# Appendix for Model 03110203

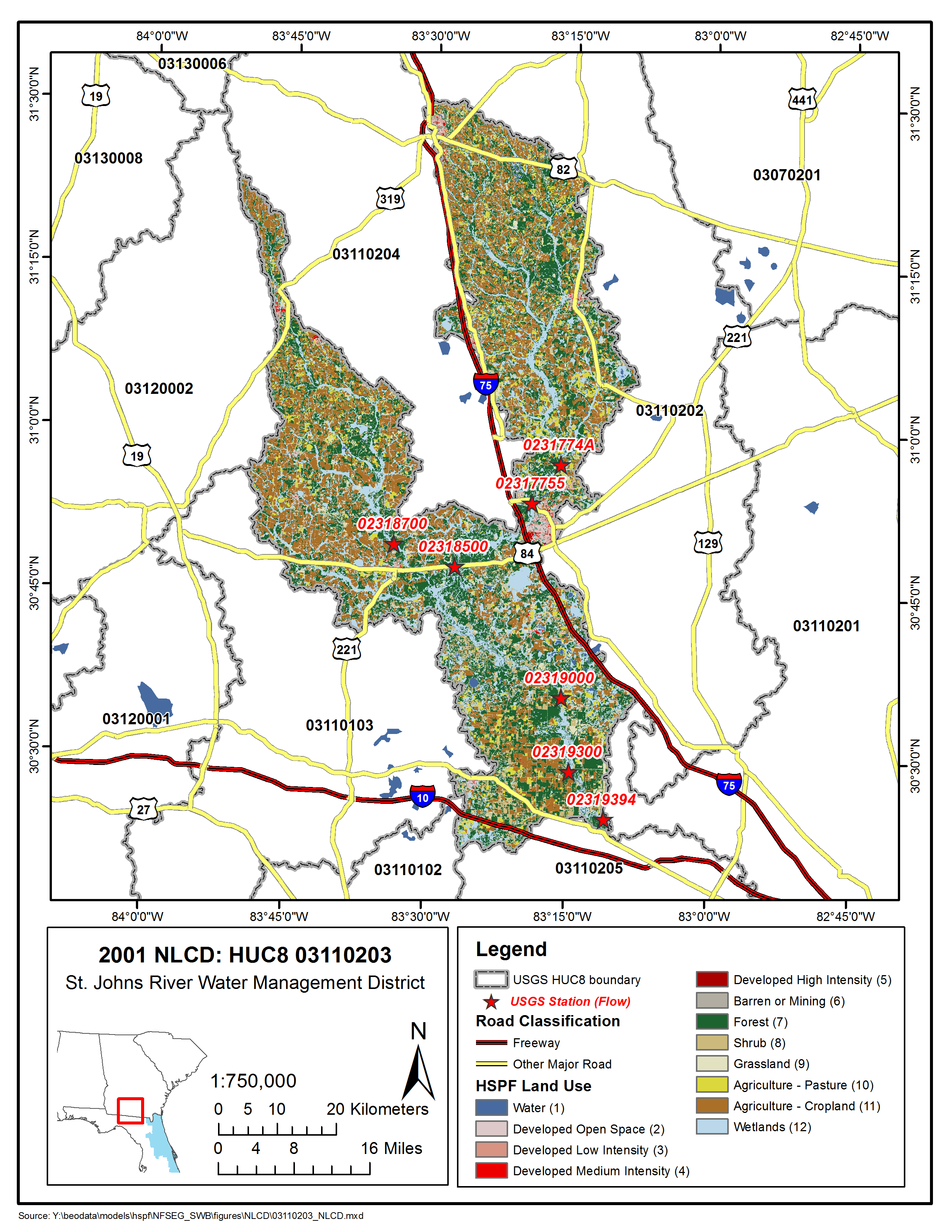


Figure 03110203-1: Land Cover from the National Land Cover Database.

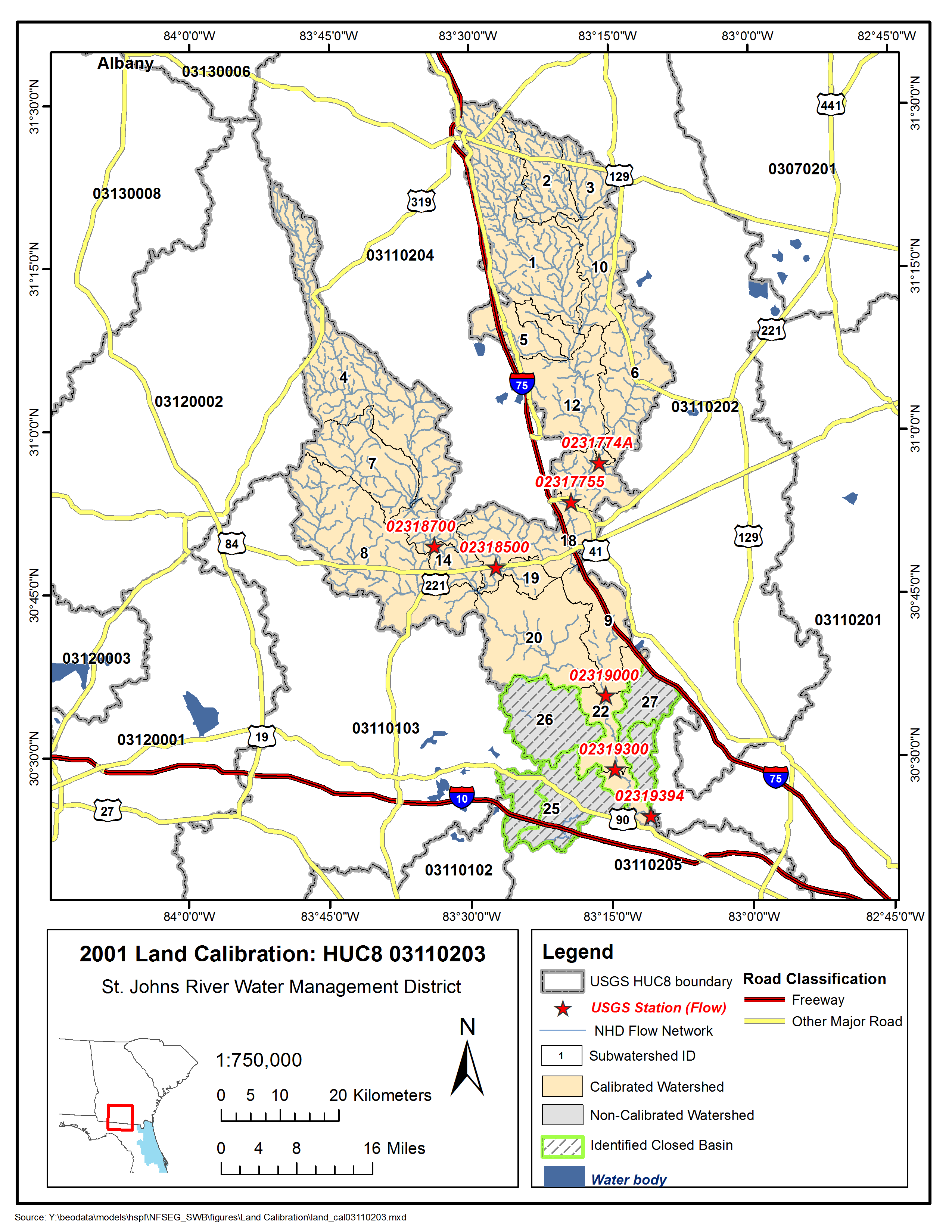


Figure 03110203-2: Calibrated sub-watersheds.

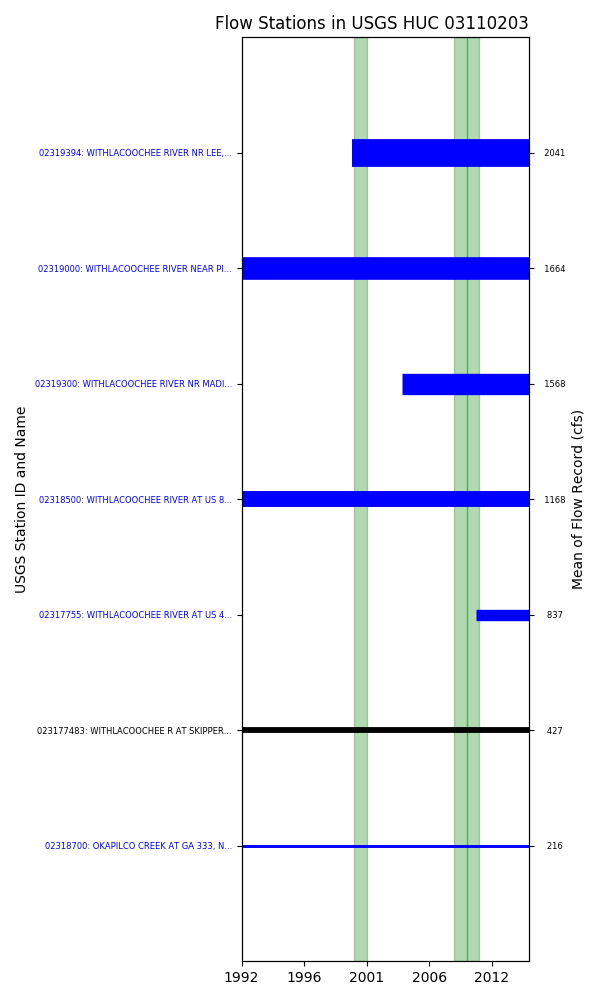


Figure 03110203-3: Station period of record. Blue color identifies gauges used for calibration.

## HSPF Reach 13, USGS Gauge 02318700

Table 03110203-1: Comparison Statistics Between HSPF Reach 13 and USGS Gauge 02318700.

|  |  |
| --- | --- |
| Statistic | Value |
| Bias | -73.11 |
| Standard error | 193.31 |
| Relative bias | -0.31 |
| Relative standard error | 0.52 |
| Nash-Sutcliffe coefficient | 0.73 |
| Kling-Gupta coefficient | 0.48 |
| Coefficient of efficiency | 0.63 |
| Index of agreement | 0.79 |

Table 03110203-2: Hydrologic Indices Between USGS Gauge 02318700 and HSPF Reach 13.

|  |  |  |  |
| --- | --- | --- | --- |
| Hydrologic Index and description (Olden and Poff, 2003) | Observed 02318700 | Simulated Reach 13 | Percent Difference |
| MA1: Mean, all daily flows | 231.94 | 158.86 | -31.51 |
| MA2: Median, all daily flows | 33.00 | 48.80 | 47.88 |
| MA3: CV, all daily flows | 216.43 | 155.00 | -28.38 |
| MA4: CV, log of all daily flows | 170.91 | 140.65 | -17.71 |
| MA5: Mean daily flow / median daily flow | 7.03 | 3.26 | -53.68 |
| MA9: (Q10 - Q90) / median daily flow | 18.23 | 9.04 | -50.42 |
| MA10: (Q20 - Q80) / median daily flow | 8.48 | 5.07 | -40.26 |
| MA11: (Q25 - Q75) / median daily flow | 6.04 | 3.51 | -42.01 |
| MA12: Mean monthly flow, January | 319.50 | 261.08 | -18.28 |
| MA13: Mean monthly flow, February | 482.34 | 335.96 | -30.35 |
| MA14: Mean monthly flow, March | 621.95 | 378.23 | -39.19 |
| MA15: Mean monthly flow, April | 314.69 | 176.89 | -43.79 |
| MA16: Mean monthly flow, May | 67.45 | 36.58 | -45.76 |
| MA17: Mean monthly flow, June | 106.87 | 42.48 | -60.25 |
| MA18: Mean monthly flow, July | 144.17 | 95.05 | -34.08 |
| MA19: Mean monthly flow, August | 146.06 | 126.31 | -13.52 |
| MA20: Mean monthly flow, September | 88.31 | 83.49 | -5.46 |
| MA21: Mean monthly flow, October | 147.65 | 97.81 | -33.76 |
| MA22: Mean monthly flow, November | 90.66 | 79.47 | -12.34 |
| MA23: Mean monthly flow, December | 155.28 | 127.79 | -17.71 |
| ML1: Mean minimum monthly flow, January | 61.97 | 74.68 | 20.51 |
| ML2: Mean minimum monthly flow, February | 131.29 | 131.05 | -0.18 |
| ML3: Mean minimum monthly flow, March | 120.57 | 127.01 | 5.34 |
| ML4: Mean minimum monthly flow, April | 45.29 | 48.47 | 7.03 |
| ML5: Mean minimum monthly flow, May | 11.23 | 7.62 | -32.17 |
| ML6: Mean minimum monthly flow, June | 7.17 | 4.57 | -36.33 |
| ML7: Mean minimum monthly flow, July | 18.29 | 34.54 | 88.81 |
| ML8: Mean minimum monthly flow, August | 19.21 | 40.03 | 108.41 |
| ML9: Mean minimum monthly flow, September | 3.53 | 14.66 | 315.63 |
| ML10: Mean minimum monthly flow, October | 12.55 | 20.97 | 66.99 |
| ML11: Mean minimum monthly flow, November | 20.49 | 33.29 | 62.42 |
| ML12: Mean minimum monthly flow, December | 39.62 | 50.91 | 28.49 |
| ML13: CV of minimum monthly flows | 179.95 | 166.04 | -7.73 |
| ML14: Mean minimum daily flow / mean median annual flow | 0.00 | 0.00 | 17.11 |
| ML15: Mean minimum annual flow / mean annual flow | 0.00 | 0.00 | 70.18 |
| ML16: Median minimum annual flow / median annual flow | 0.00 | 0.00 |  |
| ML20: Ratio of baseflow volume to total flow volume | 0.32 | 0.48 | 51.73 |
| ML22: Mean annual minimum flow divided by catchment area | 0.00 | 0.00 | 9.30 |
| RA1: Mean of positive changes from one day to next (rise rate) | 120.34 | 50.65 |  |
| RA2: CV, mean of positive changes from one day to next (rise rate) | 370.76 | 397.68 |  |
| RA3: Mean of negative changes from one day to next (fall rate) | 62.45 | 20.21 |  |
| RA4: CV, mean of negative changes from one day to next (fall rate) | 373.03 | 346.28 |  |
| RA5: Ratio of days that are higher than previous day | 0.27 | 0.28 |  |
| RA6: Median of difference in log of flows over two consecutive days of rising | 0.23 | 0.19 |  |
| RA7: Median of difference in log of flows over two consecutive days of falling | 0.19 | 0.11 |  |
| RA8: Number of flow reversals from one day to the next | 57.79 | 74.21 |  |
| RA9: CV, number of flow reversals from one day to the next | 34.49 | 19.08 |  |

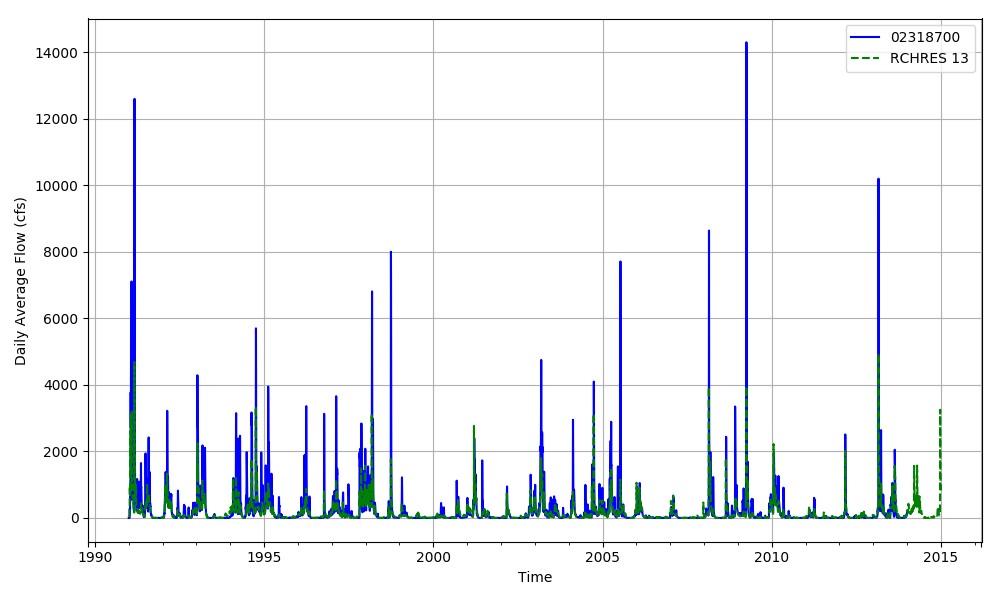


Figure 03110203-4: Daily flow for HSFP reach 13 and USGS station 02318700.

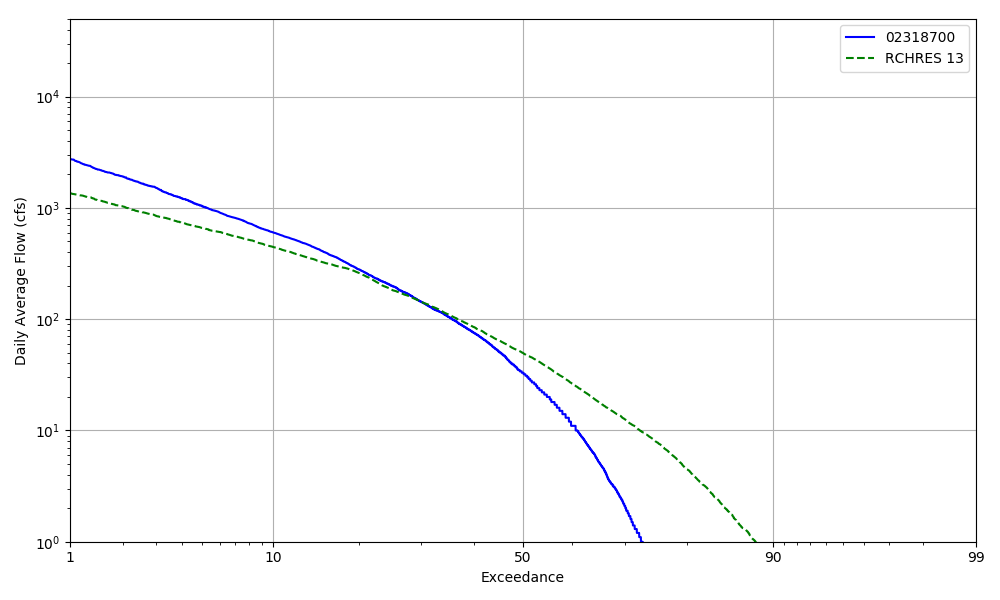


Figure 03110203-5: Daily exceedance for HSFP reach 13 and USGS station 02318700.

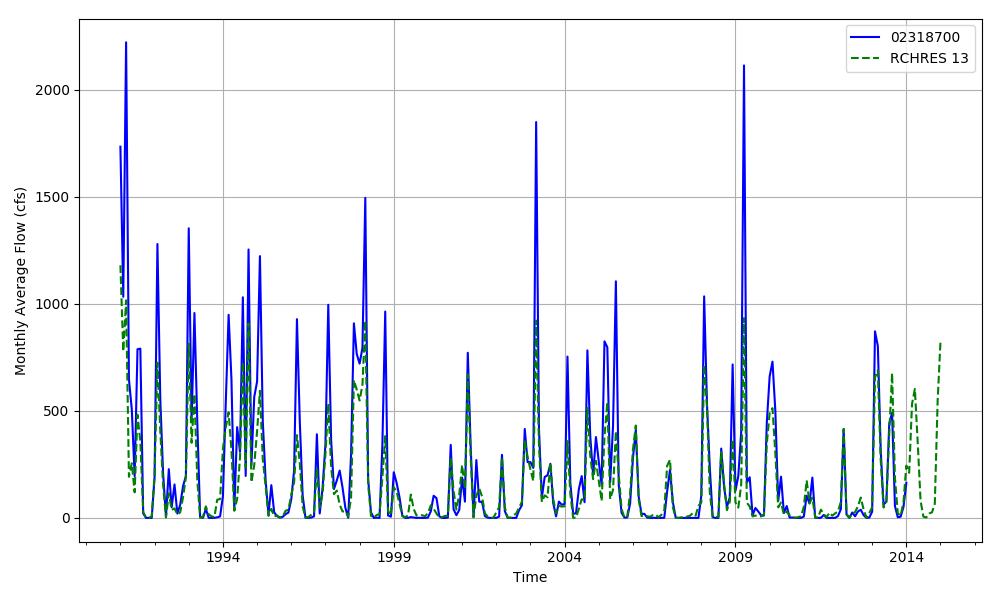


Figure 03110203-6: Monthly flow for HSFP reach 13 and USGS station 02318700.

## HSPF Reach 15, USGS Gauge 0231774A

Table 03110203-3: Comparison Statistics Between HSPF Reach 15 and USGS Gauge 0231774A.

|  |  |
| --- | --- |
| Statistic | Value |
| Bias | -191.01 |
| Standard error | 427.66 |
| Relative bias | -0.42 |
| Relative standard error | 0.60 |
| Nash-Sutcliffe coefficient | 0.65 |
| Kling-Gupta coefficient | 0.37 |
| Coefficient of efficiency | 0.57 |
| Index of agreement | 0.75 |

Table 03110203-4: Hydrologic Indices Between USGS Gauge 0231774A and HSPF Reach 15.

|  |  |  |  |
| --- | --- | --- | --- |
| Hydrologic Index and description (Olden and Poff, 2003) | Observed 0231774A | Simulated Reach 15 | Percent Difference |
| MA1: Mean, all daily flows | 455.66 | 264.98 | -41.85 |
| MA2: Median, all daily flows | 95.00 | 80.13 | -15.65 |
| MA3: CV, all daily flows | 196.57 | 157.46 | -19.90 |
| MA4: CV, log of all daily flows | 162.61 | 143.10 | -12.00 |
| MA5: Mean daily flow / median daily flow | 4.80 | 3.31 | -31.06 |
| MA9: (Q10 - Q90) / median daily flow | 12.24 | 9.12 | -25.47 |
| MA10: (Q20 - Q80) / median daily flow | 5.56 | 4.71 | -15.19 |
| MA11: (Q25 - Q75) / median daily flow | 3.93 | 3.56 | -9.27 |
| MA12: Mean monthly flow, January | 619.18 | 438.70 | -29.15 |
| MA13: Mean monthly flow, February | 971.43 | 584.48 | -39.83 |
| MA14: Mean monthly flow, March | 1143.39 | 652.71 | -42.91 |
| MA15: Mean monthly flow, April | 589.44 | 328.09 | -44.34 |
| MA16: Mean monthly flow, May | 125.46 | 63.92 | -49.05 |
| MA17: Mean monthly flow, June | 181.78 | 67.79 | -62.71 |
| MA18: Mean monthly flow, July | 294.06 | 131.07 | -55.43 |
| MA19: Mean monthly flow, August | 359.01 | 168.54 | -53.05 |
| MA20: Mean monthly flow, September | 257.95 | 149.99 | -41.85 |
| MA21: Mean monthly flow, October | 221.65 | 153.08 | -30.94 |
| MA22: Mean monthly flow, November | 183.12 | 122.38 | -33.17 |
| MA23: Mean monthly flow, December | 336.43 | 217.56 | -35.33 |
| ML1: Mean minimum monthly flow, January | 155.39 | 126.02 | -18.90 |
| ML2: Mean minimum monthly flow, February | 275.87 | 226.39 | -17.94 |
| ML3: Mean minimum monthly flow, March | 244.04 | 218.49 | -10.47 |
| ML4: Mean minimum monthly flow, April | 92.54 | 93.86 | 1.42 |
| ML5: Mean minimum monthly flow, May | 32.93 | 14.79 | -55.08 |
| ML6: Mean minimum monthly flow, June | 17.26 | 8.84 | -48.81 |
| ML7: Mean minimum monthly flow, July | 55.82 | 46.67 | -16.39 |
| ML8: Mean minimum monthly flow, August | 65.10 | 59.72 | -8.26 |
| ML9: Mean minimum monthly flow, September | 22.21 | 23.42 | 5.42 |
| ML10: Mean minimum monthly flow, October | 36.28 | 31.00 | -14.57 |
| ML11: Mean minimum monthly flow, November | 61.06 | 52.91 | -13.35 |
| ML12: Mean minimum monthly flow, December | 105.00 | 88.76 | -15.47 |
| ML13: CV of minimum monthly flows | 155.01 | 166.97 | 7.72 |
| ML14: Mean minimum daily flow / mean median annual flow | 0.06 | 0.01 | -76.21 |
| ML15: Mean minimum annual flow / mean annual flow | 0.02 | 0.01 | -56.97 |
| ML16: Median minimum annual flow / median annual flow | 0.03 | 0.00 | -96.52 |
| ML20: Ratio of baseflow volume to total flow volume | 0.34 | 0.48 | 43.99 |
| ML22: Mean annual minimum flow divided by catchment area | 0.04 | 0.01 | -72.15 |
| RA1: Mean of positive changes from one day to next (rise rate) | 161.57 | 79.48 |  |
| RA2: CV, mean of positive changes from one day to next (rise rate) | 371.03 | 427.60 |  |
| RA3: Mean of negative changes from one day to next (fall rate) | 86.32 | 32.92 |  |
| RA4: CV, mean of negative changes from one day to next (fall rate) | 391.04 | 388.00 |  |
| RA5: Ratio of days that are higher than previous day | 0.33 | 0.29 |  |
| RA6: Median of difference in log of flows over two consecutive days of rising | 0.16 | 0.16 |  |
| RA7: Median of difference in log of flows over two consecutive days of falling | 0.13 | 0.10 |  |
| RA8: Number of flow reversals from one day to the next | 77.58 | 66.46 |  |
| RA9: CV, number of flow reversals from one day to the next | 20.61 | 18.03 |  |

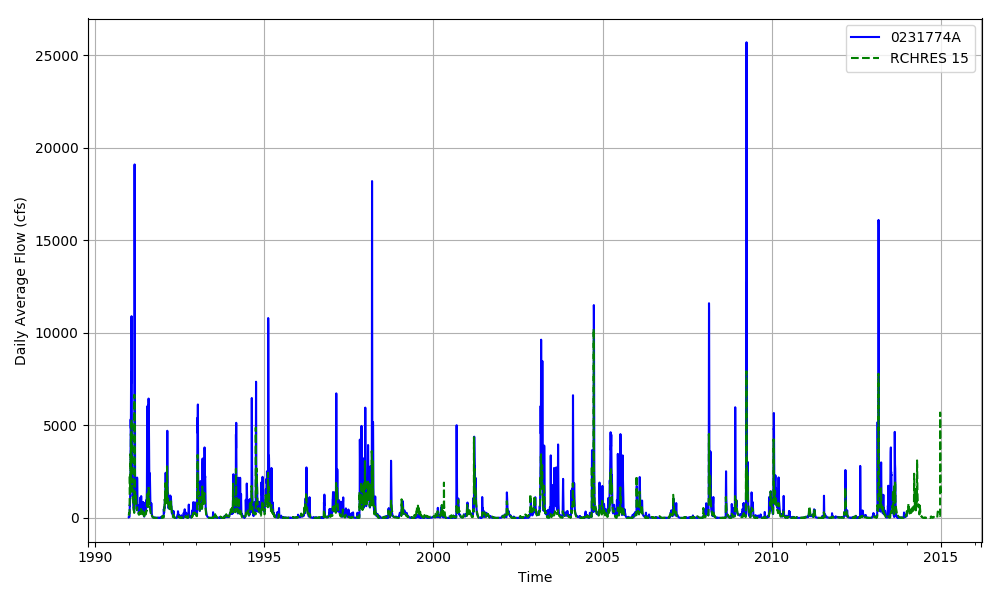


Figure 03110203-7: Daily flow for HSFP reach 15 and USGS station 0231774A.

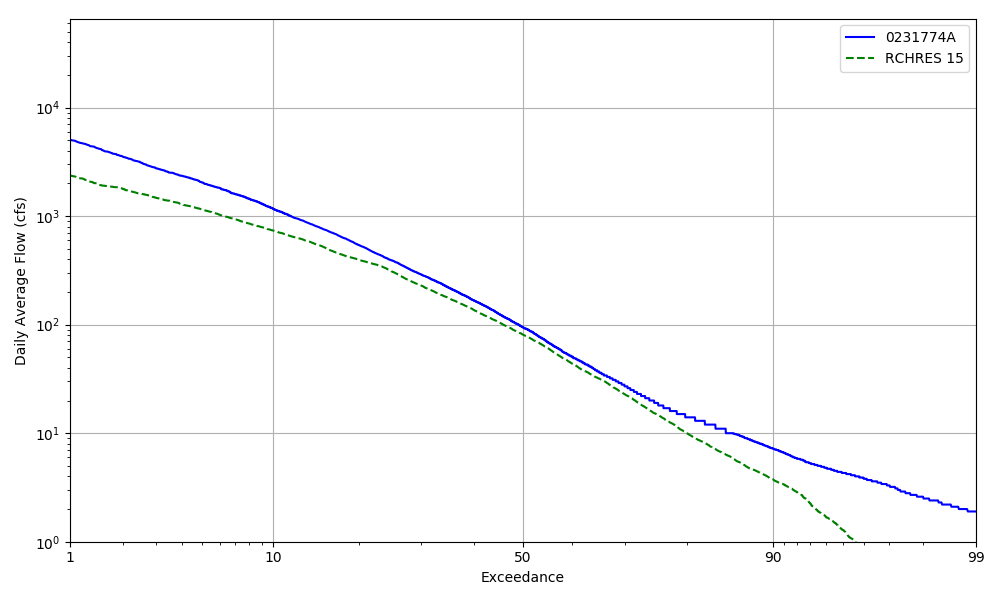


Figure 03110203-8: Daily exceedance for HSFP reach 15 and USGS station 0231774A.

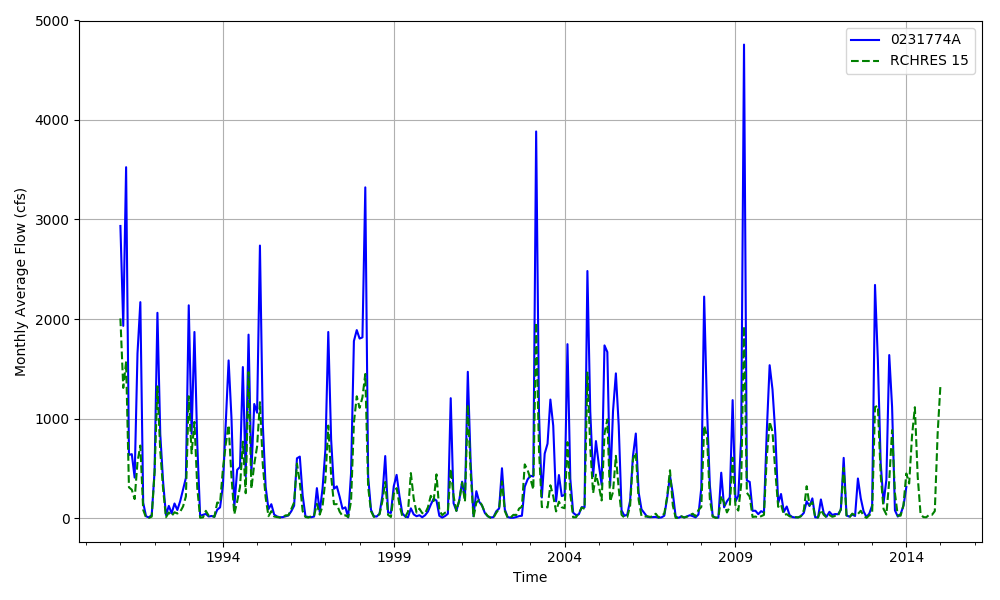


Figure 03110203-9: Monthly flow for HSFP reach 15 and USGS station 0231774A.

## HSPF Reach 16, USGS Gauge 02317755

Table 03110203-5: Comparison Statistics Between HSPF Reach 16 and USGS Gauge 02317755.

|  |  |
| --- | --- |
| Statistic | Value |
| Bias | -70.21 |
| Standard error | 223.94 |
| Relative bias | -0.29 |
| Relative standard error | 0.49 |
| Nash-Sutcliffe coefficient | 0.76 |
| Kling-Gupta coefficient | 0.54 |
| Coefficient of efficiency | 0.66 |
| Index of agreement | 0.82 |

Table 03110203-6: Hydrologic Indices Between USGS Gauge 02317755 and HSPF Reach 16.

|  |  |  |  |
| --- | --- | --- | --- |
| Hydrologic Index and description (Olden and Poff, 2003) | Observed 02317755 | Simulated Reach 16 | Percent Difference |
| MA1: Mean, all daily flows | 239.62 | 169.52 | -29.25 |
| MA2: Median, all daily flows | 23.00 | 36.31 | 57.88 |
| MA3: CV, all daily flows | 228.57 | 162.26 | -29.01 |
| MA4: CV, log of all daily flows | 199.79 | 161.29 | -19.27 |
| MA5: Mean daily flow / median daily flow | 10.42 | 4.67 | -55.19 |
| MA9: (Q10 - Q90) / median daily flow | 21.72 | 12.73 | -41.41 |
| MA10: (Q20 - Q80) / median daily flow | 7.70 | 4.65 | -39.65 |
| MA11: (Q25 - Q75) / median daily flow | 4.91 | 2.91 | -40.86 |
| MA12: Mean monthly flow, January | 28.33 | 42.35 | 49.48 |
| MA13: Mean monthly flow, February | 500.29 | 393.75 | -21.29 |
| MA14: Mean monthly flow, March | 633.13 | 472.61 | -25.35 |
| MA15: Mean monthly flow, April | 195.15 | 169.23 | -13.28 |
| MA16: Mean monthly flow, May | 35.59 | 28.57 | -19.73 |
| MA17: Mean monthly flow, June | 89.60 | 25.44 | -71.61 |
| MA18: Mean monthly flow, July | 402.17 | 140.48 | -65.07 |
| MA19: Mean monthly flow, August | 347.06 | 257.73 | -25.74 |
| MA20: Mean monthly flow, September | 70.21 | 94.70 | 34.89 |
| MA21: Mean monthly flow, October | 21.06 | 20.03 | -4.90 |
| MA22: Mean monthly flow, November | 13.32 | 6.03 | -54.78 |
| MA23: Mean monthly flow, December | 18.59 | 19.02 | 2.34 |
| ML1: Mean minimum monthly flow, January | 19.33 | 17.63 | -8.81 |
| ML2: Mean minimum monthly flow, February | 19.33 | 51.09 | 164.23 |
| ML3: Mean minimum monthly flow, March | 123.33 | 241.93 | 96.16 |
| ML4: Mean minimum monthly flow, April | 70.00 | 89.42 | 27.74 |
| ML5: Mean minimum monthly flow, May | 9.03 | 8.19 | -9.35 |
| ML6: Mean minimum monthly flow, June | 7.70 | 8.40 | 9.07 |
| ML7: Mean minimum monthly flow, July | 78.12 | 14.73 | -81.15 |
| ML8: Mean minimum monthly flow, August | 20.00 | 62.86 | 214.31 |
| ML9: Mean minimum monthly flow, September | 11.97 | 33.95 | 183.49 |
| ML10: Mean minimum monthly flow, October | 14.53 | 2.96 | -79.66 |
| ML11: Mean minimum monthly flow, November | 14.67 | 3.58 | -75.57 |
| ML12: Mean minimum monthly flow, December | 18.00 | 7.27 | -59.59 |
| ML13: CV of minimum monthly flows | 193.11 | 225.75 | 16.91 |
| ML14: Mean minimum daily flow / mean median annual flow | 0.28 | 0.04 | -86.94 |
| ML15: Mean minimum annual flow / mean annual flow | 0.08 | 0.02 | -75.99 |
| ML16: Median minimum annual flow / median annual flow | 0.30 | 0.04 | -87.61 |
| ML20: Ratio of baseflow volume to total flow volume | 0.20 | 0.40 | 98.45 |
| ML22: Mean annual minimum flow divided by catchment area | 0.08 | 0.01 | -85.78 |
| RA1: Mean of positive changes from one day to next (rise rate) | 142.84 | 57.25 |  |
| RA2: CV, mean of positive changes from one day to next (rise rate) | 462.30 | 449.84 |  |
| RA3: Mean of negative changes from one day to next (fall rate) | 67.43 | 22.82 |  |
| RA4: CV, mean of negative changes from one day to next (fall rate) | 610.53 | 495.68 |  |
| RA5: Ratio of days that are higher than previous day | 0.25 | 0.28 |  |
| RA6: Median of difference in log of flows over two consecutive days of rising | 0.20 | 0.16 |  |
| RA7: Median of difference in log of flows over two consecutive days of falling | 0.12 | 0.10 |  |
| RA8: Number of flow reversals from one day to the next | 57.50 | 53.00 |  |
| RA9: CV, number of flow reversals from one day to the next | 48.48 | 51.02 |  |

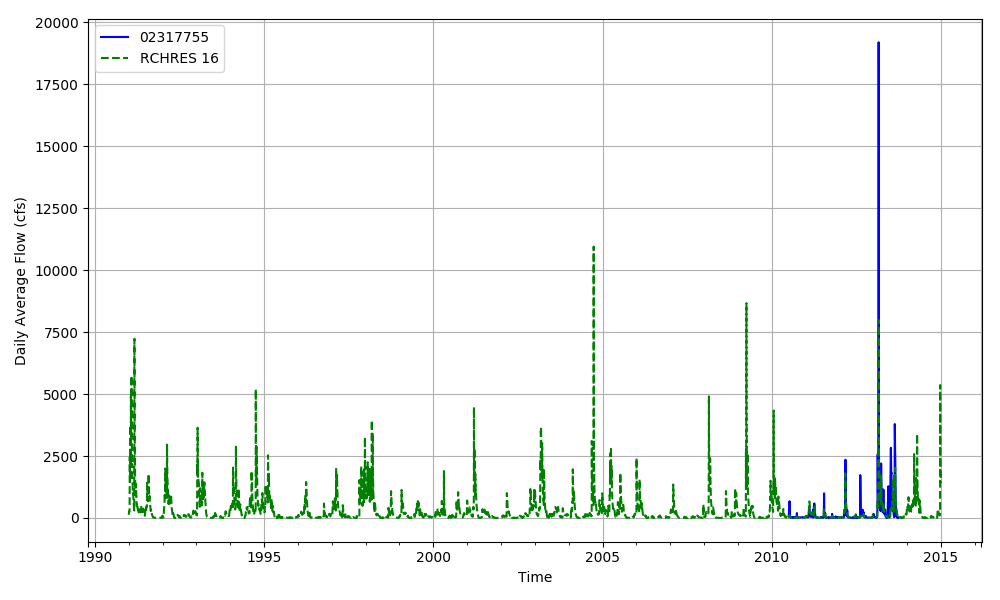


Figure 03110203-10: Daily flow for HSFP reach 16 and USGS station 02317755.

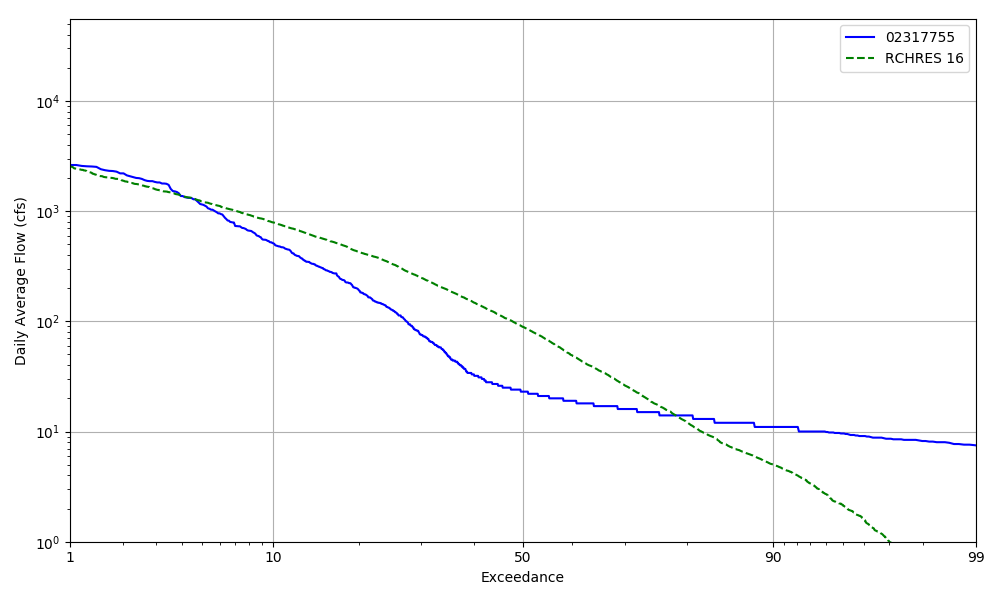


Figure 03110203-11: Daily exceedance for HSFP reach 16 and USGS station 02317755.

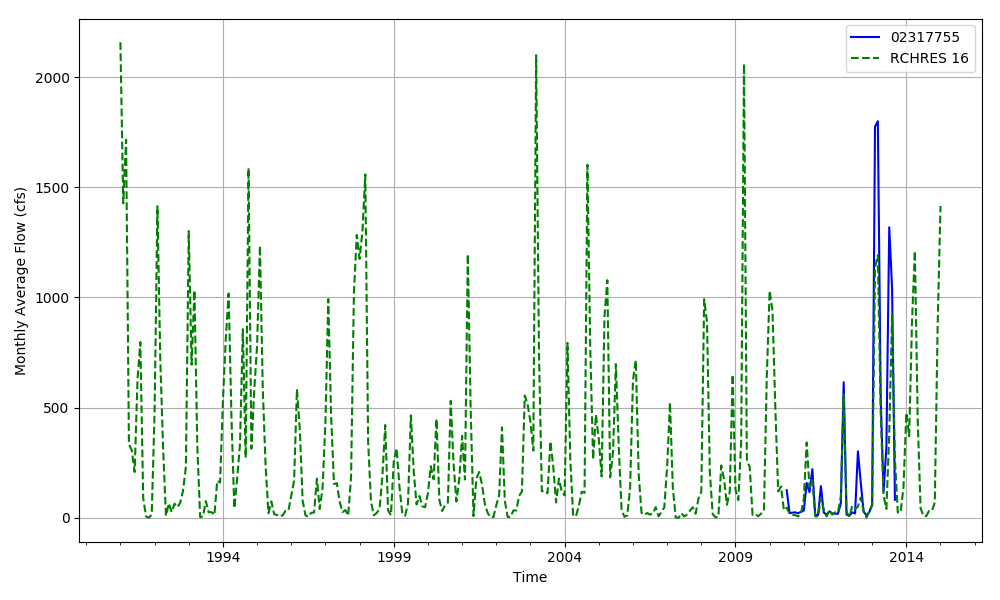


Figure 03110203-12: Monthly flow for HSFP reach 16 and USGS station 02317755.

## HSPF Reach 18, USGS Gauge 02318500

Table 03110203-7: Comparison Statistics Between HSPF Reach 18 and USGS Gauge 02318500.

|  |  |
| --- | --- |
| Statistic | Value |
| Bias | -153.71 |
| Standard error | 805.77 |
| Relative bias | -0.12 |
| Relative standard error | 0.41 |
| Nash-Sutcliffe coefficient | 0.83 |
| Kling-Gupta coefficient | 0.70 |
| Coefficient of efficiency | 0.71 |
| Index of agreement | 0.84 |

Table 03110203-8: Hydrologic Indices Between USGS Gauge 02318500 and HSPF Reach 18.

|  |  |  |  |
| --- | --- | --- | --- |
| Hydrologic Index and description (Olden and Poff, 2003) | Observed 02318500 | Simulated Reach 18 | Percent Difference |
| MA1: Mean, all daily flows | 1233.78 | 1078.73 | -12.57 |
| MA2: Median, all daily flows | 254.00 | 389.76 | 53.45 |
| MA3: CV, all daily flows | 164.49 | 145.23 | -11.71 |
| MA4: CV, log of all daily flows | 157.24 | 131.14 | -16.60 |
| MA5: Mean daily flow / median daily flow | 4.86 | 2.77 | -43.02 |
| MA9: (Q10 - Q90) / median daily flow | 13.69 | 6.88 | -49.70 |
| MA10: (Q20 - Q80) / median daily flow | 6.72 | 3.78 | -43.72 |
| MA11: (Q25 - Q75) / median daily flow | 4.55 | 2.94 | -35.35 |
| MA12: Mean monthly flow, January | 1419.02 | 1529.73 | 7.80 |
| MA13: Mean monthly flow, February | 2436.72 | 2262.51 | -7.15 |
| MA14: Mean monthly flow, March | 2971.81 | 2375.94 | -20.05 |
| MA15: Mean monthly flow, April | 1783.21 | 1279.37 | -28.25 |
| MA16: Mean monthly flow, May | 437.06 | 367.43 | -15.93 |
| MA17: Mean monthly flow, June | 502.03 | 310.88 | -38.07 |
| MA18: Mean monthly flow, July | 810.96 | 586.57 | -27.67 |
| MA19: Mean monthly flow, August | 894.92 | 733.21 | -18.07 |
| MA20: Mean monthly flow, September | 505.11 | 572.43 | 13.33 |
| MA21: Mean monthly flow, October | 620.45 | 582.33 | -6.14 |
| MA22: Mean monthly flow, November | 431.42 | 483.33 | 12.03 |
| MA23: Mean monthly flow, December | 842.12 | 873.84 | 3.77 |
| ML1: Mean minimum monthly flow, January | 481.39 | 585.94 | 21.72 |
| ML2: Mean minimum monthly flow, February | 911.05 | 939.56 | 3.13 |
| ML3: Mean minimum monthly flow, March | 836.95 | 836.47 | -0.06 |
| ML4: Mean minimum monthly flow, April | 329.18 | 470.13 | 42.82 |
| ML5: Mean minimum monthly flow, May | 141.86 | 143.30 | 1.01 |
| ML6: Mean minimum monthly flow, June | 61.79 | 99.73 | 61.41 |
| ML7: Mean minimum monthly flow, July | 264.82 | 255.44 | -3.54 |
| ML8: Mean minimum monthly flow, August | 228.82 | 314.29 | 37.35 |
| ML9: Mean minimum monthly flow, September | 57.21 | 142.38 | 148.86 |
| ML10: Mean minimum monthly flow, October | 97.30 | 169.81 | 74.52 |
| ML11: Mean minimum monthly flow, November | 168.93 | 252.63 | 49.55 |
| ML12: Mean minimum monthly flow, December | 281.93 | 395.44 | 40.26 |
| ML13: CV of minimum monthly flows | 176.31 | 133.09 | -24.52 |
| ML14: Mean minimum daily flow / mean median annual flow | 0.12 | 0.10 | -16.01 |
| ML15: Mean minimum annual flow / mean annual flow | 0.03 | 0.05 | 43.55 |
| ML16: Median minimum annual flow / median annual flow | 0.08 | 0.10 | 30.80 |
| ML20: Ratio of baseflow volume to total flow volume | 0.38 | 0.51 | 34.78 |
| ML22: Mean annual minimum flow divided by catchment area | 0.17 | 0.41 | 146.12 |
| RA1: Mean of positive changes from one day to next (rise rate) | 295.84 | 303.02 |  |
| RA2: CV, mean of positive changes from one day to next (rise rate) | 318.31 | 415.78 |  |
| RA3: Mean of negative changes from one day to next (fall rate) | 169.01 | 134.94 |  |
| RA4: CV, mean of negative changes from one day to next (fall rate) | 325.99 | 391.08 |  |
| RA5: Ratio of days that are higher than previous day | 0.34 | 0.31 |  |
| RA6: Median of difference in log of flows over two consecutive days of rising | 0.14 | 0.08 |  |
| RA7: Median of difference in log of flows over two consecutive days of falling | 0.12 | 0.07 |  |
| RA8: Number of flow reversals from one day to the next | 71.12 | 54.38 |  |
| RA9: CV, number of flow reversals from one day to the next | 24.76 | 26.97 |  |

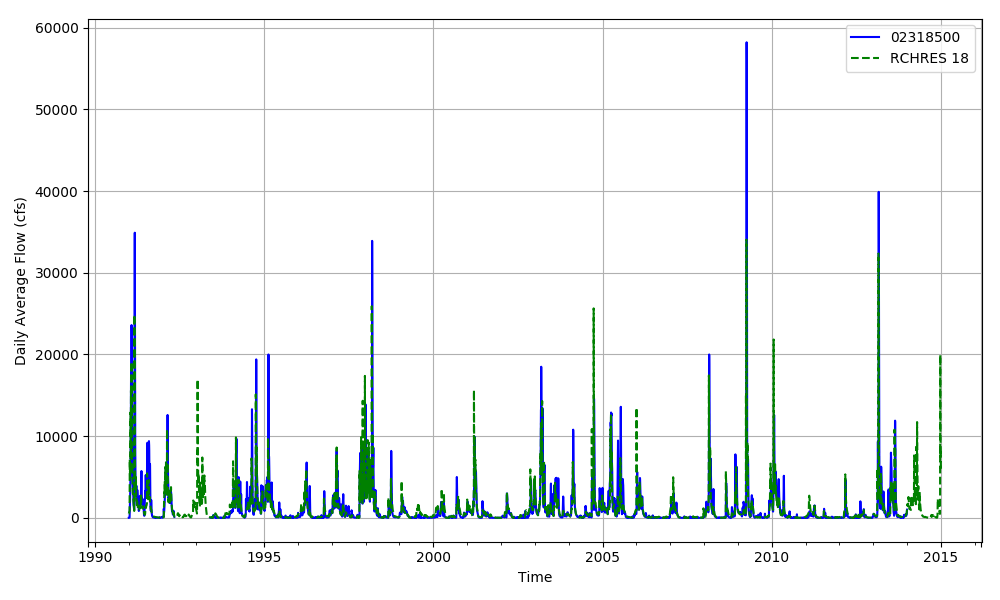


Figure 03110203-13: Daily flow for HSFP reach 18 and USGS station 02318500.

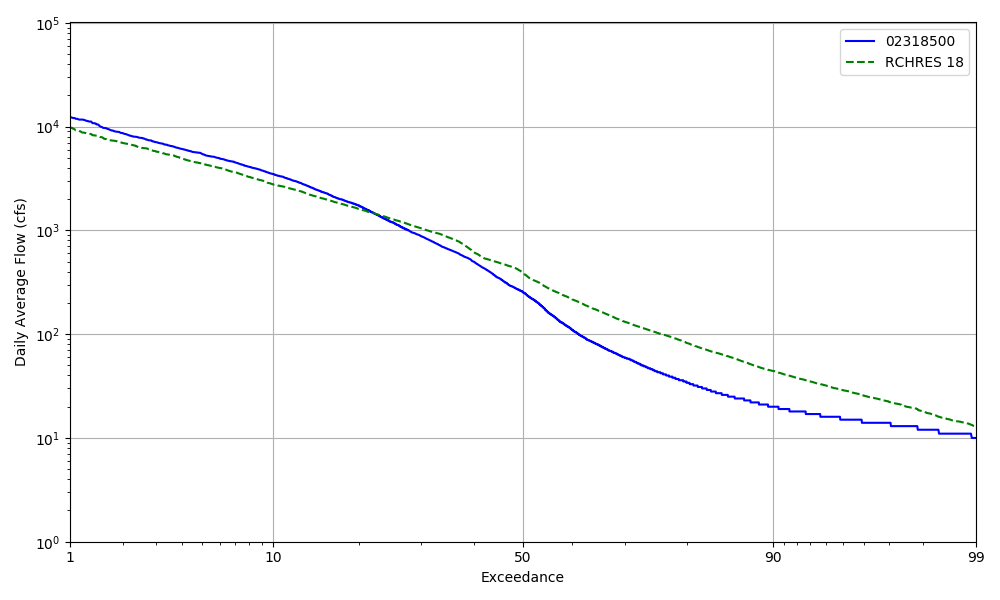


Figure 03110203-14: Daily exceedance for HSFP reach 18 and USGS station 02318500.

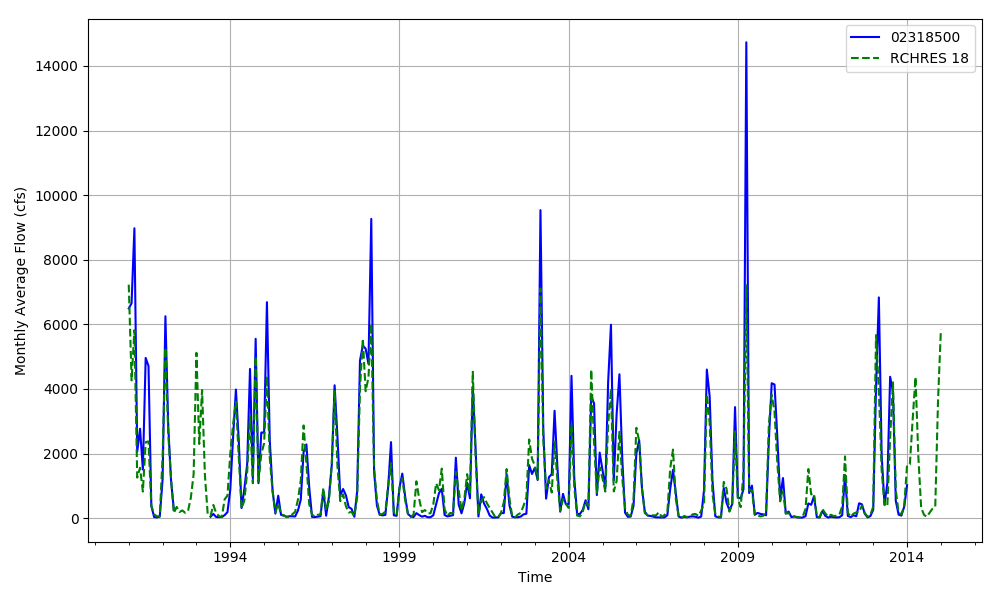


Figure 03110203-15: Monthly flow for HSFP reach 18 and USGS station 02318500.

## HSPF Reach 21, USGS Gauge 02319000

Table 03110203-9: Comparison Statistics Between HSPF Reach 21 and USGS Gauge 02319000.

|  |  |
| --- | --- |
| Statistic | Value |
| Bias | -211.81 |
| Standard error | 1052.32 |
| Relative bias | -0.12 |
| Relative standard error | 0.42 |
| Nash-Sutcliffe coefficient | 0.82 |
| Kling-Gupta coefficient | 0.72 |
| Coefficient of efficiency | 0.69 |
| Index of agreement | 0.83 |

Table 03110203-10: Hydrologic Indices Between USGS Gauge 02319000 and HSPF Reach 21.

|  |  |  |  |
| --- | --- | --- | --- |
| Hydrologic Index and description (Olden and Poff, 2003) | Observed 02319000 | Simulated Reach 21 | Percent Difference |
| MA1: Mean, all daily flows | 1751.75 | 1538.92 | -12.15 |
| MA2: Median, all daily flows | 554.00 | 639.69 | 15.47 |
| MA3: CV, all daily flows | 144.97 | 136.62 | -5.76 |
| MA4: CV, log of all daily flows | 136.39 | 120.39 | -11.73 |
| MA5: Mean daily flow / median daily flow | 3.16 | 2.41 | -23.92 |
| MA9: (Q10 - Q90) / median daily flow | 8.09 | 5.79 | -28.49 |
| MA10: (Q20 - Q80) / median daily flow | 4.12 | 3.24 | -21.41 |
| MA11: (Q25 - Q75) / median daily flow | 3.02 | 2.51 | -16.89 |
| MA12: Mean monthly flow, January | 2111.70 | 2338.27 | 10.73 |
| MA13: Mean monthly flow, February | 3337.94 | 3150.21 | -5.62 |
| MA14: Mean monthly flow, March | 4380.68 | 3479.22 | -20.58 |
| MA15: Mean monthly flow, April | 2687.78 | 1892.78 | -29.58 |
| MA16: Mean monthly flow, May | 757.60 | 596.31 | -21.29 |
| MA17: Mean monthly flow, June | 839.83 | 535.99 | -36.18 |
| MA18: Mean monthly flow, July | 1166.75 | 915.87 | -21.50 |
| MA19: Mean monthly flow, August | 1285.79 | 1128.98 | -12.20 |
| MA20: Mean monthly flow, September | 772.83 | 874.79 | 13.19 |
| MA21: Mean monthly flow, October | 1077.71 | 921.92 | -14.46 |
| MA22: Mean monthly flow, November | 709.81 | 753.68 | 6.18 |
| MA23: Mean monthly flow, December | 1165.67 | 1261.45 | 8.22 |
| ML1: Mean minimum monthly flow, January | 807.83 | 836.37 | 3.53 |
| ML2: Mean minimum monthly flow, February | 1461.74 | 1371.75 | -6.16 |
| ML3: Mean minimum monthly flow, March | 1458.22 | 1329.50 | -8.83 |
| ML4: Mean minimum monthly flow, April | 803.87 | 774.53 | -3.65 |
| ML5: Mean minimum monthly flow, May | 365.22 | 289.30 | -20.79 |
| ML6: Mean minimum monthly flow, June | 246.91 | 228.99 | -7.26 |
| ML7: Mean minimum monthly flow, July | 536.00 | 452.55 | -15.57 |
| ML8: Mean minimum monthly flow, August | 462.87 | 525.11 | 13.45 |
| ML9: Mean minimum monthly flow, September | 230.57 | 293.25 | 27.19 |
| ML10: Mean minimum monthly flow, October | 297.04 | 321.30 | 8.16 |
| ML11: Mean minimum monthly flow, November | 365.48 | 413.62 | 13.17 |
| ML12: Mean minimum monthly flow, December | 551.39 | 614.16 | 11.38 |
| ML13: CV of minimum monthly flows | 133.20 | 116.35 | -12.65 |
| ML14: Mean minimum daily flow / mean median annual flow | 0.27 | 0.19 | -29.91 |
| ML15: Mean minimum annual flow / mean annual flow | 0.11 | 0.09 | -21.60 |
| ML16: Median minimum annual flow / median annual flow | 0.20 | 0.18 | -12.09 |
| ML20: Ratio of baseflow volume to total flow volume | 0.49 | 0.55 | 13.00 |
| ML22: Mean annual minimum flow divided by catchment area | 1.22 | 1.22 | 0.71 |
| RA1: Mean of positive changes from one day to next (rise rate) | 284.52 | 371.74 |  |
| RA2: CV, mean of positive changes from one day to next (rise rate) | 275.10 | 381.89 |  |
| RA3: Mean of negative changes from one day to next (fall rate) | 173.09 | 165.35 |  |
| RA4: CV, mean of negative changes from one day to next (fall rate) | 286.80 | 328.58 |  |
| RA5: Ratio of days that are higher than previous day | 0.37 | 0.31 |  |
| RA6: Median of difference in log of flows over two consecutive days of rising | 0.08 | 0.07 |  |
| RA7: Median of difference in log of flows over two consecutive days of falling | 0.06 | 0.05 |  |
| RA8: Number of flow reversals from one day to the next | 65.54 | 60.08 |  |
| RA9: CV, number of flow reversals from one day to the next | 24.18 | 23.00 |  |

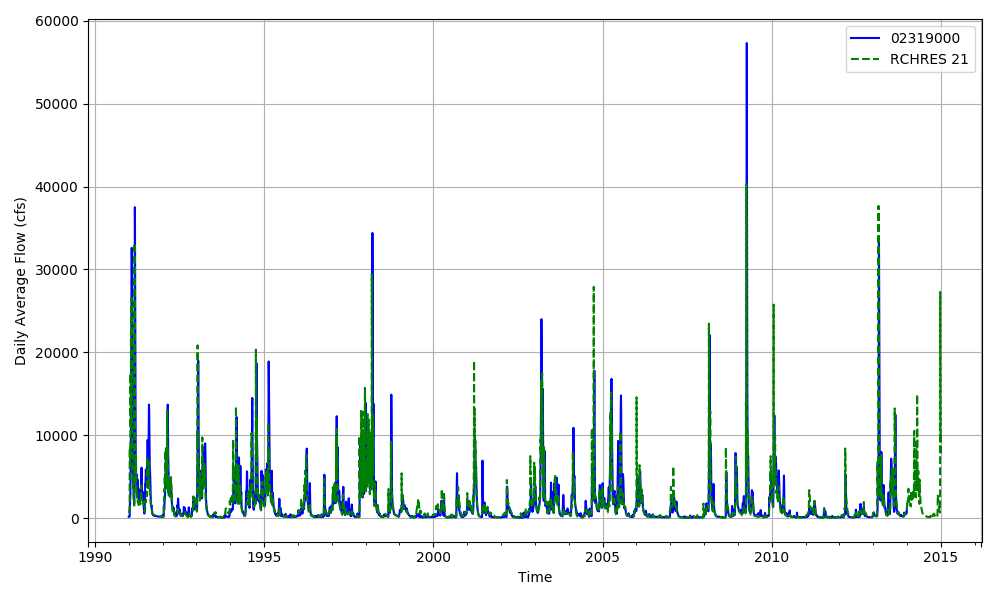


Figure 03110203-16: Daily flow for HSFP reach 21 and USGS station 02319000.

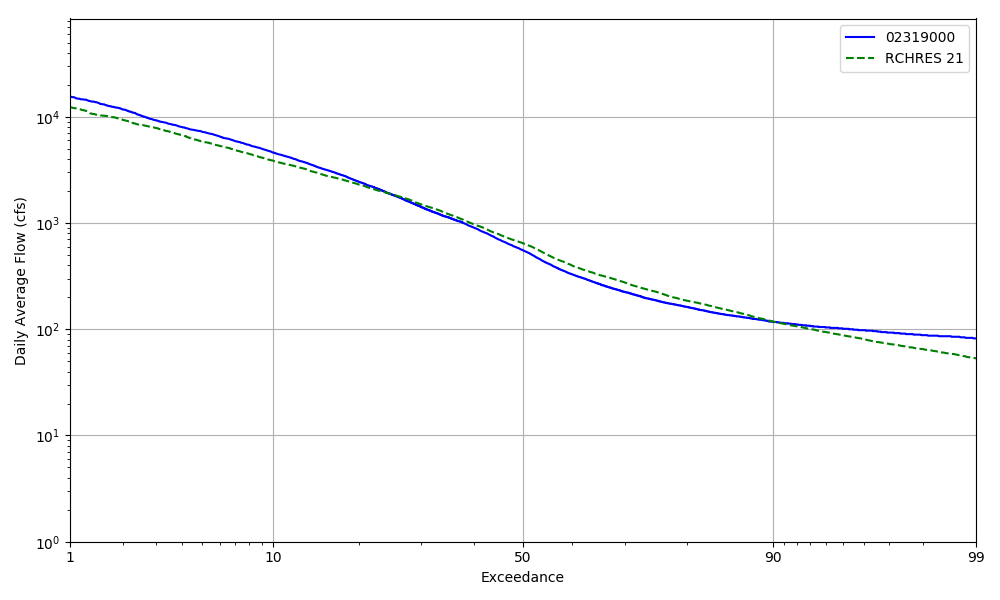


Figure 03110203-17: Daily exceedance for HSFP reach 21 and USGS station 02319000.

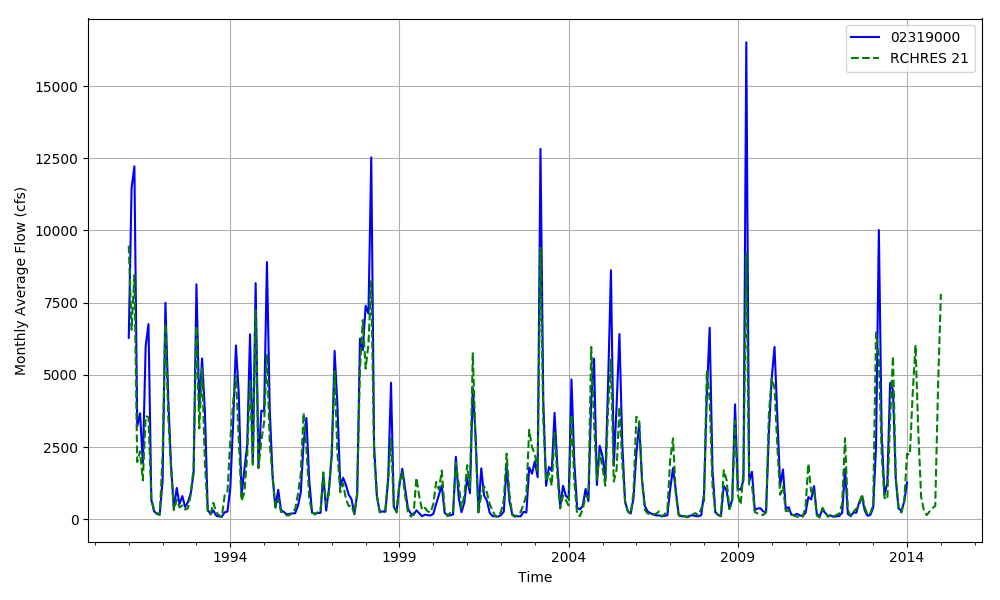


Figure 03110203-18: Monthly flow for HSFP reach 21 and USGS station 02319000.

## HSPF Reach 22, USGS Gauge 02319300

Table 03110203-11: Comparison Statistics Between HSPF Reach 22 and USGS Gauge 02319300.

|  |  |
| --- | --- |
| Statistic | Value |
| Bias | 25.43 |
| Standard error | 1142.12 |
| Relative bias | 0.02 |
| Relative standard error | 0.47 |
| Nash-Sutcliffe coefficient | 0.77 |
| Kling-Gupta coefficient | 0.70 |
| Coefficient of efficiency | 0.61 |
| Index of agreement | 0.79 |

Table 03110203-12: Hydrologic Indices Between USGS Gauge 02319300 and HSPF Reach 22.

|  |  |  |  |
| --- | --- | --- | --- |
| Hydrologic Index and description (Olden and Poff, 2003) | Observed 02319300 | Simulated Reach 22 | Percent Difference |
| MA1: Mean, all daily flows | 1454.18 | 1470.57 | 1.13 |
| MA2: Median, all daily flows | 375.00 | 596.55 | 59.08 |
| MA3: CV, all daily flows | 147.37 | 130.70 | -11.31 |
| MA4: CV, log of all daily flows | 139.56 | 112.05 | -19.71 |
| MA5: Mean daily flow / median daily flow | 3.88 | 2.47 | -36.43 |
| MA9: (Q10 - Q90) / median daily flow | 9.34 | 5.37 | -42.53 |
| MA10: (Q20 - Q80) / median daily flow | 5.41 | 3.04 | -43.91 |
| MA11: (Q25 - Q75) / median daily flow | 4.17 | 2.24 | -46.27 |
| MA12: Mean monthly flow, January | 1343.82 | 1830.67 | 36.23 |
| MA13: Mean monthly flow, February | 2028.44 | 2800.62 | 38.07 |
| MA14: Mean monthly flow, March | 3058.79 | 2661.45 | -12.99 |
| MA15: Mean monthly flow, April | 3530.22 | 2347.16 | -33.51 |
| MA16: Mean monthly flow, May | 713.06 | 735.87 | 3.20 |
| MA17: Mean monthly flow, June | 833.55 | 663.19 | -20.44 |
| MA18: Mean monthly flow, July | 1399.19 | 1121.54 | -19.84 |
| MA19: Mean monthly flow, August | 1005.61 | 1282.31 | 27.52 |
| MA20: Mean monthly flow, September | 577.31 | 728.23 | 26.14 |
| MA21: Mean monthly flow, October | 220.25 | 386.61 | 75.54 |
| MA22: Mean monthly flow, November | 364.39 | 519.00 | 42.43 |
| MA23: Mean monthly flow, December | 1096.41 | 1376.58 | 25.55 |
| ML1: Mean minimum monthly flow, January | 706.00 | 948.27 | 34.32 |
| ML2: Mean minimum monthly flow, February | 1011.44 | 1201.66 | 18.81 |
| ML3: Mean minimum monthly flow, March | 1261.89 | 1258.49 | -0.27 |
| ML4: Mean minimum monthly flow, April | 994.89 | 1028.02 | 3.33 |
| ML5: Mean minimum monthly flow, May | 406.56 | 435.25 | 7.06 |
| ML6: Mean minimum monthly flow, June | 300.78 | 366.18 | 21.75 |
| ML7: Mean minimum monthly flow, July | 480.00 | 574.79 | 19.75 |
| ML8: Mean minimum monthly flow, August | 412.11 | 617.66 | 49.88 |
| ML9: Mean minimum monthly flow, September | 281.00 | 475.62 | 69.26 |
| ML10: Mean minimum monthly flow, October | 135.11 | 298.45 | 120.89 |
| ML11: Mean minimum monthly flow, November | 252.00 | 385.53 | 52.99 |
| ML12: Mean minimum monthly flow, December | 475.00 | 583.06 | 22.75 |
| ML13: CV of minimum monthly flows | 135.73 | 92.33 | -31.97 |
| ML14: Mean minimum daily flow / mean median annual flow | 0.24 | 0.41 | 70.84 |
| ML15: Mean minimum annual flow / mean annual flow | 0.12 | 0.22 | 84.52 |
| ML16: Median minimum annual flow / median annual flow | 0.20 | 0.37 | 85.24 |
| ML20: Ratio of baseflow volume to total flow volume | 0.50 | 0.57 | 15.57 |
| ML22: Mean annual minimum flow divided by catchment area | 1.32 | 2.65 | 99.95 |
| RA1: Mean of positive changes from one day to next (rise rate) | 225.88 | 319.59 |  |
| RA2: CV, mean of positive changes from one day to next (rise rate) | 420.56 | 372.30 |  |
| RA3: Mean of negative changes from one day to next (fall rate) | 137.81 | 128.99 |  |
| RA4: CV, mean of negative changes from one day to next (fall rate) | 350.57 | 353.05 |  |
| RA5: Ratio of days that are higher than previous day | 0.36 | 0.29 |  |
| RA6: Median of difference in log of flows over two consecutive days of rising | 0.07 | 0.04 |  |
| RA7: Median of difference in log of flows over two consecutive days of falling | 0.06 | 0.03 |  |
| RA8: Number of flow reversals from one day to the next | 79.50 | 47.60 |  |
| RA9: CV, number of flow reversals from one day to the next | 49.01 | 27.70 |  |

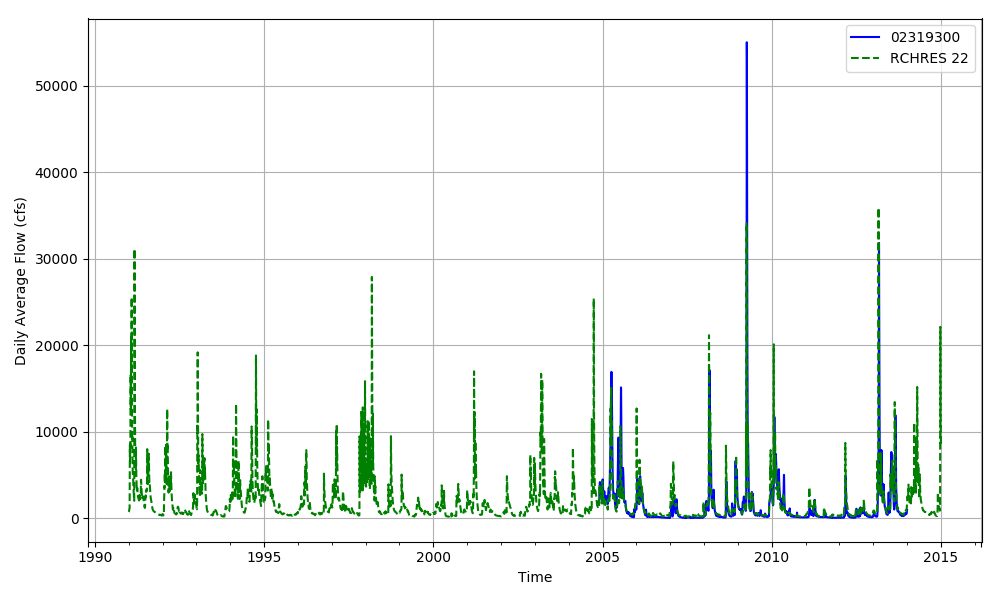


Figure 03110203-19: Daily flow for HSFP reach 22 and USGS station 02319300.

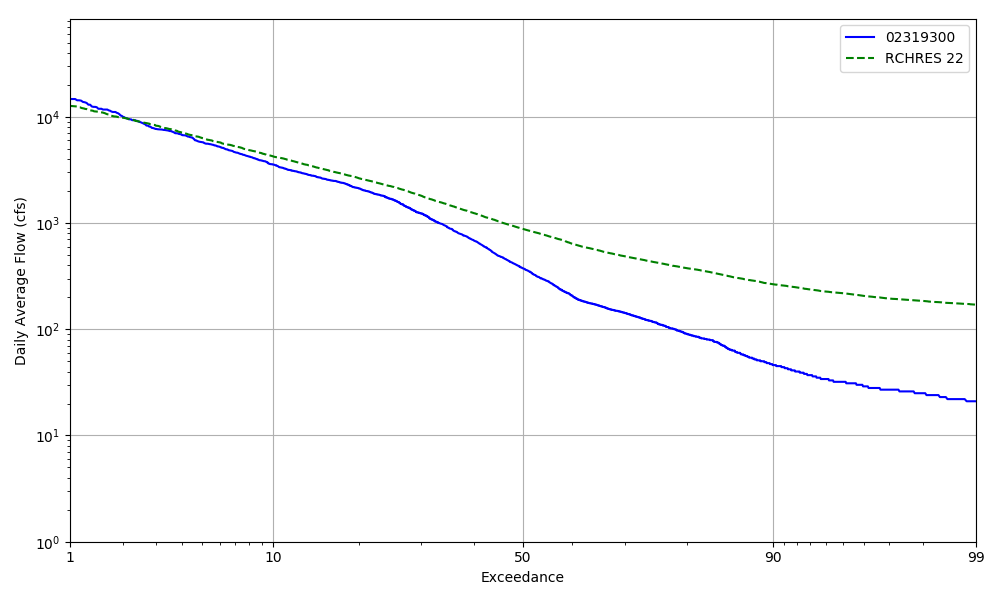


Figure 03110203-20: Daily exceedance for HSFP reach 22 and USGS station 02319300.

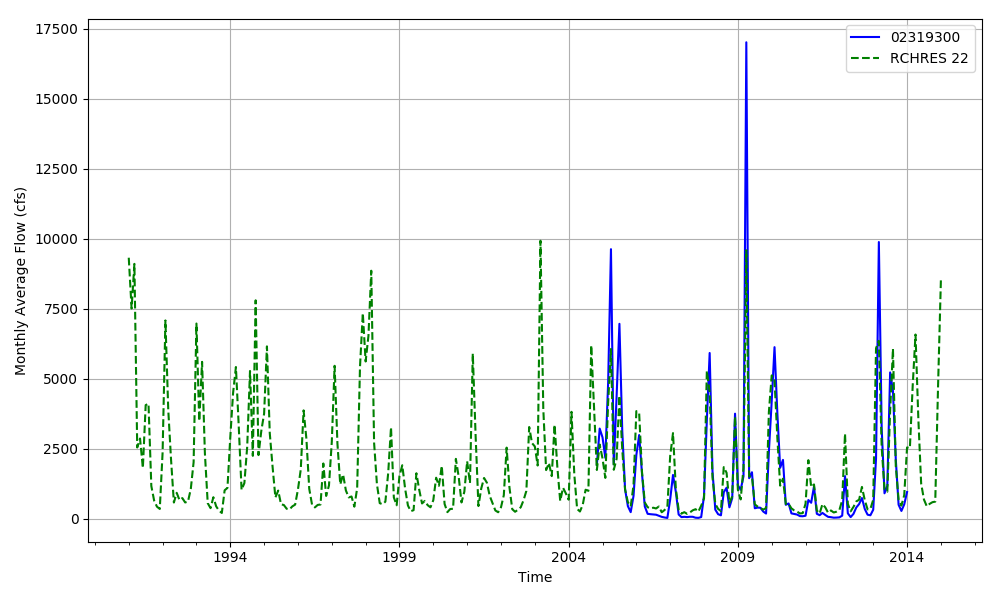


Figure 03110203-21: Monthly flow for HSFP reach 22 and USGS station 02319300.

## HSPF Reach 23, USGS Gauge 02319394

Table 03110203-13: Comparison Statistics Between HSPF Reach 23 and USGS Gauge 02319394.

|  |  |
| --- | --- |
| Statistic | Value |
| Bias | -210.67 |
| Standard error | 1104.47 |
| Relative bias | -0.11 |
| Relative standard error | 0.46 |
| Nash-Sutcliffe coefficient | 0.79 |
| Kling-Gupta coefficient | 0.73 |
| Coefficient of efficiency | 0.61 |
| Index of agreement | 0.79 |

Table 03110203-14: Hydrologic Indices Between USGS Gauge 02319394 and HSPF Reach 23.

|  |  |  |  |
| --- | --- | --- | --- |
| Hydrologic Index and description (Olden and Poff, 2003) | Observed 02319394 | Simulated Reach 23 | Percent Difference |
| MA1: Mean, all daily flows | 1900.13 | 1683.45 | -11.40 |
| MA2: Median, all daily flows | 943.00 | 932.73 | -1.09 |
| MA3: CV, all daily flows | 92.27 | 98.02 | 6.23 |
| MA4: CV, log of all daily flows | 101.33 | 95.71 | -5.55 |
| MA5: Mean daily flow / median daily flow | 2.01 | 1.80 | -10.43 |
| MA9: (Q10 - Q90) / median daily flow | 4.22 | 3.43 | -18.88 |
| MA10: (Q20 - Q80) / median daily flow | 2.41 | 2.03 | -15.85 |
| MA11: (Q25 - Q75) / median daily flow | 1.85 | 1.55 | -16.24 |
| MA12: Mean monthly flow, January | 1298.53 | 1431.62 | 10.25 |
| MA13: Mean monthly flow, February | 1816.69 | 1975.85 | 8.76 |
| MA14: Mean monthly flow, March | 3268.34 | 3129.99 | -4.23 |
| MA15: Mean monthly flow, April | 3511.79 | 2376.75 | -32.32 |
| MA16: Mean monthly flow, May | 1004.98 | 724.77 | -27.88 |
| MA17: Mean monthly flow, June | 1319.11 | 837.36 | -36.52 |
| MA18: Mean monthly flow, July | 1389.25 | 999.19 | -28.08 |
| MA19: Mean monthly flow, August | 1197.74 | 1114.62 | -6.94 |
| MA20: Mean monthly flow, September | 1149.64 | 1291.65 | 12.35 |
| MA21: Mean monthly flow, October | 888.41 | 795.48 | -10.46 |
| MA22: Mean monthly flow, November | 780.79 | 844.62 | 8.17 |
| MA23: Mean monthly flow, December | 1245.21 | 1206.23 | -3.13 |
| ML1: Mean minimum monthly flow, January | 948.80 | 990.36 | 4.38 |
| ML2: Mean minimum monthly flow, February | 1221.30 | 1099.88 | -9.94 |
| ML3: Mean minimum monthly flow, March | 1455.40 | 1340.92 | -7.87 |
| ML4: Mean minimum monthly flow, April | 1498.20 | 1118.52 | -25.34 |
| ML5: Mean minimum monthly flow, May | 794.40 | 552.16 | -30.49 |
| ML6: Mean minimum monthly flow, June | 671.20 | 542.00 | -19.25 |
| ML7: Mean minimum monthly flow, July | 920.20 | 786.44 | -14.54 |
| ML8: Mean minimum monthly flow, August | 883.30 | 802.84 | -9.11 |
| ML9: Mean minimum monthly flow, September | 673.20 | 683.75 | 1.57 |
| ML10: Mean minimum monthly flow, October | 655.67 | 644.31 | -1.73 |
| ML11: Mean minimum monthly flow, November | 663.50 | 689.91 | 3.98 |
| ML12: Mean minimum monthly flow, December | 820.30 | 876.67 | 6.87 |
| ML13: CV of minimum monthly flows | 85.95 | 78.87 | -8.24 |
| ML14: Mean minimum daily flow / mean median annual flow | 0.36 | 0.37 | 1.71 |
| ML15: Mean minimum annual flow / mean annual flow | 0.20 | 0.21 | 4.17 |
| ML16: Median minimum annual flow / median annual flow | 0.38 | 0.39 | 1.95 |
| ML20: Ratio of baseflow volume to total flow volume | 0.65 | 0.66 | 2.00 |
| ML22: Mean annual minimum flow divided by catchment area | 16669.59 | 16670.18 | 0.00 |
| RA1: Mean of positive changes from one day to next (rise rate) | 198.63 | 279.50 |  |
| RA2: CV, mean of positive changes from one day to next (rise rate) | 315.83 | 318.00 |  |
| RA3: Mean of negative changes from one day to next (fall rate) | 132.90 | 121.34 |  |
| RA4: CV, mean of negative changes from one day to next (fall rate) | 309.90 | 285.32 |  |
| RA5: Ratio of days that are higher than previous day | 0.39 | 0.30 |  |
| RA6: Median of difference in log of flows over two consecutive days of rising | 0.04 | 0.04 |  |
| RA7: Median of difference in log of flows over two consecutive days of falling | 0.04 | 0.03 |  |
| RA8: Number of flow reversals from one day to the next | 83.25 | 40.42 |  |
| RA9: CV, number of flow reversals from one day to the next | 60.18 | 48.52 |  |

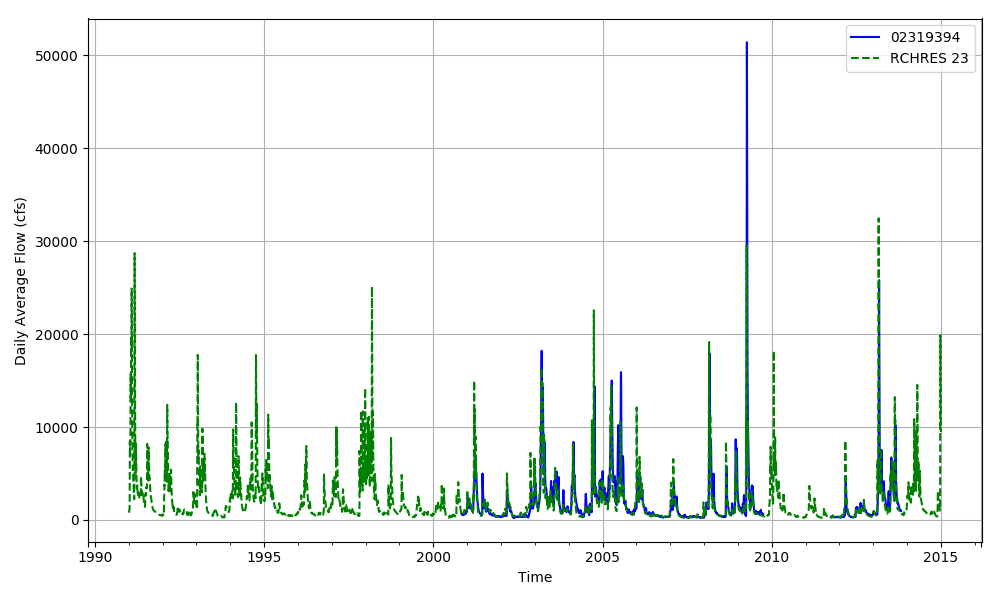


Figure 03110203-22: Daily flow for HSFP reach 23 and USGS station 02319394.

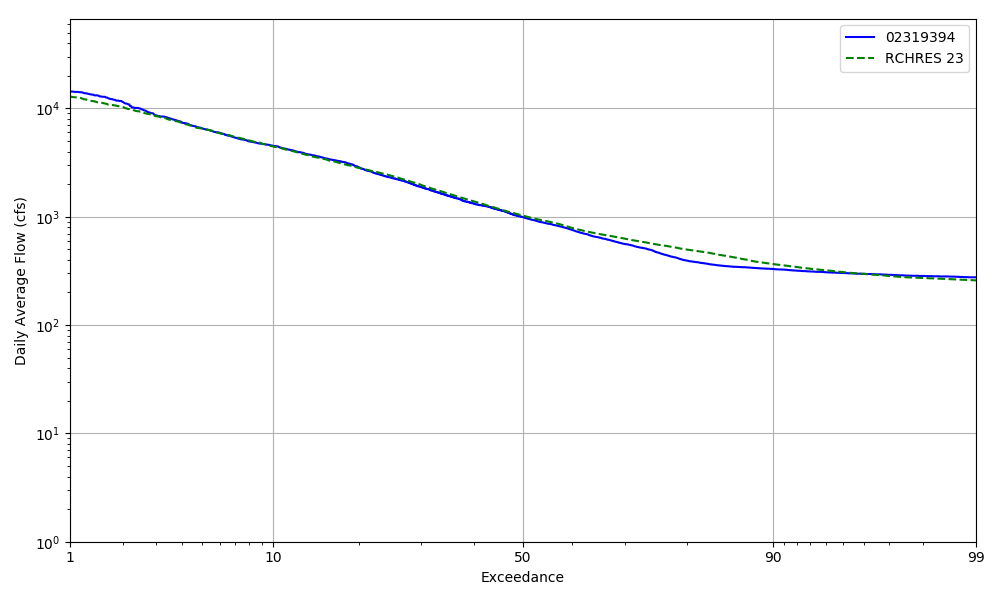


Figure 03110203-23: Daily exceedance for HSFP reach 23 and USGS station 02319394.

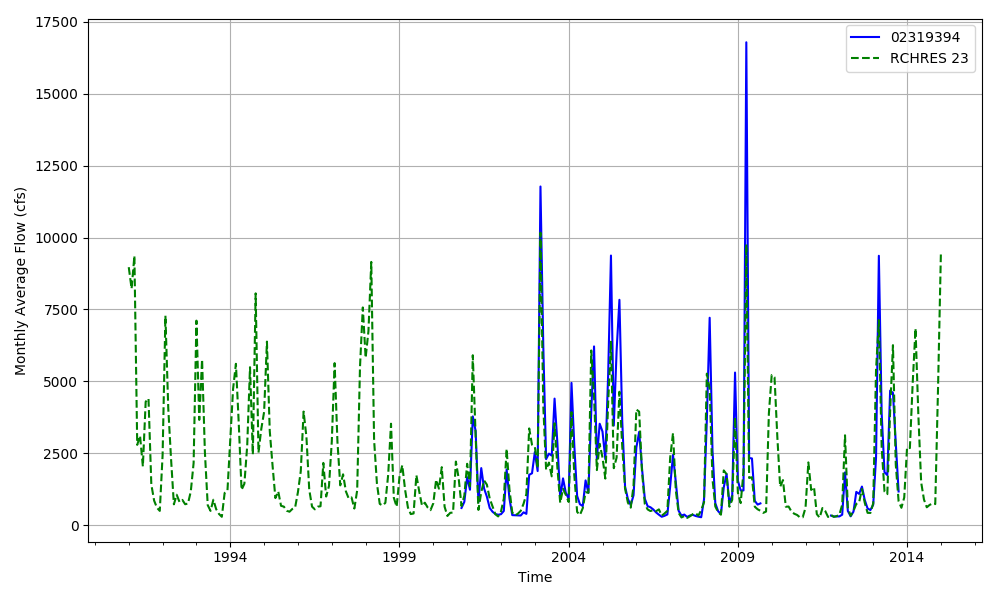


Figure 03110203-24: Monthly flow for HSFP reach 23 and USGS station 02319394.