CHAPTER SEVEN

Water Quality Analysis

7.1 INTRODUCTION

Chapter Seven provides an analysis of the water quality information and problems described in Chapter Four, "Current and Future Conditions", and Chapter Five, "Identification of Problems." Section 7.2 summarizes the identified water quality problems and their likely causes. Section 7.3 discusses the water quality concerns and management needs for the numerous lakes in the planning area. Section 7.4 recommends potential solutions to the water quality problems. The recommended solutions include a range of programmatic measures and capital improvement projects.

7.2 EXISTING WATER QUALITY PROBLEMS REVIEW

TABLE 7-1 lists the water quality problems identified during basin characterization. These problems were identified based on a variety of sources as discussed in Chapter Five.

TABLE 7-1
Water Quality Problems in the Nisqually River Basin Planning Area

			Parameter of Concern				
Problem ID	**Location**	**Description**	**Bacteria**	**Phosphorus**	**Suspended Solids**	**Temperature**	**Other**
ASH-03	Near Nisqually River south of National Park.	Reports of off-road vehicles in streams.			X		
ASH-04	Creek crossing Mt Tacoma Canyon Rd approx 1 mile east of intersection with SR 706	Channel/bank erosion; clearing/logging near stream; construction in or near stream.			X		
ASH-05	31313 Mt. Tacoma Canyon Rd E	Septic/drain field problems[1]	X				
ASH-06	Creek crossing Mt Tacoma Canyon Rd approx 500 m northeast of intersection with SR 706	Cloudy water reported in streams/ditches.			X		
BRI-20	Brighton Creek Sub-basin	Septic/drain field problems[1]	X				
BRI-22	Brighton Creek Sub-basin	Septic/drain field problems[1]	X				

TABLE 7-1
Water Quality Problems in the Nisqually River Basin Planning Area

			Parameter of Concern				
Problem ID	**Location**	**Description**	**Bacteria**	**Phosphorus**	**Suspended Solids**	**Temperature**	**Other**
CLR-03	Clear Lake	High nutrient and pollutant levels. Listed on 303(d) in 1996 and 1998 for total phosphorous. Algae blooms. Septic system failures[1].	X	X			
COP-01	Copper Creek Sub-basin	Septic/drain field problems[1]	X	X			
ELB-02	North of SR 706 at Park Junction Road	Park Junction development proposed for this area could affect Elbe Creek.			X		
ELB-04	Elbe Sub-basin	Septic/drainfield problems	X	X			
ELB-05	East end of Alder Lake	Clearing/logging near water at east end of Alder Lake.			X		
HRN-02	All along lower Horn Creek, especially adjacent to Allen Rd S	Many small farms; livestock; septic failure/seepage[1]; suds in creek; septic tanks near creek.	X	X	X		
HRN-07	Horn Creek Sub-basin	Septic/drain field problems[1]	X	X			
HRN-12	Horn Creek Sub-basin	Septic/drain field problems[1]	X	X			
HRN-13	Horn Creek Sub-basin	Septic/drain field problems[1]	X	X			
HRN-15	Horn Creek Sub-basin	Septic/drain field problems[1]	X	X			
HRT-04	Hart's Creek west of Wilcox Dairy	Runoff from dairy could lead to water quality problems (fecal coliform, nutrient loading).	X	X			
HRT-05	Harts Lake Sub-basin	Septic/drain field problems[1]	X	X			
HRT-09	Harts Lake	Cloudy water in streams/ditches; Hart's Lake. Manure in/near streams; high algae. Fish kill.	X	X	X		
KRG-05	Kreger Creek Sub-basin	Septic/drain field problems[1]	X	X			
LMR-02	Meadows near confluence of Little Mashel River and Midway Creek	Cattle in watershed	X	X	X		
LMR-03	Tributary to Midway Creek, east of Alder-Cutoff Highway	Cattle in watershed	X	X	X		
LMR-04	Headwaters of Midway Creek	Cattle in watershed	X	X	X		
LYN-03	Lynch Creek adjacent to Eatonville	Cloudy water in streams/ditches; stormwater discharge/development along creek.	X	X	X		

TABLE 7-1
Water Quality Problems in the Nisqually River Basin Planning Area

			Parameter of Concern				
Problem ID	**Location**	**Description**	**Bacteria**	**Phosphorus**	**Suspended Solids**	**Temperature**	**Other**
MAL-02	Lower Mashel River, approx 0.7 mile reach beginning at the confluence with the Nisqually River	303(d) violation for temperature				X	
MAL-06	Lower reach of Mashel River (~1.5 miles from Eatonville)	Cloudy water in streams/ditches			X		
MAM-02	Middle Mashel River, approx 3 mile reach east of railroad tracks east of Eatonville	303(d) violation for temperature				X	
MUR-04	Murray Creek in the vicinity of the gravel pit, west of SR 507	Reports of off-road vehicles in streams.			X		
MUR-07	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
MUR-08	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
MUR-13	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
MUR-16	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
MUR-25	336th St S between 78th Ave S and Locke Drive	Clearing, logging, and construction in or near streams. Debris and blockages of the drainage.			X		
MUR-29	Murray Creek Sub-basin	Septic/drain field problems[1]	X	X			
NIS-03	Nisqually River (Township/Range/Section: 18N, 01E, 08)	Listed on state 303(d) for fecal coliform, temperature and chromium in 1998.	X			X	X
OHL-02	Lower Ohop Creek, primarily the lowest 0.75 miles	Low BIBI scores (County Site 29, Tribe Site 107) and elevated water temperatures. Lower portion listed under 303(d) (fecal coliform).	X			X	X
OHL-06	Lower Ohop Creek approximately from SR 161 to confluence with Nisqually River	Low BIBI scores (County Site 29, Tribe Site 107) and elevated water temperatures.				X	X
OHU-04	Ohop Lake (40502, 40314 Ski Pk Rd)	Cloudy water in streams/ditches; mass wasting; clearing/logging near stream/lake.		X	X		
OHU-07	Ohop Lake	High phosphorus levels in Ohop Lake; algae. 303(d) violation for total phosphorus.		X			
OHU-10	Tributary streams to Ohop Lake	Clearing/logging near stream/lake.			X		

TABLE 7-1
Water Quality Problems in the Nisqually River Basin Planning Area

			Parameter of Concern				
Problem ID	Location	Description	Bacteria	Phosphorus	Suspended Solids	Temperature	Other
OHU-15	Upper Ohop Sub-basin	Septic/drain field problems[1]	X	X			
OHU-19	Along Twentyfive Mile Cr approximately 500 meters upstream from confluence with Ohop Creek	Cattle in stream	X	X	X		
RED-01	Nisqually River outlet to Puget Sound	Nisqually Beach closed by DOH for biotoxins or pollution.	X				
RED-02	Estuary parallel to the Nisqually Estuary a few hundred meters to the east	Red Salmon Creek on state 303(d) list in 1998 for exceeding fecal coliform standards.	X				
TWU-05	Rapjohn Lake	High turbidity of runoff from adjacent property that is being cleared for timber.			X		
TWU-17	Upper Tanwax Creek	Manure in/near streams. Cattle, pastures, houses and barns in the valley.	X	X			
TWU-18	Upper Tanwax Sub-basin	Septic/drain field problems[1]	X	X			
TWU-20	Upper Tanwax Creek	High turbidity, sediments. Cloudy water in streams/ditches.			X		
TWU-26	Tanwax Lake	Septic failure/seepage[1]; cloudy water in streams/ditches; channel/bank erosion; oil, litter, algae.	X	X			
TWU-30	Upper Tanwax Sub-basin	Septic/drain field problems[1]	X	X			
TWU-32	Benbow Dr E at Lake Whitman	Cloudy water in streams/ditches; channel/bank erosion at Whitman Lake.			X		

[1]According to the TPCHD, septic/drainfield failures are usually repaired soon after the problems have been identified. Thus, the specific system failures listed above have probably been corrected. However, the failures may be indicative of the potential for other systems in the area to fail due to age, soil, water table, or other local conditions.

As shown in *TABLE 7-1*, the most common water quality problems in the Nisqually River Basin planning area are elevated levels of fecal coliform bacteria, phosphorus, suspended solids, and water temperatures.

The water quality problems in the planning area are primarily associated with rural land use activities and non-point sources, such as failing septic systems, livestock waste, land clearing, construction, logging, and off-road vehicle use. Stormwater runoff is also a potential pollution

source in several portions of the planning area. Sections 7.2.1 through 7.2.4 below discuss the fecal coliform, phosphorus, suspended solids, and water temperature problems and their likely sources or causes.

7.2.1 Fecal Coliform Problems

Fecal coliform bacteria come from feces of warm-blooded animals. Common sources of fecal coliform are failing septic systems, livestock, pets, and wildlife (e.g., birds, rodents). High fecal coliform levels may indicate a health risk to people who come into contact with contaminated water through recreational uses (swimming and boating) or ingest it.

Septic system effluent typically contains high concentrations of bacteria. Septic system drainfields tend to clog over time. Severe clogging can result in surface failures and allow inadequately treated effluent to flow overland into lakes and streams, with little contaminant removal en route. In general, the risk of failure is generally greater for older systems.

Septic system failures are a common problem in the basin planning area because many of the rural houses were originally built as part-time residences. In recent years they have been converted to full-time residences. In particular, septic systems serving shoreline homes may provide inadequate treatment if the water table is high or if they are too close to the surface water body. Lack of maintenance can also lead to inadequate treatment. Problem identification sources such as the County's Service Response System and the basin resident questionnaire reported 23 incidents of septic system failures. Of these, five were reported in the Murray Creek subbasin, and five were reported in the Horn Creek subbasin. The remaining 13 were dispersed throughout the other subbasins in the planning area.

Because the basin is largely rural, there is a significant amount agricultural land use. Both commercial livestock operations and hobby farms are common. During the basin characterization, several agricultural sites were noted that could be significant sources of fecal pollution:

- Hobby farms in the Red Salmon Creek subbasin
- Hobby farms in the Horn Creek subbasin
- Hobby farms in the Tanwax Creek subbasin
- Wilcox Dairy Farm near Harts Lake
- Cattle grazing and dairy farms (since closed) in the lower Ohop Creek subbasin
- Cattle in streams in the upper Ohop Creek subbasin
- Cattle grazing in the Little Mashel River subbasin

Current and past 303(d) listings indicate elevated fecal coliform levels in the Nisqually River (lower reaches), Red Salmon Creek, and Ohop Creek. In addition, the Washington State Department of Health has closed the Nisqually Reach adjacent to the mouth of the Nisqually River and McAllister Creek to harvesting of shellfish due to high fecal coliform. A report produced by the Nisqually Tribe (Whiley and Walter, 1998) also suggests that the Mashel River contains significant levels of fecal coliform.

Ecology submitted the Nisqually Watershed bacteria and dissolved oxygen TMDL (Water Cleanup Plan) in June 2005. The TMDL encompasses the Red Salmon Creek and Ohop Creek subbasins, which were listed for fecal coliform bacteria only (i.e., not dissolved oxygen). In May 2007, Ecology published the Water Quality Implementation Plan that prescribes the specific actions to attain the load reductions required by the TMDL. Details from the Ecology's TMDL report and implementation plan are summarized below:

- ***Red Salmon Creek*** –The Nisqually Tribe sampled Red Salmon Creek at river mile 1.40 for a number of parameters, including fecal coliform bacteria, from July 1993 - April 1995. During that period, there was a significant positive correlation between the two-day antecedent rainfall and fecal coliform levels. Fecal coliform concentrations were chronically elevated, and some of the highest median fecal coliform levels were seen during storm events (Whiley and Walter, 1996).

  Red Salmon Creek and its tributaries above river mile 1.4 are considered fresh water bodies. The state water quality criteria for "extraordinary" fresh water bodies (geometric mean fecal coliform concentration must be less than 50 colonies/100 mL, with no more than 10% of samples above 100 colonie/100 mL). From river mile 1.4 to the mouth, the marine standards apply, which call for a geometric mean less than 14 colonies with no more than 10% of samples above 43 colonies per 100 mL). During Ecology's 2002-2003 sampling, Red Salmon Creek at RM 1.44 met the freshwater standards but exceeded the marine standards for fecal coliform.. Wash Creek, a small tributary upstream of river mile 1.4 did not meet either the freshwater standard. Even if both Red Salmon RM 1.44 and Wash Creek met the extraordinary primary contact standards for freshwater, Red Salmon would not meet marine standards during the low tide period. The downstream sample sites at RM 1.4 and the unnamed tributary at RM 1.3 are both classified as marine water due to salinity, while the upstream sites are freshwater. Due to freshwater inputs of fecal coliform from upstream sources, the critical period is the low tide period annually.

  The floodplain and estuary of Red Salmon Creek have been used for cattle grazing. Ecology's TMDL report identified livestock as the primary source of bacterial pollution affecting Red Salmon Creek. In 2007, the Nisqually Tribe removed all livestock operations from the Red Salmon Creek subbasin (personal communication with Jeanette Dorner, Nisqually Tribe, 2008).

  Surface Water Management participated in the development of the Water Quality Implementation Plan for Red Salmon Creek and has committed to several programmatic actions (e.g., stormwater BMP implementation, coordination with the Pierce Conservation District) that will help protect water quality in the Red Salmon Creek subbasin (James 2007).

- ***Ohop Creek*** – A 1997 report by Whiley and Walter found that fecal coliform levels were higher at lower Ohop Creek sites (river miles 6.0, 3.3, 2.0, and the mouth) than farther upstream. During the study, the lower Ohop Creek stations received drainage from two dairy farms that have since closed (although portions of the lower Ohop Valley are still used for grazing). Significantly higher levels of fecal coliform were seen in the creek during the dry season, especially at the lower stations.

- ***Lynch Creek*** – Identified in the TMDL study as a source of bacteria to Ohop Creek below the lake. Stormwater is believed to be a primary contributor of bacteria to Lynch Creek. Stormwater from a large portion of the Town of Eatonville is conveyed to Lynch Creek via a large channel. Eatonville has recently purchased land adjacent to the lower reach of the stormwater channel (i.e., just above its confluence with Lynch Creek), which could serve as the site for some type of regional stormwater treatment facility. The Town participated in the development of the Water Quality Implementation Plan, and has committed to (1) design a bio-filtration system to treat discharges to Lynch Creek, and (2) investigate low-impact development techniques for stormwater management (James 2007).
- The Nisqually Tribe and the Pierce Conservation District have been working on a large habitat restoration project on lower Ohop Creek. The project will include a number of elements that should enhance water quality, including riparian plantings, removal of drainage tiles, and buffers and fencing to reduce livestock access to the creek (James 2007).

Surface Water Management has committed to a number of non-structural measures designed to improve water quality in Lynch Creek and Ohop Creek (James 2007). These include:

- Provide pet owner education materials to the Town of Eatonville
- Monitor Ohop and Lynch Creeks
- Investigate bacteria sources affecting Lynch Creek
- Continue implementation of stormwater BMPs
- Complete the Nisqually River Basin Plan

Surface Water Management met with the Town of Eatonville to visit the potential site for the regional stormwater treatment facility. The County considered partnering with the Town on the design, construction, and costs for the potential stormwater facility if it was determined that the unincorporated areas of the county contributed to stormwater problems at this location. However, the tributary area to the facility lies almost entirely within the Town. Therefore, no recommendations have been made for the County to contribute at this time.

7.2.2 Phosphorus

Phosphorus plays a major role in freshwater ecosystem dynamics. Nearly all freshwater lakes are limited by phosphorus. High levels of phosphorus can lead to algal blooms and accelerated eutrophication of a lake system. Lake eutrophication is a key concern in the planning area, which contains 16 lakes. Ecology has identified three of the lakes (Ohop, Clear, and Harts) as "polluted" and listed the remaining 13 as "waters of concern" for eutrophication due to phosphorus pollution. Phosphorus can come from a variety of sources, including septic systems, livestock, and urban runoff.

Septic systems can contribute phosphorus via overland flow caused by septic system failure. As discussed in Section 7.2.1, septic system drainfields tend to clog over time, resulting in surface failures that allow inadequately treated effluent to flow overland into lakes and streams.

Septic failures have been reported for a number of locations within the Nisqually River planning area (see *Table 7-1*). Septic failures that occur in shoreline areas have the greatest potential to discharge phosphorus and bacteria to receiving waters because there is little opportunity for pollutant removal en route.

Septic systems can also contribute phosphorus via groundwater flow. Phosphorus usually moves very slowly in soil and groundwater because it adsorbs on soil particles and forms chemical complexes with low solubilities. Over a long period of time, groundwater "plumes" from shoreline septic systems can carry phosphorus to nearby lakes or streams.

Section 7.2.1 above discusses several areas where water is prone to contamination from fecal coliform bacteria from livestock and other agricultural activities. These agricultural activities may also contribute phosphorus to receiving waters. In addition, there are three areas where stormwater runoff may contribute to water quality problems, including elevated phosphorus levels:

- *Eatonville* –Much of the town's stormwater runoff drains to Lynch Creek, which has been noted as a potential water quality concern for Lynch and Ohop Creeks.
- *Upper Nisqually Valley* – Growth is expected around the communities of Elbe, National, Ashford, and near the park entrance, which could lead to increased urban stormwater runoff. In addition, a large development is planned for the Park Junction area east of Elbe.
- *Murray Creek Subbasin* – Development in the Murray Creek subbasin, particularly in the area between Roy and McKenna, could lead to increased urban stormwater runoff.

In addition to these specific areas, there is significant development around some of the lakes in the planning area such as Clear Lake, Ohop Lake, and Tanwax Lake. Other lakes with homes near the shoreline include, Alder Lake, Harts Lake, Kreger Lake, Lake Serene, Lake Twenty-Seven, Rapjohn Lake, Silver Lake, Twin Lakes, and Whitman Lake. Stormwater runoff from paved and landscaped shoreline areas could carry phosphorus and other pollutants to the adjacent lakes.

7.2.3 Suspended Sediment

High levels of suspended sediments in natural waters can be harmful to aquatic organisms and can transport pollution that adsorbs to particles. In addition, sediments can settle out in slow-moving reaches, decreasing drainage system conveyance capacity and decreasing aquatic habitat quality. Suspended sediments also increase water turbidity. Highly turbid water can be a sign of high levels of suspended sediments. Highly turbid or cloudy water was reported in at least eight locations in the planning area, including Harts Lake, Whitman Lake, Rapjohn Lake, Tanwax Creek, Lynch Creek, Ohop Lake, the Mashel River, and Hershey Creek (east of Ashford). In addition, EDT analysis indicated that high turbidity contributes to habitat impairment in the lower and middle reaches of the Nisqually River (lower reaches upstream of estuary, Whitewater, McKenna, near Wilcox).

High levels of suspended sediments are often caused by human disturbances upstream. The following potential sources of suspended sediments were identified:

- *Construction in or near Streams and Lakes* – This is potentially a problem for all areas experiencing development near streams and lakes. Basin residents specifically reported seeing an increase in turbidity in Tanwax Creek related to construction near Tanwax Lake.
- *Logging and Land Clearing* – A significant amount of logging and land clearing occurs in the basin. Some of it is related to the commercial logging industry in the eastern part of the basin, and some is related to continued residential development of rural areas. Specific problems with logging and land clearing near lakes and streams were identified in the Murray Creek subbasin (near Locke Drive), near Rapjohn Lake, near and around Ohop Lake, Hershey Creek near Ashford, and on the east end of Alder Lake.
- *Mass Wasting* – Mass wasting is large-scale, down slope movement of earth such as a land slide or the slumping of a river bank. Disturbances such as timber harvesting can lead to land instability and mass wasting events. A watershed characteristics and conditions inventory of the upper Mashel River watershed (Jones and Stokes, 1991) noted several occurrences of mass wasting, including three large debris flows. A debris flow in this case is a rapidly occurring mass wasting event that is transported primarily by water down a stream channel.
- *Off-Road Vehicle Disturbance* – Many rural portions of the planning area have problems with off-road vehicles driving outside of allowed areas, including through streams and wetland habitat. This type of disturbance can lead to erosion and increased suspended sediments. Off-road vehicle disturbance tends to be dispersed over large areas, but three specific areas were identified: 1) near the gravel pit in the Murray Creek subbasin, 2) south of Mt. Rainier National Park in the Ashford subbasin, and 3) developing areas of the Tanwax Creek subbasin.
- *Urban Development* – Increased stormwater runoff from areas of urban development can lead to increased levels of suspended sediments in receiving waters.

7.2.4 Water Temperature

Elevated water temperatures can be harmful to salmon. Water temperatures have exceeded the state standard in the Mashel River and lower Ohop Creek. Recent sampling in the Mashel River found that the temperature standard was exceeded 30% of the time at the mouth of the river and 18% of the time at river mile 60. The elevated temperatures may be related to sparse shade along the stream.

Water temperatures in lower Ohop Creek have frequently exceeded the state standard during the summer. The most frequent temperature exceedances were observed in the reach just downstream of Ohop Lake. The elevated temperatures in this reach are likely due to the discharge of warm water from the lake. Although water temperatures generally improved with distance downstream from the lake, water temperatures near the mouth have often exceeded the state temperature standard, probably due to the sparse riparian canopy along this reach.

7.3 LAKE WATER QUALITY PROBLEMS

The Nisqually River Basin planning area encompasses more than 16 lakes. *Figure 7-1* shows the major lakes in the planning area.

Much of the residential development in the planning area is concentrated around lakes, notably Clear, Ohop, and Tanwax lakes. Lakeshore development increases the potential for lake pollution due to land clearing, construction, septic systems, fertilizer and pesticide use, trash, and runoff from impervious areas.

Lakes with public boat ramps may be more susceptible to invasive weed problems.

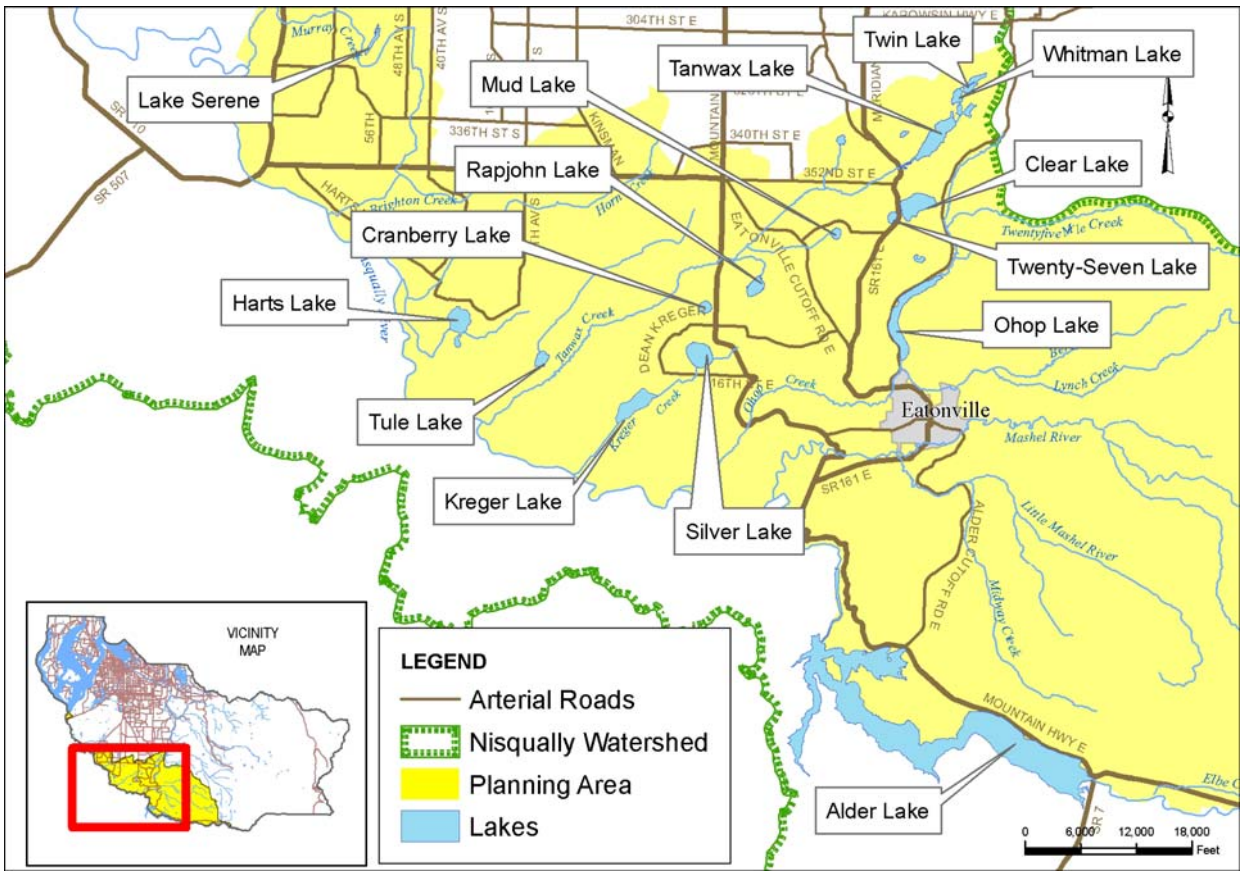

FIGURE 7-1. Lakes in the Nisqually River Basin Planning Area

Lake eutrophication is a key concern in the planning area. Ecology has identified three of the lakes (Ohop, Harts, and Clear) as "polluted" and 13 as "waters of concern" for lake eutrophication due to phosphorus pollution.

Lake eutrophication can involve a range of problems including:

- Excessive and/or invasive aquatic plant growth
- Excessive algal growth (typically due to elevated phosphorus inputs to the lake) and toxic algae (cyanobacteria) blooms
- Poor water clarity due to algal growth and/or soil eroded from the lake watershed
- Low dissolved oxygen levels caused by excessive aquatic plant growth and/or discharges of oxygen-demanding materials into the lake

Potential nutrient sources include land use activities (such as removal of native vegetation along lakeshores and tributary streams), point source discharges (such as wastewater treatment plant and industrial discharges), and non-point discharges (such as agricultural runoff, stormwater, and septic systems). Flow controls (e.g. weirs) can affect lake parameters such as temperature and suspended sediment.

Although recreational usage and aesthetic values of lakes can be impaired by excessive aquatic plant and algae growth, healthy lakes typically require some level of algae and aquatic plants. Algae are primary producers and serve as the food base for many lake organisms, including fish and benthic invertebrates. Aquatic plant communities provide oxygen for aquatic life; habitat and food for waterfowl, fish, amphibians, invertebrates, and insects; protection of the shoreline from erosive waves; and stabilization of bottom sediments from re-suspension (Cooke et al. 2005).

However, excessive algal and aquatic plant growth and its effects on water quality are the most common problems addressed in the management of shallow, eutrophic lakes (Cooke et al. 2005). Excessive algal blooms hinder lake recreation, are unsightly, and deplete lake oxygen levels during decomposition. Certain strains of blue-green algae (also known as cyanobacteria) can be toxic to people and animals if ingested; thus, algae-dominated lakes require close surveillance to ensure public safety. Aquatic plants, especially invasive species, can grow out of control in nutrient-rich lakes. Excessive aquatic plant growth similarly hinders lake recreation, is unsightly, and can negatively alter lake food webs.

The factors typically affecting the abundance and distribution of plants within lakes are nutrients, light availability, sediment characteristics, wind, and wave energy (Nichols, 2001). Algae growth is often limited by nutrient (usually phosphorus) concentrations in the water column. The cycling of phosphorus in lakes is complex and dependent upon a variety of physical, chemical, and biological factors. Generally, the addition of phosphorus to a lake will increase the rate and amount of algae production (Bachmann, 2001). However, lake size and depth control how nutrients affect algal growth.

In deeper lakes, there is generally a continual loss of nutrients from the epilimnion to the hypolimnion as algae and particulate matter die and sink to the bottom of the lake. In contrast, the frequent mixing of shallow lakes typically results in a relatively rapid return of nutrients from most settled material into the water column.

Controlling nutrient inputs to lakes is a key component in maintaining or improving lake water quality. Septic systems and runoff from agricultural land are two potential sources for nutrient inputs to lakes and contributing streams. Stormwater runoff can also contribute nutrients to lakes from fertilizers and eroded soil.

In Pierce County, the Tacoma-Pierce County Health Department is responsible for septic system design, inspection, and repair. Pierce Conservation District addresses runoff from agricultural land through voluntary landowner participation in its conservation planning program. Surface Water Management addresses stormwater quality through its NPDES MS4 permit program and basin planning. The Washington State Department of Ecology (Ecology) also supports programs to address invasive aquatic weeds and toxic algae in lakes. The control measures implemented by these agencies are described in greater detail in "Appendix I."

Once lake sediments are enriched with nutrients, addressing invasive or excessive aquatic vegetation generally requires controlling plant growth through physical, mechanical, chemical, or biological control methods. Examples of physical and mechanical control methods include hand pulling and harvesting with machines. Examples of chemical control methods include herbicides that target certain types of aquatic vegetation and alum to reduce concentrations of plant-available forms of Phosphorus. Examples of biological control methods include herbivorous fish (such as sterilized grass carp), weevils that feed on target aquatic plants, and restoration of native aquatic plant communities.

Ecology recommends that lake management groups and local governments collaborate in the development of integrated aquatic vegetation management (IAVM) plans for lakes with aquatic plant management issues. An IAVM plan evaluates the available control methods and selects the most appropriate methods for the lake conditions and management goals. Ecology generally will not issue permits for application of certain aquatic herbicides and other control techniques unless the applicant has completed an IAVM.

7.3.1 Lake Survey

As discussed in Chapter 4, little information was available for many of the lakes in the Nisqually River Basin planning area. To address this data gap, Surface Water Management conducted a survey to obtain additional information about lake water quality problems in the planning area.

A questionnaire was sent to the property owners around the 16 lakes shown in *Figure 7-1*. The questionnaire asked for information relevant to lake water quality including:

- Lake access and use
- Fish populations
- Algae blooms
- Aquatic weeds
- Water quality
- Fertilizer and lake habitat
- Septic systems
- Lake management groups
- Willingness to pay for lake management actions
- Other problems and issues

The questionnaire also asked for information about lake flooding and water level control. "Appendix F" contains a detailed description of the survey and its findings. *TABLE 7-2* summarizes the surveys findings relevant to lake water quality.

TABLE 7-2
Lake Water Quality Survey Results

Lake	Fish Kills	Algae Blooms	Aquatic Weeds	Water Quality
Alder Lake	x	x	x	
Clear Lake	x	x	x	x
Cranberry Lake	No data[1]	No data[1]	No data[1]	No data[1]
Harts Lake	x	x	x	x
Kreger Lake	No data[1]	No data[1]	No data[1]	No data[1]
Lake Serene	x	x	x	x
Lake Twenty-Seven				
Mud Lake	No data[1]	No data[1]	No data[1]	No data[1]
Ohop Lake	x	x	x	x
Rapjohn Lake				
Silver Lake	x	x		x
Tanwax Lake	x	x	x	x
Trout Lake	No data[1]	No data[1]	No data[1]	No data[1]
Tule Lake	No data[1]	No data[1]	No data[1]	No data[1]
Twin Lakes		x	x	x
Whitman Lake	x	x	x	x

[1]No completed questionnaires were received for these lakes.

The questionnaires also asked respondents to describe their specific issues or concerns. Specific issues identified included:

- For Clear Lake, one respondent described concerns related to motor boat and jet ski usage and water quality; another respondent indicated there is an aquatic weed management program in place.
- For Harts Lake, there was one complaint regarding aquatic plants (milfoil) and one complaint regarding trash left in the lake by fishermen and hunters.
- Ohop Lake has a Lake Improvement Club that has been controlling aquatic weeds using an IAVM approved by Ecology. Ohop Lake also limits water ski and jet ski activity to the period from 11:00 AM to 3:30 PM, with a speed limit of 8 mph during other hours. Ohop Lake respondents expressed concerns about sediment buildup, failing septic systems, fireworks, motor boats, and excessive populations of cormorants reducing the fish in the lake.
- On Lake Serene, one respondent noted that thick weeds preclude fishing and swimming, and that past herbicide applications were not effective in controlling aquatic plant growth.
- For Whitman Lake, four respondents expressed concern that motor boats and jet skis are damaging the lake.

The survey results indicate that most of the lakes in the Nisqually River Basin planning area have public access points, and most are used for boating, swimming and fishing. In addition, Clear Lake, Harts Lake, and Silver Lake provide water for irrigation.

Survey respondents were asked to rate the importance of lake issues. As shown in *TABLE 7-3*, water quality issues received the highest average ranking of importance and flooding issues in and around lakes received the lowest average ranking of importance. (Note: Lake-related flooding is discussed in Chapter 6 of this Basin Plan.)

TABLE 7-3
Perceived Importance of Lake Issues

Rank of Issue	Issue	Average Ranking*
1	Water Quality	1.3
2	Fish Health	1.6
3	Algae Blooms	1.7
4	Water Weeds	1.9
5	Septic System Use	1.9
6	Fertilizer Use	2.2
7	Lake Level	2.3
8	Flooding	2.8

*1 is most important and 4 is least important

7.3.2 Lake Water Quality Management Gap Analysis

A gap analysis was conducted to evaluate the existing lake management activities in the planning area and identify additional activities that would be needed for a fully functional lake management program. The gap analysis determined that a fully functional lake management program should include the following components:

1. Monitoring and Source Identification
2. Volunteer Monitoring
3. Data Management and Dissemination
4. Education and Outreach
5. Community Technical Assistance
6. Inter-Agency Coordination and Information Sharing
7. Implementation of the Aquatic Invasive Plant Program
8. Funding for Lake Projects
   a. Lake Projects: Detailed lake studies
   b. Lake Projects: In-lake control and management strategies
   c. Lake Projects: Watershed strategies
   d. Lake Projects: Provide funding for private projects
9. Enforcement
10. Legal Authority

The analysis found that Surface Water Management, the Tacoma-Pierce County Health Department, Pierce Conservation District, and the state departments of Ecology and Fish and Wildlife currently perform some, but not all, of the lake management activities listed above. *TABLE 7-4* summarizes the gaps in current activities related to the lake management program components listed above. "Appendix I" contains a detailed description of the lake management gap analysis.

TABLE 7-4
Gaps in Pierce County Lakes Program

Lake Management Component	Function	Current work	Gap/Need
Monitoring and Source Identification	Identify water quality problems (including aquatic weeds and toxic algae) and their sources or causes, track changes in water quality over time. Determine which lakes need further study or improvement.	TPCHD has 0.5 FTE to monitor 7 beaches at 4 lakes for fecal bacteria, and to respond to algae concerns on all lakes.	Limited water quality data is available for many lakes. TPCHD only reports lake water quality concerns, does not propose how to address concerns. Need additional info to organize lake management activities and determine which lakes need proposed projects for additional study and water quality improvement activities. Need to use a boat to conduct lake water quality monitoring at multiple sites in lakes (not just public access points).
Volunteer Monitoring	Train volunteers in lake monitoring techniques, collect samples from volunteers, perform testing on samples, and distribute data to public via website.	PCD Stream Team provides equipment loan of 3 lake kits to landowners.	Volunteer monitoring provides an opportunity for residents to take an active part in monitoring lake health, and provides economic and useful background data on lake functions and health. Volunteers can collect data at more frequent intervals than County staff.
Data Management and Dissemination	Make monitoring data and other program information accessible to other organizations and to the public.	TPCHD grant will be used to provide algae data on the web. PCD shares data with TPCHD.	Monitoring data needs to be accessible to other organizations and to the public. If additional monitoring is conducted, data management and dissemination will be required as well.
Education and Outreach	Perform outreach and education regarding lake-friendly landscaping, on-site sewage treatment, lake health, etc.	TPCHD, PCD, WDFW, and Ecology perform limited outreach and education. PCD provides outreach and education on watershed health and nutrient management. PCD and TPCHD distribute lake management brochures.	Additional outreach and education activities are needed to inform the public about lake issues and motivate changes to improve lake health

TABLE 7-4
Gaps in Pierce County Lakes Program

Lake Management Component	Function	Current work	Gap/Need
Community Technical Assistance	Answer questions on lake health and functions. Help lakeshore owners obtain grants, form lake management districts, and determine appropriate fees or rates. Provide technical guidance on lake projects.	TPCHD and PCD provide limited technical assistance related to lakes. PCD provides aquatic weed management advice when requested.	Lakeshore property owners and recreational users often want to know more about lake health and address problems on lakes. Assistance for these stakeholders is needed.
Inter-Agency Coordination and Information Sharing	Share information on lake management activities with other local and state agencies (e.g., TPCHD, PCD, Ecology).	Limited inter-agency coordination occurs. PCD shares data with TPCHD and communicates with Ecology.	Inter-agency coordination is needed to improve the efficiency and effectiveness of lake management activities.
Aquatic Invasive Species Management	Implement activities recommended by PCWP Invasive Vegetation project such as education, lake monitoring and management activities.	PCWP is currently conducting an Invasive Vegetation project.	Invasive aquatic species reduce recreational and aesthetic qualities of lakes and put lakes at risk for shifts in ecological functions and decreased habitat quality.
Funding for lake projects	Provide funding to implement projects to improve lake health.	None.	As a result of the Aquatic Invasive Plant Program, monitoring information, public requests, and detailed lake studies, various capital lake projects are likely to be proposed. Funding to implement these projects will be needed.
Lake Projects: Detailed lake studies	Perform detailed analysis of lake characteristics, functions, problems, and proposed projects to address problems.	None.	Costs could range from $150,000 to $400,000 or more per lake studied. There are five 1st Tier Lakes in the Nisqually Basin that could require detailed studies. Funding will be needed.
Lake Projects: In-lake control and management strategies	As a result of the Invasive Vegetation project and detailed lake studies, in-lake control and management strategies are likely to be proposed including aquatic plant harvesting or chemical control.	Ecology provides small grants for aquatic weed and algae management.	Costs could range from $10,000 to $8 million or more per lake studied and managed. Funding will be needed.

TABLE 7-4
Gaps in Pierce County Lakes Program

Lake Management Component	Function	Current work	Gap/Need
Lake Projects: Watershed strategies	As a result of the Invasive Vegetation project and detailed lake studies, watershed strategies such as stormwater treatment, agricultural runoff management, and forestry runoff management to reduce inputs of nutrients, bacteria, and other pollutants to lakes that receive stormwater runoff.	PCWP and PCD implement watershed improvements for stormwater and water quality enhancement.	Costs could range from $10,000 to $20 million or more per lake studied and managed. Funding will be needed.
Lake Projects: Funding for private projects	As a result of education, outreach, and monitoring, lakeshore owners may request assistance in retrofitting septic systems, funding in-lake treatment or management, etc.	Ecology provides small grants for aquatic weed and algae management.	Costs could range from $10,000 to $1 million or more per requested project. Funding will be needed.
Enforcement	Enforcement options may be needed to address sources of water quality problems.	Limited to none. TPCHD has ability to obtain search warrant if they have evidence that a property is discharging untreated wastewater, but this option is rarely used.	The need for additional enforcement options will be evaluated as the lake management program is implemented. No FTE staff need is currently identified.
Legal Authority	As a public agency, Pierce County requires legal authority to implement programs such as the lake management program.	Pierce County is responsible for addressing surface water quality under the NPDES MS4 program and the TMDL program.	To implement a lake management program, a County-wide ordinance may be needed to establish the program and the lake management function in Surface Water Management. This will not require on-going FTE support, however temporary initial investment by County staff of 0.1 FTE may be needed.

NOTES:
PCWP = Pierce County Surface Water Management
TPCHD = Tacoma-Pierce County Health Department
PCD = Pierce Conservation District
WDFW = Washington Department of Fish and Wildlife

7.4 POTENTIAL FUTURE PROBLEMS

As described in Chapter 4, the predominant existing land uses in the basin planning area are rural residential, agricultural and forested/open land. Most of the basin is currently zoned for forest land (eastern portion of the basin) and rural residential development (western portion of the basin). PALS staff is not aware of any planned conversions from commercial forest to subdivisions other than the Park Junction resort, between Elbe and Ashford. Outside of Eatonville, there are no subdivisions planned or vested, but there may be a few vested short plats in the planning area. However, large tracts in the planning area, such as between Ohop and Harts Lakes, are being converted from commercial timber to rural residential 20-acre parcels.

Future development in the Nisqually River planning area is expected to be relatively low density; consequently, effective impervious areas (EIAs) are not expected to increase very much. Only five of the 23 subbasins in the planning area are projected to experience EIA increases of more than 1%. Two subbasins are projected to experience EIA increases of more than 5%, the Lower Mashel River and Red Salmon Creek subbasins (see Chapter Four).

Rural zoning allows for residences, pastures and hobby farms. Further development in the rural zoning areas would increase automobile usage in the basin. These areas may have logging roads that were not intended for increased traffic and may go through critical areas. In addition, people often clear the land to improve their views. Therefore, areas that were once forested will have less trees and native vegetation, more impervious areas, and may have pets, livestock, septic systems, and increased traffic–all possible pollutant sources. The County's site development and critical areas regulations are designed to reduce the potential for adverse water quality impacts from new development.

7.5 POTENTIAL SOLUTIONS

This section describes how water quality problems identified in the Nisqually River Basin will be addressed. *TABLE 7-5* summarizes the actions recommended. Proposed programmatic measures and CIP projects are described in Chapter Nine and *Figures 9-1* through *9-8* show CIP project locations.

7.5.1 Problems Resolved or Not Addressed in the Basin Plan

During Basin Plan development, one resident reported cloudy water in a creek crossing Mt. Tacoma Canyon Rd (Problem ID ASH-06). Subsequent field investigations did not identify cloudy water or a potential source of cloudy water.

7.5.2 Maintenance and Enforcement Issues

Four reported problems were related to impacts or potential impacts from land clearing from logging and/or development. Construction plan review and site inspections are not under the purvey of Surface Water Management. These problems will be referred to Pierce County Planning and Land Services (PALS) for enforcement of County ordinances. One of these problems also included debris and blockages of a drainage. This problem can be addressed with a maintenance activity.

7.5.3 Capital Improvement Program Projects

Eleven CIP projects were developed to address water quality as well as habitat problems. Six are land acquisition projects. Some of these are agricultural lands which are sources of bacterial pollutants. Farm waste can enter streams from run-off or directly from livestock with access to the stream. Livestock access can also damage the creek channels contributing sediment. Acquiring these lands will also prevent logging and construction which can also result in sediment discharges to streams. Revegetation projects associated with land acquisition will also help stabilize streambanks and increase shading, thereby reducing suspended solids and stream temperatures. One of these projects is acquiring and preserving a wetland. Wetlands help maintain water quality through biofiltration and groundwater recharge for streams. Wetlands also reduce erosion by attenuating flow.

Four of the projects are restoration projects and one project is a revegetation project. All eleven projects will allow vegetation in riparian areas to be maintained or restored. Vegetation will provide shade and lower water temperatures.

7.5.4 Programmatic Measures

Five programmatic measures (two county-wide and three basin-specific) are recommended to protect and improve water quality:

- **PRG00-06**, Develop and Implement an Education, Outreach, and Technical Assistance Program
- **PRG00-13,** Implement Elements of Shellfish Protection Program
- **PRG00-15,** Develop and Implement a Lake Water Quality Management Program
- **PRG11-03**, Enhance Nisqually River Council Capacity
- **PRG11-04**, Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems
- **PRG11-05**, Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan

In addition to the lake water quality problems identified in Chapter 5, problems associated with the other lakes in the planning area were identified during the water quality analysis described in this Chapter. The recommended action for these lake problems is to implement the Lake Management Plan (PRG00-15).

7.5.5 Problems Requiring More Detailed Data or Analysis

No separate recommendations were made for additional studies. However, additional studies for lakes are included as part of PRG00-15 (Develop and Implement a Lake Water Quality Management Program).

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
ASH-03	Near Nisqually River south of National Park.	Reports of off-road vehicles in streams.	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
ASH-04	Creek crossing Mt Tacoma Canyon Rd approx 1 mile east of intersection with SR 706	Channel/bank erosion; clearing/logging near stream; construction in or near stream.	Problem will be referred to PALS for enforcement of development regulations.
ASH-05	31313 Mt.Tacoma Canyon Rd E	Septic/drain field problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
ASH-06	Creek crossing Mt Tacoma Canyon Rd approx 500 m northeast of intersection with SR 706	Cloudy water reported in streams/ditches.	Location investigated and a problem was not observed.
BRI-20	34414 8th Av Ct E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
BRI-22	1612 338th St E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
CLR-03	Clear Lake	High nutrient and pollutant levels. Listed on 303(d) in 1996 and 1998 for total phosphorous. Algae blooms. Septic system failures.	Develop and Implement a Lake Water Quality Management Program (PRG00-15).
COP-01	33107 Mt.Tacoma Canyon Rd E	Septic/drain field problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
ELB-02	North of SR 706 at Park Junction Road	Park Junction development proposed for this area could affect Elbe Creek.	Problem will be referred to PALS for enforcement of development regulations.

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
ELB-04	55218 Park Junction Rd E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
ELB-05	East end of Alder Lake	Clearing/logging near water at east end of Alder Lake.	Problem will be referred to PALS for enforcement of development regulations or DNR for enforcement of logging regulations.
HRN-02	All along lower Horn Creek, especially adjacent to Allen Rd S	Many small farms; livestock; septic failure/seepage; suds in creek; septic tanks near creek.	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
HRN-07	37407 S 18th Ave	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRN-12	113 354th St E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRN-13	712 358th St E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRN-15	2420 SR 702 E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRT-04	Hart's Creek west of Wilcox Dairy	Runoff from dairy could lead to water quality problems (fecal coliform, nutrient loading).	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06), and Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05).
HRT-05	41910 40th Ave S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
HRT-09	Harts Lake	Cloudy water in streams/ditches; Hart's Lake. Manure in/near streams; high algae. Fish kill.	Develop and Implement Lake Water Quality Management Program (PRG00-15), Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
KRG-05	3204 416th St E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
LMR-02	Meadows near confluence of Little Mashel River and Midway Creek	Cattle in watershed	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
LMR-03	Tributary to Midway Creek, east of Alder-Cutoff Highway	Cattle in watershed	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
LMR-04	Headwaters of Midway Creek	Cattle in watershed	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
LYN-03	Lynch Creek adjacent to Eatonville	Cloudy water in streams/ditches; stormwater discharge/development along creek.	Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan (PRG11-05).
MAL-02	Lower Mashel River, approx 0.7 mile reach beginning at the confluence with the Nisqually River	303(d) violation for temperature	Mashel River Property Acquisition (CIP20-MAL-AC01), Mashel Shoreline Buffer Acquisition (CIP20-MAL-AC02), Mashel Small Properties Acquisition (CIP20-MAL-AC03), and Mashel Eatonville Reach Riparian Revegetation (CIP20-MAL-VC01), Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Develop and Implement Countywide Vegetation Management Program, (PRG00-16).
MAL-06	Lower reach of Mashel River (~1.5 miles from Eatonville)	Cloudy water in streams/ditches	Mashel River Property Acquisition (CIP20-MAL-AC01), Mashel Shoreline Buffer Acquisition (CIP20-MAL-AC02), Mashel Small Properties Acquisition (CIP20-MAL-AC03), Mashel Eatonville Reach Instream Restoration Phase II (CIP20-MAL-RST01),
MAM-02	Middle Mashel River, approx 3 mile reach east of railroad tracks east of Eatonville	303(d) violation for temperature	Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Develop and Implement Countywide Vegetation Management Program, (PRG00-16).
MUR-04	Murray Creek in the vicinity of the gravel pit, west of SR 507	Reports of off-road vehicles in streams.	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06). Enhance Nisqually River Council Capacity (PRG11-03).
MUR-07	8513 311th St S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
MUR-08	29001 81st Ave S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
MUR-13	Hinkleman Road and 316th St S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
MUR-16	32010 72nd Ave S	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
MUR-25	336th St S between 78th Ave S and Locke Drive	Clearing, logging, and construction in or near streams. Debris and blockages of the drainage.	Culvert maintenance will be performed and problem will be referred to PALS for enforcement of development regulations.
MUR-29	8416 350th St Ct S	Septic/drain field problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
NIS-03	Nisqually River (Township/Range/Section: 18N, 01E, 08)	Listed on state 303(d) for fecal coliform, temperature and chromium in 1998.	Nisqually Mainstem Acquisition (CIP11-NIS-AC01), Enhance Nisqually River Council Capacity (PRG11-03). Develop and Implement a Program to Enhance Degraded Riparian Habitat and Water Quality (PRG00-05), and Develop and Implement Countywide Vegetation Management Program, (PRG00-16).
OHL-02	Lower Ohop Creek, primarily the lowest 0.75 miles	Low BIBI scores (County Site 29, Tribe Site 107). Lower portion listed under 303(d) (fecal coliform).	Ohop Creek Property Acquisition Phases 1 (CIP14-OHL-AC01), 2 (-AC02), and 3 (-AC03), Lower Ohop Valley Restoration Phases 1 (-RST01), 2 (-RST02) and 3 (-RST03), Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan (PRG11-05).
OHL-06	Lower Ohop Creek approximately from SR 161 to confluence with Nisqually River	Low BIBI scores (County Site 29, Tribe Site 107). Elevated water temperatures.	Ohop Creek Property Acquisition Phases 1 (CIP14-OHL-AC01), 2 (-AC02), and 3 (-AC03), Lower Ohop Valley Restoration Phases 1 (-RST01), 2 (-RST02) and 3 (-RST03).
OHU-04	Ohop Lake (40502, 40314 Ski Pk Rd)	Cloudy water in streams/ditches; clearing/logging near stream/lake.	Develop and Implement a Lake Water Quality Management Program (PRG00-15).
OHU-07	Ohop Lake	High phosphorus levels in Ohop Lake; algae. 303(d) violation for Total Phosphorus.	Develop and Implement Lake Water Quality Management Program (PRG00-15), Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
OHU-10	Tributary streams to Ohop Lake	Clearing/logging near stream/lake.	Develop and Implement a Lake Water Quality Management Program (PRG00-15).
OHU-15	38015 Orville Rd E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).

TABLE 7-5
Specific Water Quality Recommendations

Problem ID	Location	Description	Recommendation
OHU-19	Along Twenty-five Mile Cr approximately 500 meters upstream from confluence with Ohop Creek	Cattle in stream	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
RED-01	Nisqually River outlet to Puget Sound	Nisqually Beach closed by DOH for Biotoxin or pollution.	Nisqually Mainstem Acquisition Phases 1 (CIP11-NIS-AC01), 2 (-AC02), and 3 (-AC03). Implement Elements of Shellfish Protection Program (PRG00-13), Enhance Nisqually River Council Capacity (PRG11-03), Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan (PRG11-05).
RED-02	Estuary parallel to the Nisqually Estuary a few hundred meters to the east	Red Salmon Creek on state 303(d) list in 1998 for exceeding fecal coliform standards.	Nisqually Mainstem Acquisition Phases 1 (CIP11-NIS-AC01), 2 (-AC02), and 3 (-AC03). Implement Elements of Shellfish Protection Program (PRG00-13), Enhance Nisqually River Council Capacity (PRG11-03), Implement Elements of Nisqually Bacteria TMDL Water Quality Implementation Plan (PRG11-05).
TWU-05	Rapjohn Lake	High turbidity of runoff from adjacent property that is being cleared for timber.	Problem will be referred to DNR for enforcement of logging regulations.
TWU-17	Upper Tanwax Creek	Manure in/near streams. Cattle, pastures, houses and barns in the valley.	Develop and Implement an Education, Outreach, and Technical Assistance Program (PRG00-06).
TWU-18	37021 103rd Av Ct E	Septic/drain field problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
TWU-20	Upper Tanwax Creek	High turbidity, sediments. Cloudy water in streams/ditches.	Tanwax Creek Wetland Protection Phase 1 (CIP11-TWU-AC01), and Phase 2 (CIP11-TWU-AC02).
TWU-26	Tanwax Lake	Septic failure/seepage; cloudy water in streams/ditches; channel/bank erosion; oil, litter, algae.	Develop and Implement a Lake Water Quality Management Program (PRG00-15). Tanwax Creek Wetland Protection Phase 1 (CIP11-TWU-AC01), and Phase 2 (CIP11-TWU-AC02).
TWU-30	32612 Benbow Dr E	Septic/drainfield problems	Coordinate with Tacoma-Pierce County Health Department to Address Reported Septic System Problems (PRG11-04).
TWU-32	Benbow Dr E at Lake Whitman	Cloudy water in streams/ditches; channel/bank erosion at Whitman Lake.	Develop and Implement a Lake Water Quality Management Program (PRG00-15). Tanwax Creek Wetland Protection Phase 1 (CIP11-TWU-AC01), and Phase 2 (CIP11-TWU-AC02).