Figure 31. Rock and Beaverton Creek Dissolved Oxygen - Percent of Saturation

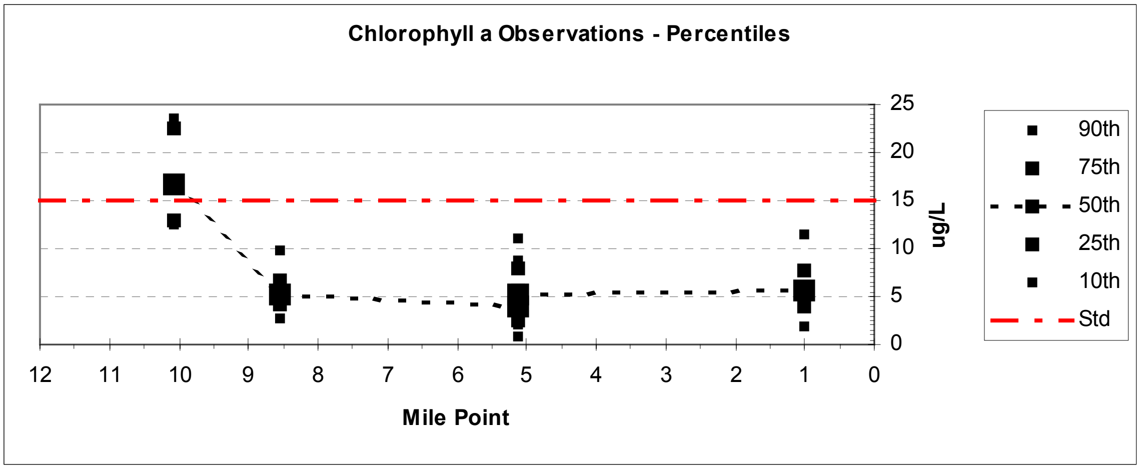


Figure 32. Rock and Beaverton Creek Observed Chlorophyll a

Water Quality Modeling

In order to evaluate the sensitivity of dissolved oxygen concentrations to temperature and sediment oxygen demand, a steady-state QUAL2E water quality model was developed by DEQ of Rock and Beaverton Creeks. Inputs to the model for channel geometry, velocity, flow and temperature were extracted from a Heat Source temperature model of Rock and Beaverton Creeks which was also developed by DEQ.

MODEL CALIBRATION

The model was constructed for the same summer, low flow day for which the Heat Source model was calibrated. However, detailed data on dissolved oxygen and other water quality parameters is not available for this day. Therefore, the model was calibrated on median summer dissolved oxygen concentrations for the past ten years (July 1 through September 30). Modeled flow rates are presented in Figure 33 and daily average temperatures calculated by Heat Source are presented in Figure 34.

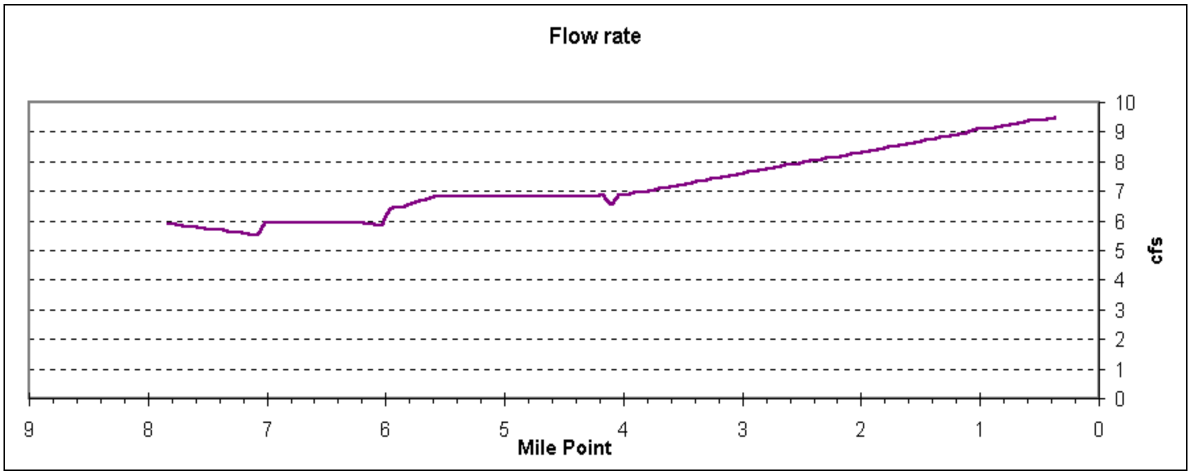


Figure 33. Modeled Flow Rate

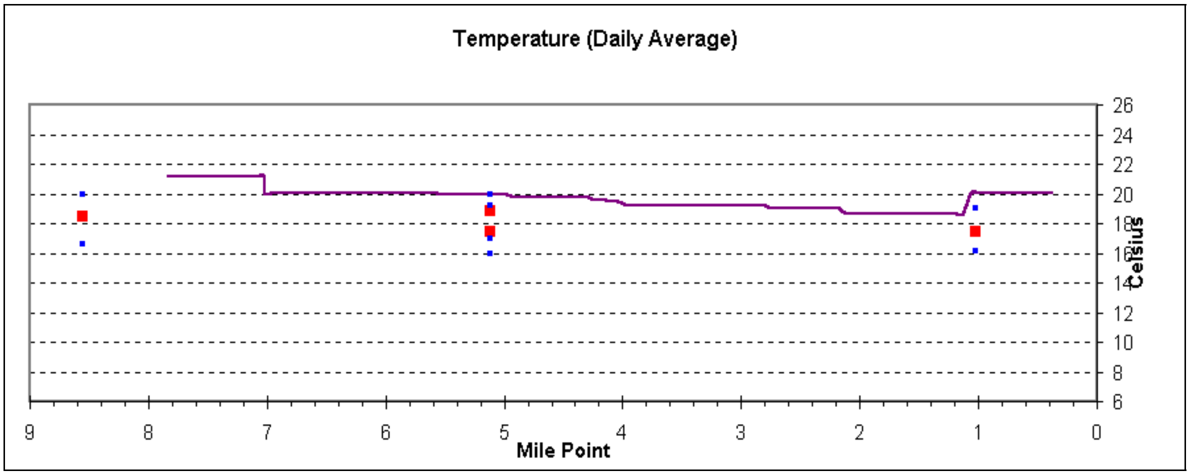


Figure 34. Model Calibration Temperatures

Shown also on Figure 34 are statistical summaries of instantaneous summer temperatures measured over the past 10 years (July 1 – September 30). Median temperatures are shown by large squares and 25th and 75th percentile temperatures are shown by small squares. As shown, the daily average temperature for the day of model calibration is higher than the median summer temperature. Since dissolved oxygen saturation is inversely related to temperature, primary focus during model calibration was placed on matching median dissolved oxygen concentrations as a percentage of saturation, rather that absolute dissolved oxygen concentrations. To achieve calibration the SOD was adjusted within the 25th to 75th percentile range of measured Tualatin Basin SOD rates until the calculated percent saturation matched the observations reasonably well. A uniform SOD_{20} rate of 3.0 $g/m^2/day$ was found to provide a good fit of saturation DO to the median measured summer values (see Figure 35).

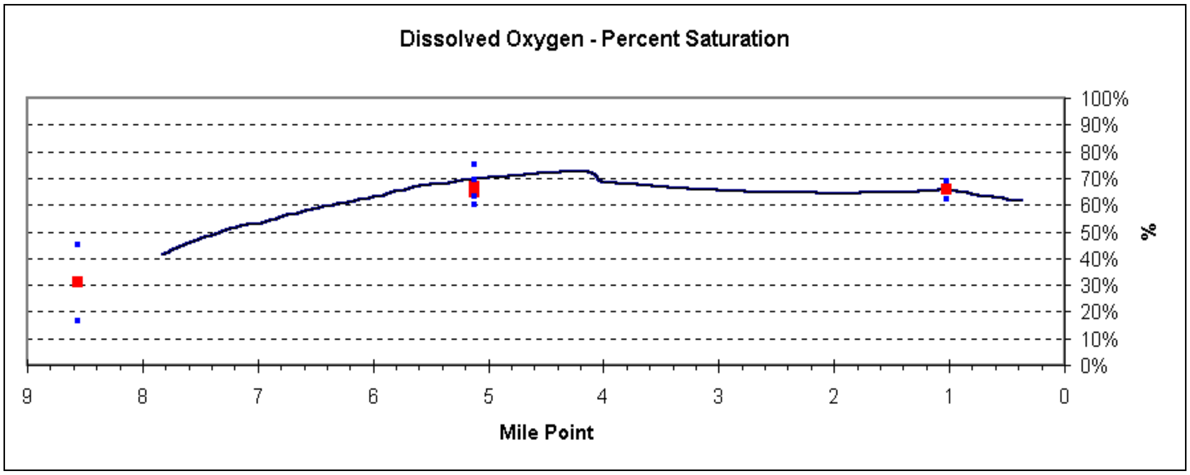


Figure 35. Model Calculated Percent DO Saturation - Calibration vs. Observations

Model calculated dissolved oxygen vs. median measured summer concentrations is presented in Figure 36. As shown, the calculated DO matches the observations reasonably well. Also shown on Figure 36 is saturation DO (uppermost curve) and DO deficit.

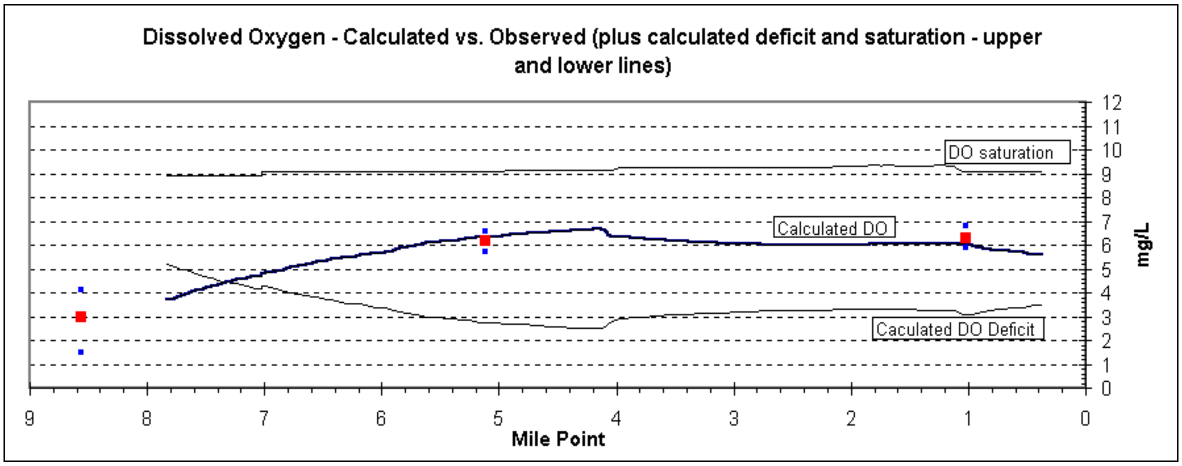


Figure 36. Model Calculated Dissolved Oxygen - Calibration vs. Observations

Since algae is also of potential concern in the system, it was included in the model. Calculated vs. observed chlorophyll a is presented in Figure 37.

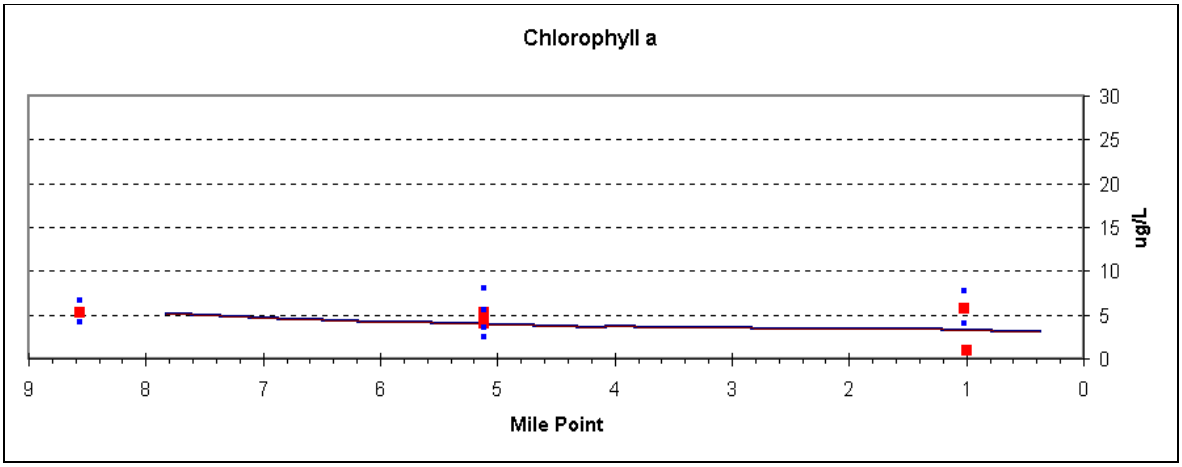


Figure 37. Model Calculated Chlorophyll a (Algae) - Calibration vs. Observations

The model indicated that algae is not a significant contributor to the oxygen balance in the stream relative to sediment oxygen demand.

MODEL SIMULATION 1 – SENSITIVITY TO TEMPERATURE REDUCTION

Heat Source temperature modeling showed that improving shade in the system would result in significant reductions in stream temperature. The QUAL2E model was used to evaluate the impact that the site potential shade scenario would have on the stream. The cooler temperatures calculated by Heat Source for the site potential shade scenario vs. the current critical condition scenario are shown in Figure 38.

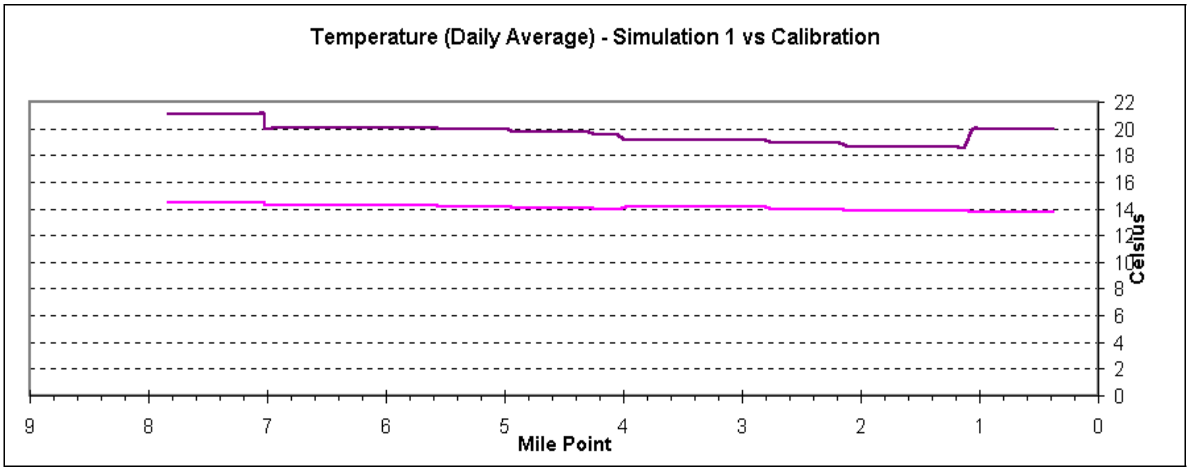


Figure 38. Temperature – Site Potential Shade Scenario vs. Calibration

As shown, significant temperature reductions are expected for this scenario. For this scenario, the QUAL2E calculated dissolved oxygen concentrations are shown on Figures 39 and 40.

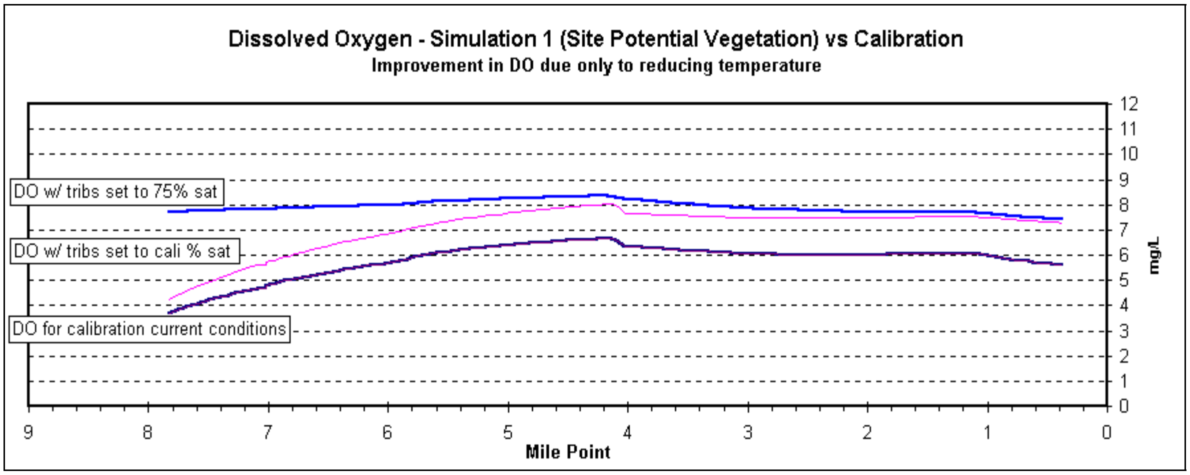


Figure 39. Dissolved Oxygen – Site Potential Shade with No SOD Reduction

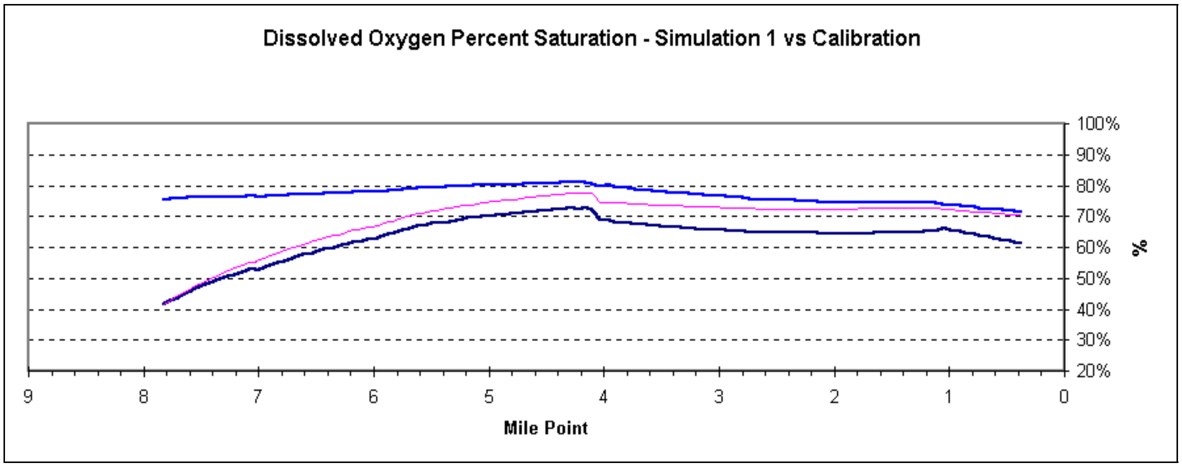


Figure 40. Dissolved Oxygen Percent Saturation – Site Potential Shade with No SOD Reduction

Three curves are shown. The lowermost curves show calculated DO and percent saturation for the current critical condition calibration. The middle curves show calculated DO and percent saturation for the site potential temperature condition if boundary and tributary DO concentrations are unchanged as percentages of saturation from calibration conditions. The uppermost curves show calculated DO and percent saturation if boundary and tributary DO concentrations are increased to 75% of saturation. Since the percent shade allocations provided to meet the temperature standard will apply to all reaches of Beaverton Creek and its tributaries, it is reasonable to assume that boundary and tributary DO concentrations will be improved by an amount similar to the modeled portions of Rock and Beaverton Creeks. Therefore, the uppermost curves are calculated conditions for the site potential scenario. As shown by Figure 39, improving shade will result in significant improvements in dissolved oxygen as well as temperature.

The model indicates that site potential shade levels will result in a daily average DO of greater than 6.5 mg/L. However, the applicable standard for Rock and Beaverton Creeks is 6.5 mg/L as an absolute minimum. While no data is available on diel DO fluctuation, it is assumed that DO fluctuates somewhat due to fluctuations in temperature and its impact on saturation DO, as well as due to algae photosynthesis and respiration. Therefore, a daily average DO of 8.0 mg/L or greater should be targeted.

MODEL SIMULATION 2 – SENSITIVITY TO SOD REDUCTION

Additional modeling was performed to determine the percent reduction in SOD needed to maintain a daily average DO of 8.0 mg/L or greater. The model indicated that a 20% reduction in SOD, coupled with site potential shade conditions, will result in a daily average DO concentration of 8.0 mg/L being met in all reaches (see Figures 41 and 42, uppermost curves). Note that for this scenario boundary and tributary DO concentrations were set to 80% of saturation.

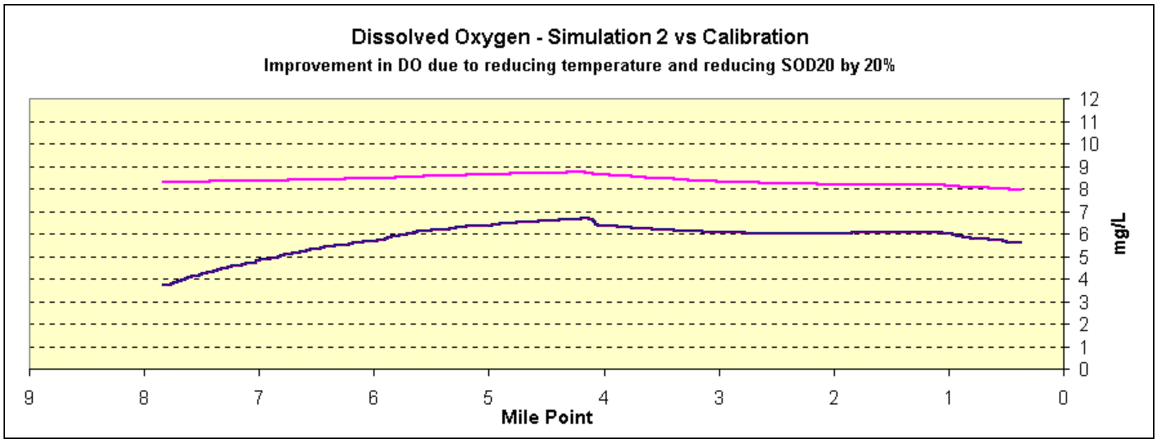


Figure 41. Dissolved Oxygen - Site Potential Shade with 20% SOD Reduction

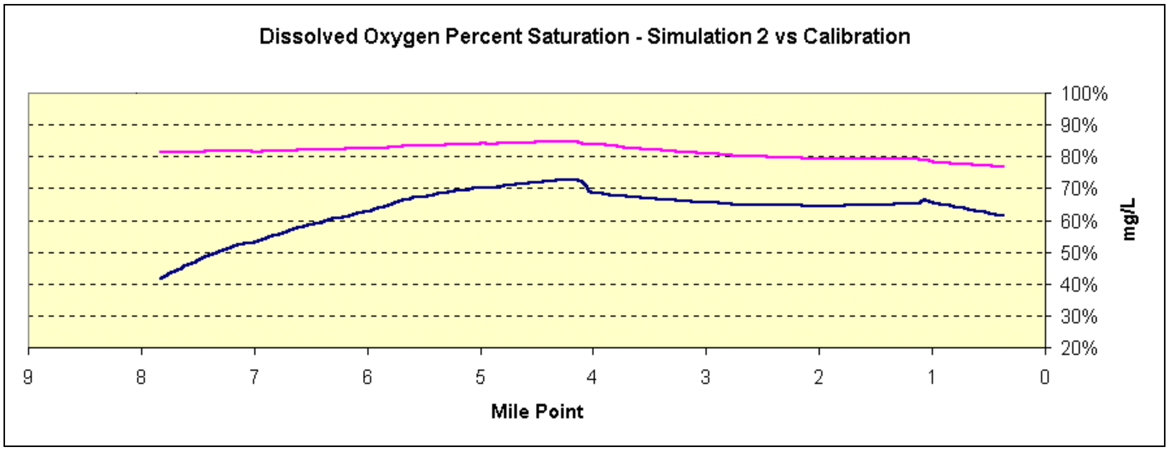


Figure 42. Dissolved Oxygen Saturation - Site Potential Shade with 20% SOD Reduction

The model indicates that a 20% SOD reduction combined with site potential shade levels will result in a daily average DO of 8.0 mg/L and should be adequate to maintain DO concentrations greater than 6.5 mg/L at all times.

Rock and Beaverton Creek Water Quality Data

Rock and Beaverton Cr and Tribs
1989-1998

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
Temp (deg C) (JUL-SEP)								
Rock Cr at HWY 8 Br (USA)	152	11.5	14.7	16.1	17.4	19.0	19.9	22.0
Rock Cr at Quatama Rd	83	10.6	13.4	14.9	16.2	17.7	18.6	20.2
Beaverton Cr at 170th Ave	60	13.6	14.9	16.6	18.5	20.0	20.7	24.6
Beaverton Cr at 216th (DEQ)	26	13.0	14.5	17.0	18.8	20.0	21.1	23.3
Beaverton Cr at 216th (USA)	117	11.3	14.9	16.0	17.4	19.2	20.2	21.8
Beaverton Cr at Millikan Way	26	15.4	16.2	17.7	19.9	20.8	21.6	25.4
Bronson Cr at 205th Ave	42	14.4	15.1	15.9	17.5	18.4	19.9	21.9
Willow Cr at 185th	17	13.9	15.2	16.5	17.7	20.0	21.4	22.2
Cedar Mill Cr at Jay St	43	13.1	14.9	16.1	17.7	18.4	20.1	21.0
Johnson Cr S at Glenbrook	57	13.8	14.5	16.0	17.5	19.0	20.0	22.0
Hall Cr at 110th Ave	58	12.1	14.6	15.5	16.7	17.4	18.9	20.0

Station Name	Number of Observations	Minimum	PERCENTILES 10	 25	 50 (median)	 75	 90	Maximum
BOD (JUL-SEP)								
Beaverton Cr at 216th (DEQ)	26	0.6	0.8	1.0	1.3	1.6	3.4	7.2
Ammonia (JUL-SEP)								
Rock Cr at HWY 8 Br (USA)	127	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Rock Cr at Quatama Rd	77	0.0	0.0	0.0	0.1	0.1	0.2	0.3
Beaverton Cr at 170th Ave	43	0.0	0.0	0.1	0.1	0.1	0.1	0.2
Beaverton Cr at 216th (DEQ)	26	0.0	0.0	0.0	0.1	0.1	0.2	0.7
Beaverton Cr at 216th (USA)	90	0.0	0.0	0.0	0.1	0.1	0.1	0.2
Beaverton Cr at Millikan Way	15	0.0	0.0	0.0	0.1	0.1	0.3	0.3
Bronson Cr at 205th Ave	29	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Willow Cr at 185th	17	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Cedar Mill Cr at Jay St	43	0.0	0.0	0.1	0.1	0.1	0.1	0.5
Johnson Cr S at Glenbrook	39	0.0	0.0	0.1	0.1	0.1	0.2	0.5
Hall Cr at 110th Ave	41	0.0	0.0	0.0	0.0	0.1	0.1	0.3

NO2,3 (JUL-SEP)

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
Rock Cr at HWY 8 Br (USA)	128	0.2	0.3	0.3	0.4	0.6	0.8	1.4
Rock Cr at Quatama Rd	77	0.1	0.2	0.3	0.3	0.4	0.8	1.0
Beaverton Cr at 170th Ave	43	0.1	0.1	0.1	0.2	0.3	0.4	0.6
Beaverton Cr at 216th (DEQ)	26	0.4	0.4	0.5	0.7	0.9	1.3	1.3
Beaverton Cr at 216th (USA)	91	0.2	0.3	0.5	0.7	1.0	1.4	2.5
Beaverton Cr at Millikan Way	15	0.0	0.0	0.0	0.0	0.0	0.2	0.3
Bronson Cr at 205th Ave	30	0.0	0.0	0.1	0.1	0.1	0.1	0.2
Willow Cr at 185th	17	0.1	0.1	0.2	0.2	0.2	0.3	0.3
Cedar Mill Cr at Jay St	43	0.3	0.4	0.5	0.6	0.8	1.0	1.2
Johnson Cr S at Glenbrook	39	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Hall Cr at 110th Ave	41	0.2	0.2	0.2	0.3	0.4	0.5	0.7

TKN (JUL-SEP)

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
Rock Cr at HWY 8 Br (USA)	154	0.3	0.4	0.4	0.4	0.6	0.7	1.2
Rock Cr at Quatama Rd	82	0.3	0.4	0.5	0.6	0.6	0.8	1.5
Beaverton Cr at 170th Ave	61	0.3	0.4	0.5	0.6	0.7	0.8	1.6
Beaverton Cr at 216th (DEQ)	26	0.4	0.4	0.5	0.6	0.7	1.0	1.0
Beaverton Cr at 216th (USA)	118	0.3	0.4	0.4	0.5	0.6	0.7	0.9
Beaverton Cr at Millikan Way	27	0.4	0.6	0.6	0.7	0.8	1.0	5.1
Bronson Cr at 205th Ave	45	0.3	0.3	0.4	0.5	0.6	0.7	0.9
Willow Cr at 185th	17	0.3	0.5	0.5	0.6	0.6	0.9	1.3
Cedar Mill Cr at Jay St	43	0.4	0.4	0.6	0.7	0.8	1.3	1.6
Johnson Cr S at Glenbrook	57	0.3	0.4	0.5	0.6	0.9	1.4	4.6
Hall Cr at 110th Ave	59	0.2	0.3	0.3	0.4	0.5	0.8	1.5

TKN-NH3,4 (Org N) (JUL-SEP)

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
Rock Cr at HWY 8 Br (USA)	125	0.2	0.3	0.4	0.4	0.5	0.6	1.2
Rock Cr at Quatama Rd	76	0.3	0.4	0.4	0.5	0.6	0.8	1.2
Beaverton Cr at 170th Ave	43	0.3	0.3	0.4	0.5	0.6	0.8	1.5
Beaverton Cr at 216th (DEQ)	26	0.1	0.3	0.3	0.5	0.6	0.9	0.9
Beaverton Cr at 216th (USA)	90	0.2	0.3	0.4	0.4	0.5	0.6	0.9
Beaverton Cr at Millikan Way	15	0.4	0.4	0.6	0.6	0.7	2.6	4.9
Bronson Cr at 205th Ave	29	0.3	0.3	0.4	0.4	0.5	0.7	0.8
Willow Cr at 185th	17	0.3	0.4	0.4	0.5	0.6	0.9	1.3
Cedar Mill Cr at Jay St	43	0.3	0.4	0.5	0.6	0.7	1.0	1.5
Johnson Cr S at Glenbrook	39	0.2	0.3	0.4	0.5	1.0	1.6	4.5
Hall Cr at 110th Ave	41	0.2	0.2	0.3	0.4	0.5	0.7	1.4

DO (probe) (JUL-SEP)

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
Rock Cr at HWY 8 Br (USA)	152	3.8	5.4	5.9	6.3	6.8	7.2	8.4
Rock Cr at Quatama Rd	82	1.2	2.4	3.1	4.2	5.1	6.1	6.7
Beaverton Cr at 170th Ave	60	0.1	1.0	1.5	3.0	4.1	5.0	6.9
Beaverton Cr at 216th (USA)	117	3.7	5.3	5.7	6.2	6.6	7.2	8.7
Beaverton Cr at Millikan Way	25	0.4	0.4	0.9	1.1	5.9	6.6	7.2
Bronson Cr at 205th Ave	33	4.1	4.8	5.3	6.0	6.5	7.1	7.3
Willow Cr at 185th	17	2.1	2.3	3.5	4.0	4.6	5.0	5.2
Cedar Mill Cr at Jay St	43	4.2	4.7	5.3	5.9	6.9	7.6	9.2
Johnson Cr S at Glenbrook	56	0.2	0.8	1.7	3.4	4.6	5.9	7.7
Hall Cr at 110th Ave	58	5.5	5.6	6.2	7.3	7.8	8.5	9.2

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
DO (winkler) (JUL-SEP)								
Beaverton Cr at 216th (DEQ)	26	5.7	5.8	5.9	6.4	7.1	8.5	8.6
DO %Sat (JUL-SEP)								
Rock Cr at HWY 8 Br (USA)	151	42.0	58.0	62.0	66.0	69.0	73.8	87.0
Rock Cr at Quatama Rd	82	17.0	25.3	30.0	42.5	52.3	62.7	70.0
Beaverton Cr at 170th Ave	60	1.0	10.1	16.5	31.0	45.0	52.8	71.0
Beaverton Cr at 216th (DEQ)	26	58.0	61.0	63.0	67.0	75.3	86.8	91.0
Beaverton Cr at 216th (USA)	117	37.0	55.9	60.0	65.0	69.5	75.2	88.0
Beaverton Cr at Millikan Way	25	4.0	4.0	9.5	12.0	65.5	76.6	79.0
Bronson Cr at 205th Ave	33	5.2	50.4	57.0	63.0	68.0	74.2	76.0
Willow Cr at 185th	17	23.0	23.0	35.0	42.0	49.0	52.2	57.0
Cedar Mill Cr at Jay St	43	47.0	51.2	57.0	61.0	72.0	80.0	94.0
Johnson Cr S at Glenbrook	56	2.0	8.4	18.3	37.5	50.0	61.3	83.0
Hall Cr at 110th Ave	58	55.0	58.0	64.8	75.0	80.5	86.3	96.0

Chl a (JUL-SEP)

Rock Cr at HWY 8 Br (USA)	149	0.7	1.8	4.0	5.7	7.8	11.4	86.3
Rock Cr at Quatama Rd	64	1.3	2.2	3.6	6.0	10.2	17.9	32.5
Beaverton Cr at 170th Ave	15	2.7	2.8	4.2	5.2	6.6	9.7	10.4
Beaverton Cr at 216th (DEQ)	25	0.2	0.9	2.5	4.0	5.6	8.7	9.8
Beaverton Cr at 216th (USA)	68	1.5	2.1	3.5	5.2	8.0	11.0	15.9
Beaverton Cr at Millikan Way	6	12.6	12.6	12.9	16.7	22.6	23.6	23.6
Bronson Cr at 205th Ave	17	0.7	0.9	1.5	3.0	3.8	6.0	6.6
Johnson Cr S at Glenbrook	36	2.0	2.6	4.2	5.9	9.6	13.8	19.3
Hall Cr at 110th Ave	15	0.7	0.8	1.3	1.6	2.4	5.7	6.1

APPENDIX D-4

APPENDIX D-4 Page 1 - Summary of USGS Model Runs: Predicted Percentage of Time Resulting in DO Violations With Varying WWTP Ammonia Loads - 1991

1991 Simulated 10-ft. Average DO at Elsner (RM 16.2)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs	597	311	190	179	166	178
Med. Monthly	cfs	577	277	187	178	161	165
Avg. T - RM 3.4	C	13.0	16.2	21.2	21.4	18.3	14.2
Rock Ck. NH3	mg/L	0.048	0.037	0.034	0.047	0.043	0.032
Rood Rd. NH3	mg/L	0.110	0.034	0.045	0.033	0.041	0.102
% Time in Violation	30d	0	0	0	0	0	0
at 0 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 50 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% T in Violation	30d	0	0	0	0	0	0
at 100 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 250 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 500 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	2	0
at 750 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	7	81	64
at 1000 lb/d	7d	0	0	0	10	13	0
Ammonia	Min.	0	0	0	3	0	0
% Time in Violation	30d	0	0	0	40	100	100
at 1250 lb/d	7d	0	0	0	16	23	11
Ammonia	Min.	0	0	0	6	2	0
% Time in Violation	30d	0	0	0	50	100	100
at 1500 lb/d	7d	0	0	0	32	37	25
Ammonia	Min.	0	0	0	8	5	0
% Time in Violation	30d	0	0	12	100	100	100
at 2000 lb/d	7d	0	0	0	45	63	54
Ammonia	Min.	0	0	0	18	18	9
% Time in Violation	30d	0	0	27	100	100	100
at 2500 lb/d	7d	0	0	13	58	100	86
Ammonia	Min.	0	0	3	30	33	34
% Time in Violation	30d	0	6	67	100	100	100
at 3000 lb/d	7d	0	0	35	81	100	93
Ammonia	Min.	0	0	7	40	48	66
% Time in Violation	30d	0	60	100	100	100	100
at 3500 lb/d	7d	0	0	55	90	100	96
Ammonia	Min.	0	0	15	53	73	75
% Time in Violation	30d	0	81	100	100	100	100
at 4000 lb/d	7d	0	17	65	100	100	100
Ammonia	Min.	0	0	21	62	91	79
% Time in Violation	30d	0	92	100	100	100	100
at 5000 lb/d	7d	0	43	87	100	100	100
Ammonia	Min.	0	11	35	76	100	84
% Time in Violation	30d	0	100	100	100	100	100
at 6000 lb/d	7d	0	60	100	100	100	100
Ammonia	Min.	0	22	62	89	100	88

1991 Simulated 10-ft. Average DO at Stafford (RM 5.5)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs	597	311	190	179	166	178
Med. Monthly	cfs	577	277	187	178	161	165
Avg. T - RM 3.4	C	13.0	16.2	21.2	21.4	18.3	14.2
Rock Ck. NH3	mg/L	0.048	0.037	0.034	0.047	0.043	0.032
Rood Rd. NH3	mg/L	0.110	0.034	0.045	0.033	0.041	0.102
% Time in Violation	30d	0	0	0	0	0	0
at 0 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 50 lb/d	7d	0	0	0	0	7	0
Ammonia	Min.	0	0	0	0	0	0
% T in Violation	30d	0	0	0	0	0	0
at 100 lb/d	7d	0	0	0	0	10	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 250 lb/d	7d	0	0	0	0	13	0
Ammonia	Min.	0	0	0	0	3	0
% Time in Violation	30d	0	0	0	0	0	0
at 500 lb/d	7d	0	0	0	3	17	0
Ammonia	Min.	0	0	0	1	8	0
% Time in Violation	30d	0	0	0	0	0	0
at 750 lb/d	7d	0	0	0	6	20	0
Ammonia	Min.	0	0	0	2	11	0
% Time in Violation	30d	0	0	0	25	25	31
at 1000 lb/d	7d	0	0	0	10	23	0
Ammonia	Min.	0	0	0	2	12	0
% Time in Violation	30d	0	0	0	34	46	67
at 1250 lb/d	7d	0	0	0	13	23	18
Ammonia	Min.	0	0	0	3	15	2
% Time in Violation	30d	0	0	0	40	68	100
at 1500 lb/d	7d	0	0	0	16	27	57
Ammonia	Min.	0	0	0	3	18	8
% Time in Violation	30d	0	0	0	49	100	100
at 2000 lb/d	7d	0	0	0	23	30	100
Ammonia	Min.	0	0	0	12	28	25
% Time in Violation	30d	0	0	0	60	100	100
at 2500 lb/d	7d	0	0	0	26	90	100
Ammonia	Min.	0	0	0	17	35	71
% Time in Violation	30d	0	0	5	100	100	100
at 3000 lb/d	7d	0	0	10	61	100	100
Ammonia	Min.	0	0	1	23	58	84
% Time in Violation	30d	0	31	24	100	100	100
at 3500 lb/d	7d	0	0	16	81	100	100
Ammonia	Min.	0	0	7	31	78	100
% Time in Violation	30d	0	64	90	100	100	100
at 4000 lb/d	7d	0	3	23	94	100	100
Ammonia	Min.	0	0	11	42	85	100
% Time in Violation	30d	36	100	100	100	100	100
at 5000 lb/d	7d	0	63	61	100	100	100
Ammonia	Min.	0	10	20	67	94	100
% Time in Violation	30d	57	100	100	100	100	100
at 6000 lb/d	7d	0	90	77	100	100	100
Ammonia	Min.	0	27	32	84	97	100

Notes: DO levels were simulated.
Ten foot averages are used since they are considered to be the most representative of waters impacted by nitrification.
Simulated violations are based on the Oregon Administrative Rule for cool water habitat.
Moving thirty day averages were considered violations if they were below 6.5 mg/L.
Moving seven day averages were considered violations if they were below 5.0 mg/L.
Daily values were considered violations if they were below 4.0 mg/L.
Flows, Temperature and Rood Rd./Rock Ck. ammonia levels are instream measurements.

APPENDIX D-4 Page 2 - Summary of USGS Model Runs: Predicted Percentage of Time Resulting in DO Violations With Varying WWTP Ammonia Loads - 1992

1992 Simulated 10-ft. Average DO at Elsner (RM 16.2)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs	356	156	153	136	143	141
Med. Monthly	cfs	263	149	144	130	135	123
Avg. T - RM 3.4	C	17	20.9	21.5	21.5	17.9	14.5
Rock Ck. NH3	mg/L	0.058	0.040	0.058	0.052	0.045	0.028
Rood Rd. NH3	mg/L	0.113	0.025	0.035	0.038	0.041	0.044
% Time in Violation at 0 lb/d Ammonia	30d	0	0	0	0	0	53
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 50 lb/d Ammonia	30d	0	0	0	0	0	59
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% T in Violation at 100 lb/d Ammonia	30d	0	0	0	0	0	67
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 250 lb/d Ammonia	30d	0	0	0	0	0	90
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 500 lb/d Ammonia	30d	0	0	0	0	22	100
	7d	0	0	0	0	0	11
	Min.	0	0	0	0	0	0
% Time in Violation at 750 lb/d Ammonia	30d	0	0	0	0	41	100
	7d	0	0	0	0	7	75
	Min.	0	0	0	0	0	0
% Time in Violation at 1000 lb/d Ammonia	30d	0	0	0	0	59	100
	7d	0	0	0	0	20	100
	Min.	0	0	0	0	2	24
% Time in Violation at 1250 lb/d Ammonia	30d	0	0	0	0	70	100
	7d	0	0	0	0	30	100
	Min.	0	0	0	0	7	56
% Time in Violation at 1500 lb/d Ammonia	30d	0	0	0	10	100	100
	7d	0	0	0	0	73	100
	Min.	0	0	0	0	14	72
% Time in Violation at 2000 lb/d Ammonia	30d	0	0	10	48	100	100
	7d	0	0	16	19	100	100
	Min.	0	0	1	0	35	95
% Time in Violation at 2500 lb/d Ammonia	30d	0	21	92	100	100	100
	7d	0	7	32	52	100	100
	Min.	0	1	9	7	67	99
% Time in Violation at 3000 lb/d Ammonia	30d	0	52	100	100	100	100
	7d	0	17	94	100	100	100
	Min.	0	7	19	29	95	100
% Time in Violation at 3500 lb/d Ammonia	30d	35	100	100	100	100	100
	7d	24	40	100	100	100	100
	Min.	1	15	32	60	99	100
% Time in Violation at 4000 lb/d Ammonia	30d	100	100	100	100	100	100
	7d	40	63	100	100	100	100
	Min.	4	26	53	85	100	100
% Time in Violation at 5000 lb/d Ammonia	30d	100	100	100	100	100	100
	7d	48	100	100	100	100	100
	Min.	21	51	81	99	100	100
% Time in Violation at 6000 lb/d Ammonia	30d	100	100	100	100	100	100
	7d	52	100	100	100	100	100
	Min.	37	73	96	100	100	100

1992 Simulated 10-ft. Average DO at Stafford (RM 5.5)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs	356	156	153	136	143	141
Med. Monthly	cfs	263	149	144	130	135	123
Avg. T - RM 3.4	C	17	20.9	21.5	21.5	17.9	14.5
Rock Ck. NH3	mg/L	0.058	0.040	0.058	0.052	0.045	0.028
Rood Rd. NH3	mg/L	0.113	0.025	0.035	0.038	0.041	0.044
% Time in Violation at 0 lb/d Ammonia	30d	0	0	0	0	0	62
	7d	0	0	0	0	0	11
	Min.	0	0	0	0	0	0
% Time in Violation at 50 lb/d Ammonia	30d	0	0	0	0	0	67
	7d	0	0	0	0	0	21
	Min.	0	0	0	0	0	0
% T in Violation at 100 lb/d Ammonia	30d	0	0	0	0	0	72
	7d	0	0	0	0	0	32
	Min.	0	0	0	0	0	0
% Time in Violation at 250 lb/d Ammonia	30d	0	0	0	0	0	96
	7d	0	0	0	0	0	64
	Min.	0	0	0	0	0	4
% Time in Violation at 500 lb/d Ammonia	30d	0	0	0	4	21	100
	7d	0	0	0	0	0	100
	Min.	0	0	0	0	0	31
% Time in Violation at 750 lb/d Ammonia	30d	0	0	0	65	95	100
	7d	0	0	0	32	13	100
	Min.	0	0	0	1	0	64
% Time in Violation at 1000 lb/d Ammonia	30d	0	0	9	100	100	100
	7d	0	0	0	42	53	100
	Min.	0	0	0	6	4	89
% Time in Violation at 1250 lb/d Ammonia	30d	0	0	35	100	100	100
	7d	0	0	32	55	67	100
	Min.	0	0	0	28	20	96
% Time in Violation at 1500 lb/d Ammonia	30d	0	0	61	100	100	100
	7d	0	0	35	100	80	100
	Min.	0	0	8	46	43	97
% Time in Violation at 2000 lb/d Ammonia	30d	0	8	100	100	100	100
	7d	0	0	48	100	100	100
	Min.	0	0	34	80	73	99
% Time in Violation at 2500 lb/d Ammonia	30d	0	55	100	100	100	100
	7d	0	23	77	100	100	100
	Min.	0	0	44	100	98	100
% Time in Violation at 3000 lb/d Ammonia	30d	0	76	100	100	100	100
	7d	0	77	100	100	100	100
	Min.	0	19	72	100	100	100
% Time in Violation at 3500 lb/d Ammonia	30d	9	100	100	100	100	100
	7d	0	83	100	100	100	100
	Min.	0	43	84	100	100	100
% Time in Violation at 4000 lb/d Ammonia	30d	55	100	100	100	100	100
	7d	0	87	100	100	100	100
	Min.	0	77	91	100	100	100
% Time in Violation at 5000 lb/d Ammonia	30d	100	100	100	100	100	100
	7d	24	97	100	100	100	100
	Min.	6	87	100	100	100	100
% Time in Violation at 6000 lb/d Ammonia	30d	100	100	100	100	100	100
	7d	48	100	100	100	100	100
	Min.	16	91	100	100	100	100

Notes: DO levels were simulated.
Ten foot averages are used since they are considered to be the most representative of waters impacted by nitrification.
Simulated violations are based on the Oregon Administrative Rule for cool water habitat.
Moving thirty day averages were considered violations if they were below 6.5 mg/L.
Moving seven day averages were considered violations if they were below 5.0 mg/L.
Daily values were considered violations if they were below 4.0 mg/L.
Flows, Temperature and Rood Rd./Rock Ck. ammonia levels are instream measurements.

APPENDIX D-4 Page 3 - Summary of USGS Model Runs: Predicted Percentage of Time Resulting in DO Violations With Varying WWTP Ammonia Loads - 1993

1993 Simulated 10-ft. Average DO at Elsner (RM 16.2)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs	1021	566	214	157	204	186
Med. Monthly	cfs	952	453	215	158	195	180
Avg. T - RM 3.4	C	15.3	17.3	18.8	20.8	17.5	14.5
Rock Ck. NH3	mg/L	0.034	0.035	0.024	0.026	0.041	0.038
Rood Rd. NH3	mg/L	0.100	0.088	0.033	0.076	0.024	0.045
% Time in Violation	30d	0	0	0	0	0	0
at 0 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 50 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% T in Violation	30d	0	0	0	0	0	0
at 100 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 250 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 500 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 750 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	20	0	64
at 1000 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	67	7	100
at 1250 lb/d	7d	0	0	0	16	0	11
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	2	100	35	100
at 1500 lb/d	7d	0	0	0	45	0	29
Ammonia	Min.	0	0	0	3	0	0
% Time in Violation	30d	0	0	65	100	100	100
at 2000 lb/d	7d	0	0	0	68	23	64
Ammonia	Min.	0	0	0	19	0	13
% Time in Violation	30d	0	0	83	100	100	100
at 2500 lb/d	7d	0	0	29	71	40	79
Ammonia	Min.	0	0	0	38	6	30
% Time in Violation	30d	0	0	97	100	100	100
at 3000 lb/d	7d	0	0	58	77	50	96
Ammonia	Min.	0	0	2	61	17	64
% Time in Violation	30d	0	7	100	100	100	100
at 3500 lb/d	7d	0	0	65	94	60	100
Ammonia	Min.	0	0	8	73	35	77
% Time in Violation	30d	0	18	100	100	100	100
at 4000 lb/d	7d	0	0	87	100	67	100
Ammonia	Min.	0	0	37	78	44	84
% Time in Violation	30d	0	35	100	100	100	100
at 5000 lb/d	7d	0	3	100	100	80	100
Ammonia	Min.	0	0	71	86	52	91
% Time in Violation	30d	0	45	100	100	100	100
at 6000 lb/d	7d	0	10	100	100	100	100
Ammonia	Min.	0	2	84	91	62	99

1993 Simulated 10-ft. Average DO at Stafford (RM 5.5)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs	1021	566	214	157	204	186
Med. Monthly	cfs	952	453	215	158	195	180
Avg. T - RM 3.4	C	15.3	17.3	18.8	20.8	17.5	14.5
Rock Ck. NH3	mg/L	0.034	0.035	0.024	0.026	0.041	0.038
Rood Rd. NH3	mg/L	0.100	0.088	0.033	0.076	0.024	0.045
% Time in Violation	30d	0	0	0	0	0	0
at 0 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	0
at 50 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% T in Violation	30d	0	0	0	0	0	0
at 100 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	8
at 250 lb/d	7d	0	0	0	0	0	0
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	33
at 500 lb/d	7d	0	0	0	0	0	14
Ammonia	Min.	0	0	0	0	0	0
% Time in Violation	30d	0	0	0	0	0	88
at 750 lb/d	7d	0	0	0	0	0	43
Ammonia	Min.	0	0	0	0	0	2
% Time in Violation	30d	0	0	0	0	10	100
at 1000 lb/d	7d	0	0	26	3	0	75
Ammonia	Min.	0	0	0	0	0	11
% Time in Violation	30d	0	0	14	26	24	100
at 1250 lb/d	7d	0	0	32	16	0	82
Ammonia	Min.	0	0	0	1	0	30
% Time in Violation	30d	0	0	36	40	32	100
at 1500 lb/d	7d	0	0	39	26	0	86
Ammonia	Min.	0	0	1	5	0	45
% Time in Violation	30d	0	0	57	100	100	100
at 2000 lb/d	7d	0	0	48	39	3	89
Ammonia	Min.	0	0	24	18	0	84
% Time in Violation	30d	0	0	66	100	100	100
at 2500 lb/d	7d	0	0	55	52	93	100
Ammonia	Min.	0	0	44	34	2	86
% Time in Violation	30d	0	0	74	100	100	100
at 3000 lb/d	7d	0	0	58	74	100	100
Ammonia	Min.	0	0	48	42	30	86
% Time in Violation	30d	0	0	81	100	100	100
at 3500 lb/d	7d	0	0	61	87	100	100
Ammonia	Min.	0	0	51	53	77	97
% Time in Violation	30d	0	0	89	100	100	100
at 4000 lb/d	7d	0	0	65	100	100	100
Ammonia	Min.	0	0	54	67	94	100
% Time in Violation	30d	0	5	100	100	100	100
at 5000 lb/d	7d	0	0	74	100	100	100
Ammonia	Min.	0	0	64	81	100	100
% Time in Violation	30d	0	36	100	100	100	100
at 6000 lb/d	7d	0	0	97	100	100	100
Ammonia	Min.	0	0	73	88	100	100

Notes: DO levels were simulated.
Ten foot averages are used since they are considered to be the most representative of waters impacted by nitrification.
Simulated violations are based on the Oregon Administrative Rule for cool water habitat.
Moving thirty day averages were considered violations if they were below 6.5 mg/L.
Moving seven day averages were considered violations if they were below 5.0 mg/L.
Daily values were considered violations if they were below 4.0 mg/L.
Flows, Temperature and Rood Rd./Rock Ck. ammonia levels are instream measurements.

APPENDIX D-4 Page 4 - Summary of USGS Model Runs: Predicted Percentage of Time Resulting in DO Violations With Varying WWTP Ammonia Loads - 1996

1996 Simulated 10-ft. Average DO at Elsner (RM 16.2)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs						
Med. Monthly	cfs	1794	379	200	200	196	299
Avg. T - RM 3.4	C						
Rock Ck. NH3	mg/L						
Rood Rd. NH3	mg/L						
% Time in Violation at 0 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 50 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% T in Violation at 100 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 250 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 500 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 750 lb/d Ammonia	30d	0	0	0	10	4	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 1000 lb/d Ammonia	30d	0	0	0	63	30	33
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0

1996 Simulated 10-ft. Average DO at Stafford (RM 5.5)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs						
Med. Monthly	cfs	1794	379	200	200	196	299
Avg. T - RM 3.4	C						
Rock Ck. NH3	mg/L						
Rood Rd. NH3	mg/L						
% Time in Violation at 0 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 50 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% T in Violation at 100 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 250 lb/d Ammonia	30d	0	0	0	0	14	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 500 lb/d Ammonia	30d	0	0	0	0	57	40
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 750 lb/d Ammonia	30d	0	0	0	0	97	61
	7d	0	0	0	0	6	3
	Min.	0	0	0	0	0	0
% Time in Violation at 1000 lb/d Ammonia	30d	0	0	0	10	100	75
	7d	0	0	0	13	10	14
	Min.	0	0	0	0	0	0

Ten foot averages are used since they are considered to be the most representative of waters impacted by nitrification.
Simulated violations are based on the Oregon Administrative Rule for cool water habitat.
Moving thirty day averages were considered violations if they were below 6.5 mg/L.
Moving seven day averages were considered violations if they were below 5.0 mg/L.
Daily values were considered violations if they were below 4.0 mg/L.
Flows, Temperature and Rood Rd./Rock Ck. ammonia levels are instream measurements.

APPENDIX D-4 Page 5 - Summary of USGS Model Runs: Predicted Percentage of Time Resulting in DO Violations With Varying WWTP Ammonia Loads 1997

1997 Simulated 10-ft. Average DO at Elsner (RM 16.2)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs						
Med. Monthly	cfs	492	394	193	190	283	695
Avg. T - RM 3.4	C						
Rock Ck. NH3	mg/L						
Rood Rd. NH3	mg/L						
% Time in Violation at 0 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 50 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% T in Violation at 100 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 250 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 500 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 750 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 1000 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0

1997 Simulated 10-ft. Average DO at Stafford (RM 5.5)

Farm. Flows:		May	June	July	Aug	Sept.	Oct.
Avg. Monthly	cfs						
Med. Monthly	cfs	492	394	193	190	283	695
Avg. T - RM 3.4	C						
Rock Ck. NH3	mg/L						
Rood Rd. NH3	mg/L						
% Time in Violation at 0 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 50 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% T in Violation at 100 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 250 lb/d Ammonia	30d	0	0	0	0	0	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 500 lb/d Ammonia	30d	0	0	0	0	8	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 750 lb/d Ammonia	30d	0	0	0	0	33	0
	7d	0	0	0	0	0	0
	Min.	0	0	0	0	0	0
% Time in Violation at 1000 lb/d Ammonia	30d	0	0	0	13	60	0
	7d	0	0	0	6	0	0
	Min.	0	0	0	0	0	0

Notes: DO levels were simulated.
Ten foot averages are used since they are considered to be the most representative of waters impacted by nitrification.
Simulated violations are based on the Oregon Administrative Rule for cool water habitat.
Moving thirty day averages were considered violations if they were below 6.5 mg/L.
Moving seven day averages were considered violations if they were below 5.0 mg/L.
Daily values were considered violations if they were below 4.0 mg/L.
Flows, Temperature and Rood Rd./Rock Ck. ammonia levels are instream measurements.

APPENDIX D-5

Appendix D-5 Page 1: Design Concentrations at Rock Creek WWTP

	Max Modeled Loading w/o Violations	Instream Loading				With WWTPs @ Minimum of 100 lb/day and Instream at TMDL levels				
Month/Year	WWTPs	Tualatin River Upstream (at Rood Br.)	Rock Creek	Median Farmington Flow (cfs)	Design Concentration (mg/L)	WWTPs	Tualatin River Upstream	Rock Creek	Median Farmington Flow (cfs)	Design Concentration (mg/L)
May-91	4000	295	6	577	1.38					
May-92	3000	128	4	263	2.21					
May-93	6000	406	11	952	1.25					
Jun-91	2500	38	5	277	1.70					
Jun-92	1500	16	2	149	1.89					
Jun-93	3000	198	8	453	1.31					
Jul-91	1500	39	3	187	1.53					
Jul-92	750	21	2	144	1.00					
Jul-93	750	31	3	215	0.68					
Aug-91	250	24	3	178	0.29					
Aug-92	250	27	1	130	0.40					
Aug-93	750	19	1	158	0.90					
Sep-91	0	29	2	161	0.04					
Sep-92	250	42	2	135	0.40	100	19.404	6.468	120	0.195
Sep-93	750	21	2	195	0.74					
Sep-96	100	30	2	196	0.12					
Sep-97	250	32	2	283	0.19					
Oct-91	750	52	1	165	0.90					
Oct-92		20	1	123		100	19.404	6.468	120	0.195
Oct-93	100	29	4	180	0.14					
Oct-96	250	70	5	299	0.20	Note: Upstream and Rock Creek loads are based on given load allocations.				
Oct-97	1000	160	7	695	0.31					

Notes:

1) The design concentration is calculated by dividing the total loading (instream plus WWTP) by the product of the median Farmington Flow (cfs) and the conversion factor of 5.39.

2) Bold border indicates appropriate design concentrations. These were selected based on either being most conservative, or based on minimum 100 lb/day WLA.

3) Shaded cells indicate estimate instream loads. All other monthly instream loads were calculated by using the measured monthly median flow and median concentrations.

Appendix D-5 Page 2: Design Concentrations at Durham WWTP

	Max Modeled Loading w/o Violations	Instream Loading			With WWTPs @ Minimum of 100 lb/day and Instream at TMDL levels			
Month/Year	WWTPs	Fanno Creek	Median Farmington Flow (cfs)	Design Concentration (mg/L)	WWTPs	Fanno Creek	Median Farmington Flow (cfs)	Design Concentration (mg/L)
May-91	4000	2	577	1.29				
May-92	3000	2	263	2.12				
May-93	6000	11	952	1.17				
Jun-91	2500	2	277	1.68				
Jun-92	1500	1	149	1.87				
Jun-93	3000	3	453	1.23				
Jul-91	1500	2	187	1.49				
Jul-92	750	1	144	0.97				
Jul-93	750	1	215	0.65				
Aug-91	250	1	178	0.26				
Aug-92	250	1	130	0.36				
Aug-93	750	2	158	0.88				
Sep-91	0	1	161	0.00				
Sep-92	250	1	135	0.34	100	5	120	0.162
Sep-93	750	1	195	0.71				
Sep-96	100	1	196	0.10				
Sep-97	250	3	283	0.17				
Oct-91	750	2	165	0.85				
Oct-92		1	123	0.00	100	5	120	0.162
Oct-93	100	2	180	0.11				
Oct-96	250	3	299	0.16				
Oct-97	1000	6	695	0.27				

Note: Fanno Creek loads are based on given load allocations.

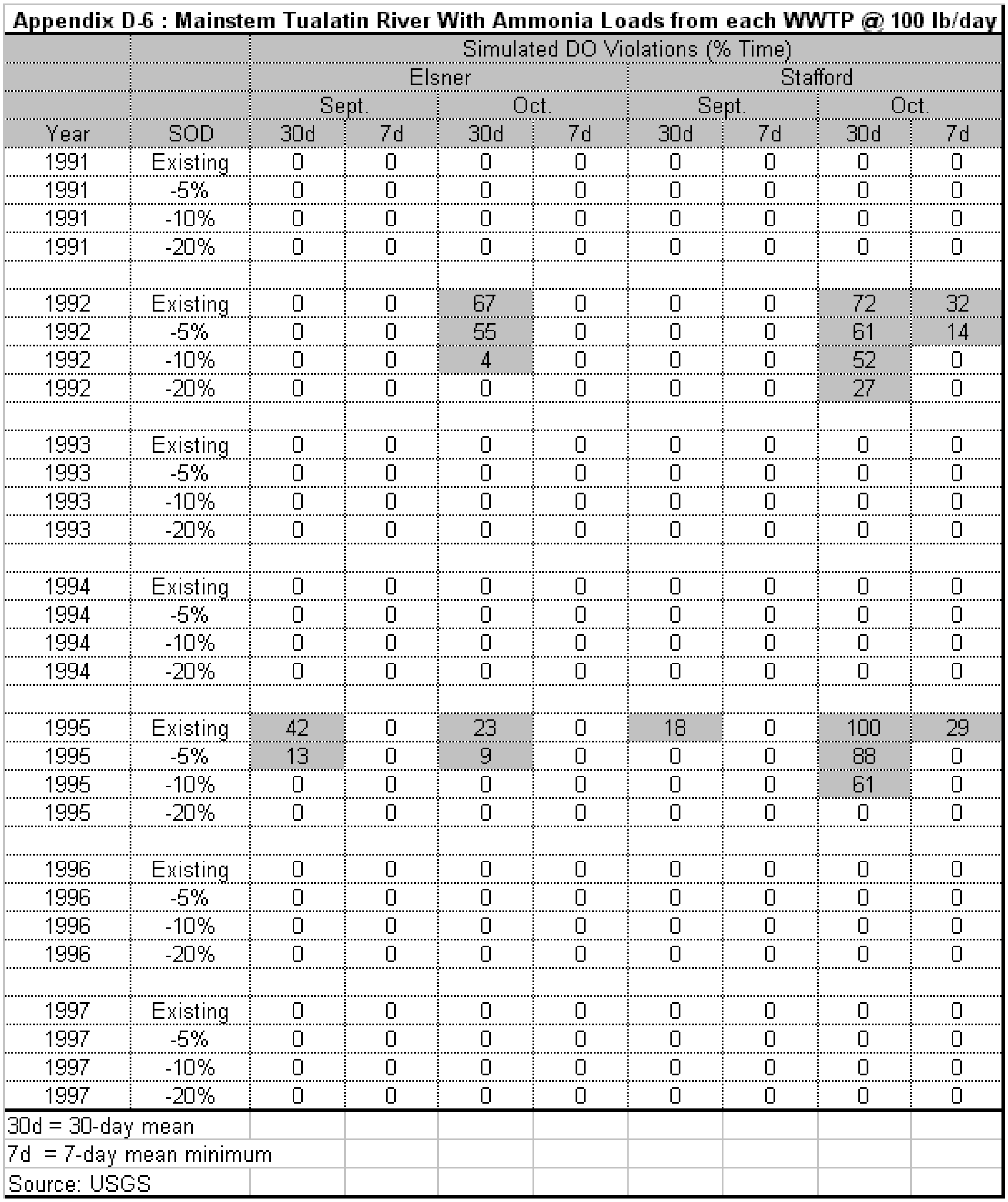
Notes:

1) The design concentration is calculated by dividing the total loading (instream plus WWTP) by the product of the median Farmington Flow (cfs) and the conversion factor of 5.39.

2) Bold border indicates appropriate design concentrations. These were selected based on either being most conservative, or based on minimum 100 lb/day WLA.

3) Shaded cells indicate estimate instream loads. All other monthly instream loads were calculated by using the measured monthly median flow and median concentrations.

APPENDIX D-6



Appendix D-6 : Mainstem Tualatin River With Ammonia Loads from each WWTP @ 100 lb/day

		Simulated DO Violations (% Time)							
		Elsner				Stafford			
		Sept.		Oct.		Sept.		Oct.	
Year	SOD	30d	7d	30d	7d	30d	7d	30d	7d
1991	Existing	0	0	0	0	0	0	0	0
1991	-5%	0	0	0	0	0	0	0	0
1991	-10%	0	0	0	0	0	0	0	0
1991	-20%	0	0	0	0	0	0	0	0
1992	Existing	0	0	67	0	0	0	72	32
1992	-5%	0	0	55	0	0	0	61	14
1992	-10%	0	0	4	0	0	0	52	0
1992	-20%	0	0	0	0	0	0	27	0
1993	Existing	0	0	0	0	0	0	0	0
1993	-5%	0	0	0	0	0	0	0	0
1993	-10%	0	0	0	0	0	0	0	0
1993	-20%	0	0	0	0	0	0	0	0
1994	Existing	0	0	0	0	0	0	0	0
1994	-5%	0	0	0	0	0	0	0	0
1994	-10%	0	0	0	0	0	0	0	0
1994	-20%	0	0	0	0	0	0	0	0
1995	Existing	42	0	23	0	18	0	100	29
1995	-5%	13	0	9	0	0	0	88	0
1995	-10%	0	0	0	0	0	0	61	0
1995	-20%	0	0	0	0	0	0	0	0
1996	Existing	0	0	0	0	0	0	0	0
1996	-5%	0	0	0	0	0	0	0	0
1996	-10%	0	0	0	0	0	0	0	0
1996	-20%	0	0	0	0	0	0	0	0
1997	Existing	0	0	0	0	0	0	0	0
1997	-5%	0	0	0	0	0	0	0	0
1997	-10%	0	0	0	0	0	0	0	0
1997	-20%	0	0	0	0	0	0	0	0

30d = 30-day mean
7d = 7-day mean minimum
Source: USGS

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