Appendix D. North Santiam and Santiam River Model Set-Up and Application

The original North Santiam and Santiam River model was constructed and calibrated for June through October 2001 and April through October 2002 (Sullivan and Rounds, 2004). For application to the conditions of this study, updated flow, temperature, and meteorological boundary conditions had to be created.

Boundary Inflows

Boundary inflows to the river model include the North Santiam River below Big Cliff Dam (RM 58.1), Rock Creek (RM 49.3), the Little North Santiam River (RM 39.2), and the South Santiam River (RM 11.7). Other waters entering the river model include precipitation on the water surface, groundwater inflows, and effluent from the Stayton and Jefferson wastewater treatment plants located at RMs 27.5 and 9.0, respectively.

For the initial simulations representing current conditions and for testing purposes, measured hourly streamflow from the North Santiam River at Niagara (USGS gaging station 14181500) was used as the upstream boundary because that site is near Big Cliff Dam. For simulations in the study based on hypothetical Detroit Dam scenarios, the simulated outflow from the upstream Detroit Lake and Big Cliff Reservoir models was used as the upstream boundary for the river model.

For most of the *normal* and *cool/wet* environmental scenarios, measured hourly streamflow for the Rock Creek near Mill City site (USGS station 14181750) were available and were used directly. For the *hot/dry* scenario, however, no measured data were available for that site. In the absence of measured data, hourly streamflow for Rock Creek was estimated by multiplying the measured hourly streamflow from the Little North Santiam River near Mehama (USGS site 14182500) by a drainage area ratio of 0.17 (ratio of the Rock Creek drainage area to the Little North Santiam River drainage area).

Measured hourly streamflow data were available for the time periods of all three environmental scenarios for the Little North Santiam River (USGS site 14182500). That station is located 2 mi upstream from its confluence with the North Santiam River.

South Santiam River streamflow data were estimated at the river's confluence with the North Santiam River using hourly streamflow measurements at the South Santiam River at Waterloo (USGS site 14187500). Measured streamflows at Waterloo were multiplied by 1.1 (as a drainage area expansion factor) to account for net inflows and withdrawals between the Waterloo gage and the North Santiam River confluence.

Measured precipitation data were obtained from the National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC). Daily total precipitation data for the upstream two branches of the model, upstream of the Little North Santiam River confluence (RM 39.2), were taken from a site at Detroit Dam (NCDC station 352292). For the downstream three model branches, daily total precipitation data were measured at Stayton, Oregon (NCDC station 358095).

Groundwater inflow, flow from small ungaged creeks, and errors in gaged streamflow data were accounted for by using a distributed tributary in the model for each of the six branches. For the initial simulation, distributed tributary flow files created for 2001–02 by Sullivan and Rounds (2004) were used. These initial inflows were then adjusted in a second simulation for each environmental scenario to eliminate the difference between simulated and measured streamflows in each branch. This adjustment was justified because it could not be assumed that groundwater inflow and the cumulative inflow from small unmeasured creeks would remain similar from year to year.

Additional inflow to the model included municipal wastewater effluent from the cities of Stayton and Jefferson. Records containing daily effluent discharges for both municipalities were provided in monthly Discharge Monitoring Reports (DMRs) to ODEQ (Robert Dicksa, Oregon Department of Environmental Quality, written commun., 2011).

Surface-Water Withdrawals

Surface-water withdrawals from the river model included municipal water supply (cities of Gates, Mill City, Salem, Stayton, and Jefferson) and irrigation (Santiam Water Control District and the Sidney Irrigation Cooperative) (fig. 3). Data for these withdrawals were provided by the Oregon Water Resources Department Water Use Reporting Database. Although the withdrawals were reported as monthly total volumes, they were converted to a rate in cubic meters per second for the model. Monthly withdrawal rates were assigned to just the midpoint of each month, and the model then was set up to linearly interpolate between those monthly midpoints for each model time step.

Boundary Water Temperatures

Using the same methods employed by Sullivan and Rounds (2004), measured or estimated water temperatures were assigned to all boundary flows entering the river model. For testing purposes and for simulating existing conditions, hourly water temperature data measured in the North Santiam River at Niagara (USGS station 14181500) were used as the upstream boundary for the model at Big Cliff Dam. For other model scenarios, simulated release temperatures from the Big Cliff Reservoir model were used.

Measured hourly water temperature data were available for the Little North Santiam River near Mehama (USGS site 14182500). Measured hourly water temperature data from Rock Creek near Mill City (USGS site 14181750) were available only for 2006. Although Sullivan and Rounds (2004) used measured water temperature data from the Little North Santiam River near Mehama as estimated water temperatures for Rock Creek in their 2001–02 simulations, a comparison of water temperatures in Rock Creek and the Little North Santiam River showed that Little North Santiam River water temperatures were about 10°C warmer than temperatures in Rock Creek in summer. Because of that difference, measured hourly water temperature data from 2006 for the Rock Creek site were used for all three (*hot/dry*, *normal*, and *cool/wet*) environmental scenarios.

Measured daily-mean air temperature data for precipitation entering the river model through the water surface were available from the Detroit and Stayton NCDC meteorological stations that were used for the daily precipitation data. Data from the Detroit station were used for branches 1–2, and data from the Stayton station were used for branches 3–6.

Water temperatures for groundwater and ungaged tributaries flowing into the six model branches were estimated using a weighted average approach from Sullivan and Rounds (2004). For the two upstream model branches, 70 percent of the flow was assumed to come from ungaged tributaries. Daily-mean water temperatures measured at the Little North Santiam River near Mehama (USGS site 14182500) were used for this portion of the flow. For the remaining 30 percent of flow, which was assumed to be groundwater, a constant temperature of 11.5°C was assigned. For the four downstream model branches, flow was weighted as 50 percent ungaged tributary flow and 50 percent groundwater and the temperatures were estimated accordingly.

For the Stayton and Jefferson municipal wastewater outflows, measured daily-mean water temperatures were taken from information included in the monthly DMRs provided to ODEQ.

Meteorological Data

Meteorological inputs for the three environmental scenarios for the river model were constructed using the same data sources and methods as those used by Sullivan and Rounds (2004). Air temperature, dew-point temperature, wind speed, and wind direction data were obtained from the Stayton meteorological site. Solar radiation data were obtained from the Solar Radiation Monitoring Laboratory at the University of Oregon for their meteorological site in Eugene. Cloud cover data were computed using a comparison between measured and theoretical clear-sky solar radiation rates, in which the nighttime cloud cover information was interpolated from values near sunrise and sunset. For more information on these data sources and methods, see Sullivan and Rounds (2004).