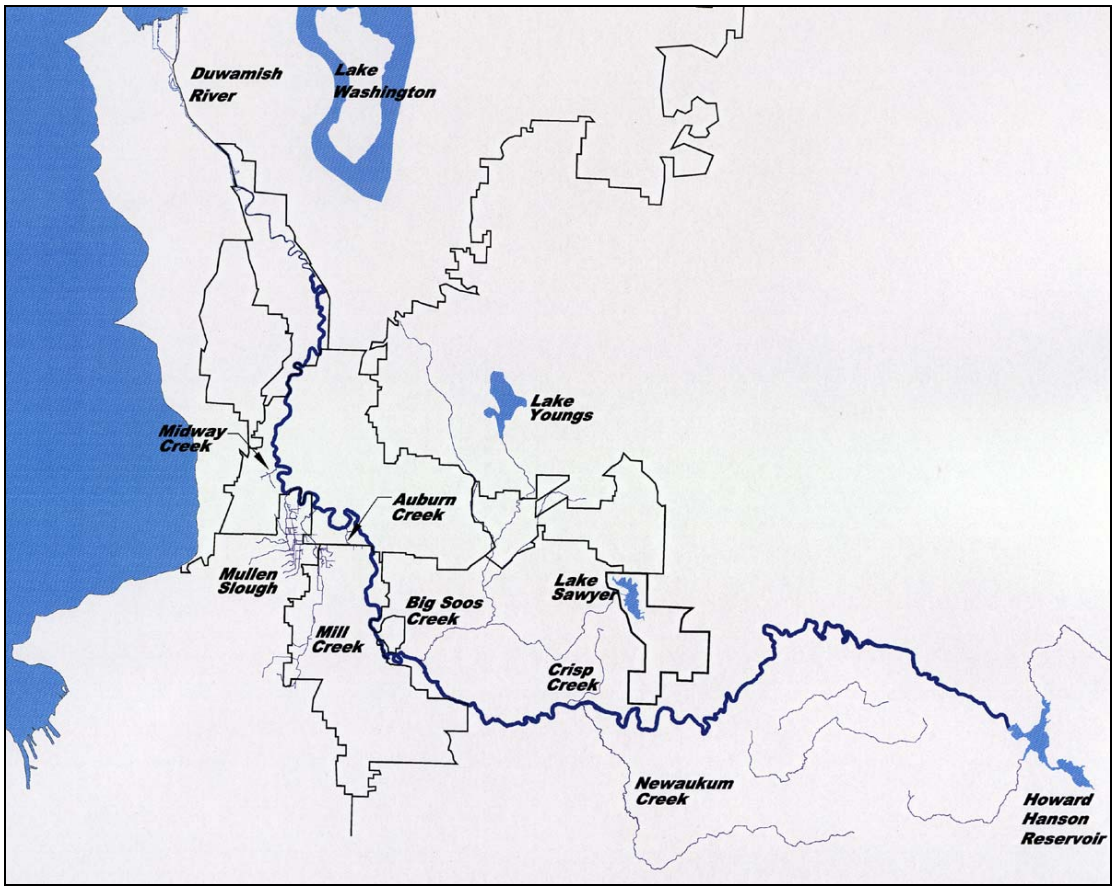

Figure 88: Modeled Tributaries to Green River

Table 7: Tributary River Miles and Segment Numbers

Tributary	River Mile	Model Segment Number
Newaukum Creek	41.10	26
Crisp Creek	40.40	32
Big Soos Creek	33.80	77
Auburn Creek	25.50	134
Mill Creek	23.80	145
Mullen Slough	21.60	159
Midway Creek	19.60	171

2.5.1 Newaukum Creek

Newaukum Creek is approximately six km below the upstream boundary, at River Mile 41.1. It is a large tributary, with a basin size of approximately 7,200 hectares (17,800 acres).

May 1995 – Nov 1996

Flow

USGS has a flow gage (12108500) approximately 1.50 km upstream of the confluence of Newaukum Creek with the Green River. Data were obtained in 15-minute intervals for this gage from October 1, 1994 to December 31, 2002. Figure 89 shows the data for the model simulation period. The complete

data set is included in Appendix A.

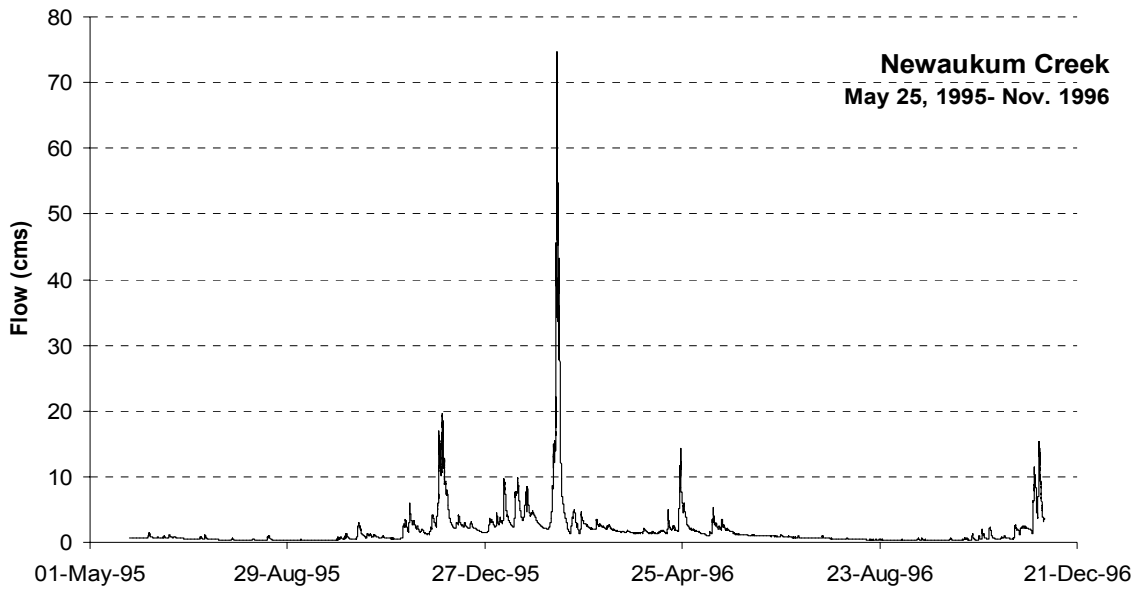

Figure 89: Newaukum Creek Flow: May 25, 1995 – Nov 1996

Temperature

USGS monitored hourly temperatures on Newaukum Creek from July 1996 to September 1998 at the same location as flow, 1.50 km upstream of the confluence with Green River. There were no data available from May 25, 1995 to July 1996 during the model calibration period. To fill this gap, data from July 1996 to September 1998 were compared to data from Big Soos Creek (Station 54a) for the same time period. The resulting correlation equation is:

$$\text{Station } 12108500 = 0.9529(\text{Station } 54a) + 0.3982$$

Figure 90 shows the temperature correlation for the two stations, Figure 91 shows the correlated values with the data, and Figure 92 shows the completed temperature record for the model calibration period.

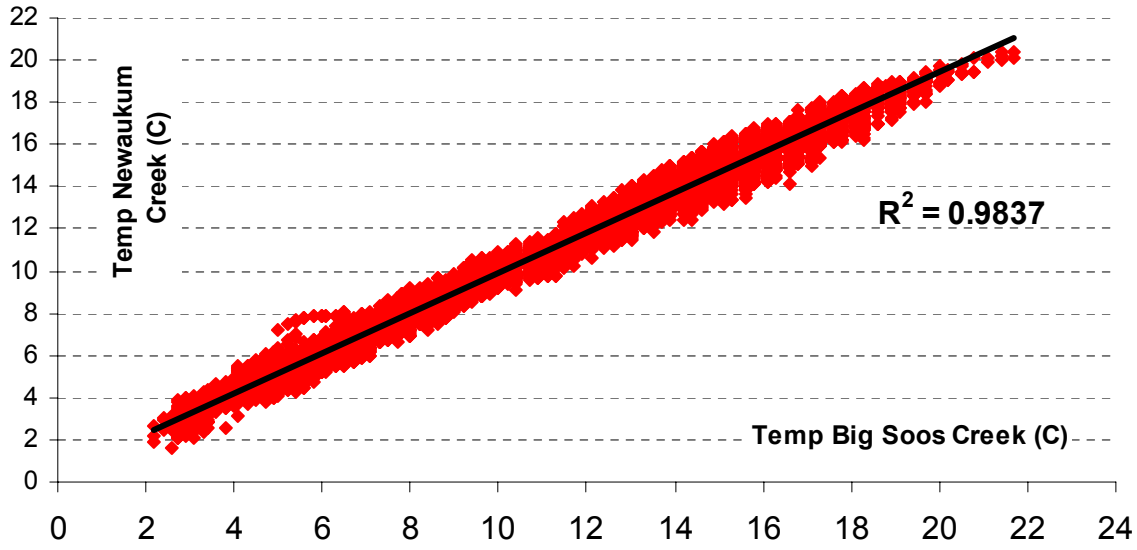

Figure 90 (above): Correlation between Big Soos Temperature and Newaukum Creek station

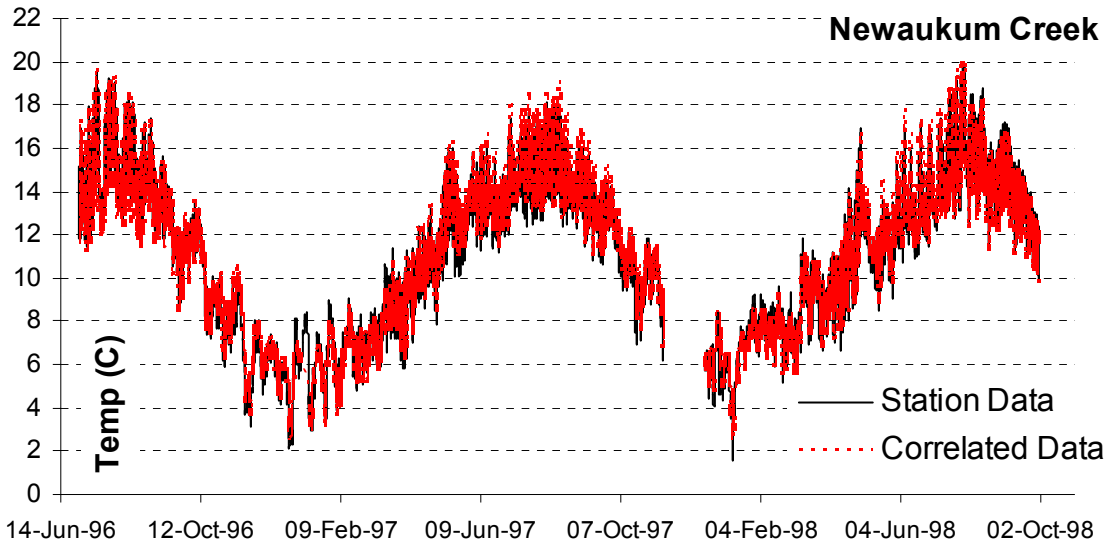

Figure 91: Newaukum Creek: Station versus correlated data, 1995-1996

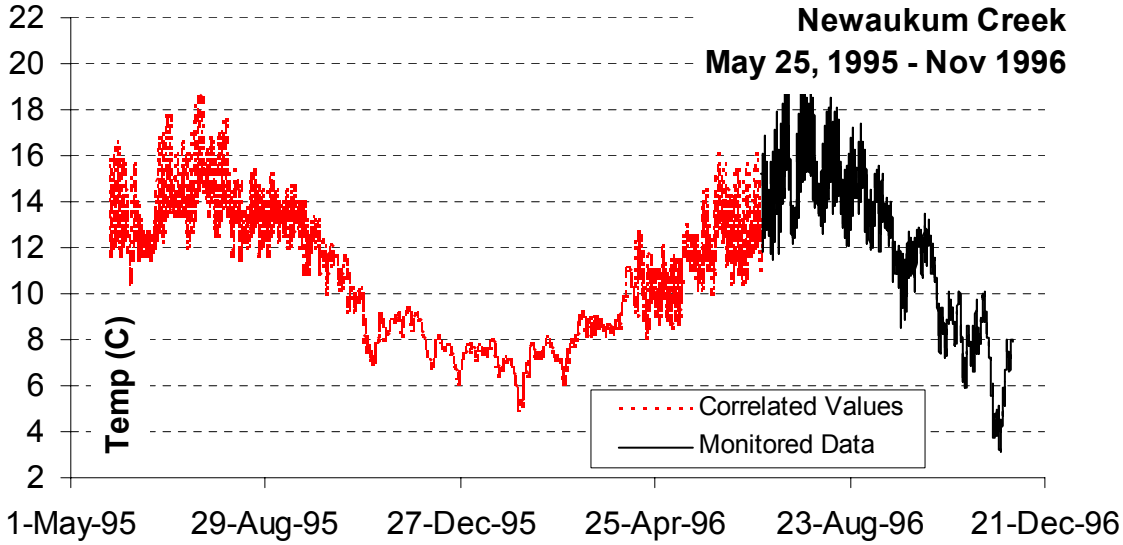

Figure 92: Newaukum Creek Temperature: May 25, 1995 – Nov 1996

Water Quality

King County monitored all the water quality constituents during the model calibration period except chlorophyll a and alkalinity (Locator 0322). Figure 93 through Figure 107 shows the water quality conditions for Newaukum Creek during the model calibration period. See Appendix D for procedures used in developing the water quality tributary condition, including filling data gaps.

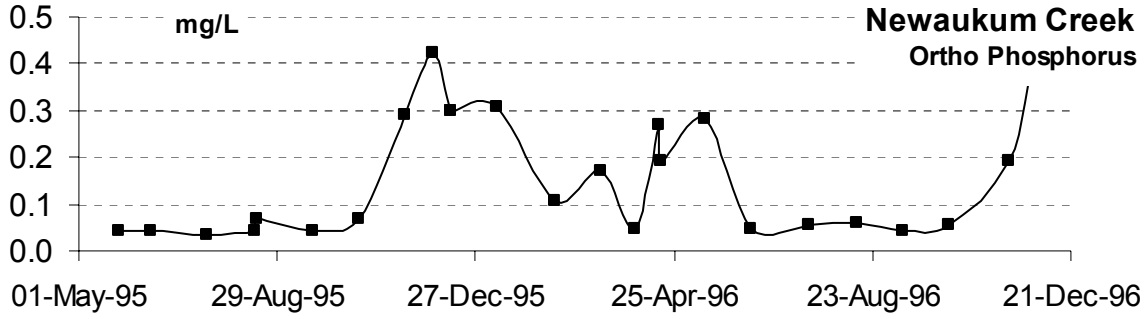

Figure 93: Ortho phosphorus Newaukum Creek: May 25, 1995 – Nov 1996

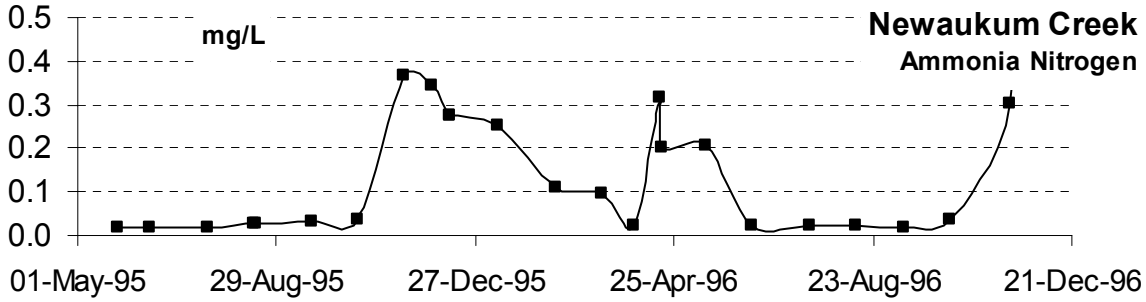

Figure 94: Ammonia Newaukum Creek: May 25, 1995 – Nov 1996

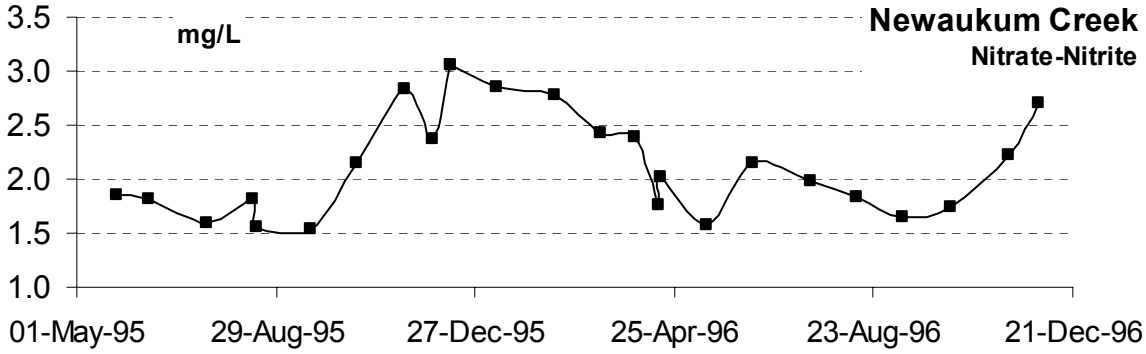

Figure 95: Nitrate-Nitrite Newaukum Creek: May 25, 1995 – Nov 1996

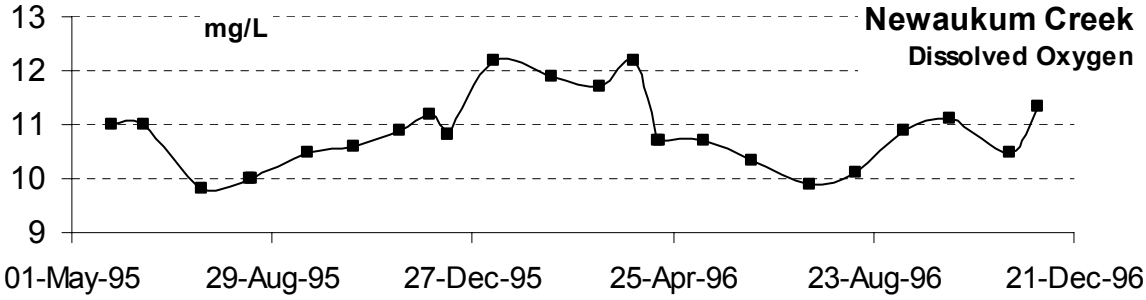

Figure 96: DO Newaukum Creek: May 25, 1995 – Nov 1996

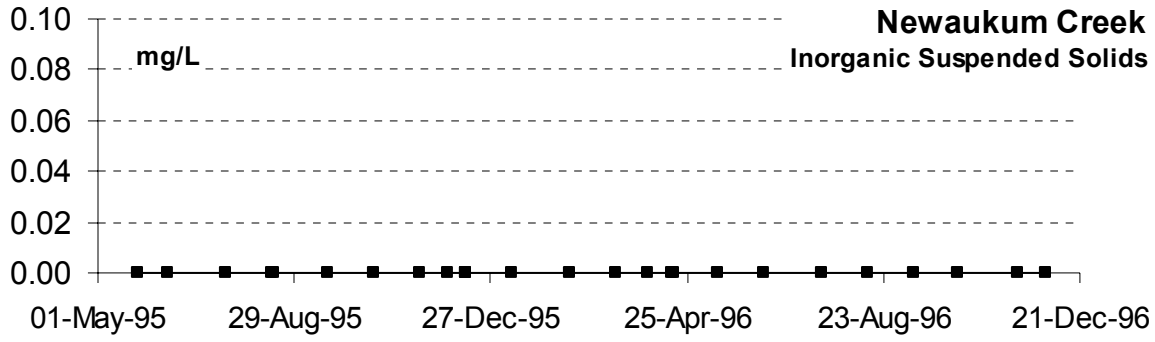

Figure 97: ISS Newaukum Creek: May 25, 1995 – Nov 1996

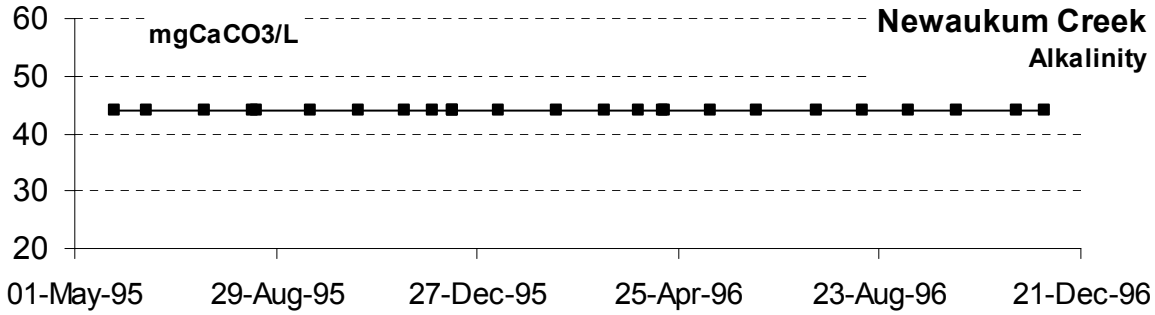

Figure 98: Alkalinity Newaukum Creek: May 25, 1995 – Nov 1996

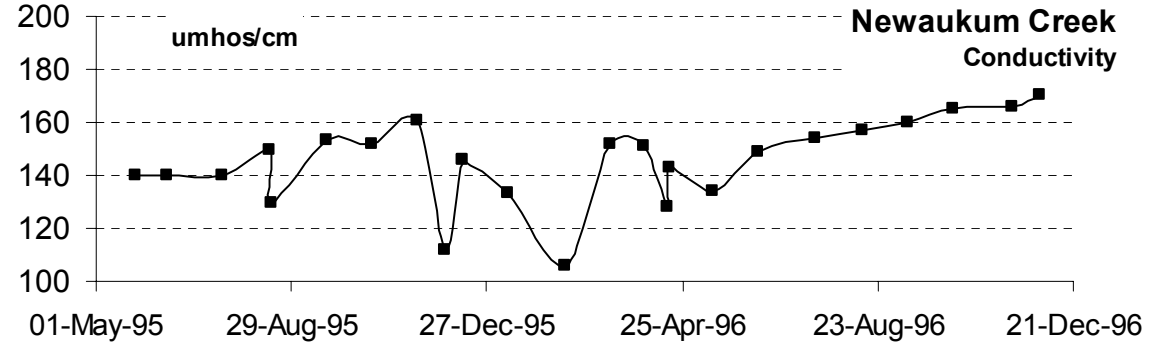

Figure 99: Conductivity Newaukum Creek: May 25, 1995 – Nov 1996

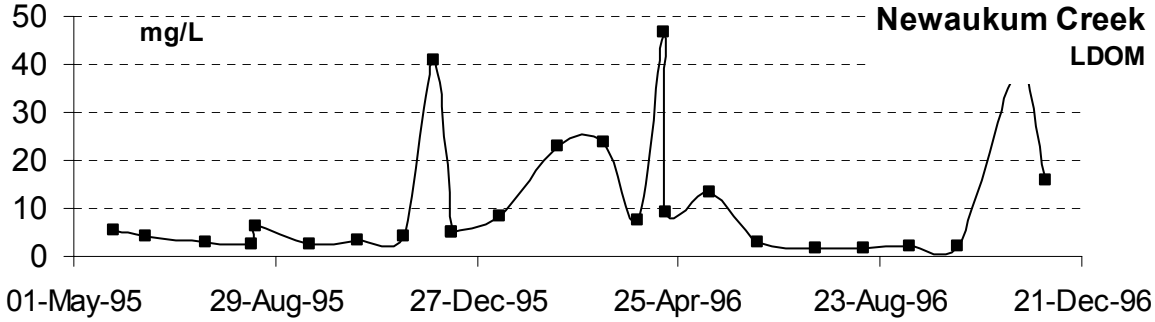

Figure 100: LDOM Newaukum Creek: May 25, 1995 – Nov 1996

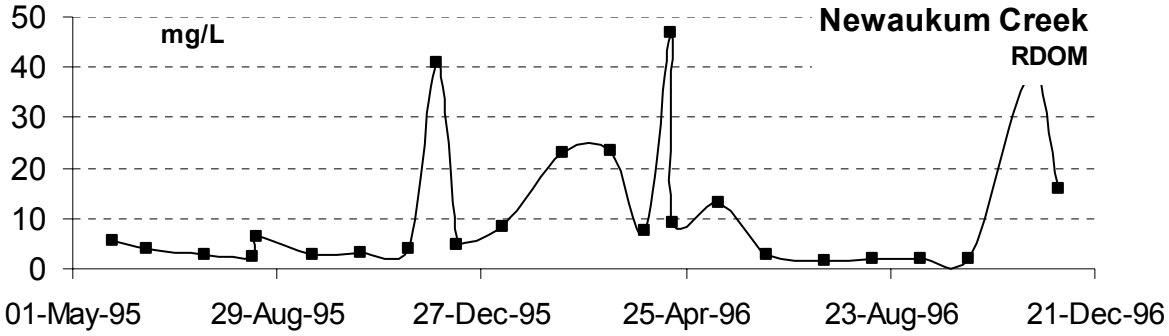

Figure 101: RDOM Newaukum Creek: May 25, 1995 – Nov 1996

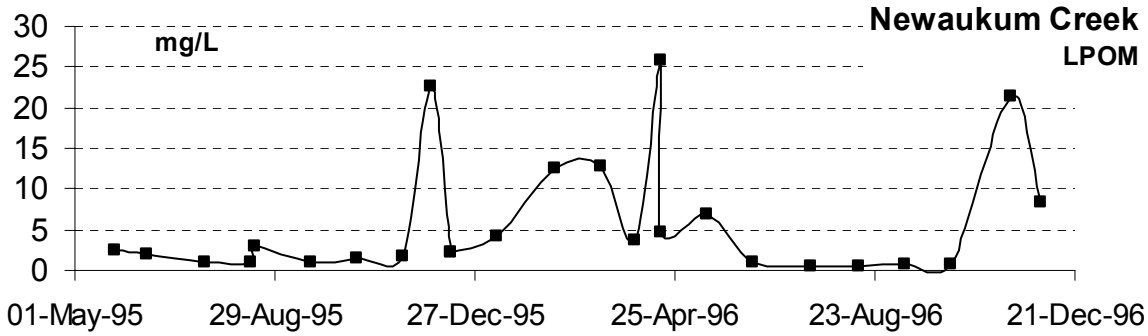

Figure 102: LPOM Newaukum Creek: May 25, 1995 – Nov 1996

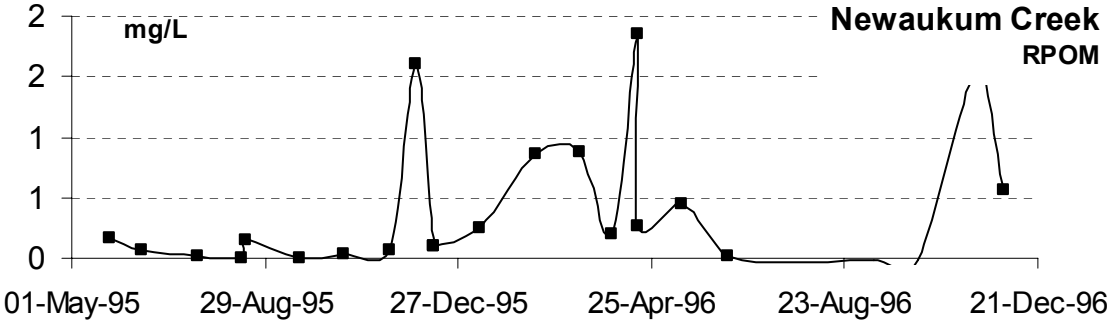

Figure 103: RPOM Newaukum Creek: May 25, 1995 – Nov 1996

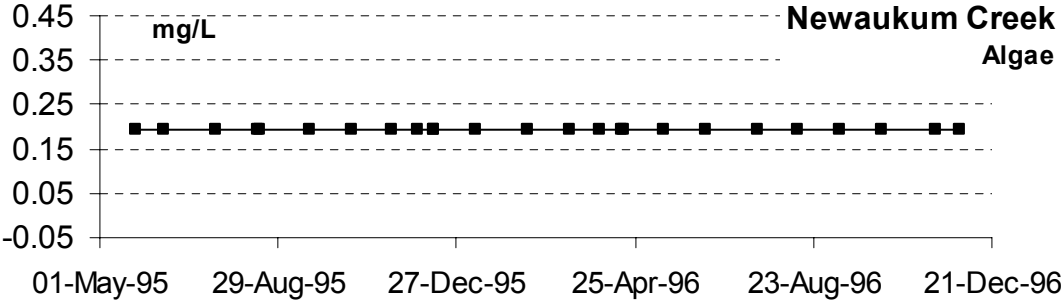

Figure 104: Algae Newaukum Creek: May 25, 1995 – Nov 1996

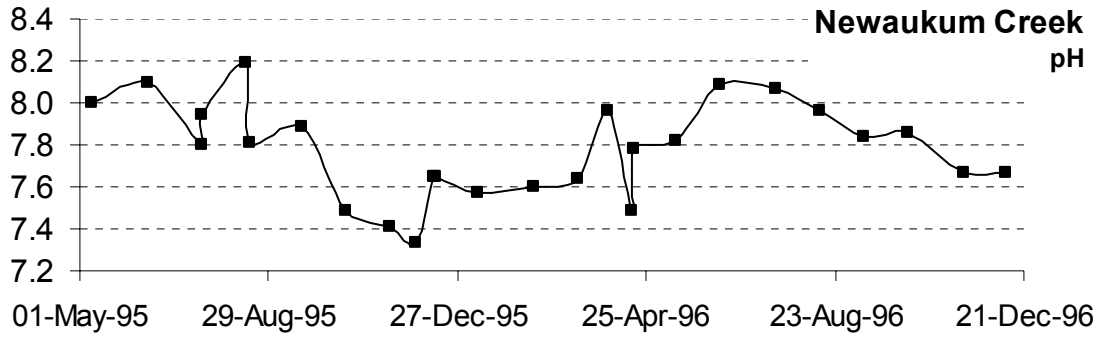

Figure 105: pH Newaukum Creek: May 25, 1996 - Nov 1996

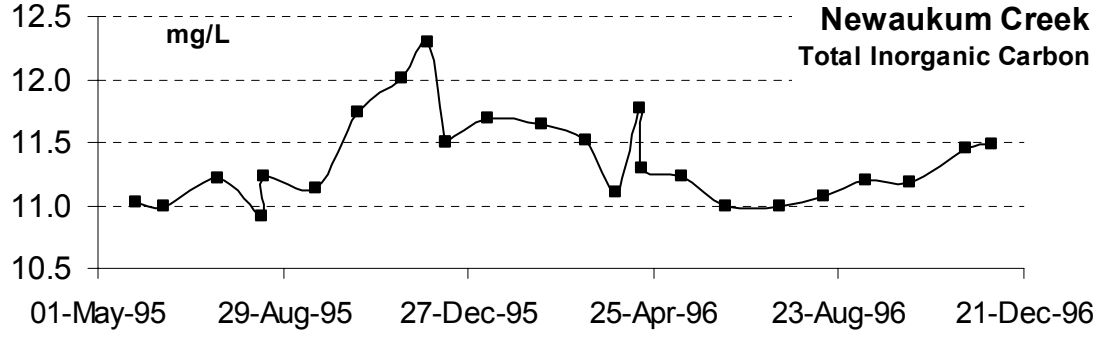

Figure 106: TIC Newaukum Creek: May 25, 1995 – Nov 1996

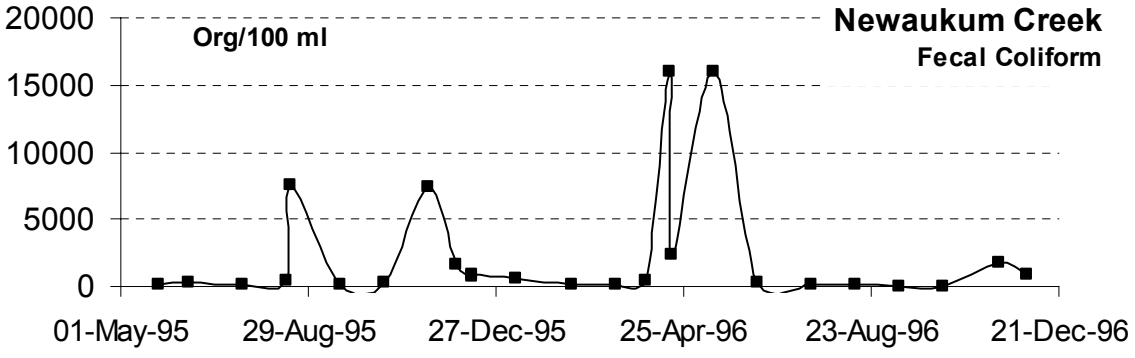

Figure 107: Fecal Coliform Newaukum Creek: May 25, 1995 - Nov 1996

April 2001 – July 2002

Flow

The USGS gage (12108500) on Newaukum Creek was used for this model calibration period. Figure 108 shows the data for the model calibration period. The complete data set is included in Appendix A.

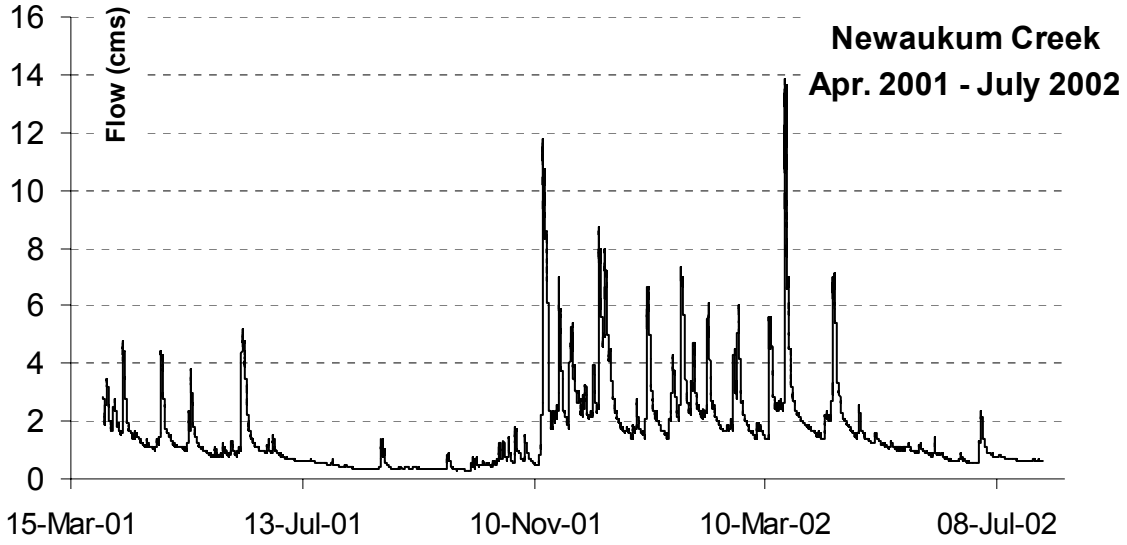

Figure 108: Newaukum Creek Flow: Apr 2001 – July 2002

Temperature

The Green-Duwamish Water Quality Assessment study (Site GRT09) recorded temperatures on the lower Newaukum River from July 23, 2001 to October 25, 2001, and from March 14, 2002 through the end of the model run period. There were two data gaps to be filled: From April 1, 2001 through July 23, 2001 and from October 26, 2001 through March 14, 2002. The data gaps were filled by correlating Crisp Creek temperatures (Site 0321) with Newaukum Creek temperature data using the following equation:

$$\text{Newaukum Creek temperature} = (1.63)(\text{Crisp Creek temperature}) - 6.21$$

Figure 109 shows the temperature correlation between the sites, Figure 110 compares correlated values to actual data from Newaukum Creek, and Figure 111 shows the temperature record for this calibration period with correlated values included.

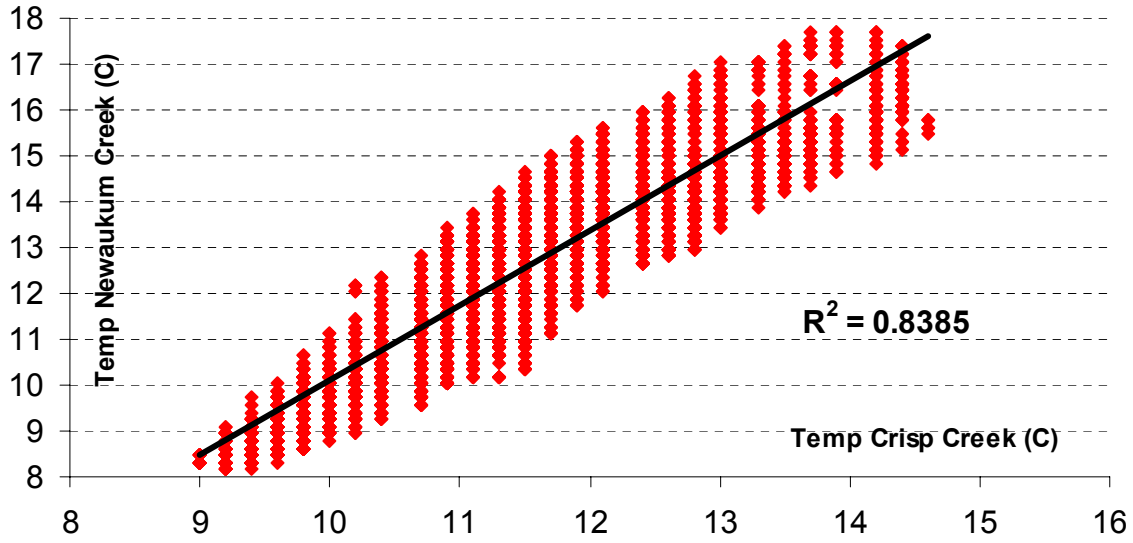

Figure 109: Correlation between Crisp Creek and Newaukum Creek Temperature

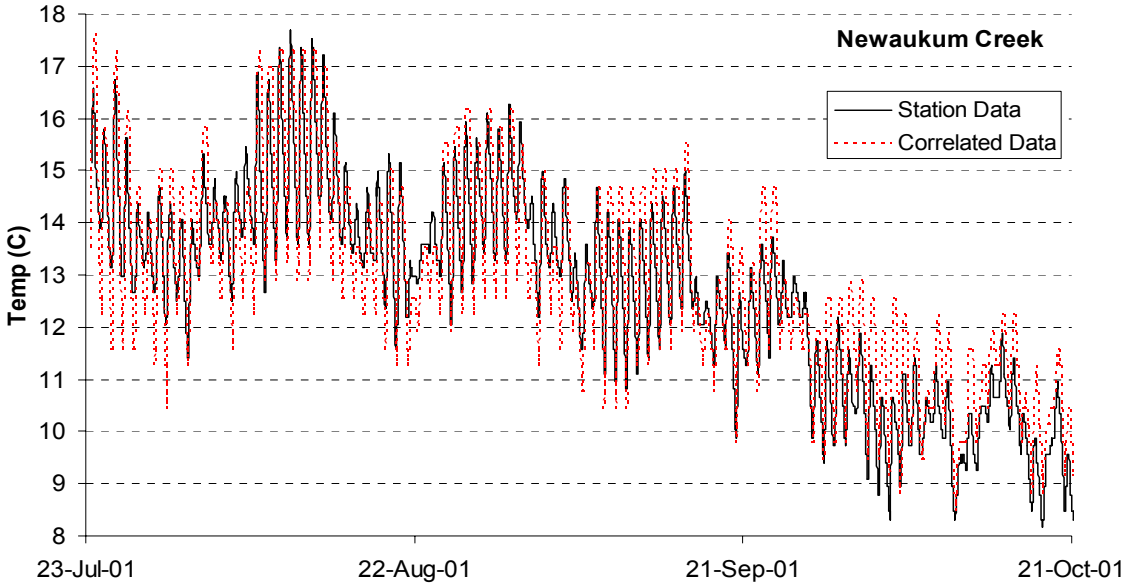

Figure 110: Station versus correlated data, 2001-2002

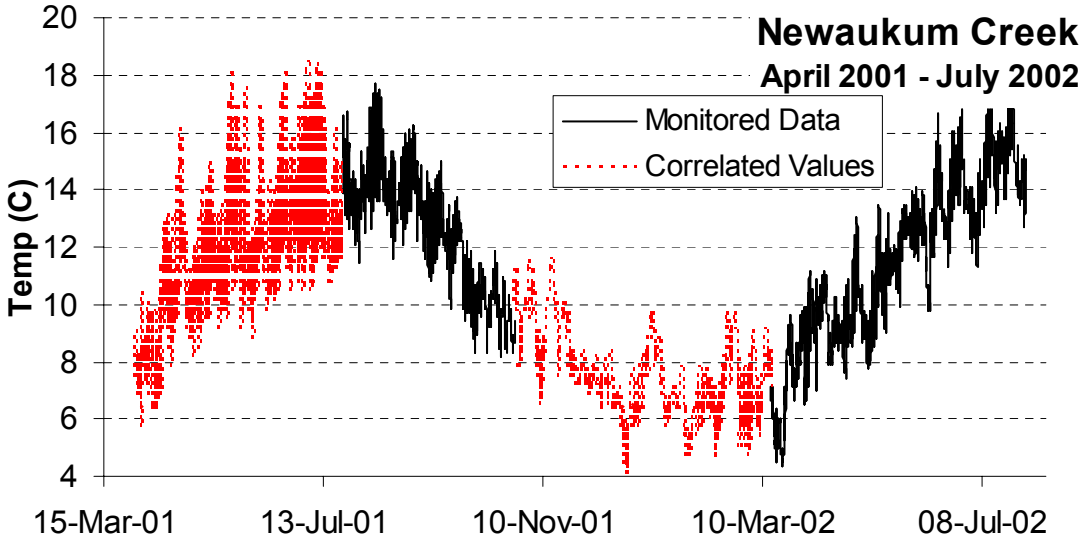

Figure 111: Newaukum Creek Temperature: Apr 2001 – July 2002

Water Quality

King County provided water quality samples on Newaukum Creek from 1995 to 2002 (Locator 0322) for all water quality constituents except chlorophyll a. Figure 112 through Figure 126 show the water quality conditions for the model calibration period. Data for the complete time period are included in Appendix A. See Appendix D for procedures used in developing the water quality tributary condition, including filling data gaps.

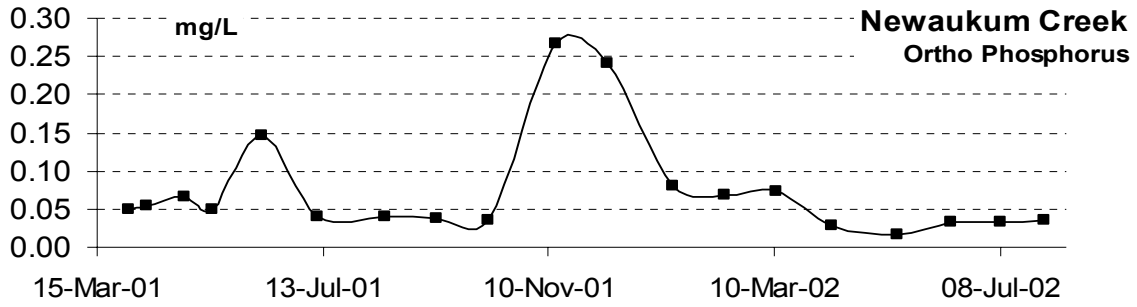

Figure 112: Ortho phosphorus Newaukum Creek: Apr 2001 – July 2002

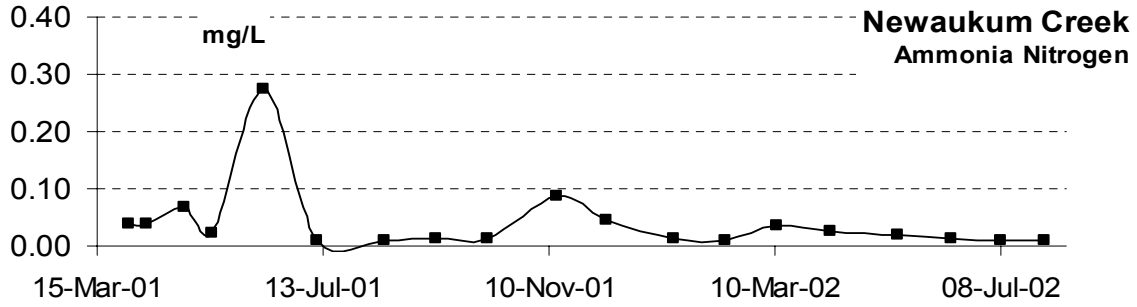

Figure 113: Ammonia Newaukum Creek: Apr 2001 – July 2002

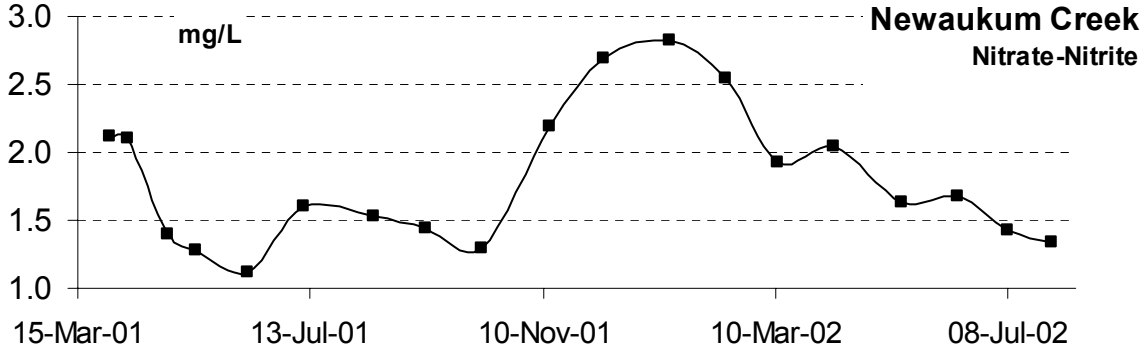

Figure 114: Nitrate-Nitrite Newaukum Creek: Apr 2001 – July 2002

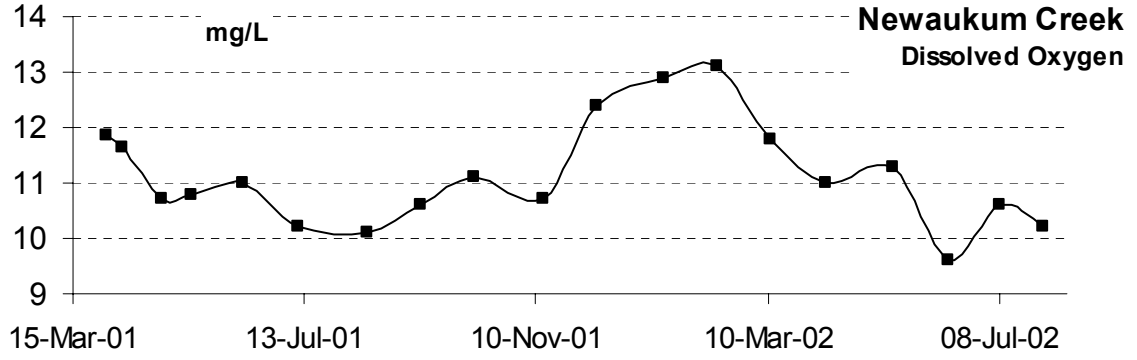

Figure 115: DO Newaukum Creek: Apr 2001 – July 2002

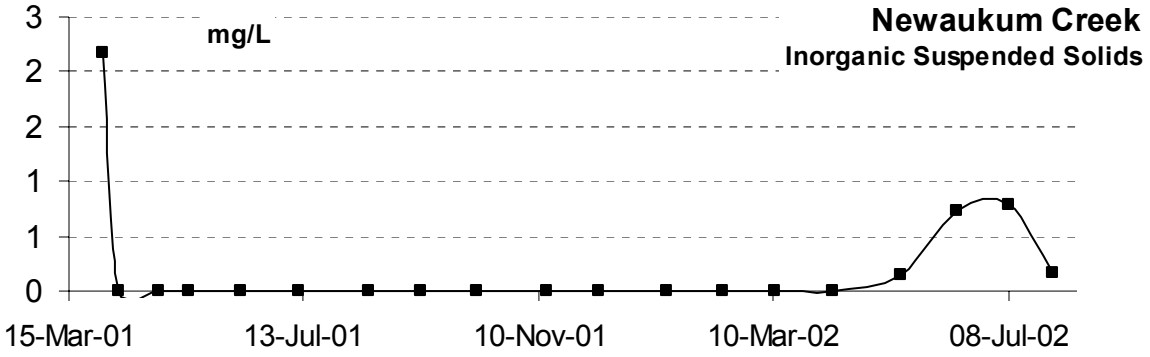

Figure 116: ISS Newaukum Creek: Apr 2001 – July 2002

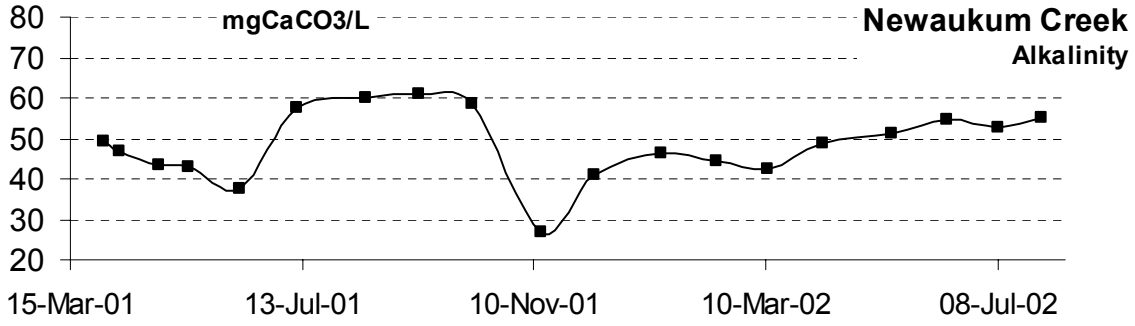

Figure 117: Alkalinity Newaukum Creek: Apr 2001 – July 2002

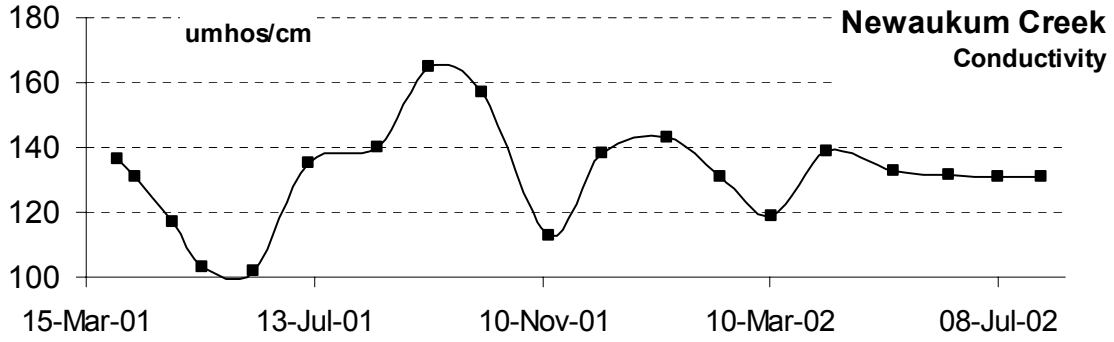

Figure 118: Conductivity Newaukum Creek: Apr 2001 – July 2002

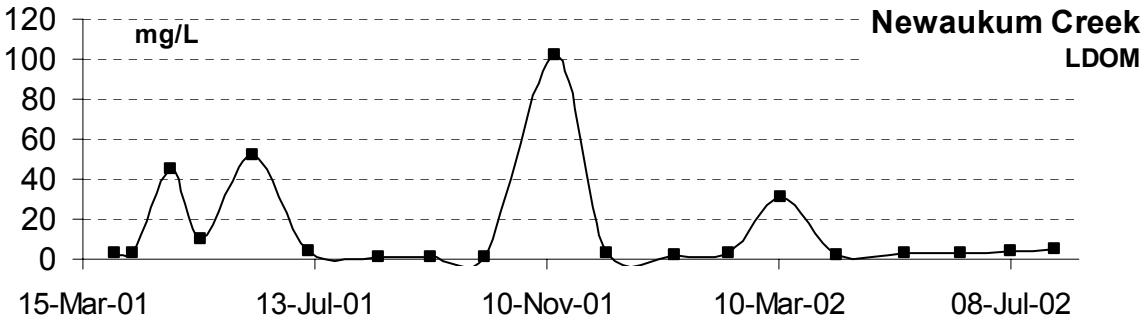

Figure 119: LDOM Newaukum Creek: Apr 2001 – July 2002

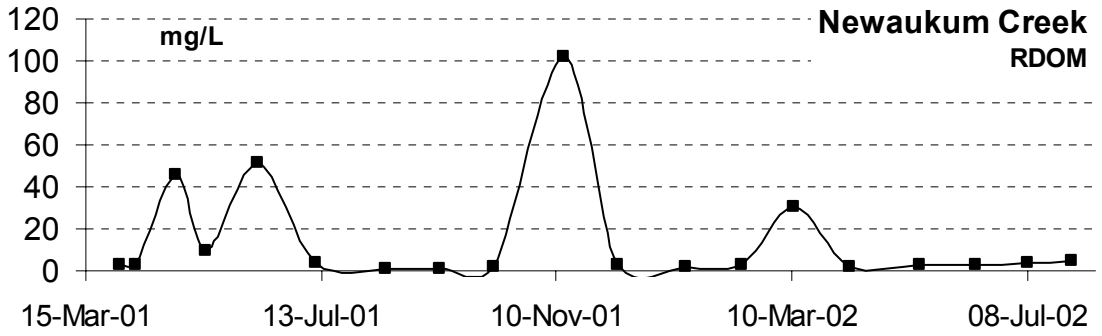

Figure 120: RDOM Newaukum Creek: Apr 2001 – July 2002

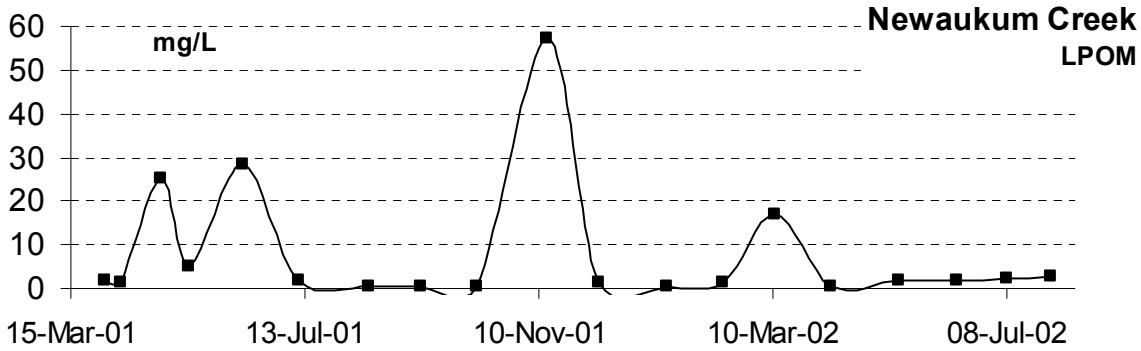

Figure 121: LPOM Newaukum Creek: Apr 2001 – July 2002

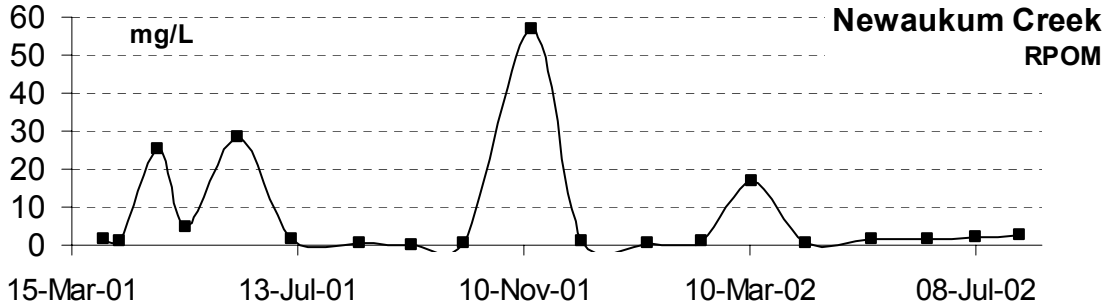

Figure 122: RPOM Newaukum Creek: Apr 2001 – July 2002

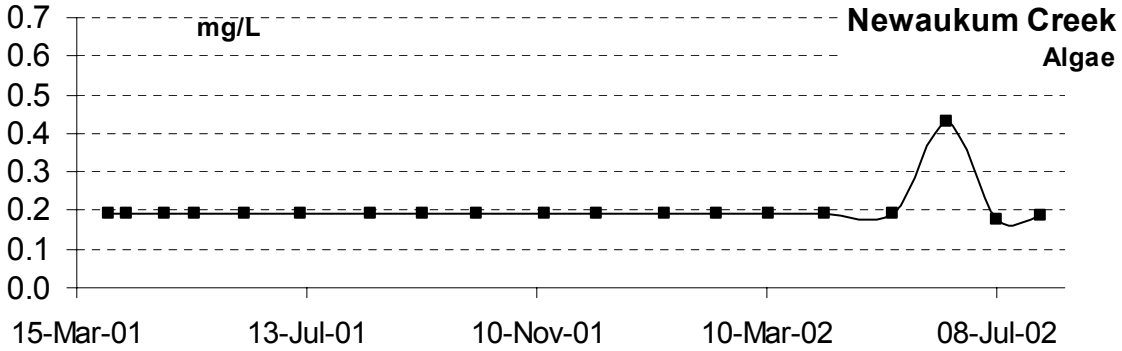

Figure 123: Algae Newaukum Creek: Apr 2001 – July 2002

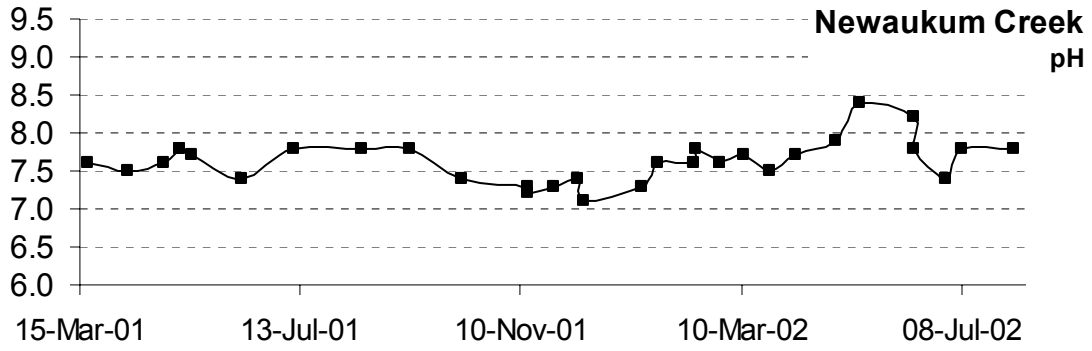

Figure 124: pH Newaukum Creek: Apr 2001 - July 2002

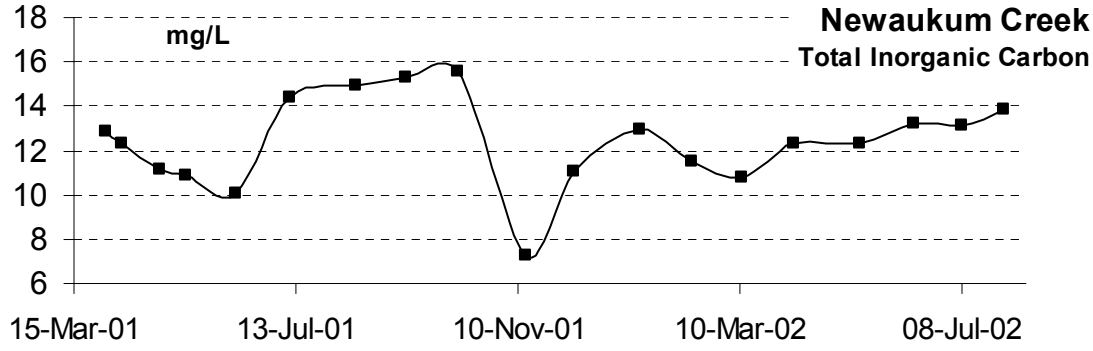

Figure 125: TIC Newaukum Creek: Apr 2001 – July 2002

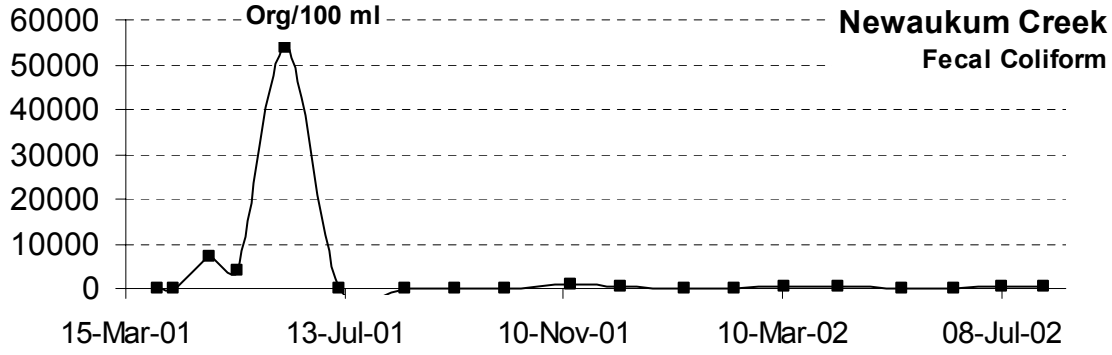

Figure 126: Fecal Coliform Newaukum Creek: Apr 2001 - July 2002

2.5.2 Crisp Creek

Crisp Creek enters the Green River approximately eight km downstream from Flaming Geyser State Park, at River Mile 40.4. King County monitors flow, temperature, and water quality at a fish hatchery approximately 3.0 km upstream of the confluence with the Green River.

May 25, 1995 – November 1996

Flow

King County gage #40d records flow every 15-minutes on Crisp Creek approximately 3.0 km upstream from the confluence with the Green River. Flow data for this gage were provided by King County from August 25, 1994 to March 18, 2003. Figure 127 is a graph showing flow for the model

period. The entire data set are included in Appendix A.

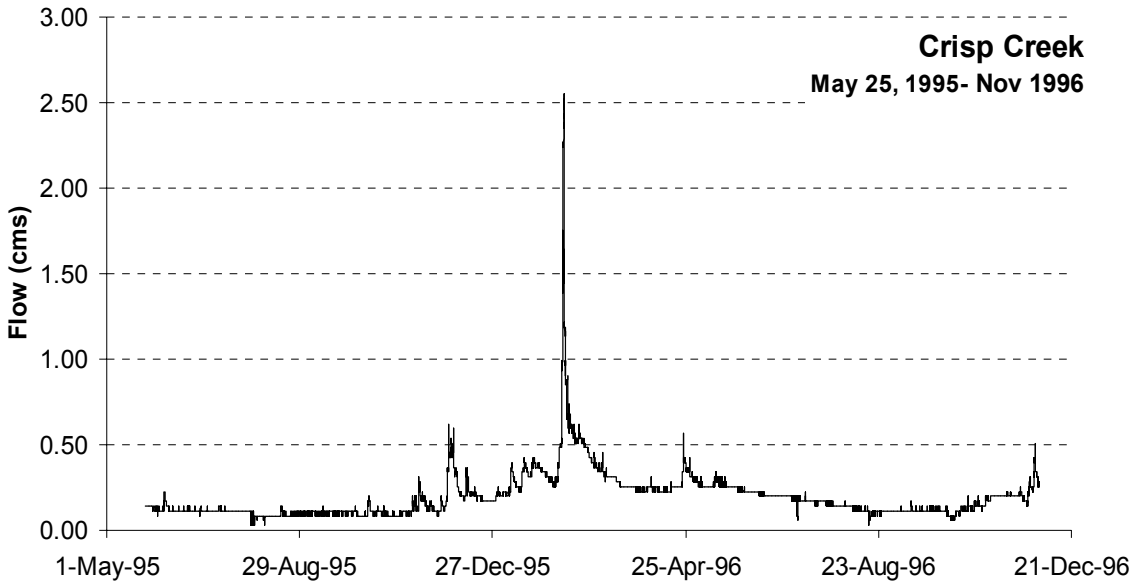

Figure 127: Crisp Creek Flow: May 25, 1995 – Nov 1996

Temperature

King County station #40d records temperature at 15-minute intervals, but did not begin monitoring until October 10, 1997. Therefore, compelted tempearture data was needed for this model run period. Comparing temperatures recorded on Big Soos Creek with temperatures from Crisp Creek from October 1997 to June 1999, the following correlation was obtained:

$$\text{Crisp Creek Temp} = 0.5731(\text{Big Soos Temp}) + 3.7364$$

Figure 128 shows the temperature correlation between the two sites, Figure 129 compares correlated values to monitored data from Crisp Creek, and Figure 130 shows the correlated temperature values for this model run period .

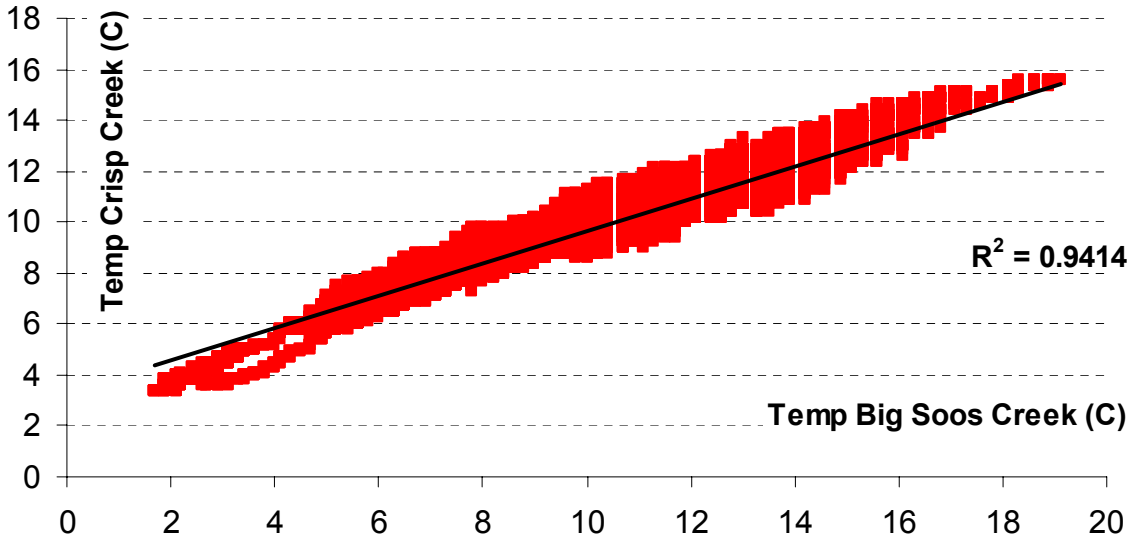

Figure 128 (above): Correlation between Big Soos Temperature and Crisp Creek

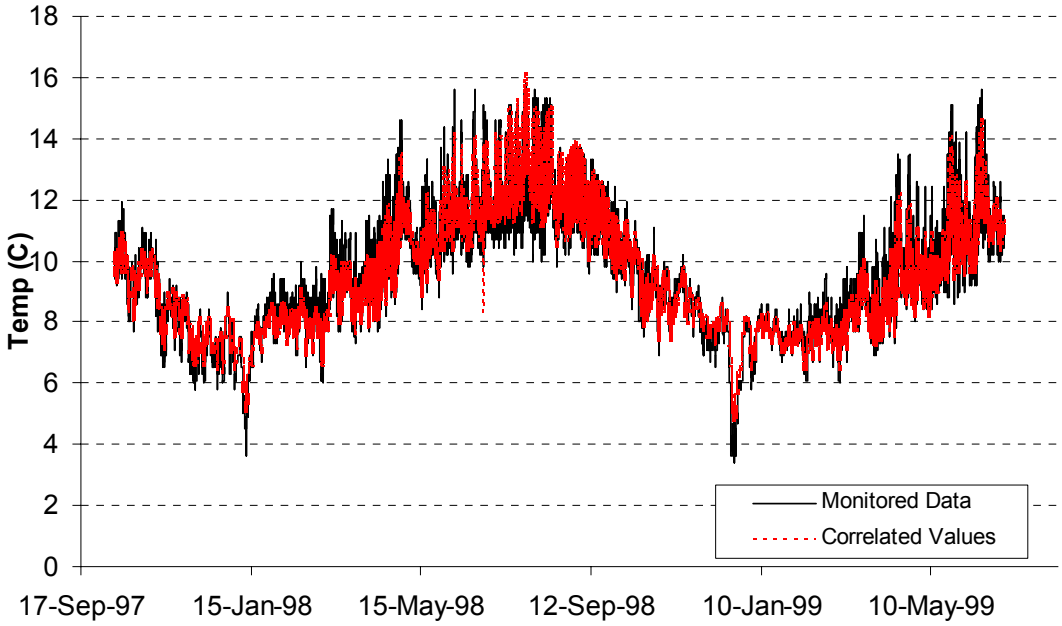

Figure 129: Crisp Creek: Station versus correlated data, 1995-1996

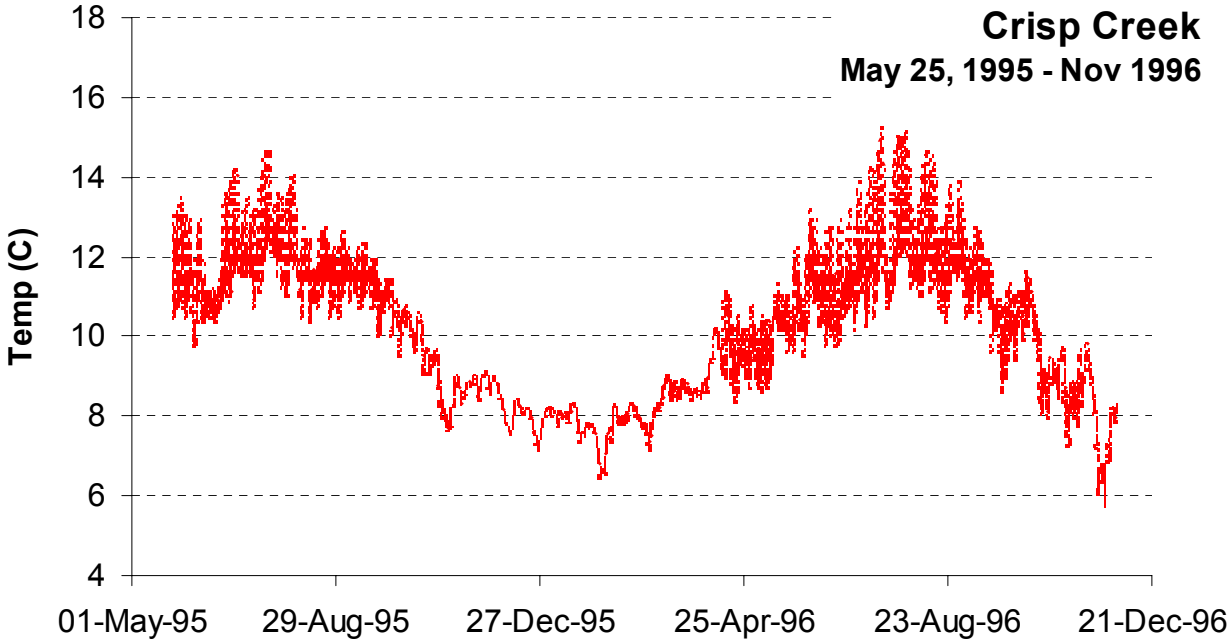

Figure 130: Crisp Creek Temperature: May 25, 1995 – Nov 1996

Water Quality

King County has provided water quality samples on Crisp Creek from 1995 to 2002 (Locator 0322). Monthly grab samples are available for the model calibration period for all constituents except chlorophyll a and alkalinity. See Appendix D for procedures used in developing the water quality

tributary condition, including filling data gaps, and Figure 131 through Figure 145 for the constituents for the model calibration period.

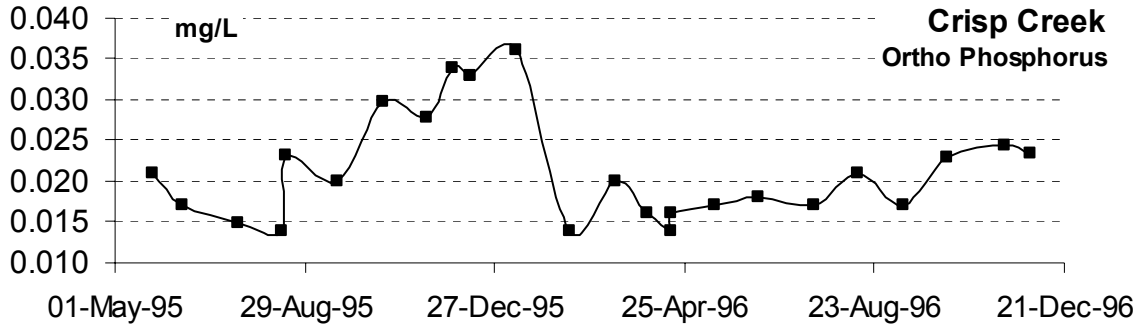

Figure 131: Ortho phosphorus Crisp Creek: May 25, 1995 – Nov 1996

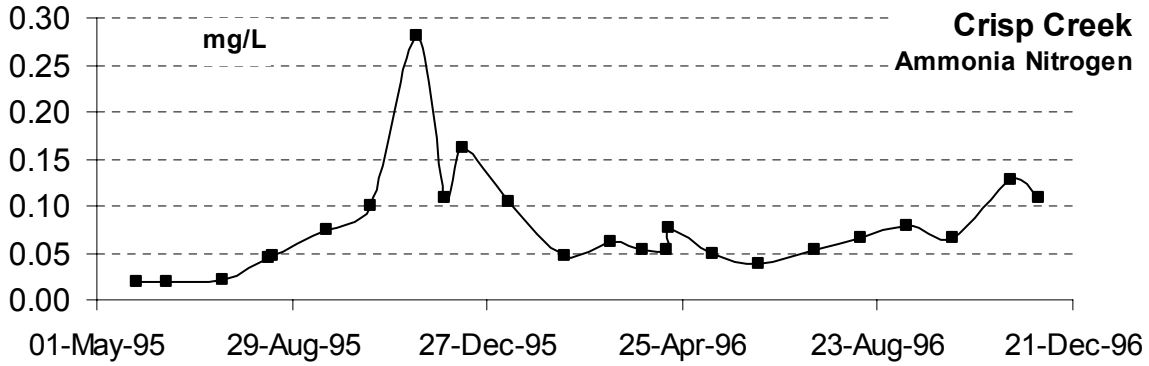

Figure 132: Ammonia Crisp Creek: May 25, 1995 – Nov 1996

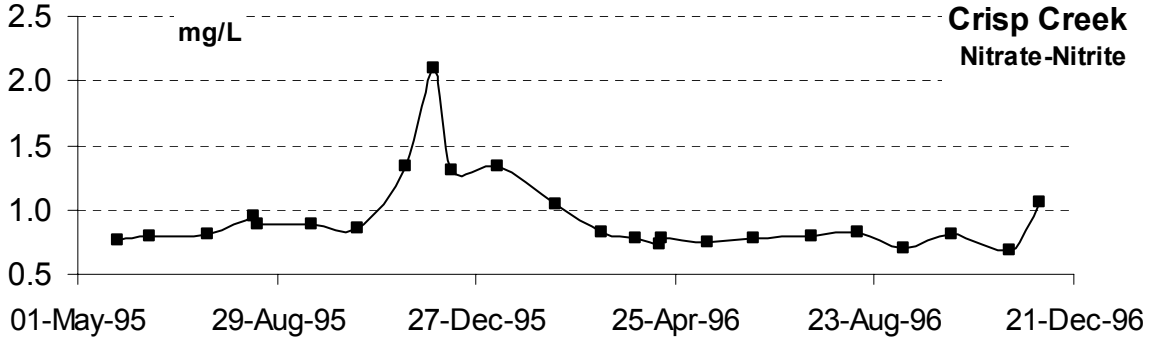

Figure 133: Nitrate-Nitrite Crisp Creek: May 25, 1995 – Nov 1996

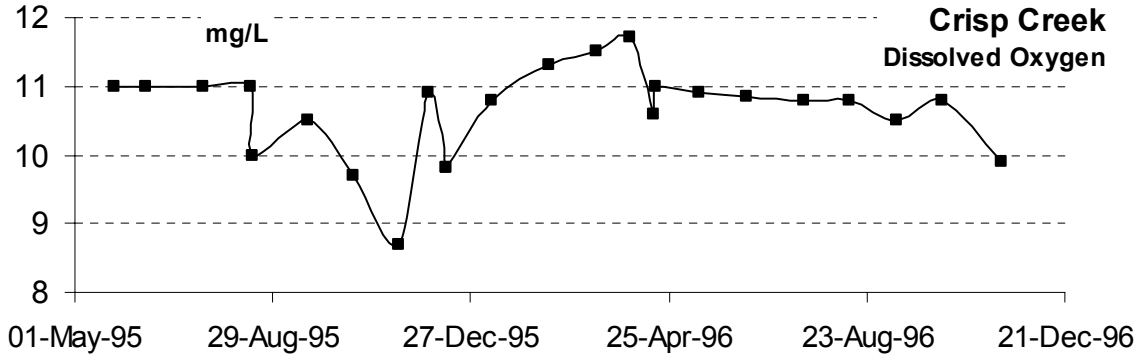

Figure 134 (above): DO Crisp Creek: May 25, 1995 – Nov 1996

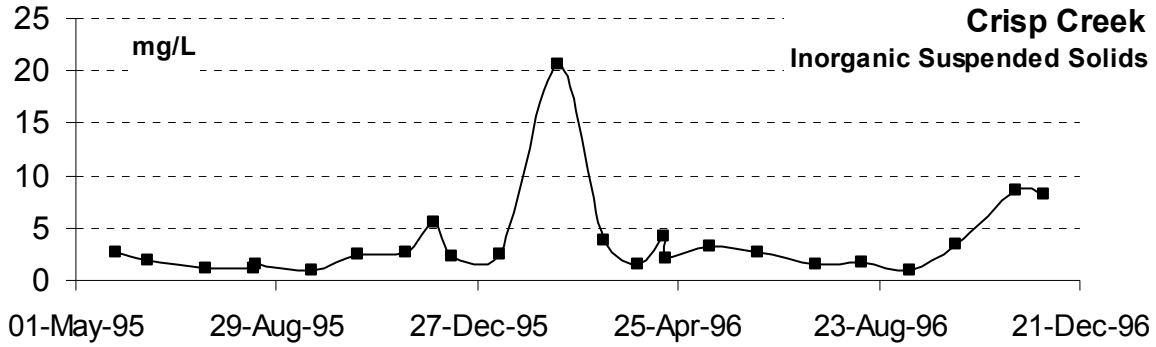

Figure 135: ISS Crisp Creek: May 25, 1995 – Nov 1996

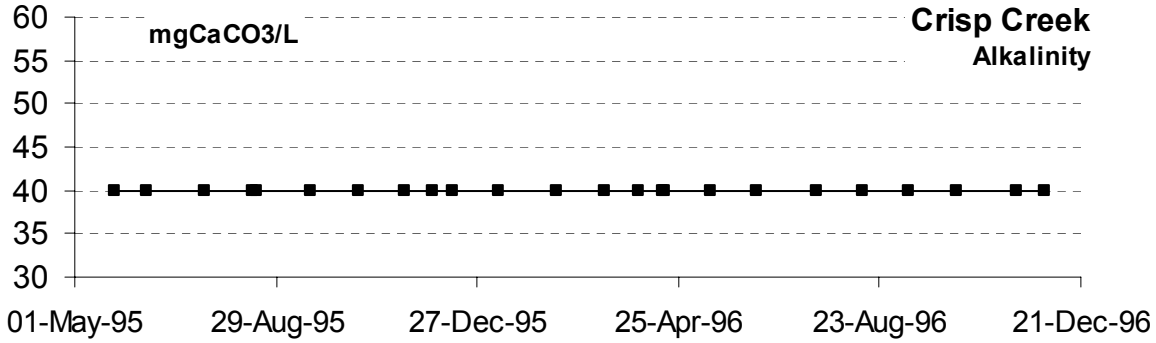

Figure 136: Alkalinity Crisp Creek: May 25, 1995 - Nov 1996

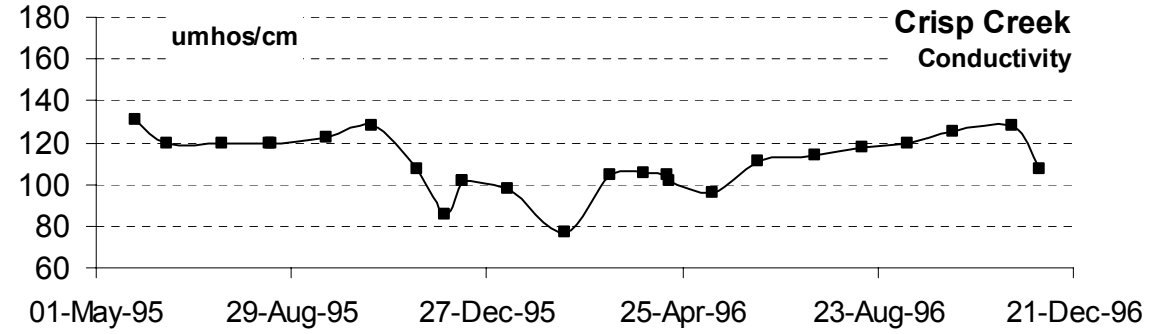

Figure 137: Conductivity Crisp Creek: May 25, 1995 – Nov 1996

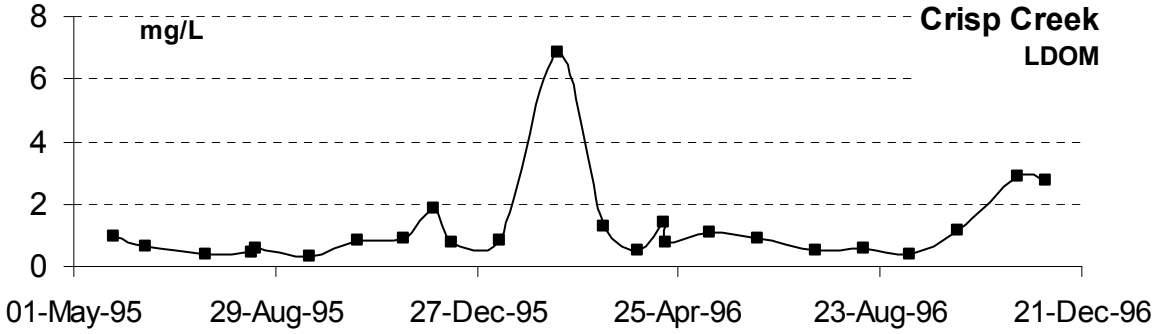

Figure 138: LDOM Crisp Creek: May 25, 1995 – Nov 1996

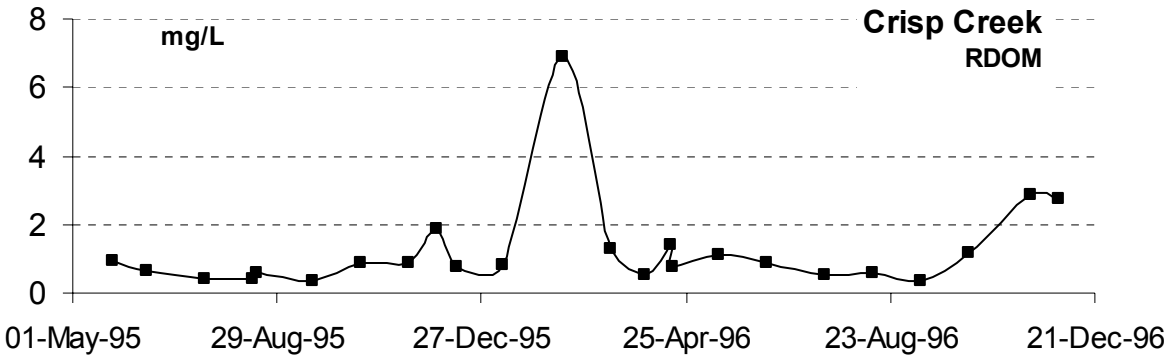

Figure 139: RDOM Crisp Creek: May 25, 1995 – Nov 1996

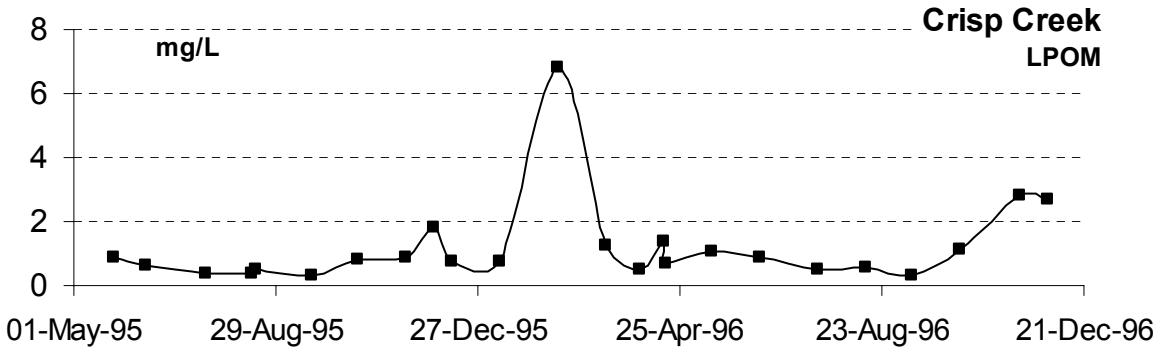

Figure 140: LPOM Crisp Creek: May 25, 1995 – Nov 1996

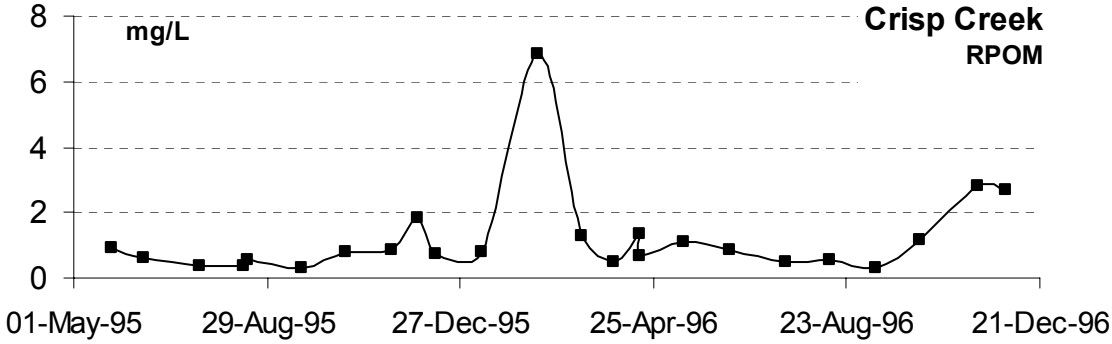

Figure 141: RPOM Crisp Creek: May 25, 1995 – Nov 1996

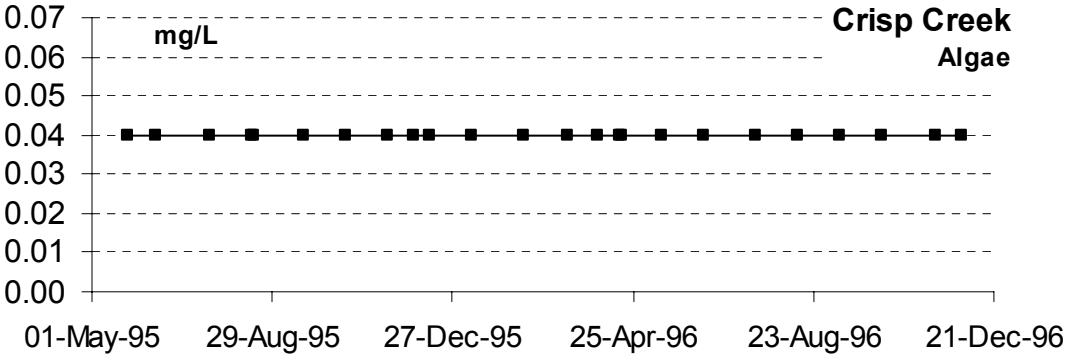

Figure 142: Algae Crisp Creek: May 25, 1995 – Nov 1996

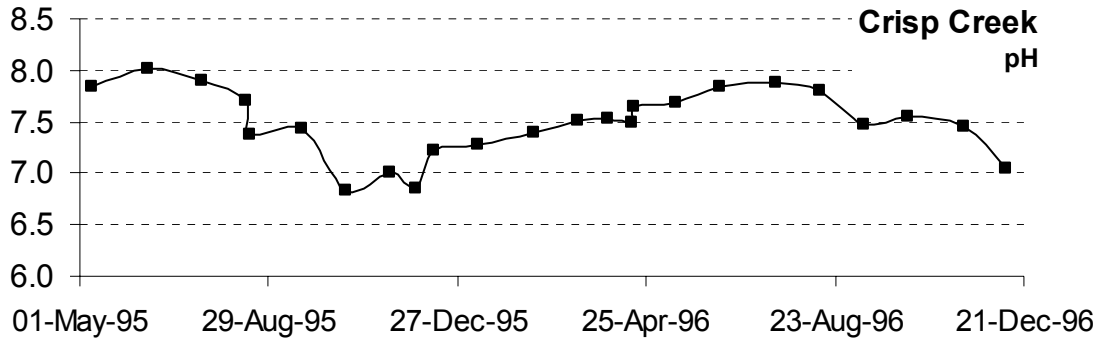

Figure 143: pH Crisp Creek: May 25, 1995 - Nov 1996

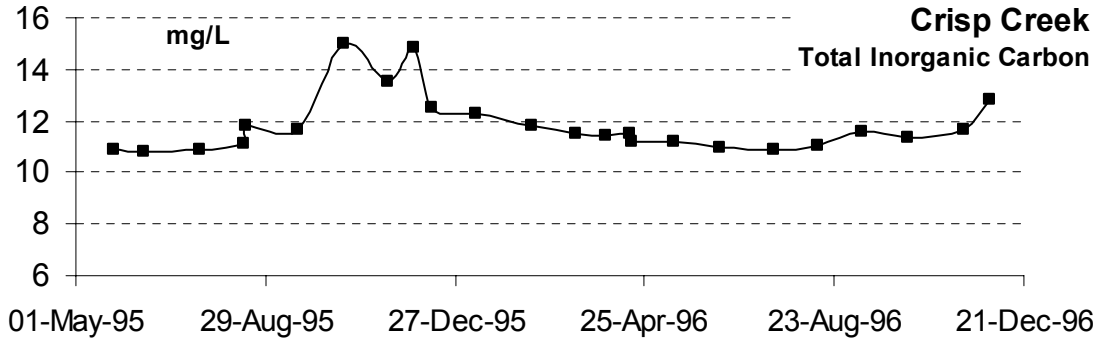

Figure 144: TIC Crisp Creek: May 25, 1995 – Nov 1996

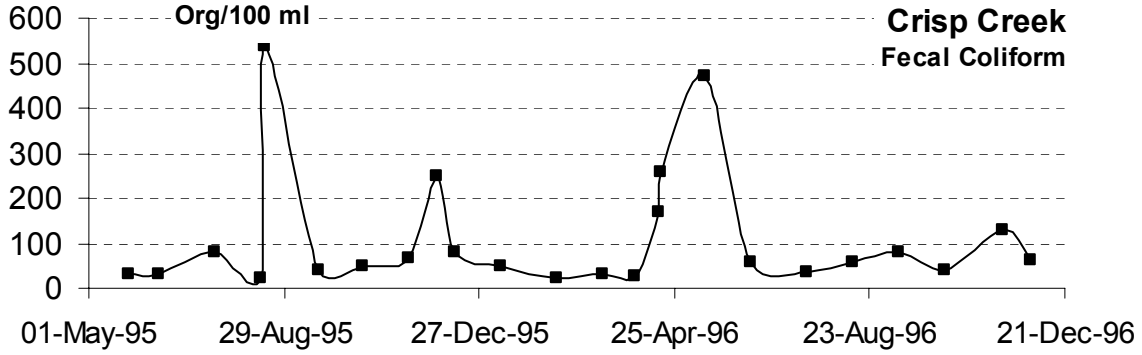

Figure 145: Fecal Coliform Crisp Creek: May 25, 1995 - Nov 1996

April 2001 – July 2002

Flow

King County gage #40d has flow data for this model calibration period in 15-minute intervals. The entire data set are included in Appendix A, and Figure 146 is a graph showing flow for the model calibration period.

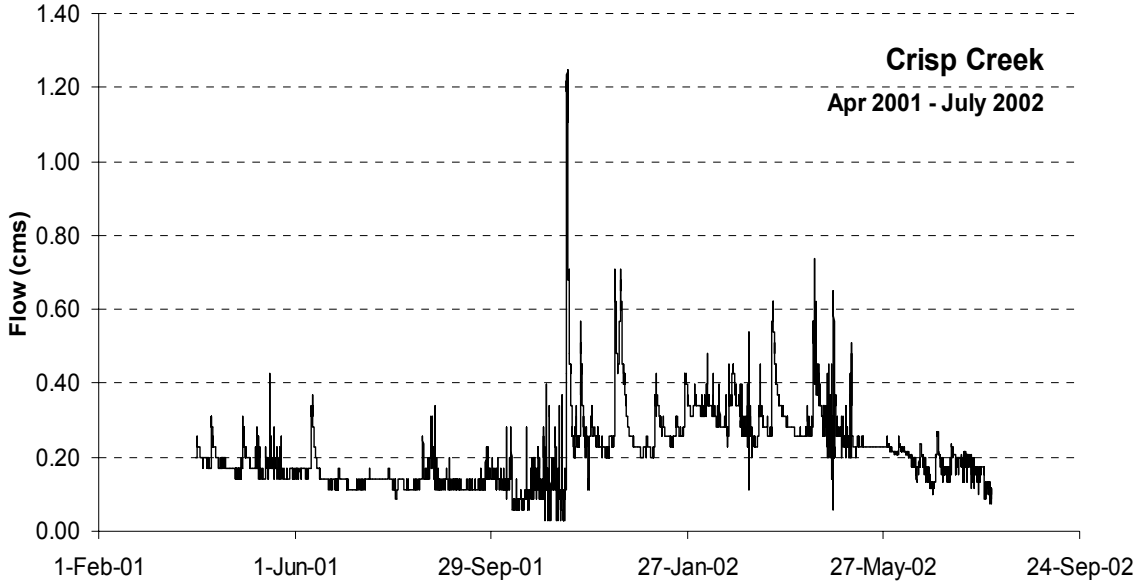

Figure 146: Crisp Creek Flow: Apr 2001 – July 2002

Temperature

Station #40d also recorded temperature for this model calibration period. Figure 147 shows the data for the model simulation period.

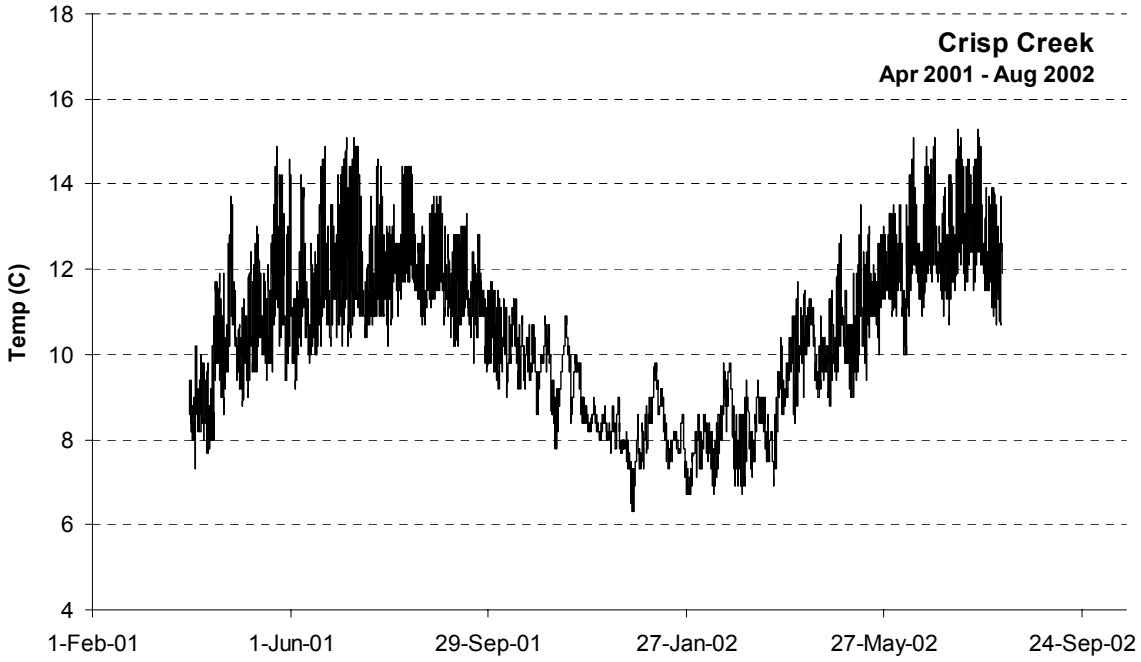

Figure 147: Crisp Creek Temperature: Apr 2001 – July 2002

Water Quality

King County has provided water quality samples on Crisp Creek from 1995 to 2002 (Locator 0321). Data are available for all constituents except chlorophyll a for the model calibration period. Figure 148 through Figure 162 shows data for the model calibration period. See Appendix D for procedures used in assembling the water quality data, including estimating missing data.

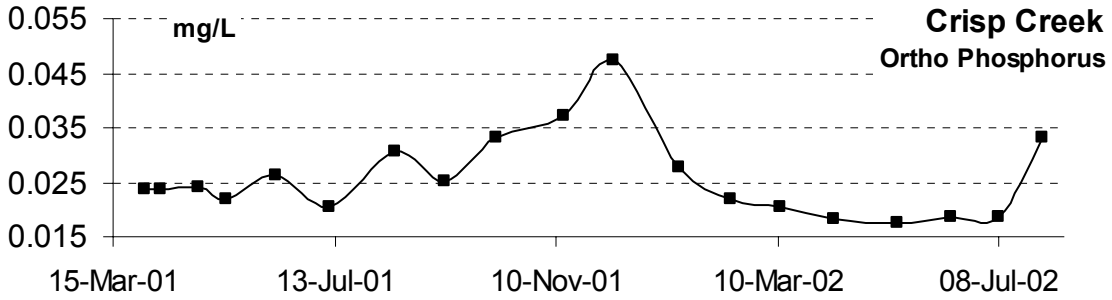

Figure 148: Ortho phosphorus Crisp Creek: Apr 2001–July 2002

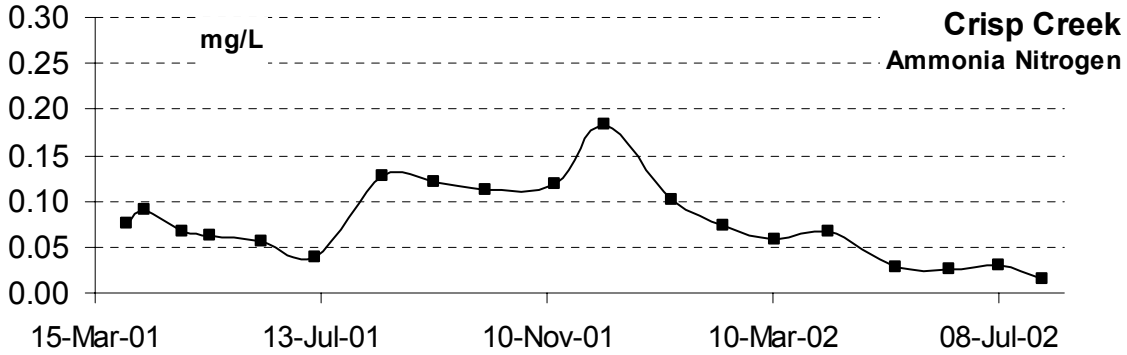

Figure 149: Ammonia Crisp Creek: Apr 2001–July 2002

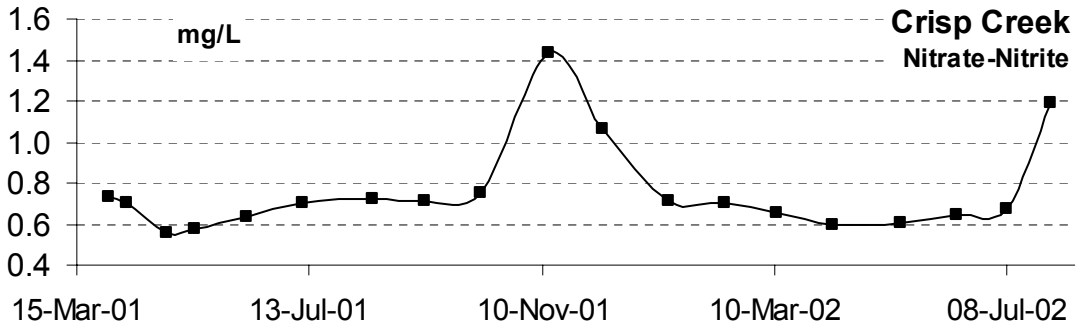

Figure 150: Nitrate-Nitrite Crisp Creek: Apr 2001–July 2002

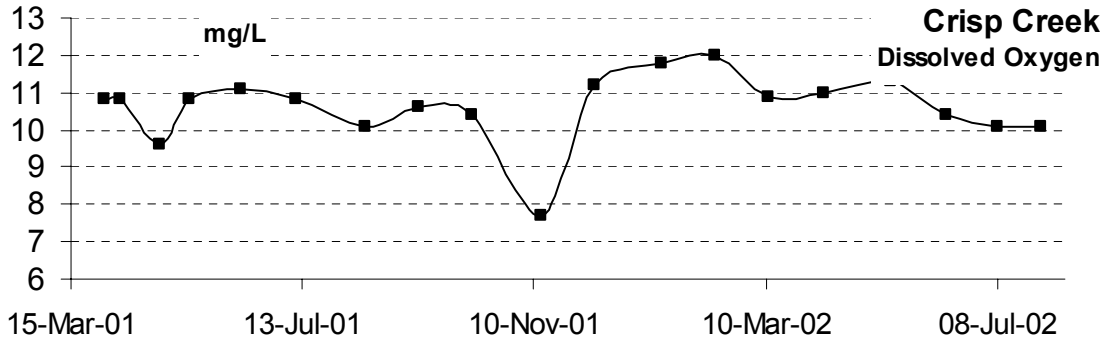

Figure 151: DO Crisp Creek: Apr 2001–July 2002

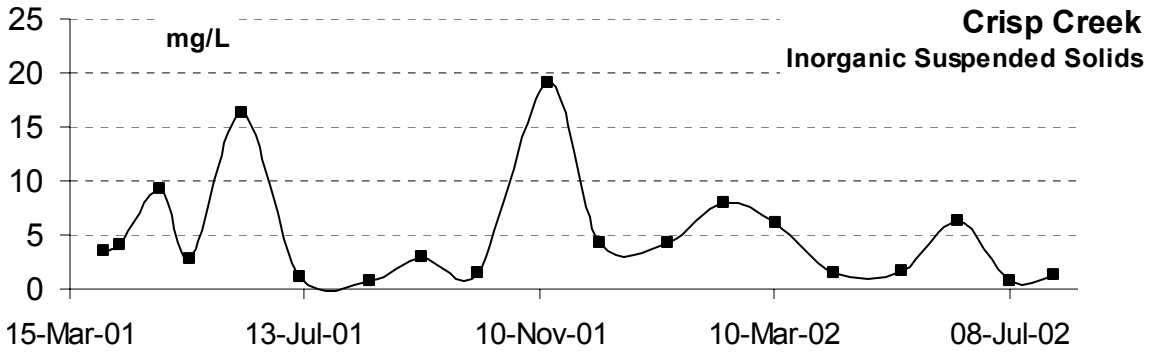

Figure 152: ISS Crisp Creek: Apr 2001–July 2002

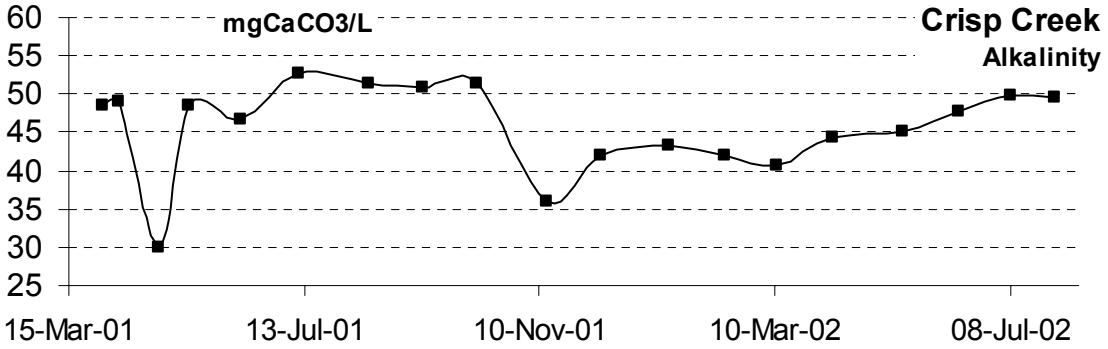

Figure 153: Alkalinity Crisp Creek: Apr 2001–July 2002

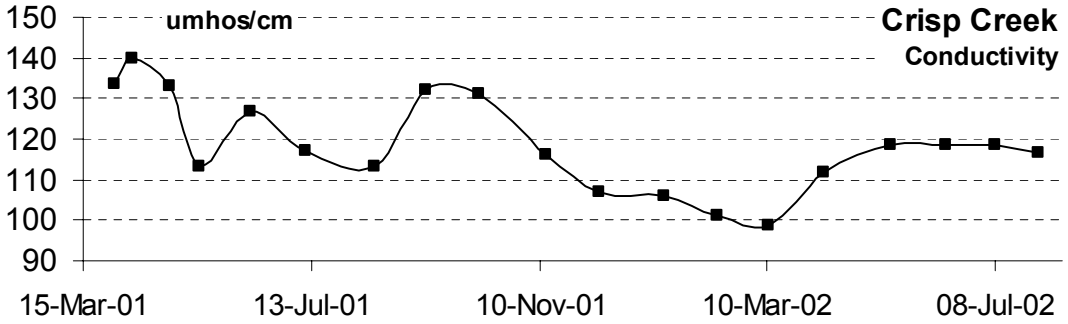

Figure 154: Conductivity Crisp Creek: Apr 2001–July 2002

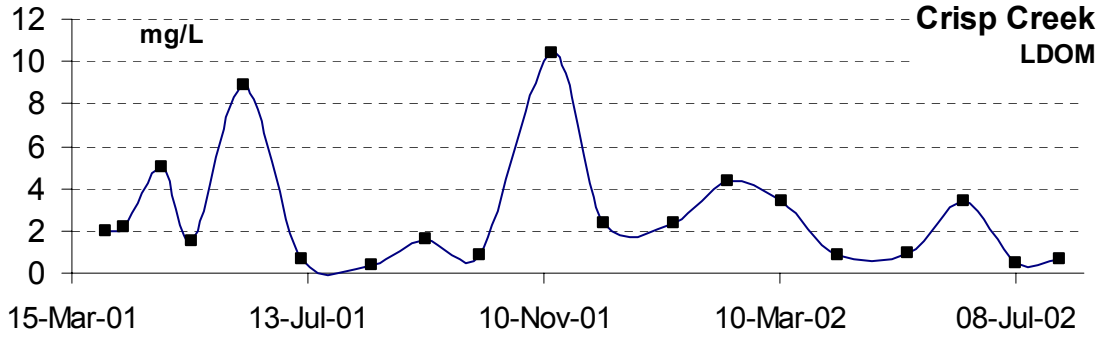

Figure 155: LDOM Crisp Creek: Apr 2001–July 2002

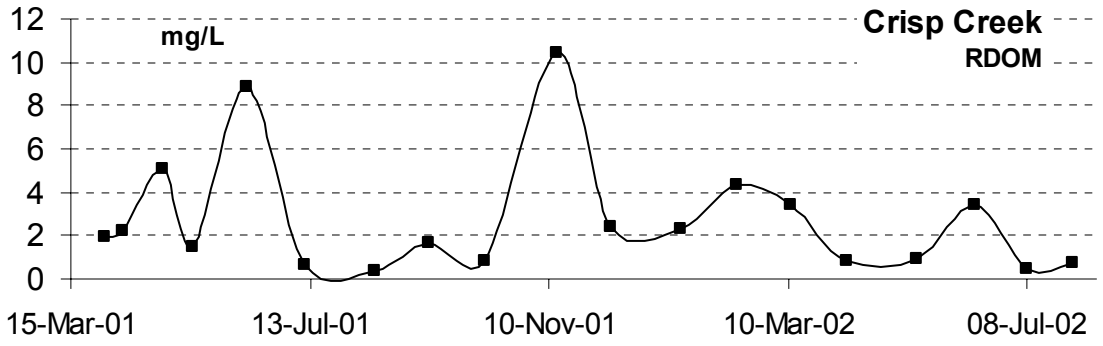

Figure 156: RDOM Crisp Creek: Apr 2001–July 2002

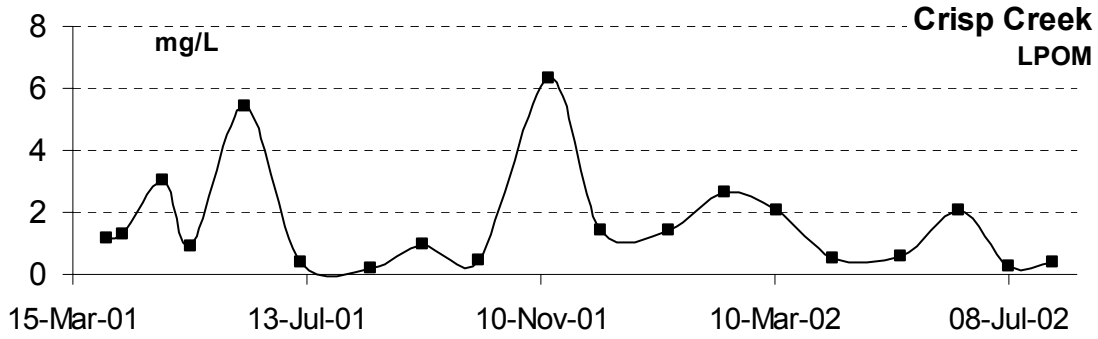

Figure 157: LPOM Crisp Creek: Apr 2001–July 2002

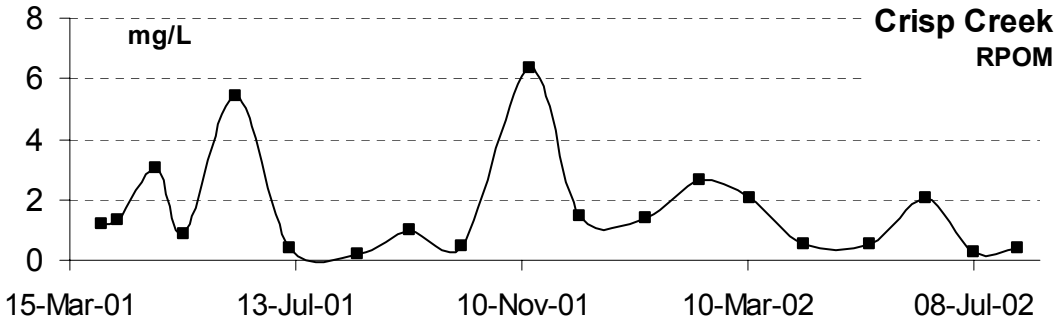

Figure 158: RPOM Crisp Creek: Apr 2001–July 2002

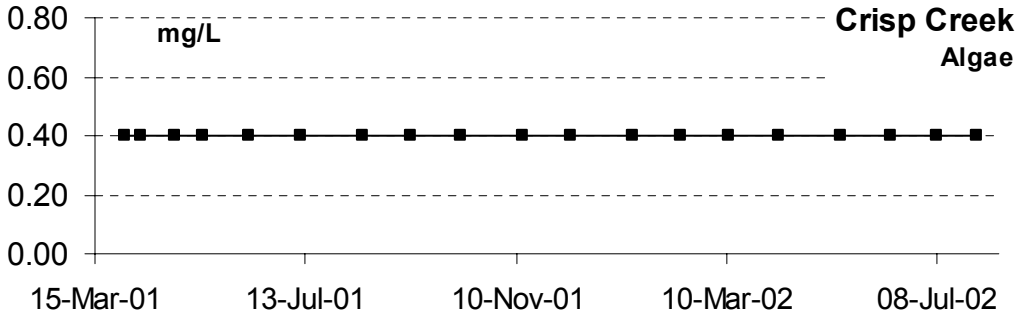

Figure 159: Algae Crisp Creek: Apr 2001–July 2002

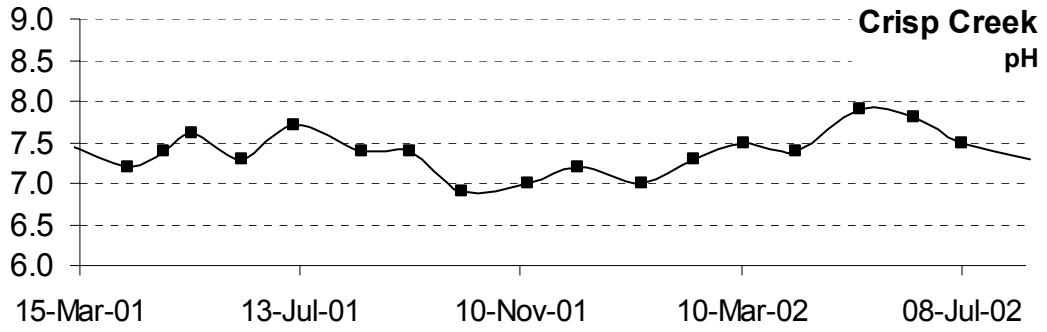

Figure 160: pH Crisp Creek: Apr 2001-July 2002

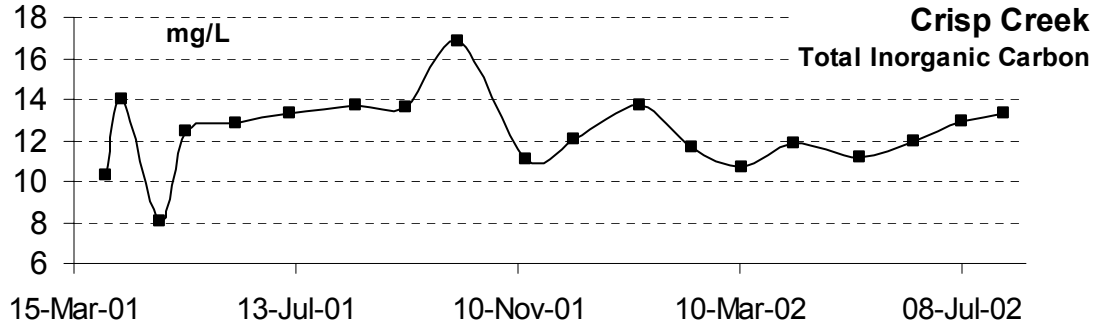

Figure 161: TIC Crisp Creek: Apr 2001–July 2002

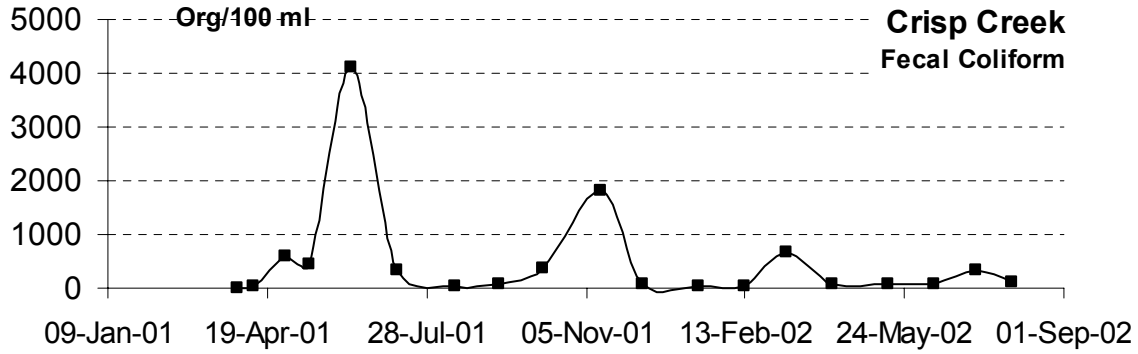

Figure 162: Fecal Coliform Crisp Creek: Apr 2001 - July 2002

2.5.3 Big Soos Creek

Big Soos Creek is the largest tributary contributing flow to the Green River. Big Soos Creek enters Green River at River Mile 33.80. The tributary basin is approximately 17,500 hectares (310,000 acres).

May 25, 1995 – Nov 1996

Flow

Flow data from USGS Gage 12112600 are available in 15-minute intervals from October 1, 1994, to December 31, 2002. The complete data set is included in Appendix A, and Figure 163 shows the flow data for the model simulation period.

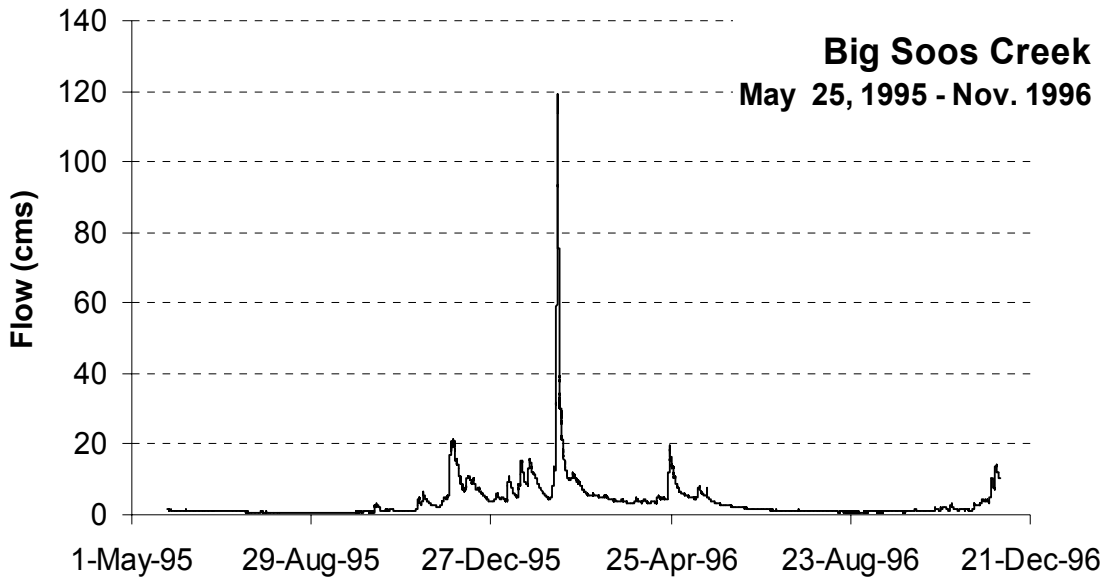

Figure 163: Big Soos Creek Flow: May 25, 1995 – Nov 1996

Temperature

There is one gap in temperature from October 30, 1995 to April 12, 1996. There is little temperature data available during this time period, so to fill this data gap Station BIC, on the Green River near Tukwila, was used. The correlation equation is as follows:

Temperature at Station 54a = (0.5682)(Temperature at Station BIC) + 4.0774

Figure 164 shows the temperature correlation between the two sites, Figure 165 compares correlated values to monitored data from Big Soos Creek, and Figure 166 shows the temperature data for this calibration period with correlated values included. Note that Station 54a records temperature in 15-minute intervals, and Station BIC recorded in half-hour intervals, so the correlated data are also in half-hour intervals.

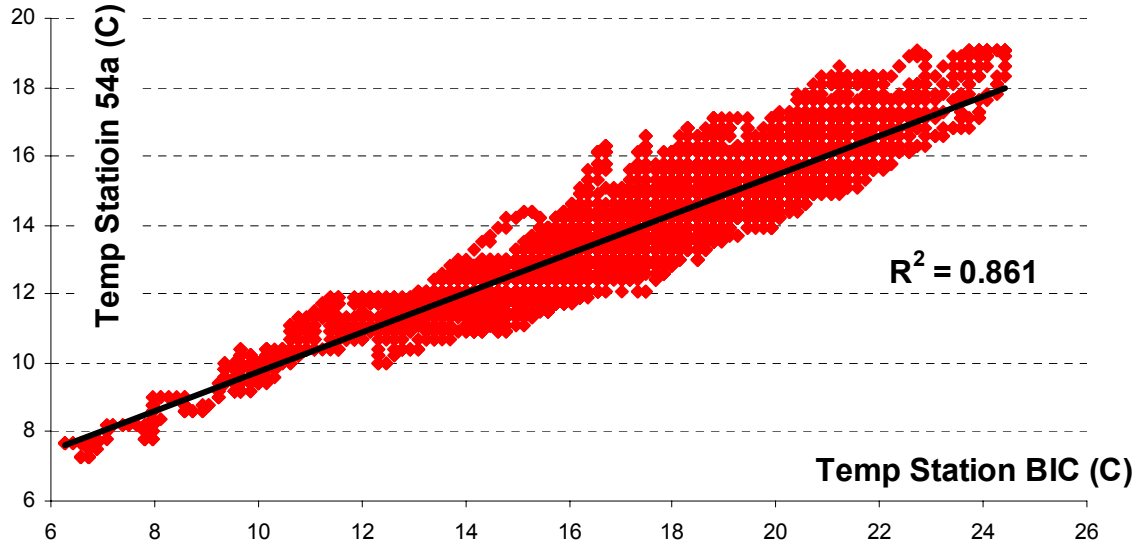

Figure 164: Correlation between Big Soos Creek and Station BIC

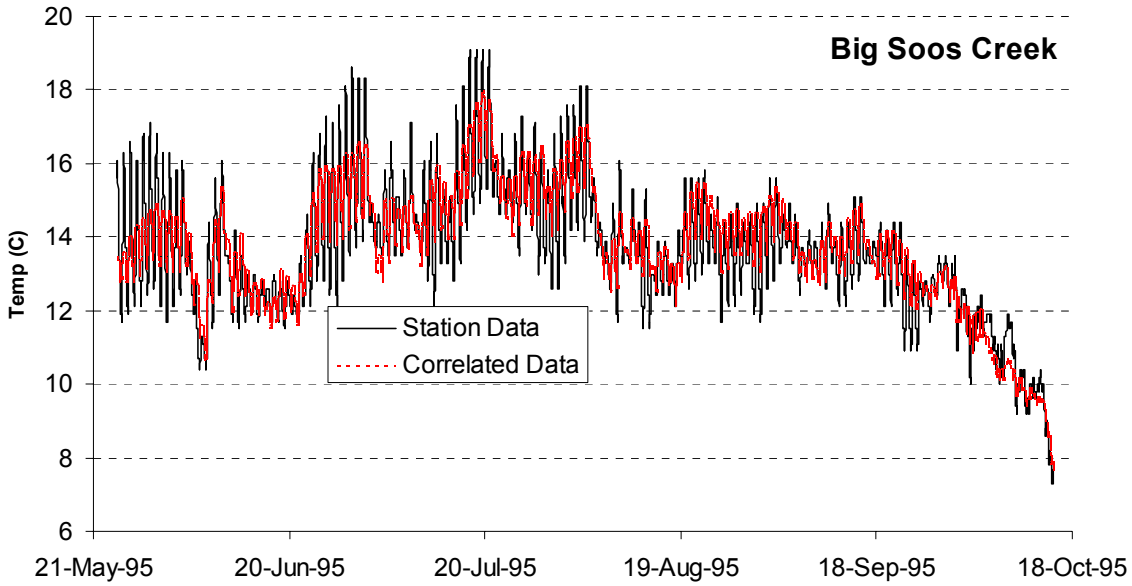

Figure 165: Big Soos Creek: Station data versus correlated values, 1995 - 1996

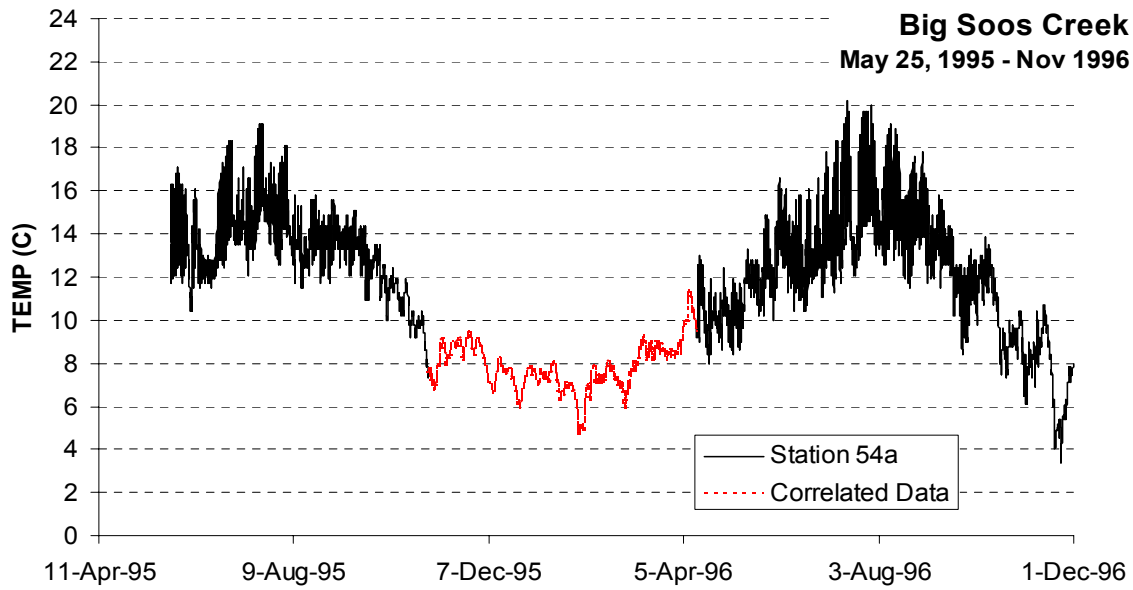

Figure 166: Big Soos Creek Temperature: May 25, 1995 – Nov 1996

Water Quality

King County has been collecting water quality samples at the mouth of Big Soos since 1995 (Locator A320). Data are available for all constituents except chlorophyll a and alkalinity. Figure 167 through Figure 181 shows graphs of the water quality constituents for the model calibration period. See Appendix D for procedures used in assembling the water quality data, including estimating missing data.

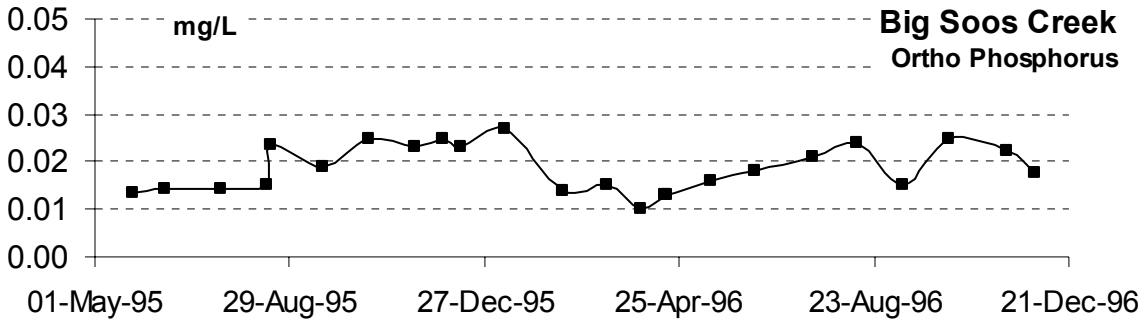

Figure 167: Ortho phosphorus Big Soos Creek: May 25, 1995 – Nov 1996

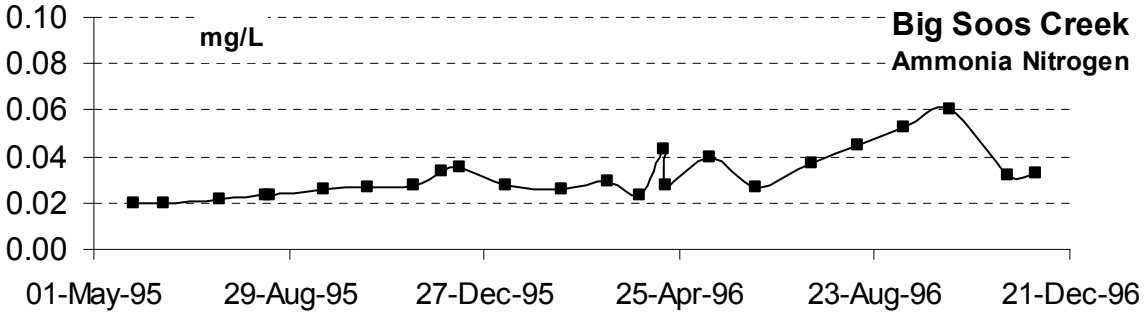

Figure 168: Ammonia Big Soos Creek: May 25, 1995 – Nov 1996

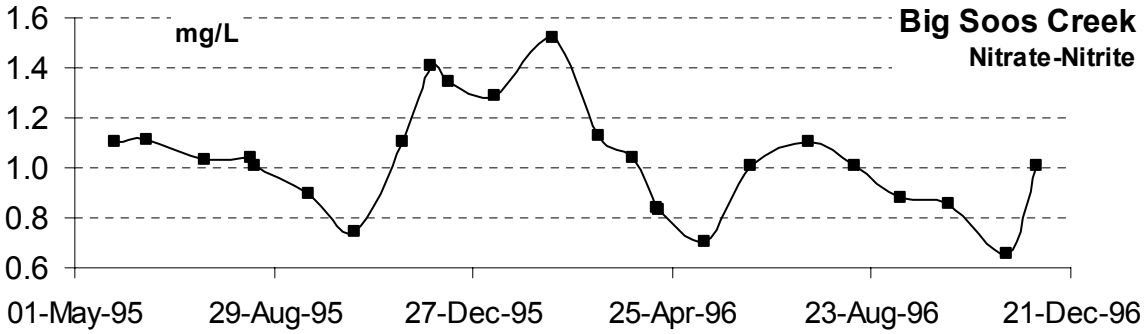

Figure 169: Nitrate-Nitrite Big Soos Creek: May 25, 1995 – Nov 1996

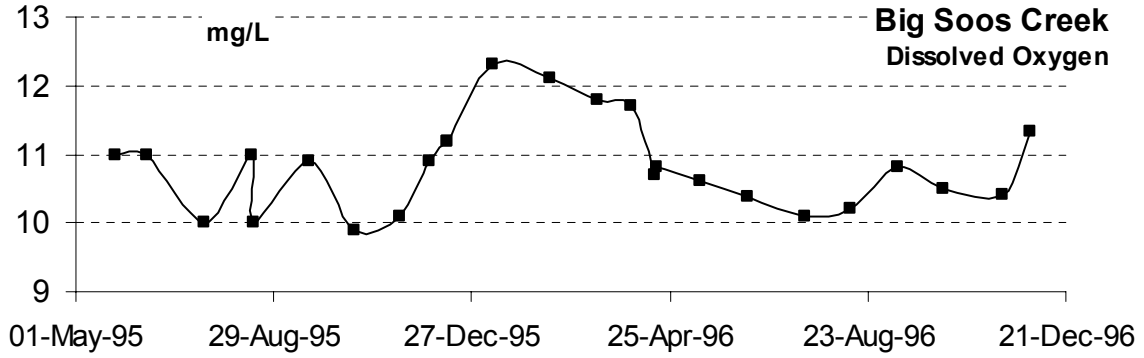

Figure 170: DO Big Soos Creek: May 25, 1995 – Nov 1996

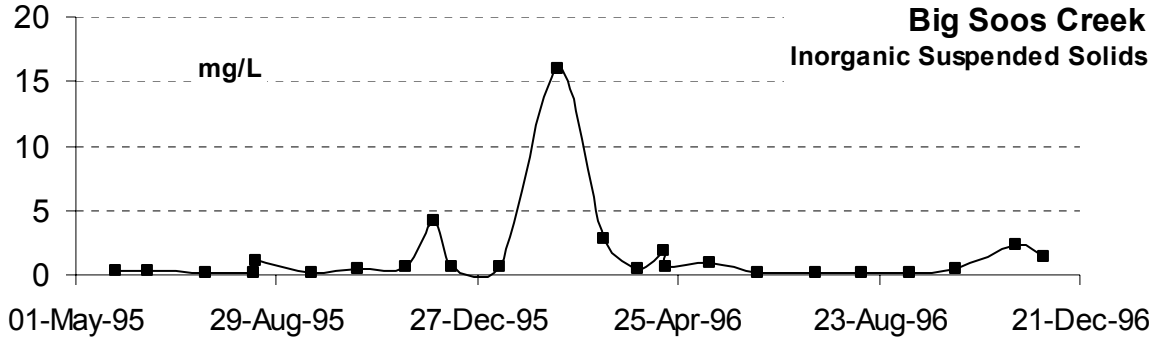

Figure 171: Big Soos: ISS Creek: May 25, 1995 – Nov 1996

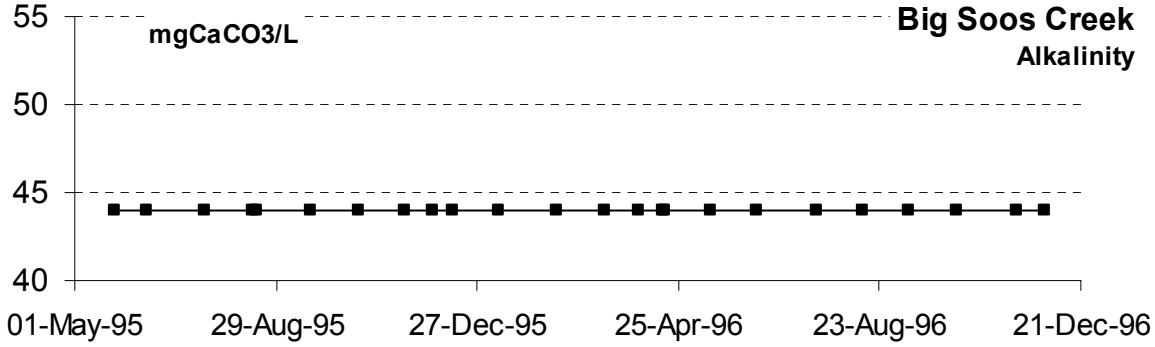

Figure 172: Alkalinity Big Soos Creek: May 25, 1995 – Nov 1996

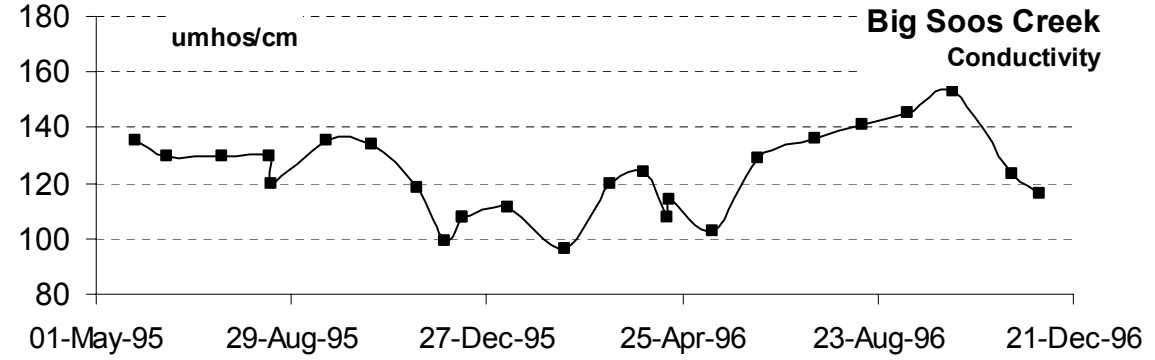

Figure 173: Conductivity Big Soos Creek: May 25, 1995 – Nov 1996

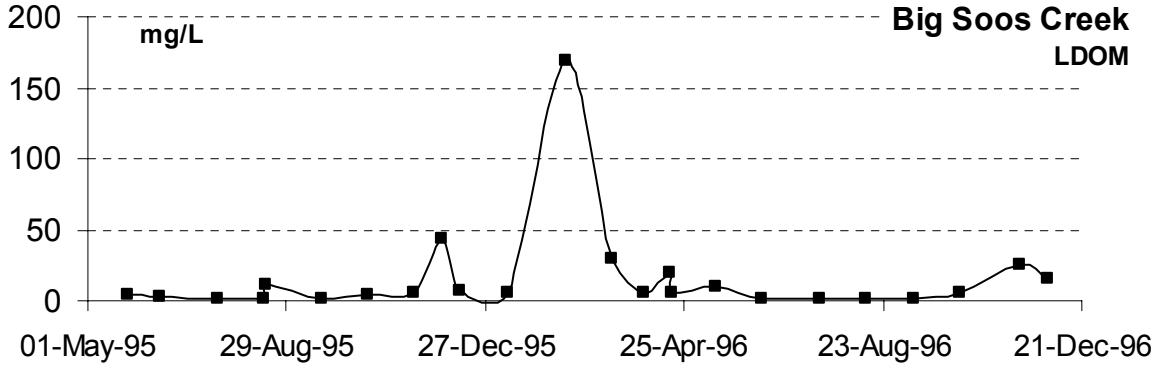

Figure 174: LDOM Big Soos Creek: May 25, 1995 – Nov 1996

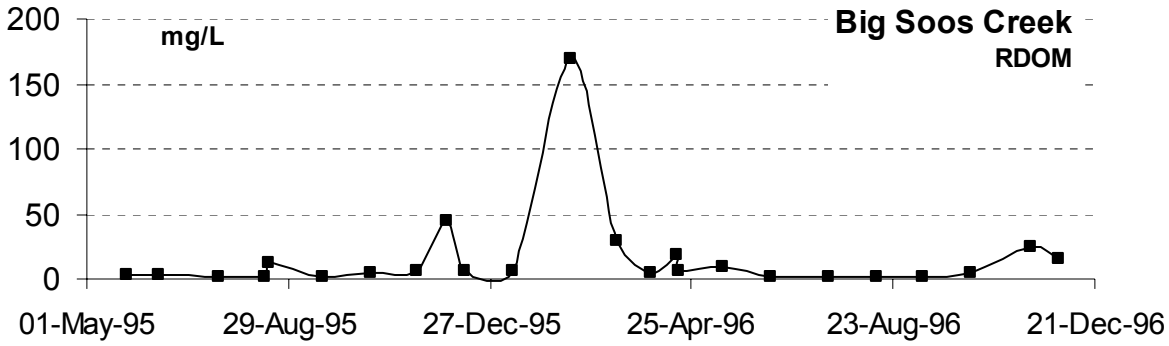

Figure 175: RDOM Big Soos Creek: May 25, 1995 – Nov 1996

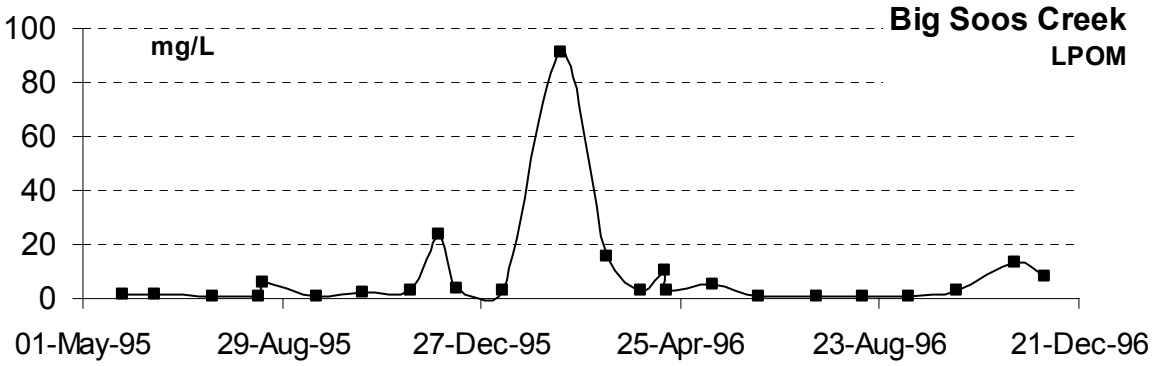

Figure 176: LPOM Big Soos Creek: May 25, 1995 – Nov 1996

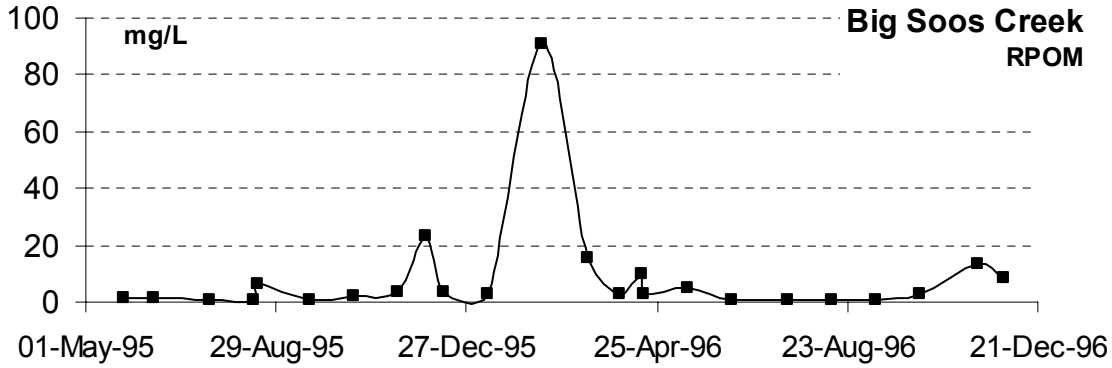

Figure 177: RPOM Big Soos Creek: May 25, 1995 – Nov 1996

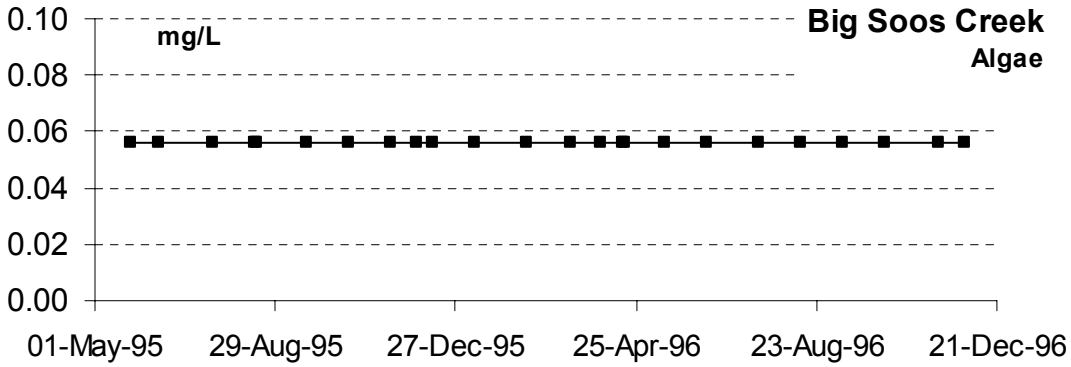

Figure 178: Algae Big Soos Creek: May 25, 1995 – Nov 1996

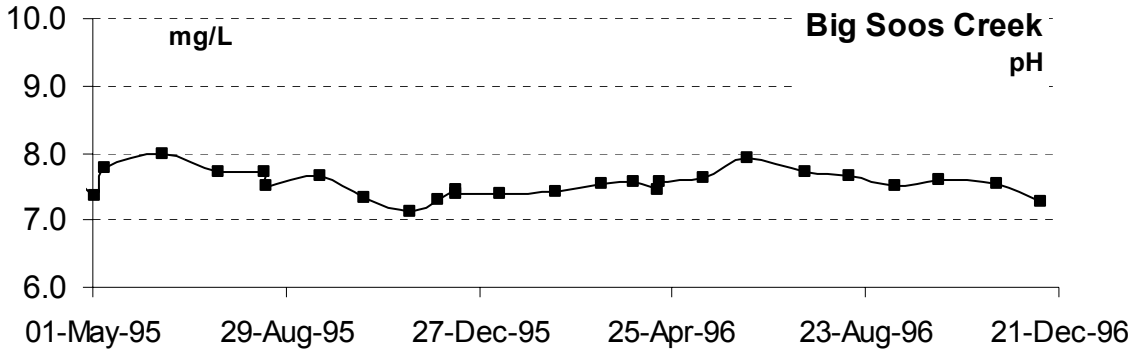

Figure 179: pH Big Soos Creek: May 25, 1995 - Nov 1996

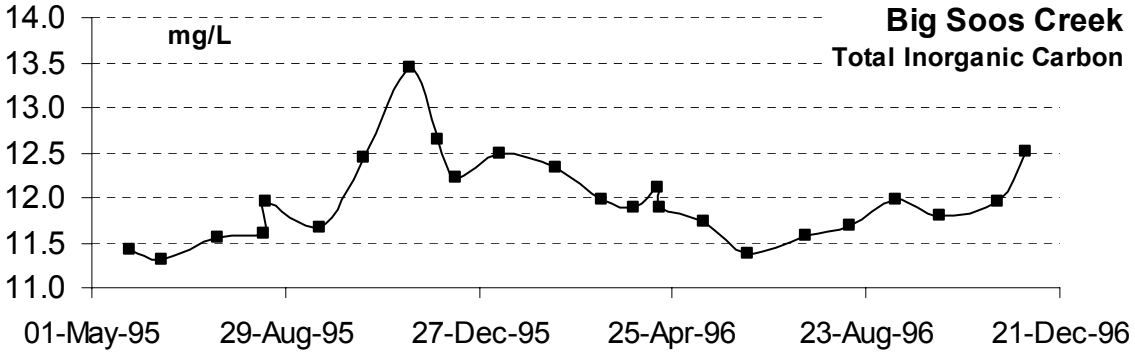

Figure 180: TIC Big Soos Creek: May 25, 1995 – Nov 1996

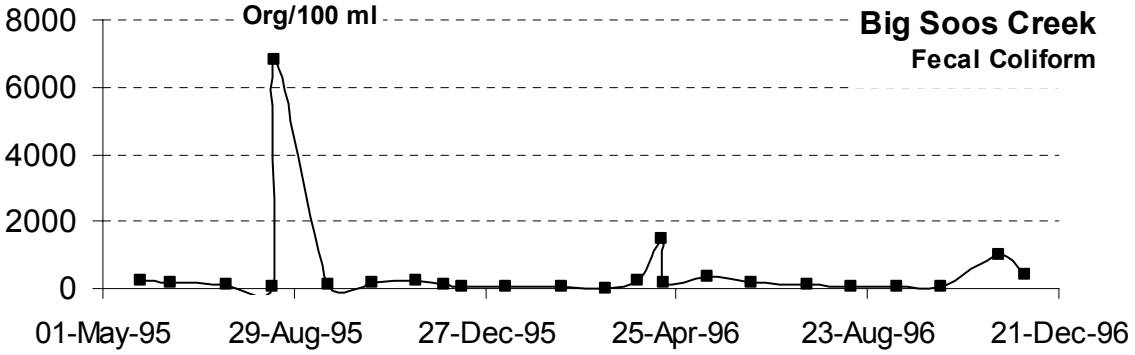

Figure 181: Fecal Coliform: May 25, 1995 - Nov 1996

April 2001 – July 2002

Flow

Flow data from USGS Gage 12112600 were also used for this model calibration period. The complete data set is included in Appendix A, and Figure 182 shows the flow data for the model simulation period.

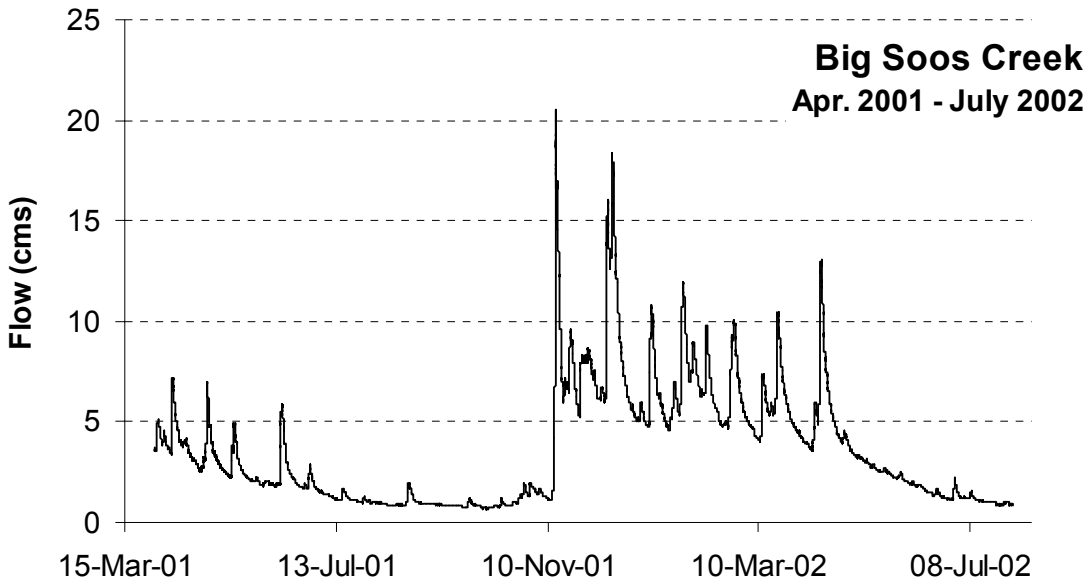

Figure 182: Big Soos Creek Flow: Apr 2001 – July 2002

Temperature

King County provided temperature data from a station at the mouth of Soos Creek from October 1, 1994 to August 1, 2002, in 15-minute intervals (Station 54a). Data for the model calibration period are shown in Figure 183.

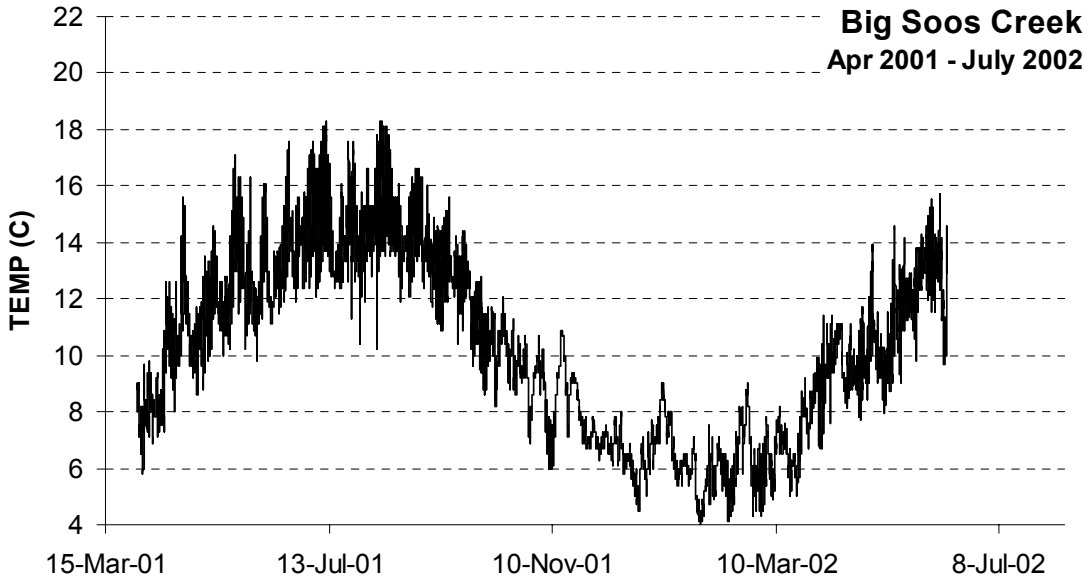

Figure 183: Big Soos Temperature: Apr 2001 – July 2002

Water Quality

King County has provided water quality data at the mouth of the Big Soos Creek from 1995 through 2002 (Station A320). Data are available for all constituents except chlorophyll a. Figure 184 through Figure 198 show graphs of the data for the model calibration period. Data from 1995-2002 are shown in Appendix A. See Appendix D for procedures used in assembling the water quality data, including estimates of missing data.

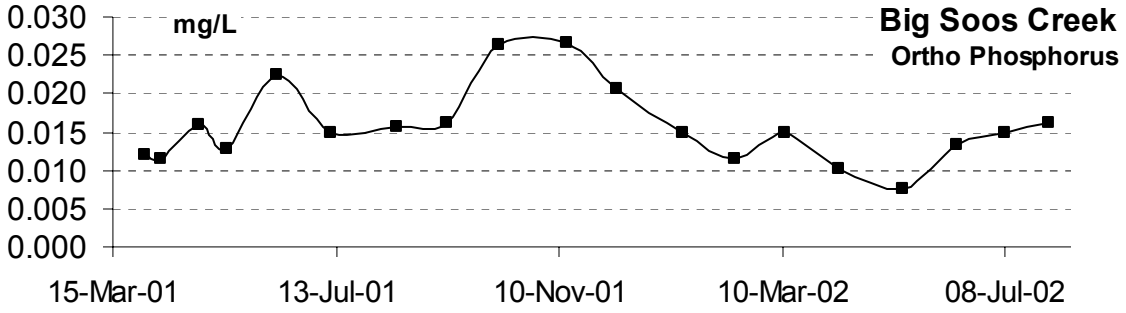

Figure 184: Ortho Phosphorus Big Soos: Apr 2001 – July 2002

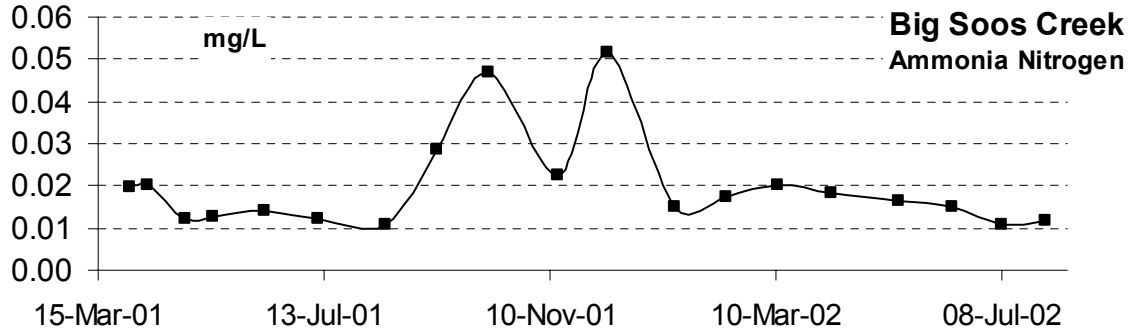

Figure 185: Ammonia Big Soos: Apr 2001 – July 2002

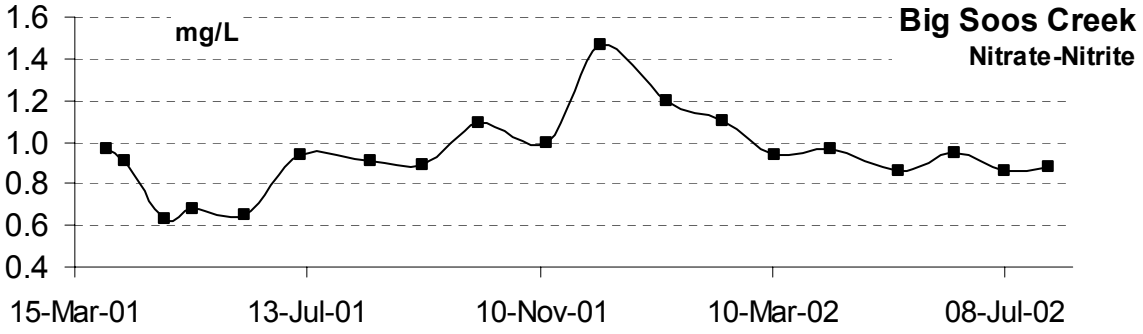

Figure 186: Nitrate-Nitrite Big Soos: Apr 2001 – July 2002

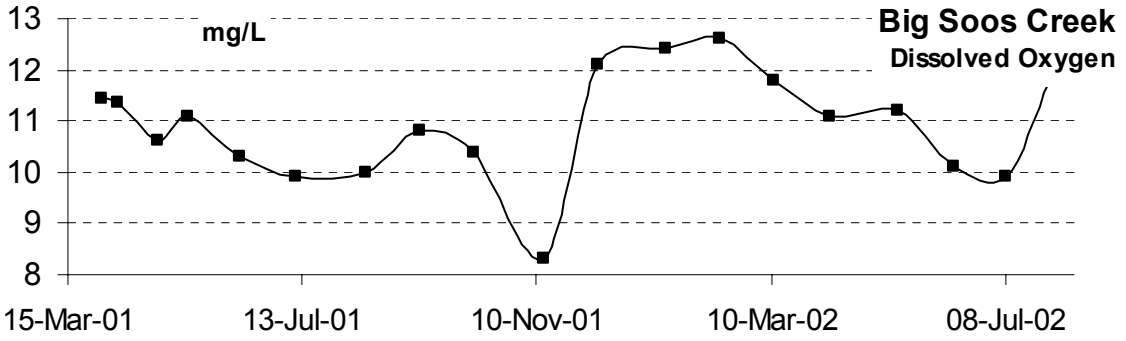

Figure 187: DO Big Soos: Apr 2001 – July 2002

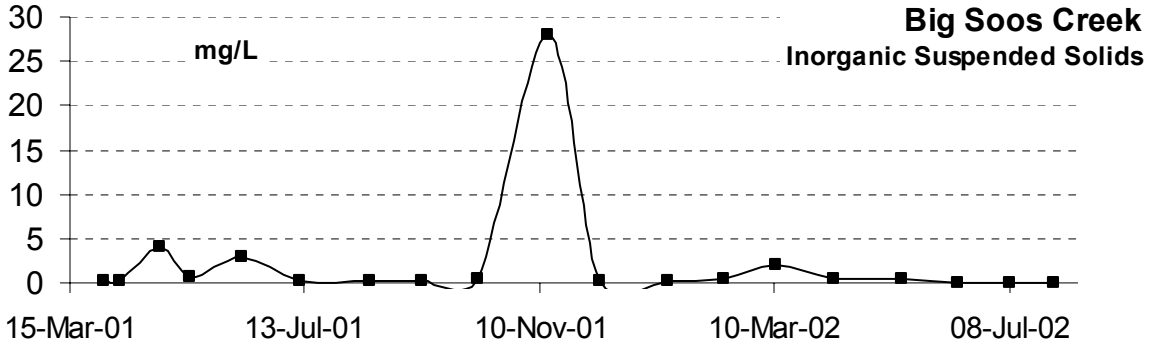

Figure 188: ISS Big Soos: Apr 2001 – July 2002

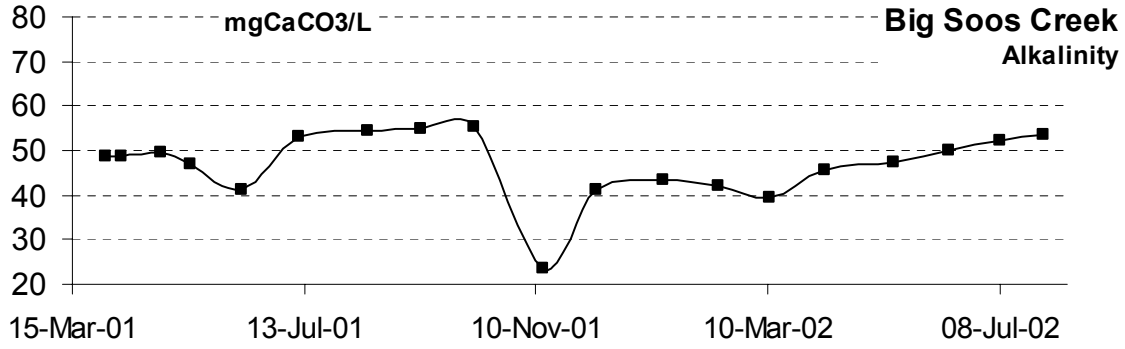

Figure 189: Alkalinity Big Soos: Apr 2001 – July 2002

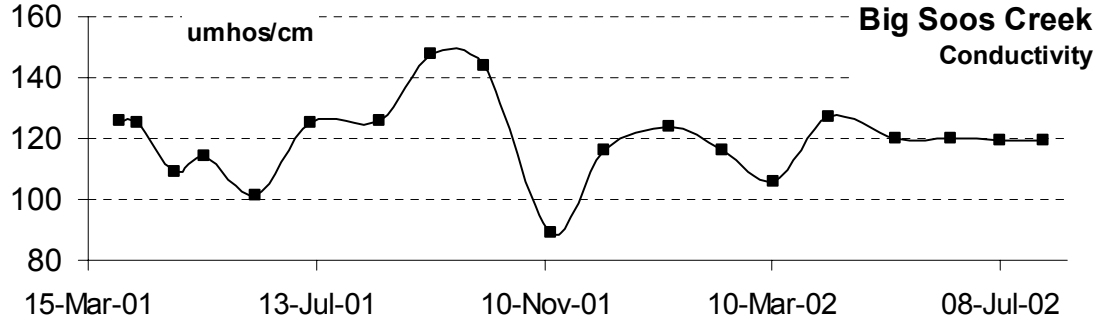

Figure 190: Conductivity Big Soos: Apr 2001 – July 2002

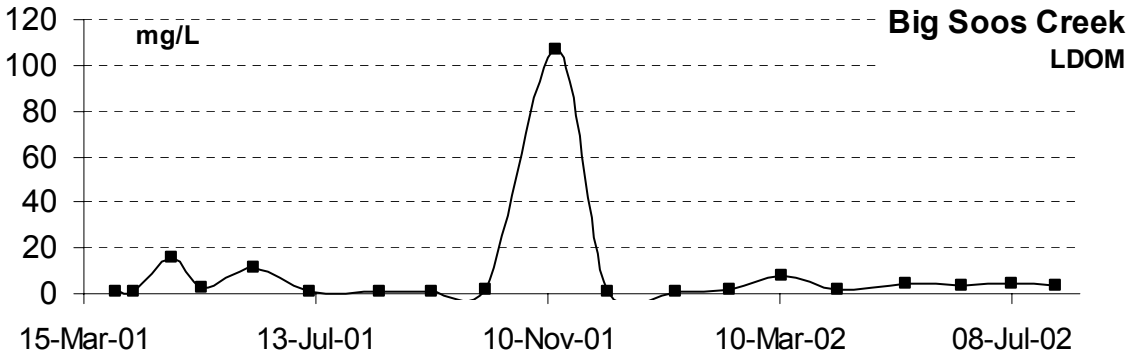

Figure 191: LDOM Big Soos: Apr 2001 – July 2002

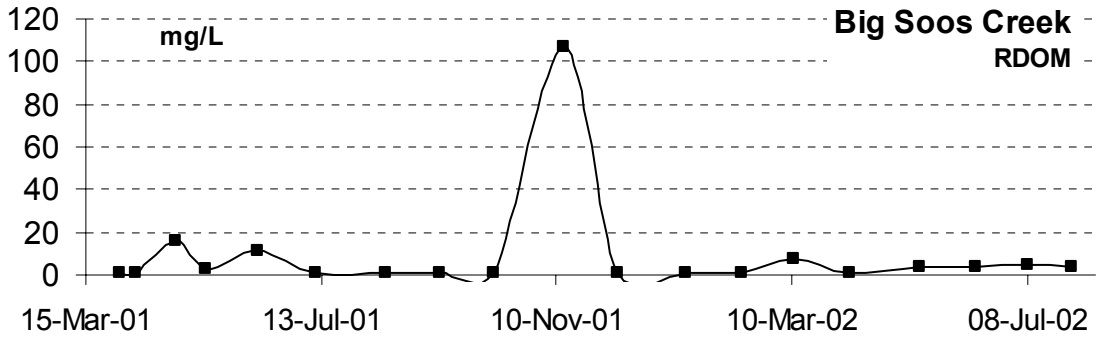

Figure 192: RDOM Big Soos: Apr 2001 – July 2002

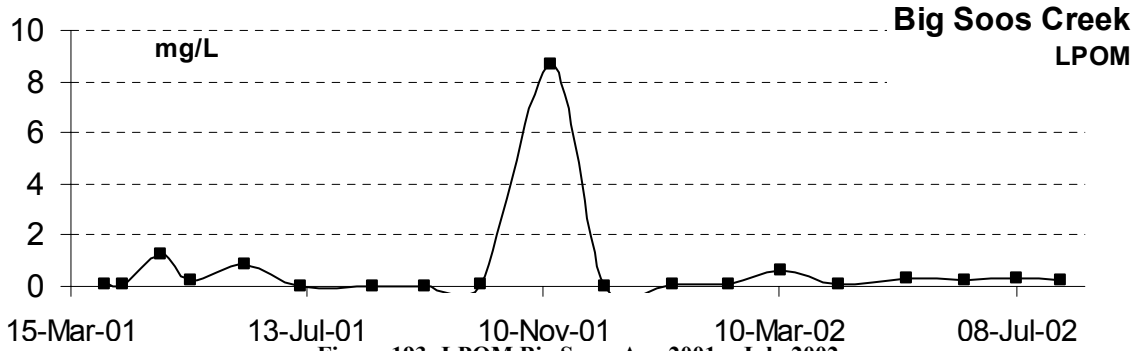

Figure 193: LPOM Big Soos: Apr 2001 – July 2002

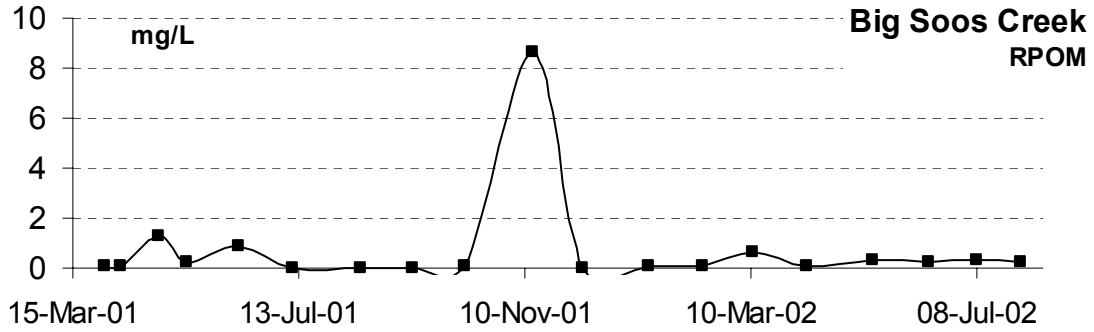

Figure 194: RPOM Big Soos: Apr 2001 – July 2002

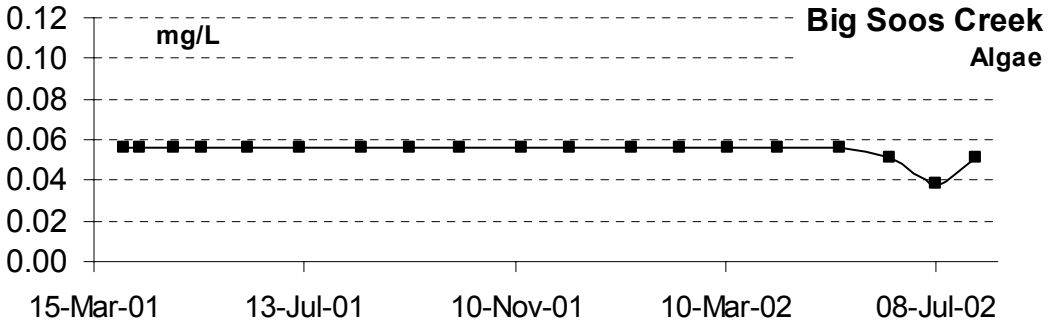

Figure 195: Algae Big Soos: Apr 2001 – July 2002

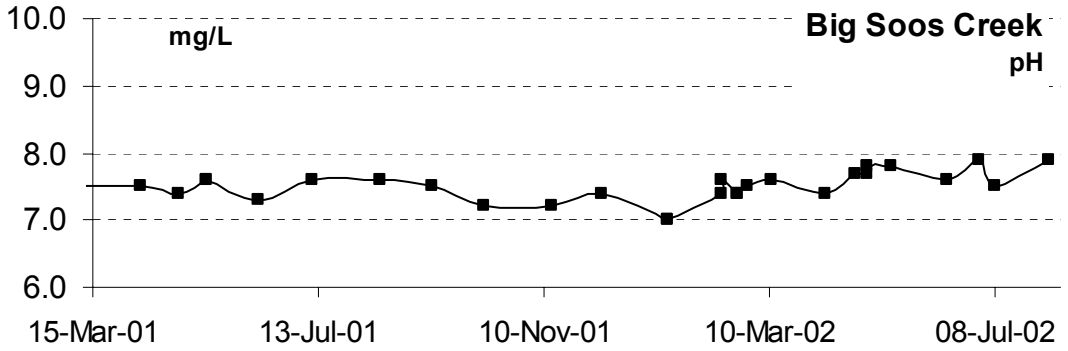

Figure 196: pH Big Soos: Apr 2001 - July 2002

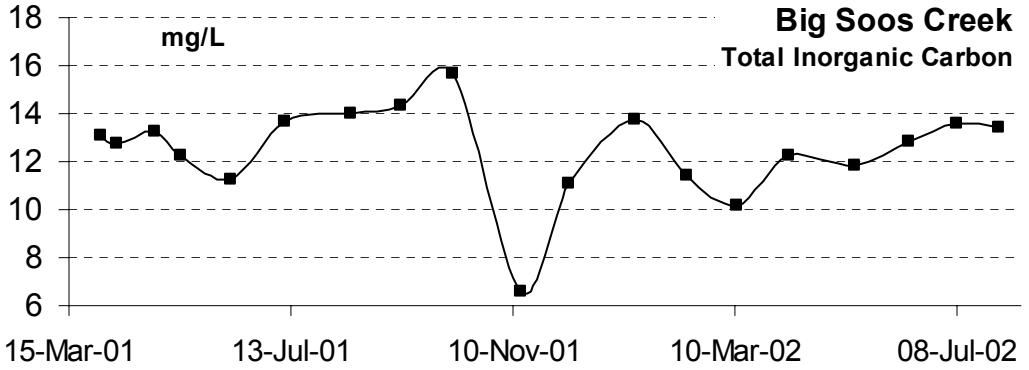

Figure 197: TIC Big Soos: Apr 2001 – July 2002

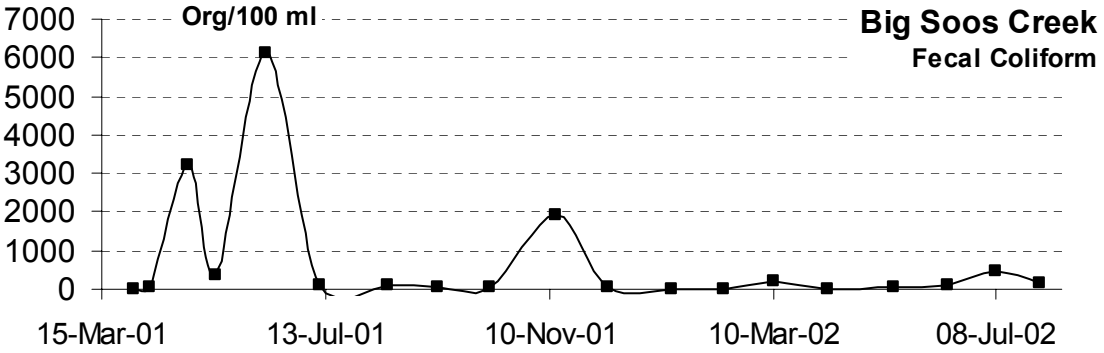

Figure 198: Fecal Coliform Big Soos: Apr 2001 - July 2002

2.5.4 Mill Creek

Mill Creek is another small tributary to Green River, with an approximate basin size of 3,950 hectares (9760 acres), which enters the Green River at River Mile 23.80.

May 25, 1995 – November 1996

Flow

King County maintained a flow gage on Mill Creek, but it was removed because the county believes backwater from the Green River made data from this gage unreliable (DeGasperi, 2003). Data were provided for this gage in 15-minute intervals from August 22, 1989 to April 6, 1996. These data are shown in Appendix A. Note the number of time periods where the gage data is at zero. These are time

periods of "bad" data, possibly where flow is reversed in the creek.

King County also modeled the Mill Creek basin using HSPF from October 1948 to December 2002. Daily average flow data were provided from this model. Flow data from Station 41a were graphed against the HSPF data. Figure 199 shows the comparison. The highs and lows occur at the same time, but the HSPF data are consistently larger in magnitude. Because there is a question of the reliability of data from Station 41a, HSPF data will be used for both model calibration periods. Figure 200 shows the data for the model simulation period.

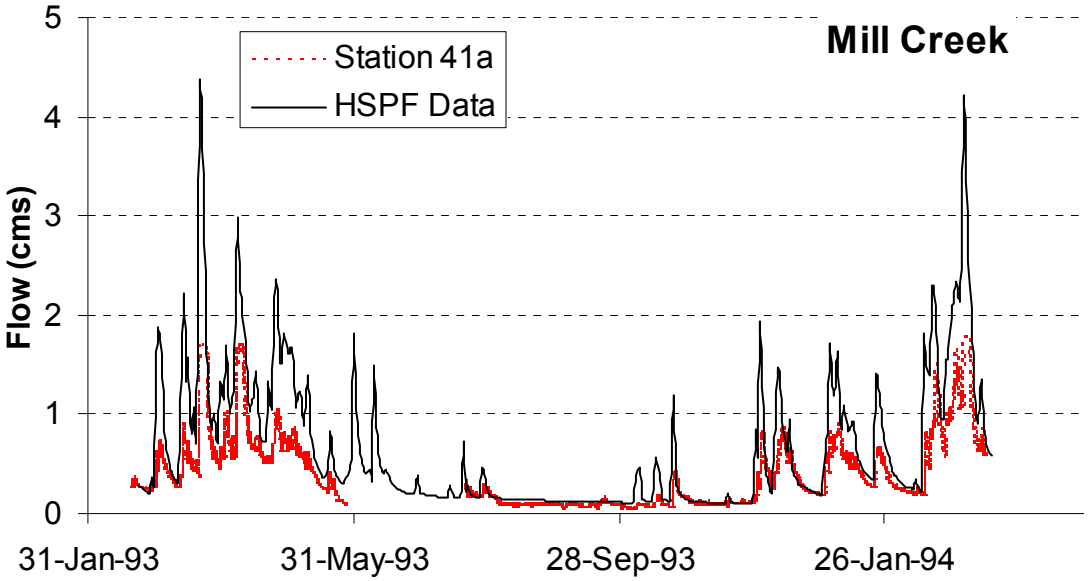

Figure 199: Mill Creek Flow Comparison

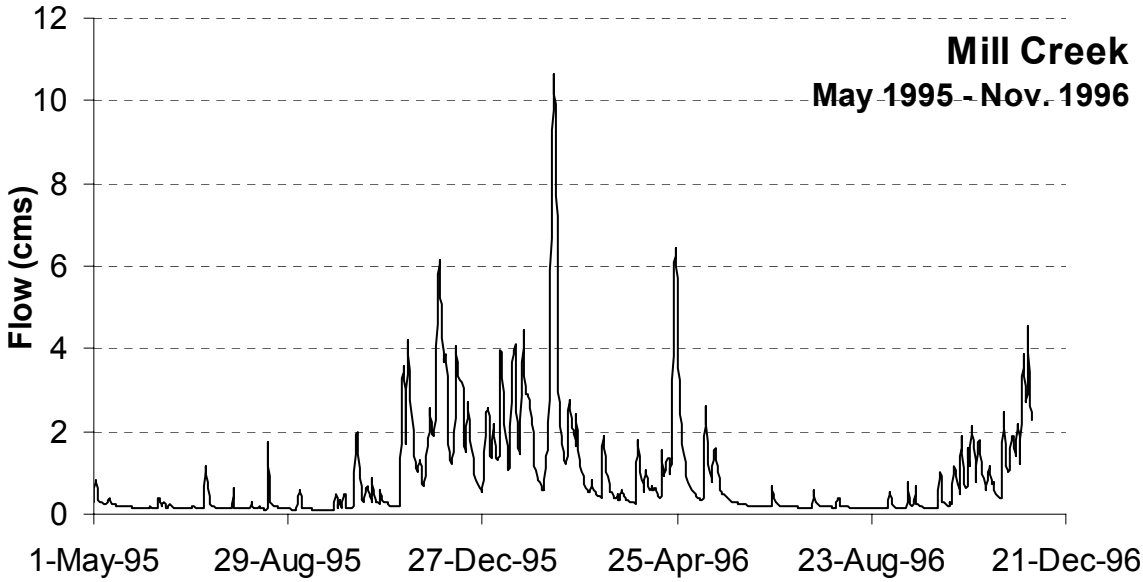

Figure 200: Mill Creek Flow: May 25, 1995 – Nov 1996

Temperature

Temperature monitoring data are not available until October 1999. Temperature data from Big Soos Creek will be used for this time period. Data from Big Soos Creek were chosen because it is the

closest tributary to Mill Creek. See Figure 166 for temperature data.

Water Quality

King County has provided water quality data for the mouth of Mill Creek from 1990 to December 2002. Data are available for all constituents except chlorophyll a, and alkalinity. See Appendix A for water quality data for the entire time period, and Figure 201 through Figure 215 for data for the model calibration period. See Appendix D for procedures used in assembling the water quality data, including estimating missing data.

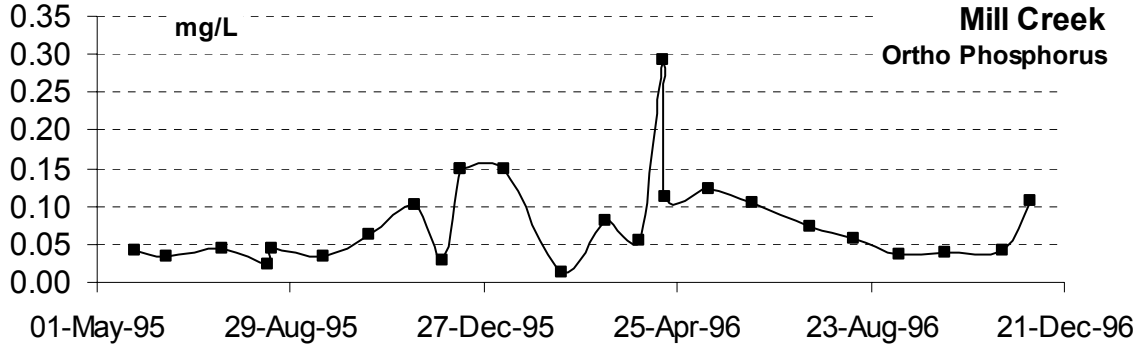

Figure 201: Ortho phosphorus Mill Creek: May 25, 1995 – Nov 1996

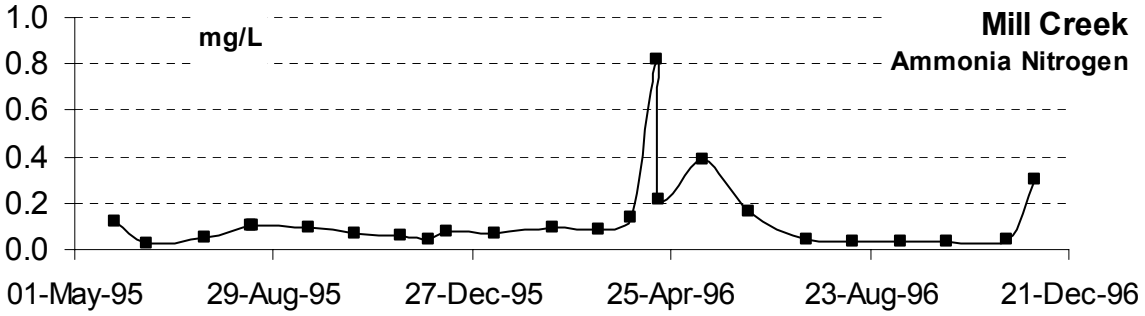

Figure 202: Ammonia Mill Creek: May 25, 1995 – Nov 1996

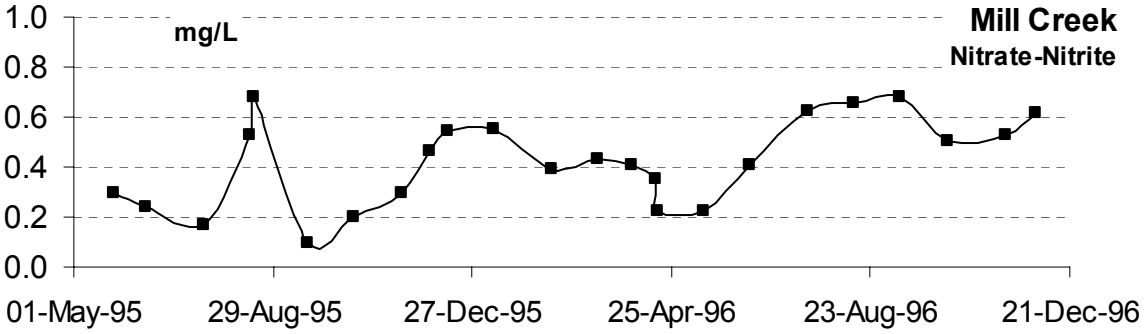

Figure 203: Nitrate-Nitrite Mill Creek: May 25, 1995 – Nov 1996

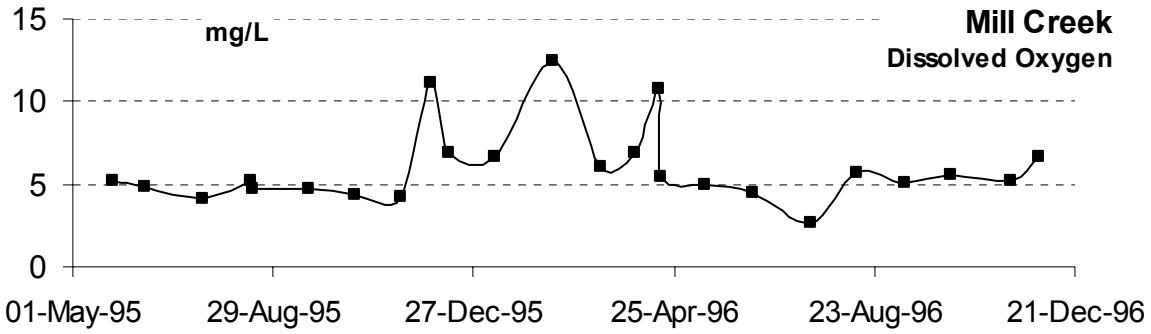

Figure 204: DO Mill Creek: May 25, 1995 – Nov 1996

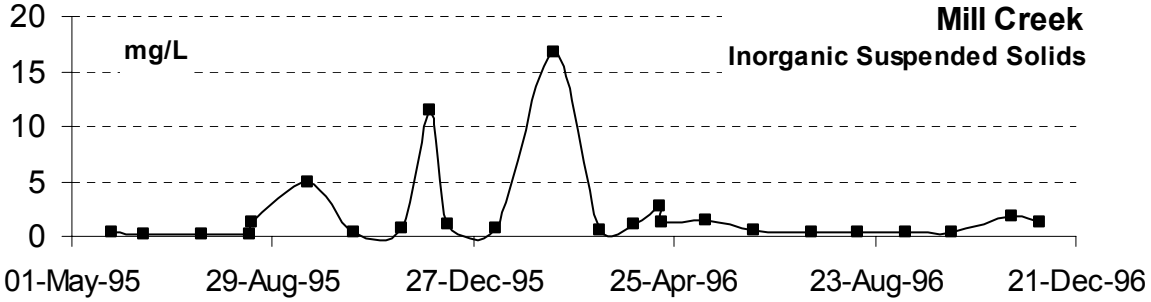

Figure 205: ISS Mill Creek: May 25, 1995 – Nov 1996

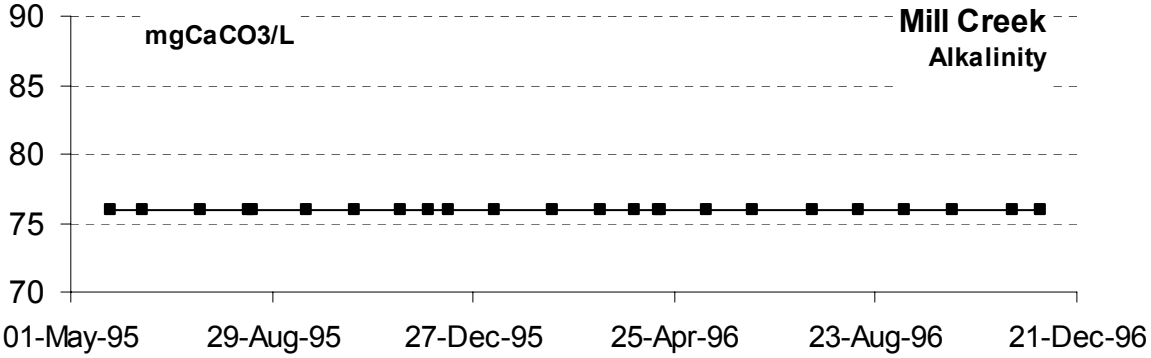

Figure 206: Alkalinity Mill Creek: May 25, 1995 – Nov 1996

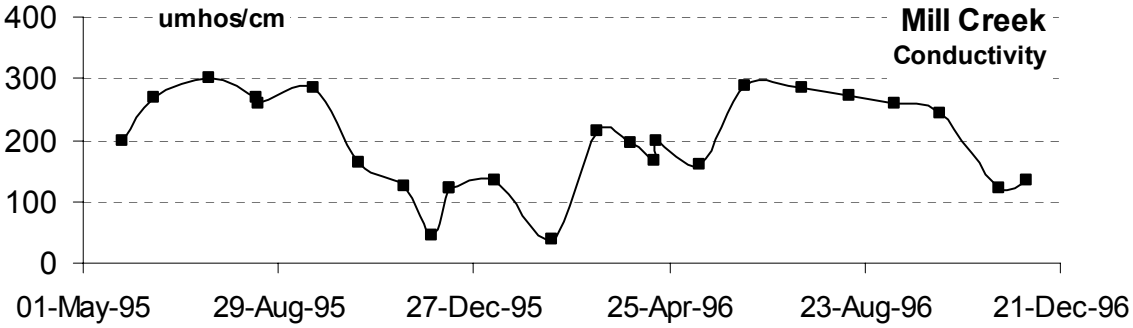

Figure 207: Conductivity Mill Creek: May 25, 1995 – Nov 1996

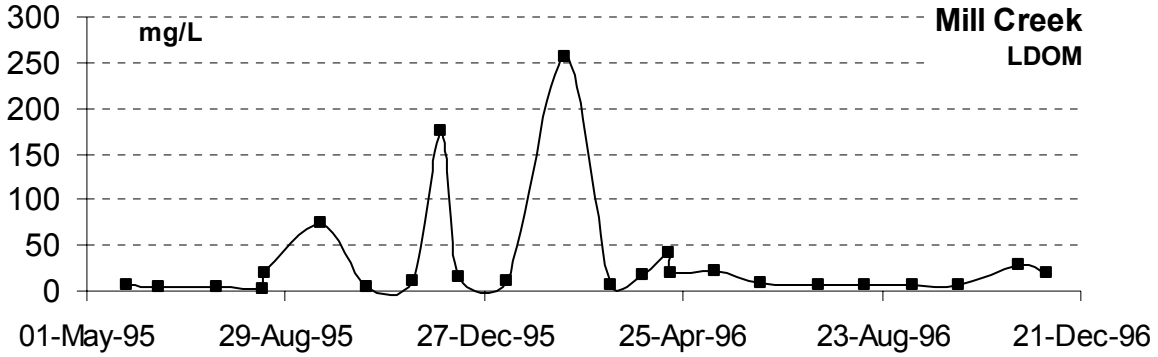

Figure 208: LDOM Mill Creek: May 25, 1995 – Nov 1996

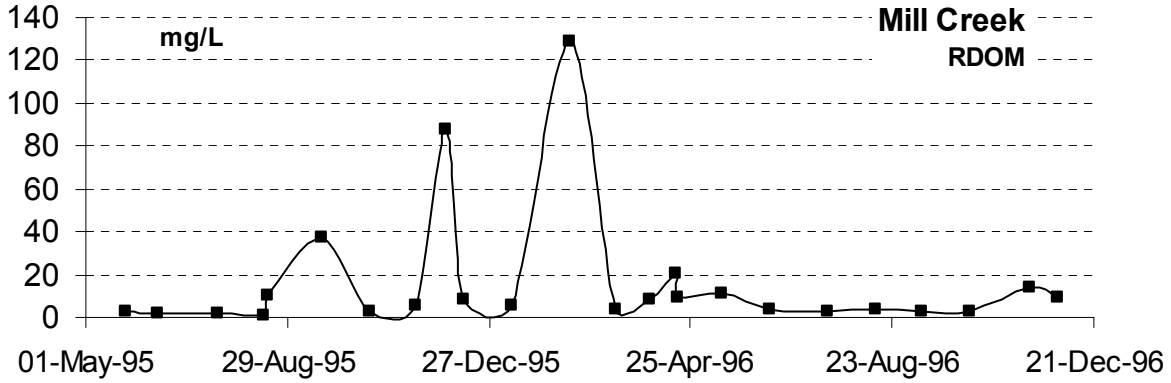

Figure 209: RDOM Mill Creek: May 25, 1995 – Nov 1996

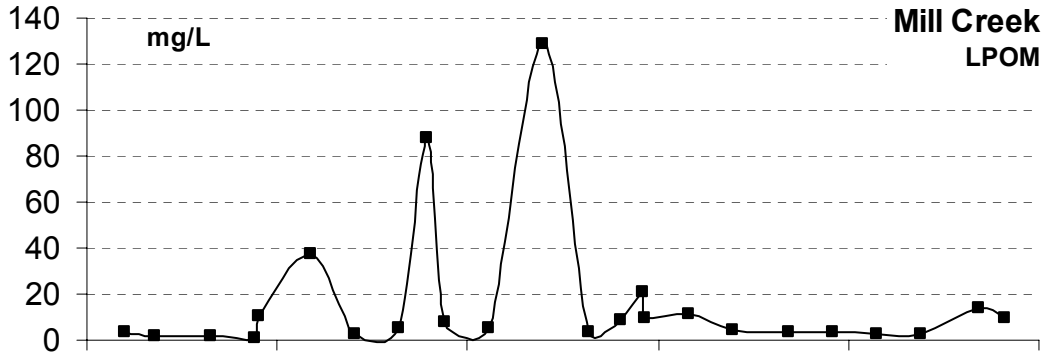

Figure 210: LPOM Mill Creek: May 25, 1995 – Nov 1996

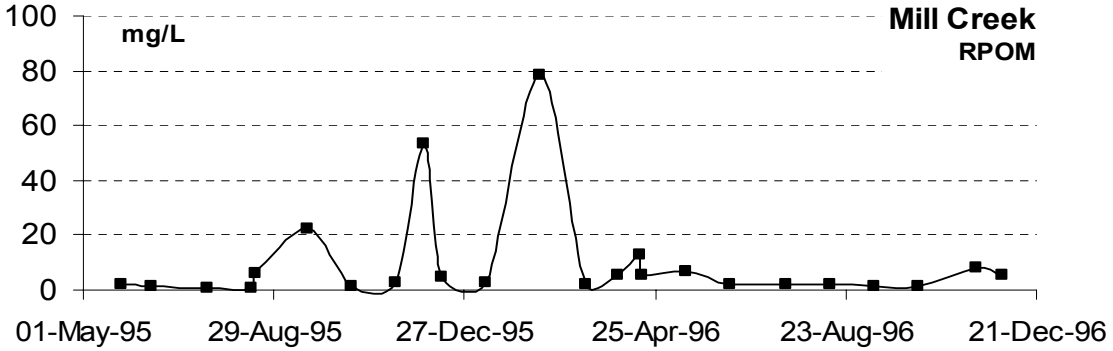

Figure 211: RPOM Mill Creek: May 25, 1995 – Nov 1996

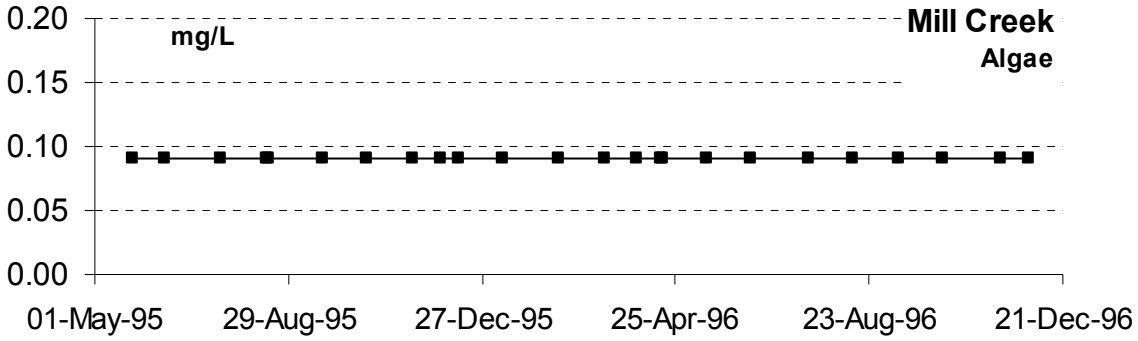

Figure 212: Algae Mill Creek: May 25, 1995 – Nov 1996

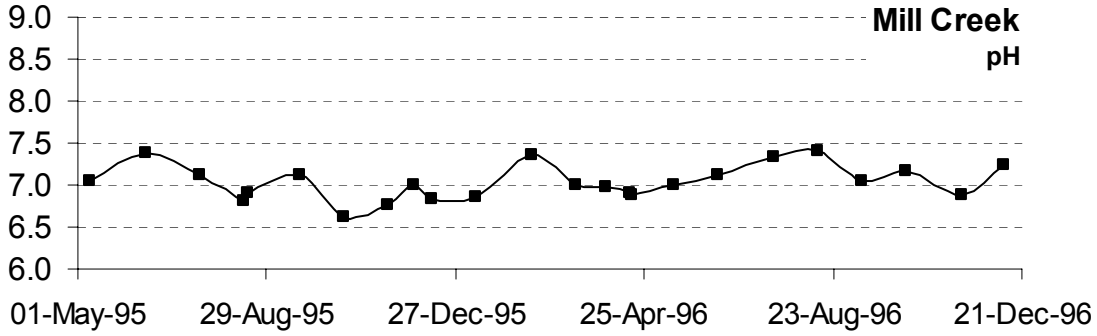

Figure 213: pH Mill Creek: May 25, 1995 - Nov 1996

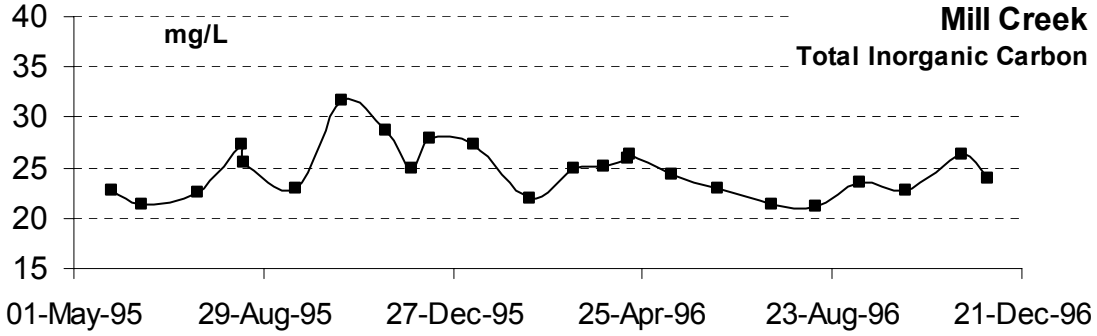

Figure 214: TIC Mill Creek: May 25, 1995 – Nov 1996

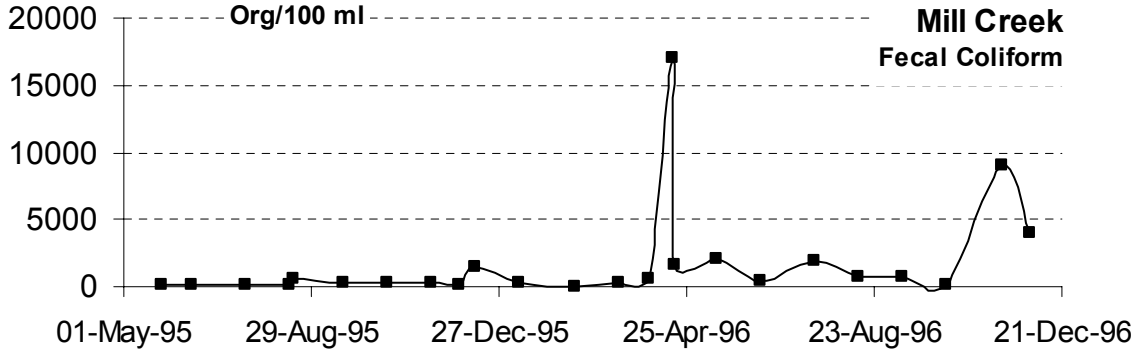

Figure 215: Fecal Coliform: May 25, 1995 - Nov 1996

April 2001 – July 2002

Flow

HSPF daily model output flows were used for this calibration period. Figure 216 shows the data for this model calibration period.

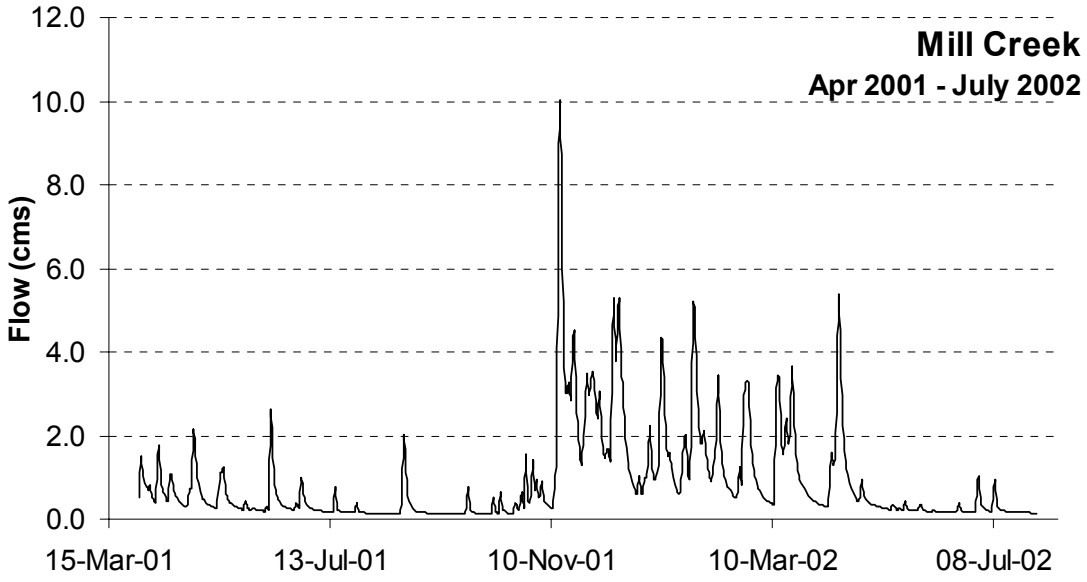

Figure 216: Mill Creek Flow: Apr 2001 – July 2002

Temperature

King County has also recorded temperature at the mouth of Mill Creek (Station 41a) beginning in October 1999 in 15-minute intervals. Figure 217 is a graph of temperature data for the model calibration period. Note that when backwater from the Green River enters Mill Creek the backwater would influence this temperature data also.

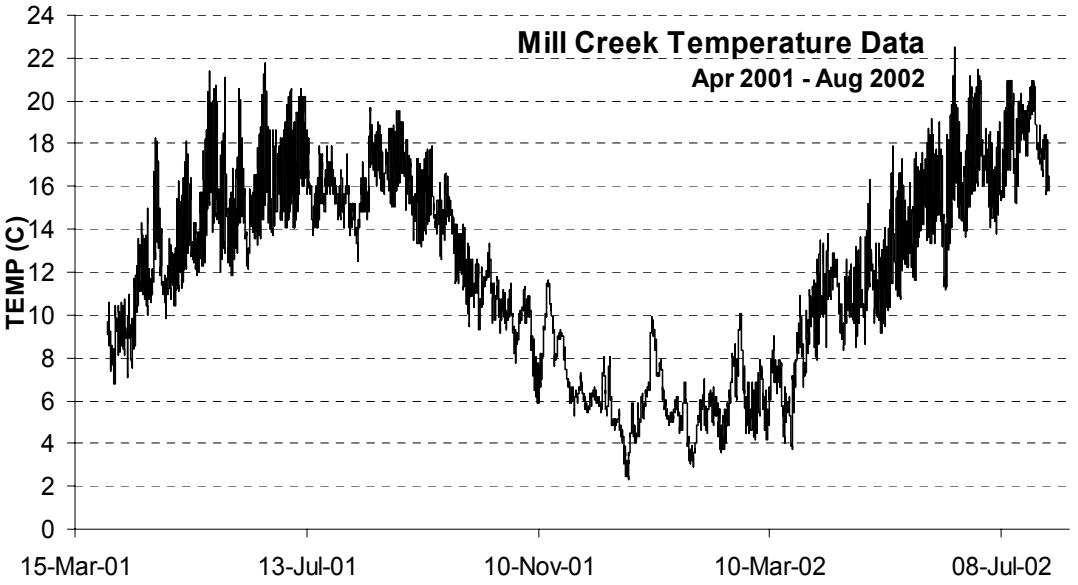

Figure 217: Mill Creek Temperature: Apr 2001 – July 2002

Water Quality

King County has provided water quality data at the mouth of Mill Creek from 1995 through 2002 (Station A315). Figure 218 through Figure 232 shows these data for the model calibration period. See Appendix D for procedures used in assembling the water quality data, including estimating missing data.

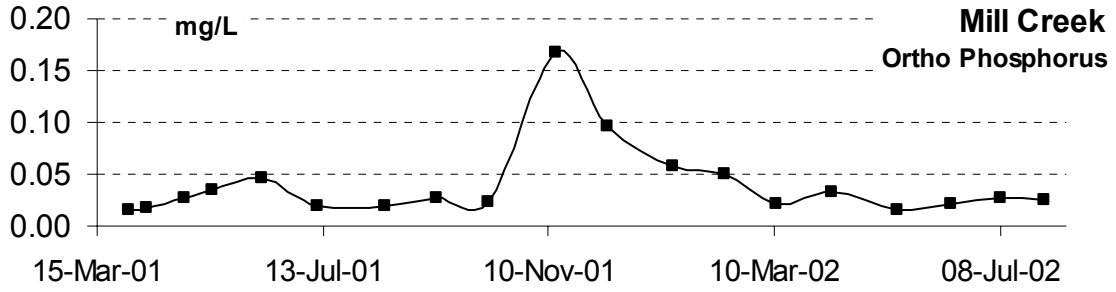

Figure 218: Ortho phosphorus Mill Creek: Apr 2001-July 2002

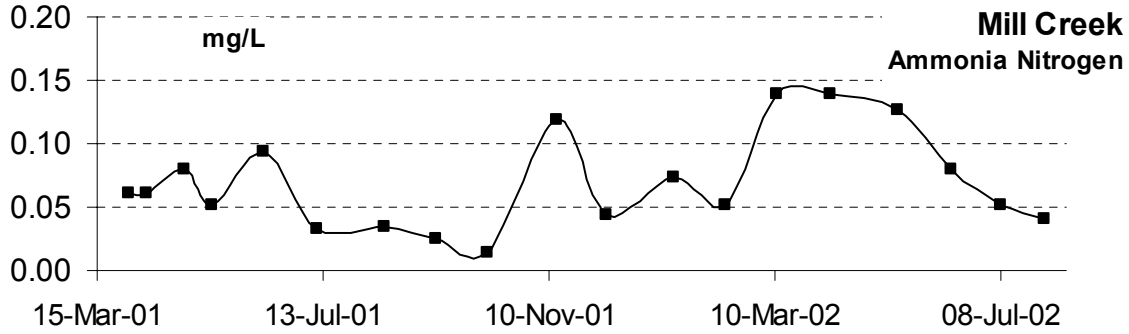

Figure 219: Ammonia Mill Creek: Apr 2001-July 2002

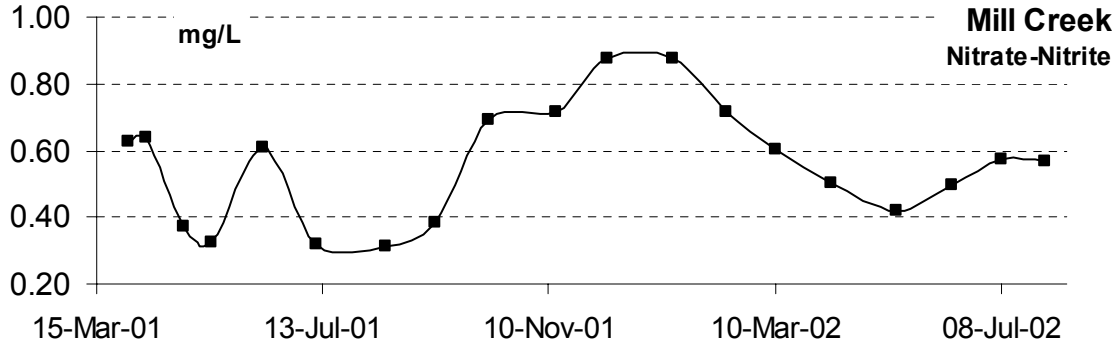

Figure 220: Nitrate-Nitrite Mill Creek: Apr 2001-July 2002

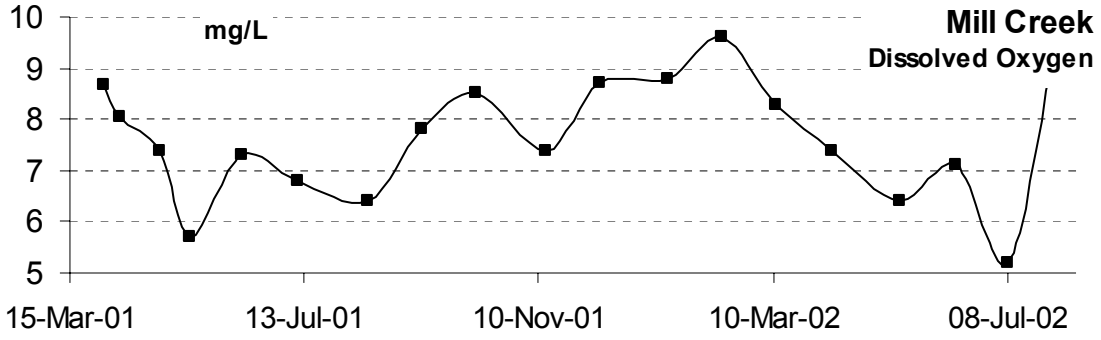

Figure 221: DO Mill Creek: Apr 2001-July 2002

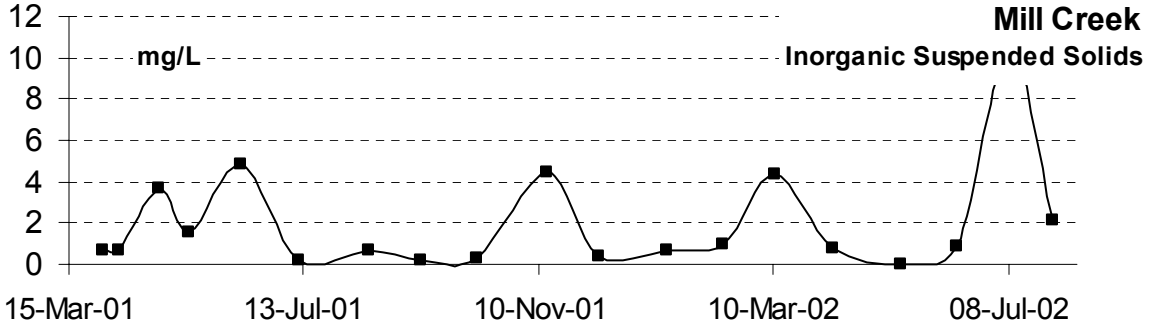

Figure 222: ISS Mill Creek: Apr 2001-July 2002

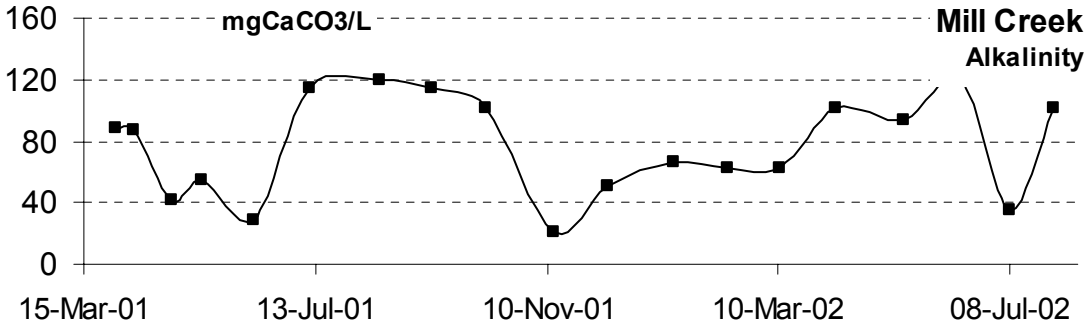

Figure 223: Alkalinity Mill Creek: Apr 2001-July 2002

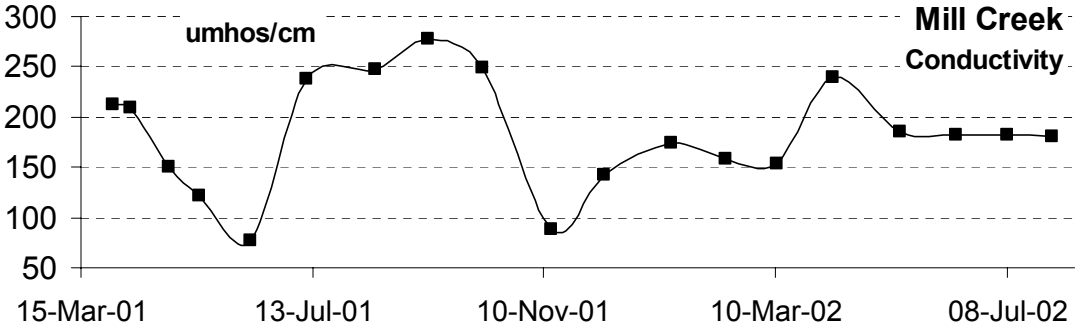

Figure 224: Conductivity Mill Creek: Apr 2001-July 2002

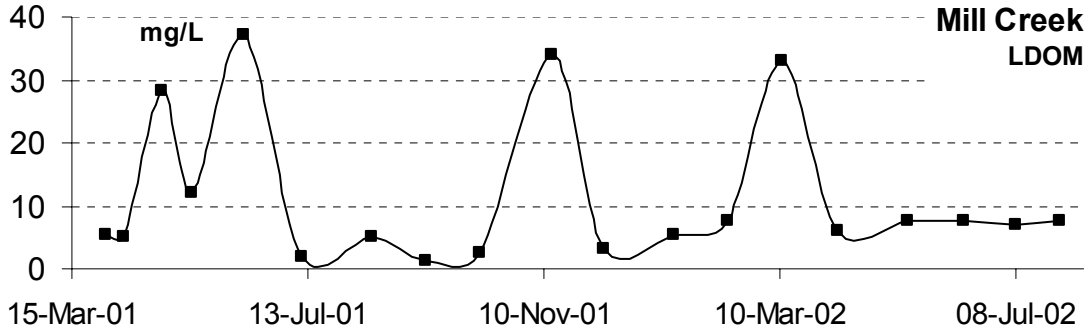

Figure 225: LDOM Mill Creek: Apr 2001-July 2002

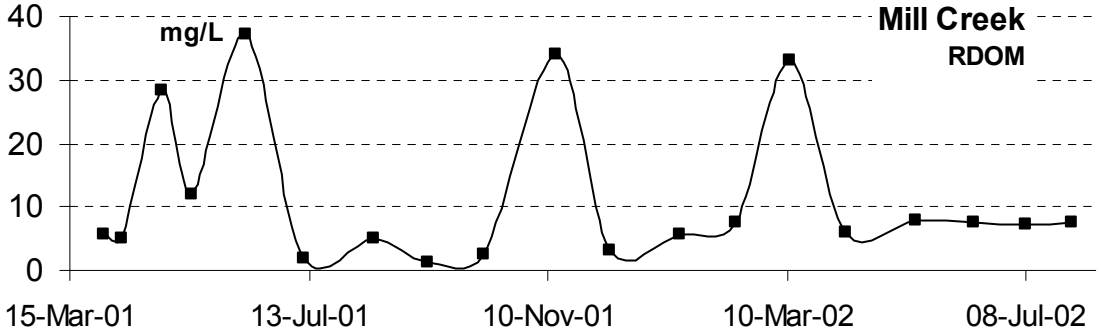

Figure 226: RDOM Mill Creek: Apr 2001-July 2002

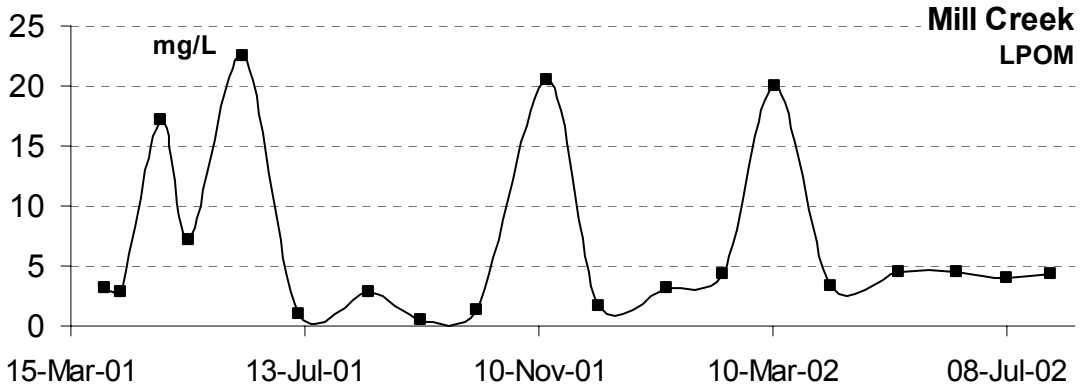

Figure 227: LPOM Mill Creek: Apr 2001-July 2002

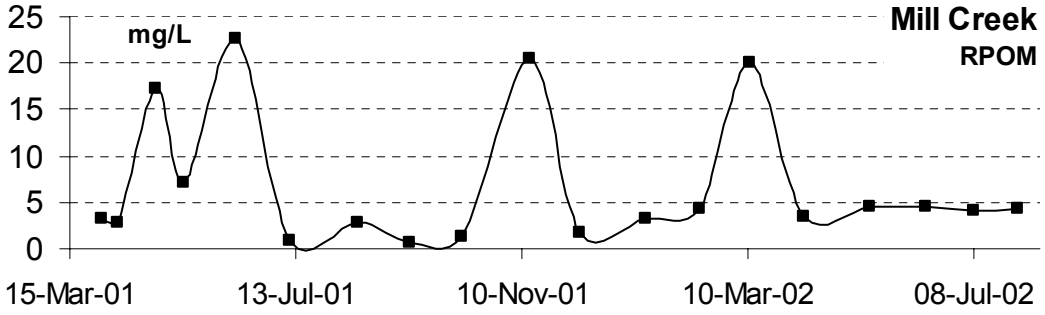

Figure 228: RPOM Mill Creek: Apr 2001-July 2002

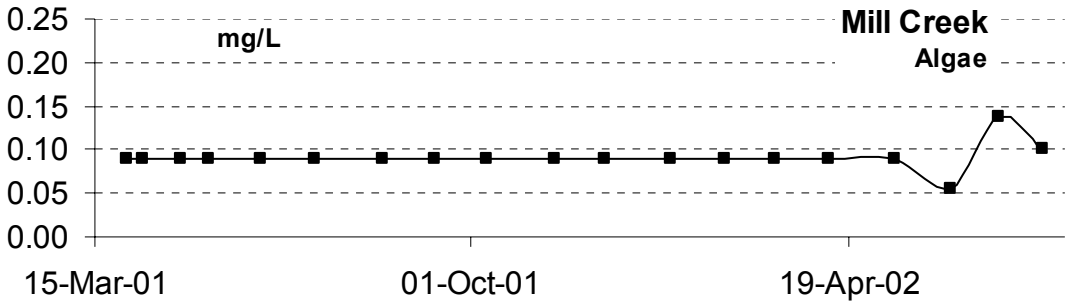

Figure 229: Algae Mill Creek: Apr 2001-July 2002

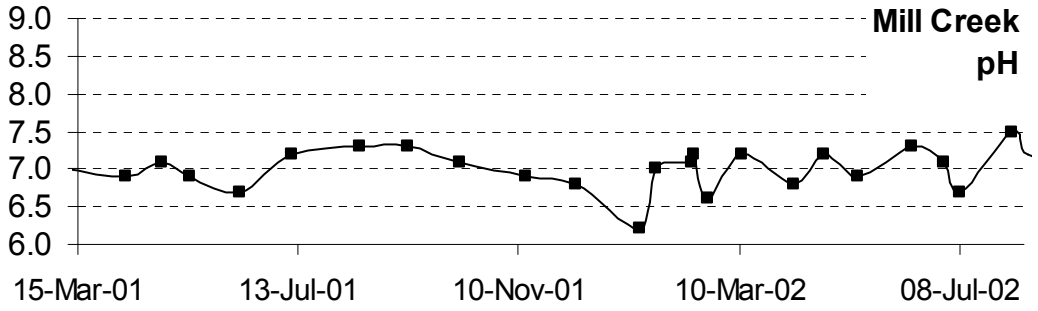

Figure 230: pH Mill Creek: Apr 2001 - July 2002

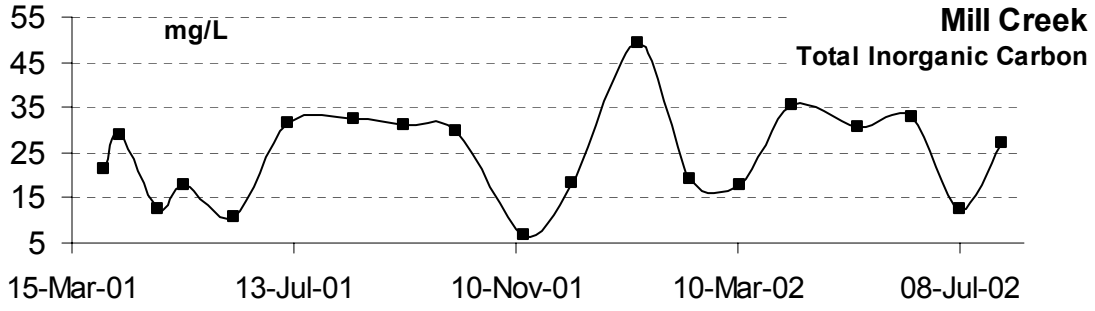

Figure 231: TIC Mill Creek: Apr 2001-July 2002

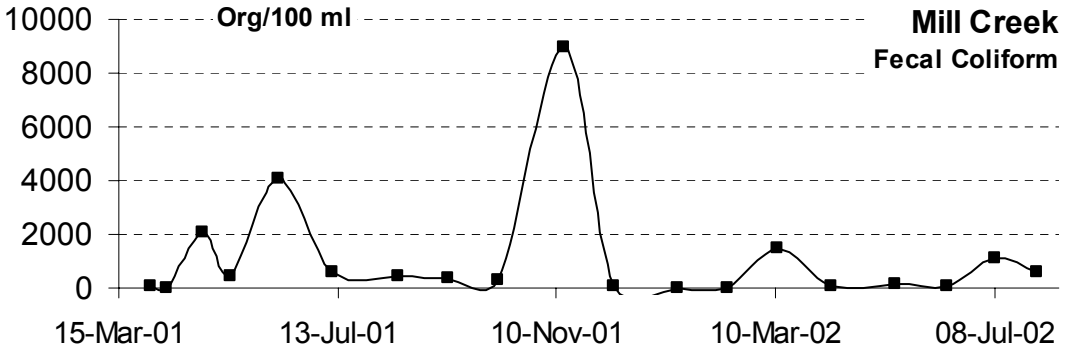

Figure 232: Fecal Coliform Mill Creek: Apr 2001 - July 2002

2.5.5 Auburn Creek, Mullen Slough, and Midway Creek

Auburn Creek, Mullen Slough, and Midway Creek are three of the smallest tributaries to the Green River. The only available data are a few water quality samples collected on Mullen Slough.

May 25, 1995 – November 1996

Flow

King County provided daily average flow from HSPF models of these three tributaries from 1948 to 2001. This information will be used in the model. Figure 233 through Figure 235 shows the flow data for the model simulation period.

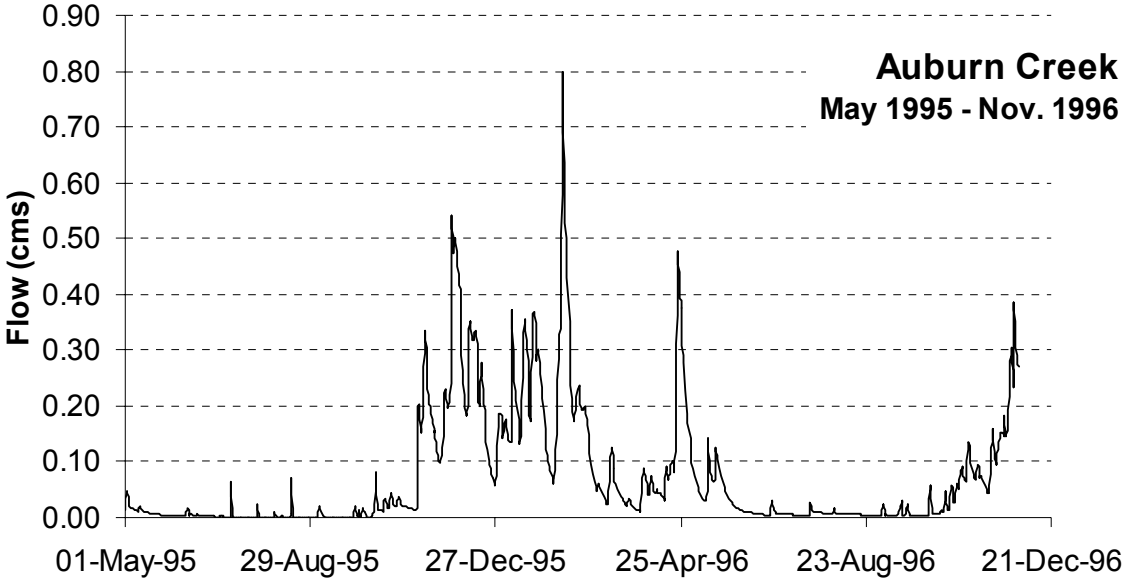

Figure 233: Auburn Creek Flow: May 25, 1995 – Nov 1996 (HSPF)

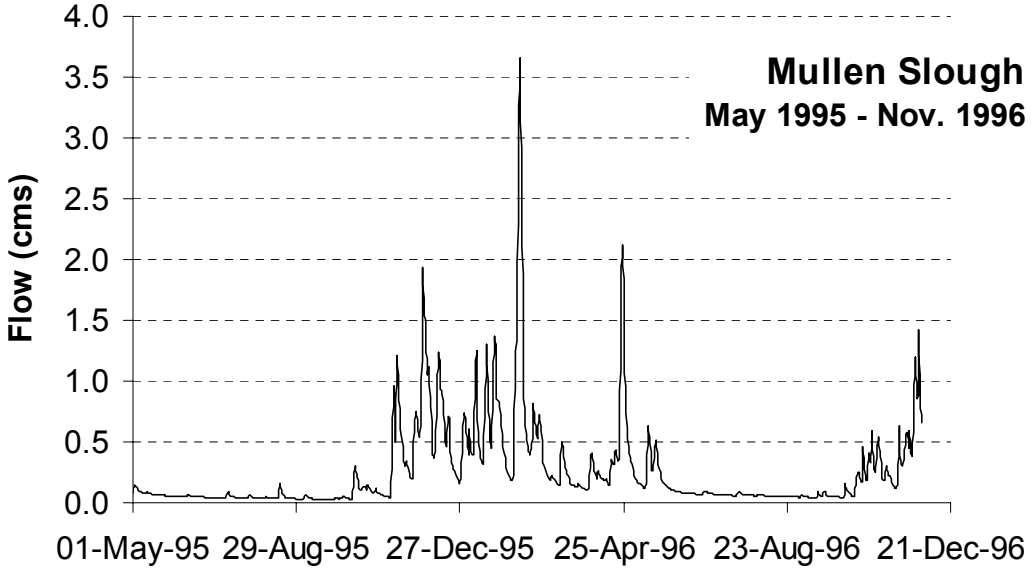

Figure 234: Mullen Slough Flow: May 25, 1995 – Nov 1996 (HSPF)

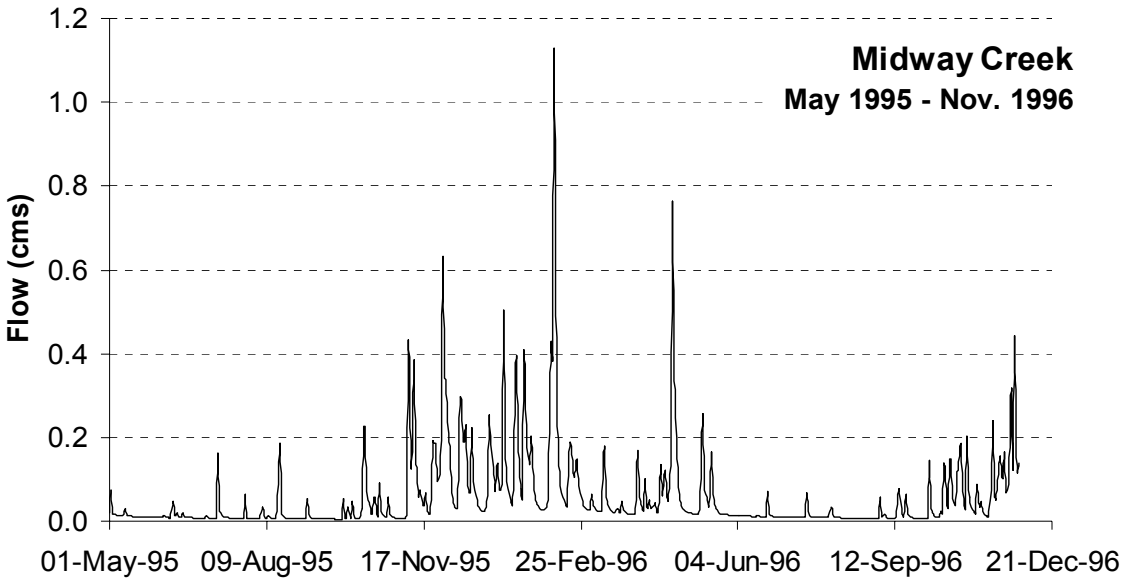

Figure 235: Midway Creek Flow: May 25, 1995 – Nov 1996 (HSPF)

Temperature

Water temperature has not been monitored on these creeks. Temperature data from Big Soos Creek will be used for this model calibration period. Figure 166 shows the temperature for the model simulation period. Big Soos Creek was chosen because it is the closest creek to these creeks with available data for this model run period.

Water Quality

Water quality constituents have not been sampled on these creeks for this model calibration period. Water quality data from Mill Creek will be used. See Figure 201 through Figure 214 for graphs of data for this model calibration period. Mill Creek was chosen because it is the closest creek with available data for this model run period.

April 2001 – Nov 2002

Flow

HSPF flow data will be used for these tributaries. Figure 236 through Figure 238 shows the flow data for the model calibration period.

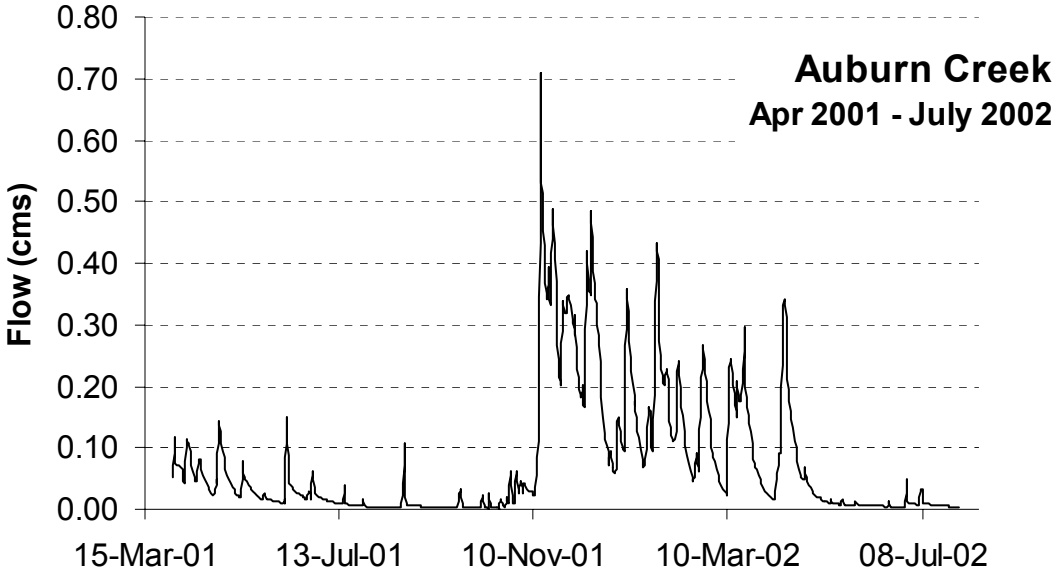

Figure 236: Auburn Creek Flow: Apr 2001 – July 2002

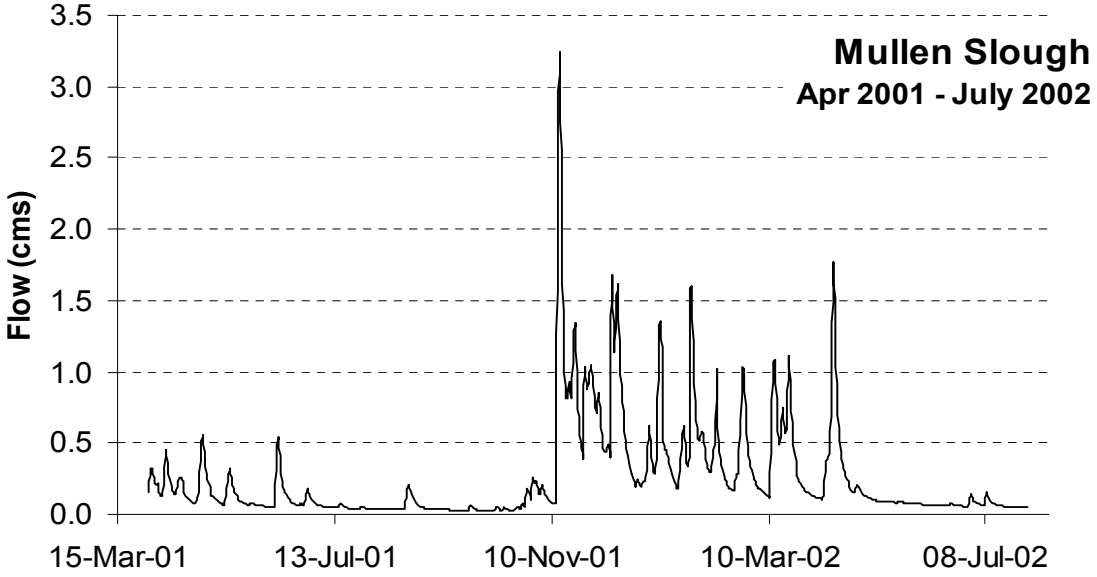

Figure 237: Mullen Slough Flow: Apr 2001 – July 2002

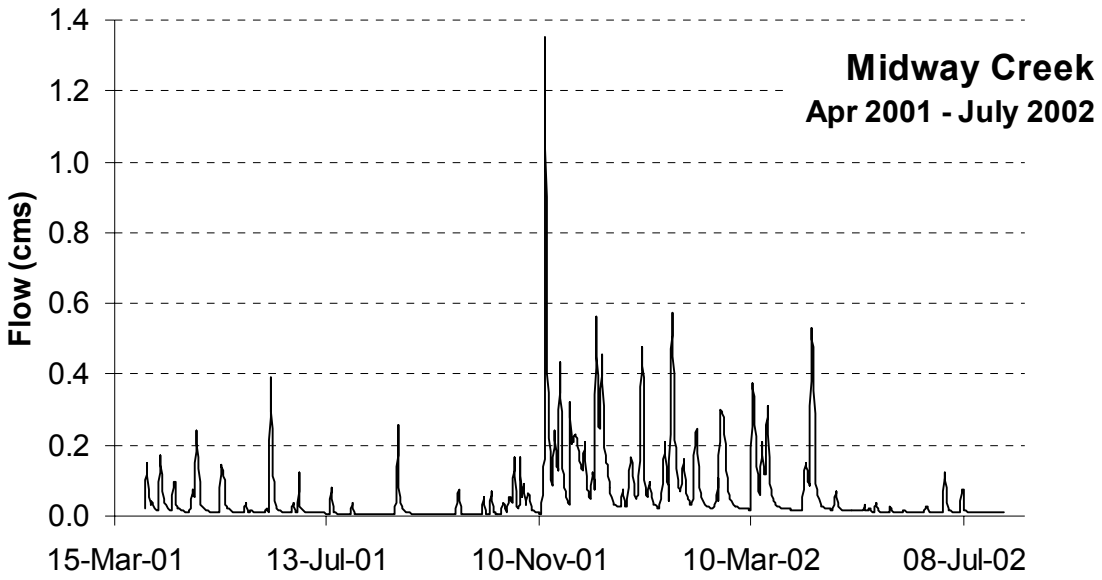

Figure 238: Midway Creek Flow: Apr 2001 – July 2002

Temperature

Water temperature has not been monitored on these creeks. Temperature data from Mill Creek, the closest tributary to these creeks will be used. Figure 217 shows the temperature for the model simulation period.

Water Quality

Water quality constituents have not been sampled on these creeks for this model calibration period. Water quality data from Mill Creek will be used. Mill Creek was chosen because it is the closest tributary with sampled data. See Figure 218 through Figure 231 for data for the model calibration period.

2.6 Groundwater

Groundwater contributes flow to the river along most of its length, and except for a stretch near Auburn, Green River gains more water from groundwater than it loses (Luzier 1969; Woodward et al. 1995). Luzier (1969) believes there are significant groundwater inflows south of Kent where the river traverses the valley, and this report also identifies numerous springs in the slopes of the Green River Gorge, which is east of Flaming Geyser State Park. Woodward et al. (1995) identifies 25 springs in the hill-slopes above the Green River between the upstream and downstream boundaries of this modeling project. The arrows in Figure 239 show the location of these springs.

There is little data available that quantifies inflow from groundwater, and Woodward et al., (1995) did not find adequate data to estimate baseflow in the Green River. The report does include an estimate of discharge from springs in the bluffs above the river. Table 8 lists the discharge per mile from these springs as estimated in Woodward et al (1995). The information is broken down into contributions to each branch of the model. The inflow rate from these springs is less than a tenth of a percent of the flow rate of the river.

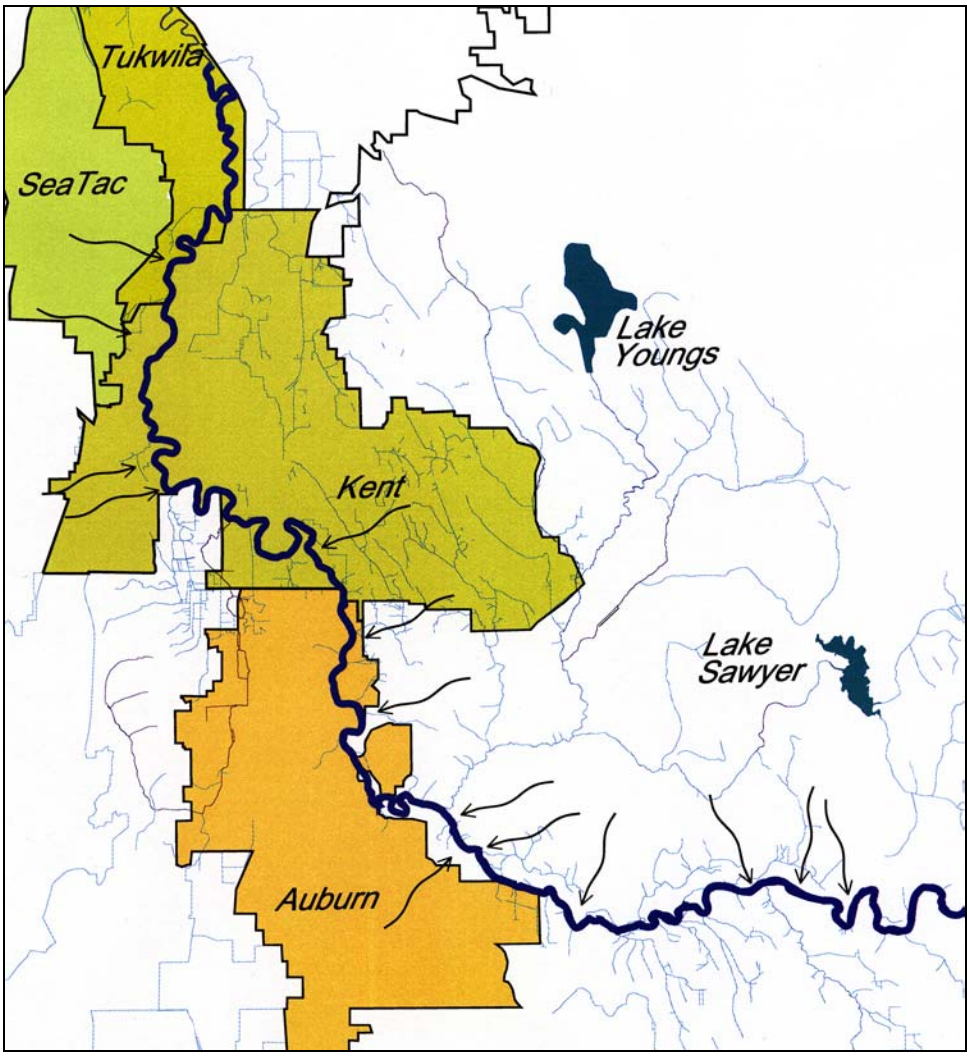

Figure 239: Groundwater Springs

Table 8: Groundwater Inflows per Branch

Branch	Discharge (cfs/mile)	Miles per branch	Discharge (cfs)
1	.01	3.90	.039
2	.01	3.40	.034
3	0.24	4.20	.042
4	0.24	7.0	1.0
5	0.27	15.50	4.20

Since the flow rates in Table 8 are not significant enough to be considered in the model, and no other reliable data are available for estimating groundwater and smaller tributaries downstream of Auburn, groundwater inflows will not be included in the Lower Green River. This will be reviewed during model calibration.

2.7 Distributed Tributaries

To address flow contributions from a series of smaller tributaries on the upper end of the Lower Green River and the lower end of the Middle Green River, King County hydrologists have simulated surface runoff using HSPF. Figure 240 shows the limits of Basin MG1. Basins MG2 and MG3 were added to the upstream boundary.

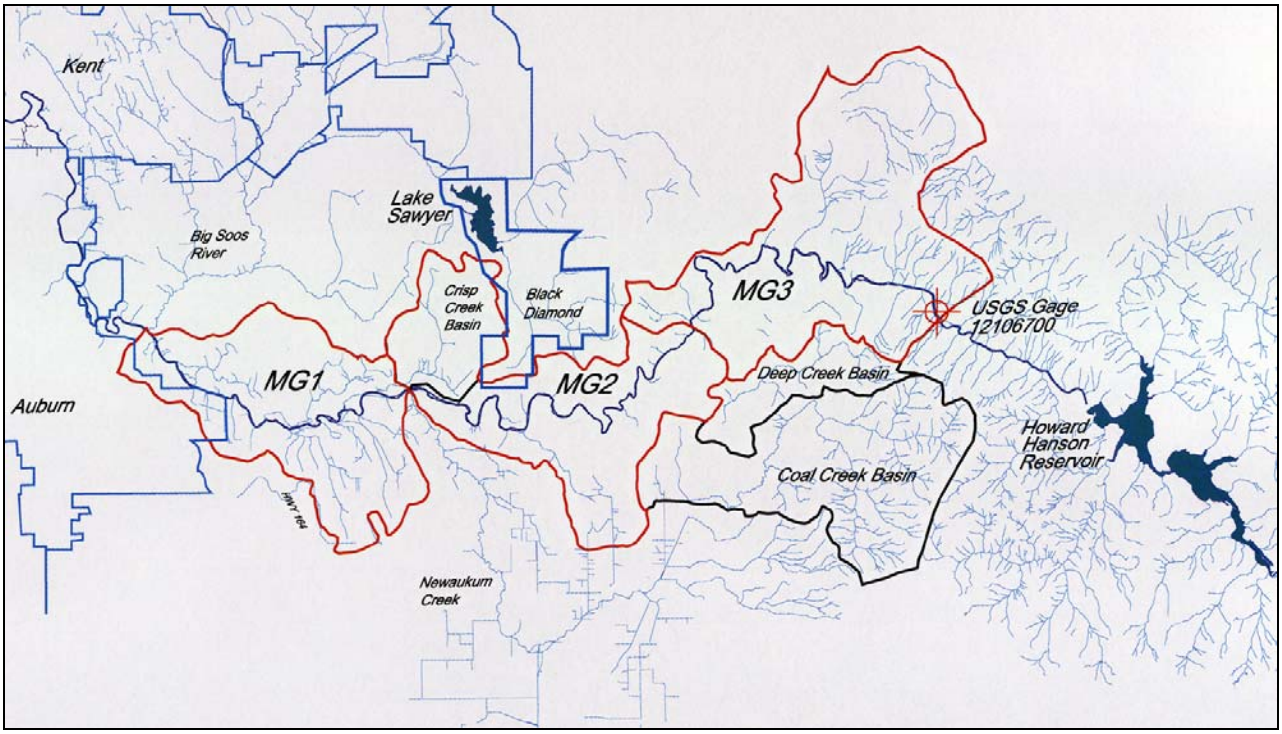

Figure 240: Basin MG1

Inflow from Basin MG1 will be added as a distributed tributary to Branches two and three. Table 9 shows the segments and percentage of the flow attributed to each branch.

Table 9: Basin MG1 Distributed Tributary

Branch	Number of Segments	Area (hectare)	% of Basin MG1
2	22	1,920	52
3	27	1,767	48
TOTAL	49	3,687	100

May 25, 1995 – Nov 1996

Flow

Daily average flow was provided for this basin (HSPF data). It was divided evenly among the segments in each branch, and split between the two branches based upon the percentage of area within MG1 in each branch. The distributed discharges for each branch are shown in Figure 241 and Figure 242 for the proposed model period.

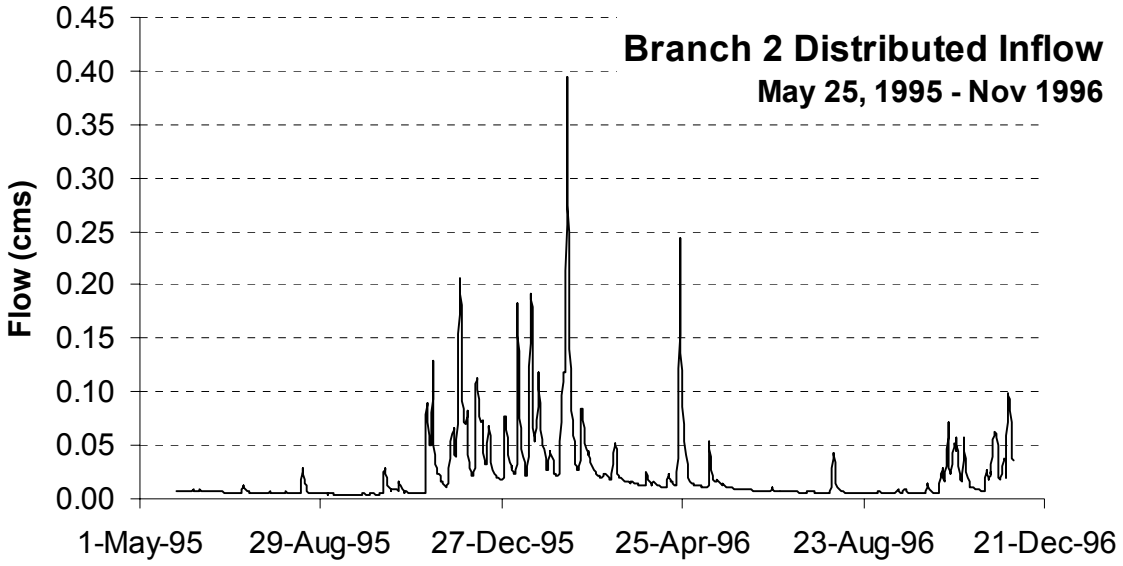

Figure 241: Branch 2 Distributed Flow: May 25, 1995 – Nov 1996

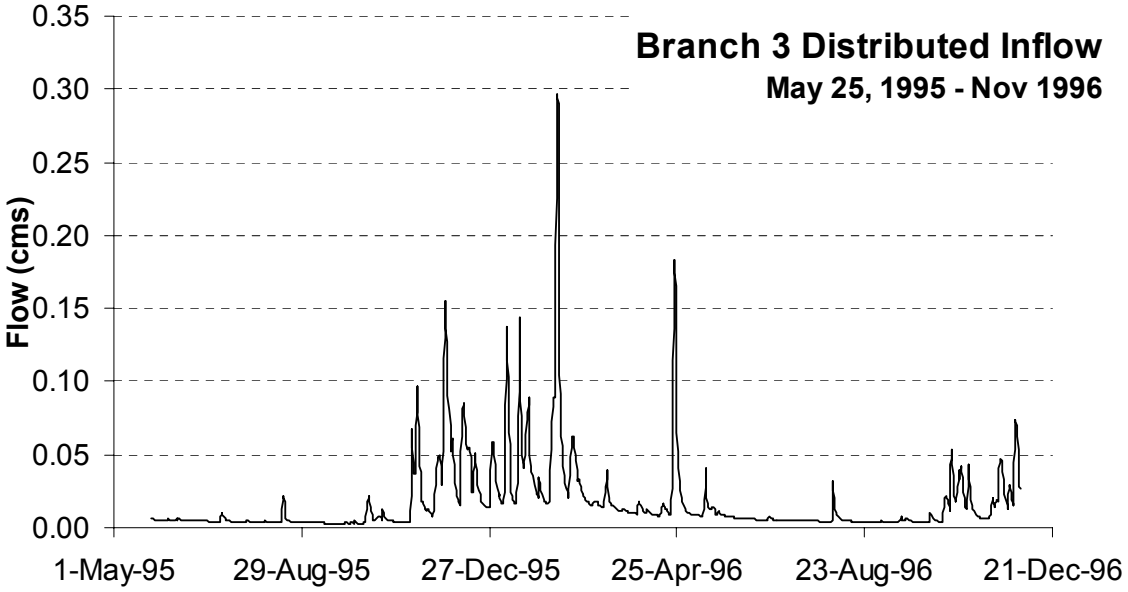

Figure 242: Branch 3 Distributed Flow: May 25, 1995 – Nov 1996

Temperature

A 1995-1996 temperature study conducted by King County recorded temperature at numerous locations at the downstream end of Basin MG1. None of these monitoring locations have complete data for the model calibration period. The station with the most complete data set, Station "NEE" was used for both distributed tributaries. There were three data gaps to be filled:

- The first 14 hours of May 25, 1995
- November 3, 1995 – June 7, 1996

- October 29, 1996 – November 30, 1996

To fill these data gaps, data from the upstream boundary was correlated with data from this monitoring location. Station "WHI" was used as the upstream temperature boundary for the May 25, 1995-November 1996 calibration period. Because it had missing data, the data from the upstream boundary, including filled gaps, was used in the correlation. The equation relating the two temperatures is as follows:

$$\text{NEE temperature} = 0.923*(\text{WHI temperature}) + 0.775$$

Figure 243 shows the correlation between the two stations, Figure 244 shows the correlated values and station data, and Figure 245 is the temperature data used in the model calibration period.

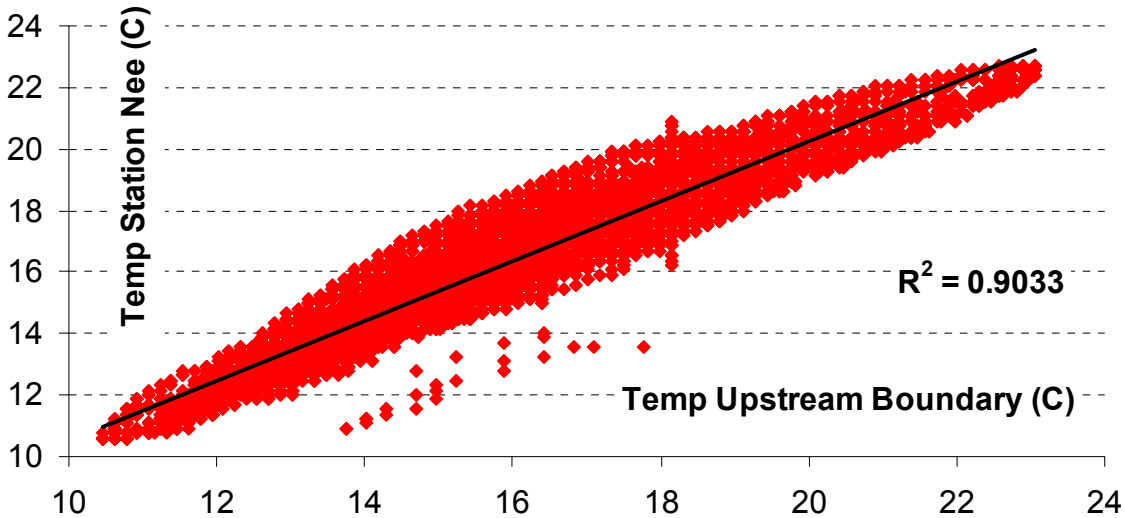

Figure 243: Correlation between upstream boundary temperature and station "nee"

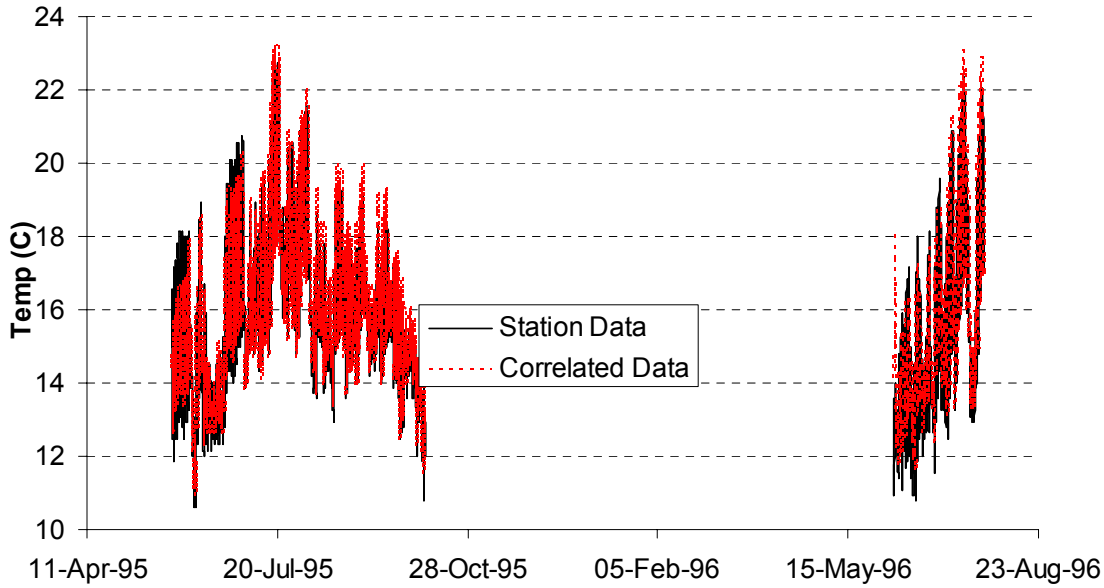

Figure 244: Distributed Tributary: Correlated versus station data 1995-1996

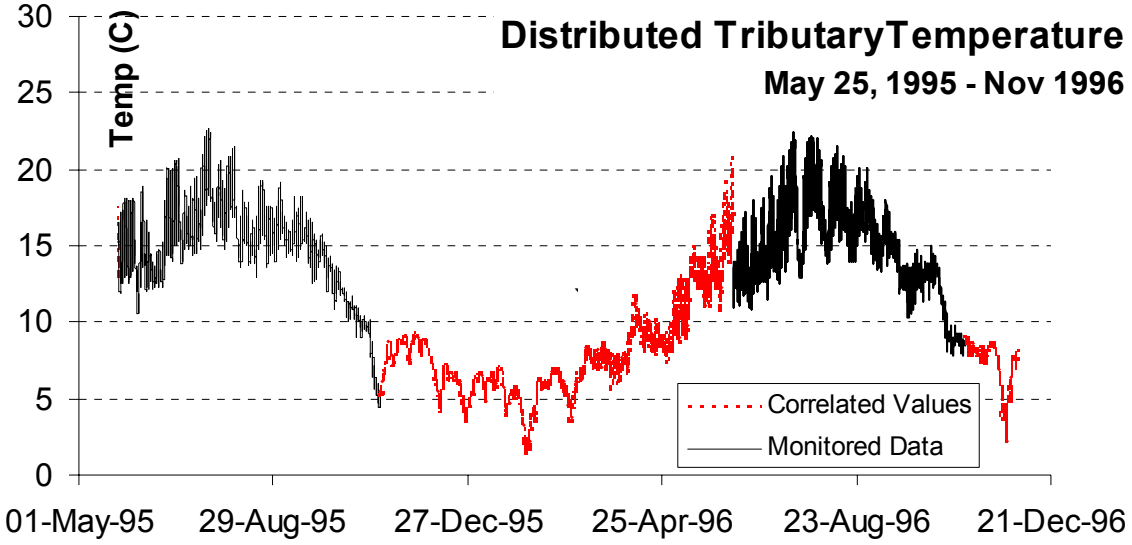

Figure 245: Distributed Tributary Temperature: May 25, 1995 – Nov 1996

Water Quality

Water quality data are not available for the distributed tributaries. Data from Big Soos Creek will be used. This is the closest tributary with monitored data. See Figure 167 through Figure 180.

April 2001 - July 2002

Flow

Daily average flow was provided for this basin (HSPF data). It was divided evenly among the segments in each branch, and split between the two branches based upon the percentage of area within MG1 in each branch. The distributed discharges for each branch are shown in Figure 246 and Figure 247 for the proposed model period.

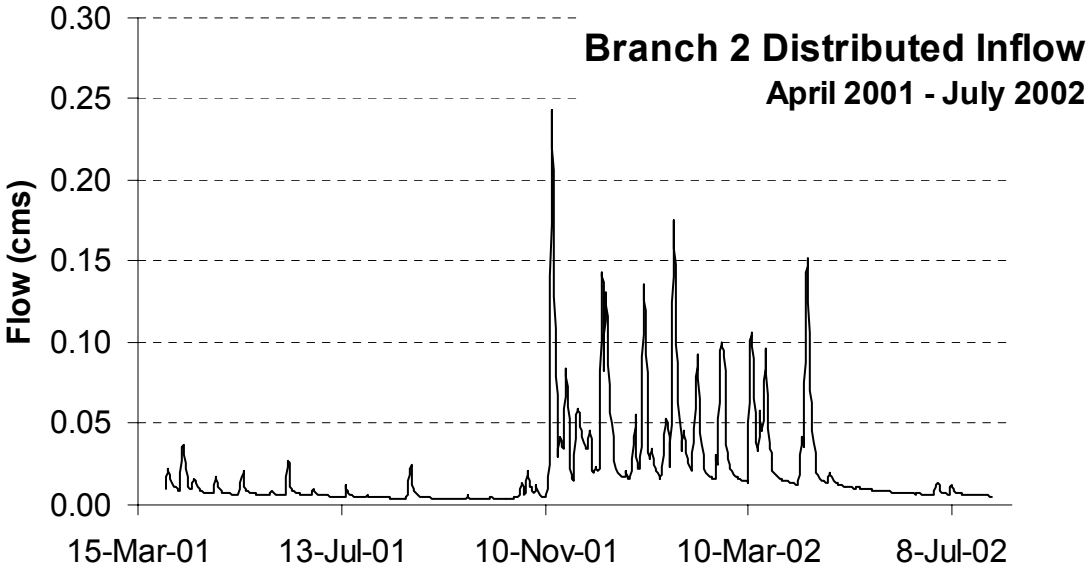

Figure 246: Branch 2 Distributed Inflow: Apr 2001 – July 2002

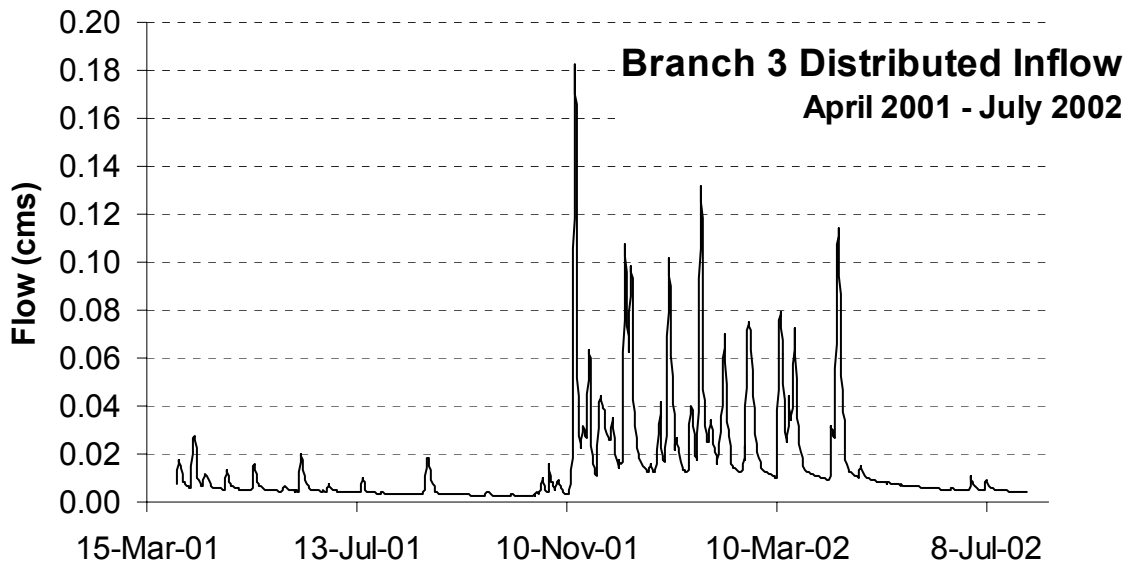

Figure 247: Branch 3 Distributed Inflow: Apr 2001 – July 2002

Temperature

King County monitors temperature on the Green River inside the downstream boundary of Branch two. Locator GRT04 has temperature data from July 2001 to the end of this model calibration period. About four km downstream of GRT04, a University of Washington monitoring station (GR1) has temperature data from April 2001 to July 2001. These data were correlated with data from GRT04 to fill this time period. The correlation equation is as follows:

$$GRT04 = (GR1)(0.894) + 1.7154$$

Figure 248 graphs the two stations and shows the linear regression line, Figure 249 shows correlated values and station data, and Figure 250 shows the temperature data for the model calibration period. These data will be used for both distributed tributaries.

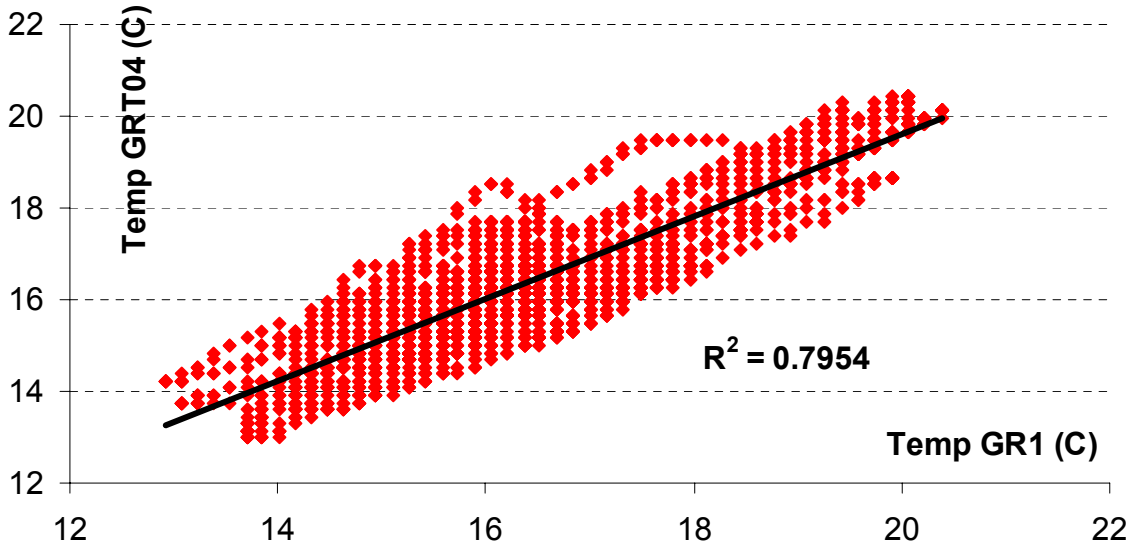

Figure 248: Correlation between station Gr1 and station GRT04

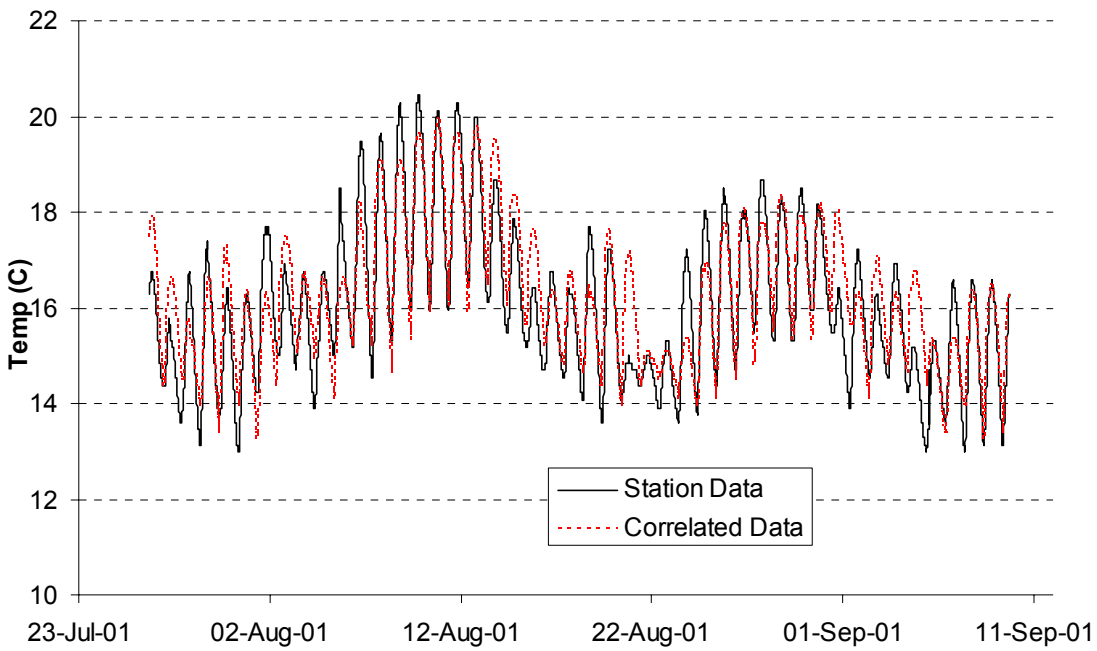

Figure 249: Distributed tributary: Correlated versus station data 2001-2002

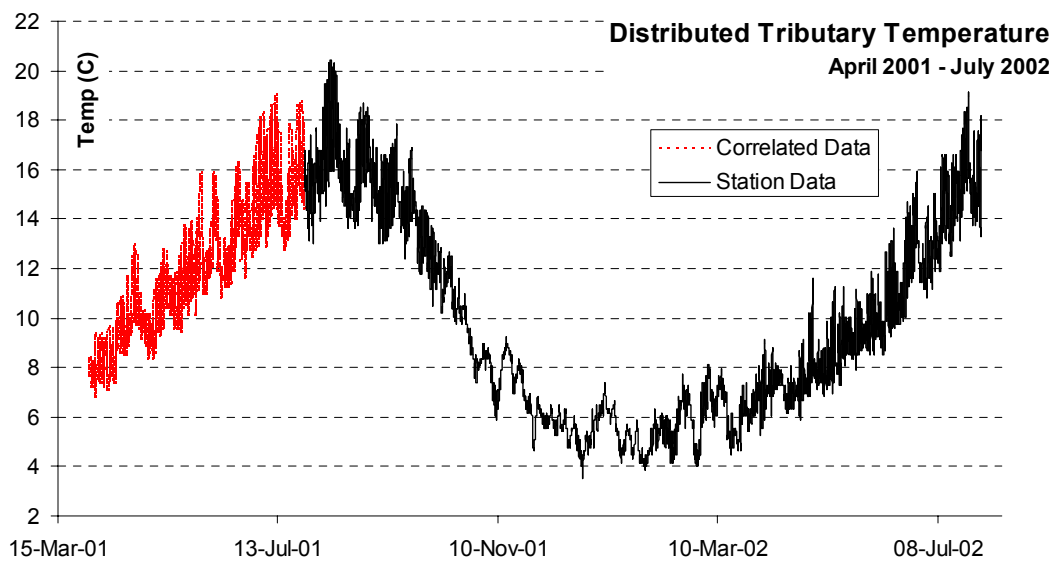

Figure 250: Distributed Tributary Temperature: Apr 2001 – July 2002

Water Quality

Water quality data are not available for the distributed tributaries. Data from Big Soos Creek will be used. See Figure 184 through Figure 197.

2.8 Meteorological Data

The Seattle-Tacoma (SeaTac) International Airport is less than a mile west of the downstream project boundary at Tukwila. The airport collects weather data including air temperature, dew point temperature, cloud cover, air pressure, wind speed, wind direction, and cloud cover. King County assembled this data in a database file for years 1995 through March 2000. Additional data for the

remainder of 2000 and for years 2001 and 2002 were collected for use in the model. Data were obtained in hourly intervals.

May 25, 1995 - Nov 1996

Figure 251 shows air temperature, Figure 252 shows dew point temperature, and Figure 253 shows wind speed.

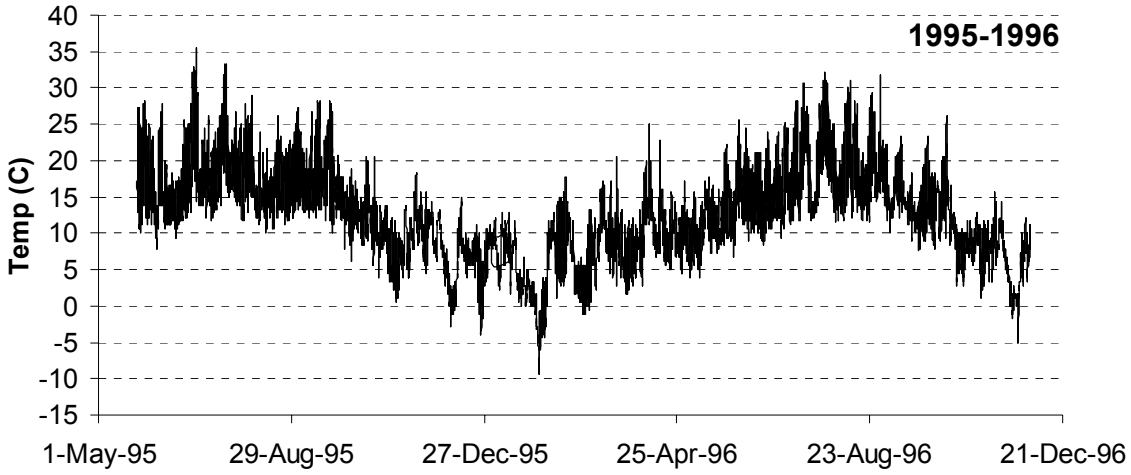

Figure 251: Air Temperature at Seattle-Tacoma International Airport

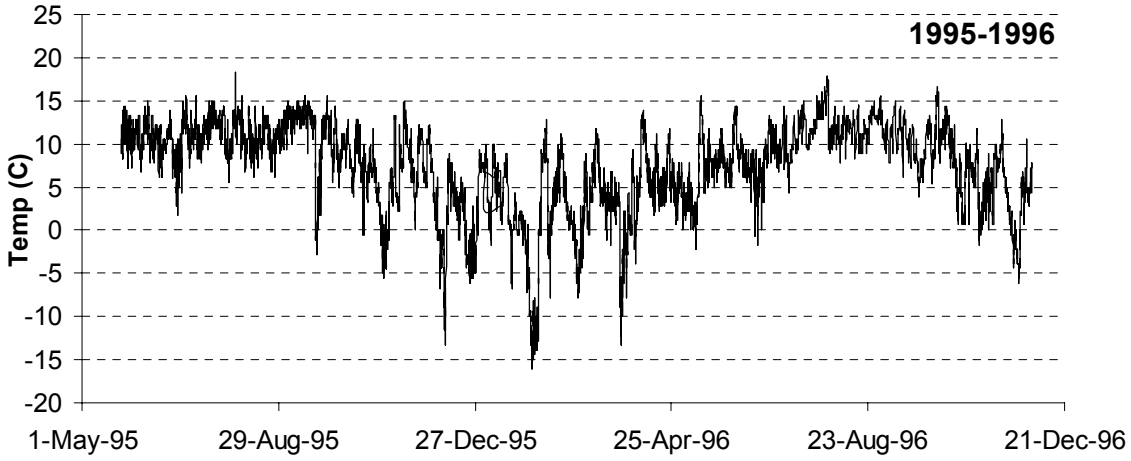

Figure 252: Dew Point Temperature at Seattle-Tacoma International Airport

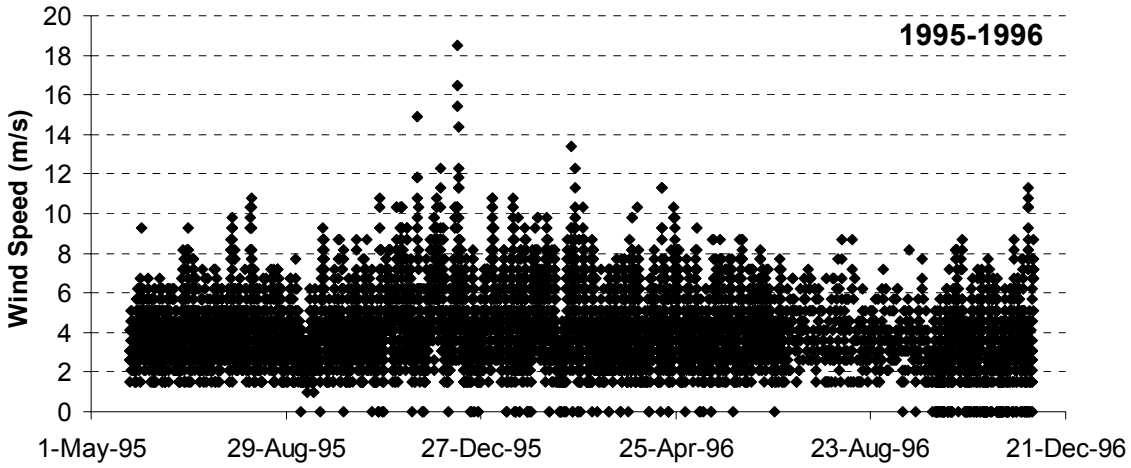

Figure 253: Wind Speed at Seattle-Tacoma International Airport

Note that in Figure 253 no wind values were recorded between 0 and 1.50 m/s.

Figure 254 shows the frequency of the direction of the wind. Note that in this figure the number on the bottom axis of the bar graph refers to the angle of the wind direction, and the number on top of the bar refers to the number of times wind speed was recorded between that angle and the next angle left. For example, at 360 degrees there were 1011 times the wind was recorded at an angle between 331 degrees and 360 degrees.

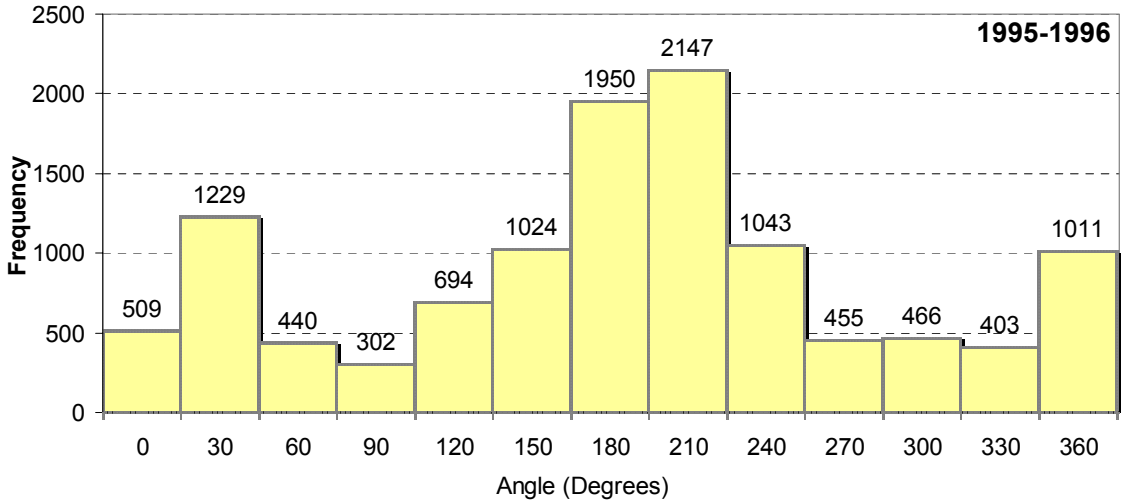

Figure 254: Frequency of Wind Direction at Seattle-Tacoma International Airport

In Figure 255 cloud cover varies on a scale of 0 to 10 with zero representing no cloud cover and ten representing full cloud cover. These were recorded to the nearest whole number.

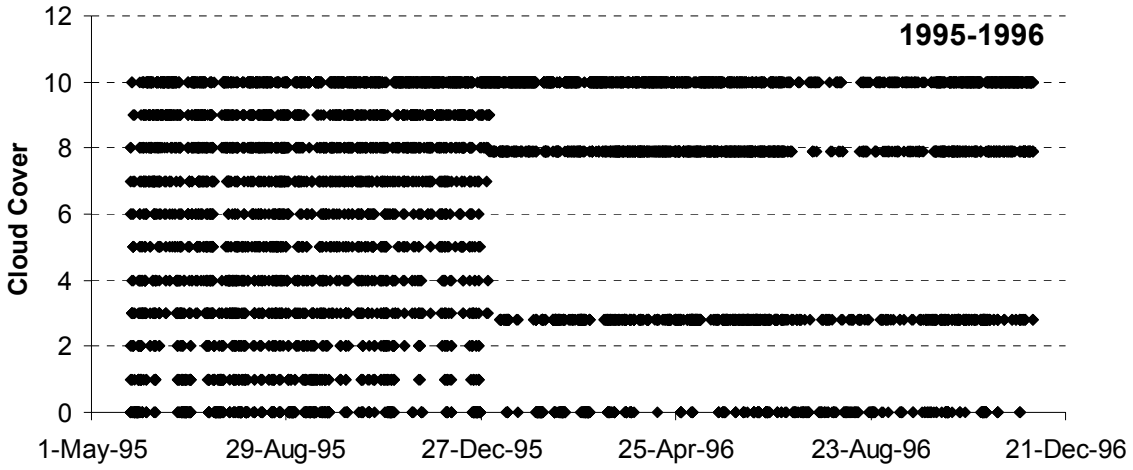

Figure 255: Cloud Cover at Seattle-Tacoma International Airport

The National Oceanic and Atmospheric Administration have a Level I ISIS (Integrated Surface Irradiance Study) station in Seattle which measures shortwave solar radiation data. These data are available from the NOAA web site in 15-minute intervals and was provided by King County for 1995 through 2000. Figure 256 is a graph of the shortwave solar radiation for the model simulation period.

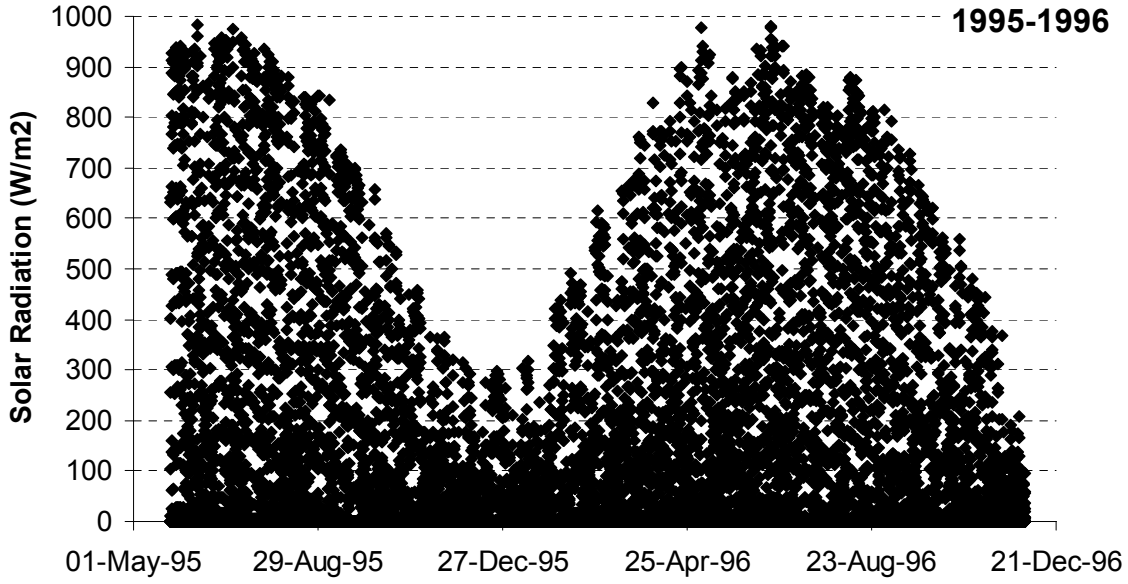

Figure 256: Shortwave Solar Radiation for model calibration period

April 2001 - July 2002

Figure 257 through Figure 262 are graphs of air temperature, dew point temperature, wind speed, wind direction, cloud cover, and shortwave solar radiation for this model calibration period.

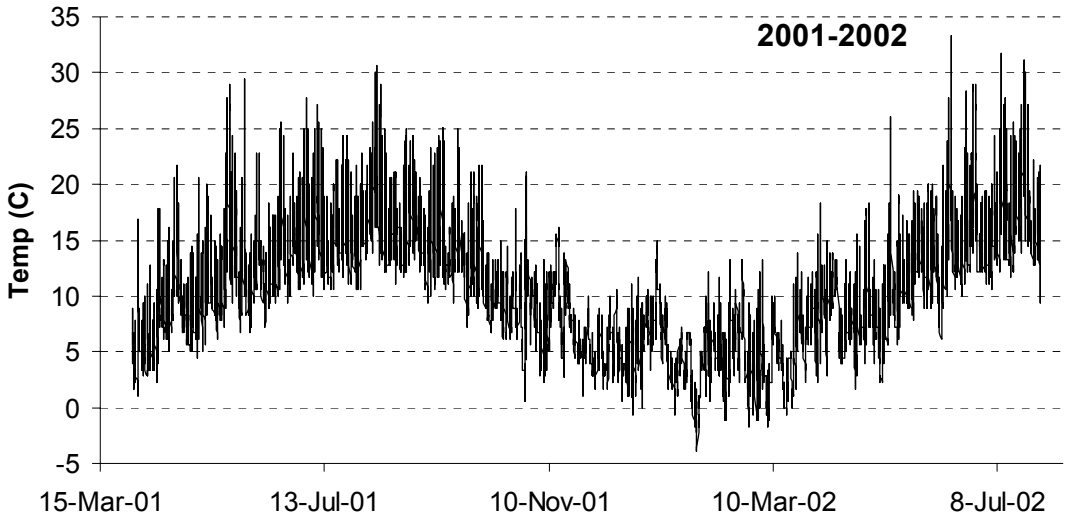

Figure 257: Air Temperature at Seattle-Tacoma International Airport

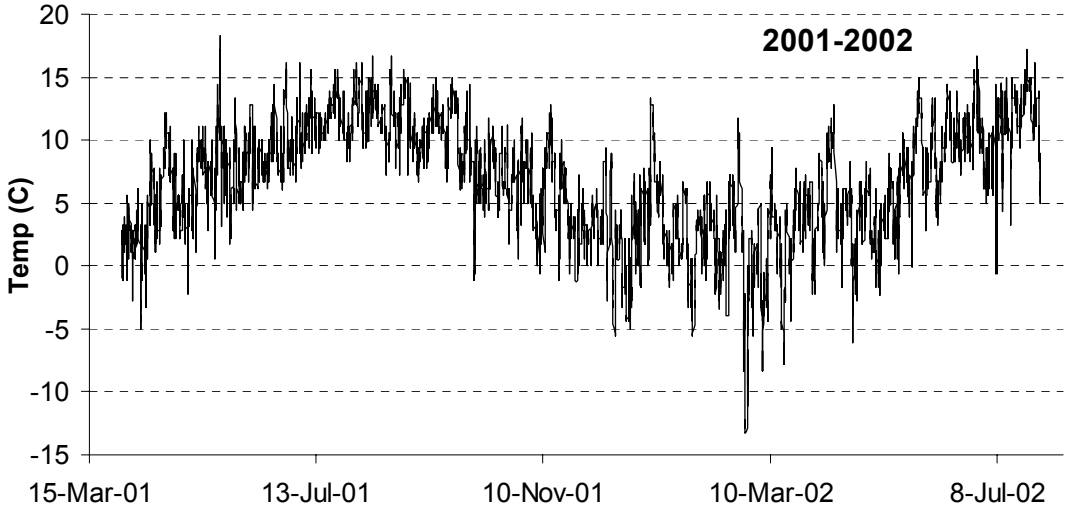

Figure 258: Dew Point Temperature at Seattle-Tacoma International Airport

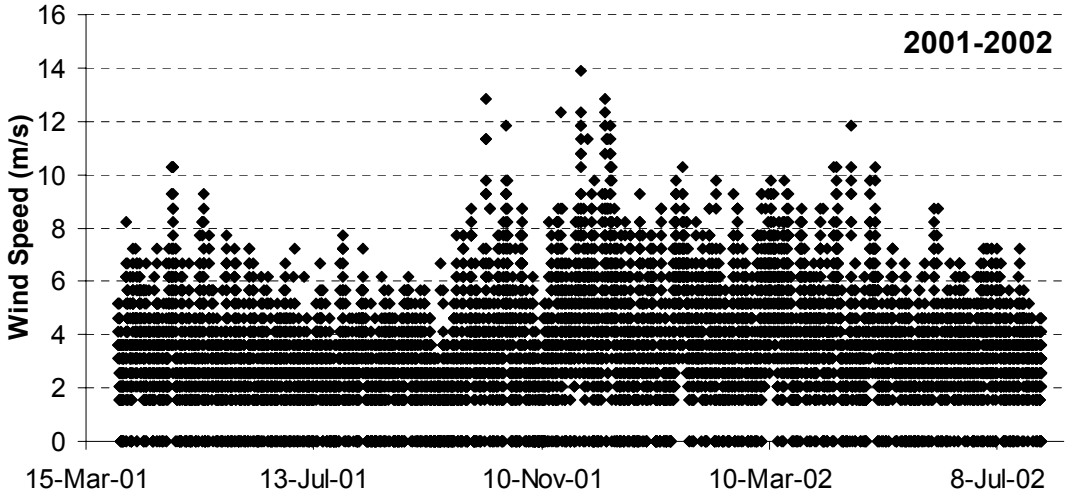

Figure 259: Wind Speed at Seattle-Tacoma International Airport

Note that in Figure 259 no wind values were recorded between 0 and 1.50 m/s.

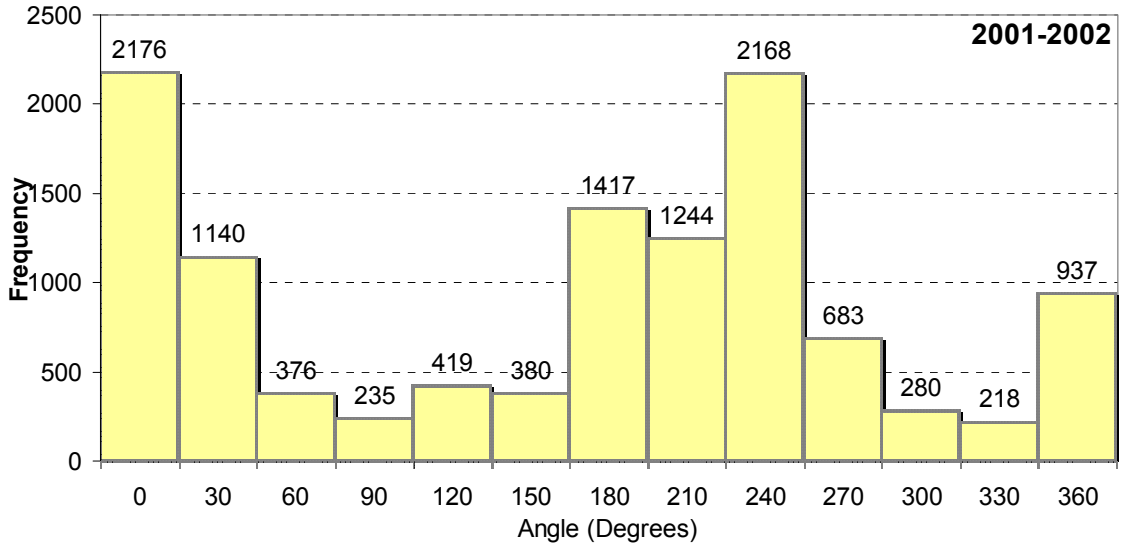

Figure 260: Frequency of Wind Direction at Seattle-Tacoma International Airport

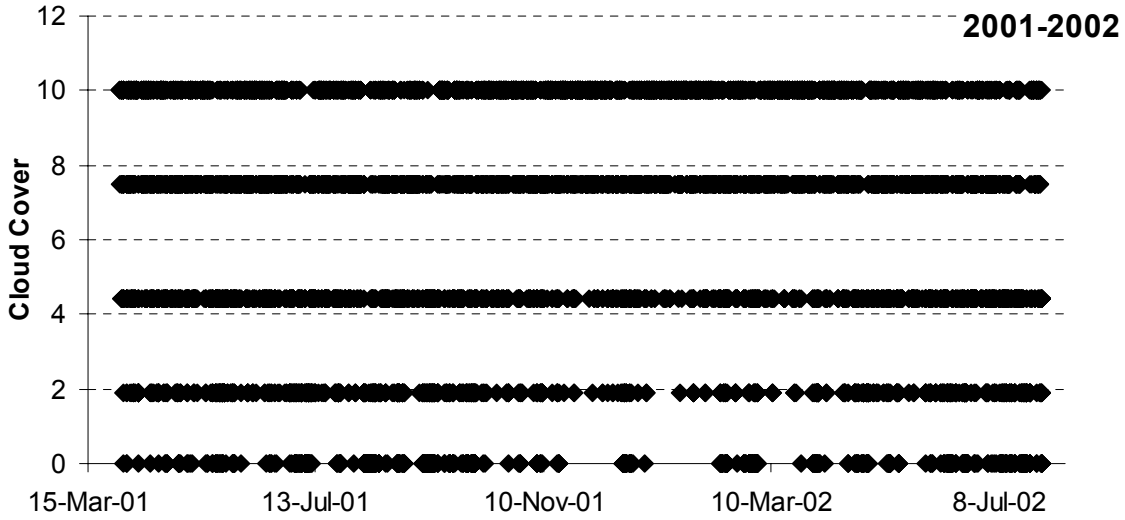

Figure 261: Cloud Cover at Seattle-Tacoma International Airport

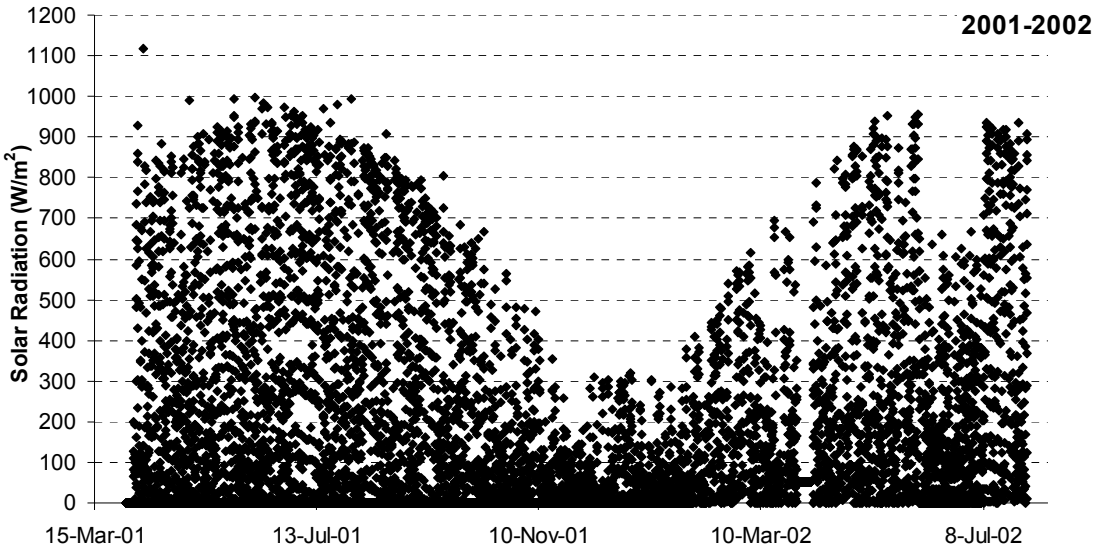

Figure 262: Shortwave solar Radiation from Seattle ISIS Station

The shortwave solar radiation for this model calibration period had a number of negative values during late evening and early morning hours. These values were set to zero.

2.9 Shading

Model input for the dynamic shading algorithm includes tree top elevations, distances from centerline to controlling vegetation from both stream banks, and a shade reduction factor for both streambanks (Cole, 2002).

King County assembled shade data and processed it using a Washington Department of Ecology spreadsheet program. This program is a modification of the Shade-a-lator program developed by Oregon's Department of Environmental Quality. Information from King County was further processed for the input file to CE-QUAL-W2.