Watershed Modeling Report

July 2017

***Appendix B** of the*
Little Bear Creek Basin Plan,
A Final Watershed-Scale Stormwater Plan
Prepared in Fulfillment of Special Condition
S5.C.5.c.vi of the Phase I Municipal
Stormwater Permit

Prepared for:
Snohomish County

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LITTLE BEAR CREEK BASIN PLAN

WATERSHED MODELING REPORT

Prepared for:

Snohomish County

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July 2017

NHC Ref. No. 2000498

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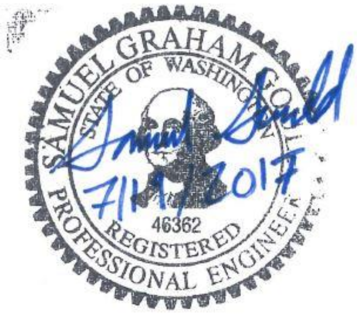

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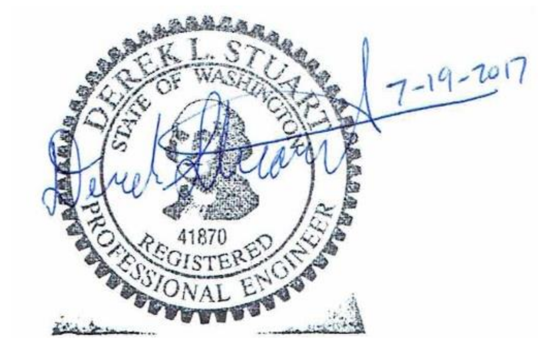

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1 INTRODUCTION

The Little Bear Creek system, in south Snohomish County (County), is an important resource for fish, recreation, and aesthetic enjoyment. Compared to other nearby Snohomish County watersheds undergoing urbanization, Little Bear has relatively good water quality and stream habitat conditions. However, land development over time has affected water quality and flow patterns in the watershed, and conditions may worsen with potential future development. Portions of the creek system are currently water quality impaired for bacteria, temperature, dissolved oxygen, and mercury (Howell Creek tributary only).

The Washington Department of Ecology (Ecology) approved the County's selection of a subset of Little Bear Creek to meet the watershed planning requirement under Special Condition S5.C.5.c of the County's National Pollutant Discharge Elimination System (NPDES) Phase I Permit (Permit). The project site and study area for the S5.C.5.c planning effort is the portion of Little Bear Creek in unincorporated Snohomish County. The objective of the watershed planning requirement is to:

> *Identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support "existing uses," and "designated uses," as those terms are defined in WAC 173-201A-020, throughout the stream system.* (NPDES Phase I permit, Section S5.C.5.c.)

This modeling report documents development and calibration of the HSPF hydrologic and water quality model of Little Bear Creek; simulation of existing, pre-development, and future build-out scenarios; and results of these scenarios relative to water quality standards and biological targets, fulfilling Permit requirement S5.C.5.c.iv(1).

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2 WATER QUALITY STANDARDS AND TARGETS

Special Condition S5.C.5.c of the Permit requires evaluation of water quality and aquatic health conditions for existing, historic (forested), and future build-out land use conditions compared to state standards using a continuous flow and water quality model.

2.1 Water Quality Standards

The State of Washington's water quality standards, listed in WAC section 173-201A, provide useful metrics by which to evaluate many of the individual water quality constituents of greatest concern within the Little Bear Creek watershed. The individual criteria vary depending on the designated uses for a receiving water but many standards are related to supporting salmonid fish uses (spawning, rearing, migration). Designated beneficial uses for Little Bear Creek are documented in the *Little Bear Creek Basin Planning Current Conditions Assessment* (Snohomish County, 2016).

Among the water quality parameters listed in Chapter 173-201A of the WAC, temperature, fecal coliform bacteria, dissolved copper, and dissolved zinc—listed in Table 1 below—are the constituents required for analysis under Special Condition S5.C.5.c. of the Permit and are the constituents targeted in this Basin Plan.

Table 1 Water Quality Standards for Permit-Mandated Constituents

Parameter	WAC Freshwater Water Quality Standard	Numeric Criteria
Fecal coliform Bacteria	173-201A-200 (2)(b)	Extraordinary Primary Contact: geometric mean value < 50 colonies /100 mL, with ≤ 10 % exceeding 100 colonies /100 mL
Temperature[1]	173-201A-200 (1)(c)	• Supplemental temperature criteria (Sept 15-May 15): maximum 7-day average of the daily maximum temperature (7DADMax) is 13°C (55.4°F) • Core Summer Salmonid Habitat criteria (June 15-Sept 14): maximum 7DADMax of 16°C (60.8°F) • Spawning, Rearing, Migration criteria (May 16-June 14): maximum 7DADMax of 17.5°C (63.5°F)
Dissolved Copper (Cu)	173-201A-240	Acute[2] $(0.960)(e^{(0.9422[\ln(\text{hardness})] - 1.464)})$ Chronic[3] $(0.960)(e^{(0.8545[\ln(\text{hardness})] - 1.465)})$
Dissolved Zinc (Zn)	173-201A-240	Acute[2] $(0.978)(e^{(0.8473[\ln(\text{hardness})] + 0.8604)})$ Chronic[3] $(0.986)(e^{(0.8473[\ln(\text{hardness})] + 0.7614)})$

[1]Temperature (7DADMax) not to exceed the maximum of the criteria or forested temperature plus 0.3°C at a probability frequency of more than once every ten years on average
[2] Acute criteria, 1-hour average concentration not to be exceeded more than once every three years on the average.
[3] Chronic criteria, 4-day average concentration not to be exceeded more than once every three years on the average.

2.2 B-IBI Targets

In addition to water quality conditions, the Permit requires assessment and projection of biological conditions (represented by the benthic index of biotic integrity, or B-IBI) based on relationships between B-IBI and hydrologic characteristics. Several regional studies (e.g. DeGasperi et al., 2009; King County, 2012; Horner, 2013; King County, 2015) have examined the relationship between hydrology, particularly flashiness of storm response, and B-IBI scores. It has thus been posited that correlations between hydrologic metrics and B-IBI scores based on observed data can be used to estimate biological response (which cannot be modeled) from hydrologic response (which can be modeled) for alternative watershed conditions. To meet the requirement of Permit Section 5.C.5.iv(4), the Little Bear Creek study used three selected hydrologic metrics to estimate B-IBI scores for future build out conditions and to analyze the effectiveness of stormwater management strategies in meeting flow-based B-IBI targets. The County evaluated the relationship between hydrologic metrics and B-IBI in a separate memo report (Snohomish County, 2017), that describes sampling locations and data. This memo is also included as Appendix G to the Little Bear Creek Watershed-scale Stormwater Plan.

The Little Bear Creek basin planning project used hydrologic metrics computed from simulated streamflows to estimate B-IBI scores at sites along Little Bear Creek for development and stormwater management scenarios. The study used linear regressions between selected flow metrics and B-IBI scores developed from regional studies and data. B-IBI scores in the Little Bear Creek watershed were significantly correlated with several hydrologic metrics previously identified at the regional scale (e.g. DeGasperi et al., 2009) for their correlation with the biological integrity of Puget Sound Lowland streams. Linear regression equations of long-term average B-IBI scores at ten mainstem Little Bear Creek locations on selected hydrologic metrics generally conformed with B-IBI regressions using data from 26 sites in the Lake Washington/Cedar/Sammamish watershed collected as part of the WRIA 8 Status and Trends report (King County, 2015).

Little Bear Creek B-IBI scores were best correlated with the average annual High Pulse Count (HPC), High Pulse Range (HPR), and Richards-Baker Index (RBI) metrics for the B-IBI data available (2002-2015). Annual values of these metrics, computed from model-simulated flows, and the flow-BIBI relationships established from the WRIA 8 dataset (King County, 2015) and specified in the equations below were used to estimate best-fit predictions of B-IBI for mainstem sites on Little Bear Creek. The estimate of an average B-IBI score for a given scenario is based on the arithmetic mean of B-IBI scores computed for each of the three flow metrics.

High Pulse Count: $BIBI = -1.63 \times HPC + 50.3\ (r = 0.87, r^2 = 0.75, p < 0.0001)$

High Pulse Range: $BIBI = -0.096 \times HPR + 50.9\ (r = 0.74, r^2 = 0.54, p < 0.0001)$

Richards-Baker Index: $BIBI = -59.3 \times RBI + 47.2\ (r = 0.87, r^2 = 0.75, p < 0.0001)$

B-IBI scores from Little Bear Creek tributaries were not well-correlated with the regional data and regressions, suggesting that factors other than hydrology may play a larger role in biological conditions on these smaller streams. For this reason, hydrologically-based estimates of B-IBI were computed only for mainstem analysis points. Hydrologic metric and B-IBI correlations and analysis associated with the Little Bear Creek basin planning study are documented further in correspondence between Snohomish County and Ecology (Snohomish County, 2017).

Washington State does not currently have a standard for biological conditions as represented by B-IBI. For the purposes of watershed planning, Ecology (2016) recommended that the target B-IBI score be the lower of:

- 38, or
- 90% of the forested conditions B-IBI score.

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3 HSPF MODEL DEVELOPMENT

Hydrologic Simulation Program Fortran (HSPF, version 12.4[1]) was selected for flow and water quality modeling for the Little Bear Creek basin planning study. HSPF is a continuous simulation model developed by the U.S. EPA and is the accepted standard hydrologic model for stormwater analysis in western Washington.

The Little Bear Creek study area (Figure 1) drains 13.6 square miles (8,710 acres) of mixed rural, residential, and commercial land use. From its headwaters near 156th Street SE, the mainstem of Little Bear Creek flows predominantly north to south to the King County line at 244th Street SE. Five major (named) tributaries contribute to Little Bear Creek, adding drainage area from east and west of the Little Bear Creek valley. From upstream to downstream, those are Trout Creek, West Trib, Great Dane Creek, Cutthroat Creek, and Rowlands Creek. Drainage areas for these tributaries, as well as major segments of the Little Bear mainstem, are summarized in Table 2. These nine subbasins comprise the primary analysis units for the Little Bear Creek Basin Plan. Modeling was performed at a smaller catchment scale to better capture local conditions and drainage networks with each subbasin, as described in the following sections. Catchment level results were then aggregated to the subbasin level corresponding to the major tributaries and regions of the Little Bear Creek study area. Model ID numbers included in Table 2 refer to the downstream reach number in each subbasin (see Section 3.7 and Figure 15).

[1] A modified version of HSPF 12.4 was provided by AquaTerra in 2016 for this project to fix a bug in the water quality routine used to simulate metals. This correction is not currently available in the publicly distributed version of HSPF.

Table 2 Major Drainage Basins in the Little Bear Creek Watershed

Drainage Basin	Model ID	Area (acres)
Little Bear Upper (Upstream of Trout Cr)	R900	1,275
Trout Creek	R800	608
West Trib	R700	432
Little Bear Middle (Trout Cr to Great Dane Cr)	R600	2,087
Great Dane Creek	R500	1,481
Cutthroat Creek	R400	755
Little Bear Lower 228th (Great Dane Cr to 228th St)	R300	586
Rowlands Creek	R200	374
Little Bear Lower CL (228th St to County Line)	R100	1,111

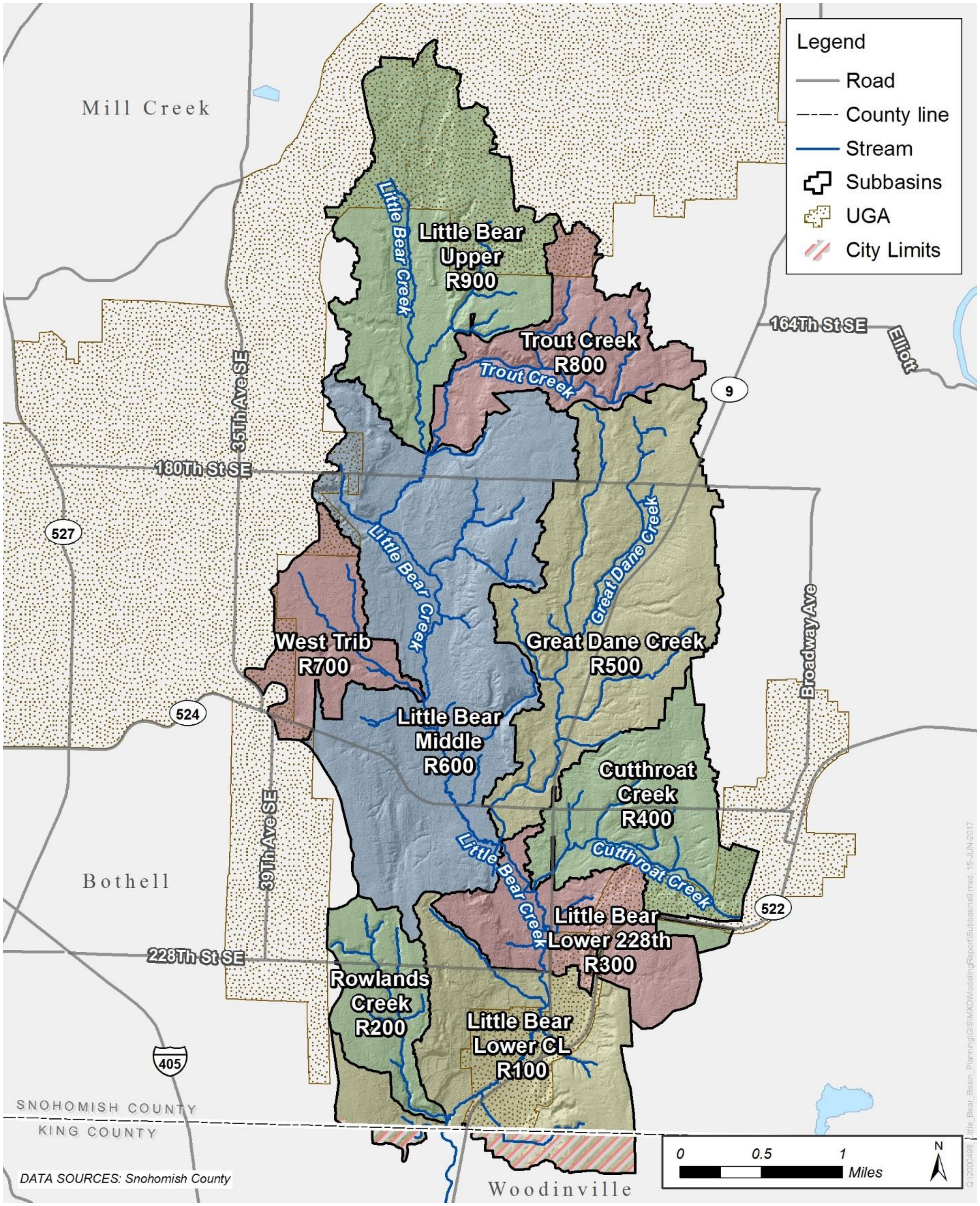

Figure 1 Little Bear Creek Study Area Basin. Diagonal hatched areas within city limits are included in study area basin but not study area.

3.1 Catchment Delineation

HSPF model catchments were delineated to major stormwater facilities, flow and water quality monitoring locations, major road crossings, and confluences of Little Bear Creek and major tributaries. For the existing conditions model, 222 catchments were delineated based on Puget Sound LiDAR Consortium's 2010 composite LiDAR surface and storm drainage network data provided by Snohomish County. Due to the large number of catchments and limitations on the number of operations (e.g. PERLNDs, IMPLNDs, RCHRESs, BMPRACs) that can be used in a single HSPF model, the model for the Little Creek study area basin was divided into an upper and lower model as shown in Figure 2.

3.2 Precipitation Inputs

Figure 3 shows the locations of precipitation gaging stations in and around the Little Bear Creek basin. Snohomish County has been collecting precipitation data at the Silver Lake Water District Office (Silver Lake) continuously since the late 1980s, the longest record in the area. Several other stations operated by Snohomish and King Counties have periods of record ranging from about seven to twenty years, as summarized in Table 3. A precipitation gage at 180th Street and Interurban was installed in 2014 by Snohomish County for purposes of the Little Bear Creek basin planning study.

Table 3 Precipitation Stations Near Little Bear Creek

Station Name	Agency	Available Timestep	Period of Record
Silver Lake	Snohomish Co	15-minute	11/1987 - present
Willis Tucker Park	Snohomish Co	1-hour	2/2008 – present
180th at Interurban	Snohomish Co	15-minute	7/2014 – present
Brightwater (BW_rain)	King Co	15-minute	10/2005 – present
Little Bear I&I (BEAR)	King Co	15-minute	10/2000 - present
Cottage Lake (02w)	King Co	15-minute	11/1992 – present
North Creek Maltby I&I (MNCR)	King Co	15-minute	10/2000 – present
Bothell I&I (BOTH)	King Co	15-minute	10/2001 – present
Martha Lake I&I (MCSN)	King Co	15-minute	11/2000 - present

Regional mapping of annual precipitation normals (PRISM, 2015) shows a west-to-east increasing precipitation gradient across the Little Bear Creek basin, with annual precipitation increasing by about 10 percent across the watershed (from 41 inches to 45 inches). However, a distinct gradient is not apparent from analyzing individual gage records in the area. Figure 4 shows a scatter plot of daily rainfall for various gages versus daily rainfall at Silver Lake, where the County has a long-term record. Points for all gages fall close to the one-to-one line (red line in figure). Linear trend lines for the individual gages (not shown) suggest that other gages come in slightly lower than Silver Lake—counter to the regional mapping—though within a couple percent.

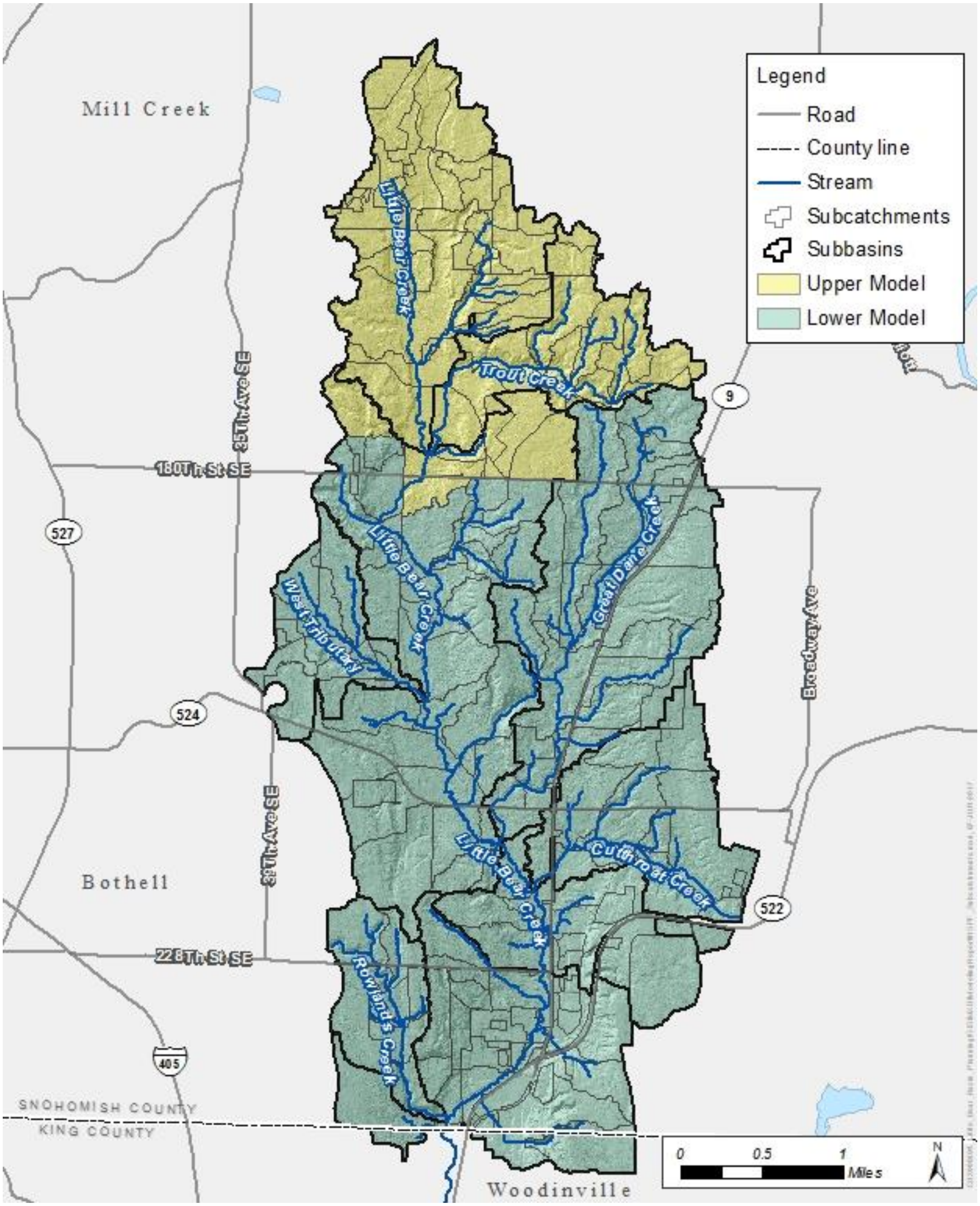

Figure 2 HSPF Model Areas

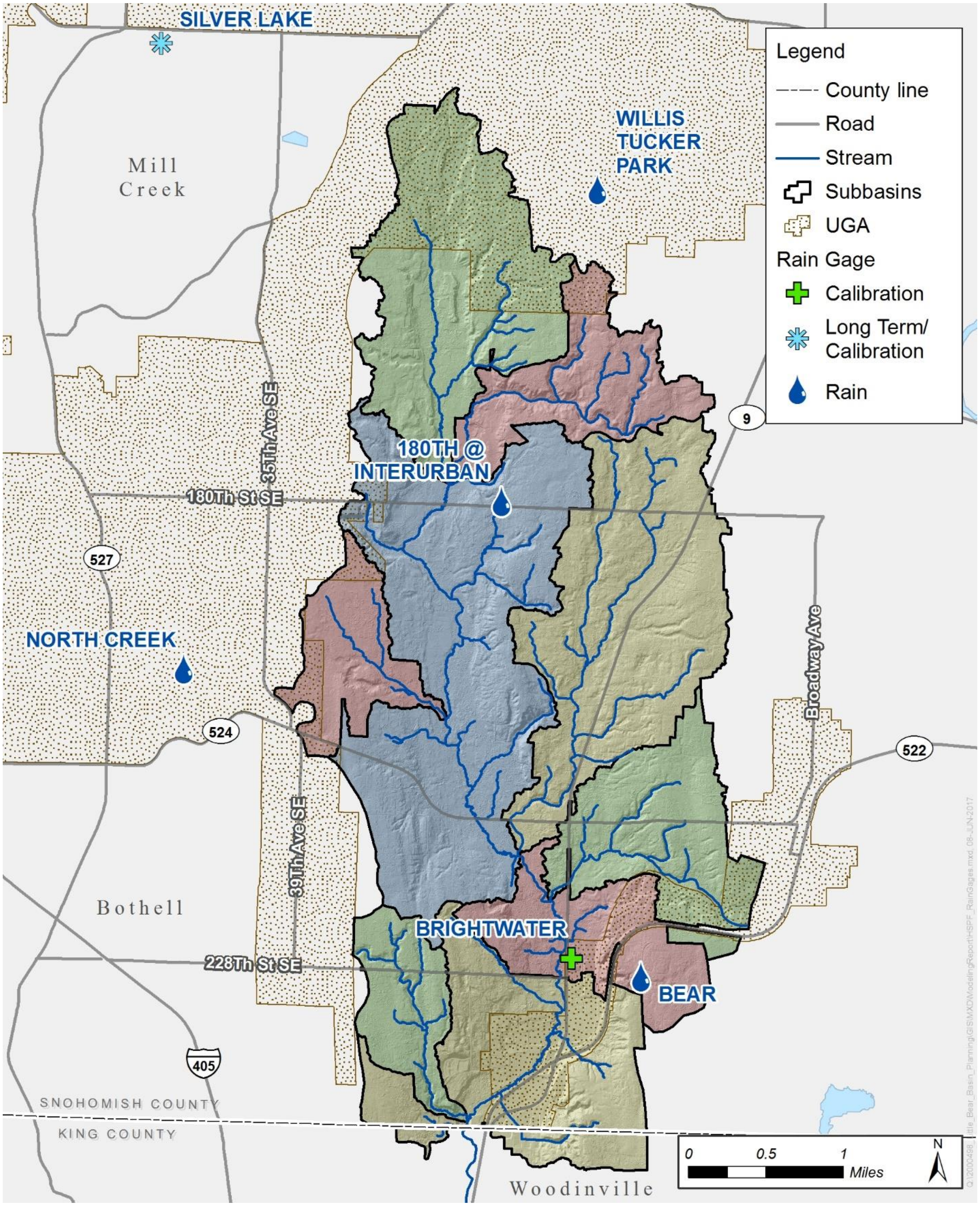

**Figure 3	Rain Gages in Little Bear Creek Vicinity**

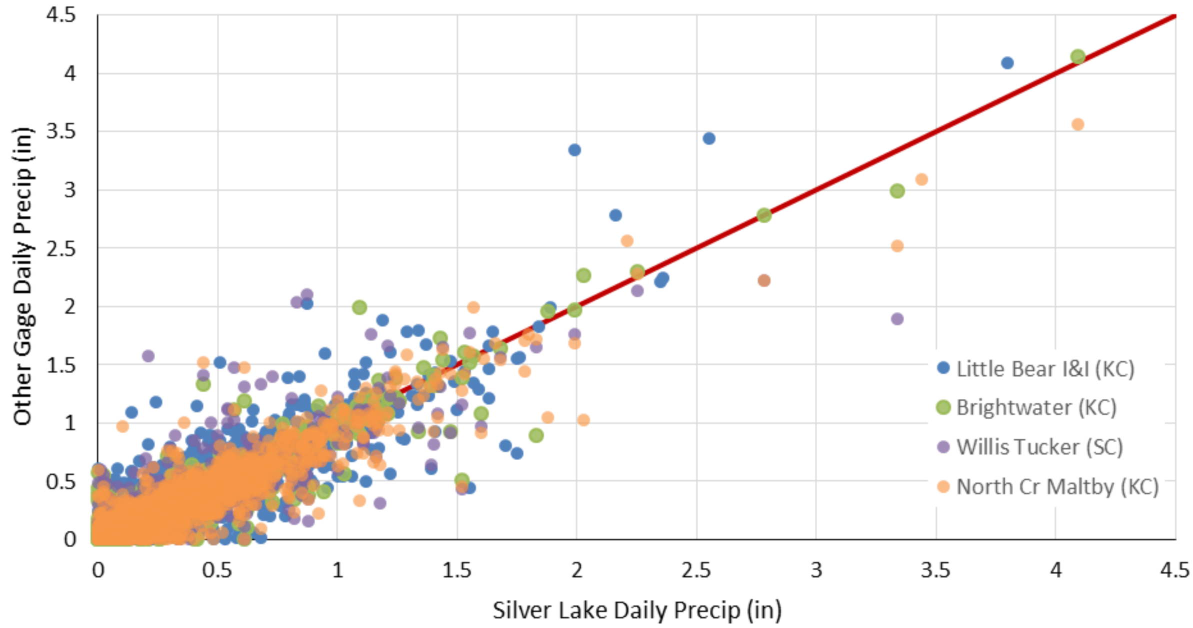

Figure 4 Daily Precipitation Comparison of Little Bear Area Gages to Silver Lake

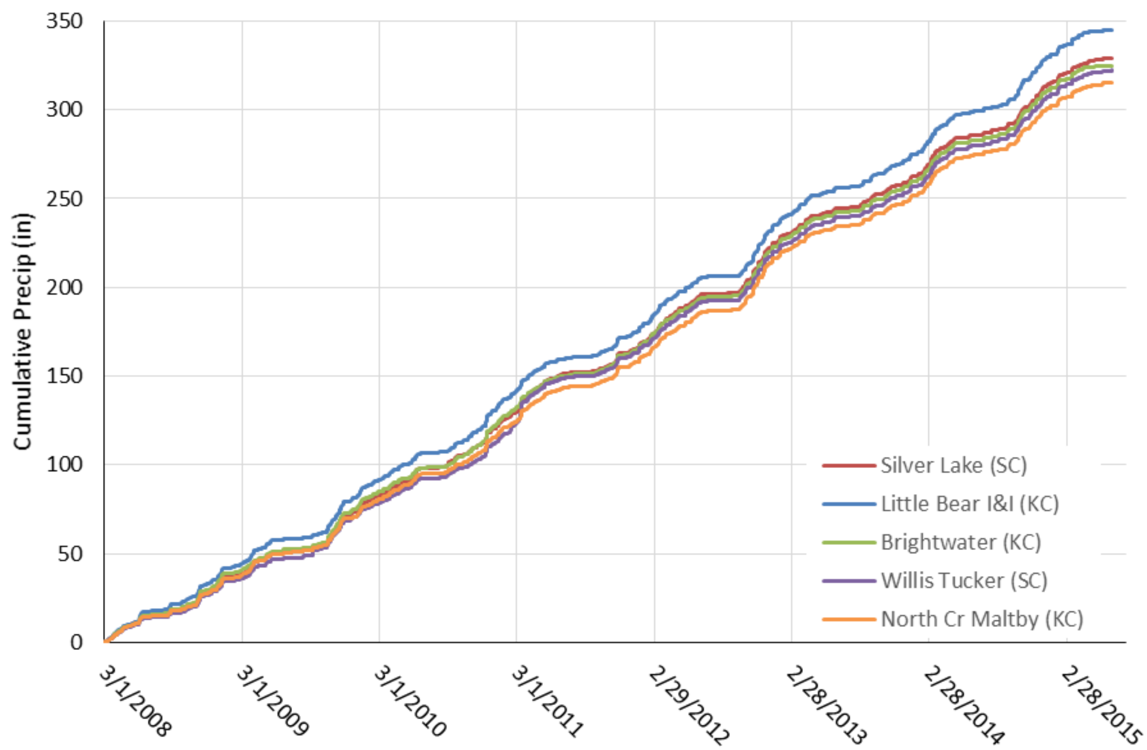

Figure 5 Cumulative Precipitation (2008-2015) for Little Bear Area Precipitation Gages

Figure 5 shows a cumulative precipitation plot for the same gages for the period from March 2008 through June 2015, when data for all five gages were available. The cumulative plot shows all but the Little Bear I&I gage tracking quite consistently; North Creek Maltby drops lower in spring 2011 but then resumes a consistent trajectory with the other three gages. The Little Bear I&I gage totals are distinctly higher than the other gages, including Brightwater, which is located within half a mile. It is not clear why cumulative totals are higher at this site, but the result seems to be an anomaly given the otherwise fairly consistent totals in the area and the close day-to-day tracking with Silver Lake seen in Figure 4. Based on analysis of area gages, precipitation appears to be fairly consistent over the Little Bear watershed, though spatial patterns for individual storms vary. For this reason, distinct rainfall zones were not defined for the Little Bear Creek HSPF model.

3.3 Meteorological Data

In addition to rainfall, the following meteorological parameters are needed for the simulation of temperature within HSPF.

- Air Temperature
- Dew Point Temperature
- Cloud Cover
- Solar Radiation
- Wind Speed

With the exception of pan evaporation and solar radiation, time series for all of these parameters were developed using National Weather Service data from Snohomish County Airport (Paine Field), Seattle Naval Air Station (Sand Point), Seattle Tacoma International Airport (SeaTac), Boeing Field and Olympia Airport. The period of record for each of these locations is shown in Table 4. The data sources for each meteorological parameter are summarized in Table 5, and locations are shown in Figure 6.

Table 4 Meteorological Stations

Name	ISD Station ID	Period of Record
Snohomish County Airport	727937 24222	1/1/2006 – Present
	727937 99999	10/1/1941 – 12/31/2005
WSFO Seattle Sand Point	999999 94290	1/1/2005 – Present
Seattle NAS	999999 24244	3/1/1945 – 6/1/1970
Seattle Tacoma International Airport	727930 24233	1/1/1948 – Present
Boeing Field	727935 24234	10/1/1943 – Present
Olympia Airport	727920 24227	1/1/1973 – Present

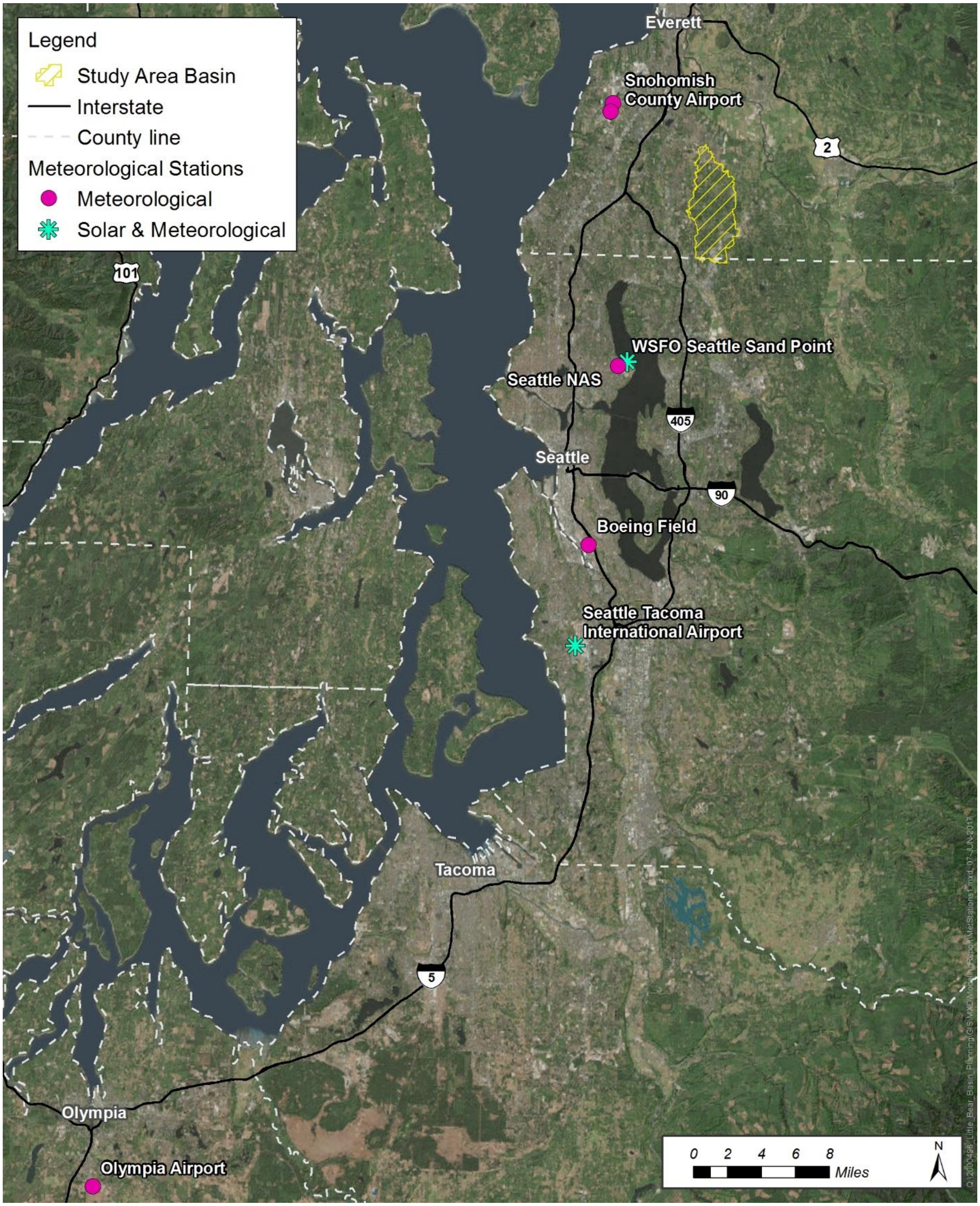

Figure 6 Meteorological Data Source Locations

Table 5 Meteorological Data Sources

Name	Air Temperature	Dew Point	Cloud Cover	Wind Speed
Snohomish County Airport	1950 -2016	2005-2016	2005-2012	1998-2016
WSFO Seattle Sand Point	Gaps > 4 hours			
Seattle NAS		1950-1970	1950-1970	1950-1970
Seattle Tacoma International Airport	Gaps > 4 hours	1970-2005	1970-2005 2012-2016	1970-1998
Boeing Field			Gaps in 2015	
Olympia Airport			Gaps in 2015	

Daily pan evaporation data were obtained from the Puyallup pan evaporation station, with winter months filled using the Jensen-Haise equation. The station operated from water year 1960 through 1997; monthly average values from the observed period of record were applied for water year 1950 through 1959 and 1998 through 2016 to extend the record to the period needed for the hydrologic modeling.

The primary data source for cloud cover was SeaTac. Cloud cover was only available from Snohomish County Airport from 2005 to 2016. However, the cloud cover from the Snohomish County Airport and nearby stations never exceeded 50 percent from 2013 to 2016 so these data were not used (NOAA was contacted, but has not yet corrected the data). Gaps in the SeaTac data in 2015 were filled using cloud cover data from Olympia Airport and Boeing Field. All remaining gaps were filled using linear interpolation.

Solar radiation data used in the HSPF model came from three different sources:

- observed hourly solar radiation data from Sand Point collected as part of the Integrated Surface Irradiance Study (ISIS) was acquired for the period of April, 1995 through December 31, 2015
- observed hourly solar radiation data from SeaTac from 1970 through 1990
- calculated hourly solar radiation data for SeaTac available from BASINS from 1990 through March 1995 and prior to 1970.

The calculated data estimates hourly solar radiation using the potential radiation based on the longitude and latitude of the study area and losses related to cloud cover.

The primary source for air temperature was Snohomish County Airport. This data set is available from 1950. Gaps longer than four hours were filled using air temperature data available from Sand Point and SeaTac. The dew point time series was assembled using data from Snohomish County Airport, SeaTac, and Sand Point:

- Paine Field December 2005 – 2016
- SeaTac June 1970 – December 2005
- Sand Point December 1950 – May 1970

For both temperature and dew point gaps smaller than four hours were filled using linear interpolation.

The primary source for wind speed data was SeaTac airport. SeaTac data were used from 1950 to 1998. Data from Snohomish County Airport are available from 1974 to present. However, only data after 1998 were used from Snohomish County Airport due to unreasonably high average wind speeds recorded from 1974 through 1998. Wind speed gaps smaller than four hours were filled using linear interpolation.

3.4 Monitoring Data

Flow and water quality data are required to calibrate an HSPF hydrology/water quality model. Long-term water quality monitoring data are important given the statistical nature of water quality calibration. Shorter term project-specific data were also used to allow the model to be calibrated to individual events, increasing the confidence in the model's ability to reproduce conditions over a range of flow levels and storm events.

3.4.1 Flow

There are two Snohomish County sites within the study area with extended flow data records. Snohomish County sites LBLU (at 51st Avenue SE) and LBLD (at 228th Street SE) have reported flow data from 1999 to the present and were the primary flow data sources for calibration of the hydrologic model. The flow monitoring sites used for calibration are presented in Figure 7 and their period of record are given in Table 6.

Supplemental flow data were collected by CardnoTEC at DANE, LBBW, and LB58[2] for the period July 2014 through December 2015. Given the short period of record, limited number of points on the rating curves, and inconsistencies with the longer term sites, data from these sites were not used as primary sources for flow calibration. The observed volumes from October 2014 through March 2015 at LBBW and LB58 were 30 percent and 5 percent lower, respectively, than observed volume at the long-term Snohomish County flow gage at 228th Street SE. Given the very similar drainage areas for LBBW and 228th and the increase in drainage area between 228th Street and LB58, the smaller volumes at the supplemental gage locations do not make sense in the context of the longer record and suggest potential issues with the flow time series developed for these locations. At the DANE location, there was not a long-term flow record for comparison. The DANE data were compared to the simulated flows but were not used as primary calibration data, as discussed in Section 4.1.

King County has operated four stream gages on Little Bear Creek for various periods of time. The only gage currently operating is 30AN, which was installed at NE 195th Street (downstream of the study area) in May 2013. King County gage LBCC was operated at the mouth of Little Bear Creek from 2000 through 2008. Two additional sites, 30B and 30C, were monitored by King County in 2003-2004 and 2004-2005, respectively, to support the Brightwater Environmental Impact Statement (EIS). None of the King County sites were used for model calibration.

[2] The DANE and LB58 flow data sites correspond with Great Dane Cr @ Maltby Rd and LBCR @ 58th temperature sites shown in Figure 7.

3.4.2 Water Quality Constituents

The current study requires water quality data for the following four constituents:

- Fecal coliform bacteria
- Dissolved copper (Cu)
- Dissolved zinc (Zn)
- Temperature

In order to simulate these constituents in HSPF, simulation of total suspended solids (TSS), total copper, and total zinc is also required.

These constituents have been sampled under long-term ambient monitoring programs and short-term studies conducted by Snohomish County and King County. Ambient monitoring programs have collected samples at monthly intervals at four sites (LBHW, LBLU, and LBLD, and O478 [King County]). Ambient monitoring of metals ceased at all sites in January 2010. In addition to ambient monitoring, short-term studies included the SWAMP assessment (King County, 2003), the 2005 fecal coliform TMDL (Ecology, 2005), the Brightwater Treatment Plant EIS (King County, 2005), and the monitoring effort performed for this study (CardnoTEC, 2015).

Given the statistical nature of water quality model calibration, most water quality constituents were primarily calibrated at mainstem sites LBLU where both short-term project data and long-term ambient data were available, LBBW where short-term project data were available, and LBLD where long-term ambient data were available. Based on County review of the data showing inconsistencies in some periods and data sets, not all of the available monitoring data were used. Temperature calibration was limited to the two years of project data (CardnoTEC, 2015) due to changes in data collection protocols between the long-term (at LBLU and LBLD) and project temperature monitoring and the County's greater confidence in the methods used to collect the project data. Ambient copper data were not used in calibration based on the County's greater confidence in the more recent short-term project data. Zinc project data (CardnoTEC, 2015) were not used for calibration based on the lack of correlation with TSS as discussed in section 3.6. Due to changes in data review and QA/QC processes, and for consistency with current processes, only ambient zinc data collected since 2000 were used for calibration. Similarly, only the last ten years of ambient fecal coliform data were used for calibration. The periods of record used for calibration are listed in Table 6, and the water quality monitoring sites used for calibration are shown in Figure 7.

Table 6 Period of Record for Flow and Water Quality Sites Used For Model Calibration

Site Name	Constituents	Period of Record Used For Calibration	Monitoring Type
51st/LBLU	Flow	2004-2015	SWM Long Term
	Temperature	2014-2015[1]	Project Data
	TSS	2000-2009[2]	KC Ambient
		2014-2015	Project Data
	Copper	2014-2015	Project Data[3]
	Zinc	2000-2010[4]	KC Ambient
		2014-2015	Project Data
	Hardness	2014-2015	Project Data
	Fecal Coliform	2006-2015[5]	KC Ambient
		2014-2015	Project Data
LBBW	Temperature	2014-2015	Project Data
	TSS	2014-2015	Project Data
	Copper	2014-2015	Project Data[3]
	Zinc	2014-2015	Project Data
	Hardness	2014-2015	Project Data
	Fecal Coliform	2014-2015	Project Data
228th/LBLD[1]	Flow	2002-2015	SWM Long Term
	TSS	2000-2009[2]	KC Ambient
	Zinc	2000-2015	KC Ambient
	Fecal Coliform	2006-2015[5]	KC Ambient
LBCR @ Interurban	Temperature	2014-2015	Project Data
Trout Cr	Temperature	2014-2015	Project Data
Great Dane Cr @ Hwy 9	Temperature	2014-2015	Project Data
Great Dane Cr @ Maltby Rd	Temperature	2014-2015	Project Data
Cutthroat Cr	Temperature	2014-2015	Project Data
LBCR @ 58th	Temperature	2014-2015	Project Data

[1] Ambient temperature data not used due to inconsistencies with project data
[2] Ambient TSS data not used prior to 2000
[3] Ambient copper data not used
[4] Ambient zinc data prior to 2000 not used
[5] Ambient fecal coliform data prior to 2006 not used

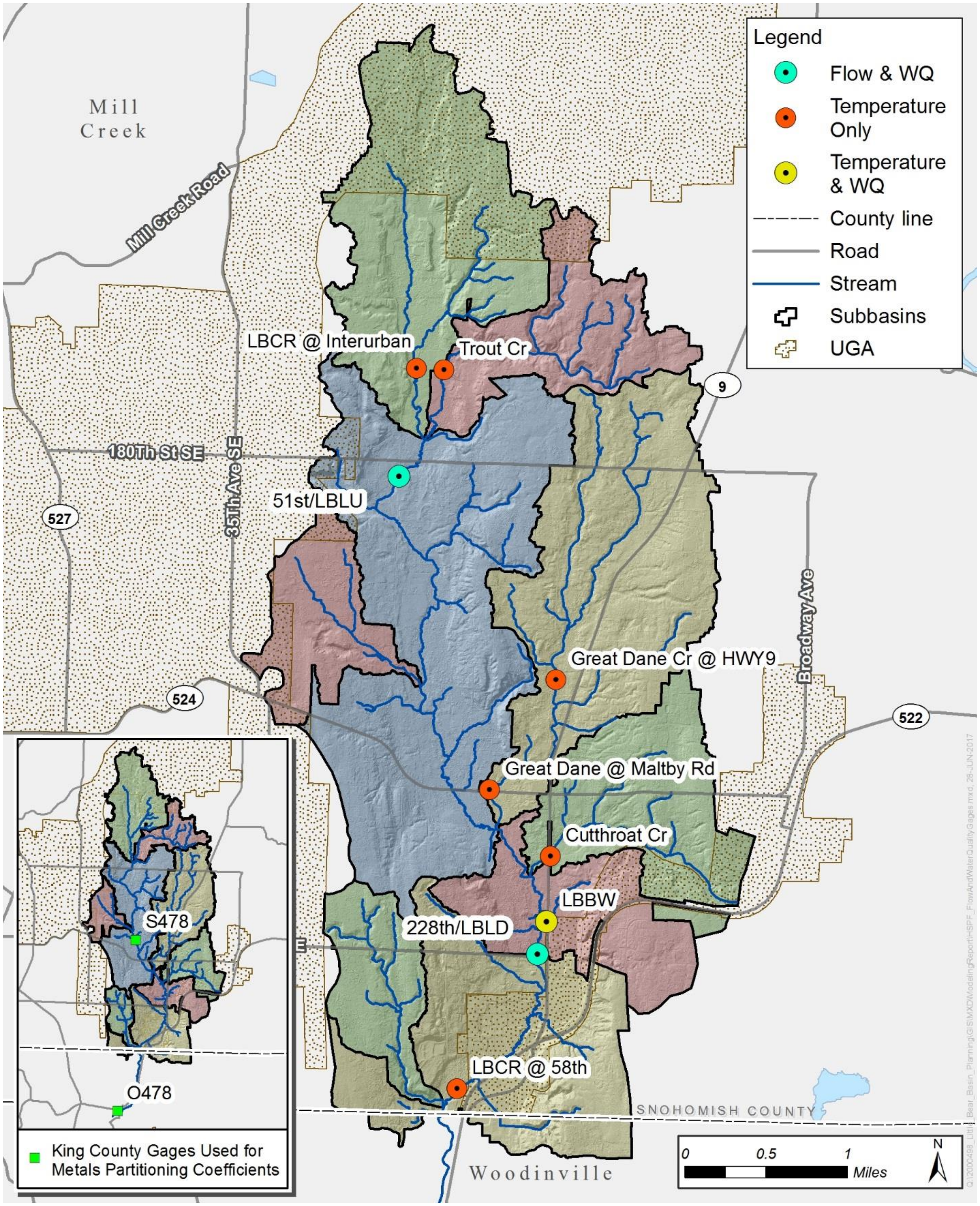

Figure 7 Flow and water quality sites used for calibration

3.5 Land Surface Segmentation

Definition of HSPF PERLND and IMPLND areas is more complex for water quality modeling than the approach historically used by the County for flow modeling only. For purposes of water quality modeling, the County's four standard cover categories (forest, pasture, grass, effective impervious) were expanded to 55 unique response units to characterize land uses (associated with different water quality constituent loadings) in addition to cover. The PERLND and IMPLND categories included in the Little Bear Creek HSPF model are listed in Table 7.

To facilitate efficient modification and development of alternative scenarios (e.g. future land use), NHC developed a pre-processing tool to largely automate processing GIS data (subbasins, soils, land cover, land use, slope, precipitation, etc.) into an HSPF SCHEMATIC block (i.e. PERLND/IMPLND areas). This program, referred to as the Schematic Tool, was based on the County's current Python-based scripts, but was updated to allow for the use of additional input data.

The existing land use and land cover conditions for the Little Bear study area basin were defined using a combination of existing conditions land use data and remotely-sensed land cover data. This is a significant departure from the Snohomish County Drainage Needs Reports *Hydrologic Modeling Protocols* (Snohomish County, 2001) that assigned land cover fractions strictly based on land use category. The new method uses a 1-meter resolution raster dataset that defines pasture, grass, forest, water, bare earth, and impervious land covers (Snohomish County, 2015d). The associated land use category[3] and factors such as age of development and location (e.g. UGA/non-UGA) were used to define the *effective* impervious fraction for impervious land cover. Initial values for effective impervious fraction were taken from EIA tables 1 and 2 of the *Hydrologic Modeling Protocols*, distributed as shown in Figure 8. Effective fractions were adjusted during model calibration, though distinctions related to relative age and density were preserved.

In areas designated as wetlands according to the Snohomish County GIS, the wetland PERLND overrides soils and land use mapping, with land cover defined from the remotely-sensed data as described above. Land cover, land use, soils/geology and wetland spatial datasets were rasterized and overlain using the HSPF Schematic Tool to assign HSPF PERLNDs or IMPLNDs to each eight-foot grid cell. The tool then aggregated the individual PERLND and IMPLND areas in each catchment to produce the runoff portion of the HSFP SCHEMATIC block.

In addition to creating distinct PERLNDs based on land use and land cover, slope categories were defined in areas with till soils. In NHC's experience, distinct runoff response attributable to land surface slope is not known well enough to warrant the use of slope to distinguish additional PERLNDs. However, to be consistent with the existing hydrology modeling protocols and previous regional studies (e.g. King County, 2003), slope distinctions were maintained. One of three slope categories—flat (less than 6 percent), moderate (6 to 15 percent) and steep (greater than 15 percent)—was assigned to each grid

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[3] The County's land use dataset includes: Rural Residential, SFR-LOW, SFR-MED, SFR-HIGH, Multifamily Residential (MFR), Commercial, Transportation, Forest, Pasture, and Grass.

cell using a slope layer created by the County from a six-foot LiDAR DEM obtained from the Puget Sound LiDAR Consortium.

Table 7 Hydrologic Response Units

ID	Soil Type	Land Use Type	County Use Code[1]	Land Cover	Slope	Comments
PERLNDs						
12	Till	Rural Forest	Forest	Forest	Flat	
13			Forest	Forest	Moderate	
14			Forest	Forest	Steep	
32		Urban Forest	Any except Forest	Forest	Flat	
33			Any except Forest	Forest	Moderate	
34			Any except Forest	Forest	Steep	
22		Pasture – Without Farm Use	Rural, SFR-LOW, Past, Grass, Forest	Pasture	Flat	
23			Rural, SFR-LOW, Past, Grass, Forest	Pasture	Moderate	
24			Rural, SFR-LOW, Past, Grass, Forest	Pasture	Steep	
26		Pasture – With Farm use[3]	Rural, SFR-LOW, Past	Pasture	Flat	AG or AGSEPTIC[2]
27			Rural, SFR-LOW, Past	Pasture	Moderate	AG or AGSEPTIC[2]
28			Rural, SFR-LOW, Past	Pasture	Steep	AG or AGSEPTIC[2]
42		Low Density Residential/Rural Grass –	Rural, SFR-LOW, Past, Grass, Forest	Grass, Bare, Impervious[4]	Flat	
43		No Septic	Rural, SFR-LOW, Past, Grass, Forest	Grass, Bare, Impervious[4]	Moderate	
44			Rural, SFR-LOW, Past, Grass, Forest	Grass, Bare, Impervious[4]	Steep	
46		Low & Medium Density Residential/Rural	Rural, SFR-LOW, SFR-MED	Grass, Bare, Impervious[4]	Flat	SEPTIC or AGSEPTIC[2]
47		Grass –	Rural, SFR-LOW, SFR-MED	Grass, Bare, Impervious[4]	Moderate	SEPTIC or AGSEPTIC[2]
48		Septic	Rural, SFR-LOW, SFR-MED	Grass, Bare, Impervious[4]	Steep	SEPTIC or AGSEPTIC[2]
52		High Density Residential Grass	SFR-MED, SFR-HIGH	Grass, Bare, Pasture, Impervious[4]	Flat	
53			SFR-MED, SFR-HIGH	Grass, Bare, Pasture, Impervious[4]	Moderate	
54			SFR-MED, SFR-HIGH	Grass, Bare, Pasture, Impervious[4]	Steep	
62		Urban Grass	Trans/Comm/MFR	Grass, Bare, Pasture, Impervious[4]	Flat	HUPARK[2]
63			Trans/Comm/MFR	Grass, Bare, Pasture, Impervious[4]	Moderate	HUPARK[2]
64			Trans/Comm/MFR	Grass, Bare, Pasture, Impervious[4]	Steep	HUPARK[2]
71	Outwash	Rural Forest	Forest	Forest		
73		Urban Forest	Any except Forest	Forest		
72		Pasture – Without Farm Use	Rural, SFR-LOW, Past, Grass, Forest	Pasture		
78		Pasture – With Farm use	Rural, SFR-LOW, Past	Pasture		AG or AGSEPTIC[2]
74		Low Density Residential/Rural Grass – No Septic	Rural, SFR-LOW, Past, Grass, Forest	Grass, Bare, Impervious[4]		
79		Low & Medium Density Residential/Rural Grass –Septic	Rural, SFR-LOW, SFR-MED	Grass, Bare, Impervious[4]		SEPTIC or AGSEPTIC[2]
75		High Density Residential Grass	SFR-MED, SFR-HIGH	Grass, Bare, Pasture, Impervious[4]		
76		Urban Grass	Trans/Comm/MFR	Grass, Bare, Pasture, Impervious[4]		HUPARK[2]
81	Saturated	Rural Forest	Forest	Forest		
83		Urban Forest	Any except Forest	Forest		
82		Pasture – Without Farm Use	Rural, SFR-LOW, Past, Grass, Forest	Pasture		
88		Pasture – With Farm use	Rural, SFR-LOW, Past	Pasture		AG or AGSEPTIC[2]
84		Low Density Residential/Rural Grass – No Septic	Rural, SFR-LOW, Past, Grass, Forest	Grass, Bare, Impervious[4]		
89		Low & Medium Density Residential/Rural Grass –Septic	Rural, SFR-LOW, SFR-MED	Grass, Bare, Impervious[4]		SEPTIC or AGSEPTIC[2]
85		High Density Residential Grass	SFR-MED, SFR-HIGH	Grass, Bare, Pasture, Impervious[4]		
86		Urban Grass	Trans/Comm/MFR	Grass, Bare, Pasture, Impervious[4]		HUPARK[2]
87		Wetlands	Any	Wetland		WETLAND[2]
91	Custer-Norma	Rural Forest	Forest	Forest		
93		Urban Forest	Any except Forest	Forest		
92		Pasture – Without Farm Use	Rural, SFR-LOW, Past, Grass, Forest	Pasture		
98		Pasture – With Farm use	Rural, SFR-LOW, Past	Pasture		AG or AGSEPTIC[2]
94		Low Density Residential/Rural Grass – No Septic	Rural, SFR-LOW, Past, Grass, Forest	Grass, Bare, Impervious[4]		
99		Low & Medium Density Residential/Rural Grass –Septic	Rural, SFR-LOW, SFR-MED	Grass, Bare, Impervious[4]		SEPTIC or AGSEPTIC[2]
95		High Density Residential Grass	SFR-MED, SFR-HIGH	Grass, Bare, Pasture, Impervious[4]		
96		Urban Grass	Trans/Comm/MFR	Grass, Bare, Pasture, Impervious[4]		HUPARK[2]
IMPLNDs						
1		Low Pollution Generating Impervious Surface (LPGIS)	SFR-HIGH, SFR-LOW, SFR-MED, MFR	Impervious[5]		Rooftops, Sidewalks, Driveways
2		High Pollution Generating Impervious Surfaces (HPGIS)	Trans	Impervious[5]		Roads, High Use Parking Areas[6]
3		Commercial/ Industrial	Comm	Impervious[5]		Commercial Rooftops, Sidewalks, Driveways, and Parking Areas

1 The land use code used in 2001 County protocols was the "TL Code" attribute.
2 Abbreviations for water quality loading distinctions in addition to standard "TL Code": hobby farms and kennels (AG), high risk septic (SEPTIC), hobby farms and kennels with high risk septic (AGSEPTIC), high use parks (HUPARK), and wetland (WETLAND)
3 Farm use defined as parcels with hobby farms or kennels, as designated from County GIS layers
4 Non-effective Impervious Area
5 Effective Impervious Area
6 Commercial and other high-use parking areas are not currently separately delineated for the Little Bear study area

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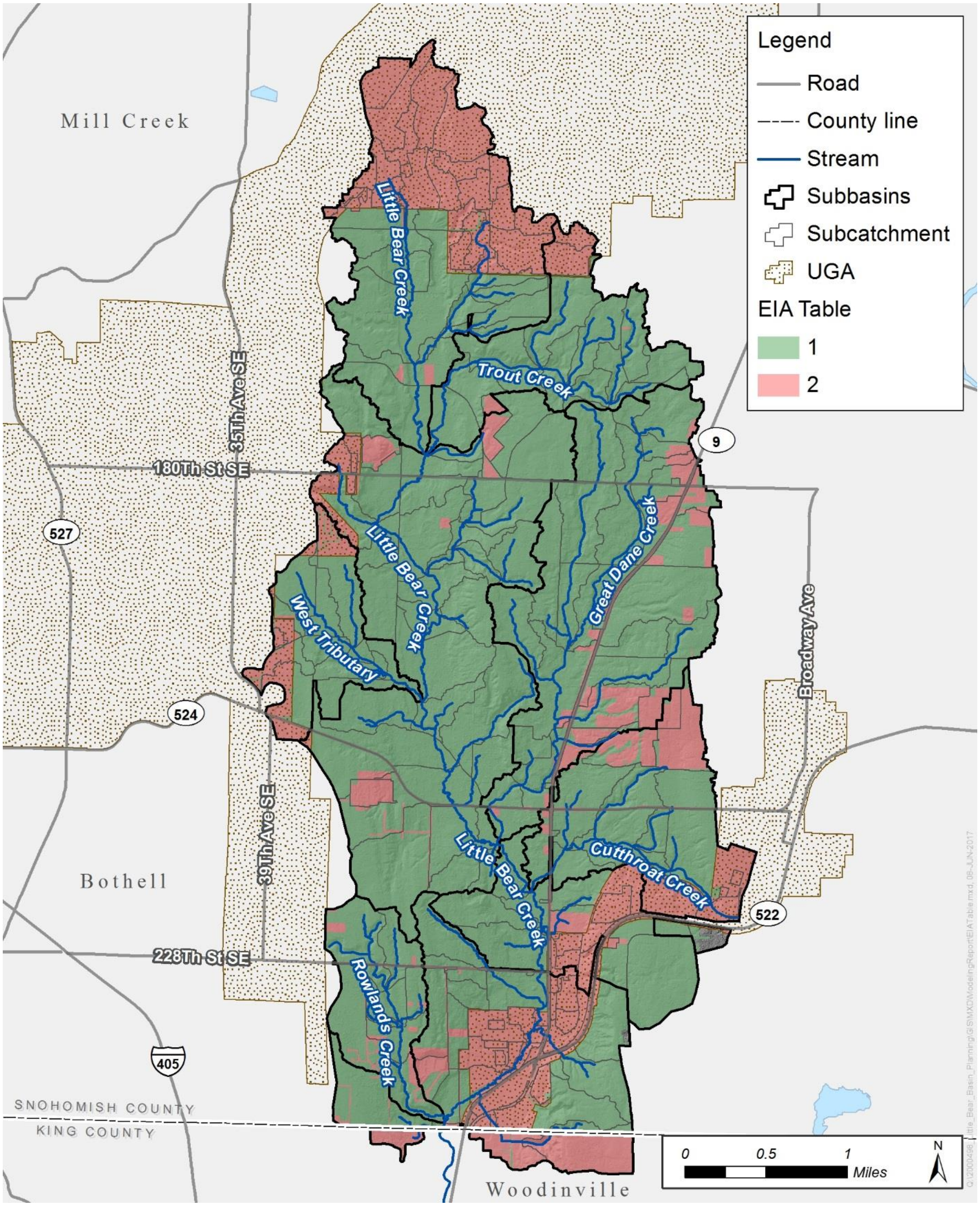


Figure 8 Effective Impervious Fraction Source Distribution. Table 1 generally applies to relatively older, less dense development areas and Table 2 to more recent and/or denser development.

3.6 Pollutant Loads

The loading rates of water quality constituents from the land surface (PERLNDs and IMPLNDs) were represented as HSPF pervious and impervious water quality constituents (PQUALs and IQUALs), respectively. Monthly or constant values for pollutant build-up, washoff, and sediment potency factors are used to determine the surface loading rates from PQUALs and IQUALS. Interflow and groundwater loading rates for PQUALS are defined as concentrations. Initial values for these parameters were determined from review of available literature values and previous models (King County, 2003, 2012; Virginia Tech 2006) and then adjusted as needed during calibration.

3.6.1 Total Suspended Sediment, Metals, and Hardness

Metals are found naturally throughout the environment and low levels of some are essential for the health of humans and other animals. However, excessive amounts can have harmful effects on health. Fish are particularly vulnerable to dissolved copper and dissolved zinc. Special Condition S5.C.5.c of the Permit identifies copper and zinc as two metals that must be addressed by the watershed scale basin plan. The Washington State water quality criteria for copper and zinc are defined separately for both chronic and acute durations as a function of hardness concentration. These standards are listed for reference in Table 1.

Since metals are associated with sediment, TSS also had to be simulated in order to calculate the surface loading rates for metals. Hardness was also needed in order to evaluate the water quality criteria associated with the standards (see Table 1). The initial parameters for TSS, copper, zinc, and hardness were taken from the Juanita Creek HSPF model (King County, 2012). The parameters were adjusted during calibration.

3.6.2 Fecal Coliform

Unlike metals, fecal coliform is not modeled in this project as being associated with sediment. The modeled loading to the stream is strictly related to surface runoff, as well as interflow and groundwater contributions, which is typically how fecal coliform is simulated in HSPF (King County, 2012; EPA, 2015). Pervious build-up rates were determined from literature values as described in the following two sections. The remaining PQUAL and IQUAL parameters, which were initially taken from the Juanita Creek model, were adjusted during calibration. Literature estimates of fecal contributions from various sources and land uses vary widely, so in the absence of local data, there is considerable uncertainty in determining where fecal coliforms in Little Bear Creek originate. A bacteria source study specific to the basin would provide additional information to refine the modeling assumptions regarding fecal sources.

Land Use-based Pollutant Loads (Excluding Septic Systems)

Regional and national loading rates from literature were used to estimate relative loads between different land uses. The loading rates were refined, preserving the relative ratios, during the calibration process to match observed data where available.

The surface loading accumulation rates for fecal coliform from pervious surfaces were determined by calculating the mass of coliform generated by animals for each pervious land use category. For the pasture with farm use (or ag pasture) category, the density of livestock (horses, goats, and sheep), poultry, and cows was estimated using animal count data provided by Snohomish County (Snohomish County 2010a, 2010b, 2013). Parcels with agricultural land use are shown in Figure 9. Bird and wildlife populations were estimated using information from other studies (e.g. Virginia Tech, 2006; Ecology, 2006). For pets, dog populations (which are the dominant contributor to fecal coliforms) were estimated based on residential parcel and household estimates from Snohomish County and dog ownership rates from the American Veterinary Medical Association (AVMA) and U.S. Census data (AVMA, 2017), and an animal waste pick-up effectiveness of 15 percent was assumed. Summaries of these populations and the resulting accumulation rates are provided in Table 8 and Table 9. Loading rates for impervious land use categories were determined during calibration, with an attempt to maintain consistent ratios between impervious types, as discussed further in Section 4.2.2.

In addition to fecal loading related to surface runoff, monthly concentrations were assigned in the HSPF model for interflow and groundwater. These concentrations were determined during calibration using data collected by Snohomish County from 2006 through 2015. In the Little Bear HSPF model, the majority of the fecal load from pervious land uses comes from interflow and groundwater, as surface runoff from pervious areas is relatively infrequent.

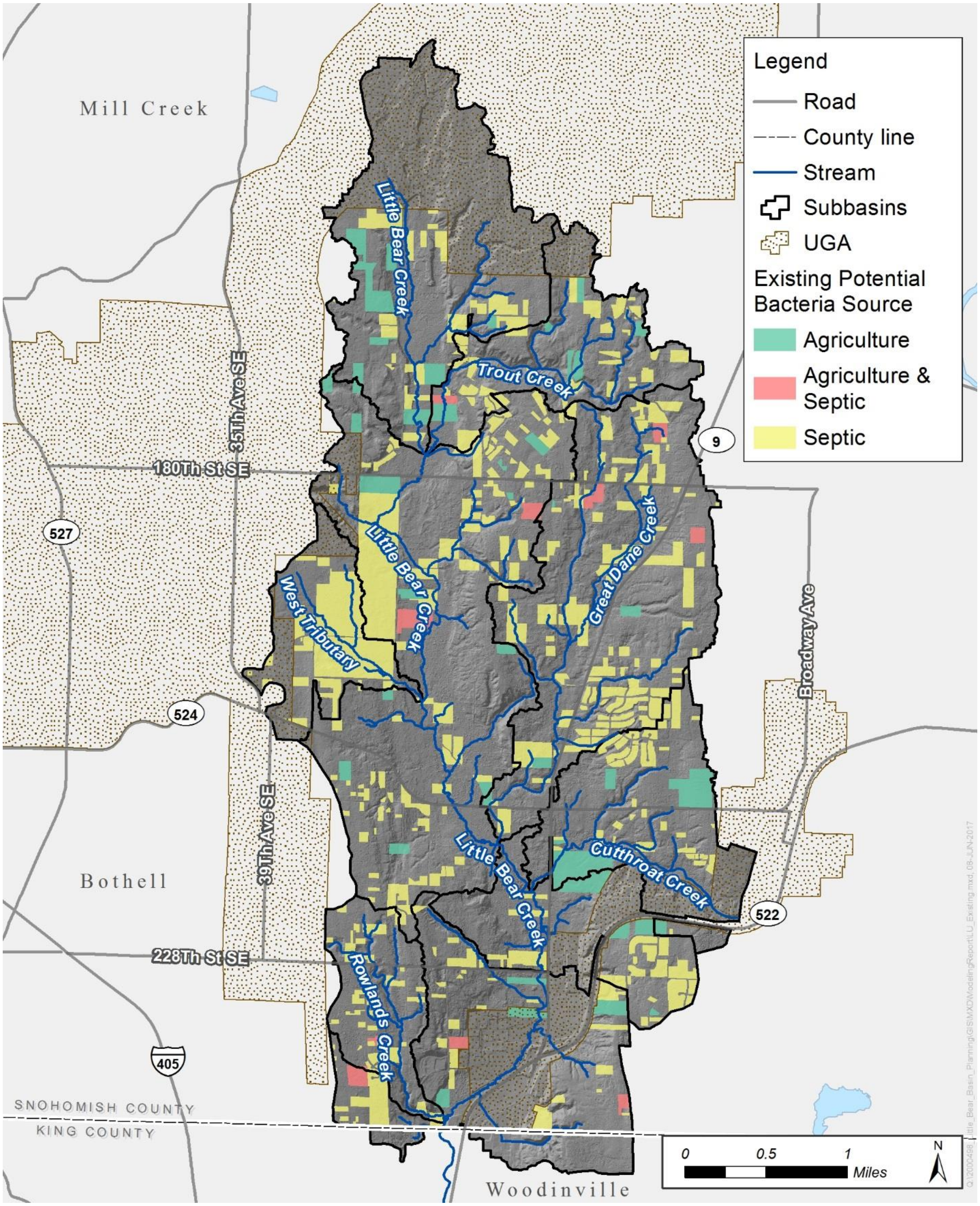


Figure 9 **Distribution of parcels with septic system and/or designated farm use (Ag).**

Table 8 Animal Density for Fecal Coliform Loading

Land Use	PERLND IDs	Animal Density (animals/acre)				
		Livestock	Large Wildlife	Small Wildlife	Large Bird	Pets†
Urban Forest	32-34;73;83;93	0	0	0.200	0.047	0
Rural Forest	12-14;71;81;91	0	0.20	0.200	0.047	0
Pasture	22-24;72;82;92	0	0	0.078	0.047	0
Ag Pasture	26-28;78;88;98	4.56	0.0234	0.078	0.047	0
Urban Grass	62-64;76;86;96	0	0	0.156	0.023	0
HD Res. Grass	52-54;75;85;95	0	0	0.078	0.023	0.3
LD Res. Grass	42-44;74;84;94; 46-48;79;89;99	0	0	0.078	0.047	0.3
Sat, Wetland	87	0	0.05	0.078	0.094	0

† Population estimate reduced by 15% waste pickup effectiveness factor.

Table 9 Fecal Coliform Loading from Animals

Land Use	PERLND IDs	Fecal Coliform Load (cfu x 10^6/acre/day)					
		Livestock	Large Wildlife	Small Wildlife	Large Bird	Pets	Non-Human Total
Load per animal (cfu x 10^6/head/day)		420	350	50	1600	450	
Urban Forest	32-34;73;83;93	0	0	10.0	75	0	85
Rural Forest	12-14;71;81;91	0	70	10.0	75	0	155
Pasture	22-24;72;82;92	0	0	3.9	75	0	79
Ag Pasture	26-28;78;88;98	1916	8.2	3.9	75	0	2003
Urban Grass	62-64;76;86;96	0	0	7.8	37	0	45
HD Res. Grass	52-54;75;85;95	0	0	3.9	37	135	176
LD Res. Grass	42-44;74;84;94; 46-48;79;89;99	0	0	3.9	75	135	214
Sat, Wetland	87	0	16.4	3.9	150	0	170

Loads from Septic Systems

In addition to non-septic system sources of fecal coliform, the loading from septic system sources within the study area was specifically accounted for in the model parameters. The loading rates were determined using a GIS-based methodology similar to that used by the Ecology South Sound septic loading study (Whiley, 2010). The method used a septic system inventory and a drainage network (streams and pipe/ditch network) to assign a higher loading rate to parcels considered to be a higher risk for discharging to a lake or stream. Whiley (2010) recommended the use of a buffer of 150 meters (about 500 feet) around the south Puget Sound shoreline to identify high-risk septic areas. For this study, a smaller 250-foot buffer was applied. This assumption was based on previous work in Thurston County (NHC, 2014) and engineering judgment regarding the zone of influence around a stream as opposed to a shoreline.

In the model, a septic loading rate was applied to all parcels that were identified as having septic systems (see Figure 9) and the primary dwelling unit (used as surrogate for the location of the septic field) was within 250 feet of the drainage network, i.e. "high-risk" septic parcels. The average septic loading rate was determined by first identifying the number of high-risk septic parcels. Next, an estimate of the number of failing or deficient septic systems was calculated by multiplying the total number of high-risk septic parcels by a deficiency rate of 1.4 percent, determined by the County based on information from the State Department of Health and Snohomish Health District. Then, the number of residents on high-risk parcels with deficient septic systems was approximated assuming one dwelling unit per parcel and 2.66 residents per dwelling unit (the county average from U.S. Census data). A total loading rate from deficient systems was then calculated by multiplying the number of residents by a production rate of $2x10^9$ fecal coliform units (cfu) per person per day (Geldreich, 1978). Finally, the average loading rate per acre was calculated by dividing the total loading rate by the total area of grass on high-risk septic parcels.

Table 10 Average Septic Loading Rate

Septic Loading Factor	Value
High-Risk Septic Parcels	701
Deficiency rate	1.4%
High-Risk Septic Parcels with Deficient Septic Systems	9.81
Residents using Deficient Septic Systems	26.1
Total Loading Rate from Deficient Septic Systems [CFU/day]	$5.22x10^{10}$
Area of Septic Grass [acres]	288
Average Loading Rate [CFU x 10^6/ day/acre]	**182**

3.7 HSPF Routing

Routing of flow and pollutant runoff from each catchment in the HSPF model was represented using one of four characteristic approaches:

- Headwater reaches with limited to no drainage system;
- Pipes, ditches, and small streams, where approximate methods were used to specify reach characteristics;
- Explicitly modeled stormwater facilities; and
- Major streams and tributaries.

Headwater catchments without defined drainage systems did not have RCHRES routing elements. Any stormwater treatment, as well as internal unit conversions in the model, were represented using BMPRACs[4], and the flow and pollutant runoff from these catchments was sent directly to the next downstream RCHRES element. Routing in catchments with clearly defined drainage systems was represented by a RCHRES. Each RCHRES is characterized in the model using an FTABLE, which defines a stage-area-storage-discharge relationship based on the geometry of the reach. The routing type applied to each catchment is shown in the map in Figure 10, and the number of catchments with each routing type—as well as the information used to develop corresponding FTABLEs—is shown in Table 11. The following sections provide more description of the modeling approach for stormwater facilities and stream reaches, as well as modifications made to the FTABLEs specifically for modeling temperature.

Table 11 Routing Type Distribution in Little Bear Creek

Routing Type	Number of Catchments	FTABLE Data Sources
Headwater Reaches	25	n/a
Pipe	14	GIS pipe diameter, length, and Manning's equation
Ditch and Culvert	19	Stream length, slope, Manning's equation
Minor Stream	55	Stream length, slope, Manning's equation and HY8 calculations for downstream culvert
Stormwater Facility	64	Facility As-Builts
Major Stream	45	HEC-RAS model

An HSPF routing schematic for the existing conditions model is included at the end of this section as Figure 15. The schematic indicates the type of routing in each catchment and illustrates how surface flow (surface water and interflow components of HSPF flow) and groundwater are routed downstream. The three digit numbers in the schematic figure are the HSPF catchment numbers.

[4] BMPRACs can store the same data as a RCHRES, however they are not associated with an FTABLE. They are commonly used as an alternative to a COPY in HSPF water quality models and allow BMPs to be represented using reduction factors.

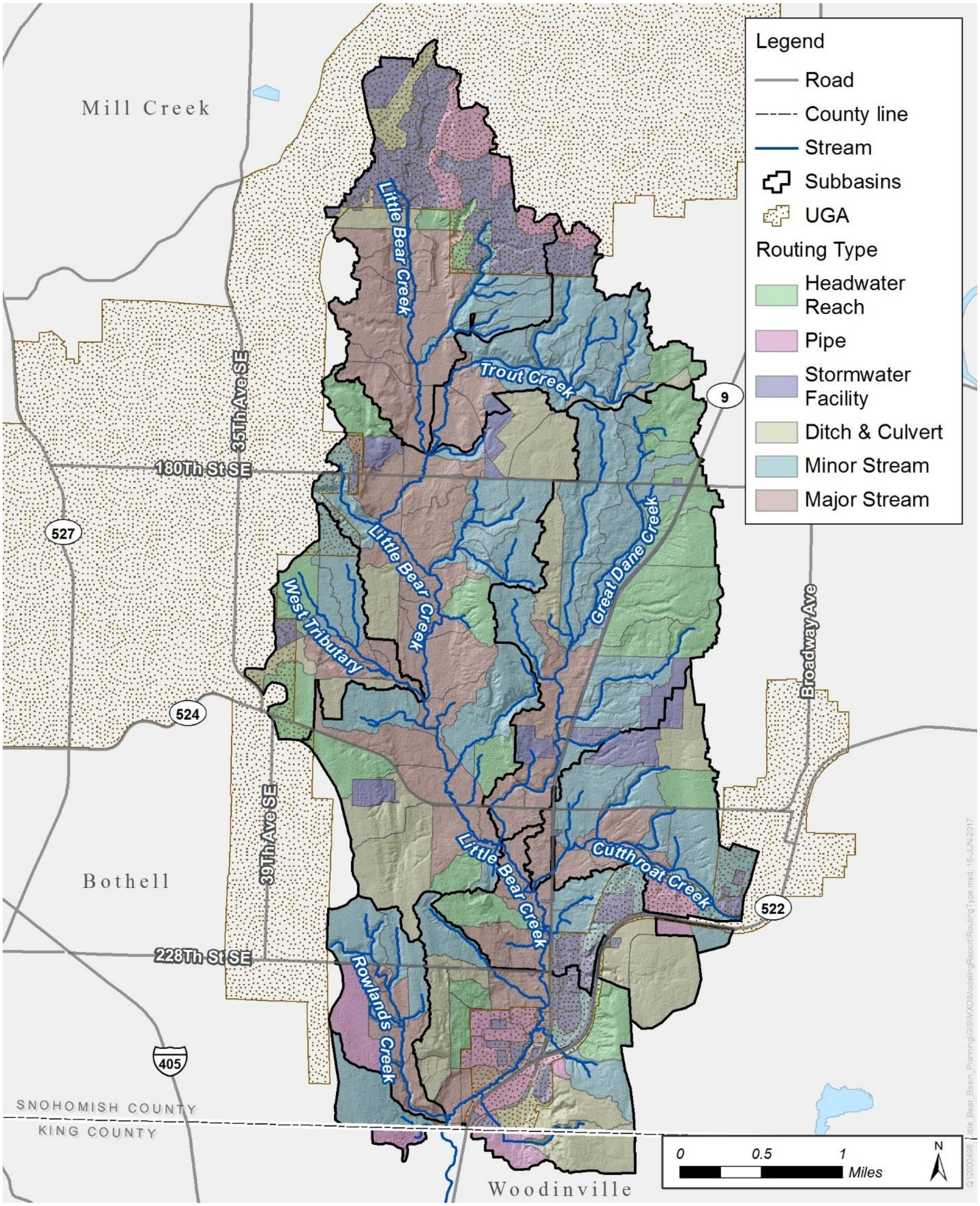


Figure 10 Catchment Routing Type

3.7.1 Groundwater Routing

Assumptions regarding groundwater routing were based on review of previous studies—which indicated a groundwater divide through the northeastern part of the watershed—and on observations of where baseflow was present during late summer stream walks. As indicated on the model schematic, groundwater followed one of three routing pathways for each catchment:

- Groundwater leaves the basin
- Groundwater does not emerge locally and is routed to a downstream reach
- Groundwater emerges in local reach (often including contributions from upstream catchments)

Hydrogeologic studies of the area dating back to a countywide USGS assessment in 1996 (Thomas et al., 1997 as referenced in King County, 2005 (Appendix 6-B)) indicate a groundwater divide crossing the northeast portion of the basin, with groundwater flow to the north and east of the divide going to the Snohomish River. The location and angle of the divide through Little Bear Creek vary between sources. The locations mapped in the Brightwater EIS (King County, 2005 (Appendix 6-B)) and a recent hydrogeologic study (Golder, 2005) are shown in Figure 11. The approximate location of the divide, in terms of which catchments have groundwater leaving the system, was refined during model calibration, as discussed in Section 4.1.

Late summer streamwalks conducted as part of this study showed that many upland catchments in the Little Bear Creek study area are ephemeral, i.e. do not receive baseflow contributions throughout the year. It was also observed that much of the tributary baseflow emerged at springs and seeps that coincided with transition from till to advance outwash geology. These observations, and correlations with geology, were used to decide whether groundwater generated in a catchment would emerge locally, i.e. in the immediate catchment reach, or farther downstream. In many tributary subbasins, several upland catchments contribute groundwater to one or two downstream reaches coinciding with observed or inferred groundwater emergence locations. Groundwater from catchments with modeled stormwater facilities was consistently assumed to bypass the facility.

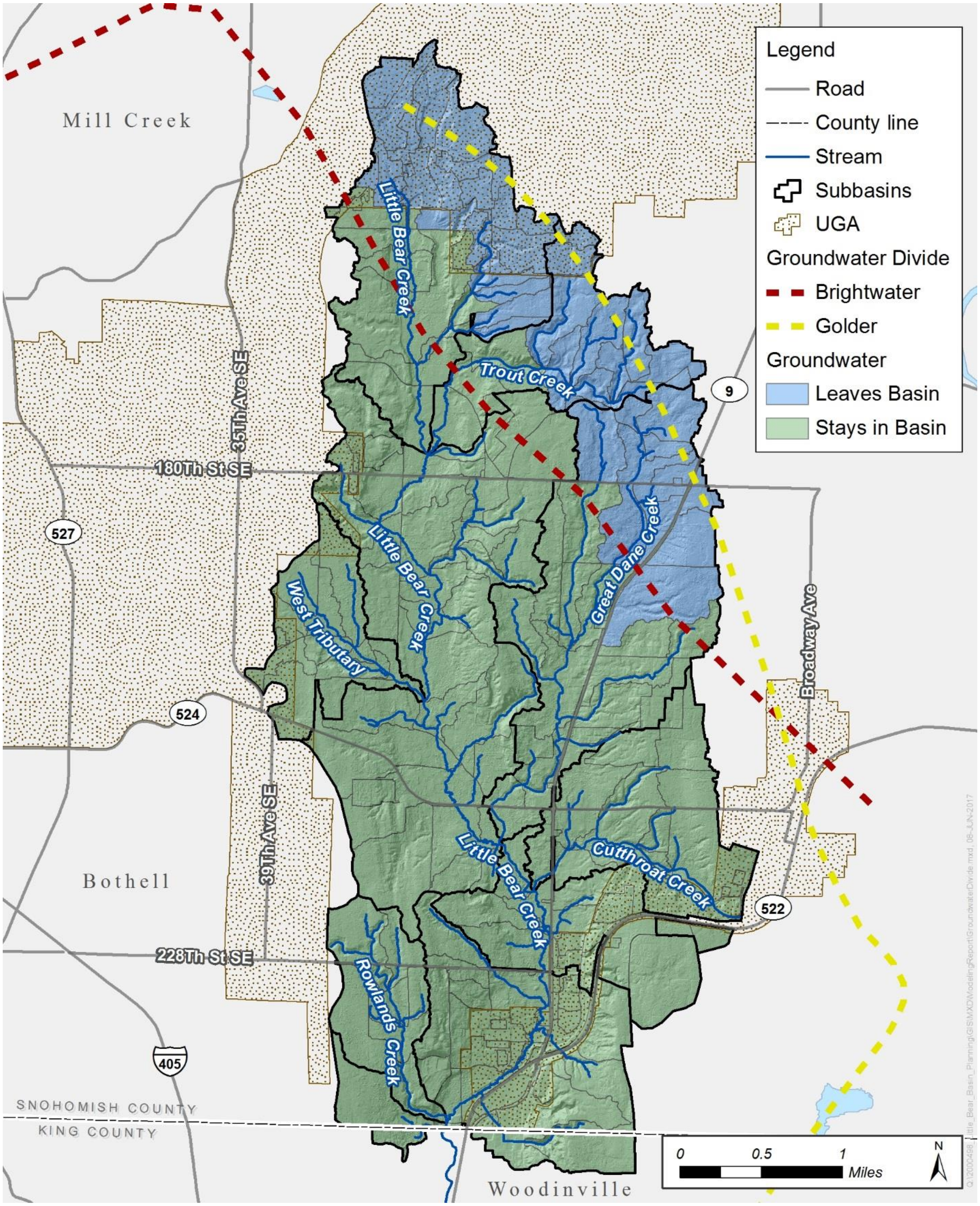


Figure 11 Potential Locations of Groundwater Divide through Little Bear Creek Basin

3.7.2 Stream Routing

FTABLEs for major stream reaches, including most of mainstem Little Bear Creek and the five major tributaries, were developed using a HEC-RAS model. A previously developed HEC-RAS model of Little Bear Creek (NHC, 2013a) was extended to include lower Trout Creek—the only significant tributary not included in the earlier model—and an extended reach of Great Dane Creek. Geometry of the modeled reaches was also refined with additional cross sections from Snohomish County's GIS drainage inventory and from cross-section surveys performed as part of this project.

The primary purpose of the HEC-RAS refinements was to improve the resolution of the model to better capture stream channel geometry in the HSPF FTABLEs. To create FTABLEs, the HEC-RAS model was run in steady state for a broad range of flows, ranging from summer low flows to extreme floods. The flow range and distribution of flows through the network were adopted from earlier modeling. HEC-RAS output for each flow profile (depth, channel length, top width, volume, and discharge) was aggregated over the length of the HSPF stream reach to compute FTABLE depth, area, volume, and discharge for 45 stream segments.

Due to limited observed water surface elevation data (other than at gage locations) and transient hydraulic conditions (often caused by beaver dams) common on Little Bear Creek, it was not practical to calibrate the HEC-RAS model as part of this study. A limited verification of the HEC-RAS model was performed by comparing HEC-RAS generated cross-section ratings (stage-discharge curves) with rating curves and stage-discharge measurements at the long-term County stream gage sites (LBLU and LBLD). Small adjustments to the Manning's roughness coefficients used in the HEC-RAS model were made based on this comparison.

3.7.3 Stormwater Facilities

Important facilities for the purpose of hydrologic modeling are typically those with significant storage and/or flow control capability. Detention facilities identified during the current conditions assessment (Snohomish County, 2016) were evaluated for inclusion in the HSPF model based on live storage volume, the age of the design (which relates to applicable flow control requirements), and location in the Little Bear Creek basin. Based on review of assembled facility data and experience with detention pond performance, a 40,000-cubic foot threshold for live storage was selected to identify "significant" flow control facilities to be included in the HSPF model, which resulted in identification of 42 large detention facilities.

An additional seven smaller detention facilities designed to the 2010 Snohomish County Drainage Manual were also included in the model. The 2010 manual was the first to require flow duration control to match forested hydrologic conditions, so newer facilities provide a higher level of flow control compared to older facilities of a similar size. The combined 49 facilities represent roughly 90% of the live storage volume identified in the LBC basin.

The remaining smaller facilities were further reviewed, and 15 additional facilities were identified to include in the HSPF model based on the following criteria:

- Size (preference for the larger facilities)

- Age (preference newer facilities)
- Land use (preference given to commercial areas)
- Multiple small ponds providing significant storage for a drainage area
- Proximity to Little Bear Creek and its tributaries

These 15 facilities represent an additional 5 percent of the live storage identified in the Little Bear Basin.

These 64 facilities were represented explicitly in the model, with FTABLEs developed using as-builts and information collected during field visits conducted as part of the current conditions assessment (Snohomish County, 2016). Water quality treatment provided by other identified stormwater facilities in the study area basin were represented indirectly using HSPF BMPRAC elements, as discussed in Section 3.8.

3.7.4 HSPF Reach Water Quality Processes

Changes that occur to water quality constituents within a routing reach are handled by three different HSPF modules: Heat Exchange and Temperature (HTRCH) for temperature, Behavior of Inorganic Sediment (SEDTRN) for TSS, and Generalized Quality Constituent (GQUAL) for metals and fecal coliform. An overview of these modules is provided below, and the reader is referred to the HSPF user's manual (Bicknell et al., 2014) for additional detail regarding the model formulations.

Temperature

Water temperatures in streams and well-mixed lakes can be calculated by tracking the net heat entering or leaving the water. HSPF includes seven different types of heat transfer in its calculation of in-stream temperatures. These are:

- Net heat transport from incident shortwave radiation
- Net heat transport from longwave radiation
- Heat transport from conduction-convection
- Heat transport from evaporation
- Heat content of precipitation
- Net heat exchange with bed
- Advection in the upstream to downstream direction

As discussed in section 4.2.1, the primary temperature calibration factors were shade, which has a direct impact on the heat transport from shortwave radiation, and bed conductivity, which controls the net heat exchange with the bed. The initial shade parameter distribution was determined using a GIS calculation based on vegetation height developed for HSPF water quality modeling in Thurston County (NHC, 2014). During calibration these initial parameters were adjusted by multiplying them by the same adjustment factor throughout the model (i.e., the magnitude of shade was changed, but the distribution of shade stayed consistent with the initial calculation). The bed conductivity parameters were based on calibrated HSPF models of similar-sized streams in Thurston County (NHC, 2014) and refined during calibration.

The HSPF temperature routines default to air temperature if the depth in the FTABLE falls below two inches. This can cause significant discontinuities in the simulated temperature for ditches and small streams during the summer months. To avoid this problem, a small amount of dead storage was added to each FTABLE representing a detention facility without dead storage, stream, ditch, or pipe reach to prevent simulated water level from falling below this depth. The added dead storage prevented the model from defaulting to air temperature and allowed the smaller creeks to be calibrated to gage data even at low flows without significantly impacting simulation of other water quality parameters.

Total Suspended Solids

In HSPF, the primary instream processes related to sediment transport are deposition, scour, and advection. There is no attrition or other changes in sediment form simulated within the routing reach. In the Little Bear Creek model, scour and deposition were activated in reaches representing all major streams, minor streams, and stormwater facilities by adjusting the critical shear stresses for deposition and scour for cohesive sediment (silt and clay) and parameters of the power function for sand. For the small number of pipe and ditch/culvert reaches, these parameters were adjusted to force sediment to pass downstream without deposition or scour. This simplification is based on an assumption that relatively little scour would occur in the pipes and ditches compared to stream channels and the fact that the HSPF sediment routines are not as well-suited to the pipe and ditch/culvert FTABLEs. The initial parametrization, as well as the adjustments made during calibration, were based on the methods outlined in Basins Technical Note 8 Sediment Parameter and Calibration Guidance for HSPF (EPA 2006).

Metals Partitioning Coefficients

Metals exist in stormwater or stream flow in both dissolved and particulate forms and have a tendency to leave their dissolved phase and attach to suspended solids. The dissolved and particulate forms of metals behave quite differently from one another, so there is a need to represent the balance between the two phases in the model in order to account for fate and transport moving downstream. For example, sediment deposition and scour affect the particulate form within the creek, but not the dissolved. Partitioning of copper and zinc between the dissolved and particulate phases was found by Ecology (1996) to be well correlated with total suspended solids (TSS) for Washington streams and rivers. The correlation is expressed as a partitioning coefficient (K_d), which defines the relationship between each metal's dissolved fraction and TSS.

$$K_d = C_p / (C_d * TSS)$$

where C_p is particulate and C_d is dissolved metal concentration.

The dissolved fraction of a given metal is commonly expressed as the metals translator (f_d), which is the fraction of dissolved metal in the total metal sample:

$$f_d = C_d / C_t$$

where C_t is total metal concentration.

HSPF simulates the loading of metals from the land surface (i.e. runoff from a PQUAL or IQUAL) as total metals; the model only distinguishes the dissolved form from the particulate form when flow enters a RCHRES (i.e. creek, ditch, pond, etc.). The HSPF RCHRES general water-quality constituent (GQUAL) routines utilize user-specified K_d factors for suspended sand, silt, and clay, and bed sand, silt, and clay to determine the relative fraction of each metal form. The Little Bear HSPF model uses one K_d factor for zinc and one for copper, the values were not varied between sediment size classes (i.e. sand, silt, or clay).

K_d values for zinc and copper were determined by applying a method similar to that outlined in Shi et. al (1996) to available project (Cardno, 2015) and ambient Little Bear Creek monitoring data. King County ambient data (from sites 0478 and S478, which are shown in Figure 7) were used, as Snohomish County ambient data for Little Bear Creek only include total metals, and thus could not be used for the purpose of developing partitioning factors.

For copper, the regression between TSS and $C_t/C_d - 1$ (i.e. the K_d factor) is very strong when plotted using all of the short term project and King County ambient monitoring data (Figure 12), and also with individual regressions developed for each site (not shown). Based on the slope of the regression line in Figure 12, the K_d factor for copper was set at 0.025 after rounding.

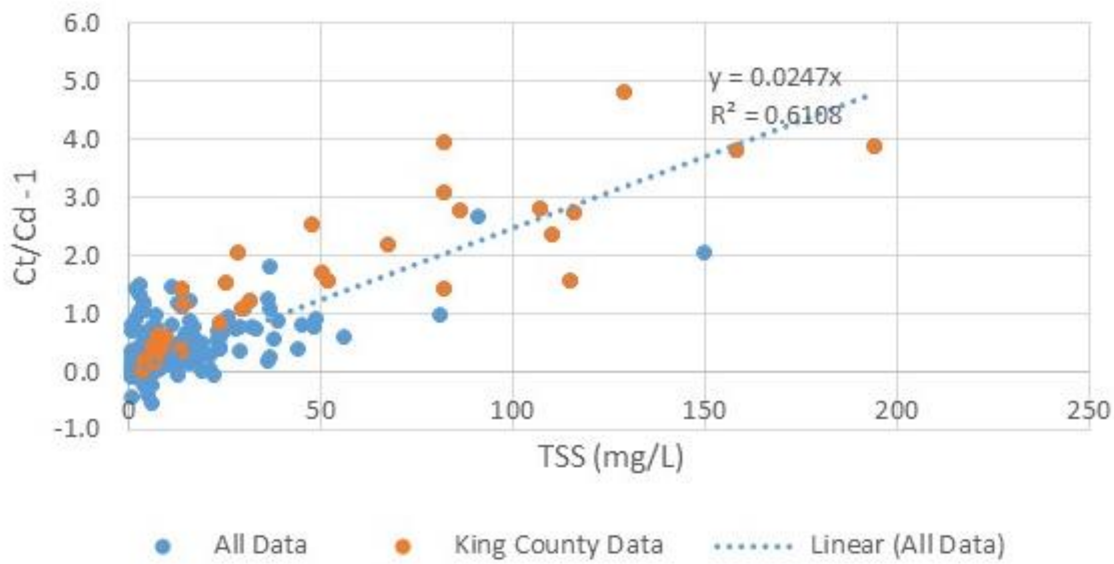


Figure 12 Copper vs. TSS Regression for project and King County ambient data

For zinc, the project data and King County data were found to have very different relationships between TSS and $C_t/C_d - 1$ (see blue and orange dots in Figure 13 respectively). The project data show no relationship, but the King County data relationship is even stronger than that for copper (R-squared of 0.81 vs. 0.61). The TSS values reported by King County are also consistently higher than those found in the project data. The lack of a relationship between TSS and $C_t/C_d - 1$ was evident for both the collective project data (all sites together) and for individual sites. The source of these differences could not be determined. Because the King County ambient data showed the expected correlation between TSS and $C_t/C_d - 1$ with ratios similar to the literature, and the project data did not, the King County data were used to establish the K_d factor for zinc (see Figure 14). The resulting TSS vs. $C_t/C_d - 1$ relationship for zinc is shown in Figure 14; the resulting K_d value is 0.043. It should be noted that the project data were still utilized for calibration of total metals.

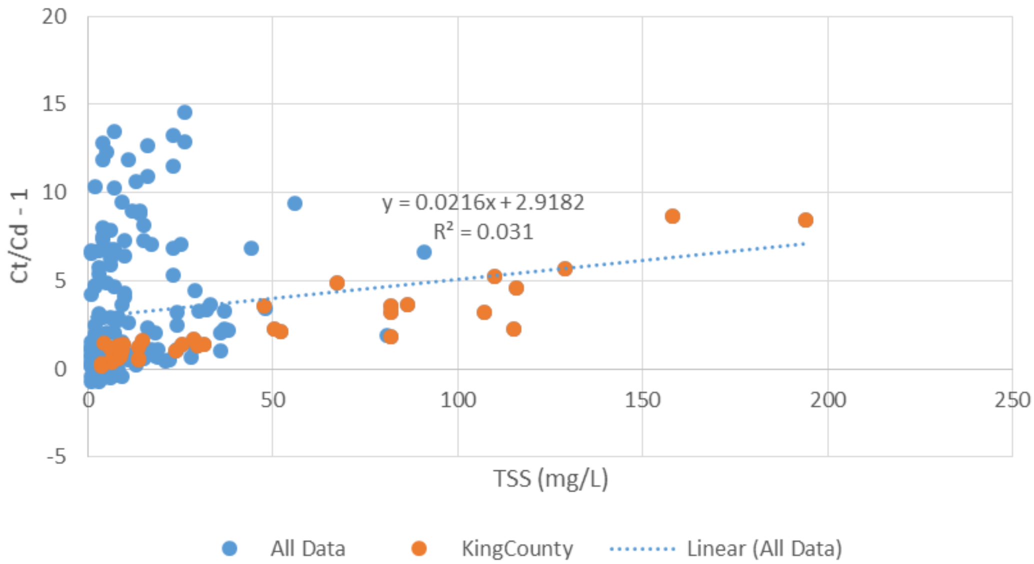


Figure 13 Zinc vs. TSS Regression for project and King County ambient data

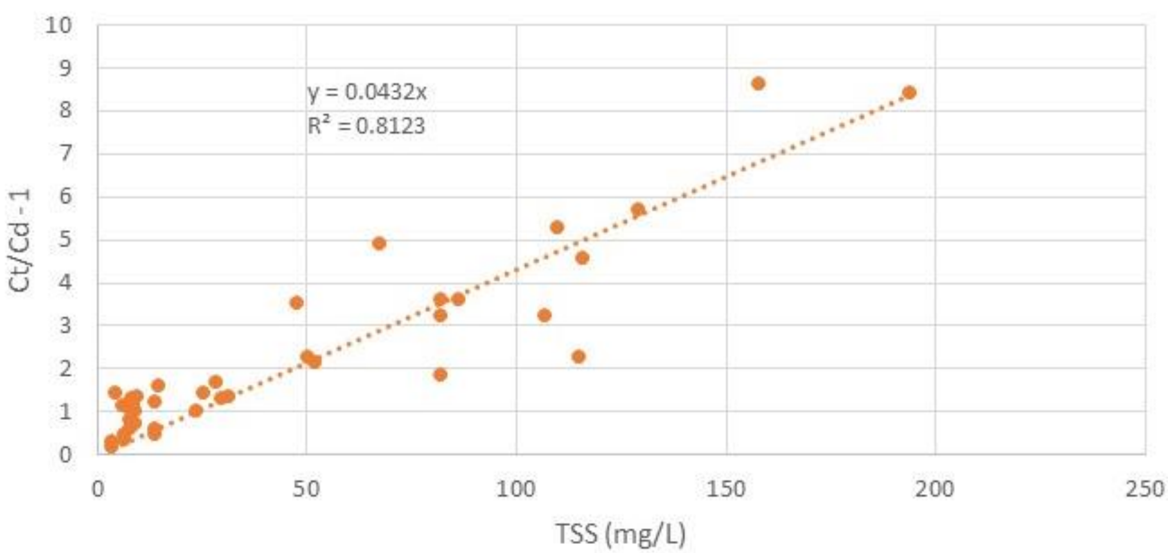


Figure 14 Zinc vs. TSS Regression for King County ambient data only

Fecal Coliform

Fecal coliform levels can be influenced by a wide range of environmental variables and instream processes. Recent research indicates that fecal coliform can be sediment-associated and suggests that bottom sediments can be a source of fecal coliform bacteria upon re-suspension in the water column during storm events (Jolley et. al., 2008). Literature and experience suggest that summer concentrations can be influenced by environmental variables such as sediment type, lower flows, greater solar radiation and higher stream temperatures, and less predation, all of which would contribute to summer regrowth (e.g., Ecology, 2008; Ecology, 2011a).

In HSPF, fecal coliform is typically not modeled as being associated with sediment, and all instream processes within a reach are represented using a single first order decay rate. While there is a temperature-dependent factor that is applied to the decay rate in HSPF, this cannot easily be used to simulate regrowth of fecal coliform bacteria in a stream. Given the level of simplification required to model fecal coliform in HSPF and the limited number of long-term fecal coliform monitoring locations in the study area basin, the same decay rate was used for all reaches throughout the model. The initial value for the decay rate was taken from King County's Juanita Creek HSPF model (King County, 2012) and was adjusted during calibration to better match the local monitoring data.

Direct deposition of fecal coliform into the stream by wildlife and/or livestock is not explicitly modeled due to lack of specific knowledge of fecal coliform sources. Instead, direct deposition loading is implicitly included within the baseflow concentrations assigned as inflows. This is discussed further in Section 4.2.5.

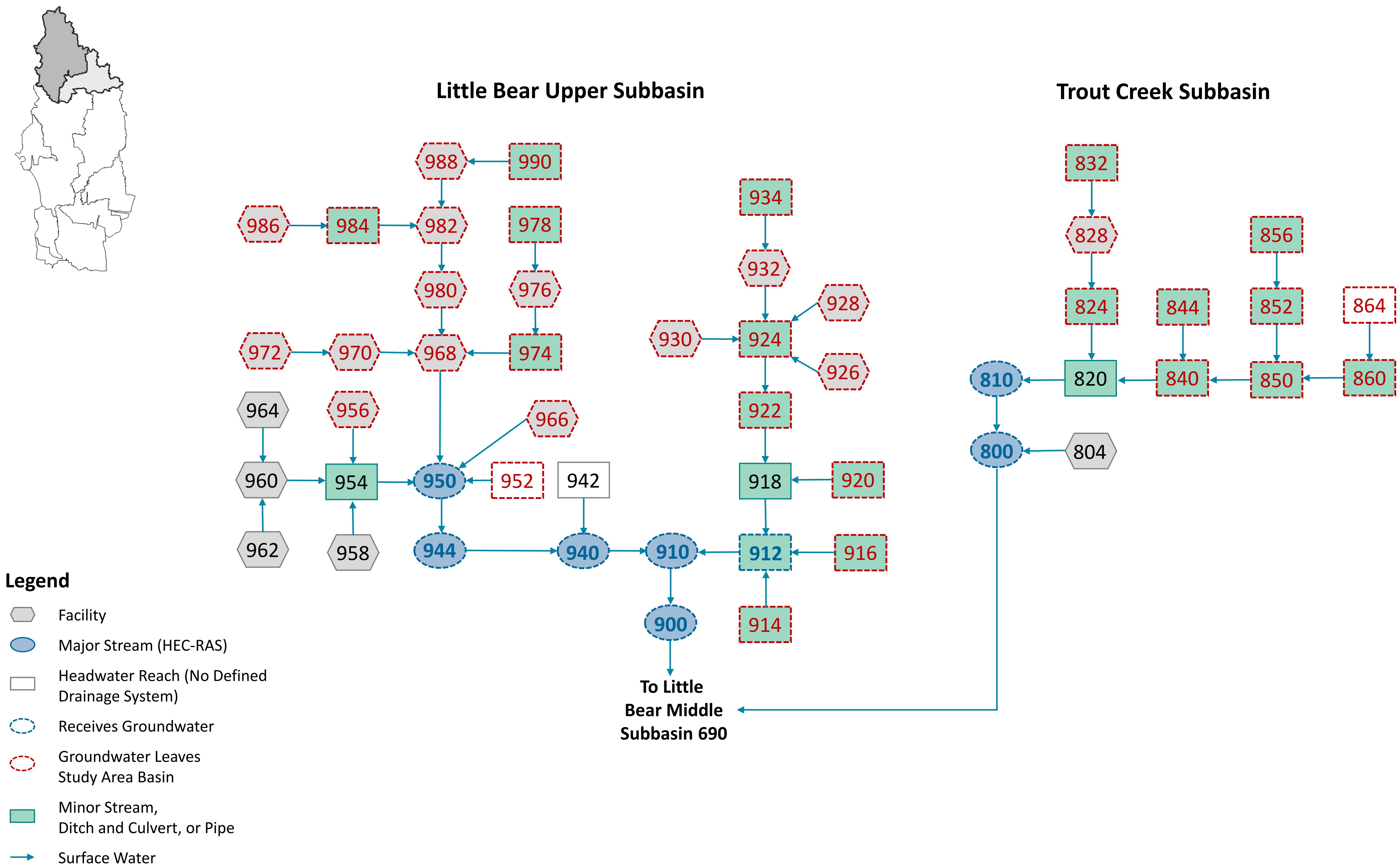
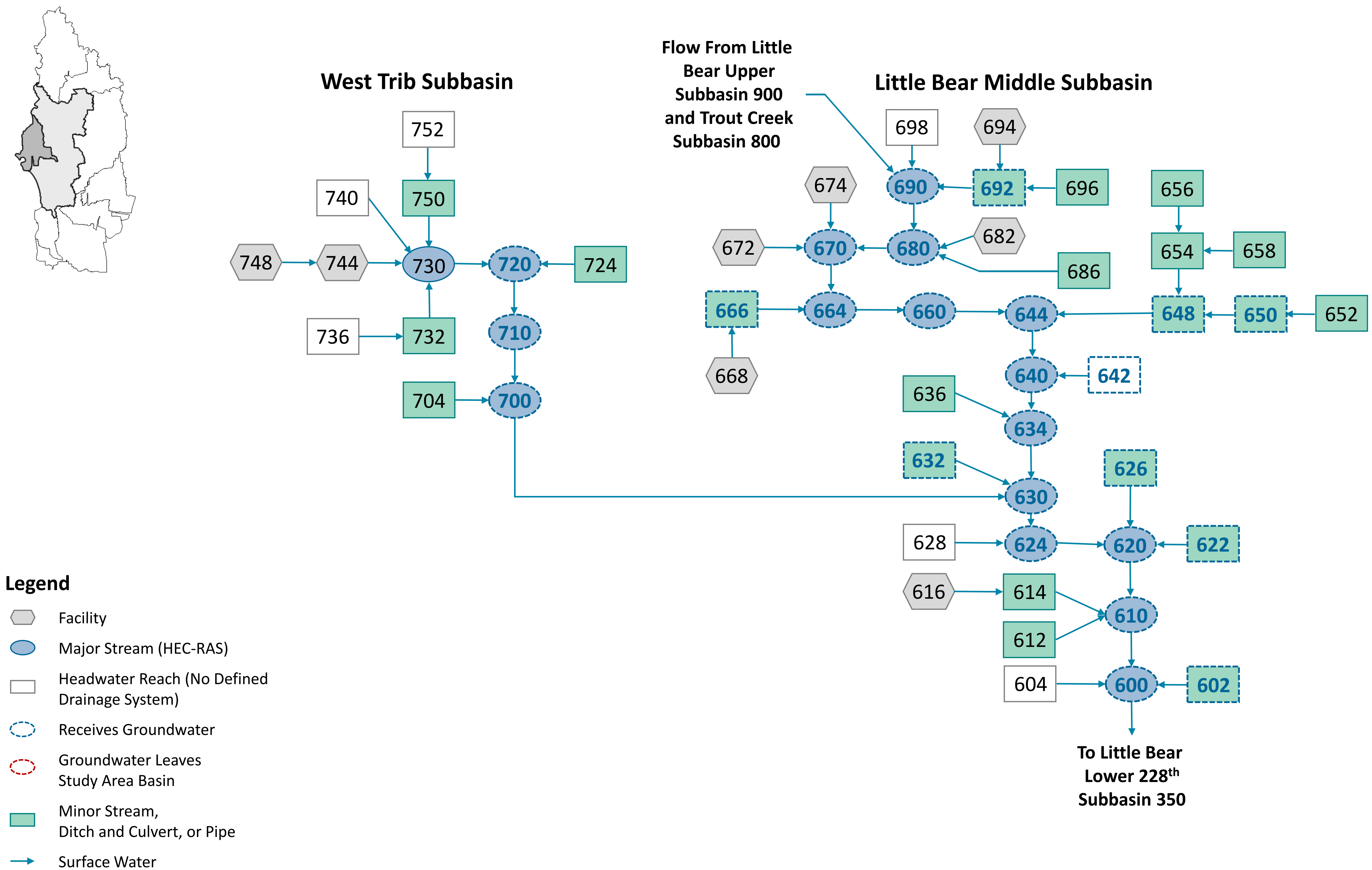
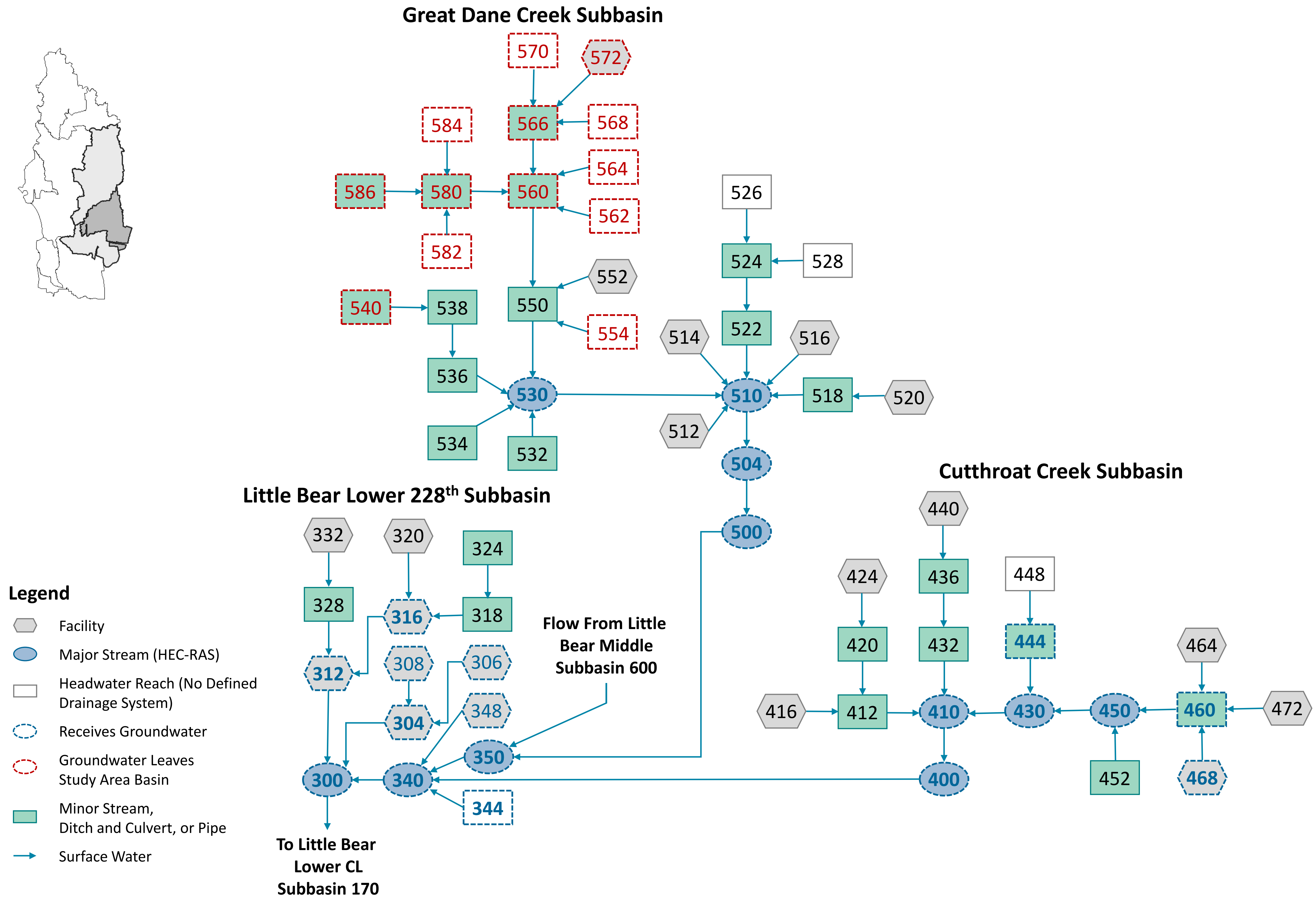


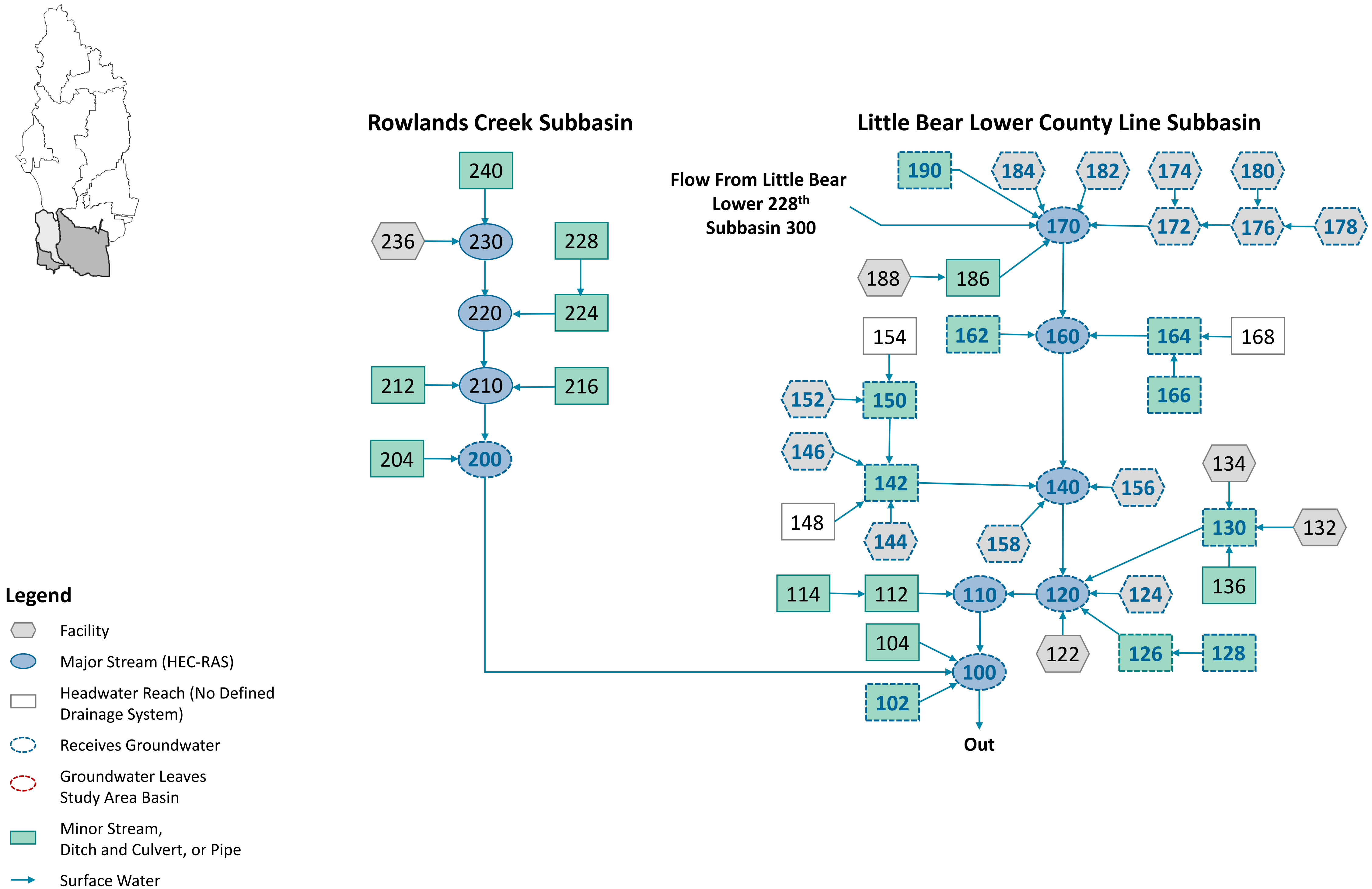
Figure 15 HSPF Routing Schematic



HSPF Routing Schematic, continued



HSPF Routing Schematic, continued



HSPF Routing Schematic, continued

3.8 Existing Water Quality Treatment

Effects of stormwater BMPs on water quality constituents are represented in the HSPF model either explicitly in FTABLEs or through reduction factors applied using BMPRACs. Figure 16 shows the catchments in the study area basin for which stormwater facilities were modeled using one or both of these representations. For BMPs identified in the current conditions assessment (Snohomish County, 2016) that are not explicitly modeled using FTABLEs, reduction factors are applied using BMPRACs. The reduction factors for each type of BMP and water quality constituent were based on data from the International Stormwater BMP Database(2014) and the Center for Watershed Protection (2007) and are listed in Table 12. An approximate drainage area was delineated in GIS for each BMP represented by reduction factors and an area-weighted average reduction factor was calculated for the catchment. In the occasional case where multiple BMPs occurred in one catchment, BMPs were assumed to be connected in series.

Table 12 Reduction factors for catchments with BMPs represented only by BMPRACs

	Bioretention	Stormfilter	Wet Pond	Wetland	Pervious Pavement	Swale	Infiltration	Detention
TSS	0.74	0.83	0.76	0.62	0.72	0.22	0.9[1]	0.6
Cu	0.39	0.43	0.51	0.53	0.35	0.14	0.65[1]	0.44
Diss Cu	0	0.14	0.34	0.36	0	0.14	0.14[2]	0.4
Zn	0.75	0.77	0.56	0.59	0.79	0.26	0.7[1]	0.57
Diss Zn	0.38	0.8	0.35	0.65	0.89	0.4	0.8[2]	0.4
Fecal	0.4[1]	0.58	0.84	0.91	0.4[1]	0	0.4[1]	0.6

[1] Center for Watershed Protection (All other values are from the International BMP Database)
[2] Value for media filter from International BMP Database

For catchments with detention facilities explicitly modeled in HSPF, reduction factors for the detention facilities were not included in the area-weighted reduction factors. For these facilities, reductions in total suspended solids as well as sediment-associated metals were simulated using the SEDTRN module. Fecal coliform reduction were represented in explicitly modeled detention facilities by first order decay simulated through the DDECAY module.

For sediment-associated water quality constituents in HSPF, such as copper and zinc, BMPRACs require four reduction factors: one for the dissolved component of the constituent and three for adsorbed fraction of the constituent associated with sand, silt, and clay. Given a lack of data to make a distinction between values for different sediment sizes, all three reduction factors for the adsorbed fraction were set to the same value. Since the reduction factors for the adsorbed component of metals are not available in literature, they were calculated from the total reduction factor, dissolved reduction factor, partitioning coefficient, and an appropriate value for total suspended solids. This was done using the relationship below:

$$R_{ads} = (A * R_t - R_d) / (A - 1)$$

$$A = TSS * K_d + 1$$

where

R_t is the total reduction factor,
R_d is the dissolved reduction factor,
K_d is the partitioning coefficient,
and TSS is a TSS concentration.

For this calculation it was assumed that the reduction factors from literature are largely related to storm loads, so a TSS value of 16 mg/L was used. This is a typical TSS storm concentration in Little Bear Creek based on review of project and ambient monitoring data.

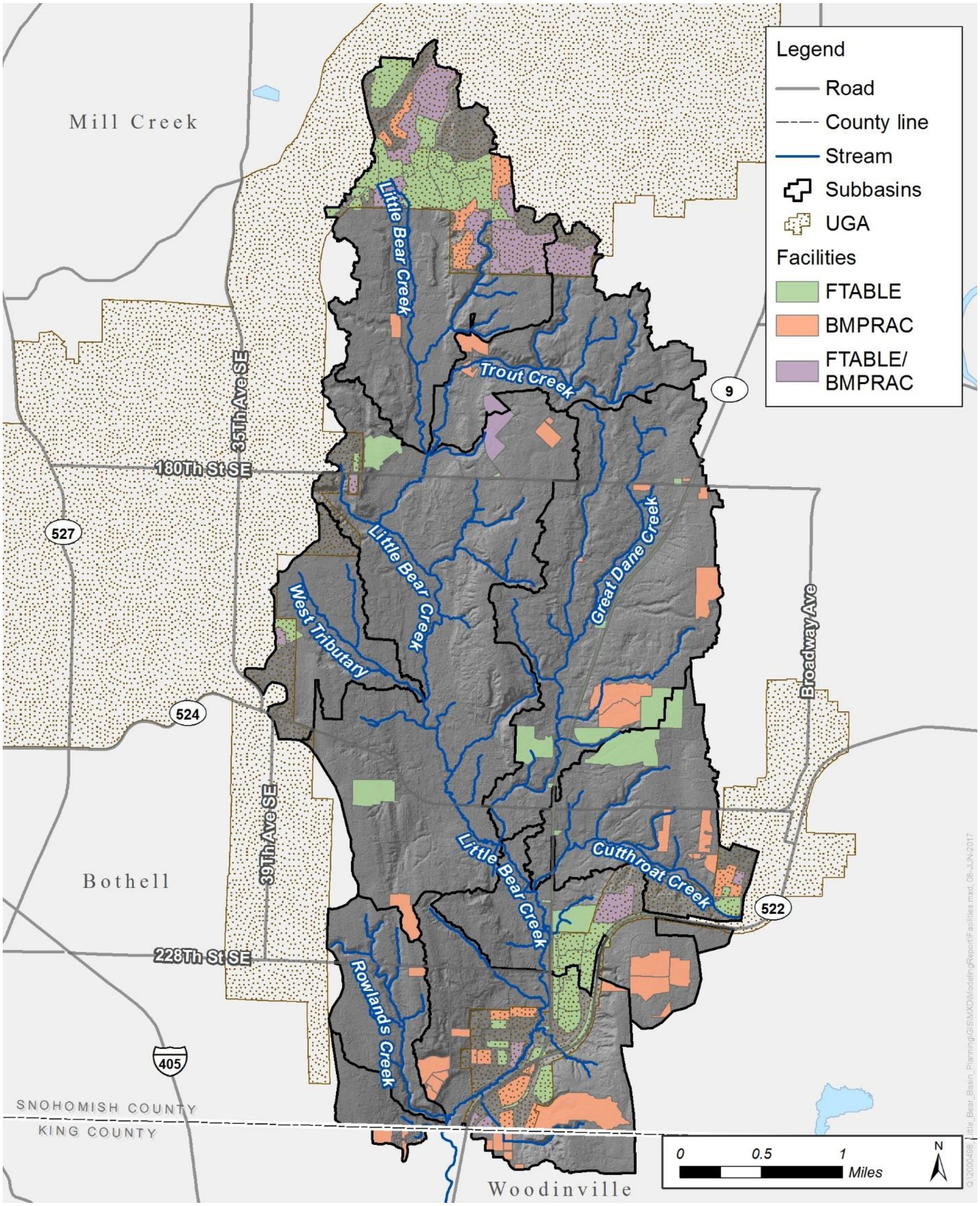


Figure 16 Catchments with Existing Stormwater Facilities Represented in HSPF

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4 HSPF MODEL CALIBRATION

The Little Bear Creek HSPF model hydrology and water quality routines were calibrated to assure that the model reasonably represents generation and transport of runoff and pollutants within the basin. Calibration is the process of adjusting model parameters within acceptable limits until the resulting simulation provides a good match to observed data.

4.1 Hydrology

NHC calibrated the HSPF model hydrology (runoff quantity) routines to available flow data using two of the County's flow gages in the Little Bear Creek basin (shown in Figure 7): Little Bear Creek at 51st Avenue SE (LBLU) and 228th Street SE (LBLD). Hydrologic calibration focused on accurate and unbiased simulation of annual and seasonal volumes, peak flows for moderate to large events, event volumes, and low-flow conditions as needed to support water quality modeling. Hydro-ecologic metrics used to estimate B-IBI (see Section 2.2) were evaluated during calibration to ensure that hydrograph characteristics related to these metrics, such as event frequency and hydrograph flashiness, are also represented by the model.

For the calibration period, both the Silver Lake and Brightwater rain gages (shown in Figure 3) were used. Although there are not systematic differences in precipitation over the watershed, timing and intensities within events does vary. For the purpose of replicating specific observed events, use of the two rain gages (Silver Lake for the upper model and Brightwater for the lower model) provided better results and ability to calibrate flows with a largely consistent set of hydrologic parameters.

In order to calibrate the hydrologic model, adjustments were necessary to the initial assumptions related to groundwater, infiltration, and impervious area connectivity. Initial model runs clearly supported the presence of a groundwater divide (King County, 2005; Golder, 2005 as discussed in Section 3.7.1) in the northern part of the basin. Without groundwater from a significant portion of the watershed diverted out of the system, it would not be possible to match long-term volumes at either flow gage. As discussed in Section 3.7.1, the estimated location of the divide varied between studies (see Figure 11). Multiple model runs were performed, with the number of catchments with the groundwater routed out of the basin increasing with each run until a reasonable long-term water balance was achieved. The area of the model where groundwater was routed out of the basin is identified with blue shading in Figure 11 and falls between the groundwater divide locations identified by the groundwater studies.

Once a reasonable overall water balance was achieved at both gages, it was apparent that the pervious and impervious storm response was too large throughout the basin. To correct this, the surface infiltration (INFILT parameter) values were increased for till for the entire basin, giving a pervious response characteristic of a weathered till that has been documented in recent geologic mapping of the northeast Lake Washington area (Troost and Wisher, 2009). The percentages of total impervious area (TIA) directly connected to the drainage system, which are applied through the Schematic Tool (Section 3.5) and affect the distribution of IMPLNDs and PERLNDS, were decreased as shown in Table 13. The final adjustment was to decrease the value of the KVARY parameter—which affects seasonal groundwater recession rates—for till and saturated soils in the upper model area (see Figure 2) to improve agreement between the simulated and observed baseflow at the 51st Avenue SE gage. The final existing conditions PERLND and IMPLND distributions for both upper and lower model areas are shown in Appendix A.

Table 13 Effective Impervious Fraction Comparison

EIA Table	Land Use	Calibrated Percent TIA Connected	DNR Percent TIA Connected
1	COMM	50†	95
	FOREST	0	0
	GRASS	0	0
	MFR	64	80
	PAST and RURAL	0	0
	SFR-HIGH	40	60
	SFR-LOW	20	20
	SFR-MED	40	40
	TRANS	72	90
	WATER	100	100
	TRANS2	72	90
2	COMM	90	95
	FOREST	0	0
	GRASS	0	0
	MFR	80	95
	PAST and RURAL	0	0
	SFR-HIGH	50	70
	SFR-LOW	20	20
	SFR-MED	40	60
	TRANS	90	95
	WATER	100	100
	TRANS2	90	95

† Many commercial areas outside of UGAs have unpaved parking areas and informal drainage systems. Lower connection efficiency would be expected and improved flow calibration.

The flow calibration was evaluated at the 51st Avenue SE and 228th Street SE gages using four different metrics:

- Long-term annual and monthly mean flows
- Minimum 7-day average flow (7Qmin)
- Event volumes and peak flows
- B-IBI metrics

The observed and simulated long-term annual and monthly mean flows are compared in Table 14. Simulated flow is in good agreement with the observed data, with the annual mean flow within three percent at both gages and the majority of the monthly mean flows within 5 to 15 percent of observed.

Table 14 Long-term Monthly Mean Flows

	51st Gage (2004-2015) Mean Flow [cfs]		Ratio of Means
	Observed	Simulated	
Annual	4.3	4.4	1.03
January	7.5	6.9	0.92
February	4.9	5.1	1.04
March	5.6	6.6	1.17
April	4.7	5.4	1.14
May	3.2	3.3	1.02
June	2.9	2.9	1.00
July	1.7	1.9	1.11
August	1.7	1.9	1.09
September	2.2	2.1	0.95
October	3.1	2.9	0.91
November	5.9	5.9	1.00
December	8.0	8.3	1.04

	228th Gage (2002-2015) Mean Flow [cfs]		Ratio of Means
	Observed	Simulated	
Annual	17.1	16.5	0.97
January	32.8	29.8	0.91
February	21.3	22.6	1.06
March	25.1	26.2	1.04
April	18.0	19.4	1.07
May	10.6	11.5	1.08
June	9.1	9.4	1.04
July	5.4	6.2	1.16
August	5.3	5.5	1.04
September	6.9	5.9	0.85
October	11.7	9.1	0.78
November	25.6	21.8	0.85
December	32.3	30.1	0.93

The 7Qmin is the minimum seven-day average flow and is an important metric in relation to temperature. From 2006 to 2015—with the exception of two years at each gage where the observed flow record either has discontinuities, varies significantly from manual measurements, or appears very low—the simulated values are well correlated with the observed values, as shown in Table 15. On average, simulated 7Qmin is within 2.5 percent of observed, and on an annual basis, simulated 7Qmin is typically within 15 percent of observed.

Table 15 Minimum 7-Day Flow (7Qmin) (2006-2015)

51st Ave WY	Obs cfs	Sim Cfs	Difference cfs	% Difference
2006	1.1	1.2	-0.2	12.3%
2007	1.4	1.3	0.0	-1.4%
2008	1.1	1.4	-0.3	22.0%[1]
2009	1.1	1.2	-0.1	8.3%
2010	0.5	1.6	-1.2	72.0%[1]
2011[2]				
2012	1.7	1.6	0.1	-9.5%
2013	2.1	1.8	0.3	-18.5%
2014	1.3	1.5	-0.2	11.5%
2015	1.3	1.4	-0.1	7.3%
		Average	0.04	-2.5%

[1] Water year not included in average due to observed flow data quality issue
[2] Significant data missing from observed flow record during dry season

228th St WY	Obs Cfs	Sim Cfs	Difference cfs	% Difference
2006	3.5	3.6	-0.1	2.3%
2007	2.9	4.2	-1.4	32.3%[1]
2008	3.2	4.6	-1.4	30.3%[1]
2009	3.6	3.8	-0.2	5.9%
2010	3.9	4.8	-0.9	17.9%
2011	4.8	4.6	0.2	-5.3%
2012	5.0	4.4	0.6	-13.7%
2013	5.0	4.9	0.1	-2.0%
2014	4.6	4.4	0.3	-6.0%
2015	4.4	4.6	-0.2	4.2%
		Average	-0.03	0.4%

[1] Water year not included in average due to observed flow data quality issue

A number of storm hydrographs were also compared at the 51st Avenue SE and 228th Street SE gages (26 and 20 events, respectively). Simulated and observed event volumes and peak flows are shown in Table 16. The simulated peak flows and event volumes are in good agreement with the observed data, are not systematically high or low, and typically are within 20 percent of the observed data, which is quite good for individual events. The event hydrographs in Figure 17 and Figure 18 provide representative examples of the quality of the fit over the full event hydrograph.

Table 16 Comparison of Simulated and Observed Peak Flows and Volumes

51st Avenue Gage		
	Percent Difference	
Event	Peak	Volume
2/1/15	2.3%	-3.8%
1/4/15	-7.3%	-12.9%
2/10/14	11.7%	2.9%
1/7/14	11.9%	-6.8%
3/15/14	20.9%	25.2%
3/4/14	6.7%	17.5%
1/27/13	0.2%	3.0%
1/6/13	8.4%	-1.1%
12/19/12	-7.1%	-5.3%
12/15/12	-24.6%	-17.3%
11/28/12	-5.7%	-2.5%
11/19/12	14.3%	22.2%
3/13/11	51.2%	28.4%
12/11/10	21.4%	5.9%
11/25/09	-10.8%	-2.7%
4/1/09	-6.7%	0.7%
11/10/08	-38.6%	-11.6%
6/2/08	-49.9%	-19.2%
12/2/07	31.4%	51.0%
12/26/06	-1.3%	1.6%
12/14/06	13.1%	22.2%
1/29/06	51.0%	37.9%
12/25/05	19.9%	24.8%
12/9/04	-20.9%	6.2%
1/27/04	-16.2%	-10.5%
11/17/03	0.5%	1.2%
Average	**1.8%**	**5.3%**

228th Street Gage		
	Percent Difference	
Event	Peak	Volume
3/13/15	63.5%	28.8%
2/2/15	12.3%	-1.6%
3/15/14	-0.5%	0.2%
3/2/14	-9.1%	-3.0%
2/10/14	13.7%	-3.0%
1/6/13	-0.2%	6.0%
12/19/12	-22.9%	-12.1%
11/19/12	-13.4%	7.9%
3/13/11	3.1%	-1.5%
3/12/11	3.1%	1.4%
12/11/10	-24.3%	-10.5%
11/25/09	-26.1%	-12.4%
11/11/08	-24.7%	-27.0%
6/2/08	22.8%	3.4%
12/2/07	-15.8%	3.5%
12/26/06	-20.0%	-15.6%
12/14/06	31.9%	7.6%
1/29/06	16.2%	5.1%
12/25/05	-4.0%	-6.1%
Average	**-0.3%**	**-0.8%**

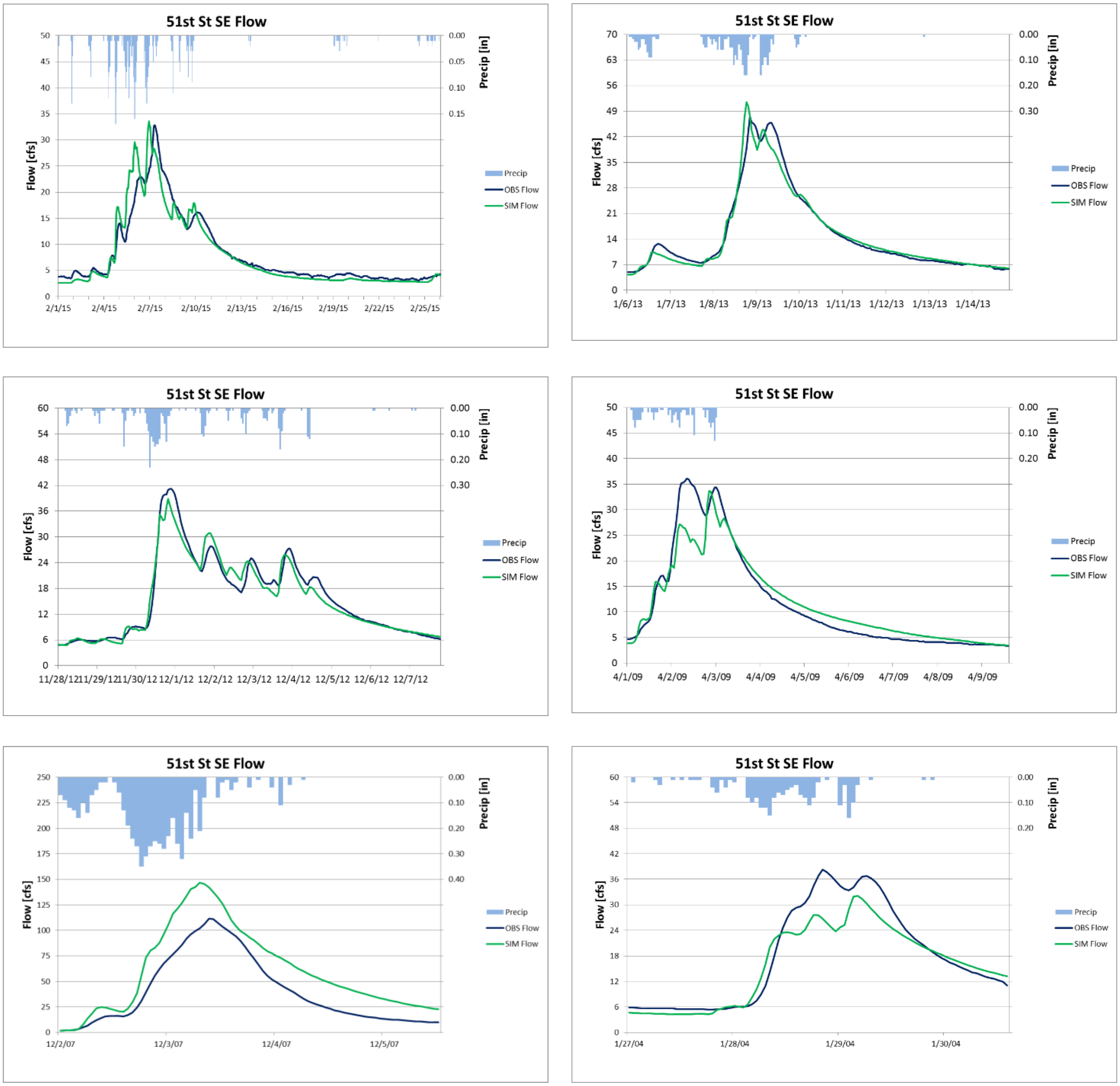


Figure 17 Event Hydrograph Comparison at 51st Ave Gage

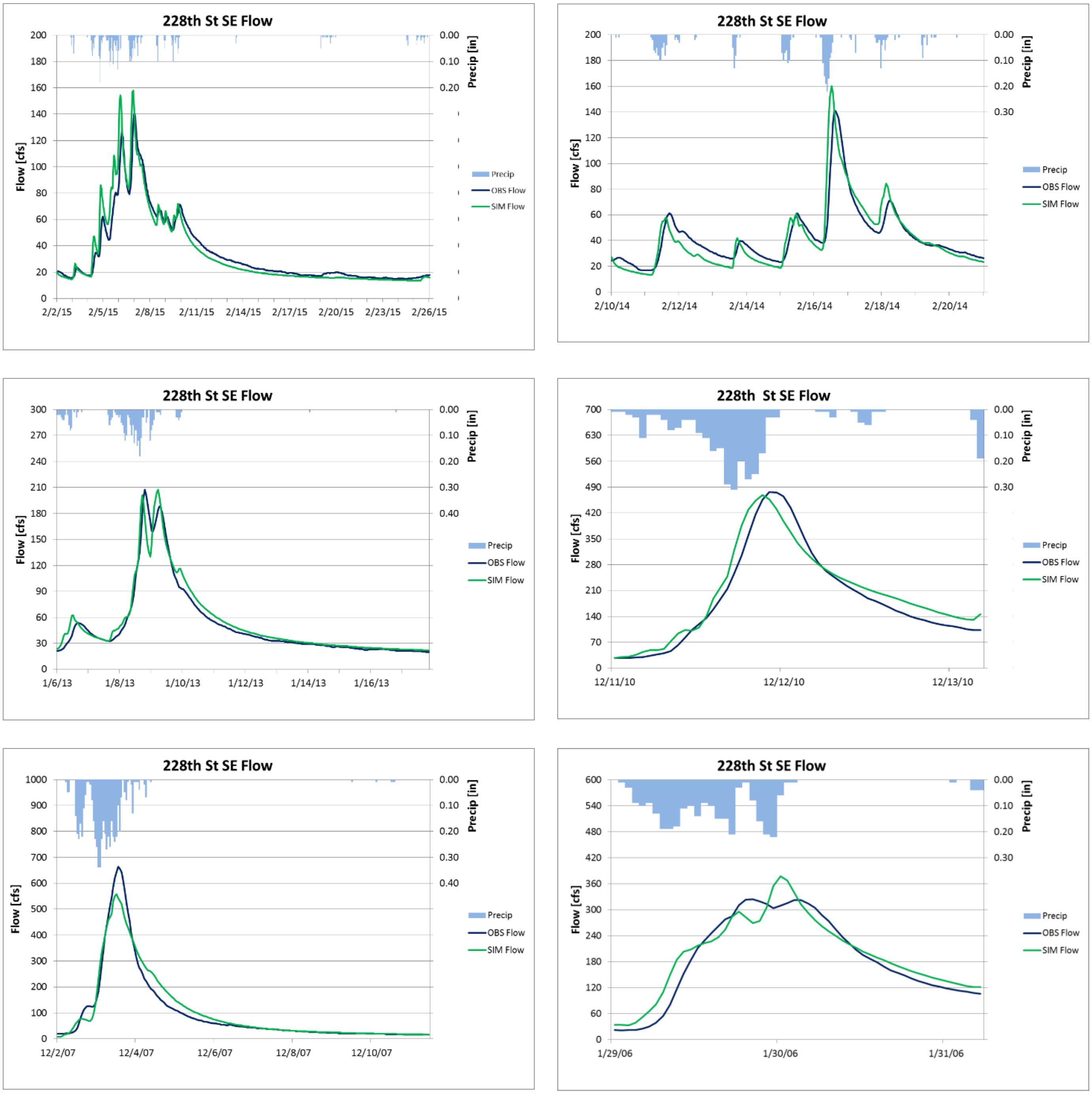


Figure 18 Event Hydrograph Comparison at 228th St Gage

The final hydrologic calibration metric is a comparison of the observed and simulated B-IBI metrics (HPC, HPR, and RBI) from 2004 to 2015, shown in Table 17 and Table 18. Correlations between hydrologic metrics and B-IBI are discussed in more detail in Section 2.2. The tables also compare the computed B-IBI (average of values computed from individual metrics) from the simulated flow metrics versus from the observed flow metrics. While the agreement between the model and the observed metrics varies from year to year, the model does a very good job of simulating the long-term average for each of the B-IBI metrics at both gages.

Table 17 Observed vs. Simulated Hydrometrics and Computed B-IBI – 51st Ave Gage (2004-2015)

Metric	HPC		HPR		RBI		Computed B-IBI	
	Obs	Sim	Obs	Sim	Obs	Sim	Obs	Sim
2004	6	7	106	137	0.24	0.31	38	35
2005	6	8	168	169	0.23	0.30	36	34
2006	6	10	92	150	0.27	0.30	38	33
2007	13	7	134	136	0.28	0.27	33	36
2008	11	12	188	188	0.29	0.33	32	30
2009	9	10	180	194	0.27	0.26	33	33
2010	11	17	147	320	0.28	0.29	33	24
2011[m]	14	12	161	161	0.32	0.31	30	32
2012[m]	4	12	52	167	0.21	0.28	41	32
2013	12	15	312	311	0.27	0.30	28	25
2014	15	11	179	115	0.22	0.28	31	34
2015	15	15	147	186	0.27	0.28	31	30
Mean	**10.4**	**11.2**	**165.3**	**190.6**	**0.26**	**0.29**	**33**	**31**

[m] Significant data missing from observed flow record during wet season. Mean computed for years without missing data.

Table 18 Observed vs. Simulated Hydrometrics and Computed B-IBI – 228th St Gage (2002-2015)

Metric	HPC		HPR		RBI		Computed B-IBI	
	Obs	Sim	Obs	Sim	Obs	Sim	Obs	Sim
2002	15	19	170	154	0.30	0.26	30	29
2003	8	3	100	99	0.20	0.24	38	40
2004	6	9	106	292	0.30	0.31	37	29
2005m	4	9	167	169	0.23	0.29	37	33
2006	7	11	158	150	0.34	0.29	34	33
2007	12	12	287	164	0.35	0.27	27	32
2008	15	14	234	204	0.35	0.32	27	29
2009m	7	9	148	181	0.37	0.27	34	33
2010	11	20	147	338	0.37	0.29	31	22
2011	12	13	196	198	0.35	0.31	30	30
2012m	7	15	132	215	0.24	0.27	37	29
2013	12	17	173	311	0.30	0.29	31	24
2014m	10	12	134	115	0.26	0.27	35	34
2015	15	14	147	148	0.25	0.28	31	31
Mean	**11.3**	**12.0**	**171.8**	**187.1**	**0.30**	**0.28**	**33**	**32**

m Significant data missing from observed flow record during wet season. Mean computed for years without missing data.

In addition to calibration at the 51st Avenue and 228th Street gages, the simulated flows were compared to short-term observed flow data at the DANE monitoring site. The overall simulated volume at this location was high compared to the observed volume and would require significant changes to the hydrologic parameters in the model to improve the agreement between the model and the observed data. This may be due in part to where groundwater emerges in the Great Dane basin, e.g. it may be bypassing the gage location. However, given the relatively short period over which flow data were collected at this location and the limited number of observations available to develop the rating curve, significant independent adjustments to parameters in the Great Dane subbasin based solely on these data did not appear warranted for the purposes of this project. If additional flow monitoring and/or hydrogeological studies are conducted in this subbasin, revisiting hydrologic calibration may be considered.

4.2 Water Quality

HSPF model water quality routines were calibrated to data collected at the same two gage locations used for flow calibration, as well as the LBBW site less than half a mile upstream of 228th Street[5]. In

[5] Project data (used for temperature, TSS, copper, hardness and fecal calibration) were collected at LBBW, while ambient data (used for TSS, zinc, and fecal calibration) were available for 228th/LBLD. The two gage sites are located in different HSPF reaches (RCHRES 300 for 228th, RCHRES 340 for LBBW), though simulated water quality is similar at both locations.

addition to these primary water quality monitoring sites, temperature was calibrated to project data collected at four supplemental sites.

Relative to stream flow, HSPF water quality constituents (temperature and concentrations) are more difficult to measure and more complex to model. As a result, both observed and simulated values have a higher degree of variability and uncertainty. Calibration approaches for water quality parameters were as follows:

- **Temperature** – Simulated stream temperatures were calibrated to time series of observed temperature. The 7DADMax metric used in the temperature standard was also computed and compared.
- **TSS, Metals and Hardness** – Simulated TSS, metals, and hardness calibration was based primarily on matching cumulative duration frequency curves (CDFs) for simulated and observed concentrations. CDF analysis allowed for use of longer data sets and allowed for more direct evaluation of the constituent loading rates, even when simulated concentration pollutographs (which also depend on flow) may not match observed concentrations for individual storm events. Pollutographs were also evaluated to compare simulated and observed concentrations during wet and dry weather periods.
- **Fecal Coliform** – CDFs were also the primary calibration method used for fecal coliform. Specific focus was placed on replicating the frequency at which both parts of the water quality standard were exceeded (see Chapter 2). Individual storm event pollutographs were not targeted due to the volatile and random nature of fecal coliform concentrations.

The calibration of each constituent focused on the seasonal periods most relevant to the water quality standards and/or metrics used for each constituent.

4.2.1 Temperature

The temperature of runoff from the land surface can be modified, but instream temperatures simulated by the model are dominated by the transfer of heat between the reach and the atmosphere and/or stream bed via processes such as solar radiation, conduction/convection, evaporation, longwave radiation, and flow exchange. The most sensitive parameters controlling these processes include ground temperature (TGRND), instream bed heat conduction (KMUD), and shade (CFSAEX). Temperature was calibrated in Little Bear Creek by adjusting values for these three parameters. The model was found to be the most sensitive to the shade (CFSAEX) parameter.

Ground temperature and groundwater temperature both have a significant impact on summertime temperatures of small streams and creeks. During stream walks conducted earlier in this project, water temperatures were measured at a number of observed springs. These spot provided an important supplement to the continuous water temperature monitoring data, which were collected at locations further downstream of springs. Based on these spot measurements—which were consistently at 11°C—and the continuous monitoring data, the groundwater temperature throughout the model was set to a constant value of 11.1°C (52°F).

Initial ground temperatures were determined from monthly average temperatures collected at the WSU AgWeatherNet site near Woodinville. These values were adjusted during calibration to improve the agreement between observed and simulated water temperatures.

Each type of heat transfer modeled in HSPF has a set of model parameters, but the key parameter that varies as a function of canopy cover is the shade variable CFSAEX, the correction factor for solar radiation. Initial CFSAEX values for existing conditions calibration were estimated using a LiDAR-derived vegetation height to calculate the fraction of a 10-meter buffer around each stream or ditch reach that was shaded by trees of a) 20 feet to 50 feet and b) greater than 50 feet in height. A weighting scheme was applied to calculate the initial CFSAEX value for each reach. These values were varied by a constant factor (to preserve relative distinctions between reaches) during calibration to best match the observed water temperatures at all calibration locations. Pipe and facility reaches were assigned CFSAEX values of 0.01 (representing enclosed) and 0.50 (open canopy), respectively. Due to the relatively small size and number of pipe and facility reaches and lack of temperature data local to these facilities, there was insufficient information to further evaluate or refine those initial values.

The other parameter that was adjusted as part of the temperature calibration was the bed heat conduction parameter (KMUD). With the exceptions of reaches that were identified as spring-fed (see discussion below), KMUD values were assigned on a regional basis, with reaches upstream of a temperature monitoring site all assigned the same value. The KMUD values were adjusted individually for the contributing area upstream of each gage to try to best meet match the downstream temperature data. West Trib and Rowlands Creek do not have observed temperature data, so KMUD parameters from the upper portion of Great Dane and Trout Creek were applied to these basins.

Two of the temperature monitoring sites, Great Dane at Maltby Road and Little Bear Creek at Interurban Boulevard, were located directly downstream of springs. These reaches have very low water temperatures during the summer, with daily minimums of approximately 11.1°C. To calibrate these reaches, very low KMUD and CFSAEX values of 5 and 0.01, respectively, were applied to keep the water temperature cold by limiting heat transfer from the ground or solar radiation. The same “spring” parameters were applied to the downstream reaches of Rowlands Creek, where springs were also identified during stream walks.

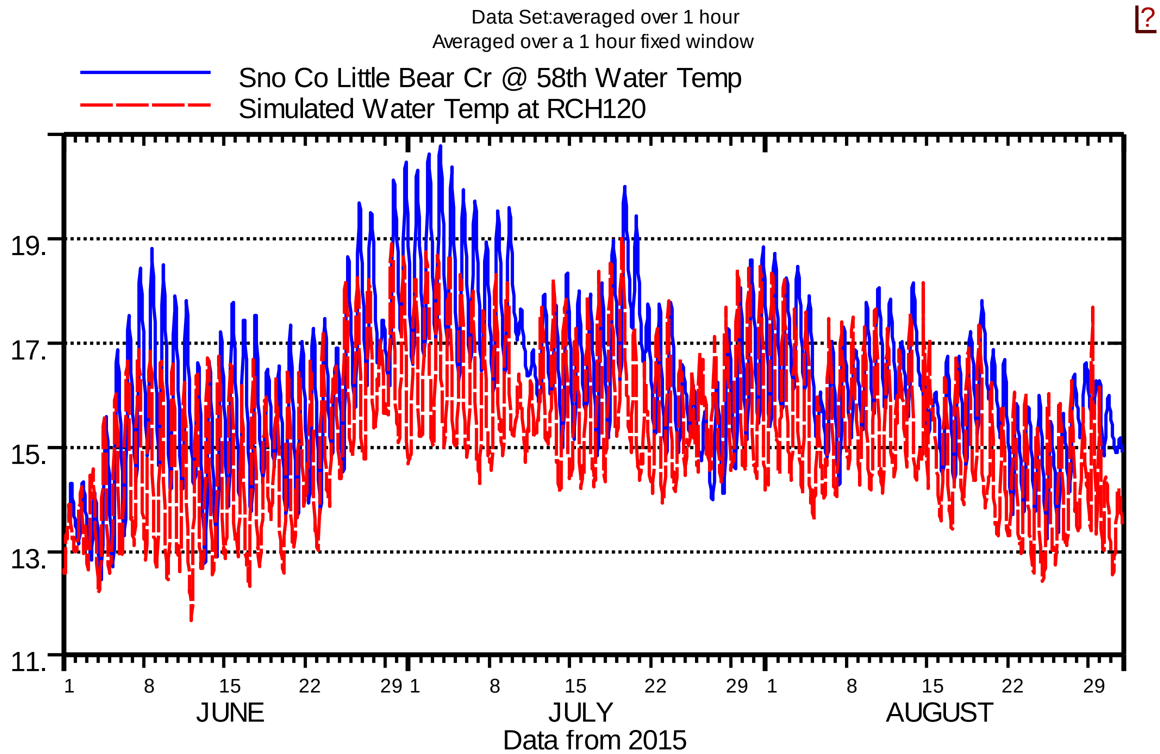
The quality of the temperature calibration was quantified by comparing simulated and observed average 7DADMAX temperatures for the supplemental, spawning/migration, and core summer periods (defined in the water quality standard) at four temperature gages where data were collected from January 2014 to December 2015. As can be seen in Table 19, the model reproduces the average 7DADMAX in each period within 1°C, and the model is most accurate during the core summer period. Figure 19 through Figure 25 show plots comparing hourly observed and simulated water temperatures during the summers of 2014 and 2015 at six temperature gage sites. The simulated data are typically unbiased and provide an adequate simulation of water temperatures. It should be noted that the simulated temperature in Trout Creek is significantly different then the observed data in the later part of the summer. It is believed that this may be due to low water levels in Trout Creek, creating dry or nearly dry conditions through August.

HSPF has limitations on temperature simulation accuracy under extremely shallow flow conditions and is best suited to simulate temperatures in larger streams where groundwater and hyporheic flow inputs are small relative to the total flow in the stream. The calibration results indicate that the flows in the Trout Creek may be small enough that the model cannot accurately match observed temperatures in late summer.

Table 19 Observed vs Simulated 7DADMax

Location	Average 7DADMax(°C)						Absolute Mean Error 7DADMax (°C)			
	Supplemental Sept 15- May 15		Spawning/Migration May 16 – Jun 14		Core Summer Jun 15 - Sept 14		Annual	Sep 15 – May 15	May 16 – Jun 14	Jun 15 – Sep 14
	Sim	Obs	Sim	Obs	Sim	Obs				
Dane	8.7	9.0	12.3	12.7	14.1	13.8	0.7	0.9	0.4	0.5
51st	9.3	9.4	16.0	16.6	17.4	17.7	0.9	1.0	1.0	0.7
LBBW	9.2	9.2	14.8	14.9	16.3	16.3	0.7	0.8	0.4	0.5
58th	10.0	10.0	16.5	17.5	16.5	16.9	0.8	1.0	1.0	0.5

Values only computed for periods with observed data
Period of record Jan 2014 – Dec 2015 except 58th (Aug 2014 – Dec 2015). Large gaps in observed data during winter months.



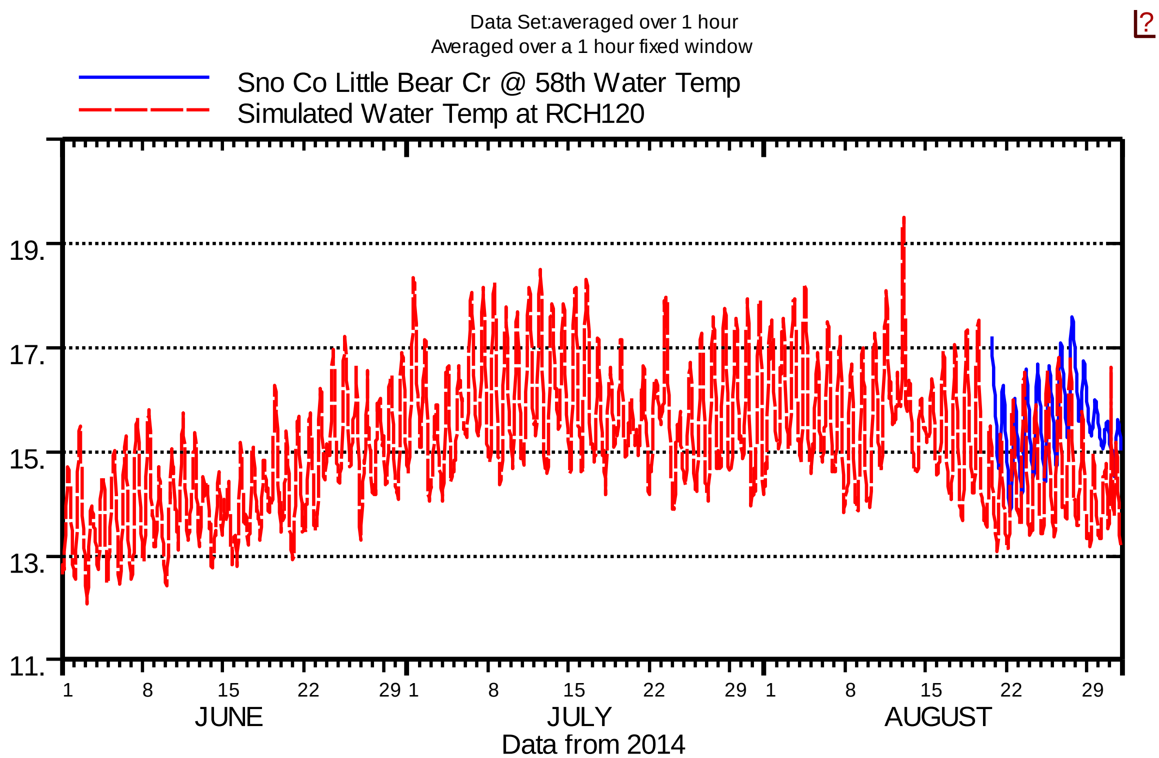
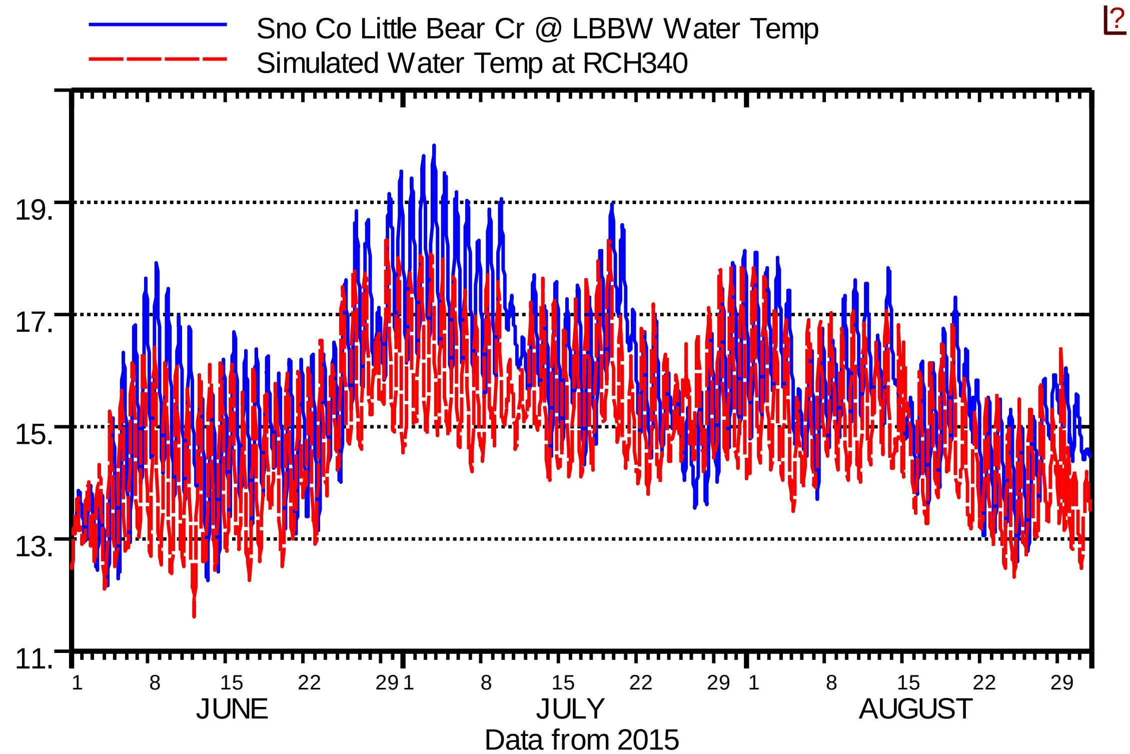


Figure 19 Simulated vs Observed Summer Temperatures – Little Bear at 58th St Gage



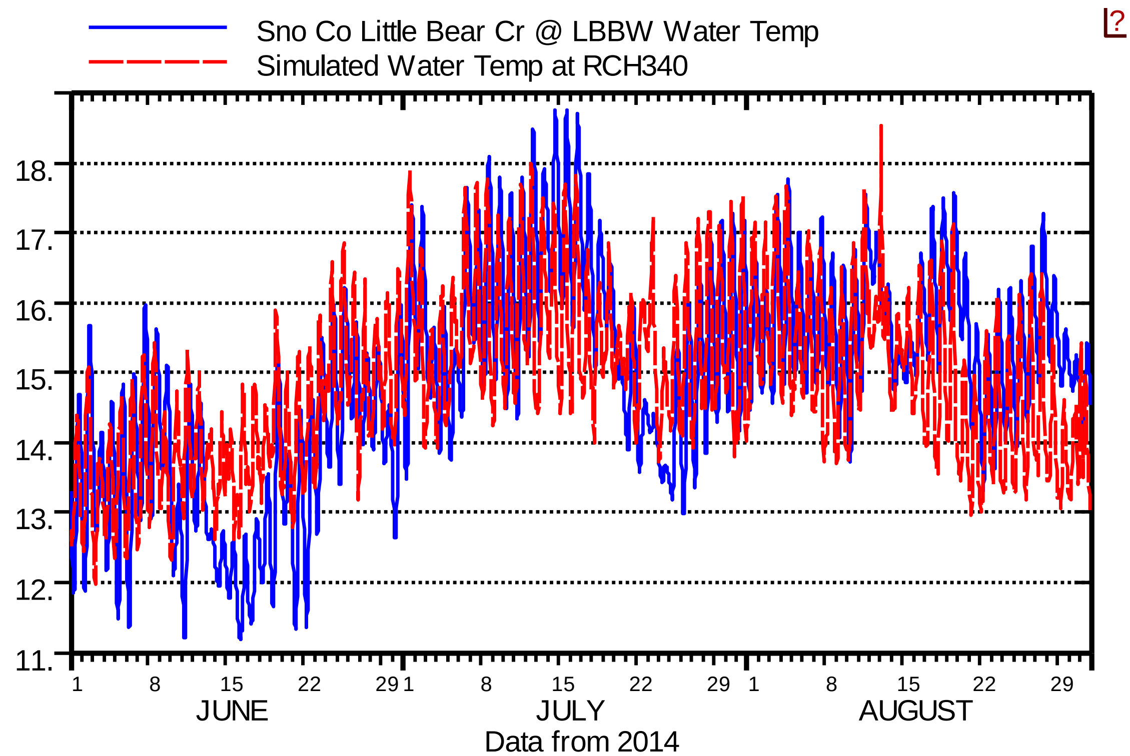
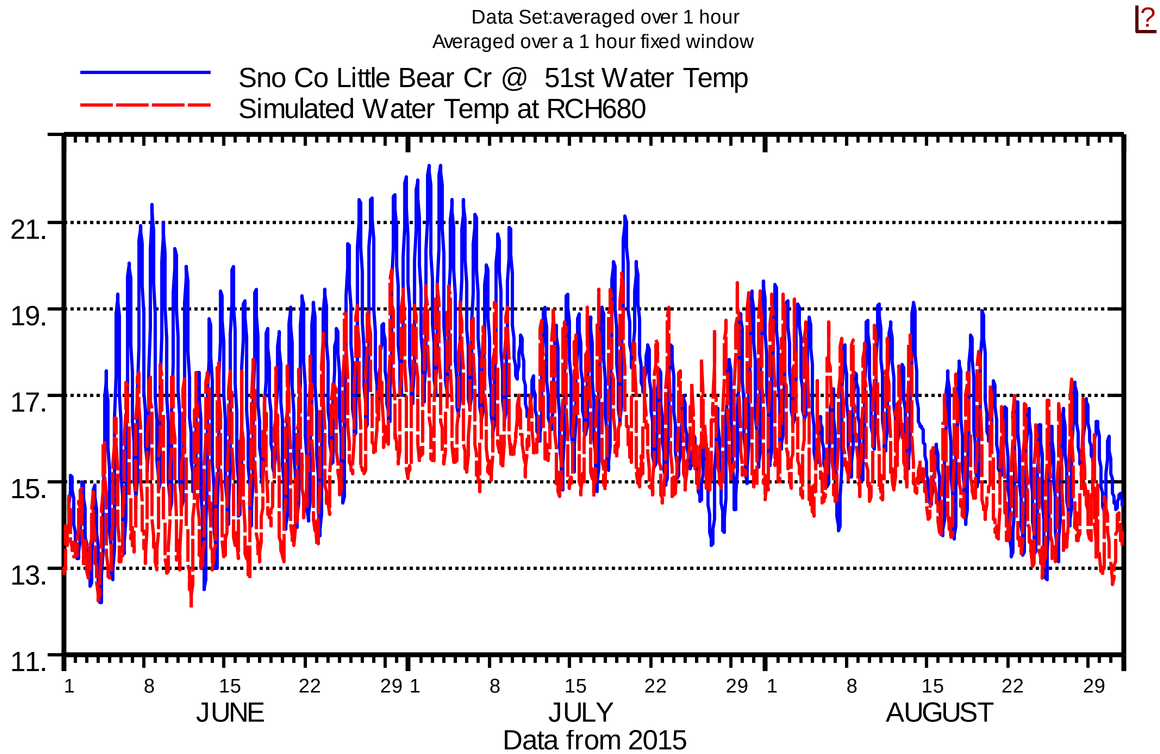


Figure 20 Simulated vs Observed Summer Temperatures – Little Bear at LBBW Gage



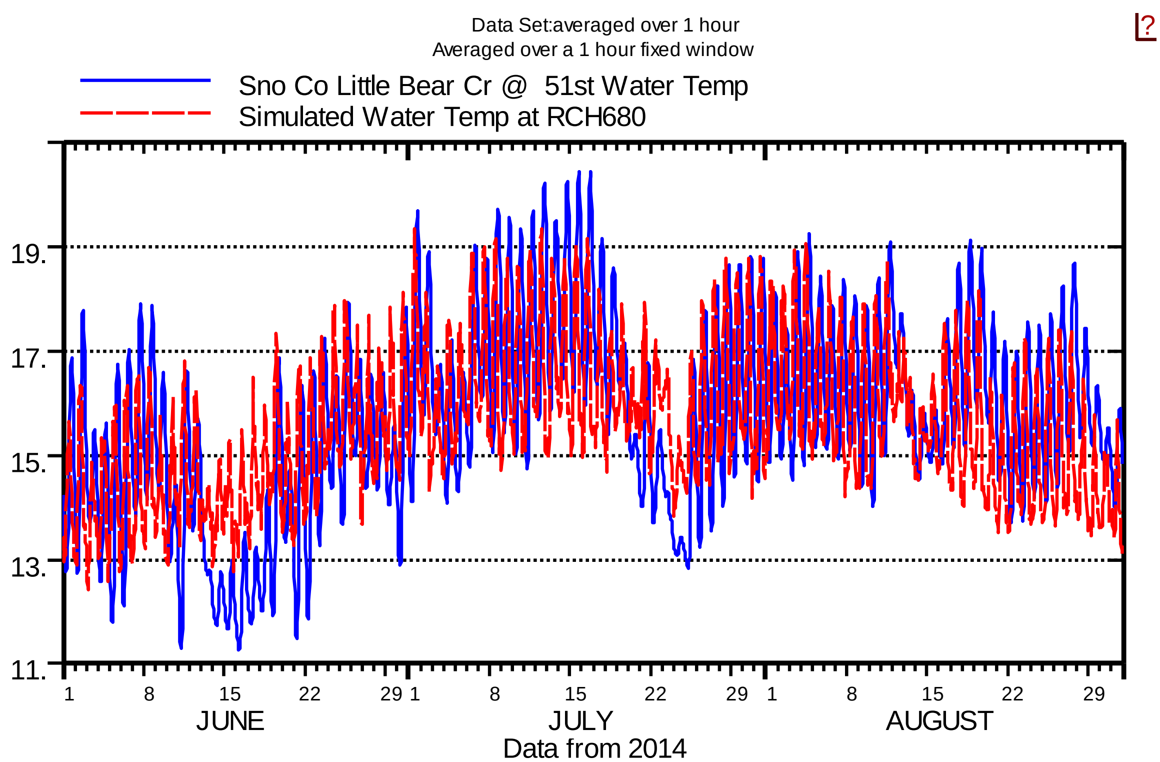
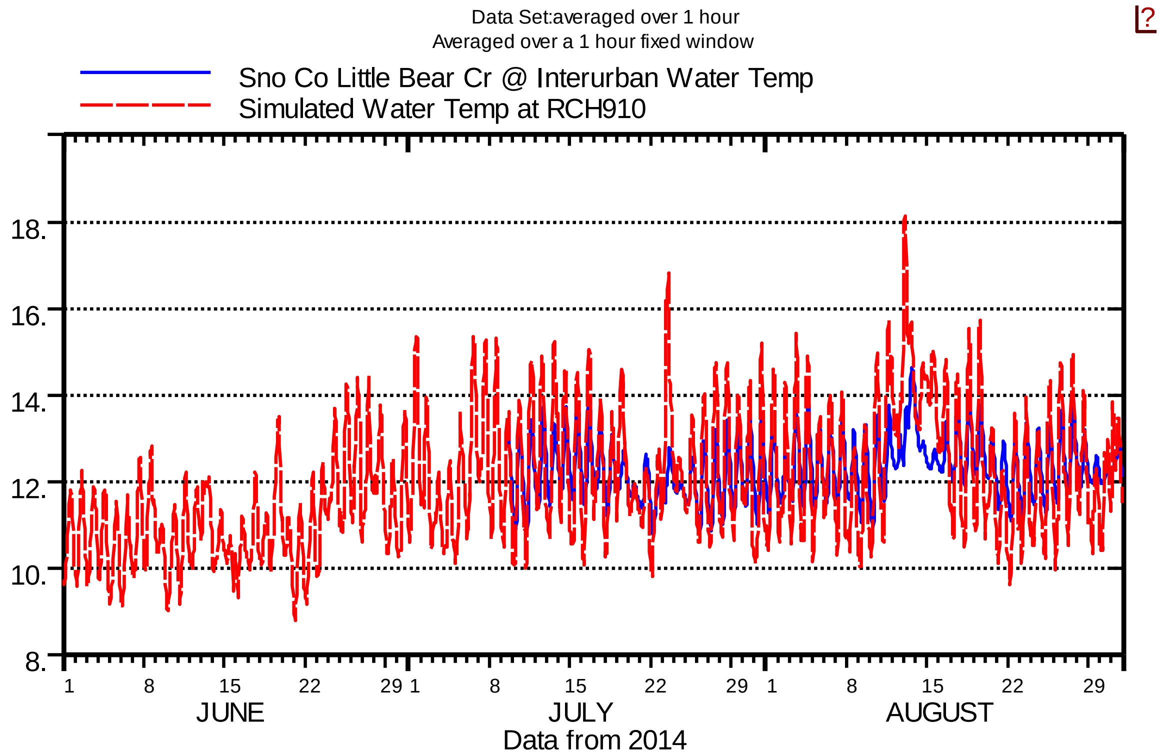


Figure 21 Simulated vs Observed Summer Temperatures – Little Bear at 51st Ave Gage



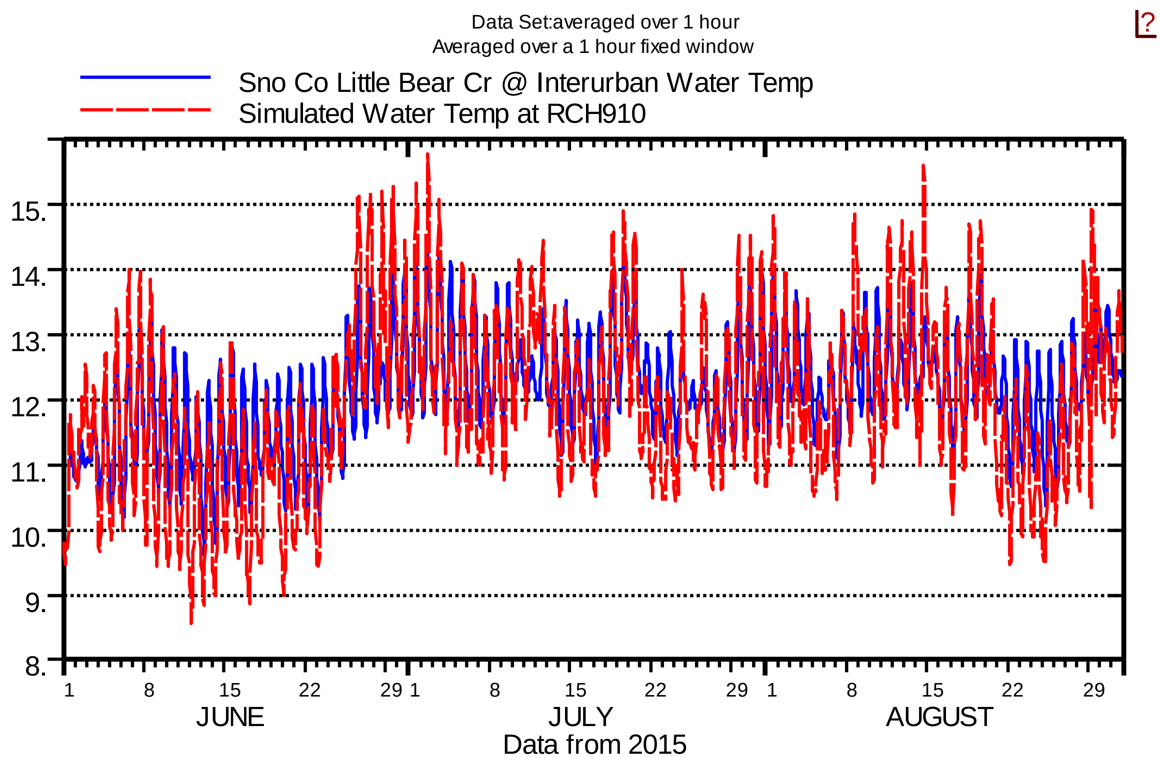
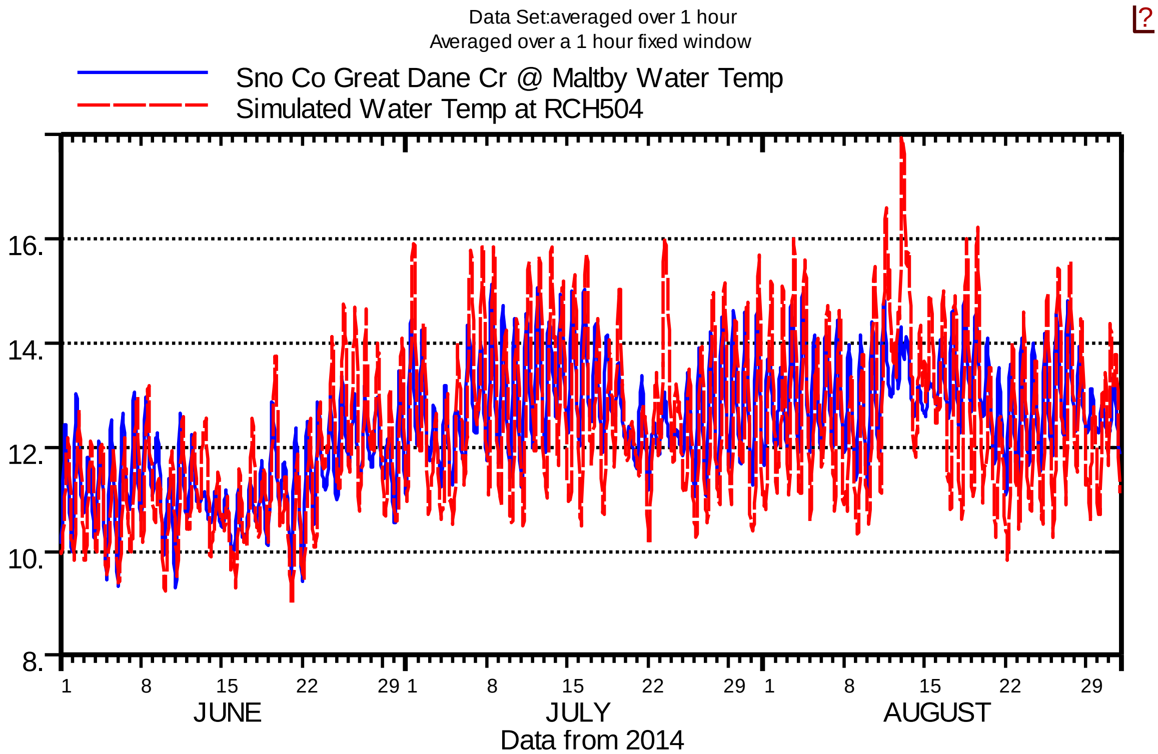


Figure 22 Simulated vs Observed Summer Temperatures – Little Bear at Interurban



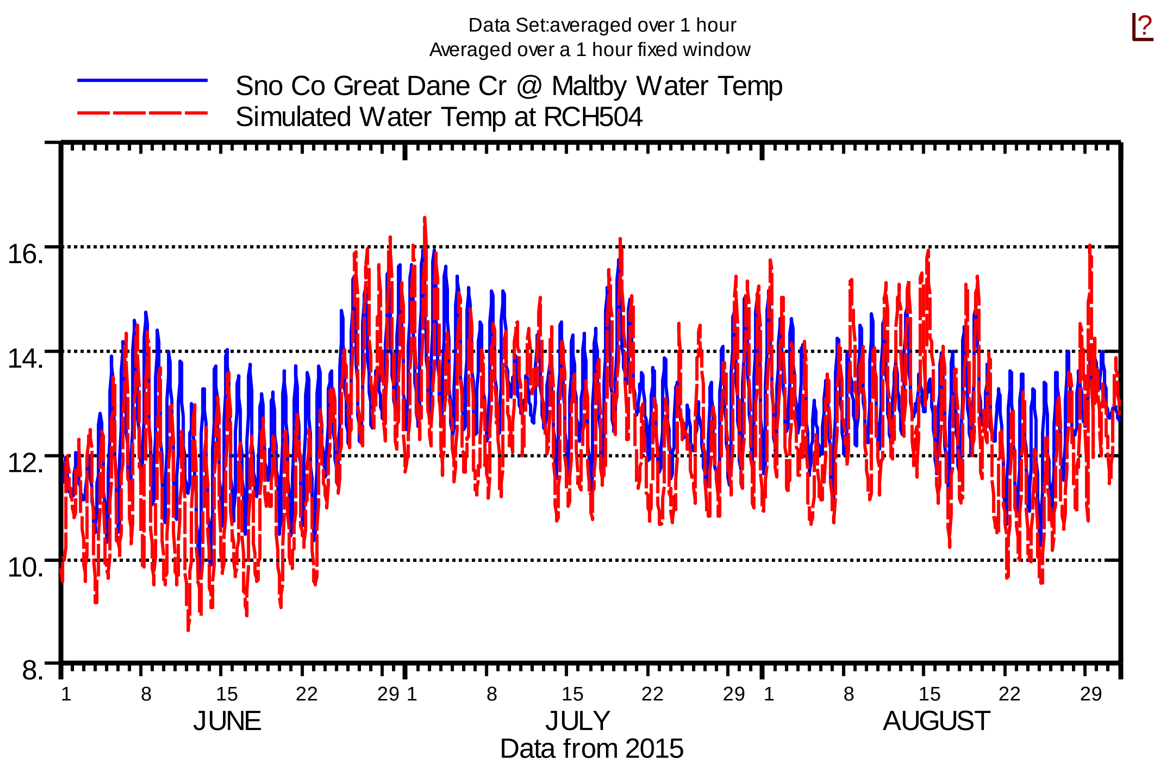
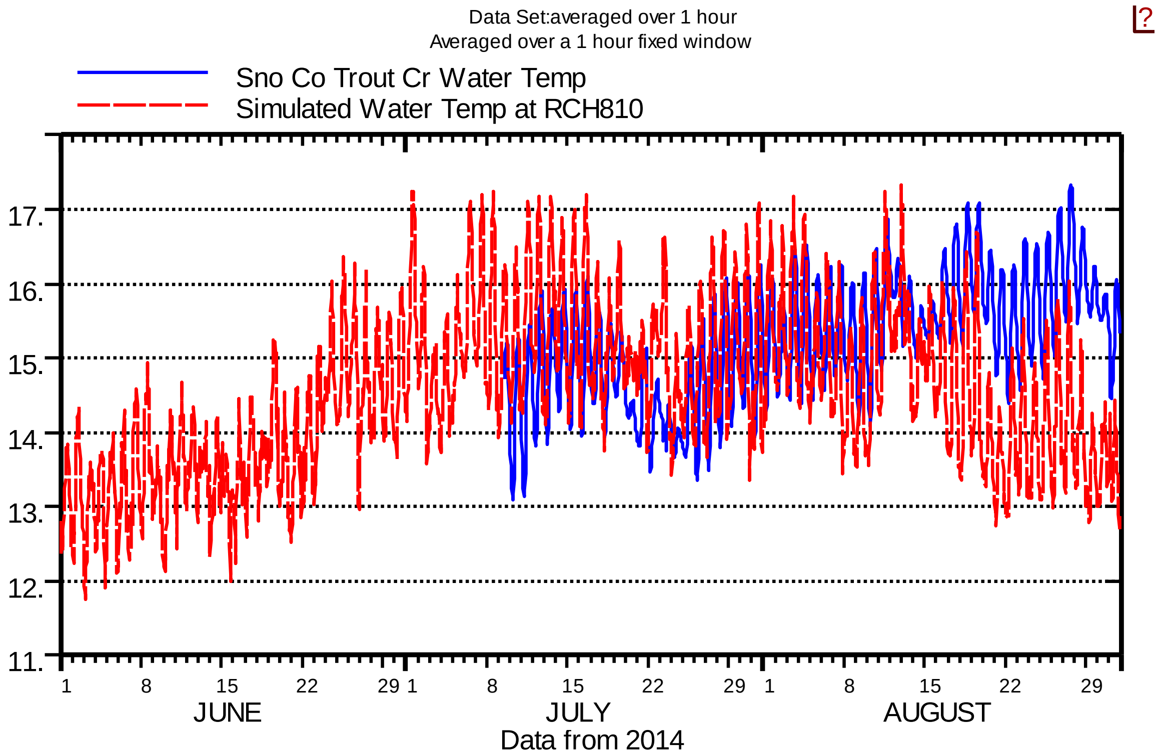


Figure 23 Simulated vs Observed Summer Temperatures – Great Dane at Maltby Road Gage



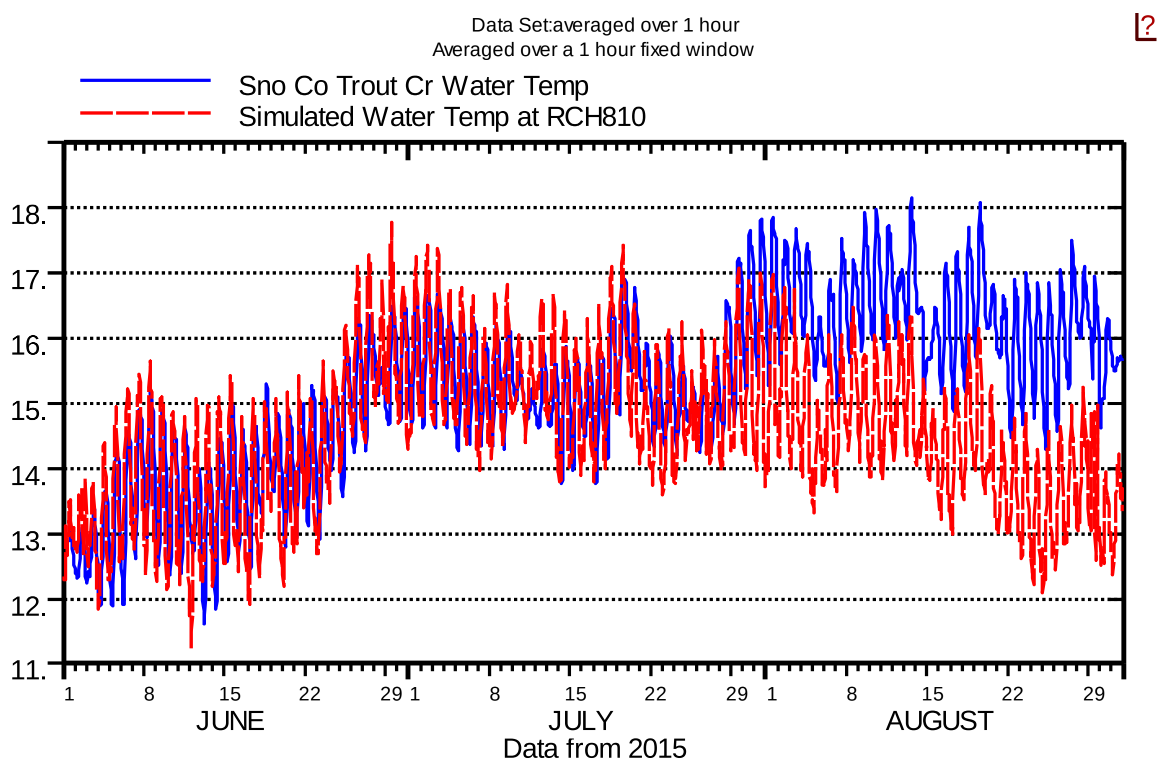
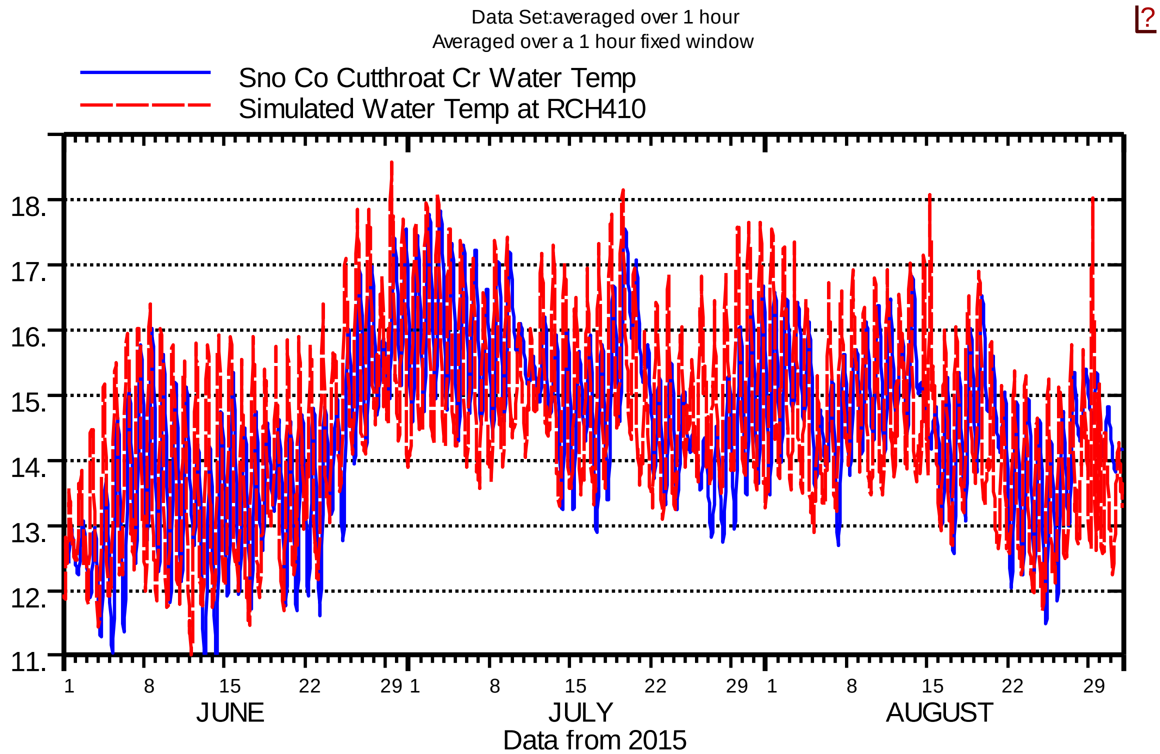


Figure 24 Simulated vs Observed Summer Temperatures – Trout Creek Gage



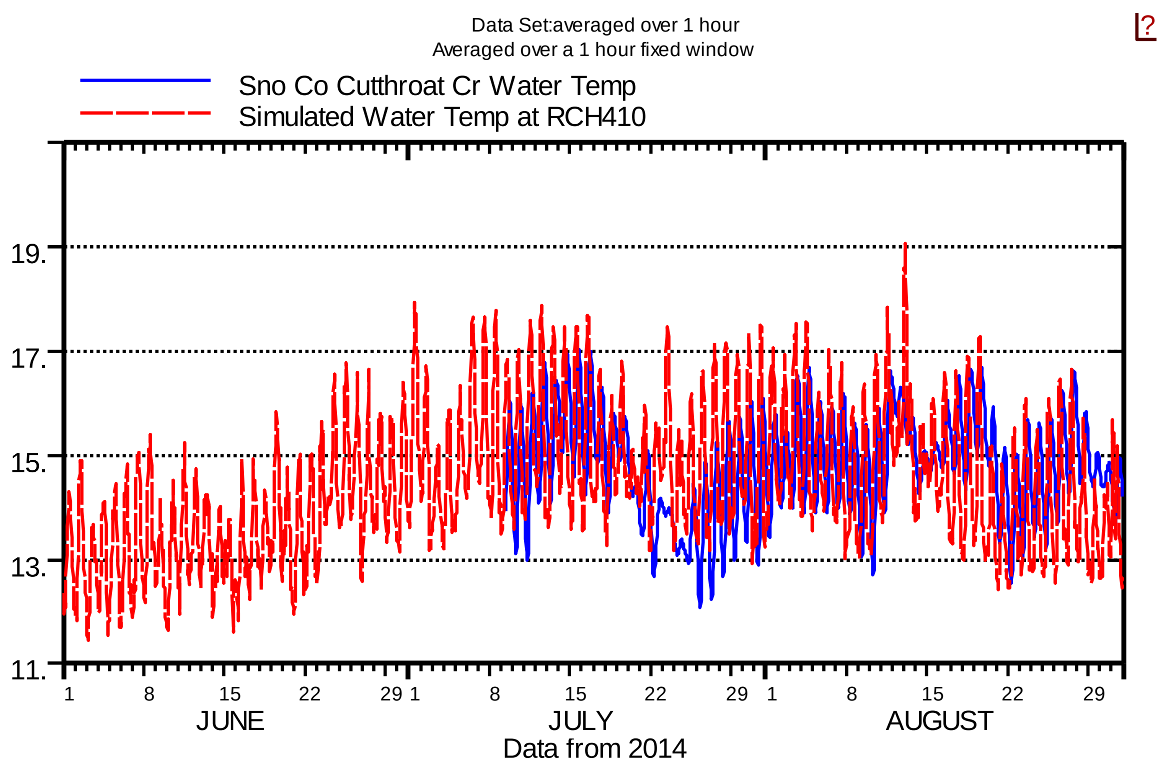


Figure 25 Simulated vs Observed Summer Temperatures – Cutthroat Creek Gage

4.2.2 Initial Surface Load Calibration to Department of Ecology S8.D Data

The Department of Ecology S8.D data provide annual load and/or concentration data for the water quality constituents being modeled for single family residential, multifamily residential, and commercial land use. The initial phase of calibration of TSS, metals, hardness and fecal coliform parameters was targeted at reproducing the ratios of loads between the three different land uses for each constituent. There were several difficulties in doing this:

- Large range of impervious percentages for individual land uses in S8.D data set
- Low surface runoff characteristic of Little Bear Creek basin limits pervious contribution, i.e. peak pollutant loads are dominated by impervious response
- Lack of land use-specific observed data in the study area.

Due to these issues there was a relatively large uncertainty related to the ratios derived from the S8.D data. During calibration these initial load ratios were targeted, but deviations were allowed when required to match in-basin observed concentration data.

4.2.3 Total Suspended Solids (TSS)

The TSS calibration involved calibrating simulated data to both cumulative duration frequency (CDF) curves combining project data (CardnoTEC, 2015) and longer term ambient data and to observed pollutographs from project data. The calibration was limited to the 51st Avenue SE, LBBW, and 228th Street SE gages, where project data and longer ambient data sets were available. TSS loads are generated from a combination of surface buildup and washoff from PERLNDs and IMPLNDs and instream processes of erosion and sedimentation. The same parameters were applied throughout the model.

During calibration it became apparent that the pervious contribution was limited to only a few larger events during the period where project data were collected, due to low pervious surface runoff in the model. Sediment loads from impervious surfaces are thus a much more significant source of sediment washoff. The surface accumulation and surface storage limit parameters for the three different IMPLNDs were adjusted to reproduce the observed data during the period when project data were available. It was assumed that erosion during the monitoring period was largely limited to the one large event in December 2015 where significant erosion was observed at the Great Dane flow gage. The instream parameters were adjusted to limit erosion to this event.

Given the relatively short project data record and the relative abundance of long-term ambient data, CDF curves were developed combining both sets of observed data. The PERLND and IMPLND buildup and washoff parameters, as well as instream process parameters, were then refined to best match simulated and observed CDF curves. The pollutographs and CDF curves for the final calibrated parameters are shown in Figure 26 through Figure 29. For the downstream location, the pollutograph compares simulated concentrations for HSPF RCHRES 340 with observed data from LBBW. The observed CDF curve uses data from both 228th and LBBW but contains significantly more data from the 228th gage due to record length, so was compared to the curve from simulated data at RCHRES 300. The model does a good job of simulating both types of curves at both locations.

Table 20 compares the average annual TSS load for commercial and residential land use[6] from the calibrated model to published load values from several western Washington studies. The range of values in the literature is very wide, indicating the difficulty and limitations of calibrating to land use specific data. The Little Bear model values fall within the published range.

Table 20 Comparison of Simulated and Literature Mean Annual Loads for TSS

	EIA Table	Model	Annual Mean Load TSS (lb/ac/year) Puget Sound Toxics Study (Ecology 2011)	Green[a]	Literature[b]
Commercial	1	60.2	49.2	153.4	374.7
	2	103.1			
Residential	1	24.1	45.1	140.8	8.9
	2	29.1			

[a] Green-Duwamish Watershed Water Quality Assessment (Herrera 2007)

[b] Burton and Pitt (2002); Horner et al. (1994); Madison et al. (1979)

[6] General land use categories are a composite of impervious and pervious (grass) HRUs.

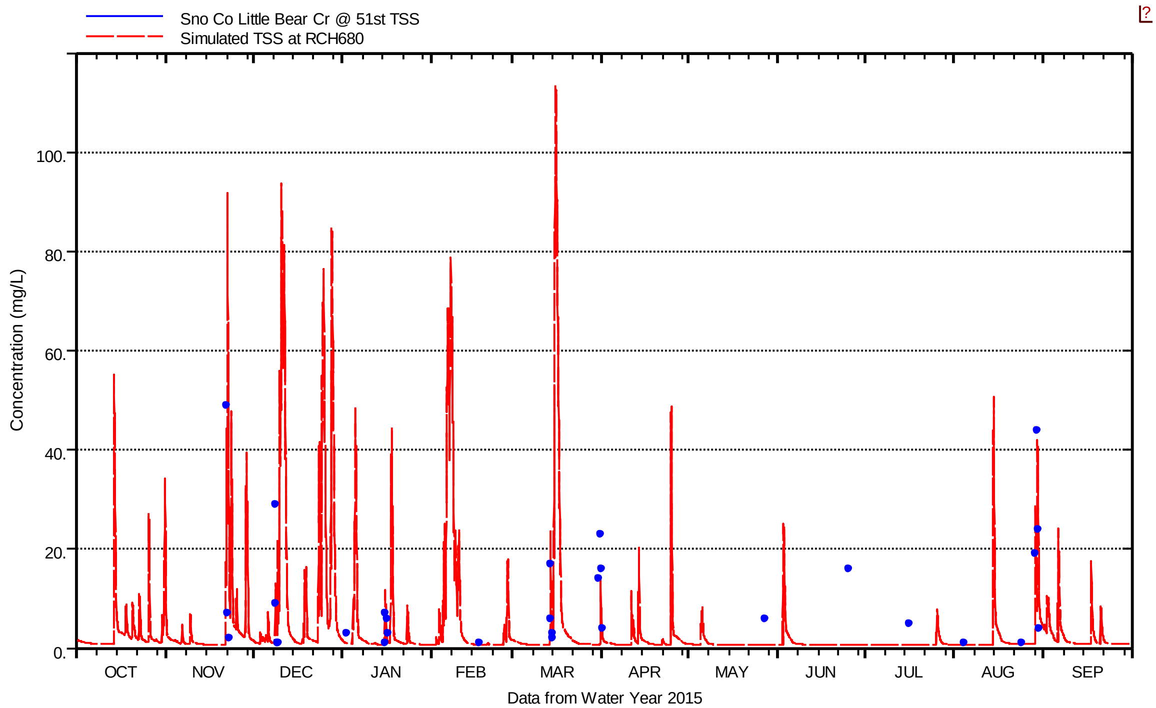


Figure 26 TSS Pollutograph at 51st Ave Gage

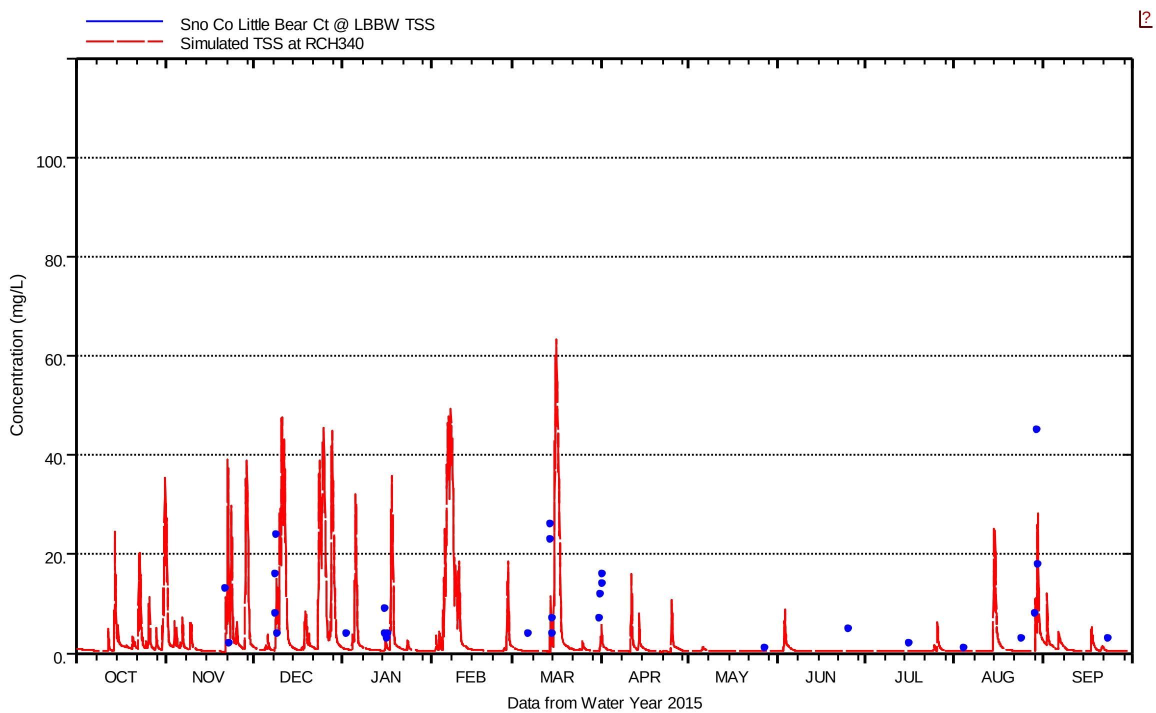


Figure 27 TSS Pollutograph at LBBW

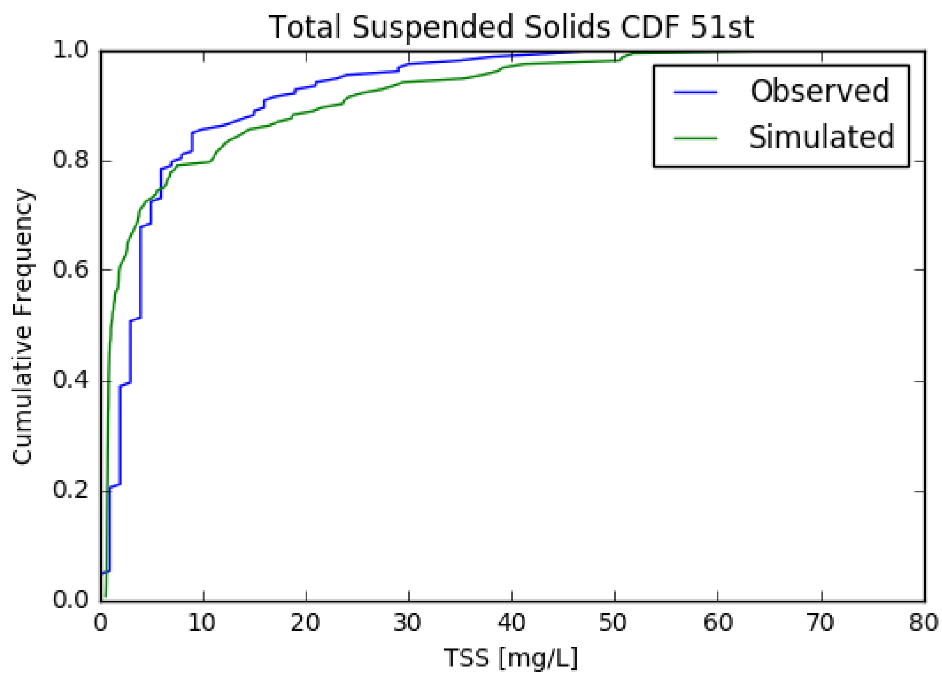


Figure 28 **TSS CDF Plot at 51st Ave Gage**

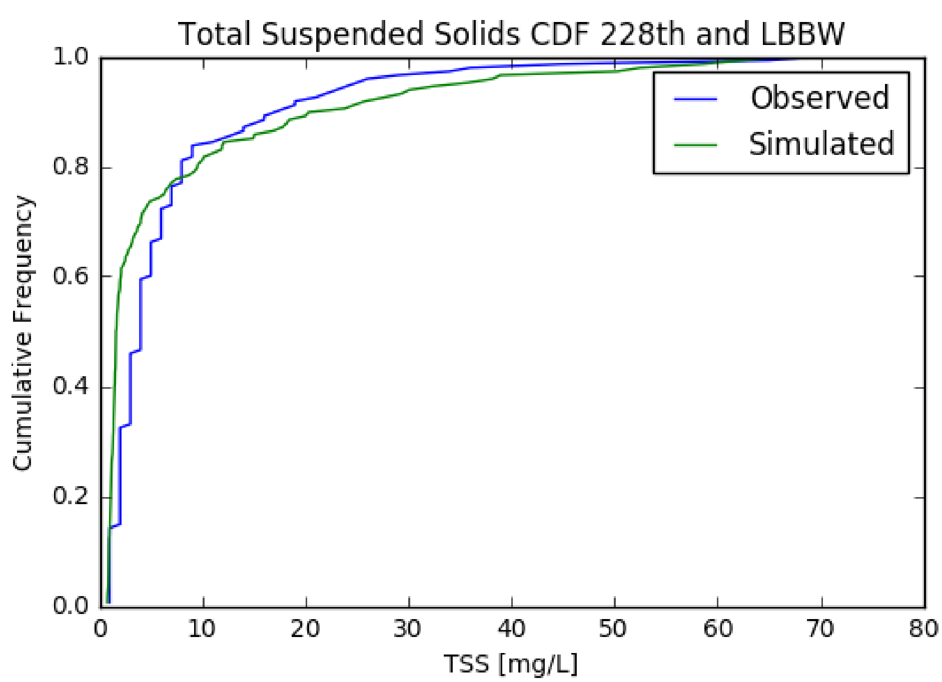


Figure 29 **TSS CDF Plot at 228th Street. Observed curve includes data from 228th and LBBW gages.**

4.2.4 Metals/Hardness

Evaluation of the copper and zinc water quality standards is required by the Permit. In order to evaluate these standards (Section 2.1), dissolved copper, dissolved zinc, hardness, and TSS must all be simulated. Copper and zinc loads, due to their sediment association, are adjusted in HSPF using monthly potency factors, interflow, and groundwater concentration for PERLNDs and a constant potency factor for IMPLNDs. The partitioning coefficients (see Section 3.6.1) were not adjusted during calibration and the calibration focused on matching total copper and zinc, for which more data were available. Hardness is simulated using buildup and washoff, so calibration involves adjusting an accumulation rate, surface storage limit, washoff parameter, interflow concentration, and groundwater concentration for PERLNDs and accumulation rate, surface storage limit, and washoff parameter for IMPLNDs.

Similar to the TSS calibration, with the exception of a few larger storm events, the pervious contribution to metals loading was limited mainly to interflow and groundwater. As a result, impervious surface contributions also dominate the metals load. The potency factor parameter for the three different IMPLNDs was adjusted to reproduce the peak concentrations seen in the observed data.

In addition to pollutographs, CDF curves were developed for total and dissolved copper and zinc. For copper, the CDF curves were developed using the recent project data. These data were collected specifically for the Little Bear Basin planning study, and there was a higher degree of confidence in the newer data than the older ambient data. For zinc, the project data were uncorrelated with TSS, as discussed in Section 3.6.1, and responded irregularly during high flows. An explanation for these characteristics could not be determined. In view of the project time constraints, the zinc data collected for the project were not used, and the zinc CDF curves thus used ambient zinc data. The monthly PERLND interflow and groundwater concentrations and IMPLND potency factors were refined to better match simulated to observed CDF curves. The interflow and groundwater concentrations primarily influenced the lower and middle portions of the CDF curves, while the IMPLND potency factor controlled the upper (less frequent) portion of the curve.

As with metals and TSS, the pervious contribution to hardness was primarily limited to interflow and groundwater loads. The accumulation rate, surface storage limit, and washoff parameter for the three different IMPLNDs were adjusted to reproduce the peak concentrations seen in the observed data. Ambient data were not available for hardness, so there were not enough data to develop CDF curves.

The calibration for total and dissolved metals was evaluated by comparing the observed and simulated pollutographs and CDF curves at the two gages. The pollutographs for total copper are shown in Figure 30 and Figure 31, and CDF curves for total and dissolved copper are presented in Figure 32 through Figure 35. For the downstream location, all observed copper data are from LBBW and are compared to simulated concentrations at RCHRES 340.

The pollutographs for total zinc are shown in Figure 36 and Figure 37, and CDF curves for total and dissolved zinc are presented in Figure 38 through Figure 39. For the downstream location, the CDF curve compares observed data from 228th with simulated concentrations from RCHRES 300; these were the data used to calibrate the model. The pollutograph compares simulated zinc concentrations for HSPF

RCHRES 340 with observed project data from LBBW, though LBBW data were not used for calibration, as discussed previously.

The model does a reasonable job of simulating both types of curves at both locations. There is considerably more discrepancy in the zinc pollutographs than the copper, which may be related to the fact that zinc is not as closely tied to TSS as copper.

The hardness pollutographs are shown in Figure 42 and Figure 43. The simulation data correlates well with the observed data. For the downstream location, the pollutograph compares simulated concentrations for HSPF RCHRES 340 with observed data from LBBW.

Table 21 and Table 22 compare the average annual copper and zinc loads, respectively, for commercial and residential land use from the calibrated model to published load values from several western Washington studies. The range of values in the literature is wide and relative loads from different land uses vary between sources, indicating the difficulty and limitations of calibrating to land use specific data. The land use based load estimates from the calibrated Little Bear model are slightly lower than the published range for copper. Zinc loads are slightly low for commercial land use and high for residential. It is important to recognize that land use based loads are not a direct input to HSPF, as in some event-based water quality models. While model parameters could be shifted to achieve a better match to land use values from other studies, this would reduce the accuracy of the calibration over portions of the CDF curve.

Table 21 Comparison of Simulated and Literature Mean Annual Loads for Total Copper

Land Use	EIA Table	Annual Mean Load Copper (lb/ac/year)			
		Model	Puget Sound Toxics Study (Ecology 2011b)	Green[a]	Literature[b]
Commercial	1	0.011	0.021	0.041	0.027
	2	0.019			
Residential	1	0.002	0.008	0.016	0.009
	2	0.003			

[a] Green-Duwamish Watershed Water Quality Assessment (Herrera 2007)

[b] Burton and Pitt (2002); Horner et al. (1994); Madison et al. (1979)

Table 22 Comparison of Simulated and Literature Mean Annual Loads for Total Zinc

Land Use	EIA Table	Model	Annual Mean Load Zinc (lb/ac/year) Puget Sound Toxics Study (Ecology 2011b)	Green[a]	Literature[b]
Commercial	1	0.153	0.203	0.295	0.625
	2	0.139			
Residential	1	0.153	0.026	0.061	0.036
	2	0.156			

[a] Green-Duwamish Watershed Water Quality Assessment (Herrera 2007)

[b] Burton and Pitt (2002); Horner et al. (1994); Madison et al. (1979)

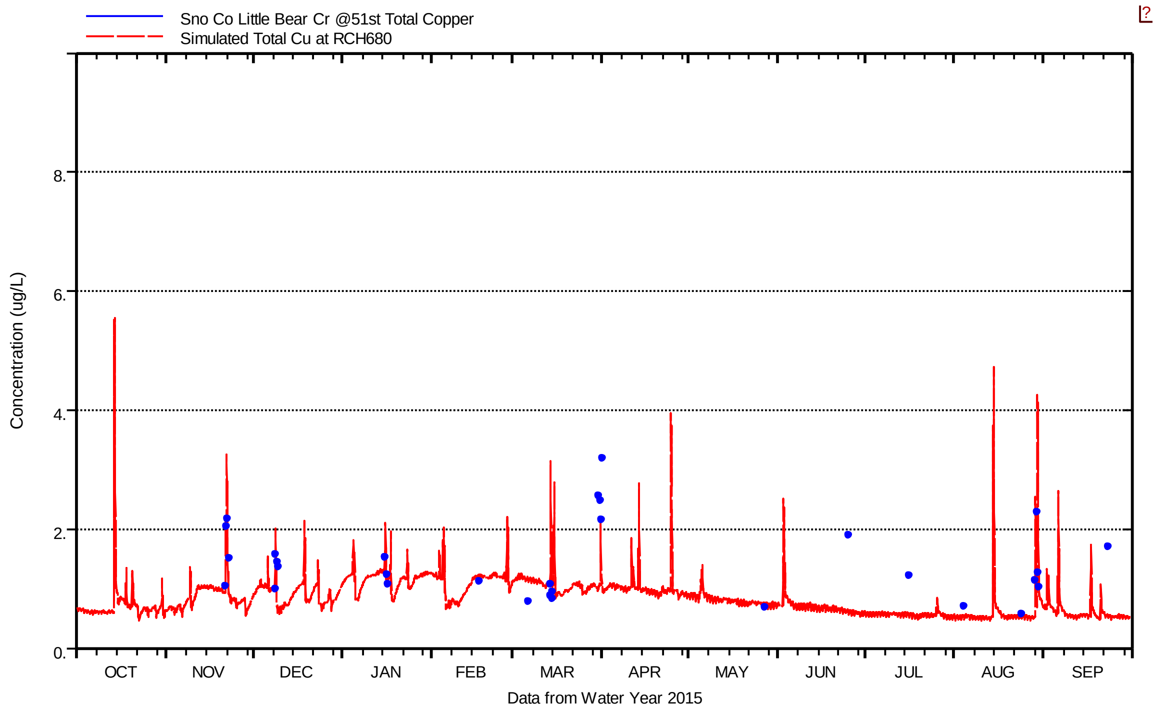


Figure 30 Total Copper Pollutograph at 51st Ave Gage

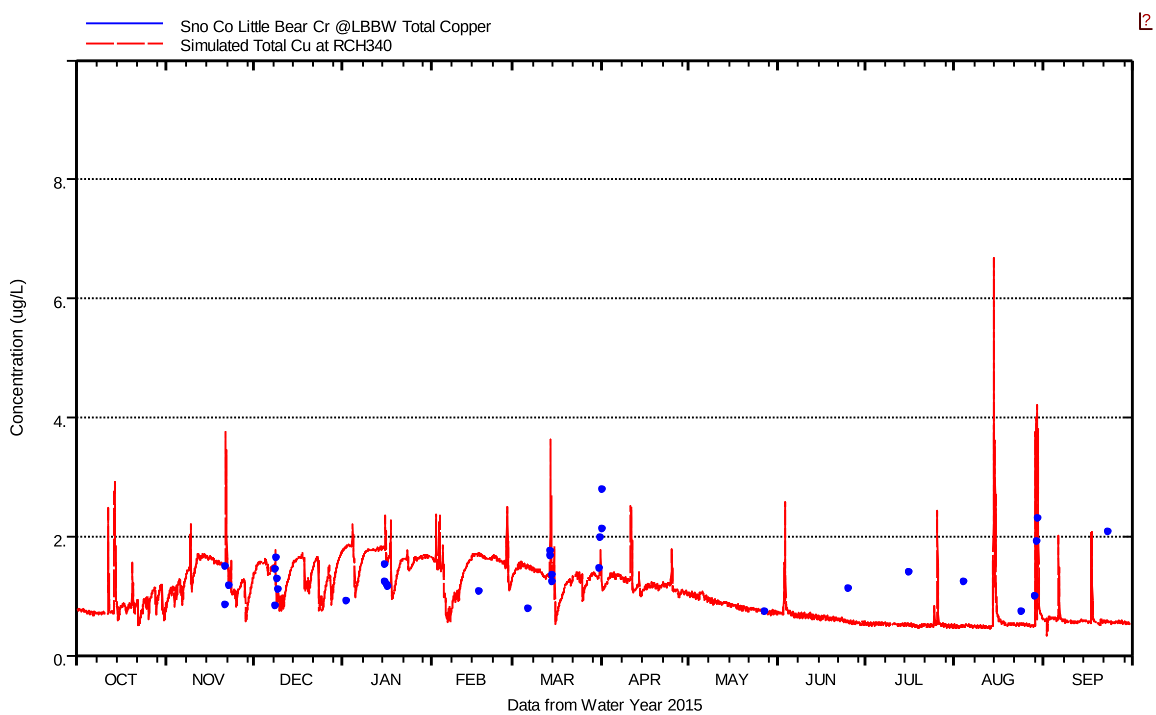


Figure 31 Total Copper Pollutograph at LBBW

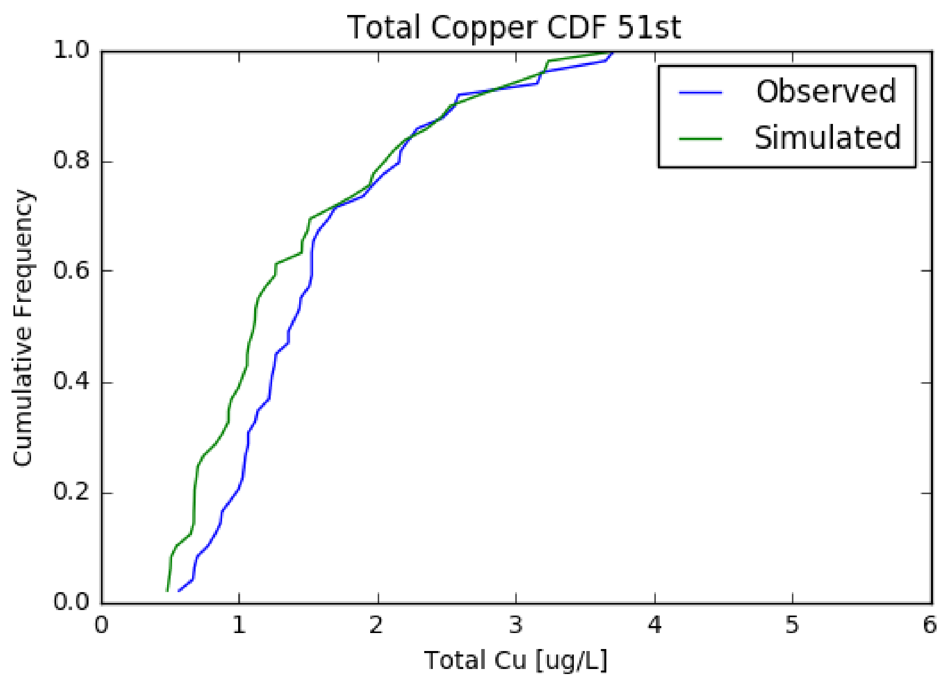


Figure 32 Total Copper CDF Plot at 51st Ave Gage

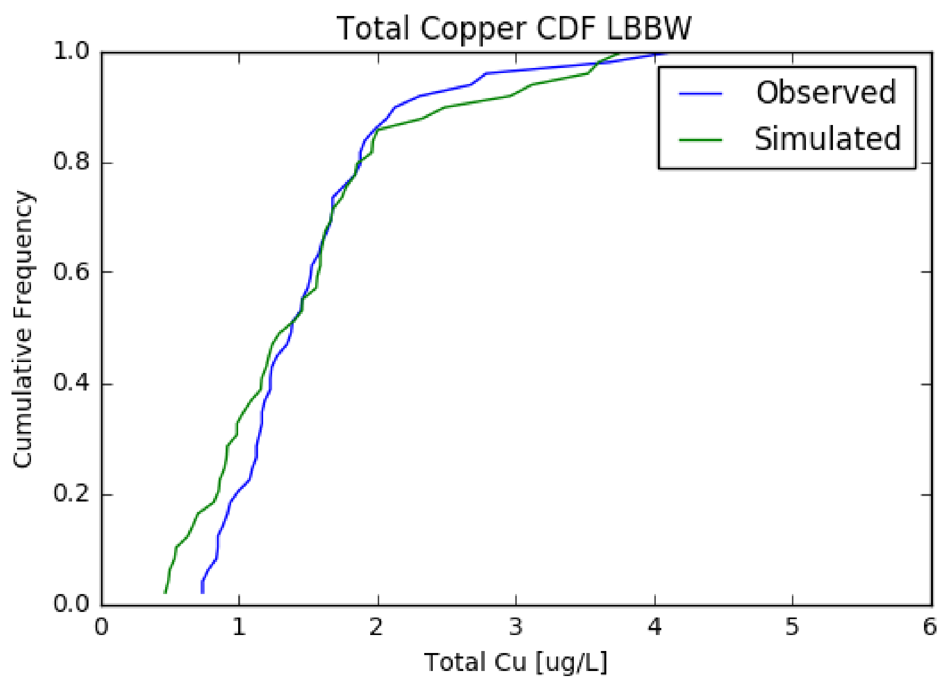


Figure 33 Total Copper CDF Plot at LBBW

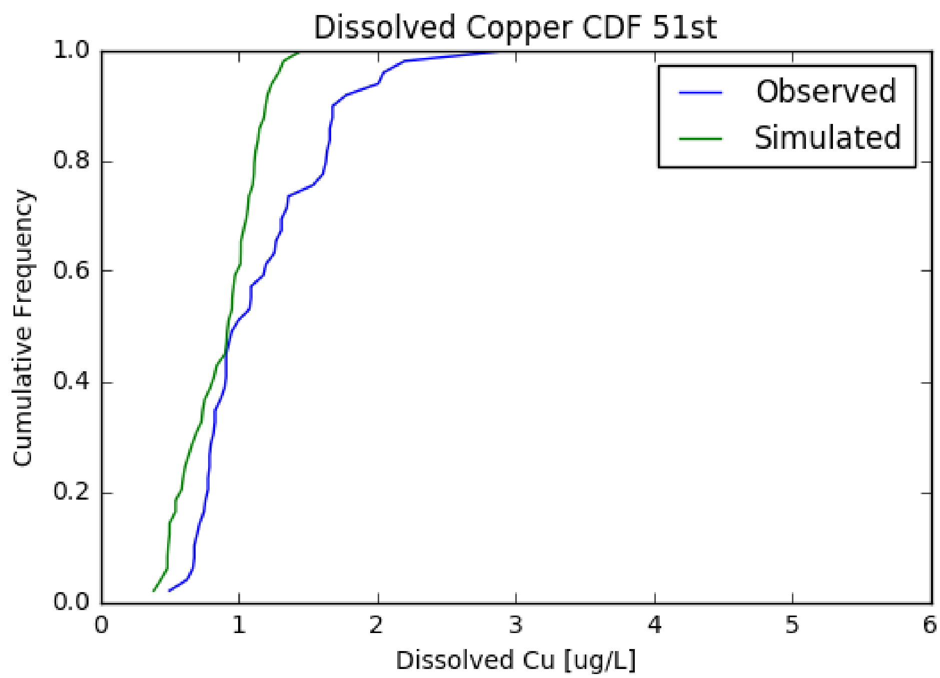


Figure 34 Dissolved Copper CDF Plot at 51st Ave Gage

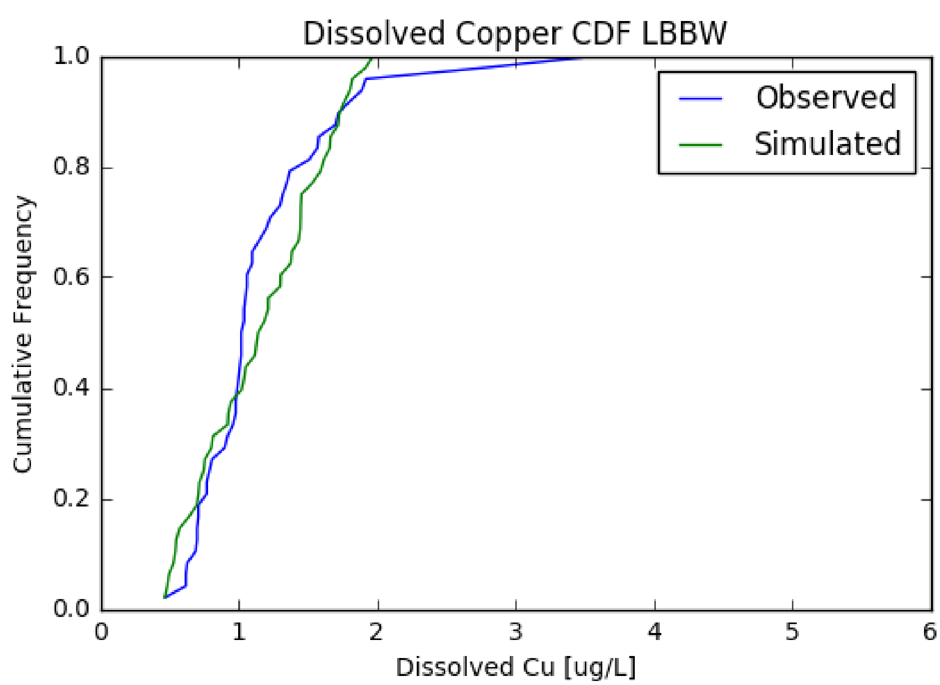


Figure 35 Dissolved Copper CDF Plot at LBBW

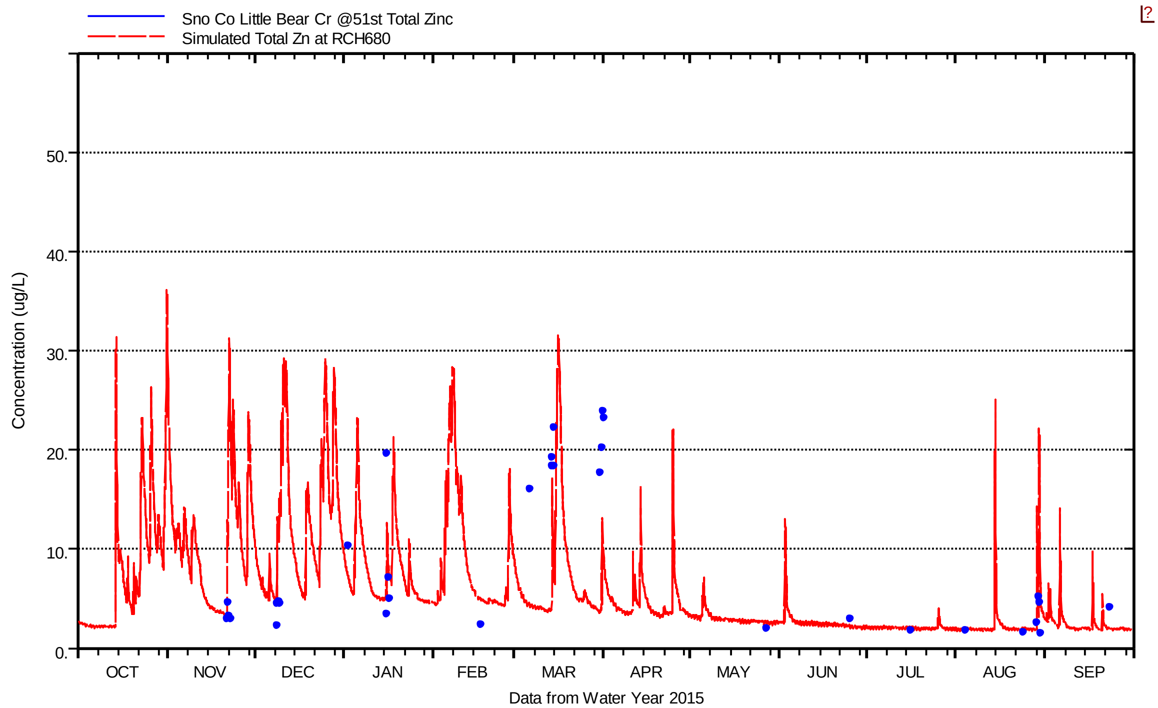


Figure 36 Zinc Pollutograph at 51st Ave Gage

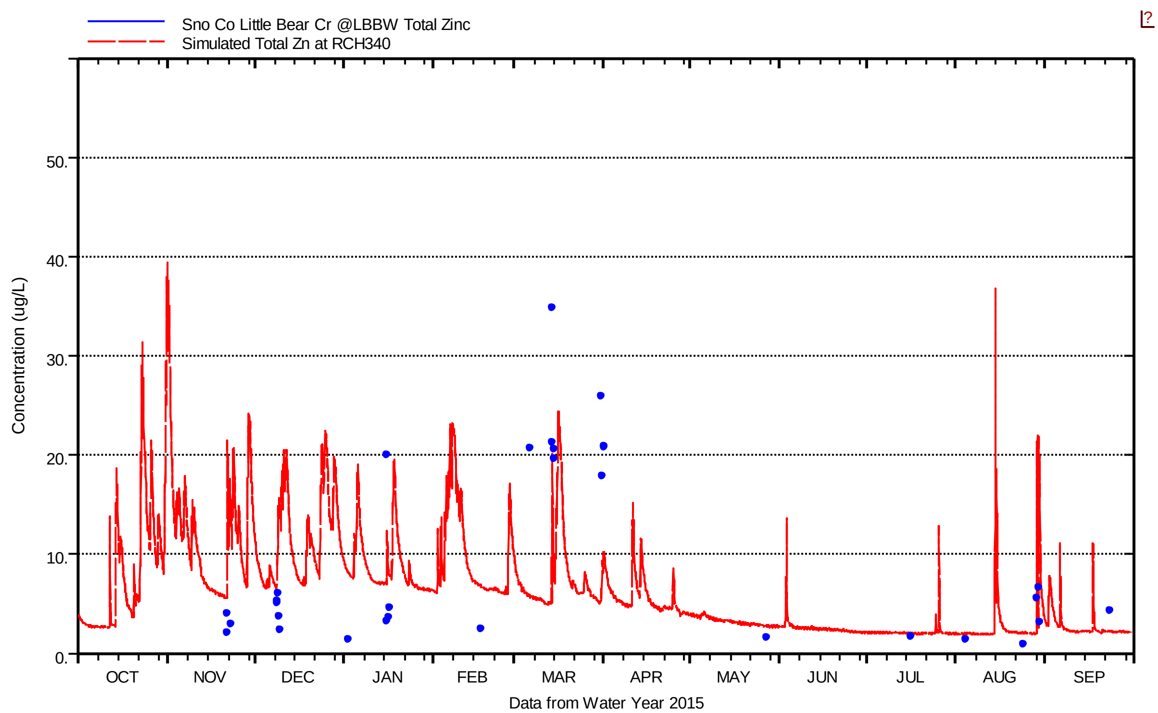


Figure 37 Zinc Pollutograph at LBBW

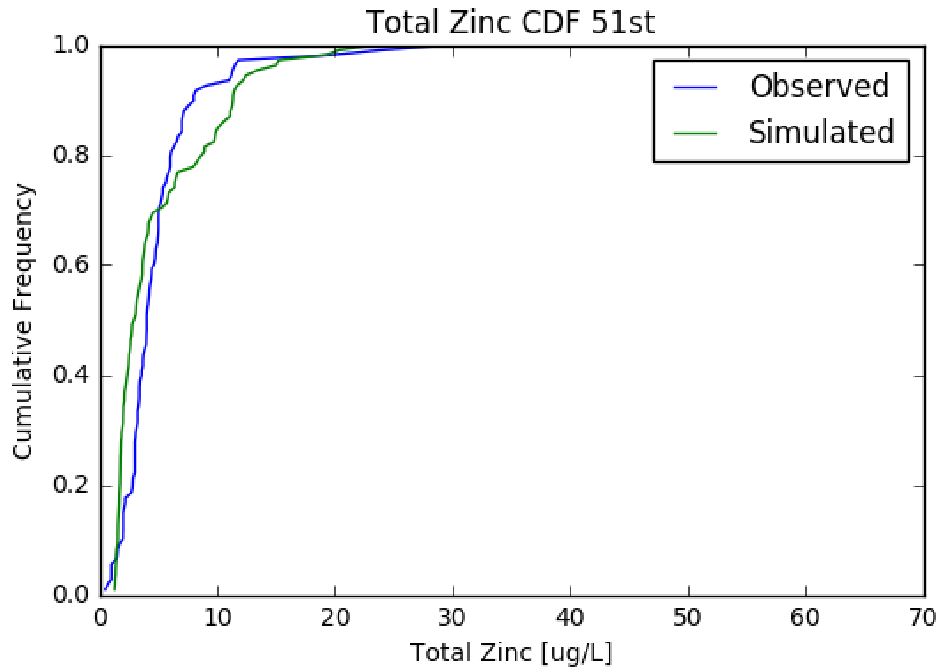


Figure 38 Total Zinc CDF Plot at 51st Ave Gage

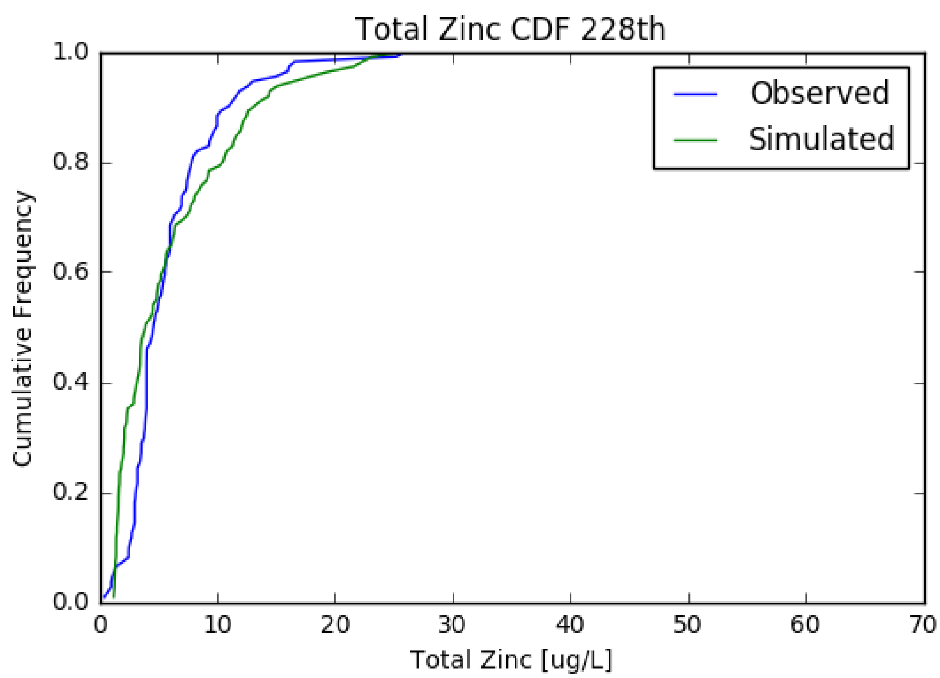


Figure 39 Total Zinc CDF Plot at 228th St Gage

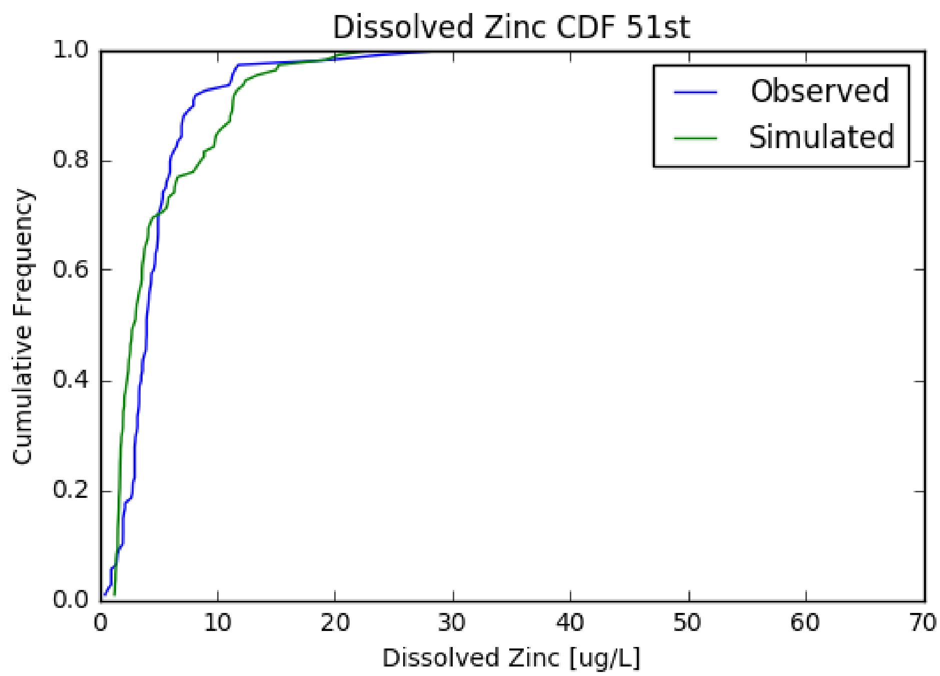


Figure 40 Dissolved Zinc CDF Plot at 51st Ave Gage

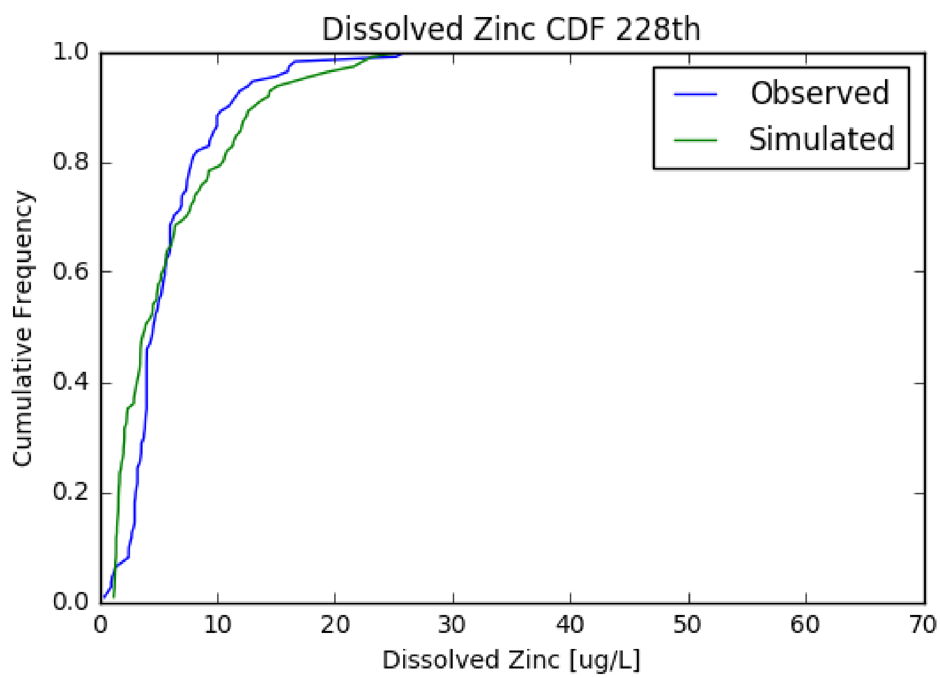


Figure 41 Dissolved Zinc CDF Plot at 228th St Gage

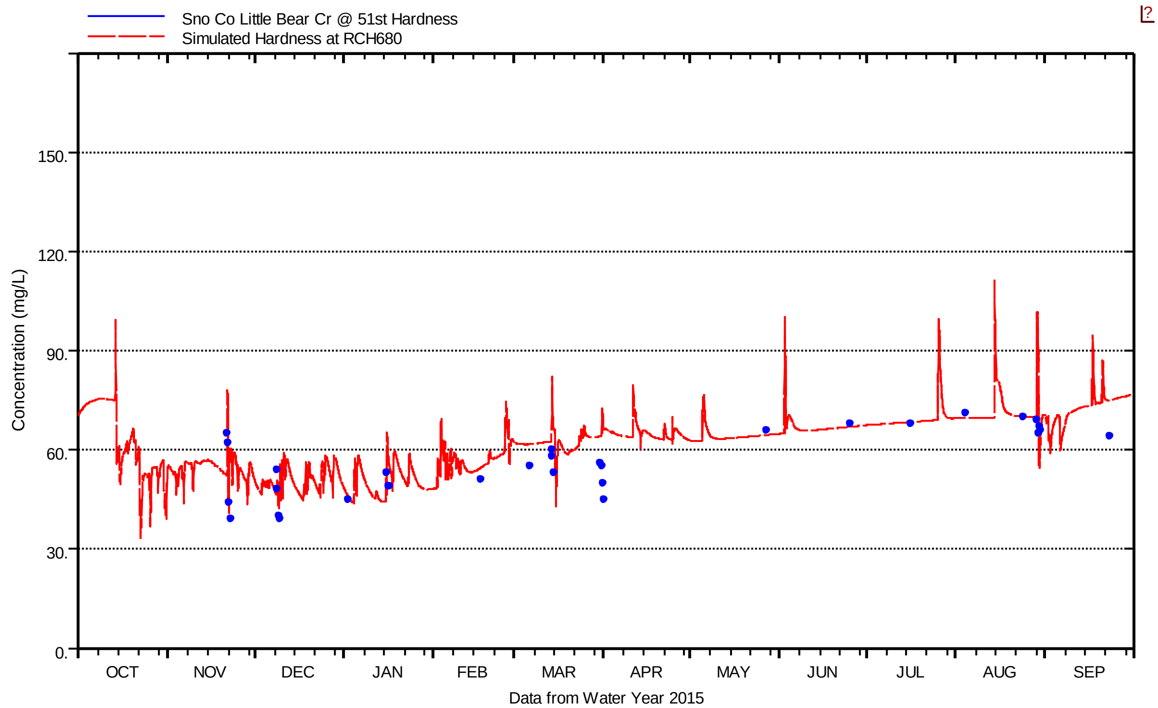


Figure 42 Hardness Pollutograph at 51st Ave Gage

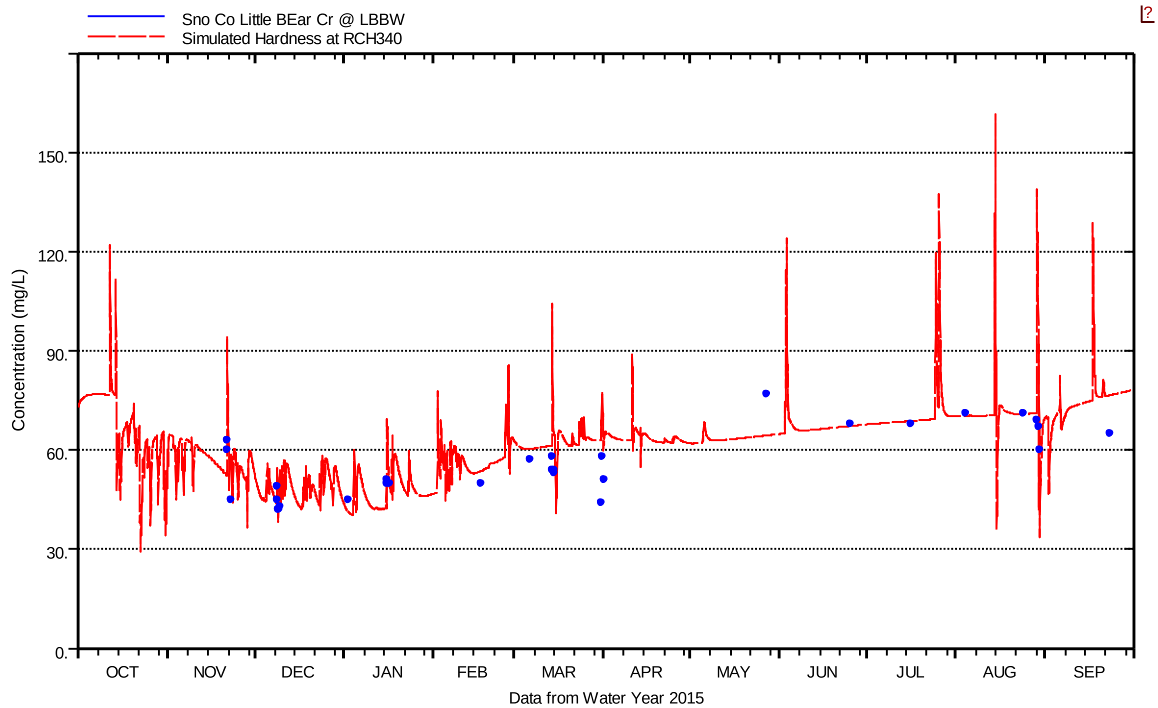


Figure 43 Hardness Pollutograph at LBBW

4.2.5 **Fecal Coliform**

Fecal coliform is simulated using buildup and washoff loading from PERLNDS and IMPLNDs, interflow concentrations, and groundwater concentrations, as well as first order decay within routing reaches. Calibration involved adjusting an accumulation rate, surface storage limit, washoff parameter, interflow concentration, and groundwater concentration for PERLNDs; accumulation rate, surface storage limit, and washoff parameter for IMPLNDs; and the first order decay parameter in RCHRES elements. Instead of matching individual storm concentrations, which is difficult due to the volatile and random nature of bacteria concentrations, calibration focused on the cumulative probability of concentrations, with specific focus on replicating the frequency at which both parts of the water quality standard are exceeded.

As shown in Table 23, the fecal coliform PERLND and IMPLND parameters were adjusted in a similar fashion to TSS and hardness. One difference was in the calibration of the base concentration in the dry season. Review of the ambient data indicated that the baseflow fecal coliform concentration increases during the summer. This may be due to direct deposition in the stream or environmental variables such as sediment type, lower flows, greater solar radiation and higher stream temperatures, and less predation, all of which would contribute to summer regrowth. The model does not explicitly include direct deposition processes, but the process could be closely replicated by increasing the groundwater concentration to generate a higher baseflow concentration. The required fecal concentrations at 51st Avenue SE and 228th Street SE were estimated from dry season samples that were collected at times when runoff did not influence the concentration (i.e. no rainfall for an extended period). A target concentration was determined for each monitoring location using 23 to 24 samples from each gage. The monthly groundwater concentrations were then adjusted to hit this target during the dry season. Plots of the observed data and simulated groundwater concentrations can be found in Figure 44.

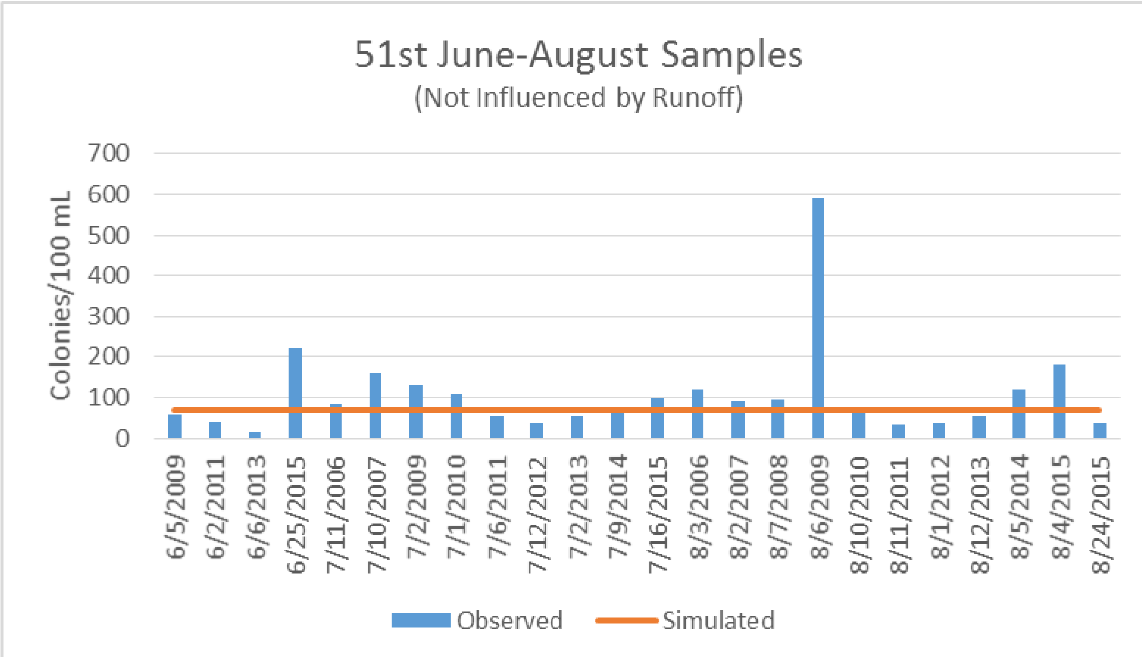
Since the fecal coliform water quality standard is designed to work with discrete samples, the CDF curves, geometric mean, and percent of values exceeding the 100 colonies per 100 milliliters criteria ("10 percent" criteria) were all based on daily sampling from the hourly time series. Daily noon values were selected from the simulated data to provide a pseudo-random set of discrete samples for assessment. The calibration targets were to simulate the geometric mean and 10 percent value for both gages were within ten percent of values calculated from the observed record. As shown in Table 24, the calibration targets were met at both gages. The CDF curves for the two gages are shown in Figure 45 and Figure 46. For the downstream location, the observed CDF curve uses data from both 228th and LBBW but contains significantly more data from the 228th gage due to record length, so was compared to the curve from simulated data at RCHRES 300. The curves show a very good correlation between the simulated and observed data.

Table 23 Fecal Calibration Parameters

Load Type	Parameters	How Parameters Determined	Impact on Geo Mean	Impact on 10 Pct
Pervious SURO Load	Accumulation rate, storage limit, washoff parameter for each PERLND	• Accumulation Rate: Literature based loading rates, Snohomish County Animal Counts (AG), Literature based Animal Counts (Non AG), Septic failure rate from County • Storage Limit: 9x accumulation rate • Washoff: Calibration parameter	Small	Small
IFWO Load	Monthly concentrations for Rural Forest, Urban Forest, Pasture, Grass, and Wetland	Adjusted during calibration to match CDF curve	Large	Moderate
AGWO Load	Monthly concentrations for Rural Forest, Urban Forest, Pasture, Grass, and Wetland	• Summer Concentrations: Determined from 23-24 summer fecal samples with no runoff • Winter Concentrations: Adjusted during calibration to meet CDF curve	Large	Large In dry season
Impervious Surface Load	Accumulation rate, storage limit, washoff parameter	• Accumulation Rate: Initial distribution from S8 data, scaled and adjusted during calibration • Storage Limit: 9x accumulation rate • Washoff: Calibration parameter	Large	Large

Table 24 Observed vs. Simulated Fecal Coliform 10 Percent and Geometric Mean Criteria

Location	10 Percent Criteria			Geometric Mean		
	Obs	Sim	% Diff	Obs	Sim	% Diff
51st	286	301	5.2	66.2	62.7	-5.2
228th	348	360	3.3	72.2	65.1	-9.7



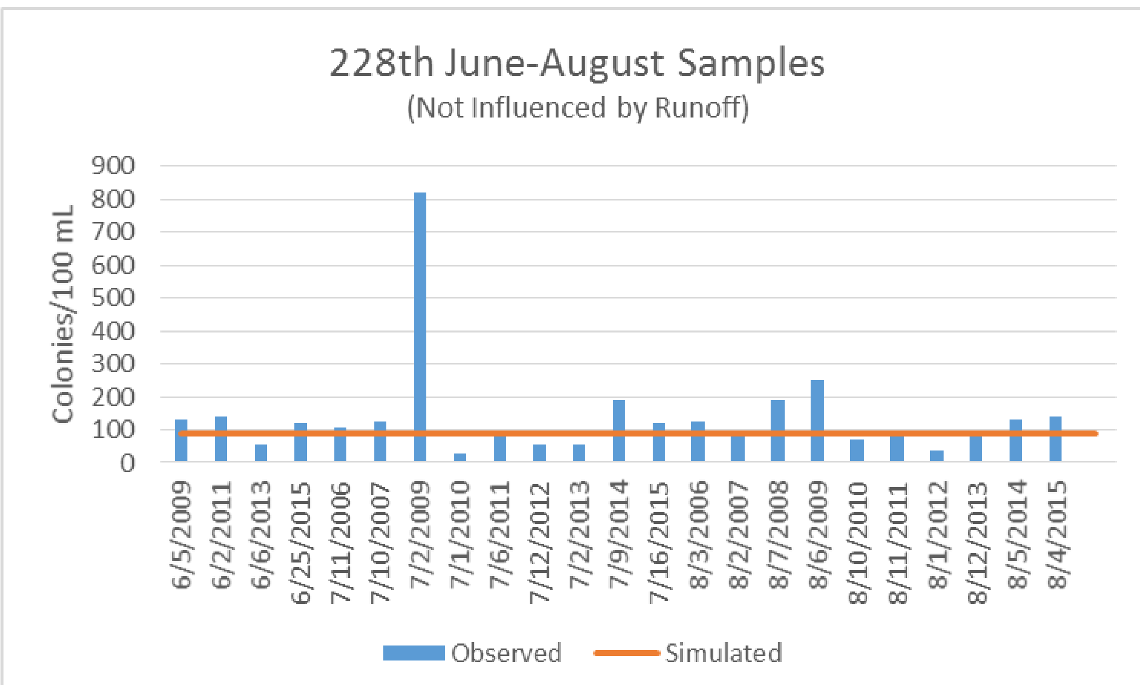


Figure 44 June-August Fecal Coliform Concentrations not Influenced by Runoff

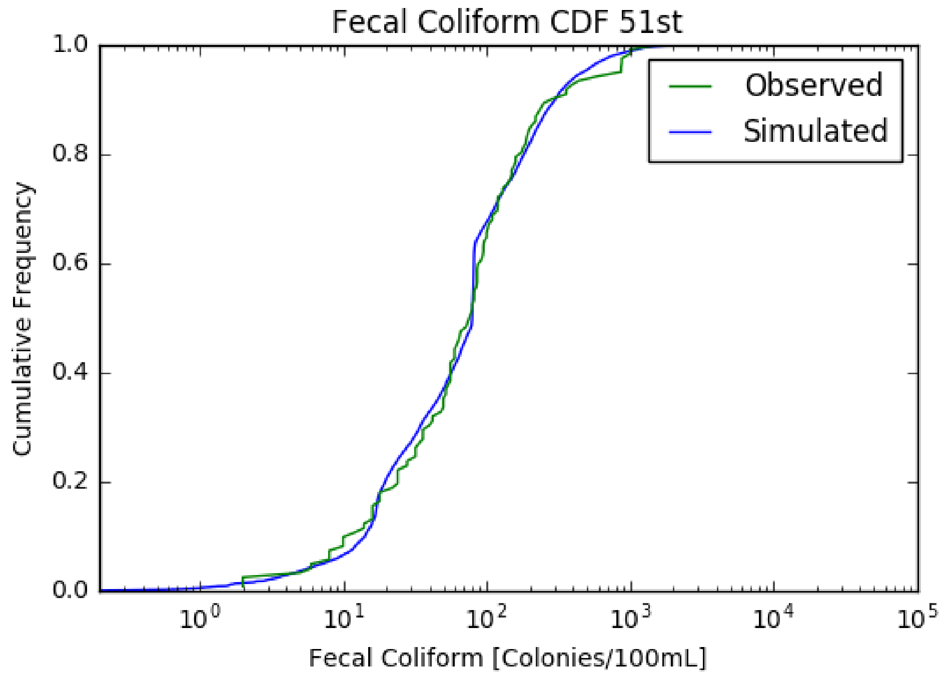


Figure 45 Fecal Coliform CDF Plot at 51st Ave Gage

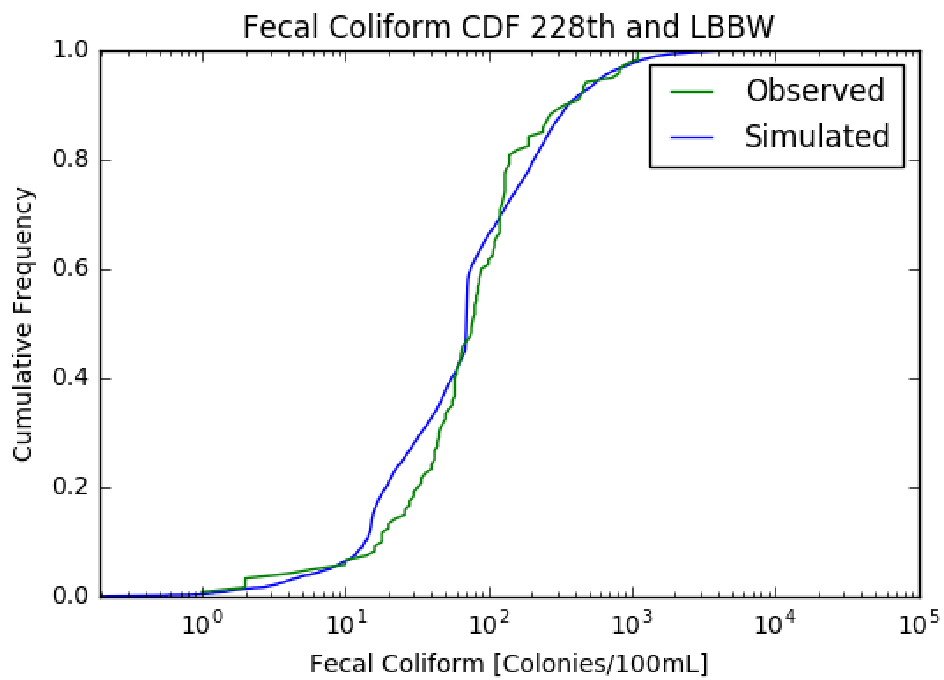


Figure 46 Fecal Coliform CDF Plot at 228th Street. Observed curve includes data from 228th and LBBW gages.

Unlike TSS and metals, annual mass loading values are not widely available for fecal coliform. Land use loadings are typically provided as median concentrations based on storm sampling. Table 25 shows a comparison of commercial/industrial and residential concentrations from three different studies or datasets. Notably, both the values and the relative loadings for each land use are very different, with the S8.D data indicating higher loading from commercial land use (largely impervious) and the National Stormwater Quality Database showing much higher contributions from residential areas.

Table 25 Comparison of Literature Values for Fecal Coliform Median Storm Concentration for Commercial/Industrial and Residential Land Uses

Land Use	Fecal Coliform Median Storm Concentration (cfu/100ml)		
	S8.D Monitoring Data (Ecology, 2015)	Green-Duwamish Watershed Water Quality Assessment Table B-8 (Herrera, 2007)	National Stormwater Quality Database v1.1 (Pitt et al., 2003)
Commercial/Industrial	515/915	648	4300/2500
Residential	198	633	8345

The use of concentration data from storm sampling makes direct comparison with HSPF loadings, which are continuously simulated over storm and non-storm periods, more difficult, and the variability limits the utility of the broader data for calibration purposes. As discussed previously, fecal calibration was targeted primarily at matching the observed CDF curves from Little Bear Creek data at multiple locations, with the relative impervious area contributions based on S8.D data. Table 26 and Table 27 show that average simulated storm concentrations (estimated for the portions of the HSPF hydrograph with surface runoff contributions) are lower than the average S8.D concentrations—as needed to match the full CDF curve—but target ratios were maintained.

Table 26 Comparison of Simulated and Statewide S8.D data for Fecal Coliform Mean Storm Concentration

Land Use	Fecal Coliform Mean Storm Concentration (cfu/100ml)		
	Model (EIA Table 1)	Model (EIA Table 2)	S8.D Monitoring Data (Ecology, 2015)
Commercial/Industrial	2179	2404	7198/4683
Residential	604	614	2153

Table 27 Comparison of Residential to Commercial Fecal Coliform Mean Storm Concentrations between Simulated and Statewide S8.D Data

	EIA Table	Model Ratio Residential/Commercial	S8 Ratio Residential/Commercial	S8 Ratio Residential/Industrial
Residential	1	28%	30%	46%
	2	26%		

5 LAND USE SCENARIOS

The Little Bear Creek HSPF model was developed and calibrated for existing conditions land use in the study area basin. As required by the Permit, historic (pre-development) and future build-out scenarios were also evaluated. Assumptions associated with each scenario are discussed in the following sections. Calibrated values for model parameters for runoff and pollutant response from each land surface type based on existing land use conditions were maintained for all land use scenarios, as there is no reason to expect a difference in fundamental response between scenarios. All three scenarios used the same 60-year simulation period (water years 1956 through 2015), with meteorological inputs reflecting the range of conditions over that time period. Differences between the scenarios are thus attributable to change in land use/land cover (i.e., distribution of hydrologic response units in the model) and routing—including treatment—of flow and associated water quality constituents. Tables summarizing hydrologic response unit (HRU) distribution in each of the three land use scenarios are included as Appendix A.

5.1 Existing Conditions

The existing conditions scenario represents the current condition of the drainage system and existing land use in the watershed. Land use and drainage facilities in this scenario are the same as the calibration version of the model. The only difference from the calibration model is that the Silver Lake precipitation gage was used for the entire model. As discussed in Section 3.2, there are no apparent systematic precipitation differences across the watershed to support development of a second distinct long-term record, so the extended Silver Lake precipitation record was applied over the entire watershed for the long-term scenario runs. The same precipitation record was used for all three land use scenarios.

5.2 Historic Conditions

The historic (i.e. forested) conditions scenario provides a reference condition and basis for comparison to assess changes in hydrology and water quality associated with development. This scenario provides a likely upper limit to what could be achievable through watershed restoration. The historic condition represents pre-European settlement conditions in the watershed, assumed to be a combination of forested and wetland land cover.

In addition to modifying non wetland land cover to (rural) forest, FTABLEs and BMPRACs representing flow and water quality treatment facilities were removed from the model. Runoff and pollutant loads from catchments upstream of the removed facilities were routed to the next downstream reach. Although constructed drainage systems can be expected to impose some change on natural drainage patterns, neither catchment boundaries nor stream and ditch FTABLEs were modified. This simplification is typical for forested scenario modeling, as pre-development drainage information is not available and has a relatively smaller impact than land use change and constructed stormwater treatment.

Stream reach elements were unchanged except for adjustment of the shading parameter (CFSAEX) to represent a forested condition along all reaches. A shading value of 0.05 was applied to all reaches, corresponding with the calibrated shading factor for fully forested tributary reaches in the existing conditions model. The shading factor has a significant impact on model-simulated water temperature.

5.3 Future Conditions

The future build-out land use conditions for the Little Bear study area reflect zoning and development planning information from the County's current Comprehensive Plan, adopted in 2015. Information from capacity analysis studies performed by the County's Planning and Development Services (PDS) department was used to identify parcels within the study area that are likely to develop or redevelop to a more intense land use. Transportation projects from the 2016-2021 Transportation Improvement Program and 2035 Comprehensive Plan, as well as future parks and trails projects, were also incorporated into the future build-out condition. Figure 47 shows the areas within the Little Bear Creek study area basin where development or redevelopment was assumed to occur.

Future land use and land cover definition methods varied based on the type of development (e.g. residential, commercial, roads, etc.) and whether the development would occur within unincorporated Snohomish County, city limits, urban growth areas (UGA), or rural areas. Land use and land cover within areas designated as unbuildable was not changed from the existing conditions scenario. In general, land cover was assumed to be consistent for a given land use in existing and future conditions, i.e. commercial areas would have the same distribution of impervious area and grass in the future scenario as is typical of existing commercial land use. More detailed land cover assumptions were developed for residential land uses outside the UGAs, reflecting the County's open space and maximum lot coverage regulations. Detailed land use and land cover assumptions for future development are documented in Appendix B.

For the future scenario the following assumptions were made regarding future development on parcels with Ag, Ag-Septic, or Septic designations in the existing conditions model. All future development outside of the UGA was assumed to be connected to septic systems, and a parcel was considered to be high-risk septic (Septic designation) if it was within a 250-foot buffer of the drainage network and had future development. This designation was applied to both future development and future existing areas of the parcel. If future development occurred on a parcel with farm use (Ag designation), it was assumed that new development would not support farm use, and the Ag designation was removed. The Ag, Ag-Septic, and Septic distribution for the future scenario is shown in Figure 48.

With the exception of the agriculture and septic classifications discussed above, all areas that were not projected to develop or redevelop (green areas in Figure 47) used the same land use and land cover information as the existing conditions model, ensuring that flow and water quality response from unchanged areas would remain consistent between the existing and future build-out scenarios. Calibrated model parameters for runoff and pollutant response from a given land surface type were maintained for all land use scenarios.

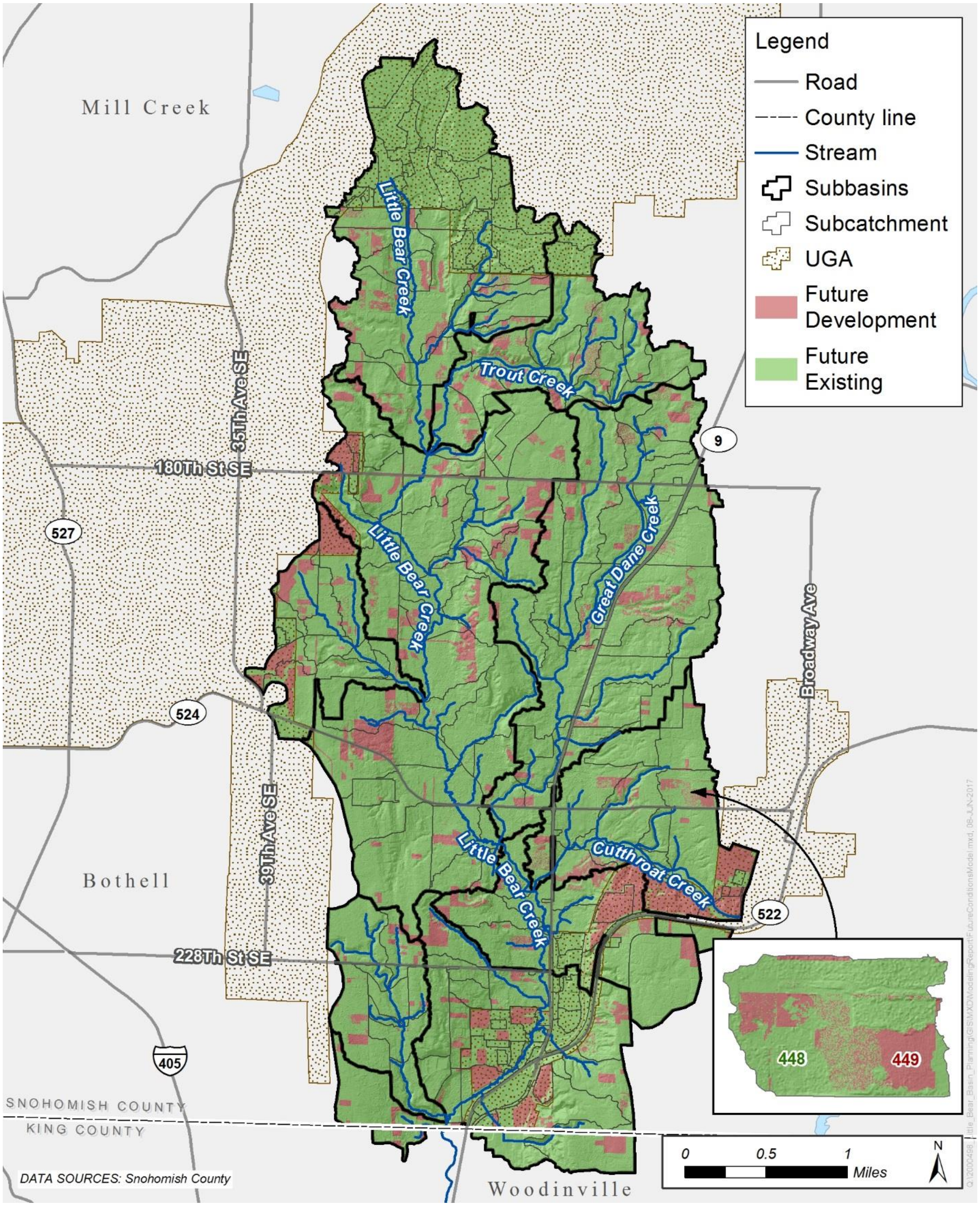


Figure 47 Future Conditions Land Use Changes. Inset shows distribution over a single catchment, with future existing and future development subcatchment designations.

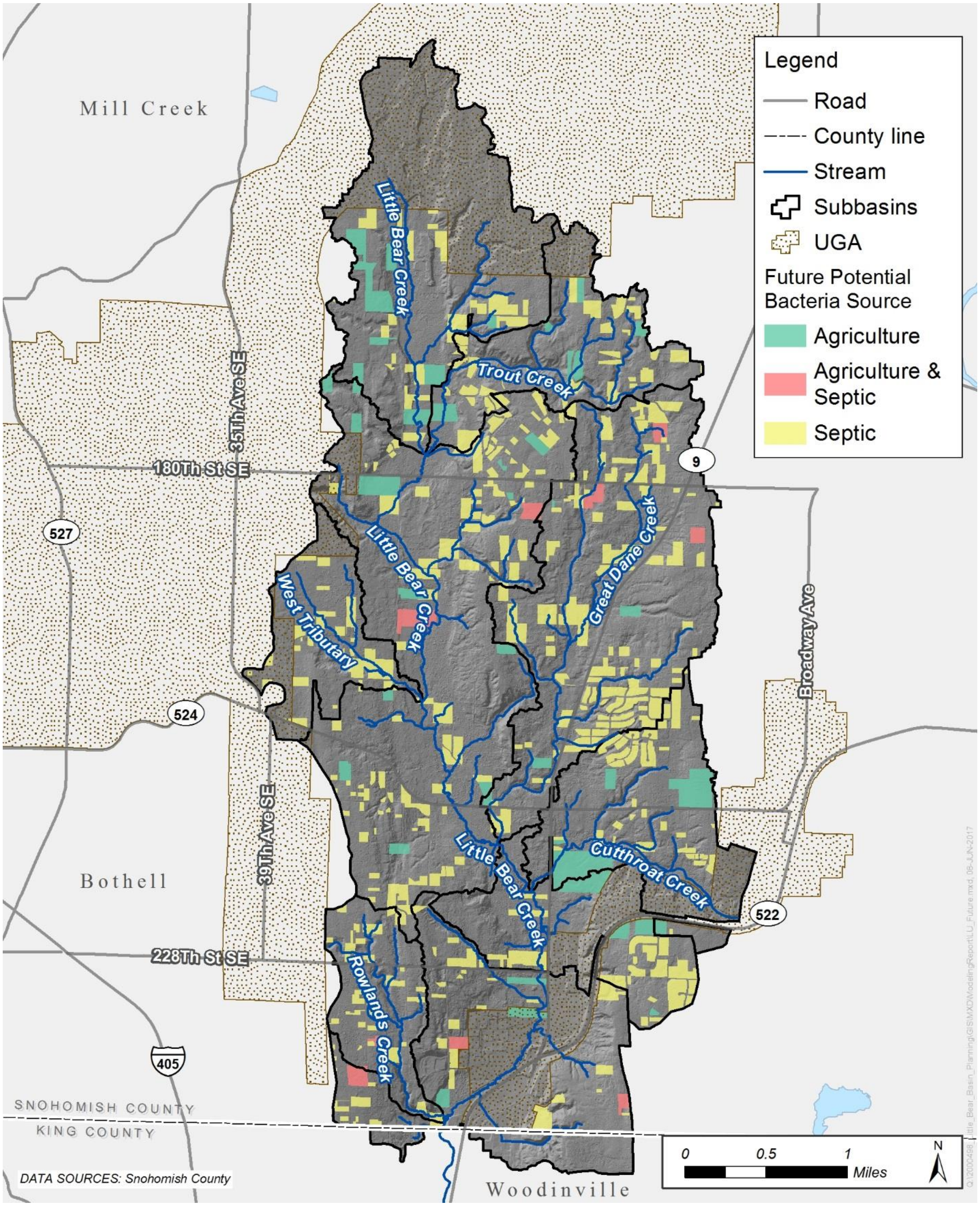


Figure 48 Future Scenario Septic Parcels

Stormwater flow control BMPs (LID, flow control, and water quality) for development and redevelopment were sized based on current Ecology standards (Ecology, 2012) and applied at the scale of the individual HSPF catchments. Thus, one FTABLE representing aggregated code-required treatment was developed for each catchment with future development. Aggregation of facilities to a single FTABLE was necessary based on the size of the model and limits to the number of operations. This simplification would produce minor performance differences compared to sequential routing through site-scale LID and downstream detention, but these would not be expected to be significant at the subbasin scale where results are being evaluated. Code-required treatment also included representation of grass areas in new development as pasture land cover to represent soil amendment BMPs under Minimum Requirement 5 (Ecology, 2012). This modeling representation of soil amendment BMPs is consistent with Ecology recommendations.

Water quality treatment from code-required facilities was represented using the same approach as was used for existing facilities. Sediment and fecal coliform reduction were modeled using RCHRES processes. Metals reductions were applied via BMPRACs. Reduction efficiencies (Table 28) were based on guidance from Ecology (2016), depending on whether enhanced or basic water quality treatment was applied. The level of water quality treatment was assigned based on land use, as indicated in Table 29.

Table 28 Reduction Factors for Future Development

WQ Facilities	Percent Reduction		Where removal occurs in HSPF model
	Enhanced Treatment	Basic Treatment	
Dissolved CU	30%	0%	BMPRAC
Dissolved ZN	60%	0%	BMPRAC
Fecal Coliform	Dependent on FTABLE	Dependent on FTABLE	FTABLE
Particulate Copper	Dependent on FTABLE	Dependent on FTABLE	FTABLE
Particulate Zinc	Dependent on FTABLE	Dependent on FTABLE	FTABLE
TSS	Dependent on FTABLE	Dependent on FTABLE	FTABLE

Table 29 Water Quality Treatment for Future Development HRUs

IMPLNDs		PERLNDs	
Commercial	Enhanced	**Urban Grass**	Enhanced
HPGIS	Enhanced	**All Others**	Basic
LPGIS	Basic		

Model catchments were split into “future existing” (no change in land use) and “future developed” catchments in the model to facilitate separate routing through existing (if present) and future stormwater treatment. For most catchments, the “future existing” areas were routed through existing BMPRACs and/or treatment facilities (if present) in parallel with “future developed” areas routed through BMPRACs and reaches representing the code-required flow and water quality treatment, with the two pathways joining as flow enters the downstream routing network (ditch or stream reaches). This default routing is illustrated in Figure 49.

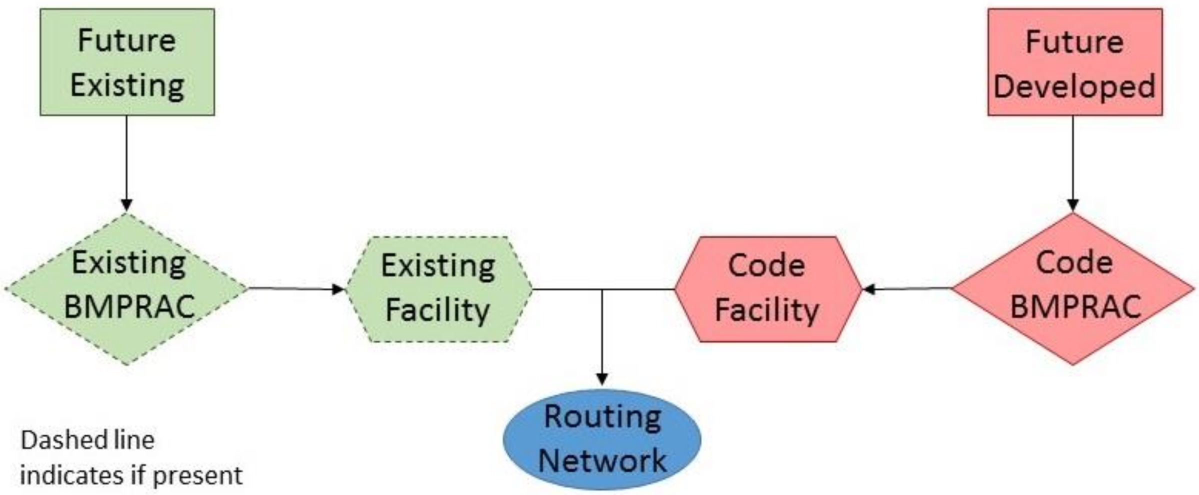


Figure 49 Default Future Catchment Routing

There were several catchments with existing facilities where most or all of the area was redeveloped, in which case it was assumed that the existing facility was removed and any remaining “future existing” areas bypassed treatment. These catchments are listed in Table 30. There were also two catchments (520 in Great Dane Creek and 682 in Little Bear Middle) where it was anticipated that development further up in the catchment would still flow through an existing downstream facility. In these catchments, “future developed” areas were routed through the code-required facility and existing facility in series. Pipe, ditch and culvert, and stream reaches—which comprise the downstream routing network—were left in place. It was assumed that stream buffer conditions would not change significantly with development, so the same shading parameter values used in the existing conditions model were applied for future build-out.

Table 30 Changes to Existing Facilities in Future Scenario

Catchment	Change
134	Removed
162	Removed
332	Removed
468	Removed
472	Removed
520	Drainage Area Reduced
682	Drainage Area Reduced

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6 RESULTS

Models for each of the three land use scenarios were run for a 60-year simulation period, using meteorological inputs for water years 1956 through 2015. The following sections compare results for the Permit-required constituents—B-IBI (as estimated from hydrologic metrics), temperature, dissolved copper and zinc, and fecal coliform—between scenarios and to Permit targets and standards.

6.1 B-IBI Metrics

As discussed in Section 2.2, High Pulse Count (HPC), High Pulse Range (HPR), and Richards-Baker Index (RBI) metrics were used to compute B-IBI scores from flows simulated in the Little Bear Creek model. The computed B-IBI scores were calculated as the arithmetic mean of B-IBI values estimated from individual hydrologic metrics.

Since B-IBI scores—both observed and computed from hydrologic metrics—vary substantially from year to year, long-term averages computed over the 60-year HSPF simulation period were used for B-IBI assessment. Hydrologic metric values and associated B-IBI scores were computed for each scenario for the four mainstem Little Bear Creek assessment points, located at the outlets of the Little Bear Upper, Little Bear Middle, Little Bear Lower 228th, and Little Bear Lower County Line subbasins (see Figure 1). B-IBI scores—and computed target based on 90 percent of forested—are shown in Table 31. Annual results for each scenario and location are included as Appendix C.

Table 31 Little Bear Creek Flow-Based B-IBI Results

Land Use Scenario	Little Bear Lower CL (R100)	Little Bear Lower 228th (R300)	Little Bear Middle (R600)	Little Bear Upper (R900)
Forested	40	40	40	38
Existing	29	31	34	31
Future Build-out	31	33	35	32
Target (90% Forested)	**36**	**36**	**36**	**35**

Both existing and future build-out scenarios fell short of the B-IBI targets at all four locations. The best conditions occurred in the Little Bear Middle subbasin, which is largely rural and characterized by extensive wetlands along the Little Bear Creek channel. In the more developed reaches, future build-out scores are slightly higher than existing conditions. This suggests that the hydrologic effects of development are being mitigated by the associated LID and flow control treatment included per current code requirements. In redevelopment areas, replacement of impervious surface with little to no existing treatment with mitigated impervious surfaces appears to provide a small net benefit.

6.2 Water Quality

State water quality standards for temperature, fecal coliform bacteria, dissolved copper, and dissolved zinc—the constituents targeted in the Basin Plan—were listed in Table 1 and are reprised in Table 32 below. Calculation methods and water quality results for each parameter compared to standards are presented in the following sections. Water quality modeling results are presented in terms of exceedances of the corresponding standard. Compliance was evaluated over a 60-year simulation period based on meteorological inputs from water year 1956 through water year 2015.

Table 32 Water Quality Standards for Permit-Mandated Constituents

Parameter	WAC Freshwater Water Quality Standard	Numeric Criteria
Fecal coliform Bacteria	173-201A-200 (2)(b)	Extraordinary Primary Contact: geometric mean value < 50 colonies /100 mL, with ≤ 10 % exceeding 100 colonies /100 mL
Temperature[1]	173-201A-200 (1)(c)	• Supplemental temperature criteria (Sept 15-May 15): maximum 7-day average of the daily maximum temperature (7DADMax) is 13°C (55.4°F) • Core Summer Salmonid Habitat criteria (June 15-Sept 14): maximum 7DADMax of 16°C (60.8°F) • Spawning, Rearing, Migration criteria (May 16-June 14): maximum 7DADMax of 17.5°C (63.5°F)
Dissolved Copper (Cu)	173-201A-240	Acute[2] $(0.960)(e^{(0.9422[\ln(hardness)] - 1.464)})$ Chronic[3] $(0.960)(e^{(0.8545[\ln(hardness)] - 1.465)})$
Dissolved Zinc (Zn)	173-201A-240	Acute[2] $(0.978)(e^{(0.8473[\ln(hardness)] + 0.8604)})$ Chronic[3] $(0.986)(e^{(0.8473[\ln(hardness)] + 0.7614)})$

[1]Temperature (7DADMax) not to exceed the maximum of the criteria or forested temperature plus 0.3°C at a probability frequency of more than once every ten years on average
[2] Acute criteria, 1-hour average concentration not to be exceeded more than once every three years on the average.
[3] Chronic criteria, 4-day average concentration not to be exceeded more than once every three years on the average.

6.2.1 Temperature

The temperature standard sets exceedance criteria for the 7DADMax temperature, which is a moving seven-day average of daily maximum temperatures. Any day with a 7DADMax value exceeding the applicable seasonal criteria was counted as an exceedance, so periods of extended high temperatures can produce multiple exceedances. The allowable exceedance frequency for the temperature criteria is one exceedance every ten years on average (less than or equal to 0.1 exceedances per year on an annual basis).

For the forested scenario, the 60-year time series of computed 7DADMax was compared to the seasonal numeric criteria listed in the temperature standard (Table 32), based on the date, to assess natural conditions relative to the standard. Table 33 shows the average exceedances per year of the temperature standard for the forested conditions scenario at each subbasin outlet. (Annual results by location and scenario are included in Appendix D.) Notably, the core summer and supplemental period temperature thresholds are exceeded well beyond the allowable rate for the modeled forested scenario.

Table 33 Forested Condition Average Number of Annual Temperature Exceedances of Numeric Criteria

	R100	R200	R300	R400	R500	R600	R700	R800	R900
Core Summer	43	2	31	21	7	29	4	27	10
Supplemental	23	4	20	16	7	21	7	18	11
Spawning, Rearing, Migration	0	0	0	0	0	0	0	0	0
Exceedances defined relative to numeric criteria listed in **Table 32**. Standard is ≤0.1 exceedance per year (1 per 10 years on average).									

During periods when a water body's temperature exceeds the criteria listed in Table 32 due to natural conditions—as demonstrated by the forested results—the temperature standard allows for an increase of no more than 0.3°C above natural conditions (WAC 173-201A-200 (1)(c)(i)). To account for this allowance for natural conditions, a time series of allowable 7DADMax temperatures was calculated from the simulated forested 7DADMax temperature time series plus 0.3°C. The existing and future build-out scenarios were then compared to the larger of the seasonal numeric criteria listed in the temperature standard (Table 32) and the allowable threshold calculated from the forested 7DADMax plus 0.3°C to determine whether the standard was exceeded for a given day. Table 34 and Table 35 show the average exceedances per year for the existing and future build-out scenarios. (Annual results by location and scenario are included in Appendix D.)

Table 34 Existing Conditions Average Number of Annual Temperature Exceedances

	R100	R200	R300	R400	R500	R600	R700	R800	R900
Core Summer	64	0.1	56	44	13	51	9	51	21
Supplemental	30	1	26	24	9	26	11	25	11
Spawning, Rearing, Migration	0.1	0	0	0	0	0	0	0	0
Exceedances defined relative to greater of numeric criteria listed in **Table 32** and forested temperature plus 0.3 °C. Standard is ≤0.1 exceedance per year (1 per 10 years on average).									

Table 35 Future Build-out Average Number of Annual Temperature Exceedances

	R100	R200	R300	R400	R500	R600	R700	R800	R900
Core Summer	63	0.1	56	40	13	51	9	51	21
Supplemental	29	1	25	20	9	25	11	25	10
Spawning, Rearing, Migration	0.1	0	0	0	0	0	0	0	0
Exceedances defined relative to greater of numeric criteria listed in **Table 32** and forested temperature plus 0.3 °C. Standard is ≤0.1 exceedance per year (1 per 10 years on average).									

The modeling shows multiple exceedances per year of the core summer (June 15 through September 14) and supplemental (September 15 through June 15) period thresholds in all subbasins except Rowlands Creek (which meets the standard for the summer period), even when the 0.3°C allowed increase above natural conditions is considered. The results show very little change—slight reductions in some subbasins—between existing and future scenarios. This suggests that the code-required stormwater treatment effectively mitigates stream temperature impacts of the anticipated future development, preventing further temperature degradation.

6.2.2 Metals

The water quality standards for dissolved copper and zinc are variable and are computed for each assessment point as a function of hardness. Typically, values for metals concentrations and hardness are not available on a continuous basis, but for this study, acute and chronic standards for both metals of concern were assessed at the hourly model time step. At each time step, the simulated hardness value was used to compute the numeric criteria using the equations listed in Table 31. The hourly values for dissolved copper and zinc concentrations were then compared to the corresponding acute and chronic criteria to determine if the standard was exceeded. Given the high frequency of sampling, consecutive hours above a given standard were counted as one exceedance event. The allowable exceedance frequency for each of the dissolved metals criteria is one exceedance every three years on average (less than or equal to 0.33 exceedances per year on an annual basis).

None of the modeled scenarios violated the acute or chronic standard for copper or zinc (Table 36 and Table 37, respectively), and in fact, there were zero exceedances of acute or chronic criteria for either copper or zinc in any of the scenarios.

Table 36 Copper Exceedances Summary

	R100	R200	R300	R400	R500	R600	R700	R800	R900
Forested									
Acute	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chronic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Existing									
Acute	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chronic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Future									
Acute	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chronic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Exceedances defined relative to variable criteria computed using equations listed in **Table 32**. Standard is ≤0.33 exceedances per year (1 per 3 years on average).

Table 37 Zinc Exceedances Summary

	R100	R200	R300	R400	R500	R600	R700	R800	R900
Forested									
Acute	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chronic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Existing									
Acute	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chronic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Future									
Acute	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chronic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Exceedances defined relative to variable criteria computed using equations listed in **Table 32**. Standard is ≤0.33 exceedances per year (1 per 3 years on average).

6.2.3 Fecal Coliform

Unlike the temperature and metals standards, for which criteria are evaluated on a time step by time step basis, the fecal coliform criteria are statistical in nature and require evaluation of a sample set of values. Fecal coliform was assessed for three groups of data on an annual (water year) basis: wet season (October through March), dry season (April through September), and annual (October through September). The noon value for each day in the assessment period was used for assessment, as a pseudo-random sampling from the continuously simulated data. For each period and year, the geometric mean and the percent of values exceeding the 100 colonies per 100 milliliters criteria ("10 percent" criteria) were computed. Any exceedance of the geometric mean or 10 percent criteria was counted as an exceedance of the standard. For consistency with the County's fecal coliform reporting, the standard was defined as no exceedances of either criteria for any period or year.

Table 38 through Table 40 show the percent of years in the 60-year modeling period that fecal coliform exceeds the water quality criteria for the forested, existing, and future build-out scenarios, respectively. Each table shows the percent of years in the modeling period exceeding the geometric mean and 10 percent exceedance criteria for the annual, wet season, and dry season periods. (Annual and seasonal *values* of the geometric mean and percent exceedance are included as Appendix E.)

Notably, the forested condition scenario exceeds the 10 percent exceedance criteria in all subbasins except Rowlands Creek. The higher exceedance rates in Trout Creek (R800) and Little Bear Upper (R900) in the forested scenario are likely due to the lack of groundwater contribution from much of those drainage areas (see Figure 11). Since groundwater concentrations of fecal coliform are generally lower than surface and interflow concentrations, the relative lack of cleaner groundwater likely results in higher overall concentrations.

All subbasins regularly exceed both fecal coliform criteria in the existing and future build-out scenarios. There is little difference in dry season exceedances or exceedances of the 10 percent exceedance criteria (regardless of period) between existing conditions and future build-out. There are fluctuations in the percent of years exceeding the geometric mean during the wet season, though no clear trend in direction, possibly reflecting shifts in runoff timing related to the addition of code-required treatment facilities with future development.

Table 38 Forested Conditions Fecal Coliform Exceedance Summary

	R100	R200	R300	R400	R500	R600	R700	R800	R900
Annual									
Geometric Mean	0%	0%	0%	0%	0%	0%	0%	0%	0%
10 Percent	2%	0%	2%	2%	0%	10%	0%	18%	25%
Wet Season									
Geometric Mean	0%	0%	0%	0%	0%	0%	0%	0%	0%
10 Percent	7%	0%	13%	5%	3%	33%	0%	50%	72%
Dry Season									
Geometric Mean	0%	0%	0%	0%	0%	0%	0%	0%	0%
10 Percent	2%	0%	3%	2%	2%	12%	0%	7%	8%

Table 39 Existing Conditions Fecal Coliform Exceedance Summary

	R100	R200	R300	R400	R500	R600	R700	R800	R900
Annual									
Geometric Mean	95%	68%	93%	100%	95%	75%	72%	95%	88%
10 Percent	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wet Season									
Geometric Mean	68%	32%	68%	87%	75%	35%	28%	72%	45%
10 Percent	100%	100%	100%	100%	100%	100%	100%	100%	100%
Dry Season									
Geometric Mean	97%	100%	97%	100%	98%	97%	100%	100%	100%
10 Percent	98%	95%	98%	98%	98%	97%	95%	100%	97%

Table 40 Future Build-out Fecal Coliform Exceedance Summary

	R100	R200	R300	R400	R500	R600	R700	R800	R900
Annual									
Geometric Mean	83%	83%	85%	93%	95%	77%	78%	97%	85%
10 Percent	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wet Season									
Geometric Mean	55%	40%	48%	47%	80%	35%	32%	75%	42%
10 Percent	100%	100%	100%	100%	100%	100%	100%	100%	100%
Dry Season									
Geometric Mean	97%	100%	97%	100%	100%	98%	100%	100%	100%
10 Percent	97%	95%	97%	97%	98%	97%	95%	100%	97%

7 CONCLUSIONS

Special Condition S5.C.5.c.iv(4) of the Permit requires use of a calibrated continuous runoff model to evaluate dissolved copper, dissolved zinc, temperature, and fecal coliform bacteria, and also biologic conditions using a correlation of hydrologic metrics with benthic index of biological integrity (B-IBI) scores. The continuous runoff HSPF model developed for the Little Bear Creek basin planning project was calibrated to measured flow, temperature, metals and bacteria concentration data at multiple locations in the Little Bear Creek study area. Using the calibrated model parameters, simulations of forested, existing, and future build-out land use conditions were run, and simulated water quality data and computed B-IBI were compared to State water quality standards and B-IBI targets.

The modeling analysis indicated that the water quality standards for dissolved metals were met throughout the Little Bear Creek study area for all three land use conditions. However, temperature and fecal coliform bacteria standards were not met in the existing or future build-out land use conditions. One of the fecal coliform criteria was also not met under the forested land use condition. Both existing and future build-out scenarios fell short of the B-IBI targets at all four mainstem Little Bear Creek assessment locations. Hence, under Special Condition S5.C.5.c.iv (5), the County is required to use the calibrated model to evaluate stormwater management strategies that would enable the study area to meet the standards and targets. Water quality and B-IBI results for the future build-out land use condition, which is the basis of the stormwater planning requirement, are summarized in Table 41.

Table 41 Modeling Results Summary for Future Build-out Condition

Constituent	Criteria	Meets Criteria	Meets Standard/ Target
Dissolved Copper	Acute	✓	✓
	Chronic	✓	
Dissolved Zinc	Acute	✓	✓
	Chronic	✓	
Temperature	Core Summer	✗	✗
	Supplemental	✗	
	Spawning/Rearing/Migration	✓	
Fecal Coliform	Geometric Mean	✗	✗
	10 Percent Exceedance	✗	
B-IBI	90% of Forested	n/a	✗

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Appendix A: Pervious and Impervious Area Distributions

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Historic (Forested) Conditions PERLND and IMPLND Distribution

ID	Soil	Land Use	Slope	Above 51st Area (acres)	Below 51st Area (acres)
PERLNDs					
12	Till	Rural Forest	Flat	832.9	1669.2
13			Moderate	767.9	2715.6
14			Steep	274.9	690.3
32		Urban Forest	Flat	0.0	0.0
33			Moderate	0.0	0.0
34			Steep	0.0	0.0
22		Pasture – Without Farm Use	Flat	0.0	0.0
23			Moderate	0.0	0.0
24			Steep	0.0	0.0
26		Pasture – With Farm use	Flat	0.0	0.0
27			Moderate	0.0	0.0
28			Steep	0.0	0.0
42		Low Density Residential/Rural Grass – No Septic	Flat	0.0	0.0
43			Moderate	0.0	0.0
44			Steep	0.0	0.0
46		Low & Medium Density Residential/Rural Grass – Septic	Flat	0.0	0.0
47			Moderate	0.0	0.0
48			Steep	0.0	0.0
52		High Density Residential Grass	Flat	0.0	0.0
53			Moderate	0.0	0.0
54			Steep	0.0	0.0
62		Urban Grass	Flat	0.0	0.0
63			Moderate	0.0	0.0
64			Steep	0.0	0.0
71	Outwash	Rural Forest		142.3	547.7
73		Urban Forest		0.0	0.0
72		Pasture – Without Farm Use		0.0	0.0
78		Pasture – With Farm use		0.0	0.0
74		Low Density Residential/Rural Grass – No Septic		0.0	0.0
79		Low & Medium Density Residential/Rural Grass –Septic		0.0	0.0
75		High Density Residential Grass		0.0	0.0
76		Urban Grass		0.0	0.0
81	Saturated	Rural Forest		63.5	66.4
83		Urban Forest		0.0	0.0
82		Pasture – Without Farm Use		0.0	0.0
88		Pasture – With Farm use		0.0	0.0
84		Low Density Residential/Rural Grass – No Septic		0.0	0.0
89		Low & Medium Density Residential/Rural Grass –Septic		0.0	0.0
85		High Density Residential Grass		0.0	0.0
86		Urban Grass		0.0	0.0
87		Wetlands		128.8	524.6
91	Custer-Norma	Rural Forest		7.6	276.9
93		Urban Forest		0.0	0.0
92		Pasture – Without Farm Use		0.0	0.0
98		Pasture – With Farm use		0.0	0.0
94		Low Density Residential/Rural Grass – No Septic		0.0	0.0
99		Low & Medium Density Residential/Rural Grass –Septic		0.0	0.0
95		High Density Residential Grass		0.0	0.0
96		Urban Grass		0.0	0.0
IMPLNDs					
1		Low Pollution Generating Impervious Surfaces (LPGIS)		0.0	0.0
2		High Pollution Generating Impervious Surfaces (HPGIS)		0.0	0.0
3		Commercial/Industrial		0.0	0.0

Existing Conditions PERLND and IMPLND Distribution

ID	Soil	Land Use	Slope	Above 51st Area (acres)	Below 51st Area (acres)
PERLNDs					
12	Till	Rural Forest	Flat	31.2	61.9
13			Moderate	160.1	399.9
14			Steep	58.5	190.8
32		Urban Forest	Flat	150.6	467.1
33			Moderate	322.0	1243.8
34			Steep	170.5	347.8
22		Pasture – Without Farm Use	Flat	86.9	221.9
23			Moderate	75.1	228.5
24			Steep	15.9	37.2
26		Pasture – With Farm use	Flat	10.6	11.6
27			Moderate	4.6	9.5
28			Steep	1.4	0.9
42		Low Density Residential/Rural Grass – No Septic	Flat	160.5	335.2
43			Moderate	81.0	313.0
44			Steep	13.9	28.0
46		Low & Medium Density Residential/Rural Grass – Septic	Flat	28.0	104.1
47			Moderate	19.9	80.7
48			Steep	4.3	10.1
52		High Density Residential Grass	Flat	157.4	73.4
53			Moderate	43.4	73.7
54			Steep	2.7	12.8
62		Urban Grass	Flat	38.9	103.9
63			Moderate	19.1	124.2
64			Steep	3.1	30.6
71	Outwash	Rural Forest		17.1	61.0
73		Urban Forest		49.5	168.9
72		Pasture – Without Farm Use		20.0	37.5
78		Pasture – With Farm use		0.0	4.5
74		Low Density Residential/Rural Grass – No Septic		21.7	44.2
79		Low & Medium Density Residential/Rural Grass –Septic		9.9	8.4
75		High Density Residential Grass		9.2	13.2
76		Urban Grass		3.4	59.3
81	Saturated	Rural Forest		32.6	12.5
83		Urban Forest		12.7	30.7
82		Pasture – Without Farm Use		9.0	6.5
88		Pasture – With Farm use		0.5	1.1
84		Low Density Residential/Rural Grass – No Septic		5.4	8.9
89		Low & Medium Density Residential/Rural Grass –Septic		1.9	3.3
85		High Density Residential Grass		0.02	0.4
86		Urban Grass		0.3	1.0
87		Wetlands		129.4	519.3
91	Custer-Norma	Rural Forest		2.4	39.4
93		Urban Forest		2.9	95.5
92		Pasture – Without Farm Use		0.6	36.3
98		Pasture – With Farm use		0.0	1.9
94		Low Density Residential/Rural Grass – No Septic		0.3	30.0
99		Low & Medium Density Residential/Rural Grass –Septic		0.4	16.7
95		High Density Residential Grass		0.0	1.1
96		Urban Grass		0.4	23.5
IMPLNDs					
1		Low Pollution Generating Impervious Surfaces (LPGIS)		88.5	137.2
2		High Pollution Generating Impervious Surfaces (HPGIS)		122.8	258.3
3		Commercial/Industrial		17.5	359.5

Future Conditions PERLND and IMPLND Distribution

ID	Soil	Land Use	Slope	Above 51st Area (acres)	Below 51st Area (acres)
PERLNDs					
12	Till	Rural Forest	Flat	31.8	52.0
13			Moderate	135.2	267.5
14			Steep	56.1	162.5
32		Urban Forest	Flat	142.5	420.3
33			Moderate	305.5	1169.4
34			Steep	162.5	335.7
22		Pasture – Without Farm Use	Flat	108.3	277.8
23			Moderate	95.3	348.6
24			Steep	19.1	62.9
26		Pasture – With Farm use	Flat	21.3	52.2
27			Moderate	31.4	91.0
28			Steep	7.4	10.7
42		Low Density Residential/Rural Grass – No Septic	Flat	124.6	267.7
43			Moderate	67.0	254.2
44			Steep	12.4	23.6
46		Low & Medium Density Residential/Rural Grass – Septic	Flat	33.7	113.7
47			Moderate	21.2	93.7
48			Steep	5.5	11.7
52		High Density Residential Grass	Flat	158.1	71.0
53			Moderate	43.6	72.7
54			Steep	2.7	12.2
62		Urban Grass	Flat	38.4	90.6
63			Moderate	18.1	105.4
64			Steep	3.1	24.3
71	Outwash	Rural Forest		16.5	55.4
73		Urban Forest		42.9	164.4
72		Pasture – Without Farm Use		24.7	52.5
78		Pasture – With Farm use		9.3	10.4
74		Low Density Residential/Rural Grass – No Septic		11.5	31.1
79		Low & Medium Density Residential/Rural Grass –Septic		10.7	14.4
75		High Density Residential Grass		9.3	13.3
76		Urban Grass		3.1	54.6
81	Saturated	Rural Forest		25.2	12.3
83		Urban Forest		11.6	28.1
82		Pasture – Without Farm Use		12.1	10.0
88		Pasture – With Farm use		5.3	2.1
84		Low Density Residential/Rural Grass – No Septic		3.2	4.9
89		Low & Medium Density Residential/Rural Grass –Septic		3.2	5.8
85		High Density Residential Grass		0.0	0.4
86		Urban Grass		0.3	0.7
87		Wetlands		128.9	509.3
91	Custer-Norma	Rural Forest		2.3	38.2
93		Urban Forest		2.3	91.8
92		Pasture – Without Farm Use		1.0	41.9
98		Pasture – With Farm use		0.2	5.8
94		Low Density Residential/Rural Grass – No Septic		0.2	24.6
99		Low & Medium Density Residential/Rural Grass –Septic		0.4	14.7
95		High Density Residential Grass		0.0	1.1
96		Urban Grass		0.0	23.1
IMPLNDs					
1		Low Pollution Generating Impervious Surfaces (LPGIS)		96.9	223.7
2		High Pollution Generating Impervious Surfaces (HPGIS)		135.2	288.5
3		Commercial/Industrial		16.9	378.6

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Appendix B: Future Development Assumptions

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The future buildout land use conditions for the Little Bear basin will be defined following the 2015 Comprehensive Plan land use designations using available zoning development standards and development planning information. Information resulting from capacity analysis studies performed by the County's Planning and Development Services (PDS) department have been used to identify parcels within the study area that are likely to develop or redevelop to a more intense land use. Transportation projects from the 2016-2021 Transportation Improvement Program and 2015 Comprehensive Plan, as well as future parks and trails projects, have been incorporated into the future buildout condition.

Future land use and land cover definition methods vary based on the type of development and whether the development occurs within Snohomish County, city limits, urban growth areas (UGA), or rural areas. Land use/cover methods for each of the areas are described below. Areas that are not projected to develop (or redevelop) will use land use/land cover information from the existing conditions model, ensuring that flow and water-quality response from unchanged areas is consistent between the two scenarios.

Rural Area:

- Parcels identified as Non-Residential
  - Will be assigned future land cover based on proposed use and County's existing protocol (2002 Drainage Needs Report Protocols, Table 2).
  - Land cover located within area designated as unbuildable will use land use/land cover information from the existing conditions model.
- Schools
  - Will be assigned future land cover based on existing land cover for similar type of school (elementary, middle, high school) within watershed.
  - Land cover located within area designated as unbuildable will use land use/land cover information from the existing conditions model.
- Parks
  - Will be assigned future land cover based on planned development activities for site.
  - Land cover located within area designated as unbuildable will use land use/land cover information from the existing conditions model.
- Parcels identified as Rural Cluster Subdivisions (RCS)
  - Assumed that 65% of parcel is set aside as restricted open space
  - All unbuildable area is assumed to be open space.
  - Open space will be calculated as larger of:
    - 65% of Total Parcel Acres
    - Unbuildable Acres
  - Open space will use land use/land cover information from the existing conditions model.
  - Right-of-way area (TRANS) will be assigned to a percentage of the development space (11% for SFR-LOW, 14% for SFR-MED).
  - Density of lots calculated as Total Dwelling Units / Development Space. Future land cover will be based on proposed use and County's existing protocol.

  - Buildable area land cover will replace existing land cover based on the development hierarchy defined below.
- Parcels identified as Residential/Non-RCS
  - (35% x # Dwelling Units) of total parcel area will be assigned as impervious to represent allowable maximum lot coverage per SCC 30.23.030 except that the impervious coverage cannot exceed the gross buildable area. This is a conservative approach taken for modeling.
  - Remaining gross buildable area assigned as grass
  - Land cover located within area designated as unbuildable will use land use/land cover information from the existing conditions model.
  - Where gross buildable acres is smaller than 4,000 sf x # Dwelling Units use 4,000 sf x # Dwelling Units as the developed lot area.
    - 4,000 sf of disturbance in buffer is a restriction of SCC 30.62A.520.
    - All disturbed area to be treated as impervious.
    - Future impervious coverage will be assigned to buildable area first.
    - Remaining future impervious coverage will replace existing land cover within unbuildable area based on the development hierarchy defined below.

UGA:

- Residential
  - Will be assigned future land cover based on proposed use and County's existing protocol (2002 Drainage Needs Report Protocols, Table 2).
  - Land cover located within area designated as unbuildable will use land use/land cover information from the existing conditions model.
- Commercial
  - Will be assigned future land cover based on proposed use and County's existing protocol (2002 Drainage Needs Report Protocols, Table 2).
  - Land cover located within area designated as unbuildable will use land use/land cover information from the existing conditions model except any existing impervious area located within unbuildable area will be considered as being replaced under developed conditions and will have appropriate LID, Flow Control, and Water Quality requirements applied.
- Schools
  - Will be assigned future land cover based on existing land cover for similar type of school (elementary, middle, high school) within watershed.
  - Land cover located within area designated as unbuildable will use land use/land cover information from the existing conditions model.

Transportation & Trails:

- Will be assigned future land cover based on planned element widths (pavement, planter strips, sidewalks) over planned project length.

Within Bothell and Woodinville City Limit:

- Will be assigned future land cover based on proposed use and County's existing protocol (2002 Drainage Needs Report Protocols, Table 2).

Development Hierarchy

- Conversion of existing land cover to future land cover will be selected base on the following hierarchy of existing land cover and slope:
  - Flat and Moderate Impervious
  - Flat Grass, then Pasture and Scrub/Shrub
  - Moderate Grass, then Pasture and Scrub/Shrub
  - Flat Forest
  - Moderate Forest
  - Steep Impervious
  - Steep Grass, then Pasture and Scrub/Shrub, then Forest
  - Critical slope Impervious, then Grass, then Pasture and Scrub/Shrub, then Forest
  - Area within mapped wetland boundaries and/or having slopes 40% or steeper will be assumed to not develop and will maintain existing land cover.

- Slopes are defined as follows:
  - Flat: 0% up to 6%
  - Moderate: 6% up to 15%
  - Steep: 15% up to 33%
  - Critical: 33% up to 40%
  - Slopes 40% and steeper are considered unbuildable (for modeling purpose)

Prepared by Snohomish County, June 2017

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Appendix C: Yearly B-IBI Metric Results

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Subbasin 100 Forested B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	3	45.5	72	44.1	0.09	41.5	43.7
1957	5	42.2	43	46.9	0.11	40.7	43.3
1958	7	38.9	90	42.4	0.11	40.1	40.5
1959	6	40.6	84	43.0	0.11	40.5	41.3
1960	5	42.2	87	42.7	0.10	40.9	41.9
1961	8	37.3	117	39.8	0.14	38.7	38.6
1962	1	48.8	2	50.9	0.07	42.7	47.5
1963	1	48.8	2	50.9	0.09	41.8	47.2
1964	8	37.3	108	40.6	0.12	39.6	39.2
1965	4	43.8	60	45.3	0.11	40.2	43.1
1966	1	48.8	3	50.8	0.06	43.3	47.6
1967	6	40.6	100	41.4	0.11	40.5	40.8
1968	5	42.2	104	41.0	0.12	39.9	41.1
1969	5	42.2	68	44.5	0.09	41.4	42.7
1970	3	45.5	58	45.5	0.09	41.6	44.2
1971	5	42.2	95	41.9	0.16	37.5	40.5
1972	5	42.2	57	45.6	0.12	40.1	42.6
1973	4	43.8	38	47.4	0.08	42.2	44.5
1974	14	27.4	158	35.8	0.15	38.1	33.8
1975	5	42.2	27	48.5	0.10	40.9	43.9
1976	12	30.7	164	35.2	0.15	37.9	34.6
1977	2	47.1	58	45.5	0.09	41.8	44.8
1978	5	42.2	126	38.9	0.12	40.0	40.4
1979	4	43.8	48	46.4	0.13	39.3	43.2
1980	5	42.2	100	41.4	0.13	39.0	40.9
1981	3	45.5	120	39.5	0.11	40.3	41.8
1982	12	30.7	148	36.7	0.17	36.9	34.8
1983	10	34.0	199	31.8	0.12	40.0	35.3
1984	7	38.9	128	38.7	0.12	39.6	39.1
1985	10	34.0	199	31.8	0.15	37.8	34.5
1986	7	38.9	163	35.3	0.19	35.8	36.7
1987	11	32.4	146	36.9	0.20	35.1	34.8
1988	1	48.8	3	50.8	0.09	41.7	47.1
1989	2	47.1	64	44.9	0.08	42.4	44.8
1990	5	42.2	62	45.1	0.08	42.1	43.1
1991	7	38.9	128	38.7	0.13	39.5	39.0
1992	3	45.5	29	48.3	0.09	41.4	45.1
1993	2	47.1	8	50.3	0.07	42.6	46.7
1994	4	43.8	40	47.2	0.07	42.8	44.6
1995	8	37.3	111	40.3	0.10	40.8	39.5
1996	12	30.7	170	34.6	0.18	36.1	33.8

Subbasin 100 Forested B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	15	25.8	226	29.2	0.21	34.6	29.9
1998	11	32.4	125	39.0	0.12	39.6	37.0
1999	11	32.4	213	30.4	0.15	38.0	33.6
2000	15	25.8	142	37.3	0.12	39.7	34.3
2001	0	50.4	0	51.1	0.04	44.4	48.6
2002	15	25.8	140	37.5	0.16	37.2	33.5
2003	2	47.1	11	50.0	0.08	42.3	46.5
2004	6	40.6	107	40.7	0.12	39.6	40.3
2005	5	42.2	130	38.5	0.13	39.1	39.9
2006	6	40.6	100	41.4	0.19	35.8	39.3
2007	8	37.3	124	39.1	0.17	36.7	37.7
2008	13	29.1	185	33.2	0.19	35.7	32.6
2009	5	42.2	100	41.4	0.12	39.8	41.1
2010	16	24.2	208	30.9	0.15	38.1	31.1
2011	11	32.4	162	35.4	0.21	34.3	34.0
2012	12	30.7	108	40.6	0.15	38.1	36.5
2013	9	35.6	156	36.0	0.19	35.4	35.7
2014	7	38.9	116	39.8	0.16	37.3	38.7
2015	10	34.0	155	36.1	0.18	36.0	35.4

Subbasin 300 Forested B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	3	45.5	73	44.0	0.10	41.2	43.6
1957	5	42.2	43	46.9	0.11	40.3	43.1
1958	7	38.9	136	37.9	0.12	39.8	38.9
1959	6	40.6	84	43.0	0.12	40.1	41.2
1960	5	42.2	87	42.7	0.11	40.5	41.8
1961	8	37.3	117	39.8	0.15	38.2	38.4
1962	1	48.8	3	50.8	0.08	42.5	47.4
1963	1	48.8	2	50.9	0.09	41.6	47.1
1964	7	38.9	108	40.6	0.13	39.2	39.6
1965	5	42.2	59	45.4	0.12	39.8	42.5
1966	1	48.8	3	50.8	0.06	43.2	47.6
1967	7	38.9	108	40.6	0.11	40.2	39.9
1968	6	40.6	104	41.0	0.13	39.5	40.4
1969	5	42.2	68	44.5	0.10	41.1	42.6
1970	3	45.5	58	45.5	0.09	41.3	44.1
1971	6	40.6	95	41.9	0.17	36.9	39.8
1972	5	42.2	57	45.6	0.12	39.7	42.5
1973	4	43.8	38	47.4	0.08	41.9	44.4
1974	14	27.4	158	35.8	0.16	37.6	33.6
1975	5	42.2	27	48.5	0.11	40.6	43.8
1976	11	32.4	164	35.2	0.16	37.4	35.0
1977	2	47.1	58	45.5	0.09	41.5	44.7
1978	5	42.2	126	38.9	0.12	39.6	40.2
1979	4	43.8	48	46.4	0.14	38.8	43.0
1980	7	38.9	100	41.4	0.14	38.5	39.6
1981	3	45.5	120	39.5	0.12	39.9	41.6
1982	13	29.1	148	36.7	0.18	36.3	34.0
1983	10	34.0	199	31.8	0.12	39.6	35.1
1984	7	38.9	128	38.7	0.13	39.2	38.9
1985	12	30.7	199	31.8	0.16	37.4	33.3
1986	7	38.9	163	35.3	0.20	35.2	36.5
1987	12	30.7	147	36.8	0.21	34.4	34.0
1988	1	48.8	3	50.8	0.09	41.4	47.0
1989	2	47.1	64	44.9	0.08	42.2	44.7
1990	5	42.2	62	45.1	0.08	41.9	43.1
1991	7	38.9	128	38.7	0.13	39.1	38.9
1992	3	45.5	29	48.3	0.10	41.1	45.0
1993	2	47.1	8	50.3	0.08	42.3	46.6
1994	4	43.8	40	47.2	0.07	42.6	44.6
1995	8	37.3	111	40.3	0.11	40.5	39.4
1996	12	30.7	170	34.6	0.20	35.4	33.6

Subbasin 300 Forested B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	16	24.2	226	29.2	0.22	33.9	29.1
1998	11	32.4	125	39.0	0.13	39.2	36.8
1999	11	32.4	213	30.4	0.16	37.5	33.4
2000	15	25.8	142	37.3	0.13	39.3	34.2
2001	0	50.4	0	51.1	0.05	44.3	48.6
2002	15	25.8	140	37.5	0.17	36.7	33.3
2003	2	47.1	11	50.0	0.08	42.1	46.4
2004	6	40.6	107	40.7	0.13	39.2	40.2
2005	5	42.2	130	38.5	0.14	38.6	39.8
2006	6	40.6	100	41.4	0.20	35.2	39.0
2007	8	37.3	124	39.1	0.18	36.1	37.5
2008	13	29.1	185	33.2	0.20	35.0	32.4
2009	5	42.2	101	41.3	0.13	39.4	41.0
2010	16	24.2	208	30.9	0.16	37.6	30.9
2011	10	34.0	162	35.4	0.23	33.6	34.3
2012	12	30.7	108	40.6	0.16	37.6	36.3
2013	11	32.4	156	36.0	0.21	34.7	34.4
2014	8	37.3	116	39.8	0.17	36.8	38.0
2015	11	32.4	155	36.1	0.19	35.4	34.6

Subbasin 600 Forested B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	5	42.2	71	44.2	0.09	41.3	42.6
1957	5	42.2	43	46.9	0.11	40.5	43.2
1958	8	37.3	136	37.9	0.12	40.0	38.4
1959	6	40.6	84	43.0	0.11	40.3	41.3
1960	5	42.2	87	42.7	0.11	40.7	41.9
1961	8	37.3	117	39.8	0.14	38.4	38.5
1962	1	48.8	3	50.8	0.07	42.7	47.4
1963	1	48.8	2	50.9	0.09	41.8	47.2
1964	8	37.3	108	40.6	0.13	39.3	39.1
1965	7	38.9	59	45.4	0.12	40.0	41.4
1966	1	48.8	3	50.8	0.06	43.4	47.6
1967	6	40.6	100	41.4	0.11	40.3	40.7
1968	5	42.2	104	41.0	0.12	39.7	41.0
1969	7	38.9	68	44.5	0.10	41.2	41.5
1970	3	45.5	58	45.5	0.09	41.5	44.2
1971	7	38.9	95	41.9	0.17	37.0	39.3
1972	5	42.2	57	45.6	0.12	39.9	42.6
1973	4	43.8	38	47.4	0.08	42.1	44.5
1974	15	25.8	158	35.8	0.16	37.7	33.1
1975	5	42.2	27	48.5	0.10	40.8	43.8
1976	12	30.7	164	35.2	0.16	37.6	34.5
1977	2	47.1	58	45.5	0.09	41.6	44.7
1978	5	42.2	126	38.9	0.12	39.7	40.3
1979	4	43.8	48	46.4	0.13	39.0	43.1
1980	6	40.6	100	41.4	0.14	38.7	40.2
1981	3	45.5	120	39.5	0.12	40.1	41.7
1982	13	29.1	148	36.7	0.18	36.4	34.1
1983	10	34.0	199	31.8	0.12	39.8	35.2
1984	7	38.9	128	38.7	0.13	39.5	39.0
1985	12	30.7	199	31.8	0.16	37.5	33.4
1986	7	38.9	163	35.3	0.19	35.4	36.5
1987	11	32.4	147	36.8	0.21	34.8	34.7
1988	1	48.8	3	50.8	0.09	41.7	47.1
1989	2	47.1	64	44.9	0.08	42.3	44.8
1990	5	42.2	62	45.1	0.08	42.0	43.1
1991	7	38.9	128	38.7	0.13	39.2	38.9
1992	3	45.5	28	48.4	0.09	41.3	45.1
1993	2	47.1	8	50.3	0.08	42.5	46.6
1994	4	43.8	40	47.2	0.07	42.8	44.6
1995	8	37.3	111	40.3	0.11	40.7	39.4
1996	13	29.1	170	34.6	0.20	35.3	33.0

Subbasin 600 Forested B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	17	22.5	226	29.2	0.22	33.9	28.5
1998	10	34.0	125	39.0	0.13	39.4	37.4
1999	11	32.4	213	30.4	0.16	37.5	33.4
2000	15	25.8	142	37.3	0.13	39.5	34.2
2001	0	50.4	0	51.1	0.04	44.4	48.6
2002	12	30.7	140	37.5	0.17	36.8	35.0
2003	2	47.1	11	50.0	0.08	42.3	46.5
2004	6	40.6	107	40.7	0.13	39.4	40.2
2005	5	42.2	130	38.5	0.14	38.7	39.8
2006	8	37.3	100	41.4	0.20	35.2	38.0
2007	8	37.3	121	39.4	0.18	36.4	37.7
2008	13	29.1	185	33.2	0.20	35.3	32.5
2009	5	42.2	100	41.4	0.12	39.6	41.1
2010	17	22.5	208	30.9	0.15	37.8	30.4
2011	10	34.0	162	35.4	0.22	33.6	34.3
2012	12	30.7	108	40.6	0.16	37.7	36.3
2013	10	34.0	156	36.0	0.21	34.7	34.9
2014	8	37.3	116	39.8	0.17	37.1	38.1
2015	12	30.7	155	36.1	0.19	35.7	34.2

Subbasin 900 Forested B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	9	35.6	70	44.3	0.11	40.2	40.0
1957	4	43.8	43	46.9	0.13	39.4	43.4
1958	6	40.6	136	37.9	0.14	38.4	38.9
1959	5	42.2	84	43.0	0.14	38.4	41.2
1960	6	40.6	133	38.2	0.13	39.1	39.3
1961	9	35.6	167	34.9	0.19	35.8	35.4
1962	1	48.8	3	50.8	0.08	42.2	47.2
1963	1	48.8	3	50.8	0.11	40.6	46.7
1964	8	37.3	108	40.6	0.17	36.7	38.2
1965	7	38.9	58	45.5	0.15	38.2	40.9
1966	1	48.8	2	50.9	0.07	43.0	47.6
1967	6	40.6	108	40.6	0.15	38.2	39.8
1968	5	42.2	105	40.9	0.15	37.8	40.3
1969	7	38.9	75	43.8	0.12	39.7	40.8
1970	4	43.8	86	42.8	0.11	40.4	42.3
1971	11	32.4	95	41.9	0.22	34.0	36.1
1972	5	42.2	57	45.6	0.15	38.2	42.0
1973	4	43.8	30	48.2	0.10	41.3	44.4
1974	10	34.0	158	35.8	0.20	34.9	34.9
1975	4	43.8	72	44.1	0.12	39.5	42.5
1976	10	34.0	165	35.1	0.20	34.9	34.7
1977	3	45.5	65	44.8	0.10	40.7	43.7
1978	7	38.9	126	38.9	0.16	37.6	38.5
1979	4	43.8	163	35.3	0.17	36.7	38.6
1980	7	38.9	100	41.4	0.18	36.4	38.9
1981	6	40.6	141	37.4	0.15	38.0	38.7
1982	16	24.2	148	36.7	0.23	33.3	31.4
1983	8	37.3	200	31.7	0.15	38.1	35.7
1984	7	38.9	128	38.7	0.15	37.8	38.5
1985	12	30.7	199	31.8	0.20	35.0	32.5
1986	9	35.6	163	35.3	0.24	32.6	34.5
1987	12	30.7	147	36.8	0.26	31.8	33.1
1988	1	48.8	3	50.8	0.10	40.8	46.8
1989	3	45.5	64	44.9	0.10	41.2	43.9
1990	4	43.8	62	45.1	0.10	40.9	43.3
1991	4	43.8	89	42.5	0.17	37.0	41.1
1992	4	43.8	81	43.2	0.11	40.2	42.4
1993	2	47.1	64	44.9	0.09	41.5	44.5
1994	3	45.5	40	47.2	0.09	41.9	44.9
1995	6	40.6	111	40.3	0.13	39.1	40.0
1996	13	29.1	198	31.9	0.25	31.9	30.9

Subbasin 900 Forested B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	22	14.3	226	29.2	0.28	30.5	24.7
1998	14	27.4	153	36.3	0.16	37.7	33.8
1999	13	29.1	203	31.4	0.20	35.0	31.8
2000	19	19.2	142	37.3	0.16	37.7	31.4
2001	0	50.4	0	51.1	0.04	44.6	48.7
2002	13	29.1	159	35.7	0.23	33.6	32.8
2003	2	47.1	11	50.0	0.09	41.7	46.3
2004	6	40.6	107	40.7	0.16	37.5	39.6
2005	6	40.6	130	38.5	0.18	36.3	38.5
2006	8	37.3	100	41.4	0.26	31.7	36.8
2007	10	34.0	150	36.6	0.23	33.5	34.7
2008	12	30.7	187	33.0	0.25	32.1	31.9
2009	7	38.9	145	37.0	0.15	37.8	37.9
2010	16	24.2	208	30.9	0.20	35.0	30.0
2011	13	29.1	162	35.4	0.29	29.9	31.5
2012	12	30.7	108	40.6	0.19	35.4	35.6
2013	12	30.7	156	36.0	0.25	31.8	32.8
2014	9	35.6	116	39.8	0.20	34.8	36.8
2015	13	29.1	156	36.0	0.24	32.9	32.6

Subbasin 100 Existing B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	13	29.1	230	28.8	0.22	34.0	30.6
1957	9	35.6	166	35.0	0.26	31.3	34.0
1958	12	30.7	166	35.0	0.28	30.4	32.0
1959	10	34.0	166	35.0	0.29	29.9	33.0
1960	12	30.7	321	20.0	0.28	30.6	27.1
1961	14	27.4	256	26.3	0.31	28.3	27.3
1962	6	40.6	223	29.5	0.29	30.0	33.3
1963	5	42.2	133	38.2	0.27	31.2	37.2
1964	15	25.8	304	21.6	0.31	28.5	25.3
1965	12	30.7	170	34.6	0.27	31.1	32.1
1966	9	35.6	130	38.5	0.25	31.9	35.3
1967	15	25.8	302	21.8	0.27	31.0	26.2
1968	11	32.4	270	24.9	0.31	28.8	28.7
1969	15	25.8	335	18.6	0.27	31.1	25.2
1970	10	34.0	168	34.8	0.25	32.2	33.7
1971	13	29.1	283	23.6	0.30	29.2	27.3
1972	13	29.1	292	22.8	0.29	30.0	27.3
1973	8	37.3	203	31.4	0.23	33.4	34.0
1974	20	17.6	198	31.9	0.28	30.6	26.7
1975	15	25.8	272	24.7	0.30	29.4	26.6
1976	19	19.2	296	22.4	0.30	29.3	23.6
1977	8	37.3	207	31.0	0.29	29.5	32.6
1978	12	30.7	140	37.5	0.29	29.7	32.6
1979	8	37.3	163	35.3	0.28	30.2	34.3
1980	10	34.0	205	31.2	0.34	26.8	30.7
1981	12	30.7	249	26.9	0.32	28.2	28.6
1982	24	11.0	286	23.4	0.30	28.9	21.1
1983	15	25.8	241	27.7	0.27	31.2	28.2
1984	9	35.6	309	21.1	0.29	29.7	28.8
1985	16	24.2	221	29.7	0.31	28.8	27.5
1986	14	27.4	335	18.6	0.34	27.0	24.3
1987	17	22.5	174	34.2	0.34	26.8	27.9
1988	9	35.6	193	32.4	0.32	27.7	31.9
1989	13	29.1	136	37.9	0.26	31.6	32.9
1990	8	37.3	190	32.7	0.26	31.8	33.9
1991	14	27.4	188	32.9	0.29	29.7	30.0
1992	10	34.0	202	31.5	0.29	29.7	31.7
1993	13	29.1	287	23.3	0.33	27.3	26.6
1994	8	37.3	135	38.0	0.23	33.1	36.1
1995	13	29.1	279	24.0	0.28	30.4	27.8
1996	17	22.5	310	21.0	0.32	28.2	23.9

Subbasin 100 Existing B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	24	11.0	261	25.8	0.30	28.9	21.9
1998	19	19.2	266	25.3	0.27	30.7	25.1
1999	22	14.3	240	27.8	0.28	30.6	24.2
2000	20	17.6	158	35.8	0.26	31.3	28.2
2001	5	42.2	307	21.3	0.30	28.9	30.8
2002	18	20.9	172	34.4	0.27	31.0	28.8
2003	6	40.6	100	41.4	0.26	31.4	37.8
2004	10	34.0	292	22.8	0.33	27.5	28.1
2005	12	30.7	169	34.7	0.31	28.5	31.3
2006	14	27.4	207	31.0	0.31	28.8	29.1
2007	15	25.8	148	36.7	0.29	29.8	30.8
2008	16	24.2	208	30.9	0.33	27.4	27.5
2009	12	30.7	197	32.0	0.29	29.8	30.8
2010	21	16.0	321	20.0	0.31	28.4	21.4
2011	15	25.8	206	31.1	0.31	28.7	28.6
2012	17	22.5	215	30.2	0.29	29.7	27.5
2013	17	22.5	335	18.6	0.31	28.6	23.2
2014	13	29.1	180	33.6	0.30	29.0	30.6
2015	18	20.9	186	33.1	0.31	28.5	27.5

Subbasin 300 Existing B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	11	32.4	206	31.1	0.20	34.9	32.8
1957	9	35.6	166	35.0	0.24	32.4	34.4
1958	11	32.4	159	35.7	0.26	31.6	33.2
1959	9	35.6	166	35.0	0.27	31.1	33.9
1960	12	30.7	321	20.0	0.25	31.8	27.5
1961	14	27.4	256	26.3	0.29	29.6	27.8
1962	4	43.8	223	29.5	0.26	31.3	34.9
1963	5	42.2	133	38.2	0.24	32.6	37.7
1964	14	27.4	304	21.6	0.29	29.9	26.3
1965	10	34.0	117	39.8	0.25	32.0	35.2
1966	9	35.6	130	38.5	0.23	33.5	35.9
1967	14	27.4	167	34.9	0.25	32.1	31.5
1968	11	32.4	269	25.0	0.28	30.0	29.1
1969	12	30.7	328	19.3	0.25	32.4	27.5
1970	9	35.6	134	38.1	0.23	33.4	35.7
1971	11	32.4	283	23.6	0.28	30.1	28.7
1972	11	32.4	292	22.8	0.27	31.1	28.8
1973	6	40.6	203	31.4	0.21	34.5	35.5
1974	19	19.2	198	31.9	0.26	31.4	27.5
1975	15	25.8	272	24.7	0.27	30.7	27.1
1976	17	22.5	193	32.4	0.28	30.5	28.5
1977	8	37.3	206	31.1	0.27	30.8	33.1
1978	11	32.4	140	37.5	0.27	30.8	33.5
1979	7	38.9	163	35.3	0.27	31.1	35.1
1980	9	35.6	139	37.6	0.32	28.0	33.8
1981	11	32.4	249	26.9	0.29	29.6	29.6
1982	20	17.6	272	24.7	0.29	29.7	24.0
1983	14	27.4	242	27.6	0.25	32.0	29.0
1984	9	35.6	309	21.1	0.27	30.8	29.2
1985	15	25.8	220	29.8	0.29	29.9	28.5
1986	14	27.4	334	18.7	0.32	28.0	24.7
1987	15	25.8	174	34.2	0.33	27.5	29.2
1988	8	37.3	191	32.6	0.30	29.3	33.1
1989	9	35.6	86	42.8	0.24	32.9	37.1
1990	8	37.3	183	33.3	0.23	33.0	34.5
1991	14	27.4	188	32.9	0.27	30.7	30.3
1992	9	35.6	202	31.5	0.27	30.9	32.7
1993	10	34.0	227	29.1	0.30	28.9	30.7
1994	8	37.3	134	38.1	0.21	34.3	36.5
1995	12	30.7	279	24.0	0.26	31.6	28.8
1996	17	22.5	310	21.0	0.31	28.8	24.1

Subbasin 300 Existing B-IBI Metrics (cont.)

	HPC		HPR		RBI		
Water Year	Value	Computed B-IBI	Value	Computed B-IBI	Value	Computed B-IBI	AVG B-IBI
1997	23	12.7	260	25.9	0.30	29.3	22.6
1998	19	19.2	266	25.3	0.26	31.6	25.4
1999	19	19.2	225	29.3	0.26	31.3	26.6
2000	19	19.2	158	35.8	0.25	32.1	29.0
2001	3	45.5	235	28.3	0.27	30.9	34.9
2002	17	22.5	172	34.4	0.26	31.3	29.4
2003	6	40.6	100	41.4	0.24	32.7	38.2
2004	10	34.0	292	22.8	0.31	28.7	28.5
2005	11	32.4	169	34.7	0.29	29.5	32.2
2006	12	30.7	151	36.5	0.29	29.5	32.2
2007	15	25.8	148	36.7	0.28	30.4	31.0
2008	16	24.2	208	30.9	0.32	28.1	27.7
2009	11	32.4	197	32.0	0.27	30.9	31.7
2010	20	17.6	321	20.0	0.30	29.3	22.3
2011	15	25.8	206	31.1	0.30	29.2	28.7
2012	17	22.5	215	30.2	0.28	30.3	27.7
2013	15	25.8	311	20.9	0.30	29.1	25.3
2014	12	30.7	180	33.6	0.29	29.9	31.4
2015	17	22.5	186	33.1	0.30	29.3	28.3

Subbasin 600 Existing B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	9	35.6	194	32.3	0.17	36.9	34.9
1957	6	40.6	124	39.1	0.21	34.7	38.1
1958	9	35.6	159	35.7	0.22	34.2	35.2
1959	8	37.3	166	35.0	0.22	33.7	35.3
1960	9	35.6	88	42.6	0.21	34.5	37.6
1961	11	32.4	195	32.2	0.24	32.4	32.3
1962	3	45.5	171	34.5	0.21	34.3	38.1
1963	4	43.8	125	39.0	0.20	35.3	39.4
1964	13	29.1	151	36.5	0.24	32.7	32.7
1965	9	35.6	117	39.8	0.21	34.3	36.6
1966	7	38.9	83	43.0	0.18	36.3	39.4
1967	11	32.4	166	35.0	0.21	34.6	34.0
1968	7	38.9	127	38.8	0.24	32.9	36.9
1969	10	34.0	241	27.7	0.20	35.0	32.3
1970	7	38.9	97	41.7	0.19	35.9	38.8
1971	10	34.0	139	37.6	0.25	32.4	34.7
1972	9	35.6	292	22.8	0.22	33.6	30.7
1973	5	42.2	83	43.0	0.17	36.7	40.7
1974	17	22.5	186	33.1	0.23	33.5	29.7
1975	14	27.4	173	34.3	0.23	33.6	31.8
1976	16	24.2	193	32.4	0.24	33.0	29.8
1977	4	43.8	70	44.3	0.22	33.7	40.6
1978	11	32.4	140	37.5	0.23	33.3	34.4
1979	7	38.9	163	35.3	0.23	33.2	35.8
1980	10	34.0	139	37.6	0.27	31.0	34.2
1981	9	35.6	211	30.6	0.24	32.4	32.9
1982	16	24.2	195	32.2	0.25	32.0	29.4
1983	12	30.7	216	30.1	0.21	34.2	31.7
1984	6	40.6	134	38.1	0.23	33.3	37.3
1985	13	29.1	221	29.7	0.25	32.3	30.3
1986	11	32.4	202	31.5	0.28	30.4	31.4
1987	13	29.1	174	34.2	0.29	29.9	31.1
1988	6	40.6	188	32.9	0.24	32.8	35.4
1989	7	38.9	75	43.8	0.19	35.6	39.4
1990	6	40.6	98	41.6	0.20	35.3	39.2
1991	12	30.7	137	37.8	0.23	33.2	33.9
1992	7	38.9	143	37.2	0.23	33.6	36.6
1993	7	38.9	200	31.7	0.25	32.2	34.3
1994	7	38.9	134	38.1	0.17	36.6	37.9
1995	10	34.0	149	36.6	0.22	34.1	34.9
1996	15	25.8	183	33.3	0.27	30.8	30.0

Subbasin 600 Existing B-IBI Metrics (cont.)

	HPC		HPR		RBI		
Water Year	Value	Computed B-IBI	Value	Computed B-IBI	Value	Computed B-IBI	AVG B-IBI
1997	20	17.6	240	27.8	0.27	30.9	25.5
1998	19	19.2	266	25.3	0.22	33.9	26.2
1999	19	19.2	225	29.3	0.23	33.3	27.3
2000	19	19.2	158	35.8	0.21	34.4	29.8
2001	0	50.4	0	51.1	0.20	34.8	45.4
2002	15	25.8	154	36.2	0.23	33.1	31.7
2003	4	43.8	100	41.4	0.19	35.4	40.2
2004	8	37.3	137	37.8	0.26	31.5	35.5
2005	10	34.0	169	34.7	0.25	32.1	33.6
2006	10	34.0	149	36.6	0.26	31.5	34.1
2007	12	30.7	147	36.8	0.24	32.6	33.4
2008	13	29.1	188	32.9	0.28	30.3	30.7
2009	10	34.0	194	32.3	0.23	33.5	33.3
2010	17	22.5	320	20.1	0.25	31.9	24.8
2011	12	30.7	161	35.5	0.27	30.8	32.3
2012	16	24.2	215	30.2	0.25	32.4	28.9
2013	15	25.8	311	20.9	0.27	30.9	25.9
2014	10	34.0	115	39.9	0.25	32.2	35.4
2015	16	24.2	186	33.1	0.26	31.6	29.6

Subbasin 900 Existing B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	13	29.1	231	28.7	0.20	34.9	30.9
1957	8	37.3	160	35.6	0.24	32.7	35.2
1958	11	32.4	167	34.9	0.25	32.2	33.2
1959	9	35.6	166	35.0	0.26	31.3	34.0
1960	10	34.0	128	38.7	0.24	32.6	35.1
1961	12	30.7	256	26.3	0.26	31.4	29.4
1962	5	42.2	224	29.4	0.27	31.0	34.2
1963	4	43.8	126	38.9	0.26	31.7	38.1
1964	14	27.4	304	21.6	0.27	30.9	26.6
1965	10	34.0	168	34.8	0.25	32.1	33.6
1966	7	38.9	83	43.0	0.23	33.2	38.4
1967	11	32.4	168	34.8	0.24	33.0	33.4
1968	8	37.3	270	24.9	0.27	30.8	31.0
1969	10	34.0	328	19.3	0.23	33.6	29.0
1970	8	37.3	168	34.8	0.22	33.8	35.3
1971	11	32.4	283	23.6	0.26	31.6	29.2
1972	11	32.4	294	22.6	0.26	31.7	28.9
1973	6	40.6	203	31.4	0.21	34.3	35.4
1974	20	17.6	306	21.4	0.24	32.6	23.9
1975	14	27.4	272	24.7	0.26	31.5	27.9
1976	15	25.8	194	32.3	0.26	31.6	29.9
1977	7	38.9	206	31.1	0.26	31.5	33.8
1978	9	35.6	140	37.5	0.27	30.7	34.6
1979	10	34.0	164	35.2	0.28	30.6	33.3
1980	9	35.6	139	37.6	0.30	29.1	34.1
1981	9	35.6	226	29.2	0.29	29.7	31.5
1982	17	22.5	287	23.3	0.26	31.7	25.8
1983	12	30.7	242	27.6	0.24	32.9	30.4
1984	9	35.6	309	21.1	0.26	31.5	29.4
1985	14	27.4	320	20.1	0.27	30.7	26.1
1986	13	29.1	266	25.3	0.30	28.9	27.7
1987	14	27.4	174	34.2	0.30	29.3	30.3
1988	6	40.6	193	32.4	0.27	31.0	34.6
1989	8	37.3	124	39.1	0.23	33.2	36.5
1990	8	37.3	183	33.3	0.23	33.1	34.6
1991	11	32.4	188	32.9	0.26	31.6	32.3
1992	9	35.6	202	31.5	0.27	30.7	32.6
1993	9	35.6	280	23.9	0.30	29.2	29.6
1994	7	38.9	135	38.0	0.21	34.3	37.1
1995	10	34.0	159	35.7	0.26	31.8	33.8
1996	15	25.8	310	21.0	0.29	29.5	25.4

Subbasin 900 Existing B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	24	11.0	261	25.8	0.28	30.1	22.3
1998	19	19.2	267	25.2	0.23	33.0	25.8
1999	12	30.7	226	29.2	0.25	32.3	30.7
2000	17	22.5	158	35.8	0.23	33.1	30.5
2001	4	43.8	236	28.2	0.28	30.3	34.1
2002	17	22.5	192	32.5	0.26	31.7	28.9
2003	5	42.2	100	41.4	0.23	33.0	38.9
2004	9	35.6	293	22.7	0.31	28.8	29.0
2005	10	34.0	170	34.6	0.29	29.6	32.7
2006	10	34.0	153	36.3	0.28	30.4	33.5
2007	10	34.0	137	37.8	0.26	31.6	34.5
2008	11	32.4	189	32.8	0.32	28.2	31.1
2009	11	32.4	198	31.9	0.25	32.1	32.1
2010	20	17.6	341	18.0	0.27	31.1	22.2
2011	13	29.1	207	31.0	0.29	29.7	29.9
2012	15	25.8	215	30.2	0.27	30.9	29.0
2013	16	24.2	334	18.7	0.28	30.3	24.4
2014	12	30.7	155	36.1	0.27	31.1	32.6
2015	15	25.8	186	33.1	0.27	31.2	30.0

Subbasin 100 Future B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	11	32.4	230	28.8	0.20	35.3	32.2
1957	9	35.6	166	35.0	0.24	32.8	34.5
1958	11	32.4	159	35.7	0.25	32.2	33.4
1959	10	34.0	166	35.0	0.26	31.7	33.6
1960	12	30.7	321	20.0	0.24	32.4	27.7
1961	14	27.4	256	26.3	0.28	30.6	28.1
1962	4	43.8	223	29.5	0.26	31.5	34.9
1963	5	42.2	133	38.2	0.24	32.7	37.7
1964	15	25.8	304	21.6	0.28	30.6	26.0
1965	10	34.0	117	39.8	0.24	32.5	35.4
1966	9	35.6	130	38.5	0.23	33.4	35.8
1967	14	27.4	167	34.9	0.24	32.9	31.8
1968	11	32.4	269	25.0	0.27	30.9	29.4
1969	13	29.1	328	19.3	0.24	33.0	27.1
1970	9	35.6	134	38.1	0.22	33.7	35.8
1971	12	30.7	283	23.6	0.27	31.1	28.5
1972	11	32.4	292	22.8	0.26	31.7	28.9
1973	8	37.3	203	31.4	0.21	34.5	34.4
1974	20	17.6	198	31.9	0.24	32.4	27.3
1975	15	25.8	272	24.7	0.26	31.3	27.3
1976	17	22.5	193	32.4	0.26	31.4	28.8
1977	8	37.3	206	31.1	0.27	31.2	33.2
1978	10	34.0	140	37.5	0.27	31.1	34.2
1979	8	37.3	163	35.3	0.26	31.8	34.8
1980	9	35.6	139	37.6	0.31	28.8	34.0
1981	11	32.4	249	26.9	0.28	30.1	29.8
1982	19	19.2	282	23.7	0.27	30.9	24.6
1983	14	27.4	241	27.7	0.24	32.7	29.3
1984	9	35.6	309	21.1	0.26	31.4	29.4
1985	15	25.8	220	29.8	0.27	30.9	28.8
1986	13	29.1	334	18.7	0.30	29.3	25.7
1987	15	25.8	174	34.2	0.31	28.8	29.6
1988	9	35.6	193	32.4	0.29	29.9	32.7
1989	8	37.3	86	42.8	0.23	33.2	37.7
1990	8	37.3	183	33.3	0.23	33.5	34.7
1991	14	27.4	188	32.9	0.26	31.7	30.7
1992	9	35.6	202	31.5	0.26	31.3	32.8
1993	10	34.0	227	29.1	0.30	29.3	30.8
1994	8	37.3	134	38.1	0.21	34.5	36.6
1995	12	30.7	279	24.0	0.25	32.2	29.0
1996	17	22.5	310	21.0	0.28	30.1	24.5

Subbasin 100 Future B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	22	14.3	260	25.9	0.28	30.6	23.6
1998	19	19.2	266	25.3	0.25	32.3	25.6
1999	20	17.6	225	29.3	0.25	32.2	26.4
2000	19	19.2	158	35.8	0.24	32.8	29.3
2001	3	45.5	235	28.3	0.28	30.5	34.8
2002	17	22.5	172	34.4	0.25	32.4	29.8
2003	6	40.6	100	41.4	0.24	32.9	38.3
2004	10	34.0	292	22.8	0.29	29.6	28.8
2005	11	32.4	169	34.7	0.28	30.2	32.4
2006	12	30.7	150	36.6	0.28	30.4	32.6
2007	14	27.4	148	36.7	0.26	31.3	31.8
2008	15	25.8	208	30.9	0.30	29.4	28.7
2009	11	32.4	197	32.0	0.26	31.5	32.0
2010	21	16.0	321	20.0	0.28	30.4	22.1
2011	15	25.8	206	31.1	0.28	30.5	29.1
2012	17	22.5	215	30.2	0.26	31.3	28.0
2013	15	25.8	312	20.8	0.28	30.4	25.7
2014	13	29.1	180	33.6	0.27	30.8	31.2
2015	17	22.5	186	33.1	0.28	30.5	28.7

Subbasin 300 Future B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	9	35.6	194	32.3	0.18	36.3	34.7
1957	8	37.3	124	39.1	0.22	33.7	36.7
1958	11	32.4	159	35.7	0.23	33.3	33.8
1959	9	35.6	166	35.0	0.24	32.8	34.5
1960	10	34.0	115	39.9	0.23	33.5	35.8
1961	14	27.4	256	26.3	0.26	31.8	28.5
1962	3	45.5	171	34.5	0.24	32.6	37.5
1963	4	43.8	125	39.0	0.22	33.7	38.9
1964	13	29.1	151	36.5	0.25	31.9	32.5
1965	10	34.0	117	39.8	0.23	33.4	35.7
1966	8	37.3	83	43.0	0.21	34.6	38.3
1967	13	29.1	167	34.9	0.22	33.9	32.6
1968	8	37.3	127	38.8	0.25	32.0	36.0
1969	12	30.7	328	19.3	0.22	34.1	28.1
1970	8	37.3	134	38.1	0.21	34.7	36.7
1971	11	32.4	283	23.6	0.25	32.0	29.3
1972	11	32.4	292	22.8	0.24	32.7	29.3
1973	5	42.2	83	43.0	0.19	35.4	40.2
1974	18	20.9	186	33.1	0.23	33.2	29.0
1975	14	27.4	173	34.3	0.24	32.4	31.4
1976	17	22.5	193	32.4	0.24	32.5	29.1
1977	4	43.8	70	44.3	0.25	32.2	40.1
1978	11	32.4	140	37.5	0.25	32.0	34.0
1979	7	38.9	163	35.3	0.25	32.4	35.5
1980	10	34.0	139	37.6	0.29	29.9	33.8
1981	11	32.4	249	26.9	0.27	31.2	30.2
1982	17	22.5	194	32.3	0.26	31.8	28.9
1983	13	29.1	216	30.1	0.23	33.5	30.9
1984	9	35.6	309	21.1	0.25	32.4	29.7
1985	14	27.4	220	29.8	0.26	31.7	29.6
1986	11	32.4	202	31.5	0.28	30.2	31.4
1987	15	25.8	174	34.2	0.29	29.5	29.8
1988	8	37.3	191	32.6	0.26	31.4	33.8
1989	8	37.3	86	42.8	0.21	34.4	38.1
1990	8	37.3	183	33.3	0.21	34.5	35.0
1991	13	29.1	137	37.8	0.24	32.7	33.2
1992	9	35.6	202	31.5	0.25	32.4	33.2
1993	10	34.0	227	29.1	0.27	30.7	31.3
1994	8	37.3	134	38.1	0.19	35.5	37.0
1995	11	32.4	149	36.6	0.23	33.3	34.1
1996	16	24.2	201	31.6	0.27	30.7	28.8

Subbasin 300 Future B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	21	16.0	260	25.9	0.27	31.0	24.3
1998	19	19.2	266	25.3	0.23	33.1	25.9
1999	19	19.2	225	29.3	0.24	32.9	27.2
2000	19	19.2	158	35.8	0.23	33.6	29.5
2001	1	48.8	1	51.0	0.25	32.1	43.9
2002	16	24.2	154	36.2	0.24	32.8	31.0
2003	4	43.8	100	41.4	0.22	34.1	39.8
2004	10	34.0	292	22.8	0.27	30.7	29.2
2005	11	32.4	169	34.7	0.27	31.1	32.7
2006	13	29.1	151	36.5	0.27	31.1	32.2
2007	13	29.1	148	36.7	0.25	32.0	32.6
2008	14	27.4	188	32.9	0.29	30.0	30.1
2009	10	34.0	194	32.3	0.24	32.6	32.9
2010	19	19.2	321	20.0	0.26	31.4	23.5
2011	14	27.4	206	31.1	0.27	30.9	29.8
2012	17	22.5	215	30.2	0.25	31.9	28.2
2013	15	25.8	311	20.9	0.27	30.9	25.9
2014	10	34.0	115	39.9	0.26	31.6	35.2
2015	17	22.5	186	33.1	0.26	31.3	29.0

Subbasin 600 Future B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	7	38.9	194	32.3	0.16	37.4	36.2
1957	6	40.6	124	39.1	0.20	35.3	38.3
1958	9	35.6	159	35.7	0.20	34.9	35.4
1959	6	40.6	85	42.9	0.21	34.4	39.3
1960	9	35.6	88	42.6	0.20	35.3	37.8
1961	9	35.6	145	37.0	0.23	33.6	35.4
1962	3	45.5	171	34.5	0.21	34.6	38.2
1963	4	43.8	125	39.0	0.19	35.5	39.4
1964	13	29.1	151	36.5	0.22	33.7	33.1
1965	9	35.6	117	39.8	0.20	35.0	36.8
1966	7	38.9	83	43.0	0.18	36.5	39.5
1967	11	32.4	166	35.0	0.19	35.4	34.3
1968	7	38.9	127	38.8	0.22	33.8	37.2
1969	8	37.3	241	27.7	0.19	35.8	33.6
1970	6	40.6	87	42.7	0.18	36.4	39.9
1971	10	34.0	139	37.6	0.23	33.5	35.0
1972	9	35.6	292	22.8	0.21	34.4	30.9
1973	4	43.8	41	47.1	0.17	37.0	42.6
1974	17	22.5	186	33.1	0.21	34.6	30.1
1975	14	27.4	173	34.3	0.21	34.4	32.1
1976	14	27.4	193	32.4	0.22	34.0	31.3
1977	4	43.8	70	44.3	0.21	34.3	40.8
1978	8	37.3	131	38.4	0.22	33.8	36.5
1979	7	38.9	163	35.3	0.22	33.9	36.0
1980	10	34.0	139	37.6	0.25	32.0	34.5
1981	8	37.3	211	30.6	0.23	33.1	33.7
1982	15	25.8	194	32.3	0.23	33.3	30.5
1983	12	30.7	216	30.1	0.20	35.0	32.0
1984	6	40.6	134	38.1	0.22	34.0	37.6
1985	12	30.7	221	29.7	0.23	33.2	31.2
1986	11	32.4	202	31.5	0.26	31.8	31.9
1987	14	27.4	174	34.2	0.26	31.2	31.0
1988	6	40.6	188	32.9	0.22	33.7	35.7
1989	7	38.9	75	43.8	0.18	36.1	39.6
1990	6	40.6	98	41.6	0.19	36.0	39.4
1991	12	30.7	137	37.8	0.22	34.2	34.2
1992	7	38.9	143	37.2	0.22	34.2	36.8
1993	7	38.9	200	31.7	0.24	32.9	34.5
1994	7	38.9	133	38.2	0.17	37.0	38.1
1995	10	34.0	149	36.6	0.20	34.8	35.2
1996	15	25.8	183	33.3	0.25	32.1	30.4

Subbasin 600 Future B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	18	20.9	240	27.8	0.25	32.1	26.9
1998	19	19.2	266	25.3	0.20	34.8	26.4
1999	19	19.2	225	29.3	0.21	34.2	27.6
2000	19	19.2	158	35.8	0.20	35.2	30.1
2001	0	50.4	0	51.1	0.21	34.6	45.4
2002	15	25.8	154	36.2	0.22	34.2	32.0
2003	4	43.8	100	41.4	0.19	35.9	40.4
2004	8	37.3	137	37.8	0.24	32.5	35.9
2005	10	34.0	169	34.7	0.24	32.9	33.9
2006	10	34.0	149	36.6	0.24	32.5	34.4
2007	11	32.4	135	38.0	0.23	33.5	34.6
2008	12	30.7	188	32.9	0.26	31.5	31.7
2009	10	34.0	194	32.3	0.21	34.4	33.6
2010	17	22.5	320	20.1	0.23	33.1	25.2
2011	12	30.7	161	35.5	0.25	32.1	32.8
2012	15	25.8	167	34.9	0.23	33.4	31.4
2013	15	25.8	311	20.9	0.25	32.1	26.3
2014	10	34.0	115	39.9	0.23	33.2	35.7
2015	17	22.5	186	33.1	0.24	32.8	29.5

Subbasin 900 Future B-IBI Metrics

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1956	13	29.1	231	28.7	0.20	35.0	30.9
1957	7	38.9	151	36.5	0.24	32.8	36.1
1958	11	32.4	167	34.9	0.24	32.5	33.3
1959	9	35.6	166	35.0	0.26	31.4	34.0
1960	10	34.0	128	38.7	0.24	32.9	35.2
1961	12	30.7	256	26.3	0.25	31.9	29.6
1962	5	42.2	224	29.4	0.27	30.9	34.1
1963	4	43.8	126	38.9	0.26	31.6	38.1
1964	14	27.4	304	21.6	0.26	31.3	26.8
1965	10	34.0	168	34.8	0.25	32.4	33.7
1966	6	40.6	83	43.0	0.23	33.0	38.9
1967	11	32.4	167	34.9	0.23	33.3	33.5
1968	8	37.3	270	24.9	0.27	30.9	31.0
1969	12	30.7	328	19.3	0.22	33.9	28.0
1970	8	37.3	168	34.8	0.22	33.9	35.3
1971	11	32.4	283	23.6	0.25	32.0	29.3
1972	11	32.4	294	22.6	0.25	31.9	29.0
1973	5	42.2	203	31.4	0.21	34.2	35.9
1974	20	17.6	306	21.4	0.23	33.1	24.0
1975	13	29.1	174	34.2	0.26	31.8	31.7
1976	14	27.4	194	32.3	0.25	32.1	30.6
1977	7	38.9	206	31.1	0.26	31.6	33.9
1978	9	35.6	140	37.5	0.27	30.8	34.7
1979	10	34.0	164	35.2	0.27	30.9	33.4
1980	9	35.6	139	37.6	0.30	29.4	34.2
1981	9	35.6	226	29.2	0.29	29.9	31.6
1982	17	22.5	287	23.3	0.25	32.4	26.1
1983	12	30.7	242	27.6	0.23	33.2	30.5
1984	9	35.6	310	21.0	0.26	31.8	29.5
1985	15	25.8	320	20.1	0.27	31.1	25.7
1986	13	29.1	266	25.3	0.29	29.4	27.9
1987	14	27.4	174	34.2	0.29	29.9	30.5
1988	6	40.6	193	32.4	0.27	31.2	34.7
1989	8	37.3	124	39.1	0.23	33.2	36.5
1990	8	37.3	183	33.3	0.23	33.2	34.6
1991	11	32.4	188	32.9	0.25	32.0	32.4
1992	9	35.6	202	31.5	0.27	30.8	32.7
1993	9	35.6	280	23.9	0.30	29.3	29.6
1994	7	38.9	135	38.0	0.21	34.5	37.1
1995	11	32.4	159	35.7	0.25	32.0	33.3
1996	15	25.8	310	21.0	0.29	30.0	25.6

Subbasin 900 Future B-IBI Metrics (cont.)

Water Year	HPC Value	HPC Computed B-IBI	HPR Value	HPR Computed B-IBI	RBI Value	RBI Computed B-IBI	AVG B-IBI
1997	23	12.7	261	25.8	0.28	30.5	23.0
1998	19	19.2	267	25.2	0.23	33.5	26.0
1999	13	29.1	226	29.2	0.24	32.7	30.3
2000	17	22.5	158	35.8	0.23	33.4	30.6
2001	4	43.8	236	28.2	0.29	29.9	34.0
2002	17	22.5	192	32.5	0.25	32.2	29.1
2003	5	42.2	100	41.4	0.23	33.1	38.9
2004	9	35.6	293	22.7	0.30	29.1	29.1
2005	10	34.0	170	34.6	0.29	29.9	32.8
2006	9	35.6	153	36.3	0.27	30.7	34.2
2007	10	34.0	137	37.8	0.25	31.9	34.6
2008	11	32.4	189	32.8	0.31	28.8	31.3
2009	10	34.0	198	31.9	0.24	32.4	32.8
2010	21	16.0	341	18.0	0.26	31.6	21.9
2011	13	29.1	207	31.0	0.28	30.3	30.1
2012	15	25.8	215	30.2	0.26	31.3	29.1
2013	16	24.2	334	18.7	0.27	30.9	24.6
2014	11	32.4	155	36.1	0.26	31.5	33.3
2015	13	29.1	186	33.1	0.26	31.7	31.3

Appendix D: Yearly Temperature Exceedance Results

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Subbasin 100 Forested Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	34	0	59
1957	44	0	47
1958	30	0	71
1959	26	0	47
1960	28	0	45
1961	22	0	55
1962	12	0	57
1963	21	0	50
1964	30	0	35
1965	13	0	51
1966	25	0	33
1967	20	0	62
1968	17	0	51
1969	27	0	41
1970	22	0	34
1971	21	0	31
1972	23	0	47
1973	9	0	45
1974	16	0	21
1975	25	0	26
1976	21	0	24
1977	25	0	30
1978	9	0	45
1979	30	0	50
1980	34	0	39
1981	25	0	37
1982	13	0	38
1983	13	0	22
1984	6	0	48
1985	25	0	36
1986	12	0	24
1987	23	0	49
1988	31	0	42
1989	35	0	38
1990	20	0	49
1991	18	0	54
1992	43	0	63
1993	27	0	26
1994	32	0	64
1995	32	0	48
1996	22	0	35
1997	28	0	37

Subbasin 100 Forested Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	30	0	51
1999	21	0	38
2000	14	0	37
2001	18	0	38
2002	18	0	35
2003	15	0	53
2004	36	0	68
2005	37	0	46
2006	14	0	39
2007	18	0	34
2008	14	0	31
2009	20	0	40
2010	15	0	34
2011	20	0	20
2012	17	0	39
2013	26	0	53
2014	15	0	52
2015	32	0	52

Subbasin 200 Forested Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	2	0	23
1957	7	0	0
1958	11	0	8
1959	2	0	2
1960	0	0	0
1961	0	0	0
1962	0	0	0
1963	1	0	0
1964	9	0	0
1965	0	0	0
1966	0	0	0
1967	0	0	0
1968	5	0	0
1969	2	0	0
1970	2	0	0
1971	0	0	0
1972	0	0	3
1973	0	0	0
1974	0	0	0
1975	10	0	0
1976	0	0	0
1977	7	0	9
1978	0	0	1
1979	3	0	3
1980	6	0	0
1981	7	0	7
1982	4	0	0
1983	5	0	0
1984	0	0	0
1985	11	0	0
1986	0	0	0
1987	6	0	6
1988	6	0	2
1989	6	0	0
1990	5	0	0
1991	11	0	0
1992	22	0	7
1993	16	0	4
1994	8	0	26
1995	15	0	6
1996	8	0	4
1997	2	0	0

Subbasin 200 Forested Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	10	0	5
1999	4	0	0
2000	0	0	0
2001	4	0	0
2002	0	0	0
2003	0	0	0
2004	3	0	1
2005	0	0	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	0	0	3
2010	2	0	0
2011	12	0	0
2012	7	0	0
2013	0	0	0
2014	0	0	0
2015	9	0	0

Subbasin 300 Forested Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	32	0	55
1957	42	0	34
1958	23	0	70
1959	23	0	35
1960	23	0	40
1961	21	0	42
1962	8	0	36
1963	19	0	34
1964	29	0	9
1965	11	0	39
1966	21	0	16
1967	18	0	48
1968	17	0	44
1969	26	0	24
1970	19	0	17
1971	19	0	30
1972	19	0	29
1973	8	0	36
1974	15	0	13
1975	24	0	14
1976	19	0	12
1977	19	0	29
1978	8	0	40
1979	26	0	34
1980	30	0	33
1981	23	0	23
1982	9	0	19
1983	13	0	0
1984	4	0	33
1985	24	0	31
1986	11	0	12
1987	19	0	46
1988	30	0	34
1989	32	0	31
1990	18	0	43
1991	18	0	48
1992	37	0	62
1993	25	0	17
1994	28	0	58
1995	26	0	44
1996	19	0	28
1997	25	0	22

Subbasin 300 Forested Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	27	0	46
1999	18	0	22
2000	12	0	27
2001	17	0	25
2002	17	0	22
2003	13	0	45
2004	28	0	63
2005	33	0	26
2006	11	0	11
2007	16	0	19
2008	13	0	12
2009	17	0	26
2010	14	0	23
2011	18	0	0
2012	16	0	12
2013	25	0	30
2014	13	0	41
2015	31	0	49

Subbasin 400 Forested Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	27	0	47
1957	42	0	13
1958	22	0	66
1959	15	0	22
1960	10	0	26
1961	15	0	21
1962	4	0	16
1963	19	0	7
1964	27	0	1
1965	5	0	20
1966	4	0	0
1967	17	0	10
1968	15	0	25
1969	20	0	15
1970	18	0	6
1971	14	0	29
1972	13	0	31
1973	6	0	13
1974	11	0	13
1975	20	0	10
1976	18	0	2
1977	16	0	27
1978	5	0	32
1979	16	0	18
1980	21	0	28
1981	22	0	24
1982	6	0	10
1983	12	0	0
1984	1	0	25
1985	20	0	28
1986	8	0	11
1987	13	0	35
1988	29	0	26
1989	23	0	4
1990	16	0	38
1991	17	0	36
1992	40	0	53
1993	23	0	15
1994	26	0	55
1995	26	0	43
1996	17	0	25
1997	19	0	22

Subbasin 400 Forested Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	26	0	40
1999	15	0	16
2000	10	0	21
2001	12	0	9
2002	14	0	8
2003	10	0	22
2004	20	0	42
2005	20	0	9
2006	3	0	8
2007	7	0	13
2008	3	0	6
2009	6	0	15
2010	11	0	7
2011	17	0	0
2012	14	0	10
2013	16	0	8
2014	11	0	31
2015	22	0	31

Subbasin 500 Forested Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	2	0	38
1957	15	0	0
1958	15	0	41
1959	3	0	6
1960	2	0	2
1961	0	0	3
1962	0	0	6
1963	9	0	1
1964	20	0	0
1965	0	0	2
1966	0	0	0
1967	3	0	2
1968	7	0	9
1969	4	0	3
1970	7	0	0
1971	3	0	18
1972	0	0	9
1973	2	0	0
1974	0	0	4
1975	10	0	2
1976	1	0	0
1977	14	0	18
1978	1	0	13
1979	5	0	6
1980	12	0	9
1981	14	0	10
1982	4	0	1
1983	8	0	0
1984	0	0	0
1985	14	0	6
1986	0	0	1
1987	8	0	12
1988	15	0	12
1989	9	0	0
1990	7	0	7
1991	14	0	5
1992	31	0	28
1993	19	0	6
1994	12	0	45
1995	16	0	17
1996	13	0	9
1997	4	0	0

Subbasin 500 Forested Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	16	0	12
1999	8	0	0
2000	5	0	0
2001	4	0	0
2002	3	0	0
2003	2	0	0
2004	8	0	23
2005	0	0	0
2006	0	0	3
2007	0	0	0
2008	0	0	0
2009	0	0	8
2010	3	0	0
2011	12	0	0
2012	8	0	0
2013	0	0	0
2014	1	0	0
2015	12	0	2

Subbasin 600 Forested Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	31	0	53
1957	42	0	29
1958	25	0	70
1959	26	0	34
1960	24	0	40
1961	22	0	38
1962	15	0	32
1963	20	0	38
1964	29	0	11
1965	11	0	35
1966	23	0	15
1967	20	0	45
1968	17	0	39
1969	26	0	22
1970	19	0	13
1971	21	0	29
1972	18	0	26
1973	9	0	30
1974	16	0	13
1975	23	0	11
1976	19	0	9
1977	17	0	29
1978	8	0	37
1979	26	0	32
1980	30	0	31
1981	24	0	22
1982	9	0	12
1983	13	0	0
1984	4	0	32
1985	24	0	31
1986	10	0	10
1987	21	0	43
1988	30	0	29
1989	33	0	32
1990	18	0	41
1991	18	0	44
1992	36	0	59
1993	26	0	14
1994	28	0	56
1995	29	0	44
1996	20	0	24
1997	24	0	23

Subbasin 600 Forested Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	27	0	42
1999	16	0	26
2000	12	0	24
2001	17	0	21
2002	18	0	19
2003	15	0	42
2004	28	0	57
2005	36	0	26
2006	14	0	10
2007	17	0	19
2008	13	0	7
2009	18	0	24
2010	14	0	21
2011	18	0	0
2012	16	0	15
2013	25	0	31
2014	13	0	40
2015	30	0	48

Subbasin 700 Forested Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	5	0	29
1957	18	0	0
1958	15	0	18
1959	3	0	5
1960	2	0	0
1961	0	0	0
1962	0	0	0
1963	7	0	0
1964	17	0	0
1965	0	0	0
1966	0	0	0
1967	1	0	0
1968	7	0	2
1969	5	0	0
1970	5	0	0
1971	2	0	4
1972	0	0	5
1973	2	0	0
1974	0	0	3
1975	11	0	0
1976	0	0	0
1977	13	0	15
1978	1	0	6
1979	5	0	5
1980	12	0	2
1981	14	0	8
1982	4	0	0
1983	8	0	0
1984	0	0	0
1985	13	0	4
1986	0	0	0
1987	8	0	11
1988	16	0	4
1989	8	0	0
1990	7	0	0
1991	13	0	3
1992	30	0	17
1993	18	0	6
1994	12	0	35
1995	16	0	12
1996	13	0	6
1997	5	0	0

Subbasin 700 Forested Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	17	0	8
1999	8	0	0
2000	5	0	0
2001	4	0	0
2002	2	0	0
2003	2	0	0
2004	8	0	6
2005	0	0	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	0	0	6
2010	3	0	0
2011	14	0	0
2012	8	0	0
2013	1	0	0
2014	0	0	0
2015	12	0	0

Subbasin 800 Forested Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	32	0	52
1957	42	0	21
1958	24	0	70
1959	20	0	35
1960	19	0	37
1961	20	0	38
1962	5	0	22
1963	19	0	9
1964	27	0	12
1965	8	0	29
1966	9	0	12
1967	18	0	25
1968	16	0	36
1969	24	0	21
1970	19	0	8
1971	15	0	29
1972	13	0	36
1973	7	0	25
1974	13	0	14
1975	22	0	13
1976	18	0	8
1977	16	0	27
1978	6	0	36
1979	21	0	27
1980	29	0	32
1981	22	0	34
1982	6	0	16
1983	12	0	0
1984	2	0	34
1985	21	0	31
1986	10	0	11
1987	17	0	39
1988	29	0	25
1989	24	0	15
1990	16	0	42
1991	17	0	43
1992	39	0	58
1993	24	0	18
1994	27	0	56
1995	30	0	43
1996	20	0	24
1997	23	0	26

Subbasin 800 Forested Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	28	0	43
1999	16	0	23
2000	11	0	25
2001	13	0	15
2002	15	0	19
2003	12	0	26
2004	24	0	47
2005	28	0	26
2006	6	0	10
2007	11	0	18
2008	5	0	10
2009	11	0	21
2010	13	0	19
2011	17	0	0
2012	14	0	22
2013	19	0	20
2014	12	0	40
2015	28	0	41

Subbasin 900 Forested Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	3	0	36
1957	26	0	0
1958	18	0	53
1959	10	0	8
1960	7	0	6
1961	2	0	5
1962	3	0	11
1963	18	0	4
1964	21	0	0
1965	3	0	7
1966	0	0	0
1967	14	0	3
1968	14	0	18
1969	9	0	4
1970	14	0	0
1971	7	0	22
1972	3	0	15
1973	4	0	7
1974	4	0	7
1975	14	0	5
1976	12	0	0
1977	15	0	22
1978	3	0	19
1979	11	0	8
1980	19	0	20
1981	21	0	17
1982	5	0	0
1983	11	0	0
1984	0	0	3
1985	18	0	12
1986	0	0	5
1987	9	0	18
1988	25	0	21
1989	16	0	0
1990	12	0	28
1991	17	0	10
1992	28	0	35
1993	21	0	9
1994	20	0	51
1995	21	0	28
1996	16	0	11
1997	6	0	0

Subbasin 900 Forested Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	22	0	16
1999	13	0	0
2000	8	0	3
2001	8	0	0
2002	12	0	1
2003	3	0	5
2004	14	0	30
2005	2	0	0
2006	0	0	5
2007	4	0	0
2008	0	0	0
2009	1	0	9
2010	9	0	0
2011	17	0	0
2012	9	0	0
2013	3	0	0
2014	4	0	1
2015	13	0	4

Subbasin 100 Existing Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	40	0	71
1957	36	0	68
1958	34	0	73
1959	27	0	62
1960	22	0	54
1961	23	0	70
1962	24	0	66
1963	27	0	64
1964	29	0	50
1965	23	0	56
1966	30	0	53
1967	26	0	71
1968	24	0	59
1969	29	0	69
1970	25	0	67
1971	33	0	52
1972	38	0	67
1973	16	0	58
1974	20	0	52
1975	28	0	48
1976	36	0	52
1977	37	0	62
1978	23	3	66
1979	44	0	66
1980	45	0	70
1981	31	0	56
1982	19	0	69
1983	25	0	39
1984	20	0	66
1985	28	0	65
1986	19	0	70
1987	38	0	70
1988	36	0	83
1989	43	0	64
1990	36	0	64
1991	21	0	59
1992	57	0	72
1993	30	0	68
1994	40	0	75
1995	46	0	77
1996	27	0	67
1997	36	0	66

Subbasin 100 Existing Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	33	0	79
1999	29	0	60
2000	23	0	66
2001	39	0	72
2002	26	0	69
2003	30	0	59
2004	40	0	75
2005	43	0	66
2006	30	0	59
2007	31	0	63
2008	19	0	57
2009	21	0	62
2010	23	0	57
2011	22	0	68
2012	26	0	56
2013	33	0	75
2014	25	0	69
2015	43	0	73

Subbasin 200 Existing Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	0	0	0
1957	0	0	0
1958	0	0	0
1959	0	0	0
1960	0	0	0
1961	0	0	0
1962	0	0	0
1963	0	0	0
1964	0	0	0
1965	0	0	0
1966	0	0	0
1967	2	0	0
1968	0	0	0
1969	0	0	0
1970	12	0	0
1971	1	0	0
1972	0	0	1
1973	0	0	0
1974	0	0	0
1975	0	0	0
1976	0	0	0
1977	3	0	0
1978	0	0	3
1979	3	0	0
1980	0	0	0
1981	0	0	0
1982	4	0	0
1983	1	0	0
1984	0	0	0
1985	0	0	0
1986	0	0	0
1987	0	0	0
1988	2	0	0
1989	2	0	0
1990	0	0	0
1991	0	0	0
1992	0	0	0
1993	4	0	0
1994	0	0	0
1995	0	0	0
1996	5	0	0
1997	0	0	0

Subbasin 200 Existing Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	6	0	0
1999	0	0	0
2000	0	0	0
2001	0	0	0
2002	0	0	0
2003	0	0	0
2004	0	0	0
2005	1	0	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	0	0	0
2010	4	0	0
2011	10	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	7	0	0

Subbasin 300 Existing Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	35	0	65
1957	33	0	54
1958	32	0	72
1959	22	0	56
1960	17	0	51
1961	22	0	69
1962	21	0	61
1963	23	0	60
1964	24	0	45
1965	17	0	54
1966	28	0	40
1967	24	0	68
1968	21	0	54
1969	26	0	55
1970	19	0	60
1971	24	0	44
1972	34	0	62
1973	10	0	58
1974	17	0	36
1975	27	0	43
1976	35	0	42
1977	34	0	48
1978	18	0	57
1979	34	0	61
1980	41	0	56
1981	20	0	50
1982	18	0	54
1983	16	0	34
1984	17	0	62
1985	25	0	50
1986	17	0	51
1987	35	0	59
1988	34	0	65
1989	37	0	57
1990	28	0	62
1991	16	0	55
1992	52	0	64
1993	24	0	47
1994	37	0	70
1995	44	0	63
1996	21	0	60
1997	35	0	53

Subbasin 300 Existing Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	31	0	73
1999	21	0	57
2000	21	0	57
2001	28	0	54
2002	23	0	59
2003	25	0	57
2004	39	0	73
2005	42	0	57
2006	22	0	54
2007	27	0	53
2008	16	0	55
2009	17	0	54
2010	21	0	51
2011	21	0	57
2012	22	0	46
2013	30	0	66
2014	21	0	66
2015	40	0	69

Subbasin 400 Existing Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	32	0	57
1957	39	0	30
1958	30	0	72
1959	18	0	45
1960	17	0	40
1961	20	0	57
1962	10	0	41
1963	21	0	29
1964	26	0	15
1965	11	0	45
1966	22	0	25
1967	21	0	65
1968	18	0	57
1969	28	0	44
1970	25	0	37
1971	25	0	34
1972	31	0	60
1973	11	0	47
1974	15	0	30
1975	26	0	20
1976	33	0	25
1977	27	0	32
1978	16	0	45
1979	36	0	52
1980	37	0	52
1981	18	0	44
1982	16	0	40
1983	16	0	20
1984	7	0	51
1985	25	0	46
1986	12	0	29
1987	29	0	53
1988	32	0	47
1989	30	0	45
1990	17	0	53
1991	18	0	51
1992	34	0	64
1993	26	0	40
1994	33	0	57
1995	35	0	51
1996	27	0	50
1997	33	0	52

Subbasin 400 Existing Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	32	0	66
1999	24	0	47
2000	15	0	39
2001	23	0	44
2002	19	0	39
2003	22	0	49
2004	38	0	71
2005	38	0	43
2006	14	0	28
2007	20	0	42
2008	18	0	28
2009	20	0	37
2010	19	0	36
2011	20	0	23
2012	16	0	44
2013	28	0	65
2014	22	0	58
2015	36	0	56

Subbasin 500 Existing Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	6	0	42
1957	21	0	2
1958	7	0	63
1959	3	0	8
1960	5	0	5
1961	0	0	7
1962	0	0	10
1963	16	0	12
1964	19	0	0
1965	2	0	7
1966	0	0	0
1967	12	0	9
1968	12	0	18
1969	10	0	6
1970	14	0	0
1971	6	0	27
1972	3	0	28
1973	4	0	6
1974	0	0	10
1975	14	0	5
1976	8	0	2
1977	13	0	22
1978	1	0	19
1979	7	0	10
1980	15	0	16
1981	10	0	17
1982	5	0	3
1983	10	0	0
1984	0	0	6
1985	13	0	15
1986	3	0	11
1987	9	0	22
1988	23	0	27
1989	13	0	0
1990	3	0	25
1991	15	0	18
1992	26	0	38
1993	19	0	15
1994	16	0	49
1995	15	0	36
1996	16	0	20
1997	11	0	9

Subbasin 500 Existing Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	21	0	27
1999	15	0	7
2000	7	0	7
2001	6	0	0
2002	8	0	5
2003	3	0	4
2004	7	0	35
2005	2	0	0
2006	0	0	6
2007	3	0	2
2008	0	0	1
2009	0	0	9
2010	8	0	1
2011	13	0	0
2012	4	0	3
2013	4	0	8
2014	3	0	17
2015	14	0	7

Subbasin 600 Existing Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	32	0	58
1957	31	0	48
1958	30	0	71
1959	22	0	50
1960	5	0	50
1961	17	0	68
1962	19	0	55
1963	20	0	52
1964	23	0	32
1965	15	0	52
1966	27	0	37
1967	21	0	68
1968	21	0	53
1969	28	0	52
1970	24	0	64
1971	24	0	39
1972	33	0	58
1973	10	0	56
1974	18	0	29
1975	27	0	38
1976	35	0	38
1977	29	0	43
1978	19	0	52
1979	37	0	61
1980	42	0	50
1981	15	0	44
1982	20	0	42
1983	15	0	30
1984	18	0	61
1985	27	0	48
1986	17	0	38
1987	32	0	58
1988	35	0	58
1989	37	0	55
1990	30	0	61
1991	16	0	54
1992	43	0	64
1993	22	0	29
1994	36	0	69
1995	46	0	50
1996	24	0	53
1997	35	0	51

Subbasin 600 Existing Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	28	0	63
1999	22	0	46
2000	21	0	48
2001	25	0	55
2002	21	0	53
2003	25	0	58
2004	39	0	67
2005	34	0	50
2006	20	0	50
2007	29	0	45
2008	17	0	54
2009	19	0	49
2010	23	0	45
2011	19	0	42
2012	23	0	45
2013	30	0	57
2014	21	0	58
2015	40	0	63

Subbasin 700 Existing Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	11	0	35
1957	30	0	1
1958	15	0	43
1959	4	0	7
1960	7	0	3
1961	0	0	5
1962	1	0	7
1963	16	0	0
1964	19	0	0
1965	3	0	6
1966	0	0	0
1967	14	0	2
1968	14	0	11
1969	13	0	4
1970	14	0	0
1971	10	0	24
1972	7	0	18
1973	5	0	3
1974	4	0	7
1975	17	0	5
1976	10	0	0
1977	15	0	19
1978	4	0	18
1979	10	0	7
1980	19	0	11
1981	15	0	16
1982	5	0	0
1983	11	0	0
1984	0	0	0
1985	16	0	8
1986	3	0	5
1987	10	0	14
1988	27	0	21
1989	17	0	0
1990	8	0	14
1991	17	0	9
1992	30	0	31
1993	21	0	7
1994	17	0	45
1995	22	0	23
1996	18	0	12
1997	11	0	3

Subbasin 700 Existing Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	25	0	17
1999	15	0	6
2000	8	0	4
2001	8	0	0
2002	9	0	1
2003	3	0	0
2004	9	0	29
2005	6	0	0
2006	0	0	4
2007	4	0	0
2008	1	0	0
2009	1	0	8
2010	10	0	0
2011	15	0	0
2012	5	0	0
2013	12	0	5
2014	7	0	4
2015	14	0	2

Subbasin 800 Existing Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	34	0	60
1957	34	0	44
1958	32	0	72
1959	20	0	51
1960	14	0	49
1961	23	0	66
1962	15	0	60
1963	25	0	53
1964	23	0	34
1965	15	0	50
1966	29	0	35
1967	22	0	67
1968	22	0	53
1969	28	0	51
1970	17	0	46
1971	23	0	38
1972	32	0	59
1973	9	0	52
1974	17	0	30
1975	26	0	35
1976	35	0	36
1977	28	0	32
1978	16	0	48
1979	38	0	56
1980	40	0	55
1981	23	0	51
1982	18	0	42
1983	16	0	33
1984	11	0	59
1985	25	0	49
1986	14	0	39
1987	28	0	56
1988	33	0	56
1989	37	0	47
1990	24	0	61
1991	17	0	54
1992	37	0	64
1993	23	0	41
1994	36	0	68
1995	41	0	48
1996	23	0	55
1997	35	0	53

Subbasin 800 Existing Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	28	0	69
1999	23	0	55
2000	18	0	47
2001	25	0	52
2002	23	0	52
2003	24	0	56
2004	39	0	69
2005	43	0	55
2006	20	0	47
2007	26	0	44
2008	14	0	52
2009	20	0	46
2010	21	0	51
2011	18	0	44
2012	21	0	47
2013	29	0	57
2014	22	0	61
2015	39	0	67

Subbasin 900 Existing Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	15	0	42
1957	20	0	7
1958	7	0	66
1959	6	0	22
1960	0	0	29
1961	5	0	23
1962	4	0	18
1963	5	0	10
1964	17	0	0
1965	3	0	16
1966	3	0	3
1967	12	0	11
1968	12	0	25
1969	14	0	16
1970	8	0	8
1971	8	0	29
1972	10	0	27
1973	5	0	21
1974	5	0	12
1975	16	0	9
1976	16	0	1
1977	13	0	28
1978	6	0	36
1979	5	0	28
1980	22	0	30
1981	2	0	23
1982	6	0	5
1983	7	0	0
1984	1	0	31
1985	13	0	29
1986	2	0	10
1987	11	0	38
1988	29	0	30
1989	12	0	21
1990	11	0	40
1991	15	0	31
1992	25	0	46
1993	8	0	11
1994	20	0	47
1995	18	0	42
1996	12	0	21
1997	18	0	13

Subbasin 900 Existing Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	18	0	30
1999	15	0	10
2000	9	0	17
2001	10	0	13
2002	9	0	8
2003	12	0	25
2004	18	0	45
2005	20	0	18
2006	5	0	8
2007	7	0	11
2008	1	0	4
2009	6	0	17
2010	11	0	6
2011	7	0	0
2012	4	0	7
2013	15	0	6
2014	6	0	28
2015	16	0	25

Subbasin 100 Future Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	40	0	71
1957	35	0	69
1958	33	0	73
1959	27	0	62
1960	19	0	53
1961	23	0	70
1962	23	0	61
1963	27	0	61
1964	27	0	48
1965	19	0	55
1966	30	0	53
1967	26	0	71
1968	23	0	58
1969	25	0	64
1970	16	0	67
1971	27	0	52
1972	36	0	66
1973	15	0	58
1974	20	0	51
1975	28	0	48
1976	35	0	51
1977	37	0	62
1978	19	3	63
1979	41	0	66
1980	45	0	69
1981	27	0	56
1982	18	0	61
1983	24	0	38
1984	19	0	66
1985	26	0	64
1986	19	0	70
1987	36	0	68
1988	36	0	83
1989	43	0	63
1990	36	0	64
1991	20	0	59
1992	56	0	71
1993	25	0	67
1994	40	0	75
1995	46	0	74
1996	23	0	66
1997	36	0	65

Subbasin 100 Future Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	30	0	79
1999	25	0	60
2000	23	0	66
2001	37	0	69
2002	25	0	69
2003	30	0	59
2004	40	0	73
2005	42	0	65
2006	30	0	59
2007	31	0	59
2008	18	0	57
2009	18	0	63
2010	23	0	57
2011	16	0	67
2012	24	0	56
2013	33	0	73
2014	24	0	69
2015	40	0	73

Subbasin 200 Future Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	0	0	0
1957	0	0	0
1958	0	0	0
1959	0	0	0
1960	0	0	0
1961	0	0	0
1962	0	0	0
1963	0	0	0
1964	0	0	0
1965	0	0	0
1966	0	0	0
1967	2	0	0
1968	0	0	0
1969	0	0	0
1970	14	0	0
1971	1	0	0
1972	0	0	1
1973	0	0	0
1974	0	0	0
1975	0	0	0
1976	0	0	0
1977	3	0	0
1978	0	0	3
1979	4	0	0
1980	0	0	0
1981	0	0	0
1982	4	0	0
1983	1	0	0
1984	0	0	0
1985	0	0	0
1986	0	0	0
1987	0	0	0
1988	2	0	0
1989	2	0	0
1990	0	0	0
1991	0	0	0
1992	0	0	0
1993	7	0	0
1994	0	0	0
1995	0	0	0
1996	5	0	0
1997	0	0	0

Subbasin 200 Future Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	6	0	0
1999	0	0	0
2000	0	0	0
2001	0	0	0
2002	0	0	0
2003	0	0	0
2004	0	0	1
2005	1	0	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	0	0	0
2010	4	0	0
2011	10	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	7	0	0

Subbasin 300 Future Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	36	0	65
1957	32	0	54
1958	30	0	72
1959	22	0	56
1960	16	0	51
1961	22	0	69
1962	21	0	58
1963	23	0	58
1964	23	0	45
1965	13	0	53
1966	28	0	39
1967	24	0	68
1968	21	0	54
1969	25	0	50
1970	13	0	58
1971	23	0	44
1972	33	0	60
1973	9	0	55
1974	17	0	38
1975	27	0	42
1976	35	0	42
1977	34	0	50
1978	13	0	57
1979	33	0	61
1980	41	0	52
1981	19	0	48
1982	17	0	53
1983	15	0	34
1984	17	0	62
1985	25	0	50
1986	14	0	51
1987	34	0	58
1988	34	0	66
1989	32	0	57
1990	28	0	62
1991	16	0	55
1992	51	0	64
1993	22	0	44
1994	37	0	69
1995	44	0	60
1996	17	0	60
1997	35	0	53

Subbasin 300 Future Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	29	0	73
1999	19	0	57
2000	21	0	56
2001	24	0	54
2002	22	0	59
2003	25	0	57
2004	39	0	70
2005	39	0	56
2006	22	0	54
2007	27	0	52
2008	15	0	55
2009	16	0	52
2010	21	0	50
2011	17	0	54
2012	21	0	46
2013	30	0	62
2014	20	0	66
2015	39	0	69

Subbasin 400 Future Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	32	0	55
1957	27	0	29
1958	27	0	70
1959	17	0	37
1960	2	0	40
1961	14	0	53
1962	10	0	34
1963	13	0	20
1964	21	0	14
1965	4	0	41
1966	19	0	17
1967	12	0	57
1968	17	0	43
1969	23	0	36
1970	10	0	32
1971	16	0	33
1972	28	0	54
1973	9	0	42
1974	12	0	27
1975	26	0	19
1976	31	0	22
1977	24	0	31
1978	10	0	40
1979	33	0	49
1980	37	0	38
1981	10	0	43
1982	9	0	31
1983	13	0	17
1984	5	0	50
1985	23	0	40
1986	9	0	29
1987	27	0	50
1988	32	0	47
1989	28	0	37
1990	17	0	52
1991	16	0	51
1992	32	0	60
1993	15	0	24
1994	28	0	57
1995	35	0	46
1996	19	0	45
1997	27	0	46

Subbasin 400 Future Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	25	0	62
1999	16	0	45
2000	15	0	40
2001	15	0	34
2002	16	0	35
2003	15	0	49
2004	36	0	59
2005	36	0	42
2006	14	0	28
2007	19	0	34
2008	12	0	29
2009	11	0	31
2010	19	0	34
2011	14	0	17
2012	15	0	42
2013	28	0	53
2014	16	0	55
2015	34	0	55

Subbasin 500 Future Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	6	0	42
1957	23	0	2
1958	7	0	63
1959	3	0	8
1960	5	0	5
1961	0	0	7
1962	0	0	10
1963	16	0	12
1964	21	0	0
1965	2	0	7
1966	0	0	0
1967	12	0	9
1968	12	0	18
1969	10	0	6
1970	14	0	0
1971	6	0	27
1972	3	0	28
1973	4	0	6
1974	0	0	10
1975	14	0	5
1976	8	0	2
1977	13	0	22
1978	2	0	19
1979	7	0	10
1980	15	0	16
1981	10	0	17
1982	5	0	3
1983	10	0	0
1984	0	0	6
1985	13	0	15
1986	3	0	11
1987	9	0	22
1988	23	0	27
1989	13	0	0
1990	3	0	25
1991	16	0	18
1992	28	0	38
1993	19	0	15
1994	16	0	50
1995	16	0	36
1996	16	0	20
1997	11	0	9

Subbasin 500 Future Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	21	0	27
1999	15	0	6
2000	7	0	7
2001	6	0	0
2002	8	0	5
2003	3	0	4
2004	7	0	35
2005	2	0	0
2006	0	0	6
2007	3	0	2
2008	0	0	1
2009	0	0	9
2010	9	0	1
2011	13	0	0
2012	4	0	3
2013	4	0	8
2014	4	0	17
2015	14	0	7

Subbasin 600 Future Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	33	0	58
1957	31	0	50
1958	31	0	71
1959	21	0	51
1960	5	0	50
1961	18	0	68
1962	19	0	55
1963	18	0	53
1964	23	0	34
1965	15	0	52
1966	26	0	36
1967	17	0	68
1968	21	0	53
1969	27	0	51
1970	21	0	64
1971	23	0	39
1972	32	0	57
1973	10	0	54
1974	17	0	28
1975	27	0	39
1976	33	0	37
1977	30	0	43
1978	19	0	51
1979	34	0	61
1980	42	0	49
1981	14	0	45
1982	19	0	43
1983	14	0	30
1984	17	0	61
1985	27	0	48
1986	16	0	39
1987	31	0	57
1988	35	0	58
1989	35	0	55
1990	30	0	61
1991	16	0	54
1992	43	0	64
1993	21	0	27
1994	36	0	69
1995	46	0	49
1996	24	0	55
1997	35	0	50

Subbasin 600 Future Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	28	0	63
1999	20	0	46
2000	22	0	48
2001	24	0	53
2002	21	0	55
2003	23	0	58
2004	39	0	67
2005	32	0	50
2006	20	0	50
2007	28	0	45
2008	17	0	54
2009	17	0	49
2010	22	0	45
2011	19	0	42
2012	23	0	45
2013	30	0	57
2014	21	0	58
2015	40	0	64

Subbasin 700 Future Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	11	0	26
1957	28	0	1
1958	16	0	45
1959	4	0	7
1960	7	0	3
1961	0	0	5
1962	1	0	7
1963	16	0	0
1964	19	0	0
1965	3	0	7
1966	0	0	0
1967	14	0	2
1968	14	0	11
1969	12	0	4
1970	16	0	0
1971	11	0	24
1972	7	0	18
1973	5	0	4
1974	3	0	7
1975	17	0	5
1976	10	0	0
1977	15	0	19
1978	3	0	18
1979	10	0	7
1980	19	0	11
1981	17	0	16
1982	5	0	1
1983	11	0	0
1984	0	0	0
1985	17	0	7
1986	3	0	4
1987	10	0	17
1988	27	0	21
1989	18	0	0
1990	8	0	14
1991	17	0	11
1992	31	0	32
1993	21	0	7
1994	17	0	45
1995	22	0	27
1996	18	0	12
1997	11	0	2

Subbasin 700 Future Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	25	0	16
1999	15	0	7
2000	8	0	5
2001	8	0	0
2002	9	0	1
2003	3	0	0
2004	9	0	33
2005	6	0	0
2006	0	0	4
2007	5	0	0
2008	1	0	0
2009	1	0	9
2010	10	0	0
2011	16	0	0
2012	6	0	0
2013	13	0	5
2014	7	0	4
2015	14	0	4

Subbasin 800 Future Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	34	0	60
1957	34	0	44
1958	32	0	72
1959	20	0	51
1960	14	0	49
1961	23	0	66
1962	15	0	59
1963	25	0	53
1964	23	0	34
1965	15	0	50
1966	29	0	35
1967	22	0	67
1968	22	0	53
1969	28	0	46
1970	15	0	45
1971	23	0	38
1972	32	0	58
1973	9	0	52
1974	17	0	29
1975	26	0	35
1976	35	0	36
1977	28	0	32
1978	16	0	48
1979	37	0	56
1980	40	0	55
1981	23	0	51
1982	18	0	42
1983	14	0	33
1984	11	0	59
1985	25	0	49
1986	13	0	39
1987	28	0	56
1988	33	0	55
1989	37	0	47
1990	24	0	61
1991	17	0	54
1992	36	0	64
1993	23	0	38
1994	36	0	68
1995	41	0	48
1996	21	0	55
1997	35	0	53

Subbasin 800 Future Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	26	0	69
1999	23	0	55
2000	18	0	47
2001	25	0	52
2002	23	0	52
2003	23	0	56
2004	39	0	69
2005	43	0	53
2006	20	0	47
2007	26	0	43
2008	14	0	52
2009	19	0	46
2010	21	0	50
2011	16	0	44
2012	21	0	47
2013	29	0	57
2014	21	0	62
2015	39	0	67

Subbasin 900 Future Temperature Exceedances

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1956	16	0	42
1957	20	0	7
1958	7	0	65
1959	6	0	22
1960	0	0	29
1961	5	0	23
1962	4	0	20
1963	5	0	10
1964	17	0	0
1965	3	0	16
1966	3	0	3
1967	12	0	12
1968	12	0	25
1969	15	0	16
1970	8	0	8
1971	8	0	29
1972	10	0	27
1973	5	0	21
1974	4	0	12
1975	16	0	9
1976	16	0	1
1977	14	0	28
1978	4	0	36
1979	6	0	28
1980	22	0	30
1981	1	0	23
1982	6	0	6
1983	7	0	0
1984	1	0	31
1985	13	0	29
1986	1	0	10
1987	11	0	38
1988	29	0	31
1989	12	0	21
1990	11	0	40
1991	15	0	31
1992	25	0	46
1993	7	0	11
1994	20	0	47
1995	18	0	41
1996	11	0	21
1997	16	0	13

Subbasin 900 Future Temperature Exceedances (cont.)

Water Year	Supplemental Temp Period	Spawning Rearing Migration Period	Core Summer Salmonid Period
1998	18	0	30
1999	15	0	10
2000	9	0	17
2001	10	0	13
2002	9	0	8
2003	12	0	26
2004	18	0	45
2005	16	0	18
2006	5	0	8
2007	7	0	11
2008	1	0	4
2009	6	0	17
2010	11	0	7
2011	7	0	0
2012	4	0	8
2013	15	0	6
2014	6	0	29
2015	15	0	25

Appendix E: Yearly Fecal Coliform Metric Results

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Subbasin 100 Forested Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	11.7	4.6	11.2	6.6	12.2	2.7
1957	9.4	2.5	7.1	4.4	12.3	0.5
1958	8.5	2.7	6.0	4.4	12.1	1.1
1959	10.9	3.6	8.1	4.4	14.8	2.7
1960	10.0	3.6	6.9	5.5	14.7	1.6
1961	11.9	5.2	9.5	7.7	14.9	2.7
1962	7.4	3.3	4.1	2.7	13.2	3.8
1963	7.8	1.9	4.5	2.7	13.4	1.1
1964	13.4	5.7	9.6	6.0	18.5	5.5
1965	9.7	4.4	6.9	7.7	13.7	1.1
1966	8.5	3.3	5.7	3.8	12.4	2.7
1967	9.7	2.5	9.2	4.4	10.3	0.5
1968	8.9	3.3	5.5	4.9	14.5	1.6
1969	11.2	5.5	8.3	4.4	15.1	6.6
1970	8.7	3.6	5.9	4.4	12.9	2.7
1971	11.9	6.8	10.6	11.0	13.5	2.7
1972	10.8	3.8	6.6	2.7	17.7	4.9
1973	8.1	3.0	5.8	4.4	11.2	1.6
1974	13.8	6.0	11.8	8.2	16.1	3.8
1975	9.6	4.1	6.6	4.4	14.0	3.8
1976	14.0	7.1	10.3	7.7	19.1	6.6
1977	9.2	2.5	4.4	1.6	19.0	3.3
1978	11.0	3.6	7.0	2.7	17.2	4.4
1979	8.7	3.0	5.5	4.9	13.6	1.1
1980	9.4	3.3	5.5	2.7	15.9	3.8
1981	10.6	4.4	5.6	2.2	20.1	6.6
1982	12.3	7.9	10.3	12.1	14.7	3.8
1983	12.1	6.8	8.7	6.6	16.9	7.1
1984	10.2	4.9	6.7	4.4	15.7	5.5
1985	12.0	6.3	8.4	7.7	16.9	4.9
1986	11.3	3.6	7.9	3.3	15.9	3.8
1987	10.2	3.3	8.2	4.4	12.7	2.2
1988	6.7	2.2	3.2	2.2	14.1	2.2
1989	7.9	2.7	7.1	5.5	8.9	0.0
1990	7.0	3.3	4.0	3.8	12.3	2.7
1991	9.8	5.2	7.1	7.7	13.6	2.7
1992	8.2	3.8	5.3	4.9	12.7	2.7
1993	8.3	5.8	3.3	4.9	20.8	6.6
1994	7.4	4.1	4.8	6.0	11.5	2.2
1995	9.8	4.7	6.8	6.6	14.1	2.7
1996	13.2	6.3	7.9	4.9	22.1	7.7
1997	16.8	11.0	11.5	8.2	24.5	13.7

Subbasin 100 Forested Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	12.3	7.9	11.1	12.1	13.6	3.8
1999	14.5	8.2	11.5	8.2	18.3	8.2
2000	13.5	6.0	12.6	9.3	14.4	2.7
2001	8.3	2.2	4.6	2.2	15.2	2.2
2002	12.2	4.9	10.9	8.8	13.6	1.1
2003	7.7	3.3	4.9	5.5	11.8	1.1
2004	9.1	4.1	6.8	7.1	12.1	1.1
2005	11.4	5.8	6.5	5.5	19.9	6.0
2006	11.8	6.0	9.3	9.3	14.9	2.7
2007	13.0	6.0	11.4	9.9	14.7	2.2
2008	12.9	6.3	9.0	7.1	18.4	5.5
2009	9.7	4.1	6.9	5.5	13.8	2.7
2010	15.1	8.8	10.6	8.8	21.4	8.7
2011	15.3	7.4	11.7	10.4	19.8	4.4
2012	12.4	8.5	7.5	7.1	20.5	9.8
2013	13.8	5.5	12.0	7.7	15.9	3.3
2014	10.4	5.8	7.0	8.2	15.3	3.3
2015	11.0	4.9	9.8	9.3	12.3	0.5

Subbasin 200 Forested Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	5.6	1.9	4.7	3.3	6.6	0.5
1957	4.9	1.4	3.5	2.7	6.8	0.0
1958	4.5	1.4	3.0	2.7	6.8	0.0
1959	5.3	1.1	4.0	2.2	7.1	0.0
1960	5.0	1.4	3.4	2.7	7.2	0.0
1961	5.9	3.6	4.6	6.0	7.7	1.1
1962	4.0	0.5	2.1	0.5	7.4	0.5
1963	4.2	1.4	2.4	2.2	7.3	0.5
1964	6.3	1.4	4.8	2.7	8.1	0.0
1965	4.8	0.8	3.4	1.1	6.9	0.5
1966	4.4	1.1	2.8	1.1	6.9	1.1
1967	5.3	0.5	4.5	1.1	6.2	0.0
1968	4.8	1.6	3.0	2.7	7.7	0.5
1969	5.7	1.6	4.1	2.2	7.9	1.1
1970	4.6	1.4	3.0	2.7	7.1	0.0
1971	6.0	3.6	5.2	6.0	7.0	1.1
1972	5.2	1.6	3.1	2.2	8.8	1.1
1973	4.3	1.1	2.9	2.2	6.4	0.0
1974	6.7	1.6	5.8	2.7	7.9	0.5
1975	4.8	1.4	3.2	2.7	7.3	0.0
1976	6.7	2.2	4.8	2.7	9.3	1.6
1977	4.4	0.3	2.2	0.0	8.8	0.5
1978	5.7	1.4	3.8	2.2	8.4	0.5
1979	4.6	1.1	2.8	1.6	7.5	0.5
1980	4.8	0.8	2.9	0.5	7.8	1.1
1981	5.2	1.6	3.0	1.6	9.2	1.6
1982	6.4	3.6	5.0	5.5	8.1	1.6
1983	6.0	2.2	4.5	3.8	8.1	0.5
1984	4.9	0.8	3.3	1.1	7.4	0.5
1985	5.9	1.6	4.0	2.2	8.5	1.1
1986	5.7	1.4	4.0	2.2	8.2	0.5
1987	5.4	1.1	4.0	1.1	7.2	1.1
1988	3.8	1.4	1.9	2.2	7.9	0.5
1989	4.6	1.1	3.6	2.2	5.9	0.0
1990	4.3	1.9	2.5	3.3	7.1	0.5
1991	5.3	1.4	3.9	2.7	7.2	0.0
1992	4.4	1.1	2.8	2.2	7.1	0.0
1993	4.4	1.6	1.9	1.1	10.2	2.2
1994	4.2	0.8	2.6	1.6	6.8	0.0
1995	5.4	2.7	3.8	4.4	7.6	1.1
1996	6.5	1.9	4.0	3.3	10.6	0.5
1997	8.2	5.5	5.4	3.8	12.2	7.1

Subbasin 200 Forested Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	5.9	3.6	4.9	5.5	7.1	1.6
1999	6.6	2.7	5.3	3.8	8.3	1.6
2000	6.3	3.0	5.6	6.0	7.1	0.0
2001	4.0	0.8	2.1	0.5	7.5	1.1
2002	6.1	1.4	5.3	2.7	6.9	0.0
2003	4.2	1.6	2.6	2.7	6.8	0.5
2004	4.9	2.5	3.7	4.9	6.4	0.0
2005	5.5	2.5	3.2	2.7	9.4	2.2
2006	5.8	2.5	4.6	3.8	7.2	1.1
2007	6.2	3.3	5.3	6.0	7.1	0.5
2008	6.2	3.3	4.3	4.4	9.0	2.2
2009	5.0	2.2	3.3	2.7	7.4	1.6
2010	7.0	3.3	4.9	3.8	10.1	2.7
2011	7.2	2.7	5.5	4.9	9.4	0.5
2012	5.6	1.6	3.4	3.3	9.1	0.0
2013	6.6	1.9	5.5	2.7	8.0	1.1
2014	5.1	1.9	3.3	3.3	7.8	0.5
2015	5.5	1.9	4.6	3.8	6.6	0.0

Subbasin 300 Forested Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	13.2	6.3	12.7	8.7	13.8	3.8
1957	10.5	2.7	7.9	4.9	13.9	0.5
1958	9.5	3.3	6.6	5.5	13.6	1.1
1959	12.3	3.6	8.9	3.8	16.8	3.3
1960	11.3	4.6	7.7	7.7	16.6	1.6
1961	13.3	5.8	10.6	8.2	16.8	3.3
1962	8.3	3.8	4.6	3.3	14.9	4.4
1963	8.7	2.5	5.0	3.3	15.1	1.6
1964	15.1	6.0	10.7	6.6	21.3	5.5
1965	10.9	5.5	7.7	8.8	15.4	2.2
1966	9.5	3.8	6.4	4.4	14.1	3.3
1967	10.8	3.3	10.2	6.0	11.5	0.5
1968	9.9	3.8	6.1	5.5	16.3	2.2
1969	12.5	6.3	9.2	5.5	17.0	7.1
1970	9.8	3.6	6.6	4.4	14.5	2.7
1971	13.3	7.9	11.6	12.1	15.4	3.8
1972	12.2	5.5	7.4	4.9	20.1	6.0
1973	9.0	3.0	6.5	4.4	12.5	1.6
1974	15.4	8.5	13.0	12.6	18.3	4.4
1975	10.8	4.7	7.4	5.5	15.7	3.8
1976	15.8	7.9	11.5	9.3	21.7	6.6
1977	10.2	3.0	4.9	2.2	21.5	3.8
1978	12.3	3.8	7.7	3.3	19.4	4.4
1979	9.7	3.3	6.1	4.9	15.4	1.6
1980	10.5	3.6	6.1	2.7	18.1	4.4
1981	11.9	5.2	6.2	2.7	22.9	7.7
1982	13.8	8.8	11.4	13.2	16.8	4.4
1983	13.6	7.9	9.7	7.1	19.1	8.7
1984	11.4	6.0	7.4	4.9	17.8	7.1
1985	13.4	6.8	9.4	7.7	19.1	6.0
1986	12.6	3.8	8.8	3.8	18.1	3.8
1987	11.4	3.0	9.0	3.8	14.3	2.2
1988	7.5	3.6	3.5	3.8	15.9	3.3
1989	8.8	2.7	7.8	5.5	9.9	0.0
1990	7.8	3.6	4.4	3.8	13.8	3.3
1991	11.0	6.0	7.9	7.7	15.3	4.4
1992	9.1	4.4	5.9	5.5	14.2	3.3
1993	9.3	6.3	3.6	4.9	23.5	7.7
1994	8.3	4.9	5.3	7.7	12.8	2.2
1995	10.9	5.8	7.5	8.8	15.9	2.7
1996	14.7	7.4	8.7	6.6	24.9	8.2
1997	18.9	12.1	12.9	8.8	27.8	15.3

Subbasin 300 Forested Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	13.9	8.2	12.5	12.6	15.4	3.8
1999	16.3	9.3	12.8	9.3	20.8	9.3
2000	15.2	7.7	14.2	12.6	16.3	2.7
2001	9.3	2.5	5.0	2.2	17.2	2.7
2002	13.7	5.5	12.2	9.3	15.4	1.6
2003	8.6	3.6	5.5	6.0	13.3	1.1
2004	10.2	4.6	7.6	7.7	13.6	1.6
2005	12.9	6.8	7.3	6.0	22.7	7.7
2006	13.1	6.8	10.2	11.0	16.8	2.7
2007	14.6	7.1	12.8	11.0	16.7	3.3
2008	14.6	7.9	10.1	9.3	21.1	6.6
2009	11.0	5.5	7.7	8.2	15.5	2.7
2010	16.9	9.3	11.8	9.3	24.1	9.3
2011	17.2	7.9	13.0	10.4	22.6	5.5
2012	14.0	9.3	8.4	8.2	23.2	10.4
2013	15.4	6.0	13.3	8.8	17.9	3.3
2014	11.6	6.3	7.8	9.3	17.3	3.3
2015	12.3	4.9	10.9	9.3	13.8	0.5

Subbasin 400 Forested Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	10.6	5.2	9.7	8.2	11.6	2.2
1957	8.4	3.6	6.1	6.0	11.7	1.1
1958	7.7	2.7	5.1	5.5	11.4	0.0
1959	9.7	3.6	6.8	4.9	13.9	2.2
1960	9.0	4.6	5.9	7.7	13.7	1.6
1961	10.5	4.1	8.0	7.1	13.7	1.1
1962	6.8	3.0	3.7	3.3	12.5	2.7
1963	7.2	3.6	4.1	6.0	12.4	1.1
1964	11.5	5.2	7.7	6.0	17.1	4.4
1965	8.5	3.6	5.7	5.5	12.7	1.6
1966	7.7	4.1	5.0	5.5	11.9	2.7
1967	8.7	3.0	7.6	6.0	9.9	0.0
1968	8.1	3.0	4.8	4.4	13.7	1.6
1969	9.8	3.6	6.8	4.4	14.2	2.7
1970	8.1	4.7	5.3	7.7	12.2	1.6
1971	10.5	5.8	8.5	8.8	13.0	2.7
1972	9.6	5.5	5.6	6.6	16.4	4.4
1973	7.3	2.2	5.0	3.8	10.5	0.5
1974	11.9	5.5	9.4	8.2	15.0	2.7
1975	8.6	3.8	5.7	6.0	12.9	1.6
1976	12.1	4.9	8.2	6.0	18.0	3.8
1977	8.2	1.9	3.9	2.7	17.1	1.1
1978	9.8	4.7	6.0	5.5	15.9	3.8
1979	7.8	2.2	4.7	3.8	12.9	0.5
1980	8.6	2.5	5.0	1.6	14.8	3.3
1981	9.6	4.4	5.0	3.3	18.5	5.5
1982	11.0	7.4	8.2	8.8	14.8	6.0
1983	10.9	6.6	7.6	7.1	15.7	6.0
1984	8.9	3.3	5.5	2.7	14.5	3.8
1985	10.6	4.4	7.2	4.9	15.6	3.8
1986	10.0	3.3	6.5	3.3	15.3	3.3
1987	8.8	2.2	6.5	2.7	12.0	1.6
1988	6.2	3.3	3.0	4.9	13.1	1.6
1989	7.1	1.9	5.9	3.8	8.6	0.0
1990	6.5	3.0	3.6	4.4	11.5	1.6
1991	8.8	4.4	6.1	7.1	12.7	1.6
1992	7.5	3.6	4.7	4.9	12.1	2.2
1993	7.5	6.3	3.0	6.0	18.5	6.6
1994	6.8	3.3	4.3	5.5	10.7	1.1
1995	8.8	4.7	5.8	7.7	13.1	1.6
1996	11.5	5.5	6.6	7.1	20.3	3.8
1997	14.6	10.7	9.2	8.8	23.2	12.6

Subbasin 400 Forested Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	10.8	6.6	9.0	10.4	12.9	2.7
1999	12.6	8.2	9.6	9.9	16.7	6.6
2000	11.6	7.1	10.0	11.5	13.5	2.7
2001	7.4	2.7	3.9	3.3	14.0	2.2
2002	10.7	4.9	9.1	9.3	12.6	0.5
2003	7.0	3.0	4.5	5.5	10.9	0.5
2004	8.2	4.9	5.9	8.7	11.4	1.1
2005	10.1	5.2	5.5	5.5	18.5	4.9
2006	10.2	5.8	7.6	9.3	13.7	2.2
2007	11.3	5.5	9.4	8.8	13.7	2.2
2008	11.8	7.7	8.0	10.4	17.4	4.9
2009	8.9	5.2	6.1	7.7	12.8	2.7
2010	12.6	6.8	8.2	7.1	19.3	6.6
2011	13.1	6.6	9.3	8.8	18.4	4.4
2012	10.6	7.4	6.2	8.7	18.0	6.0
2013	11.9	5.5	9.6	8.2	14.7	2.7
2014	9.2	4.7	6.0	7.7	14.2	1.6
2015	9.5	3.8	7.8	7.7	11.5	0.0

Subbasin 500 Forested Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	8.4	3.8	8.2	7.1	8.7	0.5
1957	7.1	2.5	5.7	4.9	8.8	0.0
1958	6.3	2.7	4.6	4.9	8.8	0.5
1959	8.1	1.9	6.4	3.3	10.1	0.5
1960	7.3	3.8	5.3	6.6	10.0	1.1
1961	8.8	5.2	7.4	7.7	10.5	2.7
1962	5.5	3.0	3.2	3.3	9.6	2.7
1963	5.7	1.9	3.4	2.7	9.4	1.1
1964	9.9	3.8	7.8	4.4	12.5	3.3
1965	6.9	3.6	5.2	6.6	9.3	0.5
1966	6.2	3.6	4.4	4.9	8.7	2.2
1967	7.4	3.3	7.1	6.0	7.6	0.5
1968	6.9	2.7	4.5	4.4	10.6	1.1
1969	8.6	3.8	6.7	4.9	11.0	2.7
1970	6.4	3.3	4.5	5.5	9.2	1.1
1971	8.7	5.8	8.0	9.3	9.4	2.2
1972	8.0	3.0	5.1	2.7	12.6	3.3
1973	6.0	2.5	4.5	3.8	7.9	1.1
1974	10.1	4.7	9.1	6.0	11.3	3.3
1975	7.1	3.3	5.1	4.4	9.7	2.2
1976	10.3	4.9	7.8	5.5	13.8	4.4
1977	6.4	1.4	3.2	1.1	12.9	1.6
1978	8.1	1.9	5.5	2.2	11.9	1.6
1979	6.4	1.9	4.2	3.3	9.7	0.5
1980	6.9	1.9	4.3	1.6	11.0	2.2
1981	7.7	2.5	4.3	1.1	13.7	3.8
1982	9.2	5.8	7.7	7.7	11.0	3.8
1983	9.0	4.7	6.8	5.5	11.8	3.8
1984	7.1	2.5	4.8	1.6	10.5	3.3
1985	8.7	4.9	6.3	6.6	12.1	3.3
1986	8.6	4.1	6.4	4.4	11.5	3.8
1987	7.5	1.9	6.2	2.7	9.2	1.1
1988	5.1	2.2	2.5	2.7	10.4	1.6
1989	6.1	2.7	5.6	5.5	6.7	0.0
1990	5.6	3.0	3.4	4.4	9.1	1.6
1991	7.5	3.6	5.9	6.0	9.5	1.1
1992	6.1	2.7	4.0	3.8	9.1	1.6
1993	6.2	4.4	2.5	2.7	15.1	6.0
1994	5.6	4.1	3.8	6.6	8.3	1.6
1995	7.5	5.2	5.5	7.7	10.2	2.7
1996	9.9	4.9	6.1	6.6	16.0	3.3
1997	13.1	9.9	9.4	7.7	18.4	12.0

Subbasin 500 Forested Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	9.1	6.8	8.5	11.5	9.7	2.2
1999	10.5	5.5	8.7	6.0	12.5	4.9
2000	9.8	6.6	9.7	10.9	10.0	2.2
2001	5.9	2.7	3.4	2.7	10.4	2.7
2002	8.9	4.1	8.4	7.7	9.4	0.5
2003	5.8	3.0	3.9	4.9	8.6	1.1
2004	6.8	4.1	5.6	7.7	8.3	0.5
2005	8.3	4.7	5.0	4.9	13.8	4.4
2006	8.6	5.2	7.3	8.2	10.0	2.2
2007	9.4	4.9	8.8	8.2	10.0	1.6
2008	9.6	6.6	7.1	8.2	13.1	4.9
2009	7.1	3.8	5.2	5.5	9.7	2.2
2010	11.3	7.9	8.2	7.7	15.4	8.2
2011	11.5	5.2	9.2	7.7	14.3	2.7
2012	8.8	6.6	5.6	8.2	13.8	4.9
2013	10.1	4.9	9.0	7.1	11.3	2.7
2014	7.5	5.2	5.2	7.7	10.9	2.7
2015	8.1	5.2	7.6	9.9	8.7	0.5

Subbasin 600 Forested Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	16.2	8.7	15.9	12.0	16.5	5.5
1957	12.6	4.4	9.4	7.7	16.8	1.1
1958	11.4	3.8	7.8	6.6	16.5	1.1
1959	14.9	6.0	10.7	6.0	20.8	6.0
1960	13.7	5.7	9.4	8.7	20.2	2.7
1961	16.2	6.8	12.8	9.9	20.5	3.8
1962	10.0	4.4	5.5	4.4	18.1	4.4
1963	10.5	3.3	5.9	3.8	18.5	2.7
1964	18.6	9.6	12.9	10.4	26.7	8.7
1965	13.2	7.4	9.3	11.0	18.6	3.8
1966	11.4	4.9	7.6	6.0	17.2	3.8
1967	13.1	5.5	12.3	9.9	13.9	1.1
1968	11.9	4.4	7.2	5.5	19.7	3.3
1969	15.1	7.7	11.1	8.2	20.4	7.1
1970	11.9	4.7	8.0	6.6	17.6	2.7
1971	16.1	10.1	13.9	14.3	18.7	6.0
1972	14.7	6.8	8.7	6.0	24.7	7.7
1973	10.8	4.1	7.8	6.6	15.1	1.6
1974	18.7	9.9	15.6	13.7	22.4	6.0
1975	13.0	6.3	8.8	8.2	19.1	4.4
1976	19.2	9.3	13.9	11.5	26.5	7.1
1977	12.4	4.4	5.8	3.3	26.6	5.5
1978	14.9	5.8	9.3	4.9	23.7	6.6
1979	11.9	5.2	7.5	7.1	18.8	3.3
1980	12.7	4.4	7.2	3.3	22.3	5.5
1981	14.7	6.8	7.4	3.3	28.9	10.4
1982	16.8	9.9	13.9	13.7	20.2	6.0
1983	16.4	11.2	11.6	11.0	23.4	11.5
1984	13.9	7.4	8.9	6.0	21.8	8.7
1985	16.3	7.7	11.4	8.8	23.3	6.6
1986	15.3	5.5	10.5	4.9	22.2	6.0
1987	13.7	4.7	10.9	6.6	17.2	2.7
1988	8.9	4.4	4.1	4.4	19.4	4.4
1989	10.5	3.6	9.3	7.1	11.8	0.0
1990	9.2	4.7	5.1	4.9	16.6	4.4
1991	13.3	7.1	9.4	9.9	18.6	4.4
1992	11.0	5.7	7.0	6.6	17.2	4.9
1993	11.2	9.3	4.3	7.7	29.1	10.9
1994	9.9	5.5	6.4	8.2	15.4	2.7
1995	13.1	7.4	8.9	12.1	19.2	2.7
1996	17.8	8.5	10.5	8.2	30.2	8.7
1997	22.9	12.9	15.5	9.9	33.7	15.8

Subbasin 600 Forested Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	16.9	9.3	15.2	14.3	18.7	4.4
1999	19.8	11.5	15.5	11.5	25.3	11.5
2000	18.4	9.3	17.2	14.8	19.6	3.8
2001	11.2	3.3	6.0	2.7	21.1	3.8
2002	16.6	6.0	14.8	10.4	18.6	1.6
2003	10.3	3.6	6.6	6.0	16.1	1.1
2004	12.2	5.5	9.1	9.3	16.5	1.6
2005	15.7	7.9	8.8	6.0	28.2	9.8
2006	15.9	7.7	12.4	12.6	20.4	2.7
2007	17.7	7.9	15.5	12.1	20.3	3.8
2008	17.8	9.3	12.3	10.4	25.9	8.2
2009	13.3	6.6	9.3	9.3	18.9	3.8
2010	20.5	11.0	14.3	11.5	29.3	10.4
2011	20.7	9.0	15.7	11.5	27.3	6.6
2012	17.0	10.9	10.1	8.7	28.7	13.1
2013	18.6	6.8	16.2	9.3	21.4	4.4
2014	14.0	7.4	9.3	11.0	21.0	3.8
2015	14.7	5.8	13.2	10.4	16.5	1.1

Subbasin 700 Forested Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	6.6	2.7	6.0	4.4	7.2	1.1
1957	5.6	2.5	4.2	4.4	7.4	0.5
1958	5.2	2.5	3.7	4.9	7.3	0.0
1959	6.3	1.6	5.0	2.7	8.0	0.5
1960	5.7	3.0	4.0	4.9	7.9	1.1
1961	6.7	4.1	5.3	7.1	8.5	1.1
1962	4.6	1.9	2.6	1.6	8.1	2.2
1963	4.7	2.7	2.8	4.4	7.9	1.1
1964	7.4	3.3	5.9	5.5	9.4	1.1
1965	5.4	1.9	3.8	2.7	7.7	1.1
1966	5.1	2.5	3.5	3.3	7.4	1.6
1967	6.1	1.6	5.5	3.3	6.7	0.0
1968	5.6	3.3	3.7	5.5	8.5	1.1
1969	6.5	1.9	4.7	2.2	8.9	1.6
1970	5.3	1.9	3.6	3.3	7.7	0.5
1971	7.0	4.4	6.3	7.1	7.7	1.6
1972	6.2	2.2	3.9	3.3	9.9	1.1
1973	4.7	1.4	3.3	2.7	6.8	0.0
1974	7.9	3.0	6.9	3.8	8.9	2.2
1975	5.7	2.7	4.1	4.9	8.0	0.5
1976	7.7	3.6	5.5	4.4	10.8	2.7
1977	5.1	1.1	2.6	1.6	10.0	0.5
1978	6.4	2.2	4.3	3.3	9.5	1.1
1979	4.9	1.6	3.0	2.7	8.1	0.5
1980	5.6	2.2	3.6	2.7	8.8	1.6
1981	6.0	2.5	3.4	1.6	10.7	3.3
1982	7.0	4.4	5.4	5.5	9.0	3.3
1983	7.0	4.4	5.4	6.6	9.2	2.2
1984	5.4	0.8	3.5	1.1	8.3	0.5
1985	6.8	2.7	4.7	3.8	9.6	1.6
1986	6.5	1.9	4.6	2.2	9.3	1.6
1987	6.0	1.6	4.6	2.2	7.8	1.1
1988	4.3	2.2	2.1	3.3	8.8	1.1
1989	5.3	1.6	4.5	3.3	6.2	0.0
1990	4.9	2.2	3.1	3.8	7.8	0.5
1991	6.0	1.9	4.7	3.8	7.8	0.0
1992	5.1	2.5	3.4	3.3	7.8	1.6
1993	5.0	4.4	2.1	4.4	11.6	4.4
1994	4.7	3.0	3.0	4.9	7.2	1.1
1995	6.2	3.3	4.6	4.9	8.3	1.6
1996	7.7	3.8	4.8	5.5	12.4	2.2
1997	9.6	7.1	6.3	5.5	14.6	8.7

Subbasin 700 Forested Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	6.7	5.5	5.8	9.3	7.8	1.6
1999	7.8	5.2	6.4	7.1	9.6	3.3
2000	7.2	3.8	6.5	7.1	7.9	0.5
2001	4.6	1.9	2.5	2.2	8.2	1.6
2002	7.0	3.3	6.4	6.6	7.7	0.0
2003	4.8	2.2	3.2	3.8	7.3	0.5
2004	5.6	4.1	4.5	7.7	7.0	0.5
2005	6.3	4.1	3.7	5.5	10.7	2.7
2006	6.6	4.7	5.4	7.1	8.0	2.2
2007	7.0	4.4	6.2	7.1	7.9	1.6
2008	7.3	5.2	5.1	7.1	10.4	3.3
2009	5.6	3.6	3.9	4.9	8.1	2.2
2010	8.0	5.5	5.6	6.6	11.6	4.4
2011	8.4	3.8	6.4	6.0	11.0	1.6
2012	6.5	3.8	4.0	7.1	10.4	0.5
2013	7.7	3.8	6.6	6.6	8.9	1.1
2014	5.7	4.1	3.8	6.6	8.7	1.6
2015	6.1	3.0	5.2	6.0	7.2	0.0

Subbasin 800 Forested Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	17.1	8.5	16.8	13.1	17.5	3.8
1957	13.2	6.0	9.9	11.0	17.5	1.1
1958	11.5	4.7	7.8	8.2	17.1	1.1
1959	15.2	6.0	11.4	8.2	20.1	3.8
1960	13.8	6.0	9.7	9.8	19.5	2.2
1961	17.0	9.3	13.4	13.7	21.5	4.9
1962	9.9	4.9	5.4	5.5	17.9	4.4
1963	10.4	4.7	5.9	6.6	18.2	2.7
1964	19.2	11.2	14.2	13.7	25.9	8.7
1965	13.3	6.6	9.6	11.5	18.3	1.6
1966	11.3	6.6	7.5	9.9	17.2	3.3
1967	14.1	6.8	13.2	13.2	15.0	0.5
1968	12.0	5.2	7.5	7.1	19.1	3.3
1969	15.9	8.8	12.3	11.5	20.4	6.0
1970	12.0	7.1	8.0	11.0	18.0	3.3
1971	16.3	10.1	14.5	16.5	18.3	3.8
1972	14.7	7.9	8.8	7.7	24.6	8.2
1973	11.0	4.7	7.9	7.7	15.3	1.6
1974	19.3	11.8	16.5	17.6	22.6	6.0
1975	13.1	6.0	9.0	8.8	19.1	3.3
1976	19.6	9.6	15.1	12.6	25.6	6.6
1977	11.7	3.8	5.5	2.7	24.9	4.9
1978	14.7	5.5	9.8	7.1	21.9	3.8
1979	12.1	5.2	7.9	9.3	18.7	1.1
1980	12.3	4.6	7.2	4.4	21.1	4.9
1981	14.3	6.6	7.3	3.8	27.7	9.3
1982	17.1	10.7	14.2	15.4	20.7	6.0
1983	16.5	9.9	12.0	9.9	22.7	9.8
1984	13.4	5.5	8.6	4.4	20.7	6.6
1985	16.4	8.2	11.6	9.9	23.2	6.6
1986	15.8	6.3	11.2	7.1	22.2	5.5
1987	13.8	3.8	10.6	5.5	18.1	2.2
1988	9.2	5.5	4.3	4.9	19.7	6.0
1989	11.1	4.4	10.0	8.2	12.4	0.5
1990	9.5	5.5	5.4	6.6	16.6	4.4
1991	13.7	8.5	10.2	13.7	18.3	3.3
1992	10.7	5.5	6.7	7.7	17.1	3.3
1993	11.2	8.2	4.1	4.9	30.2	11.5
1994	10.2	7.1	6.5	11.5	15.9	2.7
1995	13.5	9.3	9.6	15.9	19.0	2.7
1996	17.8	9.8	10.7	10.4	29.5	9.3
1997	23.4	13.7	16.9	12.1	32.2	15.3

Subbasin 800 Forested Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	17.2	9.9	15.5	15.9	19.1	3.8
1999	19.9	11.8	16.0	14.8	24.8	8.7
2000	19.1	11.2	18.3	19.1	19.9	3.3
2001	11.0	4.1	5.9	3.8	20.7	4.4
2002	17.4	8.8	15.8	15.4	19.1	2.2
2003	10.9	4.9	6.8	7.7	17.4	2.2
2004	12.5	5.5	9.8	9.8	15.9	1.1
2005	15.7	8.5	9.1	8.8	26.8	8.2
2006	16.2	8.8	12.7	14.8	20.8	2.7
2007	18.2	8.5	16.0	13.7	20.6	3.3
2008	18.0	10.4	12.6	13.1	25.8	7.7
2009	13.3	7.1	9.4	11.0	19.0	3.3
2010	21.1	13.7	15.6	17.0	28.4	10.4
2011	21.8	10.1	16.9	14.3	28.0	6.0
2012	16.7	11.5	9.7	10.4	28.6	12.6
2013	18.7	8.2	16.2	12.1	21.6	4.4
2014	14.0	6.6	9.2	9.9	21.4	3.3
2015	15.3	6.0	13.4	11.5	17.4	0.5

Subbasin 900 Forested Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	16.8	10.1	17.4	15.8	16.3	4.4
1957	12.8	6.8	9.6	11.5	17.0	2.2
1958	11.8	6.0	8.3	10.4	16.6	1.6
1959	15.4	8.2	12.0	12.6	19.9	3.8
1960	13.5	6.8	9.6	11.5	19.1	2.2
1961	16.7	9.9	13.4	14.3	20.9	5.5
1962	10.1	5.8	5.6	7.1	18.2	4.4
1963	10.7	5.2	6.2	7.1	18.5	3.3
1964	19.5	12.6	14.8	16.4	25.7	8.7
1965	13.1	8.2	9.5	12.6	18.0	3.8
1966	11.6	7.1	7.8	10.4	17.0	3.8
1967	14.3	9.9	14.0	18.7	14.6	1.1
1968	12.3	6.8	8.0	10.9	18.9	2.7
1969	15.5	9.9	12.0	11.0	20.1	8.7
1970	12.0	7.7	8.1	12.6	17.7	2.7
1971	16.6	11.2	15.8	17.6	17.5	4.9
1972	14.8	9.3	9.1	10.4	24.1	8.2
1973	10.8	4.7	7.6	7.7	15.2	1.6
1974	19.6	12.3	17.6	20.3	21.8	4.4
1975	13.2	7.7	9.4	11.5	18.6	3.8
1976	19.4	10.1	14.9	13.7	25.1	6.6
1977	12.1	6.0	5.7	7.1	25.6	4.9
1978	14.7	7.1	9.5	6.6	22.8	7.7
1979	12.0	5.2	7.7	8.2	18.7	2.2
1980	12.9	6.0	7.6	6.0	21.8	6.0
1981	14.8	8.8	7.5	6.6	28.8	10.9
1982	16.8	10.4	14.3	15.9	19.8	4.9
1983	16.4	11.5	12.2	12.1	22.1	10.9
1984	13.3	8.2	8.5	7.7	20.7	8.7
1985	16.3	8.8	11.8	11.5	22.7	6.0
1986	15.5	7.1	11.1	8.2	21.6	6.0
1987	13.7	4.1	10.7	6.0	17.5	2.2
1988	9.5	6.3	4.4	7.1	20.4	5.5
1989	11.6	6.3	10.9	12.1	12.3	0.5
1990	10.0	6.0	5.9	7.7	16.9	4.4
1991	13.9	9.3	10.7	14.8	18.0	3.8
1992	11.2	7.4	7.3	10.4	17.1	4.4
1993	11.4	11.2	4.2	8.2	30.5	14.2
1994	10.2	7.9	6.5	12.6	15.8	3.3
1995	13.6	9.9	9.9	15.9	18.7	3.8
1996	18.0	10.9	11.2	12.6	28.9	9.3
1997	22.8	15.3	16.4	14.8	31.6	15.8

Subbasin 900 Forested Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	16.7	9.6	15.4	15.9	18.0	3.3
1999	19.8	13.2	16.5	17.6	23.8	8.7
2000	18.2	10.7	17.8	18.0	18.6	3.3
2001	10.8	4.4	5.7	5.5	20.4	3.3
2002	17.2	9.3	16.3	15.9	18.2	2.7
2003	10.8	5.8	6.8	9.3	16.9	2.2
2004	12.6	7.9	10.1	14.2	15.7	1.6
2005	15.7	9.3	9.2	9.9	26.9	8.7
2006	16.1	9.9	13.1	17.0	19.9	2.7
2007	17.8	9.6	16.1	15.4	19.7	3.8
2008	17.6	11.2	12.4	14.8	25.1	7.7
2009	13.2	7.9	9.3	12.1	18.6	3.8
2010	20.4	14.0	15.2	18.1	27.4	9.8
2011	21.0	9.9	16.4	13.7	26.7	6.0
2012	16.5	11.7	9.7	10.9	27.9	12.6
2013	18.4	8.8	16.7	13.2	20.3	4.4
2014	13.5	7.9	8.9	11.5	20.6	4.4
2015	14.7	5.8	13.1	11.5	16.3	0.0

Subbasin 100 Existing Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	62.4	32.8	66.9	48.1	58.1	17.5
1957	54.8	27.7	51.8	39.6	58.0	15.8
1958	55.2	29.3	52.1	43.4	58.5	15.3
1959	72.9	36.4	71.9	48.4	73.9	24.6
1960	56.6	28.7	47.9	35.5	67.0	21.9
1961	65.6	31.5	64.4	44.0	66.8	19.1
1962	58.8	29.9	48.7	37.4	71.0	22.4
1963	55.7	26.0	45.2	31.9	68.5	20.2
1964	82.2	38.0	82.7	49.7	81.7	26.2
1965	50.5	29.0	38.5	36.8	66.2	21.3
1966	64.0	32.3	65.4	45.1	62.6	19.7
1967	61.0	29.9	76.0	48.9	49.0	10.9
1968	69.1	34.7	65.6	43.2	72.8	26.2
1969	66.4	32.3	56.5	38.5	77.9	26.2
1970	54.8	27.7	45.2	36.8	66.4	18.6
1971	70.0	37.8	77.4	54.4	63.4	21.3
1972	78.3	40.7	62.0	45.9	98.8	35.5
1973	44.2	23.6	35.6	31.9	54.9	15.3
1974	77.4	38.4	81.4	52.7	73.5	24.0
1975	58.0	29.3	54.8	37.9	61.4	20.8
1976	77.8	39.6	65.1	45.4	93.0	33.9
1977	56.9	33.4	31.8	30.8	101.5	36.1
1978	75.5	38.1	62.6	41.2	91.1	35.0
1979	50.6	27.1	37.3	31.3	68.7	23.0
1980	67.6	36.1	55.5	42.1	82.3	30.1
1981	61.9	31.8	40.2	31.9	95.0	31.7
1982	67.4	35.9	59.6	45.6	76.2	26.2
1983	62.4	33.7	55.0	41.2	70.8	26.2
1984	52.5	27.6	38.8	30.1	71.2	25.1
1985	65.3	33.2	51.6	37.9	82.5	28.4
1986	66.7	33.4	56.4	41.8	78.7	25.1
1987	56.9	27.7	57.2	40.7	56.6	14.8
1988	53.0	29.8	33.3	32.8	84.4	26.8
1989	59.0	31.0	70.6	50.5	49.3	11.5
1990	54.9	29.9	46.7	40.1	64.5	19.7
1991	68.2	31.0	74.3	44.5	62.6	17.5
1992	60.7	30.1	57.7	38.3	63.8	21.9
1993	52.8	32.9	25.4	21.4	109.2	44.3
1994	44.3	24.7	37.2	36.3	52.7	13.1
1995	61.9	31.8	55.5	41.2	68.9	22.4
1996	77.9	39.6	59.6	44.3	101.8	35.0
1997	86.3	46.0	68.8	51.6	108.0	40.4

Subbasin 100 Existing Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	62.7	32.6	66.7	48.9	59.1	16.4
1999	75.6	38.9	74.4	51.1	76.8	26.8
2000	63.8	31.4	63.4	44.3	64.2	18.6
2001	54.9	27.7	41.7	31.3	72.3	24.0
2002	64.9	31.2	72.6	46.2	58.0	16.4
2003	44.2	24.4	38.8	40.1	50.4	8.7
2004	58.2	30.1	54.6	41.5	62.0	18.6
2005	65.8	34.0	49.2	34.1	87.9	33.9
2006	61.4	30.7	56.1	45.1	67.0	16.4
2007	65.6	31.2	64.3	43.4	66.8	19.1
2008	67.5	33.9	55.0	39.9	82.8	27.9
2009	51.6	26.6	44.8	36.8	59.4	16.4
2010	77.1	38.4	56.8	39.0	104.4	37.7
2011	77.1	38.6	67.5	47.8	87.9	29.5
2012	67.6	38.8	55.4	45.9	82.6	31.7
2013	71.5	35.6	68.3	45.6	74.8	25.7
2014	53.1	30.4	43.2	41.2	65.2	19.7
2015	54.4	27.1	53.5	39.0	55.2	15.3

Subbasin 200 Existing Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	55.0	26.0	51.5	39.3	58.9	12.6
1957	49.4	22.7	43.4	34.1	56.3	11.5
1958	49.0	25.8	41.2	37.9	58.4	13.7
1959	61.1	29.9	54.6	41.2	68.3	18.6
1960	49.2	23.0	38.7	31.1	62.6	14.8
1961	56.0	26.0	50.2	37.9	62.4	14.2
1962	51.6	24.9	38.1	30.8	69.6	19.1
1963	48.3	20.8	35.8	25.8	65.0	15.8
1964	67.2	32.8	63.2	43.2	71.3	22.4
1965	44.5	23.0	32.7	29.1	60.5	16.9
1966	52.7	25.5	47.0	36.8	59.1	14.2
1967	53.6	24.4	55.8	41.2	51.4	7.7
1968	57.9	27.9	47.5	35.0	70.6	20.8
1969	57.7	26.0	43.5	29.7	76.5	22.4
1970	47.8	21.9	36.7	31.3	62.1	12.6
1971	61.5	32.6	62.6	48.9	60.3	16.4
1972	66.1	33.1	46.2	35.5	94.5	30.6
1973	40.4	18.4	30.3	25.8	53.8	10.9
1974	66.4	31.8	64.1	44.0	68.7	19.7
1975	50.5	27.1	42.3	34.6	60.2	19.7
1976	67.3	35.8	51.7	41.0	87.7	30.6
1977	51.7	30.1	27.5	27.5	96.8	32.8
1978	65.4	33.7	50.4	34.6	84.7	32.8
1979	45.2	21.6	30.6	22.5	66.7	20.8
1980	61.2	32.2	47.4	38.3	79.1	26.2
1981	54.2	27.7	34.5	29.1	84.9	26.2
1982	62.2	32.1	51.2	40.1	75.4	24.0
1983	55.8	28.5	46.0	35.7	67.7	21.3
1984	46.7	23.8	32.2	25.7	67.9	21.9
1985	58.3	28.8	42.8	33.0	79.2	24.6
1986	56.1	27.7	43.3	34.6	72.6	20.8
1987	51.3	23.0	46.6	34.6	56.5	11.5
1988	47.1	24.9	27.9	27.3	79.4	22.4
1989	52.5	25.5	54.3	41.8	50.7	9.3
1990	48.9	24.7	38.3	33.5	62.4	15.8
1991	57.5	24.7	54.7	34.1	60.5	15.3
1992	52.1	24.0	43.8	30.6	62.0	17.5
1993	47.9	29.0	22.7	20.3	100.8	37.7
1994	41.0	21.9	31.4	32.4	53.5	11.5
1995	55.1	26.3	45.9	32.4	66.1	20.2
1996	65.1	34.7	46.3	37.7	91.6	31.7
1997	74.2	38.9	54.7	42.3	100.5	35.5

Subbasin 200 Existing Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	54.6	27.9	51.9	43.4	57.5	12.6
1999	63.6	32.6	58.4	44.5	69.2	20.8
2000	53.7	24.0	48.6	35.0	59.4	13.1
2001	46.9	21.9	32.0	24.2	68.5	19.7
2002	56.9	26.6	58.8	40.1	55.0	13.1
2003	41.9	20.0	34.1	34.1	51.4	6.0
2004	49.9	24.6	42.6	33.3	58.6	15.8
2005	56.6	27.7	39.3	28.6	81.4	26.8
2006	51.9	25.2	43.9	39.0	61.2	11.5
2007	56.1	27.7	52.5	38.5	59.9	16.9
2008	58.6	29.5	44.9	34.4	76.4	24.6
2009	46.5	22.5	36.7	31.3	58.9	13.7
2010	66.3	34.0	45.3	33.5	96.9	34.4
2011	64.3	30.7	52.4	39.6	78.9	21.9
2012	55.6	31.1	41.3	36.1	74.9	26.2
2013	60.8	28.2	52.4	34.6	70.4	21.9
2014	48.9	27.7	38.1	37.9	62.8	17.5
2015	49.3	21.9	45.0	33.5	54.1	10.4

Subbasin 300 Existing Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	61.7	32.2	64.8	47.0	58.7	17.5
1957	54.2	26.3	50.2	37.4	58.5	15.3
1958	54.4	29.3	50.3	43.4	58.8	15.3
1959	70.9	36.4	68.5	48.4	73.4	24.6
1960	55.8	29.0	46.3	36.1	67.2	21.9
1961	64.7	31.2	62.3	43.4	67.1	19.1
1962	57.7	29.6	46.7	36.8	71.1	22.4
1963	54.0	25.5	42.8	30.2	68.0	20.8
1964	80.6	38.8	79.5	50.3	81.7	27.3
1965	49.8	28.8	37.8	36.3	65.5	21.3
1966	62.0	32.9	61.3	46.2	62.8	19.7
1967	59.7	29.0	72.4	47.8	49.3	10.4
1968	67.2	34.2	61.8	42.1	73.0	26.2
1969	65.5	31.2	54.6	36.3	78.4	26.2
1970	54.0	26.8	43.9	35.7	66.3	18.0
1971	69.5	37.3	75.4	53.8	64.0	20.8
1972	76.2	39.9	58.6	44.8	99.2	35.0
1973	43.8	23.8	34.7	31.9	55.2	15.8
1974	76.4	37.8	78.9	52.2	74.0	23.5
1975	57.2	28.8	52.8	37.4	62.0	20.2
1976	77.3	39.6	63.5	44.8	94.1	34.4
1977	56.8	33.4	31.2	30.8	102.9	36.1
1978	74.8	38.6	61.1	41.2	91.3	36.1
1979	50.5	26.0	37.0	29.1	68.8	23.0
1980	66.9	36.6	53.9	42.6	83.1	30.6
1981	61.6	32.6	39.5	32.4	95.9	32.8
1982	67.5	36.2	59.3	45.6	76.8	26.8
1983	62.3	34.2	53.8	41.8	72.1	26.8
1984	52.4	27.6	38.2	30.1	71.8	25.1
1985	64.7	32.3	50.2	36.3	83.4	28.4
1986	65.1	32.3	53.7	39.6	78.8	25.1
1987	56.7	27.9	56.2	41.2	57.1	14.8
1988	51.6	29.2	31.8	31.1	83.7	27.3
1989	56.8	29.9	66.0	48.4	49.0	11.5
1990	54.0	29.3	45.0	39.0	64.7	19.7
1991	66.8	30.4	70.8	43.4	63.0	17.5
1992	59.3	29.5	54.9	37.2	64.1	21.9
1993	52.8	33.4	25.2	22.0	110.2	44.8
1994	43.8	24.4	35.9	35.7	53.3	13.1
1995	61.4	31.8	54.1	40.7	69.6	23.0
1996	77.0	39.1	57.7	42.6	102.7	35.5
1997	86.4	46.6	67.6	52.2	110.2	41.0

Subbasin 300 Existing Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	62.7	32.1	65.1	47.8	60.4	16.4
1999	74.8	38.9	71.9	50.5	77.7	27.3
2000	62.9	30.9	61.8	43.2	64.1	18.6
2001	54.0	27.7	40.1	31.3	72.6	24.0
2002	64.2	31.2	70.4	46.2	58.6	16.4
2003	44.0	24.1	37.7	39.6	51.4	8.7
2004	57.0	29.5	52.9	40.4	61.6	18.6
2005	65.1	34.0	47.5	33.5	89.1	34.4
2006	60.4	30.1	54.1	44.0	67.5	16.4
2007	64.7	31.5	63.0	43.4	66.5	19.7
2008	67.0	34.4	53.9	40.4	83.3	28.4
2009	51.2	26.3	43.4	35.7	60.3	16.9
2010	76.8	38.1	55.8	37.9	105.5	38.3
2011	76.4	38.9	65.9	48.4	88.6	29.5
2012	67.0	38.5	53.1	45.4	84.5	31.7
2013	70.3	35.9	66.0	45.6	74.9	26.2
2014	53.3	29.9	42.6	40.1	66.5	19.7
2015	54.2	26.8	52.8	39.0	55.7	14.8

Subbasin 400 Existing Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	80.6	35.2	87.3	50.3	74.4	20.2
1957	69.8	30.4	67.4	42.9	72.3	18.0
1958	70.8	32.6	67.5	47.3	74.3	18.0
1959	94.8	41.4	94.3	51.6	95.3	31.1
1960	72.5	32.2	62.1	38.8	84.5	25.7
1961	82.6	37.0	82.0	51.6	83.2	22.4
1962	77.1	34.0	65.8	40.1	90.2	27.9
1963	73.4	33.7	61.4	36.3	87.6	31.1
1964	105.5	44.0	106.1	54.6	105.0	33.3
1965	63.4	33.2	48.0	37.9	83.7	28.4
1966	82.8	37.5	87.2	50.5	78.7	24.6
1967	77.7	32.9	96.8	52.7	62.5	13.1
1968	90.6	39.3	87.9	47.0	93.3	31.7
1969	84.8	36.7	71.2	42.9	100.9	30.6
1970	69.7	33.4	58.0	41.2	83.8	25.7
1971	88.3	42.2	96.4	57.1	81.0	27.3
1972	103.2	44.5	82.0	48.6	129.7	40.4
1973	55.7	29.3	45.2	36.3	68.5	22.4
1974	96.4	40.8	99.0	52.7	93.9	29.0
1975	75.0	36.4	72.1	46.7	78.0	26.2
1976	98.7	44.8	81.2	48.1	119.9	41.5
1977	72.6	37.3	41.4	35.2	126.8	39.3
1978	96.1	45.5	78.9	46.2	117.1	44.8
1979	63.9	30.1	46.4	32.4	88.0	27.9
1980	86.5	42.6	71.4	48.6	104.9	36.6
1981	78.1	36.7	51.3	34.1	118.7	39.3
1982	85.0	40.0	72.0	47.8	100.2	32.2
1983	79.3	38.6	71.3	45.6	88.1	31.7
1984	65.3	31.1	46.9	30.6	91.1	31.7
1985	83.5	36.2	66.4	39.6	104.8	32.8
1986	85.4	38.6	72.0	45.6	101.1	31.7
1987	69.7	30.7	68.1	42.3	71.3	19.1
1988	69.6	32.8	44.4	35.0	109.2	30.6
1989	77.7	36.4	94.8	56.6	63.8	16.4
1990	69.4	32.3	59.8	42.9	80.4	21.9
1991	86.2	34.0	95.6	45.6	77.7	22.4
1992	77.9	35.5	74.9	43.7	80.9	27.3
1993	66.7	39.2	32.6	25.8	135.9	52.5
1994	56.1	27.7	48.5	39.0	64.9	16.4
1995	77.5	37.5	70.0	46.2	85.8	29.0
1996	99.1	45.6	75.8	47.5	129.7	43.7
1997	108.7	50.1	84.9	54.9	138.9	45.4

Subbasin 400 Existing Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	79.0	36.2	83.8	52.7	74.5	19.7
1999	96.5	43.0	96.0	54.9	97.1	31.1
2000	79.8	33.6	78.2	45.9	81.4	21.3
2001	71.6	33.4	55.4	36.8	92.4	30.1
2002	82.0	35.6	92.1	51.6	73.1	19.7
2003	56.0	26.6	50.8	43.4	61.8	9.8
2004	75.1	35.0	70.3	43.2	80.2	26.8
2005	83.1	37.8	63.2	38.5	108.9	37.2
2006	76.8	34.8	70.5	48.4	83.7	21.3
2007	82.9	37.8	81.4	47.8	84.3	27.9
2008	87.5	39.1	73.1	46.4	104.7	31.7
2009	66.0	29.6	59.1	40.1	73.6	19.1
2010	95.1	42.7	68.2	41.8	132.5	43.7
2011	97.1	42.5	85.7	52.7	109.9	32.2
2012	85.7	41.3	72.6	48.1	101.2	34.4
2013	91.3	40.0	86.9	48.4	95.9	31.7
2014	66.9	35.6	55.5	44.5	80.6	26.8
2015	67.6	30.7	65.7	41.8	69.6	19.7

Subbasin 500 Existing Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	67.5	34.4	74.0	51.4	61.6	17.5
1957	58.4	27.7	57.0	40.1	59.8	15.3
1958	59.2	31.0	58.0	46.2	60.4	15.8
1959	77.9	38.4	80.9	52.7	75.1	24.0
1960	59.1	30.1	50.9	38.3	68.6	21.9
1961	69.6	34.0	71.4	48.4	67.9	19.7
1962	63.7	31.5	55.0	40.1	73.7	23.0
1963	58.2	26.6	49.0	33.0	69.1	20.2
1964	88.4	40.2	93.2	55.2	83.8	25.1
1965	53.1	29.6	41.8	37.4	67.4	21.9
1966	67.5	34.0	71.9	48.4	63.4	19.7
1967	64.7	31.2	83.7	51.6	50.1	10.9
1968	74.2	36.1	72.0	44.8	76.5	27.3
1969	71.4	34.0	61.4	41.2	83.1	26.8
1970	58.1	29.9	49.0	41.2	68.7	18.6
1971	75.3	38.4	85.8	56.6	66.1	20.2
1972	85.9	42.3	68.7	47.5	107.4	37.2
1973	46.1	25.5	38.2	35.7	55.7	15.3
1974	83.1	39.5	89.6	54.9	77.1	24.0
1975	62.2	32.6	60.2	44.0	64.3	21.3
1976	84.7	42.3	72.2	48.6	99.4	36.1
1977	60.6	34.5	33.9	32.4	107.8	36.6
1978	81.4	41.6	69.7	46.2	95.0	37.2
1979	53.0	27.4	40.2	30.8	69.8	24.0
1980	72.8	39.3	62.0	47.5	85.5	31.1
1981	65.5	34.0	43.6	35.2	98.4	32.8
1982	72.7	37.3	65.2	47.8	80.9	26.8
1983	67.5	36.4	60.9	46.2	74.9	26.8
1984	55.3	28.4	41.4	31.1	74.0	25.7
1985	70.0	33.7	55.8	37.9	87.7	29.5
1986	70.6	35.9	61.0	44.5	81.8	27.3
1987	60.4	29.3	63.3	43.4	57.7	15.3
1988	55.6	31.1	35.7	34.4	86.8	27.9
1989	62.2	32.6	77.9	53.3	49.7	12.0
1990	58.9	31.2	51.7	42.9	67.1	19.7
1991	73.1	32.9	83.3	47.3	64.2	18.6
1992	64.1	31.4	62.5	40.4	65.7	22.4
1993	56.5	34.0	27.0	23.6	117.9	44.3
1994	46.1	25.5	39.3	37.4	54.1	13.7
1995	66.0	34.0	61.0	44.0	71.5	24.0
1996	84.9	42.3	66.4	48.1	108.7	36.6
1997	94.1	47.7	75.8	54.4	116.7	41.0

Subbasin 500 Existing Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	67.9	34.2	74.7	51.6	61.8	16.9
1999	81.3	40.3	82.5	54.4	80.2	26.2
2000	66.2	31.4	68.2	45.9	64.3	16.9
2001	58.4	28.8	46.1	33.5	73.9	24.0
2002	68.2	33.4	78.8	51.1	59.0	15.8
2003	47.5	26.0	43.9	42.9	51.4	9.3
2004	61.7	32.8	59.4	45.4	64.0	20.2
2005	69.7	33.7	53.8	35.7	90.1	31.7
2006	64.1	32.1	60.2	47.3	68.3	16.9
2007	69.4	33.4	71.1	46.7	67.7	20.2
2008	72.8	36.6	60.7	45.4	87.3	27.9
2009	54.5	27.7	48.5	37.9	61.2	17.5
2010	84.2	40.0	63.3	40.7	111.9	39.3
2011	82.7	40.0	74.6	50.5	91.7	29.5
2012	71.6	38.3	60.0	46.4	85.4	30.1
2013	76.4	37.8	74.3	48.9	78.5	26.8
2014	57.5	32.9	47.5	43.4	69.5	22.4
2015	58.2	29.6	58.9	42.3	57.5	16.9

Subbasin 600 Existing Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	56.6	28.7	56.0	41.0	57.2	16.4
1957	49.8	24.4	43.5	35.2	57.0	13.7
1958	49.6	28.2	42.9	41.2	57.3	15.3
1959	63.1	35.1	57.1	45.6	69.6	24.6
1960	51.2	26.8	40.5	32.8	64.9	20.8
1961	59.8	29.0	54.1	39.6	66.0	18.6
1962	51.2	27.9	38.2	34.1	68.6	21.9
1963	48.0	22.5	35.4	25.3	65.1	19.7
1964	72.2	34.7	67.0	43.2	77.9	26.2
1965	45.9	26.3	34.0	33.0	61.7	19.7
1966	54.5	28.5	49.1	38.5	60.4	18.6
1967	54.1	26.8	59.6	44.5	49.2	9.3
1968	59.1	31.4	49.8	37.2	70.2	25.7
1969	59.9	29.0	47.3	31.9	75.8	26.2
1970	49.3	24.7	38.3	34.1	63.4	15.3
1971	63.9	35.3	65.7	48.9	62.1	21.9
1972	66.4	36.6	47.3	37.7	93.2	35.5
1973	41.0	22.5	31.1	29.7	53.9	15.3
1974	69.9	34.8	68.4	47.8	71.5	21.9
1975	52.2	26.3	44.9	34.6	60.8	18.0
1976	71.2	36.6	55.7	39.9	91.0	33.3
1977	52.5	31.8	27.6	28.0	99.5	35.5
1978	67.9	36.4	53.3	37.4	86.5	35.5
1979	47.3	24.9	34.0	27.5	65.9	22.4
1980	61.2	35.0	46.6	38.3	80.5	31.7
1981	57.3	32.1	35.4	31.3	92.5	32.8
1982	63.5	35.1	54.9	43.4	73.3	26.8
1983	58.4	32.1	47.7	36.8	71.2	27.3
1984	49.1	26.2	34.7	27.9	69.5	24.6
1985	60.1	31.5	44.6	34.1	80.7	29.0
1986	58.3	29.9	45.3	35.7	74.8	24.0
1987	53.5	26.3	50.3	37.9	56.9	14.8
1988	46.1	27.0	27.0	28.4	78.8	25.7
1989	50.2	26.0	52.7	41.8	47.9	10.4
1990	49.1	27.9	38.3	36.8	62.9	19.1
1991	60.0	27.1	58.6	37.9	61.4	16.4
1992	53.2	26.0	45.5	30.6	62.2	21.3
1993	49.9	32.3	23.3	19.8	106.2	44.8
1994	40.8	21.9	31.1	30.8	53.3	13.1
1995	57.0	29.3	48.1	35.7	67.6	23.0
1996	69.7	37.7	49.7	38.8	97.8	36.6
1997	80.9	43.0	60.4	45.6	108.1	40.4

Subbasin 600 Existing Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	58.6	31.2	57.2	46.2	60.1	16.4
1999	68.3	35.9	61.8	45.1	75.4	26.8
2000	58.4	28.7	55.5	39.3	61.5	18.0
2001	48.8	25.2	33.7	27.5	70.5	23.0
2002	59.7	29.3	61.5	42.3	58.0	16.4
2003	41.5	22.5	32.8	36.8	52.4	8.2
2004	51.2	27.0	44.8	36.1	58.5	18.0
2005	59.9	32.1	40.7	30.8	88.0	33.3
2006	56.3	28.2	48.4	40.7	65.4	15.8
2007	59.4	29.9	55.6	40.7	63.4	19.1
2008	61.7	32.5	47.5	36.6	80.1	28.4
2009	47.6	24.9	37.7	33.5	60.1	16.4
2010	71.0	36.7	49.8	35.7	101.0	37.7
2011	70.8	34.0	58.3	40.1	85.8	27.9
2012	61.7	36.3	45.0	40.4	84.8	32.2
2013	64.0	32.3	57.1	38.5	71.5	26.2
2014	50.6	28.5	38.8	38.5	65.8	18.6
2015	51.3	25.2	48.2	35.7	54.6	14.8

Subbasin 700 Existing Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	54.4	26.0	49.2	38.3	60.1	13.7
1957	49.3	23.0	42.6	34.6	57.0	11.5
1958	48.5	26.0	39.4	37.4	59.8	14.8
1959	60.0	30.7	52.7	40.1	68.4	21.3
1960	48.8	23.2	37.6	31.7	63.3	14.8
1961	55.8	25.5	49.7	36.8	62.7	14.2
1962	50.6	24.9	36.6	30.2	69.9	19.7
1963	47.5	21.1	34.3	23.1	65.6	19.1
1964	66.2	31.7	61.0	41.0	71.9	22.4
1965	43.6	23.0	32.1	30.8	59.1	15.3
1966	50.9	24.1	44.0	34.1	59.0	14.2
1967	52.9	25.5	54.1	42.3	51.8	8.7
1968	56.2	28.4	44.4	33.9	71.3	23.0
1969	57.2	26.3	41.5	29.1	78.7	23.5
1970	47.7	22.7	36.7	32.4	61.9	13.1
1971	61.7	31.8	61.4	46.2	61.9	17.5
1972	65.1	33.3	43.7	33.3	97.0	33.3
1973	39.5	19.7	29.7	26.9	52.5	12.6
1974	66.0	32.3	61.4	43.4	70.9	21.3
1975	50.2	26.6	41.6	35.2	60.4	18.0
1976	68.3	36.1	50.2	39.3	92.9	32.8
1977	52.5	32.1	27.5	28.6	99.8	35.5
1978	65.8	34.2	50.5	34.6	85.7	33.9
1979	45.8	23.0	31.0	24.2	67.7	21.9
1980	61.8	34.4	47.0	39.3	81.1	29.5
1981	55.0	30.1	34.2	31.3	88.0	29.0
1982	64.2	34.0	53.5	41.8	77.0	26.2
1983	57.3	29.9	46.2	35.7	70.8	24.0
1984	47.0	22.7	32.2	24.0	68.7	21.3
1985	58.8	29.3	41.4	30.8	83.5	27.9
1986	55.9	27.9	41.6	33.0	75.0	23.0
1987	51.7	23.8	46.2	34.6	57.9	13.1
1988	47.2	25.7	27.0	26.8	82.5	24.6
1989	50.3	23.3	50.4	36.8	50.3	9.8
1990	48.2	24.1	36.5	33.0	63.5	15.3
1991	56.0	24.1	51.5	32.4	60.9	15.8
1992	51.3	23.0	42.2	28.4	62.3	17.5
1993	48.4	31.0	22.5	20.9	103.7	41.0
1994	41.1	22.5	31.1	32.4	54.3	12.6
1995	54.7	26.3	44.4	31.9	67.3	20.8
1996	67.2	35.5	45.3	35.5	99.6	35.5
1997	79.5	41.6	56.2	43.4	112.2	39.9

Subbasin 700 Existing Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	56.3	29.0	52.5	44.0	60.3	14.2
1999	65.7	34.2	58.0	44.0	74.4	24.6
2000	54.5	24.3	48.4	35.0	61.3	13.7
2001	46.4	21.1	31.1	22.0	69.0	20.2
2002	57.5	27.4	57.7	42.9	57.2	12.0
2003	42.1	20.3	33.5	34.6	52.7	6.0
2004	49.3	24.3	42.0	32.8	57.9	15.8
2005	57.2	29.0	37.7	26.4	86.6	31.7
2006	52.6	25.8	43.8	37.4	63.3	14.2
2007	57.1	28.2	54.0	40.1	60.4	16.4
2008	60.2	31.1	45.5	35.5	79.4	26.8
2009	46.7	22.5	36.0	30.2	60.4	14.8
2010	68.1	34.0	44.7	32.4	103.6	35.5
2011	67.1	32.3	52.8	40.1	85.1	24.6
2012	58.3	32.5	41.2	36.1	82.3	29.0
2013	61.9	28.8	52.1	34.1	73.4	23.5
2014	50.5	29.0	39.2	38.5	65.1	19.7
2015	50.9	23.3	46.5	35.2	55.7	11.5

Subbasin 800 Existing Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	68.4	35.5	75.2	54.1	62.1	16.9
1957	58.2	29.3	54.6	43.4	61.9	15.3
1958	56.9	32.9	52.8	50.0	61.3	15.8
1959	76.6	39.7	76.7	53.8	76.5	25.7
1960	59.7	31.1	51.5	39.9	69.3	22.4
1961	71.2	35.1	70.0	50.0	72.4	20.2
1962	59.4	32.6	47.1	40.7	74.8	24.6
1963	54.5	26.6	42.3	31.3	70.1	21.9
1964	89.1	43.4	91.2	57.9	87.0	29.0
1965	52.6	29.9	42.1	39.6	65.6	20.2
1966	62.9	34.0	61.3	48.9	64.6	19.1
1967	64.2	32.6	78.4	54.9	52.6	10.4
1968	70.7	36.6	64.4	47.0	77.7	26.2
1969	72.6	35.9	62.5	44.5	84.2	27.3
1970	56.8	31.2	47.1	42.9	68.4	19.7
1971	75.8	40.0	86.1	59.3	66.8	20.8
1972	80.8	44.3	60.2	49.7	108.4	38.8
1973	46.7	26.3	37.7	36.3	57.9	16.4
1974	84.1	42.2	89.0	59.9	79.5	24.6
1975	61.6	35.3	56.9	47.3	66.5	23.5
1976	86.9	43.2	73.3	49.7	102.9	36.6
1977	60.1	35.6	31.6	33.5	113.8	37.7
1978	81.4	42.5	68.6	48.9	96.4	36.1
1979	54.6	28.8	41.9	34.6	71.1	23.0
1980	72.1	39.9	57.7	47.0	90.1	32.8
1981	66.8	36.4	42.0	35.7	106.0	37.2
1982	75.9	40.8	70.5	53.3	81.6	28.4
1983	69.4	38.1	61.1	48.4	78.7	27.9
1984	55.8	29.0	40.9	31.7	76.1	26.2
1985	71.2	34.8	56.0	39.6	90.4	30.1
1986	68.9	34.5	57.3	42.9	82.8	26.2
1987	62.6	29.6	63.4	43.4	61.8	15.8
1988	52.2	30.1	30.9	31.1	88.1	29.0
1989	58.8	32.1	68.7	52.2	50.4	12.0
1990	57.0	31.2	47.6	42.9	68.2	19.7
1991	71.5	33.7	77.4	48.4	66.1	19.1
1992	60.7	30.6	54.9	38.8	67.1	22.4
1993	57.7	36.7	25.7	24.7	129.1	48.6
1994	45.5	26.0	36.5	37.9	56.8	14.2
1995	67.3	34.5	61.4	45.1	73.7	24.0
1996	84.9	43.7	65.0	48.1	110.8	39.3
1997	98.7	49.3	79.8	56.6	122.0	42.1

Subbasin 800 Existing Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	69.3	35.6	74.2	54.4	64.7	16.9
1999	80.8	40.8	80.5	54.4	81.0	27.3
2000	66.9	32.2	69.4	47.0	64.5	17.5
2001	55.7	29.9	40.4	34.1	76.8	25.7
2002	71.4	34.2	81.6	52.2	62.6	16.4
2003	47.7	27.1	40.2	43.4	56.5	10.9
2004	59.5	32.8	57.3	46.4	61.8	19.1
2005	70.1	37.0	51.2	39.0	95.9	35.0
2006	65.1	33.4	60.7	50.0	69.8	16.9
2007	68.8	34.8	69.3	48.4	68.3	21.3
2008	73.5	38.3	60.5	47.0	89.4	29.5
2009	54.9	27.4	46.1	36.8	65.4	18.0
2010	85.9	41.6	64.1	43.4	115.0	39.9
2011	85.7	41.9	76.4	52.2	96.2	31.7
2012	71.8	40.4	54.2	46.4	95.2	34.4
2013	75.9	37.8	74.2	48.4	77.6	27.3
2014	59.0	34.2	46.9	45.1	74.1	23.5
2015	59.3	29.9	60.1	44.5	58.5	15.3

Subbasin 900 Existing Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	60.1	29.8	60.4	43.7	59.9	15.8
1957	53.1	23.8	45.6	33.5	61.8	14.2
1958	52.2	27.7	44.3	40.7	61.3	14.8
1959	66.3	34.2	60.6	44.0	72.4	24.6
1960	54.1	25.4	43.9	32.8	66.7	18.0
1961	63.5	30.1	57.1	41.2	70.6	19.1
1962	54.1	27.9	40.7	33.5	71.8	22.4
1963	52.0	23.3	38.2	26.4	70.5	20.2
1964	75.9	33.9	70.9	42.6	81.2	25.1
1965	47.8	26.0	35.1	33.0	65.0	19.1
1966	58.1	29.6	52.4	40.1	64.3	19.1
1967	58.0	27.4	63.3	45.6	53.2	9.3
1968	61.4	30.6	52.4	36.1	72.0	25.1
1969	63.2	29.3	52.1	33.0	76.7	25.7
1970	52.2	24.7	40.2	33.0	67.7	16.4
1971	64.8	34.8	66.3	48.4	63.4	21.3
1972	68.5	37.4	50.8	39.9	92.3	35.0
1973	43.5	23.0	32.9	30.2	57.3	15.8
1974	71.4	34.5	69.4	47.8	73.5	21.3
1975	54.9	26.6	47.8	34.1	63.1	19.1
1976	72.8	37.2	58.5	41.0	90.5	33.3
1977	53.7	31.5	29.0	27.5	99.0	35.5
1978	70.9	36.4	57.1	37.4	88.0	35.5
1979	50.7	26.3	37.2	30.2	68.9	22.4
1980	62.4	33.6	47.0	36.1	82.9	31.1
1981	59.2	32.1	37.0	30.8	94.5	33.3
1982	63.7	34.2	54.5	42.3	74.4	26.2
1983	58.9	32.6	48.6	38.5	71.3	26.8
1984	49.2	25.7	34.8	27.3	69.6	24.0
1985	61.0	29.9	46.1	32.4	80.6	27.3
1986	60.2	29.3	47.3	35.2	76.4	23.5
1987	55.7	25.8	51.4	36.8	60.4	14.8
1988	48.4	27.0	27.9	26.8	83.8	27.3
1989	54.7	27.9	56.2	45.1	53.1	10.9
1990	51.7	27.7	39.4	35.7	67.7	19.7
1991	62.3	27.7	60.5	38.5	64.3	16.9
1992	55.7	26.5	47.4	32.2	65.5	20.8
1993	51.9	34.2	24.7	20.9	108.3	47.5
1994	43.2	22.7	32.3	31.9	57.7	13.7
1995	59.6	28.8	49.7	35.2	71.3	22.4
1996	70.6	36.1	51.1	36.6	97.5	35.5
1997	80.6	42.5	62.1	46.2	104.4	38.8

Subbasin 900 Existing Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	60.7	30.4	59.6	45.6	61.9	15.3
1999	69.6	35.1	63.1	44.0	76.6	26.2
2000	60.8	29.5	57.3	40.4	64.6	18.6
2001	51.4	25.5	36.3	28.0	72.6	23.0
2002	61.9	29.9	62.6	42.9	61.2	16.9
2003	44.3	21.4	33.8	34.1	58.1	8.7
2004	53.5	27.3	47.2	36.1	60.7	18.6
2005	62.7	31.5	44.1	29.7	89.0	33.3
2006	58.6	28.2	49.9	40.7	68.7	15.8
2007	61.1	29.6	56.1	39.6	66.5	19.7
2008	62.9	32.2	48.7	38.3	81.1	26.2
2009	49.0	24.1	38.6	33.5	62.1	14.8
2010	71.3	36.4	50.8	35.2	99.8	37.7
2011	73.8	34.8	61.7	41.2	88.3	28.4
2012	62.5	35.2	45.6	37.7	85.7	32.8
2013	64.7	32.3	58.2	39.6	71.8	25.1
2014	51.0	28.2	38.7	37.4	67.2	19.1
2015	52.6	25.5	48.3	36.3	57.1	14.8

Subbasin 100 Future Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	59.6	30.6	62.6	45.9	56.8	15.3
1957	52.1	25.8	48.1	37.9	56.4	13.7
1958	52.4	28.5	48.4	42.9	56.8	14.2
1959	66.9	32.3	64.2	42.9	69.8	21.9
1960	53.2	26.8	44.3	35.0	63.9	18.6
1961	60.9	29.0	57.3	40.7	64.8	17.5
1962	54.5	26.8	44.0	34.1	67.5	19.7
1963	51.4	24.9	40.6	31.3	65.0	18.6
1964	76.2	36.1	75.4	48.1	77.0	24.0
1965	47.8	27.1	36.3	35.2	62.8	19.1
1966	59.6	30.7	59.2	42.3	60.1	19.1
1967	57.7	28.5	69.2	47.3	48.1	9.8
1968	63.3	33.1	58.1	42.1	69.0	24.0
1969	62.2	29.9	51.7	34.6	74.7	25.1
1970	51.0	24.7	40.8	33.0	63.6	16.4
1971	65.5	35.6	70.8	51.6	60.6	19.7
1972	71.9	38.8	56.6	44.3	91.4	33.3
1973	41.6	21.9	32.4	30.2	53.3	13.7
1974	72.6	36.4	75.5	51.1	69.8	21.9
1975	54.6	27.1	50.1	36.3	59.4	18.0
1976	72.2	37.4	59.9	43.2	86.9	31.7
1977	53.5	29.9	30.2	27.5	94.7	32.2
1978	70.2	37.5	57.8	40.7	85.1	34.4
1979	47.8	24.1	34.8	26.9	65.5	21.3
1980	62.7	33.9	50.7	39.9	77.4	27.9
1981	58.6	29.9	38.3	30.8	89.5	29.0
1982	63.2	33.7	54.8	42.3	72.7	25.1
1983	59.0	32.6	51.3	40.7	67.9	24.6
1984	49.7	26.8	36.7	30.6	67.1	23.0
1985	60.7	29.9	47.3	34.6	77.8	25.1
1986	60.9	30.4	50.0	37.4	74.2	23.5
1987	53.5	26.3	52.1	39.0	55.1	13.7
1988	49.3	27.9	30.5	30.1	79.5	25.7
1989	55.2	28.2	63.2	46.2	48.2	10.4
1990	51.5	28.2	42.2	37.9	62.7	18.6
1991	63.8	29.3	67.4	42.3	60.3	16.4
1992	56.8	27.9	52.6	35.5	61.3	20.2
1993	49.9	31.2	23.9	20.3	103.8	42.1
1994	42.6	23.0	34.8	34.1	52.1	12.0
1995	59.4	29.3	52.9	37.9	66.6	20.8
1996	72.3	36.6	55.1	39.9	94.8	33.3
1997	79.4	43.6	62.5	48.4	100.7	38.8

Subbasin 100 Future Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	59.5	30.7	61.2	46.2	57.8	15.3
1999	70.2	35.3	67.0	47.3	73.5	23.5
2000	60.8	29.5	59.6	42.1	62.0	16.9
2001	51.3	25.5	38.2	30.2	68.7	20.8
2002	62.0	28.2	68.1	41.8	56.5	14.8
2003	42.7	23.8	36.3	39.0	50.2	8.7
2004	53.2	28.4	48.3	39.3	58.7	17.5
2005	61.2	31.0	44.6	30.8	83.7	31.1
2006	58.0	28.8	51.9	43.4	64.7	14.2
2007	62.0	29.9	60.0	41.2	64.1	18.6
2008	62.3	32.5	49.9	39.3	77.8	25.7
2009	48.8	25.2	41.3	35.2	57.6	15.3
2010	71.9	36.4	52.7	36.8	98.0	36.1
2011	71.6	35.9	61.6	43.4	83.2	28.4
2012	62.7	35.8	49.7	41.5	79.0	30.1
2013	66.4	34.5	61.9	44.5	71.2	24.6
2014	49.9	27.7	39.6	37.4	62.8	18.0
2015	51.8	25.2	50.0	36.8	53.8	13.7

Subbasin 200 Future Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	59.3	26.2	57.2	39.9	61.4	12.6
1957	51.9	22.7	46.0	34.1	58.5	11.5
1958	52.1	26.0	44.7	38.5	60.7	13.7
1959	64.0	31.0	57.9	41.8	70.7	20.2
1960	51.5	23.5	40.9	31.7	64.9	15.3
1961	58.6	26.3	52.8	38.5	64.9	14.2
1962	54.1	25.2	40.2	30.8	72.7	19.7
1963	50.5	21.6	37.7	25.8	67.4	17.5
1964	70.8	33.1	67.8	43.7	73.9	22.4
1965	46.8	23.0	34.8	29.7	62.9	16.4
1966	55.7	26.0	50.3	37.4	61.6	14.8
1967	56.8	24.7	60.2	41.8	53.6	7.7
1968	60.9	28.7	50.8	35.5	73.0	21.9
1969	60.6	26.3	46.0	30.8	79.7	21.9
1970	49.8	22.2	38.3	31.3	64.6	13.1
1971	65.1	33.4	67.5	50.0	62.7	16.9
1972	69.6	33.6	49.8	36.1	97.2	31.1
1973	41.9	18.9	31.2	25.8	56.1	12.0
1974	70.2	32.3	69.3	45.1	71.1	19.7
1975	52.8	27.7	44.7	35.7	62.4	19.7
1976	70.9	36.1	55.7	41.5	90.1	30.6
1977	53.8	29.9	29.0	27.5	99.4	32.2
1978	68.3	33.7	53.4	34.6	87.4	32.8
1979	47.5	22.2	32.4	23.1	69.6	21.3
1980	63.4	32.5	49.4	37.7	81.4	27.3
1981	57.1	27.7	37.0	29.1	88.1	26.2
1982	65.0	32.9	54.1	40.7	78.1	25.1
1983	58.9	29.0	49.5	36.3	70.0	21.9
1984	49.1	24.3	34.3	26.2	70.3	22.4
1985	61.0	29.3	45.4	33.5	81.7	25.1
1986	58.5	27.7	45.3	34.1	75.3	21.3
1987	53.3	23.6	48.4	35.7	58.6	11.5
1988	49.6	24.9	29.8	27.3	82.4	22.4
1989	55.5	26.3	58.2	43.4	52.9	9.3
1990	51.6	24.9	40.9	34.1	64.9	15.8
1991	61.0	25.8	59.3	35.7	62.8	15.8
1992	54.8	25.4	46.6	32.8	64.4	18.0
1993	50.5	29.6	24.1	20.3	105.3	38.8
1994	43.5	22.2	33.9	33.0	55.9	11.5
1995	58.9	27.4	50.6	34.6	68.5	20.2
1996	68.5	35.8	50.0	39.9	93.9	31.7
1997	77.2	39.5	57.7	42.3	103.2	36.6

Subbasin 200 Future Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	57.5	28.2	55.1	43.4	60.0	13.1
1999	66.8	32.6	62.3	44.0	71.6	21.3
2000	57.0	25.1	52.6	37.2	61.7	13.1
2001	49.1	22.2	33.9	24.2	71.1	20.2
2002	60.5	27.1	64.2	41.8	57.1	12.6
2003	44.2	20.5	36.3	35.2	53.7	6.0
2004	52.1	25.4	44.7	34.4	60.8	16.4
2005	58.9	28.2	41.1	29.1	84.2	27.3
2006	54.7	25.8	47.2	39.6	63.4	12.0
2007	59.5	27.7	56.8	38.5	62.4	16.9
2008	61.0	30.1	47.3	35.0	78.8	25.1
2009	49.1	22.7	39.2	31.9	61.4	13.7
2010	69.4	34.8	48.4	34.6	99.4	35.0
2011	67.1	31.0	55.5	40.1	81.1	21.9
2012	57.9	31.1	43.5	36.6	77.2	25.7
2013	63.7	28.8	55.8	35.2	72.7	22.4
2014	50.8	27.7	39.6	37.9	65.2	17.5
2015	52.2	22.5	48.5	34.1	56.1	10.9

Subbasin 300 Future Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	58.9	30.6	60.8	45.4	57.1	15.8
1957	51.2	25.2	46.1	37.4	56.8	13.1
1958	51.6	28.2	46.9	42.3	56.7	14.2
1959	64.8	32.3	61.1	42.3	68.8	22.4
1960	52.0	27.0	42.3	35.0	64.0	19.1
1961	59.8	28.8	55.0	40.1	64.9	17.5
1962	53.2	27.7	42.0	35.2	67.4	20.2
1963	49.6	23.0	38.2	27.5	64.4	18.6
1964	74.8	35.2	72.9	45.9	76.8	24.6
1965	47.0	27.1	35.5	35.2	62.2	19.1
1966	57.7	29.6	55.3	40.7	60.1	18.6
1967	56.4	27.9	65.9	47.3	48.3	8.7
1968	61.2	33.1	54.3	41.5	69.0	24.6
1969	61.2	29.3	49.9	33.5	75.0	25.1
1970	50.1	24.4	39.5	33.0	63.6	15.8
1971	64.8	35.1	68.7	50.5	61.1	19.7
1972	69.7	38.3	53.6	42.6	90.7	33.9
1973	41.0	21.6	31.2	29.7	53.7	13.7
1974	71.6	35.9	73.1	51.1	70.1	20.8
1975	53.5	26.6	47.8	35.2	59.9	18.0
1976	71.5	37.7	58.7	42.6	87.2	32.8
1977	53.3	30.4	29.6	27.5	95.6	33.3
1978	69.1	36.7	56.3	39.6	84.8	33.9
1979	47.6	23.8	34.8	26.9	65.2	20.8
1980	61.3	33.6	48.5	39.3	77.5	27.9
1981	58.2	30.7	37.5	31.3	90.0	30.1
1982	62.8	33.4	54.4	41.8	72.5	25.1
1983	58.8	32.1	50.0	38.5	69.1	25.7
1984	49.4	27.0	36.1	30.6	67.6	23.5
1985	59.8	29.3	45.8	33.0	77.9	25.7
1986	59.2	29.9	47.4	36.8	73.8	23.0
1987	52.9	26.3	50.5	39.0	55.4	13.7
1988	47.6	27.0	29.0	28.4	78.3	25.7
1989	52.9	27.9	58.7	45.1	47.6	10.9
1990	50.6	28.2	40.6	37.9	63.1	18.6
1991	62.1	28.5	63.6	40.7	60.6	16.4
1992	55.3	27.0	49.9	35.0	61.3	19.1
1993	50.0	31.5	23.7	19.8	105.0	43.2
1994	42.2	22.5	33.6	33.0	52.8	12.0
1995	58.9	28.5	51.8	36.3	67.0	20.8
1996	70.9	36.3	53.0	39.3	94.8	33.3
1997	79.0	42.7	61.0	46.7	102.3	38.8

Subbasin 300 Future Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	59.3	29.9	59.5	45.1	59.1	14.8
1999	69.0	34.8	64.1	46.2	74.1	23.5
2000	59.7	28.7	58.2	40.4	61.2	16.9
2001	50.1	25.2	36.7	29.1	68.3	21.3
2002	61.3	29.0	65.7	42.3	57.2	15.8
2003	42.4	23.0	35.1	37.4	51.3	8.7
2004	52.0	27.6	46.2	37.7	58.4	17.5
2005	60.2	31.2	42.8	30.8	84.6	31.7
2006	57.2	27.7	50.3	41.2	65.1	14.2
2007	61.0	29.3	58.6	40.7	63.5	18.0
2008	61.4	32.0	48.4	38.3	78.0	25.7
2009	48.1	24.7	39.6	34.1	58.4	15.3
2010	71.6	36.2	51.8	35.7	98.7	36.6
2011	70.5	34.8	59.8	41.2	83.0	28.4
2012	61.7	35.8	47.1	40.4	80.8	31.1
2013	64.8	33.4	59.3	42.3	70.8	24.6
2014	50.0	27.9	39.0	37.9	64.0	18.0
2015	51.4	25.2	48.8	36.3	54.2	14.2

Subbasin 400 Future Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	62.9	27.6	61.7	39.3	64.1	15.8
1957	54.9	23.8	48.1	34.1	62.8	13.7
1958	54.2	27.4	45.9	40.1	64.0	14.8
1959	67.3	32.1	59.9	40.7	75.7	23.5
1960	55.3	26.0	44.1	32.2	69.3	19.7
1961	62.3	27.1	54.7	37.4	70.9	16.9
1962	56.9	27.1	44.0	33.0	73.6	21.3
1963	54.8	23.8	42.3	28.6	71.0	19.1
1964	77.1	35.8	71.6	44.3	83.0	27.3
1965	49.1	25.2	35.3	30.8	68.0	19.7
1966	61.6	30.1	57.4	39.6	66.1	20.8
1967	59.1	24.9	63.8	42.3	54.7	7.7
1968	63.8	31.4	54.3	38.8	74.8	24.0
1969	63.5	27.4	49.2	30.8	81.8	24.0
1970	53.1	24.9	40.8	33.0	69.0	16.9
1971	65.9	34.5	64.5	47.3	67.4	21.9
1972	73.9	35.8	55.6	38.8	98.4	32.8
1973	43.1	20.5	32.2	26.9	57.6	14.2
1974	72.3	33.7	67.7	45.6	77.1	21.9
1975	56.7	27.1	49.1	33.5	65.5	20.8
1976	73.4	38.0	56.4	42.1	95.4	33.9
1977	55.9	31.5	31.7	28.6	98.3	34.4
1978	72.7	35.1	58.2	35.2	90.8	35.0
1979	51.0	24.9	36.0	25.8	72.2	24.0
1980	64.1	32.5	49.2	35.0	83.6	30.1
1981	61.4	29.9	39.9	30.8	94.2	29.0
1982	65.1	33.4	51.6	39.6	82.0	27.3
1983	61.4	32.1	51.3	37.4	73.3	26.8
1984	50.8	25.4	35.8	26.8	71.9	24.0
1985	62.2	28.8	46.1	31.9	83.8	25.7
1986	61.8	28.5	46.8	33.5	81.6	23.5
1987	54.3	24.1	47.7	34.1	61.8	14.2
1988	50.9	26.5	30.5	27.9	85.0	25.1
1989	57.0	26.8	59.1	42.9	54.9	10.9
1990	52.6	26.3	40.2	34.1	68.9	18.6
1991	63.0	25.8	60.8	35.7	65.3	15.8
1992	57.4	26.2	49.3	31.7	66.8	20.8
1993	51.3	31.5	24.5	20.3	107.3	42.6
1994	45.3	22.5	35.7	32.4	57.5	12.6
1995	60.1	28.2	50.1	35.2	72.0	21.3
1996	71.5	36.6	50.3	38.8	101.6	34.4
1997	80.5	42.7	58.6	43.4	110.4	42.1

Subbasin 400 Future Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	62.4	30.4	59.7	45.1	65.2	15.8
1999	71.3	35.1	62.7	44.0	80.9	26.2
2000	62.5	29.5	56.4	38.8	69.2	20.2
2001	52.9	24.7	37.8	27.5	73.9	21.9
2002	63.6	28.5	63.9	40.1	63.3	16.9
2003	45.2	21.9	36.4	35.2	56.2	8.7
2004	53.8	27.3	44.7	36.6	64.7	18.0
2005	63.1	30.1	44.0	28.0	90.2	32.2
2006	59.8	27.7	50.5	40.7	70.9	14.8
2007	64.5	29.6	59.2	39.0	70.3	20.2
2008	65.2	30.9	50.3	35.5	84.4	26.2
2009	51.2	24.1	41.8	35.2	62.7	13.1
2010	71.6	36.2	48.6	36.3	105.2	36.1
2011	72.6	33.2	58.3	39.6	90.5	26.8
2012	63.5	34.4	47.6	37.7	84.9	31.1
2013	66.9	31.0	57.0	36.8	78.4	25.1
2014	52.3	26.6	40.3	36.3	67.8	16.9
2015	53.4	24.9	47.7	35.2	59.9	14.8

Subbasin 500 Future Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	71.0	35.0	80.8	52.5	62.3	17.5
1957	60.4	27.9	60.4	41.2	60.4	14.8
1958	61.6	31.2	62.3	46.7	60.9	15.8
1959	80.1	37.8	84.9	52.7	75.5	23.0
1960	60.7	30.3	53.4	38.8	69.1	21.9
1961	70.8	33.2	73.0	46.7	68.8	19.7
1962	65.4	31.0	57.4	40.1	74.3	21.9
1963	59.3	27.4	50.5	35.7	69.6	19.1
1964	91.7	39.9	99.3	54.6	84.6	25.1
1965	54.8	29.3	44.0	37.4	68.2	21.3
1966	70.0	33.7	76.4	47.3	64.1	20.2
1967	67.9	31.2	91.0	51.6	50.7	10.9
1968	76.6	35.2	76.2	43.7	77.0	26.8
1969	73.7	34.0	64.5	41.2	84.2	26.8
1970	59.2	29.9	50.3	41.8	69.6	18.0
1971	77.7	38.9	90.9	57.7	66.4	20.2
1972	88.5	42.6	73.2	48.1	106.9	37.2
1973	46.7	24.9	38.5	34.6	56.4	15.3
1974	86.2	39.7	96.0	56.0	77.4	23.5
1975	64.0	32.1	63.3	42.9	64.8	21.3
1976	86.9	42.3	76.7	49.7	98.6	35.0
1977	61.8	33.7	35.3	31.9	107.8	35.5
1978	83.5	40.8	73.1	44.5	95.3	37.2
1979	54.6	28.2	42.1	31.9	70.6	24.6
1980	73.8	39.1	64.0	47.5	85.1	30.6
1981	68.1	34.0	46.5	35.2	99.5	32.8
1982	74.2	36.4	67.8	46.7	81.2	26.2
1983	69.7	36.4	64.8	46.2	75.0	26.8
1984	56.8	29.0	43.4	32.2	74.3	25.7
1985	71.3	33.7	58.0	38.5	87.6	29.0
1986	71.9	35.1	63.0	43.4	81.9	26.8
1987	61.2	29.9	64.6	44.5	57.9	15.3
1988	57.5	31.1	37.6	34.4	88.0	27.9
1989	64.6	32.3	83.1	52.7	50.3	12.0
1990	60.9	31.2	54.4	42.9	68.2	19.7
1991	76.0	32.9	89.2	47.3	64.8	18.6
1992	66.2	31.4	66.1	39.9	66.4	23.0
1993	58.3	34.2	28.0	24.2	120.6	44.3
1994	48.1	25.2	42.0	37.4	55.0	13.1
1995	69.5	34.0	66.8	44.5	72.3	23.5
1996	87.9	41.3	71.7	45.9	107.8	36.6
1997	95.2	47.4	78.5	54.4	115.4	40.4

Subbasin 500 Future Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	69.9	34.0	78.2	51.1	62.5	16.9
1999	83.6	40.5	86.6	54.9	80.7	26.2
2000	68.9	32.0	73.1	47.0	64.9	16.9
2001	59.9	28.8	48.3	33.5	74.3	24.0
2002	71.3	33.7	85.6	51.6	59.5	15.8
2003	49.1	25.5	46.2	42.3	52.3	8.7
2004	62.9	31.4	61.5	43.2	64.3	19.7
2005	71.1	33.4	55.8	35.2	90.5	31.7
2006	66.1	31.5	63.4	47.3	68.9	15.8
2007	72.1	34.0	76.0	48.4	68.5	19.7
2008	73.7	36.3	62.4	45.4	87.0	27.3
2009	56.0	27.7	50.8	37.9	61.7	17.5
2010	86.4	40.8	66.6	42.9	111.8	38.8
2011	83.9	40.5	77.2	52.2	91.2	29.0
2012	72.9	38.3	62.4	46.4	85.3	30.1
2013	78.1	38.4	77.4	50.0	78.7	26.8
2014	58.2	32.1	48.5	42.3	69.9	21.9
2015	59.9	29.0	62.1	41.2	57.9	16.9

Subbasin 600 Future Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	58.3	28.4	58.5	41.0	58.1	15.8
1957	50.1	24.9	43.6	36.3	57.5	13.7
1958	50.4	27.1	43.9	39.6	57.7	14.8
1959	62.6	31.5	56.5	39.0	69.4	24.0
1960	51.4	25.7	40.7	33.3	64.9	18.0
1961	59.0	27.7	52.3	37.9	66.7	17.5
1962	51.3	26.6	38.3	32.4	68.4	20.8
1963	47.9	21.9	35.0	25.3	65.2	18.6
1964	72.6	34.4	67.7	43.2	77.9	25.7
1965	46.3	25.2	34.5	32.4	62.1	18.0
1966	55.2	28.8	50.1	39.6	60.9	18.0
1967	55.1	27.1	60.5	45.6	50.1	8.7
1968	58.9	30.9	49.7	37.2	69.8	24.6
1969	59.8	27.9	47.1	30.8	75.9	25.1
1970	49.0	23.6	37.5	32.4	63.9	14.8
1971	63.8	34.2	65.7	47.3	62.0	21.3
1972	66.3	33.9	48.5	36.1	90.7	31.7
1973	40.7	20.5	30.3	27.5	54.7	13.7
1974	70.1	34.8	69.2	48.4	71.0	21.3
1975	52.4	26.6	44.8	35.2	61.2	18.0
1976	70.4	37.7	55.9	42.6	88.5	32.8
1977	52.4	30.1	28.2	26.4	97.1	33.9
1978	67.3	35.3	53.1	36.3	85.2	34.4
1979	47.2	23.6	33.7	26.4	65.9	20.8
1980	60.1	33.3	45.8	37.7	79.0	29.0
1981	57.4	31.2	35.9	31.3	91.6	31.1
1982	62.6	32.9	53.6	41.2	73.2	24.6
1983	58.4	31.5	48.1	37.4	70.9	25.7
1984	49.1	26.8	34.9	29.0	68.9	24.6
1985	59.4	29.0	44.4	31.9	79.3	26.2
1986	57.3	28.5	44.2	33.5	74.2	23.5
1987	52.7	25.2	48.4	36.3	57.4	14.2
1988	46.3	26.2	27.4	27.9	78.4	24.6
1989	51.1	26.0	53.5	41.8	48.8	10.4
1990	49.5	27.1	38.2	36.3	63.9	18.0
1991	60.4	27.4	59.0	38.5	61.8	16.4
1992	53.6	26.5	45.9	32.8	62.5	20.2
1993	49.9	31.8	23.4	19.2	105.9	44.3
1994	41.8	21.1	32.0	29.7	54.5	12.6
1995	58.3	29.0	49.9	36.3	68.1	21.9
1996	68.9	36.1	49.9	37.7	95.1	34.4
1997	78.5	42.5	59.0	45.6	104.4	39.3

Subbasin 600 Future Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	58.7	30.1	56.8	45.1	60.6	15.3
1999	67.7	34.5	60.9	45.1	75.2	24.0
2000	59.2	28.1	56.3	38.3	62.1	18.0
2001	48.9	24.9	34.0	28.0	70.2	21.9
2002	60.7	28.5	62.9	41.2	58.7	15.8
2003	42.3	21.4	33.3	34.6	53.6	8.2
2004	50.5	26.2	43.6	35.0	58.5	17.5
2005	59.2	31.0	40.2	29.1	87.0	32.8
2006	56.6	27.1	48.7	39.6	65.7	14.8
2007	59.9	29.0	56.0	39.6	64.0	18.6
2008	60.7	31.4	46.8	36.6	78.8	26.2
2009	47.8	24.1	37.8	33.0	60.4	15.3
2010	70.2	35.9	49.7	34.6	98.9	37.2
2011	69.7	32.1	57.6	37.9	84.3	26.2
2012	60.8	35.0	44.2	38.8	83.6	31.1
2013	63.4	31.0	56.6	37.4	71.0	24.6
2014	49.8	27.7	37.8	37.4	65.5	18.0
2015	51.3	24.7	47.8	35.2	55.0	14.2

Subbasin 700 Future Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	59.0	26.0	53.8	38.3	64.6	13.7
1957	51.7	21.9	43.3	31.3	61.8	12.6
1958	51.5	26.0	41.5	36.8	63.9	15.3
1959	61.3	29.6	52.5	37.9	71.5	21.3
1960	50.9	21.6	39.0	29.0	66.4	14.2
1961	56.9	23.0	47.9	32.4	67.7	13.7
1962	52.9	25.2	38.3	30.8	73.0	19.7
1963	49.6	21.1	35.6	23.6	69.1	18.6
1964	68.8	31.4	62.4	39.9	75.9	23.0
1965	46.0	23.0	33.2	29.7	63.5	16.4
1966	55.2	25.2	47.9	35.2	63.6	15.3
1967	55.9	23.6	56.0	39.6	55.7	7.7
1968	58.0	27.6	45.9	33.3	73.2	21.9
1969	59.0	24.9	42.6	26.9	81.5	23.0
1970	50.0	21.9	37.6	30.8	66.3	13.1
1971	62.9	31.5	60.4	44.5	65.5	18.6
1972	68.0	33.1	47.9	33.9	96.5	32.2
1973	41.1	18.4	29.7	25.3	56.7	11.5
1974	67.4	32.3	61.3	42.9	74.2	21.9
1975	52.6	24.4	43.3	32.4	63.9	16.4
1976	69.1	36.3	51.2	39.9	93.5	32.8
1977	54.0	30.4	29.4	25.8	98.8	35.0
1978	66.9	33.2	51.6	32.4	86.8	33.9
1979	47.8	21.6	32.0	22.0	71.1	21.3
1980	61.1	30.3	45.3	33.3	82.5	27.3
1981	57.3	29.6	35.9	29.1	91.0	30.1
1982	64.1	32.9	51.0	40.7	80.4	25.1
1983	58.3	27.7	46.3	32.4	73.3	23.0
1984	48.0	23.0	32.9	23.5	70.3	22.4
1985	58.9	27.9	41.1	29.1	84.3	26.8
1986	56.8	26.3	41.1	30.2	78.3	22.4
1987	52.1	22.2	43.6	30.8	62.2	13.7
1988	49.4	24.3	28.8	25.1	84.7	23.5
1989	52.8	24.1	51.0	39.0	54.6	9.3
1990	50.7	22.7	37.4	30.2	68.5	15.3
1991	58.4	22.7	52.6	30.8	64.8	14.8
1992	53.7	23.0	43.8	28.4	65.9	17.5
1993	50.0	30.4	23.5	19.8	105.7	41.0
1994	44.7	21.4	33.9	30.2	58.9	12.6
1995	57.6	26.0	46.6	31.9	71.1	20.2
1996	67.0	34.4	45.1	34.4	99.5	34.4
1997	77.9	40.0	54.4	40.7	111.3	39.3

Subbasin 700 Future Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	58.8	28.2	53.1	42.9	65.1	13.7
1999	67.2	33.4	57.6	42.9	78.4	24.0
2000	57.8	24.6	50.5	34.4	66.2	14.8
2001	48.8	21.4	33.2	21.4	71.5	21.3
2002	60.5	26.6	58.9	40.7	62.2	12.6
2003	44.6	18.9	34.5	31.9	57.6	6.0
2004	49.8	23.8	40.8	31.1	60.8	16.4
2005	58.3	29.0	38.1	25.8	89.1	32.2
2006	55.2	24.7	44.8	36.3	67.9	13.1
2007	59.6	27.1	54.2	37.9	65.5	16.4
2008	60.6	29.8	44.8	34.4	82.0	25.1
2009	48.8	21.9	37.3	30.8	63.7	13.1
2010	67.8	34.5	44.1	32.4	104.0	36.6
2011	67.9	30.4	52.6	36.8	87.6	24.0
2012	59.9	31.7	42.2	34.4	85.0	29.0
2013	62.4	28.5	50.9	33.5	76.4	23.5
2014	51.1	26.6	38.6	36.3	67.5	16.9
2015	51.9	21.9	45.2	31.3	59.5	12.6

Subbasin 800 Future Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	74.5	36.9	86.5	56.8	64.2	16.9
1957	60.5	28.5	58.0	42.3	63.1	14.8
1958	59.9	32.1	57.8	48.4	62.0	15.8
1959	79.9	39.5	82.4	53.8	77.5	25.1
1960	61.6	30.3	54.1	39.3	70.2	21.3
1961	72.8	34.8	71.8	50.0	73.8	19.7
1962	61.4	32.3	50.1	40.7	75.2	24.0
1963	55.9	27.7	44.0	34.6	70.9	20.8
1964	93.9	42.9	99.5	57.4	88.6	28.4
1965	54.7	29.0	44.4	37.9	67.4	20.2
1966	66.4	34.0	67.1	49.5	65.8	18.6
1967	68.2	32.6	86.6	54.4	53.7	10.9
1968	73.4	35.8	68.6	45.9	78.4	25.7
1969	75.1	35.6	65.8	44.0	85.7	27.3
1970	58.3	30.1	48.3	40.7	70.3	19.7
1971	79.5	40.0	93.3	59.3	67.7	20.8
1972	84.4	42.6	66.4	48.6	107.2	36.6
1973	47.5	26.0	38.0	35.7	59.3	16.4
1974	87.6	42.2	96.4	59.9	79.7	24.6
1975	63.9	34.0	60.5	46.7	67.6	21.3
1976	89.3	43.2	78.7	49.7	101.4	36.6
1977	61.8	34.5	33.8	32.4	112.6	36.6
1978	83.6	41.6	71.7	48.4	97.4	35.0
1979	56.1	29.3	43.7	35.7	72.1	23.0
1980	72.7	38.5	59.5	45.9	88.9	31.1
1981	69.1	35.9	44.6	35.7	106.8	36.1
1982	77.7	39.5	72.7	52.2	83.0	26.8
1983	72.3	37.8	66.0	48.4	79.2	27.3
1984	56.9	29.8	42.4	33.3	76.4	26.2
1985	72.6	34.5	58.7	39.6	89.7	29.5
1986	69.9	35.1	59.0	44.0	82.9	26.2
1987	62.9	29.6	63.5	44.5	62.2	14.8
1988	54.3	29.5	33.3	30.6	88.7	28.4
1989	62.4	32.9	75.9	53.8	51.4	12.0
1990	59.2	31.2	50.5	42.9	69.5	19.7
1991	74.8	33.4	83.5	48.4	67.0	18.6
1992	63.4	30.3	58.8	38.8	68.3	21.9
1993	59.3	36.2	26.7	24.7	131.0	47.5
1994	47.7	25.8	39.1	37.9	58.1	13.7
1995	71.2	34.2	67.5	44.5	75.1	24.0
1996	87.6	42.1	70.0	46.4	109.6	37.7
1997	99.1	49.3	82.2	57.1	119.3	41.5

Subbasin 800 Future Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	71.8	35.3	78.0	53.8	66.0	16.9
1999	83.8	40.0	85.5	53.8	82.2	26.2
2000	70.4	33.3	75.0	49.7	66.1	16.9
2001	57.9	29.6	43.3	34.1	77.4	25.1
2002	75.6	34.5	89.6	52.2	63.8	16.9
2003	50.2	27.7	43.5	44.5	57.9	10.9
2004	61.6	33.1	60.1	47.0	63.1	19.1
2005	71.1	36.2	52.8	37.9	95.6	34.4
2006	68.1	32.6	64.9	48.4	71.4	16.9
2007	72.0	35.3	73.8	48.9	70.3	21.9
2008	74.9	38.0	63.1	47.5	88.9	28.4
2009	56.4	27.4	48.3	37.4	65.9	17.5
2010	87.9	41.9	67.5	44.5	114.3	39.3
2011	87.6	41.1	80.3	50.5	95.5	31.7
2012	72.7	39.6	56.1	45.4	94.2	33.9
2013	78.7	37.8	79.2	50.5	78.2	25.1
2014	59.5	32.9	47.2	42.9	74.8	23.0
2015	60.9	29.3	62.3	43.4	59.5	15.3

Subbasin 900 Future Fecal Coliform Exceedances

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1956	60.8	29.0	62.4	42.1	59.2	15.8
1957	52.2	23.8	44.9	33.5	60.8	14.2
1958	51.7	27.1	44.5	40.1	60.1	14.2
1959	64.9	31.2	59.7	40.7	70.6	21.9
1960	53.2	24.6	43.2	32.2	65.3	16.9
1961	61.7	28.8	54.9	39.6	69.4	18.0
1962	53.3	26.0	40.4	31.9	70.2	20.2
1963	50.9	21.6	37.6	25.3	68.9	18.0
1964	75.1	35.2	71.0	44.8	79.4	25.7
1965	47.1	25.5	34.6	32.4	64.1	18.6
1966	57.6	28.8	52.5	39.0	63.1	18.6
1967	57.6	27.1	63.3	46.2	52.4	8.2
1968	60.3	30.3	51.9	37.7	70.0	23.0
1969	61.8	28.2	50.9	33.0	75.0	23.5
1970	51.1	23.6	39.1	31.9	66.7	15.3
1971	63.6	34.8	65.1	50.0	62.1	19.7
1972	67.4	36.1	51.7	38.8	87.9	33.3
1973	42.5	21.1	31.7	26.9	56.8	15.3
1974	70.0	33.7	68.6	47.3	71.4	20.2
1975	53.9	26.0	47.0	34.1	61.7	18.0
1976	70.7	36.6	57.9	41.5	86.4	31.7
1977	52.5	30.1	29.0	26.4	94.8	33.9
1978	69.1	35.6	56.0	37.4	85.2	33.9
1979	49.7	24.7	36.6	28.0	67.4	21.3
1980	59.9	31.7	45.3	35.0	79.3	28.4
1981	58.3	29.9	37.1	29.7	91.5	30.1
1982	61.8	32.6	52.5	39.6	72.6	25.7
1983	57.9	32.3	48.1	38.5	69.6	26.2
1984	48.1	25.7	34.2	27.3	67.8	24.0
1985	59.3	27.7	45.2	30.8	77.7	24.6
1986	58.2	28.5	45.6	33.5	74.2	23.5
1987	53.9	23.8	48.9	34.6	59.4	13.1
1988	47.7	26.0	28.1	26.2	80.8	25.7
1989	54.1	26.8	56.0	42.9	52.2	10.9
1990	50.7	26.8	38.8	35.2	66.2	18.6
1991	61.2	27.1	59.6	38.5	62.9	15.8
1992	54.5	25.7	46.5	31.7	64.0	19.7
1993	50.5	32.3	24.3	20.9	104.7	43.7
1994	43.1	20.8	32.6	29.7	56.9	12.0
1995	59.2	28.2	50.2	34.6	69.7	21.9
1996	68.1	36.1	49.8	37.7	93.1	34.4
1997	77.1	41.4	59.8	45.1	99.3	37.7

Subbasin 900 Future Fecal Coliform Exceedances (cont.)

Water Year	Existing Gmean	Existing % > 100	Existing Gmean Wet	Existing % > 100 Wet	Existing Gmean Dry	Existing % > 100 Dry
1998	59.6	28.8	58.3	42.9	60.9	14.8
1999	67.8	33.7	61.6	42.3	74.7	25.1
2000	60.2	27.9	57.0	38.8	63.6	16.9
2001	50.4	24.1	35.8	26.9	70.8	21.3
2002	61.4	28.2	62.6	40.7	60.1	15.8
2003	44.1	21.4	33.9	33.5	57.4	9.3
2004	52.4	27.3	45.9	36.1	59.8	18.6
2005	60.8	30.1	42.9	29.1	86.0	31.1
2006	57.9	27.1	49.6	40.1	67.5	14.2
2007	60.6	27.7	55.9	37.4	65.8	18.0
2008	61.3	30.6	47.8	36.6	78.4	24.6
2009	48.1	23.0	38.0	31.9	60.9	14.2
2010	69.1	34.0	49.9	33.0	95.6	35.0
2011	71.3	33.4	59.7	39.0	85.1	27.9
2012	60.2	33.3	44.1	35.5	82.2	31.1
2013	62.8	32.3	56.5	40.1	69.9	24.6
2014	49.4	26.8	37.1	36.3	65.6	17.5
2015	51.6	23.8	47.2	34.6	56.4	13.1