CHAPTER 5.
WATER QUALITY

5.1 EXISTING WATER QUALITY DATA

The detailed listings of the Washington Department of Ecology's 1998 and 1994 *Washington State Water Quality Assessment; Section 305(b) Reports* were used to review beneficial uses and impairments of Patterson Creek. The 1998 *303(d) List of Impaired and Threatened Waterbodies* is the current list for water quality impairment status.

Data from 11 King County sampling stations and from one Washington State Department of Ecology (WDOE) sampling station near the downstream end of the watershed (Patterson Creek near Fall City) were available for review of water quality in the Patterson Creek Basin. The gauging stations are shown in Figure 5-1.

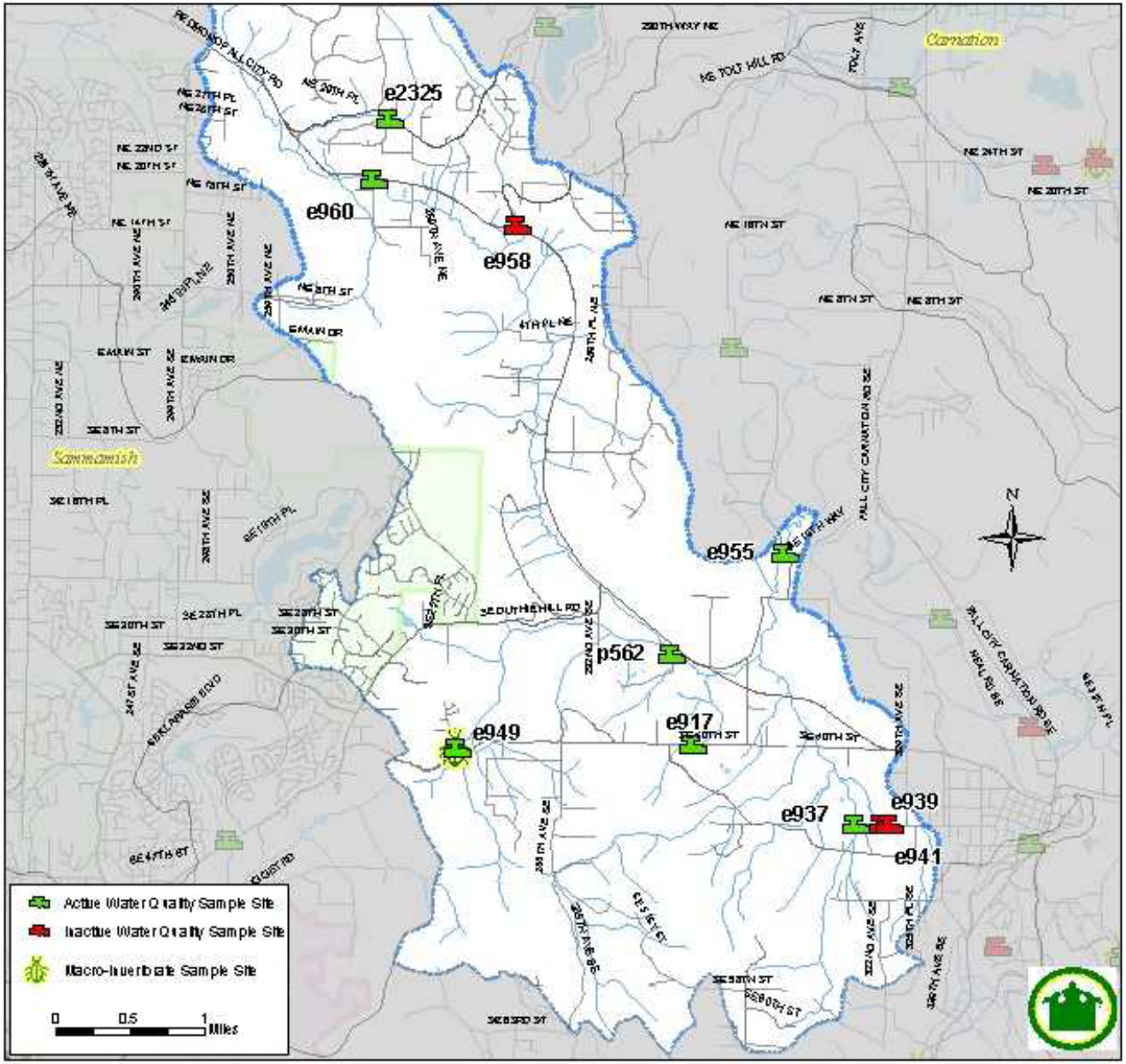
5.1.1 Water Quality Standards

Patterson Creek near Fall City is classified as a Class A freshwater stream under Washington Administrative Code (WAC) 173-201A. Table 5-1 lists water quality standards that apply to Class A waters. Characteristic uses for Class A streams include the following:

- Water supply
- Stock watering
- Fish and shellfish habitat, fishery, and migration
- Recreation
- Commerce and navigation.

State water quality standards may change in the near future. The WDOE issued a final rule on July 1, 2003; the U.S. Environmental Protection Agency and other federal agencies must approve the rule before it becomes effective, which may take several months. It does not appear that the changes in standards would materially affect conclusions about water quality in the Patterson Creek Basin. It may be desirable to update the water quality review after final adoption of the proposed new standards and the gathering of additional data.

Under the proposed new standards, the Patterson Creek Basin is designated for salmon spawning and rearing aquatic use, all primary contact uses, all water supply uses, and all other miscellaneous uses, as an undesignated tributary of the Snoqualmie River (i.e., as a tributary, Patterson Creek has the same designation as the Snoqualmie River, unless otherwise noted). Freshwater salmon spawning and rearing requirements would be more stringent than the Class A requirements in the standard for dissolved oxygen (the proposed minimum concentration is 9.5 mg/L, with a one-day minimum of 7 mg/L) and temperature (the proposed maximum is 16°C). The proposed bacteria indicator will change from fecal coliform, to E. coli, with a threshold of 100 colonies per 100 mL.



Patterson Creek

Figure 5-1

TABLE 5-1.
CLASS A CRITERIA FOR FRESHWATER STREAMS

Water Quality Parameter	Requirement
Fecal coliform	Shall not exceed a geometric mean value of 100 colonies/100 ml, and shall not have more than 10% of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 ml.
Dissolved Oxygen (DO)	Shall exceed 8.0 mg/L
Total Dissolved Gas	Shall not exceed 110 percent of saturation
Temperature	Shall not exceed 18.0°C due to human activities. When natural conditions exceed 18.0°C, no activities will be allowed that increase water temperature by more than 0.3°C.
pH	6.5 to 8.5, with human-caused variation of less than 0.2 units
Turbidity	Shall not exceed 5 NTU (nephelometric turbidity units) over background when background is 50 NTU or less, or have more than a 10% increase in turbidity when the background turbidity is more than 50 NTU.
Toxic, Radioactive or Deleterious Materials	Specific criteria per WAC 173-201A-(040-050)
Aesthetic Values	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

Source: Chapter 173-201A WAC

Water supply uses include agriculture, which has a conductivity standard (not to exceed 700 microsiemens per centimeter). Data on specific conductance was available but is not reported in this chapter, since some of the measurements were inconsistent, and the criteria for specific conductance in WAC 173-201A are not yet effective. Generally, high specific conductance indicates the presence of salts or other materials from natural or manmade sources, or tidal influence.

The standard for total suspended solids (TSS) would be 75 mg/L. TSS measurements were not observed in King County data. No information was available from the sources reviewed on aesthetics, or toxic, radioactive, or deleterious materials.

Patterson Creek is under a TMDL (total maximum daily load) plan for fecal coliform, ammonia-nitrogen, and biochemical oxygen demand (BOD). The WDOE proposed the listing in 1994, and approval was granted by the U.S. Environmental Protection Agency in 1996. The existence of a TMDL plan means that water discharges are subject to limitations for specific parameters established by the EPA.

Patterson Creek was previously listed as an impaired waterbody in the 1994 303(d) list. Since the approval of the TMDL in 1996, Patterson Creek is no longer listed; however, the TMDL plan is still in place.

The WDOE provides a Water Quality Index (WQI) based on monitoring done by WDOE's Stream Monitoring Unit. The WQI may not be consistent with WDOE's 303(d) listing because they use different data sources. Based on the water year 1996 assessment, the overall water quality at station 07P070 near Fall City was of moderate concern.

5.1.2 Water Quality Sampling Data

Table 5-2 summarizes the sampling data from the King County and WDOE sampling stations. Sampling observation periods among the King County stations varied from one to three years between January 1999 to December 2001. The WDOE data were collected in 1995-96. Four of the County sampling stations encountered occasional dry conditions. Table 5-2 provides flow-based results for comparison with the total results. All sampling stations had excursions beyond the Class A criteria, some more substantially than others. The sampling data showed seasonal variation of water quality measurements. Excursions were more pronounced under the proposed new salmon spawning and rearing standards.

Dissolved oxygen minimums during flow conditions were below 8.0 mg/L at 10 of the sampling stations, and Station E960 had a minimum DO level at the 8.0 mg/L lower limit. Average DO was below the 8.0 mg/L lower limit for Stations E939 and E960. All stations had minimums below the proposed new standard of 9.5 mg/l.

Five stations (E2325, E939, E941, E949, and E960) had minimum pH readings below the 6.5 lower limit during flow conditions. Three stations (E937, E955, and E958) had minimums at or near the 6.5 lower limit.

Average and maximum temperatures were below the Class A standard of 18°C, but several exceeded the 16°C proposed standard for salmon spawning and rearing streams. Stations E917 and E937 had maximum temperatures approaching 18°C (16.7°C and 17°C, respectively), and stations E2325, E917, E937, E941, E955, E960, P562 had maximum temperature approaching or exceeding the 16°C (ranging from 15.1°C to 17.0°C).

Average turbidity was relatively high at three locations (E917, E939, and E958), with mean counts of 7.1, 15.3, and 7.3 NTU (nephelometric turbidity units), respectively, during wet conditions. Most locations showed higher occasional turbidity, some significantly so, during rain conditions. Some higher turbidity readings occurred during stagnant (wet but no flow) conditions. Station E939 had a maximum turbidity of 122 NTU during stagnant water conditions in August 1999.

Fecal coliform was observed at the WDOE station. The geometric mean was 103 colonies per 100 ml, which was just above the 100 colonies/100 ml standard. The 90th-percentile value was 450 colonies per 100 ml. More than 10 percent of the measurements were over 200 colonies per 100 ml (three measurements out of 11). A number of exceedances of the fecal coliform threshold were observed at station 07P070 (on Patterson Creek near Fall City) between October 1995 and August 1996. WDOE station 07P070 also had limited data on ammonia-nitrogen; most measurements were below the detection limit (<0.01 mg/L).

TABLE 5-2.
PATTERSON CREEK BASIN SAMPLING SITES

Site	DO (mg/L) (A>8.0, SS>9.5[b])	PH (6.5-8.5[b])	Water Temp (^{o}C), (A<18^{o} SS<16^{o}[b])	Turbidity (NTU [a]) (<=5 NTU over existing[b])	Fecal Coliform (colonies per 100 ml[c])
E2325					
Mean	7.8	5.4	7.2	1.3	NA
Maximum	13.5	8.1	15.0	19.0	NA
Minimum	-1.0	-1.0	-1.0	-1.0	NA
E2325(wet)					
Mean	10.3	7.2	9.6	2.0	NA
Maximum	13.5	8.1	15.0	19.0	NA
Minimum	6.4	6.2	5.3	0.0	NA
E917					
Mean	11.0	7.4	10.1	7.1	NA
Maximum	13.6	7.9	16.7	82.0	NA
Minimum	7.5	6.7	3.1	0.0	NA
E937					
Mean	10.4	7.3	10.1	4.9	NA
Maximum	14.1	8.0	17.0	50.0	NA
Minimum	5.8	6.5	2.5	0.0	NA
E939					
Mean	6.9	6.5	8.8	14.3	NA
Maximum	11.8	7.7	15.8	122.0	NA
Minimum	-1.0	-1.0	-1.0	-1.0	NA
E939(wet)					
Mean	7.4	7.0	9.5	15.3	NA
Maximum	11.8	7.7	15.8	122.0	NA
Minimum	0.8	6.4	4.9	0.0	NA
E941					
Mean	8.2	6.7	9.0	3.3	NA
Maximum	13.1	7.8	16.4	21.0	NA
Minimum	-1.0	-1.0	-1.0	-1.0	NA
E941(wet)					
Mean	8.8	7.2	9.7	3.6	NA
Maximum	13.1	7.8	16.4	21.0	NA
Minimum	1.2	6.4	5.2	0.0	NA
E949					
Mean	10.3	7.5	9.7	1.9	NA
Maximum	14.0	8.1	14.8	17.0	NA
Minimum	5.9	6.4	1.8	0.0	NA
E955					
Mean	10.6	7.3	10.1	5.6	NA
Maximum	13.4	8.1	15.8	34.0	NA
Minimum	7.6	6.6	2.7	0.0	NA
E958					
Mean	10.2	7.2	9.1	7.1	NA
Maximum	15.0	8.1	13.6	27.0	NA
Minimum	-1.0	-1.0	-1.0	-1.0	NA

TABLE 5-2.
PATTERSON CREEK BASIN SAMPLING SITES

Site	DO (mg/L) (A>8.0, SS>9.5[b])	PH (6.5-8.5[b])	Water Temp (°C), (A<18° SS<16°[b])	Turbidity (NTU [a]) (<=5 NTU over existing[b])	Fecal Coliform (colonies per 100 ml[c])
E958(wet)					
Mean	10.5	7.3	9.3	7.3	NA
Maximum	15.0	8.1	13.6	27.0	NA
Minimum	2.8	6.5	3.5	0.0	NA
E960					
Mean	6.0	7.0	9.8	2.0	NA
Maximum	12.5	7.9	15.5	14.0	NA
Minimum	0.5	5.9	1.6	0.0	NA
P562					
Mean	10.1	7.3	10.1	4.9	NA
Maximum	12.3	7.9	15.1	30.0	NA
Minimum	8.0	6.8	3.0	0.0	NA
Ecology 07P070 (Near Fall City)					
Mean[d]	9.6	7.1	9.4	4.0	103
Maximum	11.1	7.4	13.0	11.0	550
Minimum	7.9	6.9	4.1	2.2	23
90th %-tile[e]					450

Note: Minimum measurement of -1.0 indicates dry condition in some measurements.

a. NTU = nephelometric turbidity units

b. Freshwater salmon spawning and rearing requirements (SS) would be more stringent than the Class A (A) requirements in the standard for dissolved oxygen (the proposed minimum concentration is 9.5 mg/L, with a one-day minimum of 7 mg/L) and temperature (the proposed maximum is 16°C). Standard is unchanged from Class A requirement for pH and turbidity

c. Fecal coliform standard will change to an e. coli standard

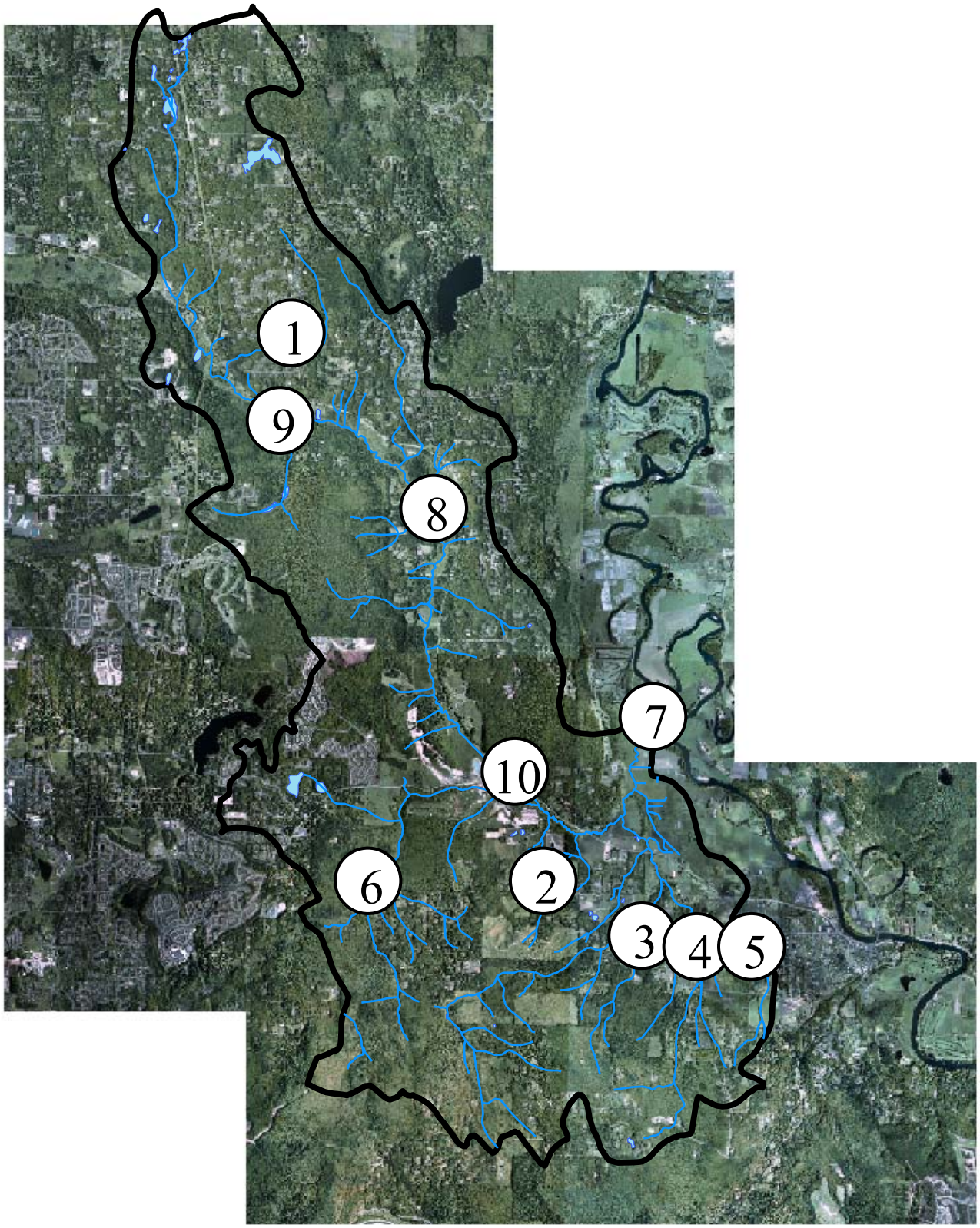
d. Geometric mean

e. Percentile values for fecal coliform only

5.2 POTENTIAL POLLUTANT SOURCES

Materials reviewed to identify potential pollutant sources included King County aerial photographs, zoning, land cover data, sensitive areas map data, and WDOE water quality data. Nearby conditions that could affect surface water quality are listed in Table 5-3. Figure 5-1 shows locations of King County sampling stations, indexed to Table 5-3, and surrounding land uses. In addition to the information in Table 5-3, the following possible pollutant sources indicated by WDOE for the 1994 303(d) listing may still contribute to the water quality excursions noted above:

- Agriculture



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PATTERSON CREEK POTENTIAL SOURCES

Figure 5-2

- Pasture land
- Animal holding, management area
- Manure lagoons
- Channelization
- Removal of riparian vegetation
- Streambank modification/destabilization

TABLE 5-3.
POTENTIAL POLLUTANT SOURCES

Site	Nearby Conditions/Potential Sources
E2325	Some residential development. Near or in erosion hazard area.
E917	Rural residential/agricultural area. Near or in erosion hazard area.
E937	Rural residential/agricultural area. Erosion hazard area upstream.
E939	Rural residential/agricultural area. Erosion hazard area upstream.
E941	Rural residential/agricultural area. Erosion hazard area upstream.
E949	Rural residential/agricultural area. Near or in erosion hazard area.
E955	Agricultural area.
E958	Rural residential/agricultural area. Near major road. Near or in erosion hazard area.
E960	Rural residential/agricultural area. Near major road. Near or in erosion hazard area.
P562	Rural residential/agricultural area. Near major road, erosion hazard area.

Since the WDOE sampling station was near the downstream end of the basin, the above list could apply to upstream locations in the basin. The sources noted by WDOE may contribute nutrients, BOD, fecal coliform, temperature, and turbidity.

Other possible causes of turbidity and pollutants could include first-flush runoff and erosion hazard areas. Other potential nearby sources include farmlands, residences, and roads.

5.3 CONCLUSIONS

Patterson Creek has impaired water quality, and is under a TMDL water quality action plan. The most significant water quality problems, for which the TMDL was developed, are fecal coliform, ammonia-nitrogen, and BOD. Data for fecal coliform and ammonia-nitrogen were not available from King County stations, and were partially available from the WDOE station near Fall City. Fecal coliform, ammonia-nitrogen, and BOD are nutrient-related parameters, and could be related to agricultural and residential activities and conditions,

such as livestock, use of fertilizers, septic system problems, cross connecting sewers, and other sources.

The widespread condition of low DO concentrations makes it difficult to draw specific conclusions. The BOD problem may be contributing to the low DO levels in the valley floor area, where farmlands are present nearby (E958, E939, E941, E955, 07P070). DO levels approaching or going below the threshold were also observed, however, in locations in the middle and upper basin (E2325, E917, E937, E949, E960, P562, 07P070). These upper locations may have low DO concentrations due to localized conditions, such as from lack of riparian cover, nearby road surface runoff, or streambank modification or destabilization.

Measured pH levels also approached or were below the minimum threshold at many locations. The low pH incidences may be caused by agricultural production (acidity), organic matter (acidity) or minerals (acidity or alkalinity). There are substantial deposits of peat in the middle reaches of the stream, which contribute to the acidity and turbidity. In view of the mixture of rural and suburban conditions and erosive soils in some upstream locations in the Patterson Creek Basin, agricultural production, mineral and organic sources could all be potential factors in the pH variances.

Rain and high-flow conditions could cause erosion and temporary increased turbidity. During dry or low-flow conditions, the presence of nutrients may cause algae blooms, but this has not been verified.

Potential temperature problems are indicated. All stations had average and maximum temperatures below the Class A standard of 18°C. If the stricter 16 degree C standard is implemented, then many stations will be in violation.

5.4 RECOMMENDATIONS FOR ACTION AND SAMPLING

Additional sampling is recommended for TMDL-related parameters: fecal coliform, BOD, and ammonia-nitrogen. Industrial discharge permits for activities in the basin could also be examined for compliance with TMDL requirements. Agricultural activities should be reviewed for effects on fecal coliform, BOD, and ammonia-nitrogen loading. Also recommended is an evaluation of the potential for streambank and riparian protection and restoration project, to improve dissolved oxygen conditions for salmonid habitat purposes.

In a broader approach to monitoring, National Pollutant Discharge Elimination System (NPDES) industrial discharge permits for activities in the basin could also be examined for compliance with water quality requirements. This would include NPDES permits for construction stormwater, industrial stormwater, and industrial wastewater discharge. While such permits are under the jurisdiction of the Department of Ecology, King County has a natural interest in monitoring the potential pollution sources that may affect surface water quality.

In a broader approach to mitigation and control of water quality impacts, King County could also consider drainage requirements that work with the rural conditions still found in much of the Patterson Creek basin. This could include review of low impact and other innovative practices for rural implementation, as part of the planned Surface Water Design Manual update.