Salmon Creek Watershed
Bacteria and Turbidity
Total Maximum Daily Load

Submittal Report

January 2001
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Total Maximum Daily Load

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By

Dave Howard

Washington State Department of Ecology
Water Quality Program
Vancouver Field Office
2108 Grand Blvd.
Vancouver, Washington 98661-4622

Telephone (360) 690-4796

e-mail dhow461@ecy.wa.gov

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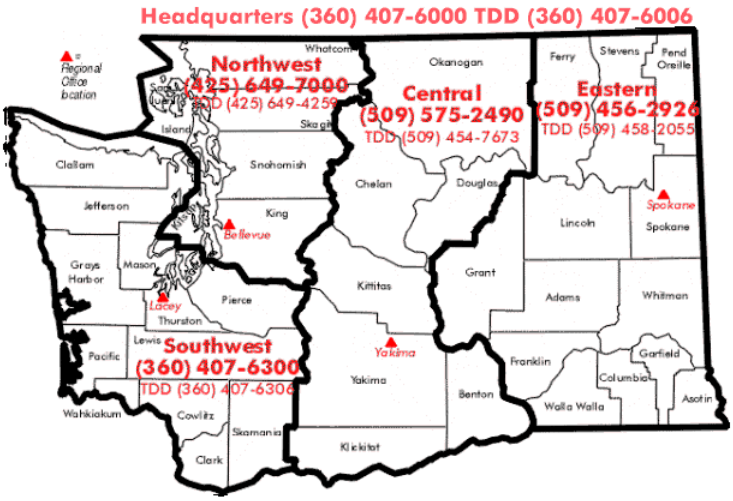

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Introduction

Clark County, the fastest growing county in the state, faces water quality challenges in the Salmon Creek watershed. The creek and its tributaries are located northeast of Vancouver and entirely within Clark County. Salmon Creek flows from the foothills of the Cascade Mountains through a mixture of small towns, small and large farms, pasture, and homes. Near the end of its journey, it meanders through a highly urbanized, developed area of Clark County and then west to Lake River, which flows into the Columbia River.

Under the Clean Water Act, every state has its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of designated uses, such as cold water biota and drinking water supply, and criteria, usually numeric criteria, to achieve those uses. When a lake, river or stream fails to meet water quality standards the Clean Water Act requires that the state place the water body on a list of "impaired" water bodies. When a water body is listed, the state is required to prepare an analysis called a Total Maximum Daily Load (TMDL). The U.S. Environmental Protection Agency (EPA) has established regulations (40 CFR 130) and developed guidance (EPA, 1991) for establishing TMDLs.

The goal of a TMDL is to ensure the impaired water will attain state water quality standards. A TMDL includes a quantitative assessment of water quality problems and of the pollutant sources that cause them. The TMDL determines the amount of a given pollutant that can be discharged to the water body and still meet standards, called the loading capacity**,** and allocates that load among the various sources. If the pollutant comes from a discrete source (referred to as a point source), such as an industrial facility's discharge pipe, that facility's share of the loading capacity is called a wasteload allocation. If the load comes from a diffuse source (referred to as a nonpoint source), such as a farm or stormwater runoff, that facility's share is called a load allocation.

The TMDL must also consider seasonal variations and include a margin of safety. The margin of safety takes into account any lack of knowledge about the causes of the water quality problem or the loading capacity. The sum of the individual allocations and the margin of safety must be equal to or less than the loading capacity.

A study completed in 1995 by the State of Washington Department of Ecology (Ecology) found significant violations of water quality standards in Salmon Creek for fecal coliform, turbidity, temperature and dissolved oxygen. Water quality monitoring by Clark Public Utilities from 1995 to 1999 shows that violations of water quality standards are continuing.

Fecal coliform is a major concern because it indicates that biological waste is entering the river. Common sources of fecal coliform are failing septic tanks and agricultural waste.

Turbidity is a measure of the ability of light to pass through the water and indicates suspended solids. Turbid water impairs the ability of fish to survive and spawn. It also degrades habitat needed for aquatic invertebrates that are a food source for fish. Runoff from construction sites and washouts due to natural and human causes sometimes cause turbid water.

Ecology is establishing a TMDL for Salmon Creek watershed for fecal coliform and turbidity. This TMDL will address potential impairments of beneficial uses on four stream segments in this watershed that are listed in the 1998 Section 303(d) list of impaired surface waters. As models and load allocations are developed for other parameters that exceed water quality standards in this watershed, they will be added to this TMDL.

This Submittal Report to EPA establishes load allocations for fecal coliform and turbidity. The report also includes a summary implementation schedule that lists the groups that will implement the cleanup of Salmon Creek.

Acknowledgements

This Submittal Report is based on the technical report written by Robert F. Cusimano and David Giglio and published as Ecology Publication No. 95-335 in October 1995. The Summary Implementation Schedule was reviewed by Liza Bucy, Clark Conservation District, Douglas M. Stienbarger, WSU Cooperative Extension Clark County and Rod Swanson, Clark County Public Works Department. I greatly appreciate their assistance in developing this report.

Methodology and Components of the TMDL

The five components of any TMDL as required by the Clean Water Act are defined as:

Loading Capacity:

The greatest amount of pollution load that a water body can receive without violating water quality standards. The loading capacity of fecal coliform and turbidity varies with seasonal flow based on the peak loading measured.

Wasteload Allocation:

The portion of a water body's loading capacity that is allocated to one of the existing or potential point sources of pollution. Salmon Creek watershed has no permitted discharges therefore, the waste load allocations are set at zero.

Load Allocations:

The portion of a water body's loading capacity that is attributed either to one of its existing or potential nonpoint sources of pollution or to natural background sources. The Salmon Creek watershed load allocations for fecal coliform are equal to the loading capacities described in the document. The reductions in fecal coliform needed to achieve the load allocations in the various stream segments of the watershed range from 98% to 32%. The reductions in turbidity necessary to meet the load allocation range from 16% to 75%.

Margin of Safety:

A margin of safety is identified to account for uncertainty when establishing a TMDL. The margin of safety can be explicit in the form of an allocation, or implicit in the use of conservative assumptions in the analysis. In this study, the margin of safety was implicit due to the use of conservative values for the geometric mean and ninety 90^{th} percentile.

Seasonal Variation:

Seasonal variation was accounted for by organizing data into "wet" and "dry" seasons. Grouping the highest and lowest six contiguous month's average flow allowed allocations to be made separately for high and low flow periods.

Monitoring the Results:

Evaluating the effectiveness of best management practices (BMPs) to achieve water cleanup is vital. In June 1995, Ecology, Clark Public Utilities, (CPU) and Clark County ratified the *Salmon Creek Basin Monitoring and Management Implementation Plan.* CPU has contracted with the Pacific Groundwater Group (PGG) to continue sampling at control points used to establish Load Allocations for fecal coliform and turbidity. Sampling began in summer 1995 and is ongoing.

Background

Salmon Creek, located entirely within Clark County, flows from the foothills of the Cascade Mountains west to Lake River which in turn flows into the Columbia River. The Cascade foothills are generally forested while the lower drainage is primarily urban. The city of Vancouver lies just south of lower Salmon Creek, and several small towns lie along the tributaries and central plains of the basin. These middle reaches contain a mixture of small towns, large and small-scale farms, pasture, and homes. Six major tributaries flow into Salmon Creek: Rock Creek and Morgan Creek to the east, Weaver Creek (also called Woodin) and Curtin Creek (also called Glenwood) in the middle, and Mill Creek and Cougar Creek to the west (Figure 1). Salmon Creek and the lower portions of Mill, Curtin, Morgan, and Rock Creeks and their associated wetlands are under shoreline jurisdiction of the Clark County Shoreline Master Program.

The Salmon Creek basin is primarily rural-residential and is characterized by gently rolling hills and alluvial flood plains. Forestry, agriculture, commercial, and industrial activities are significant uses within the basin (Wille 1990). Urban areas also comprise a considerable proportion of the basin's land area, mostly along its southwest reaches. The basin is highly urbanized near Vancouver, with many small subbasins already heavily developed. The Suds Creek, Tenny Creek, 114th Street tributary, and 119th Street tributary subbasins typify the urbanization within this portion of the Salmon Creek drainage. Cougar Creek and Curtin Creek, the larger tributaries of lower Salmon Creek, are also developing rapidly. These basins often experience problems with stormwater runoff, inadequate buffer vegetation, erosion, and sedimentation. Rapid and diverse development within the basin has also led to water quality degradation of Salmon Creek and its tributaries, resulting in non-attainment of state water quality standards.

Weaver Creek is a well-studied example of a Salmon Creek tributary suffering human-induced degradation. Flowing through Battle Ground, Weaver Creek received the town's treated wastewater, which resulted in violations of state water quality standards, most notably dissolved oxygen and ammonia. A 1978 Ecology study found that total ammonia in the wastewater treatment plant's (WWTP) outflow severely depleted the creek's dissolved oxygen levels, threatening aquatic life in the stream (Moore and Anderson 1978). The average dissolved oxygen concentration downstream of the outfall was 3.7 mg/L while the standard is a minimum of 8 mg/L for a Class A waterbody. A further investigation of Battle Ground WWTP's impacts on Weaver Creek found that although streamflow responded quickly to rain events, it was insufficient to dilute WWTP inputs (Crawford 1985). The plant was designed to use natural stream flow to dilute effluent at a 20:1 ratio, but flow from the facility was typically half that of the stream. In 1993, the United States Environmental Protection Agency approved a biochemical oxygen demand and ammonia TMDL for Weaver Creek. Subsequent to the approved TMDL, discharge from the treatment plant was rerouted to the regional wastewater treatment plant at the mouth of Salmon Creek and discharged to Lake River.

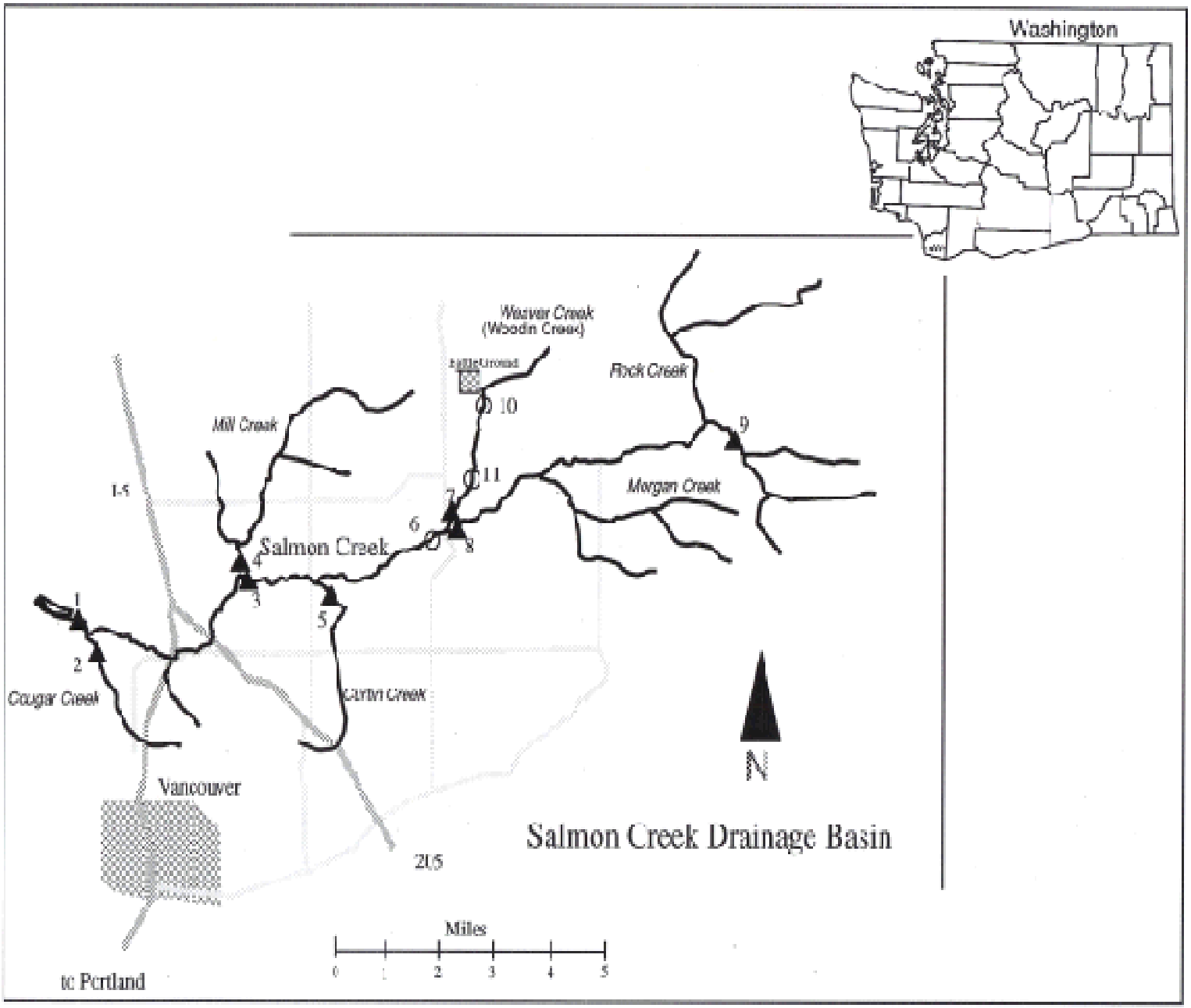

Figure 1. Salmon Creek study area and sampling locations

Fecal coliform levels on Weaver Creek, a problem throughout the basin, never met water quality standards both upstream and downstream of the WWTP (Crawford 1985). Upstream values were often higher, implying the WWTP discharge was diluting fecal coliform concentrations. Other point sources, including plywood manufacturing and dairy production, had been reported to contribute less than one percent of the coliform loading, suggesting that the fecal contamination was from nonpoint pollution (Crawford 1985).

Fecal coliform contamination is a major concern because it indicates that biological waste is entering the water. A 1981 study investigated the basin's septic systems, which were believed to contribute to nonpoint fecal coliform contamination. The study found that 3% of surveyed septic systems along the Salmon Creek drainage were leaking, and 10% had failed previously and been fixed. One finding was that 47% of failures were preventable: the result of a lack of maintenance, undersized systems, and poor siting, or physical damage (SWHD 1981).

A follow-up survey in 1989 of septic systems within Salmon Creek studied all parcels adjacent to the creek, and randomly sampled all systems within 1,000 feet of the creek and its tributaries. In this study, 5.6% of the systems were failing, sub-standard, or absent. The vast majority (92%) of systems were at least 15 years old; 58.7% of the systems had either never been pumped or were not known to have been pumped. Calculations from this study attribute from one to five percent of Salmon Creek's fecal coliform loading to failing septic systems (Newman 1989). The 1989 survey results are similar to the 1981 results, implying that septic systems contribute to but are not the major source of coliform contamination.

A 1990 study of the Salmon Creek basin by the Southwest Washington Health District (SWHD) found fecal coliform to be the most consistent and most severe violator of state water quality standards. This study isolated dairies as the primary source of contamination, with the regions around lower Morgan Creek, central Salmon Creek and Mill Creek having the highest concentrations of both dairies and coliform contamination (SWHD 1990). In response to this agriculturally-based water quality degradation, the Clark Conservation District (CCD) undertook a review of basin farming practices, recommending implementation of appropriate Best Management Practices (BMPs) for agriculture (CCD 1990). The document outlines BMPs for erosion and animal waste control, pastureland and cropland management, and stream corridor protection. It concludes with strong recommendations for stream fencing, streambank re-vegetation, and animal waste and sediment education programs to counter the negative impacts of dairy production.

Negative impacts from human land uses are not strictly recent events, however. Euro-Americans settled along Salmon Creek beginning in 1852. In 1864, A.S. Marble built the first mill on the creek. A woolen factory, which failed, also attempted to run a mill on the stream in 1867. The draining and ditching of Fourth Plain swamp (now the town of Orchards) began in 1863, which may mark the beginning of wetland losses in the area. About 1880 Isaac Dietderich built a millpond on the creek, perhaps the first man-made obstruction to salmon passage. Dairy farming in the basin goes back at least to 1882, when the Honorable H.D. Rissell owned 30 milk cows (Parsons 1983). Pasture, small-scale farms, forestry and increasing development have all contributed to impaired water quality, which has gradually reduced habitat quantity and quality for salmon and other fish and aquatic organisms.

The earliest impediments to salmonid reproduction occurred in the late 19th century, when logging dams were first constructed along Salmon Creek. Today, however, it is sedimentation from widespread development that impairs stream habitat quality. While no historical data exist, current coho, steelhead, and cutthroat trout populations are between three and five percent of what an intact

habitat might support (Wille 1989). The highest quality existing habitat presently lies within the basin's less developed headwaters: upper Salmon Creek, upper Morgan Creek, and Rock Creek. Direct cattle access along lower Salmon Creek and many tributaries increases turbidity and ammonia levels, and impairs habitat quality. As a low-gradient creek (averaging slope 0.24% over first 35 km), Salmon Creek has a limited ability to flush sediment deposits (Wille 1989). In addition to covering pool habitat for salmon, sediment buildup over time decreases the channel capacity, which increases the potential for flooding and can lead to increases in water temperature due to greater solar heating of the shallower waters.

Wetlands, which provide flood control and contribute to summer flow levels, have been estimated to constitute 3.4% of the basin (Wille 1990). Roughly half of Salmon Creek basin's wetlands are emergent (usually seasonal and adjacent to the stream), while forested and scrub-shrub wetlands are also fairly common. The greatest numbers of wetlands are within Mill Creek and Curtin Creek subbasins, but the greatest acreage lies along lower and central Salmon Creek itself. However, one fifth of recent county developments involve wetlands. Threats to wetlands include channelization and draining, as well as indiscriminate filling of privately owned wetlands (Wille 1990). Loss of remaining wetlands could contribute to further water quality degradation by removing ecologically important water detention and filtering systems.

Applicable Criteria

Within the state of Washington, water quality standards are published pursuant to Chapter 90.48 of the Revised Code of Washington (RCW). Authority to adopt rules, regulations, and standards to protect the environment is vested with the Department of Ecology. Under the federal Clean Water Act, the EPA Regional Administrator must approve the water quality standards adopted by the state (Section 303(c)(3)). Through adoption of these standards, Washington has designated certain characteristic uses to be protected and the criteria necessary to protect these uses [Washington Administrative Code (WAC), Chapter 173-201A). These standards were last adopted in November 1997.

This TMDL is designed to address impairments of characteristic uses caused by fecal coliform and turbidity. The characteristic uses designated for protection in the Salmon Creek watershed streams are as follows:

"Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (domestic, industrial, and agricultural).

(ii) Stock watering.

(iii) Fish and shellfish:

Salmonid migration, rearing, spawning, and harvesting.

Other fish migration, rearing, spawning, and harvesting.

Clam and mussel rearing, spawning, and harvesting.

Crayfish rearing, spawning, and harvesting.

(iv) Wildlife habitat.

(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation."

[WAC 173-201A-030(2)]

The water quality standards describe criteria for fecal coliform and turbidity for the protection of characteristic uses. Listed streams in the Salmon Creek watershed are designated as Class A. The following criteria are used for the protection of characteristic uses:

"fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 43 colonies/100 ml."

[WAC 173-201A-030(2)(c)(i)(A)]

"Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increases in turbidity when the background turbidity is more than 50 NTU."

[WAC 173-201A-030(2)©(vi)

The water quality standards describe the averaging periods in the calculation of the geometric mean for the fecal coliform criteria:

> *"In determining compliance with the fecal coliform criteria in WAC 173-201A-030, averaging of data collected beyond a thirty-day period,… shall not be permitted when such averaging would skew the data set as to mask noncompliance periods."*
>
> [WAC 173-201A-060(3)]

In cases where natural background conditions exceed a standard, the water quality standards state the following:

> *"Whenever the natural conditions of said waters are of a lower quality than the criteria assigned, the natural conditions shall constitute the water quality criteria."*
>
> [WAC 173-201A-070(2)]

Water quality data have been collected as part of monthly monitoring programs, as well as special studies such as stormwater sampling. The SWHD contracted with the CCD and Clark County Department of Community Development (CCDCD) to conduct monthly water quality sampling in the Salmon Creek drainage. They collected data from four sites on mainstem Salmon Creek from October 1988 through September 1989 as part of a Centennial Clean Water Fund grant from Ecology (SWHD 1990). This study also included storm event sampling from 26 sites within the basin on November 2, 1988. From May 1991 through February 1994, the SWHD also sampled water quality monthly at up to 10 sites on the mainstem and major tributaries of Salmon Creek, including the four 1988-89 mainstem sites (as annotated on Figure 1). Additionally, several diurnal samples were collected during this period.

A Quality Assurance Project Plan (QAPP) for the 1991-94 study was approved by Ecology (Gaddis 1991). All field measurements followed manufacturer's recommendations and all laboratory tests were performed at Clark County Water Quality Laboratory, accredited by Ecology. Although a QAPP was not prepared for the 1988-89 data, the same methods and procedures used in the 1991-94 study were followed. Because these studies have all been under the direction of Carl Addy of the SWHD, using acceptable quality assurance, the information is being treated as one body of data.

A pooled precision estimate was made by taking the root mean square (RMS) of the coefficient of variation (CV) for each replicate pair (Table 2). To compensate for possible differences in variation over the analytical range, coliform and turbidity replicates were divided into categories (above or below Water Quality Standards).

Given the quantity and quality of the existing data, Ecology proposed using the 1988-94 monitoring data to develop appropriate TMDLs for the Salmon Creek watershed (Cusimano and Giglio 1995). Additional field sampling was not needed to establish TMDL targets, but follow-up monitoring will be needed to evaluate the effectiveness of the pollution control measures employed in the drainage.

Water Quality & Resource Impairments

As a result of measurements made that show criteria are exceeded, five streams (representing four segments) are included on Washington's 1998 Section 303(d) list.

Table 1

Parameter:	Water Body Identification No.	Fecal Coliform	Turbidity	Temperature	Dissolved Oxygen
Salmon Creek	WA 28 1020	X	X	X	
Cougar Canyon Creek	WA 28 1023				X
Mill Creek	WA 28 1025	X			
Curtin Creek	WA 28 1026	X			
Woodin Creek	WA 28 1027	X			

Table 1. 1998 §303(d) List for the Salmon Creek Drainage

The following is a summary of the existing data. In order to better show temporal and spatial differences and to define seasonal allocation targets, the raw data were separated into dry (May-October) and wet (November-April) seasons. The seasons were established by simply grouping the highest and lowest six contiguous months average flows.

More detailed charts and graphs showing this data are available in Salmon Creek Nonpoint Source Pollution TMDL Publication No. 95-355, October 1995 and are included in appendix C

Table 2

Month	USGS Station (#1421200) near Battleground			CCDCD Station near Klineline Park		
	Average	Minimum	Maximum	Average	Minimum	Maximum
January	150	12.0	1010	268	73	787
February	116	13.0	1440	241	54	1500
March	95	18.0	502	209	61	1373
April	65	13.0	380	305	56	1840
May	38	7.4	390	114	33	697
June	20	1.2	285	62	26	445
July	7.9	0.9	71	37	20	110
August	4.4	0.6	38	27	19	43
September	5.1	0.6	104	26	19	56
October	21	1.0	760	43	19	1500
November	89	1.3	974	191	23	1500
December	134	5.4	978	308	51	1620

Table 2. Salmon Creek average, minimum, and maximum flows based on SUGS station data, 1943-1994 collected near Battleground, and average and minimum flows based on 1991-94 data collected by CCDCD at a station near Klineline Pond. All units in cfs.

Fecal Coliform

While not directly harmful themselves, fecal coliform bacteria are indicators of animal wastes (and associated pathogens) entering waterbodies. Cattle, failing septic systems, pets, and wildlife can all contribute to elevated levels. High counts of fecal coliform make waters unsuitable for human consumption and recreation.

The existing data indicate regular exceedences of the state water quality standard of 100 colonies/100 mL at all monitoring sites downstream of Salmon Creek headwaters. Fecal coliform levels vary little between dry and wet seasons. The possible influence of flow on fecal coliform concentrations was examined using flow data collected by CCDCD near Klineline Park. Correlation analysis of logarithmic transformed flow and fecal coliform data indicates no significant relationship at any of the sampling sites, except site #1, which shows a positive relationship due to one high flow and high fecal coliform value.

The 1988 storm event data reported by SWHD (1990) showed that every site exceeded the water quality standard for fecal coliform. Twenty-one of the 26 sites had values exceeding 1,000

colonies/100 mL, and eight sites had values beyond 10,000 colonies/100 mL. Again, the lowest values occurred in the less developed headwaters.

Turbidity

Turbidity measures the ability of light to penetrate water, and is an indicator of suspended particles such as clay, silt, organic matter, and small biological organisms. High turbidity impairs salmonid rearing by reducing clean gravel spawning habitat and aquatic insect habitat (a key food source for salmonids).

Five violations of the state water quality criterion for turbidity occurred on mainstem Salmon Creek between 1991 and 1993, all during November, December, and January. All sites experience occasional (wet-season) high turbidity levels. With the exceptions of Curtin Creek and Salmon Creek headwaters, turbidity appears to be a problem throughout the basin.

The 1988 storm event data reported by SWHD (1990) showed that turbidity was generally lowest in the headwaters and central mainstem of Salmon Creek (usually below or about 10 Nephelometric Turbidity Units (NTU)). A small tributary of Mill Creek was the most turbid (almost 70 NTU), and the lower Salmon Creek and Cougar Creek sites were also high (between 20 and 30 NTU). Nine of 25 storm event sampling sites violated water quality standards by exceeding natural background levels by greater than 5 NTU.

Modeling Approach

A narrative explaining the modeling approach was not developed in the Salmon Creek Technical Report (95-355). Although a mechanistic model was not used to predict possible values, statistical methods were used to determine descriptive statistics mean, standard deviation and z-score, for the sampling distribution. These statistics were used to predict a 90^{th} percentile and a geometric mean (GM) for the range of foreseeable values. The distribution was “rolled back” until the 90 percentile or the GM (which ever was more conservative) was below regulatory values. The GM and 90 percentile corresponding to this distribution were established as the Load Allocation (LA).

Loading Capacity and Wasteload Allocations

Identification of the loading capacity is an important step in developing TMDLs. EPA defines the loading capacity as "the greatest amount of loading that a water can receive without violating water quality standards."

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring a water body into compliance with water quality standards. An allocation is defined as the portion of a receiving water's loading capacity that is assigned to a particular source. By definition, a TMDL is the sum of the allocations.

Since there are no waste water discharges in the Salmon Creek watershed that are permitted by Ecology, the waste load allocations for all streams in this TMDL are zero. However, based on the

Dairy Nutrient Management Program currently being conducted, some dairies may be issued a discharge permit, which would allow only those discharges caused by chronic or catastrophic storm events prompting an overflow from facilities designed for a 25-year, 24-hour storm event. Even with this consideration, the waste load allocations for these streams will remain at zero.

The existing pollutant loads are from nonpoint sources, which means that the load allocations will be set at the loading capacity, which equals the water quality standard.

The following targets and priorities for water quality improvement are based on Washington State's numeric standards for fecal coliform and turbidity.

Fecal Coliform

To meet the TMDL, concentration-based Load Allocations were established for monitoring stations 1-9 annotated in Figure 1. Table 4 lists the dry and wet season levels for both the geometric means and the 90th percentiles for each site based on the 1988-94 data. Table 4 also lists the percent reduction required to meet the standard at each site for both parts of the criteria. The percent reductions required by each part of the criteria were then compared, and the most restrictive criterion was used to establish the Load Allocation. The allocations and percent reductions were calculated as follows:

1. Partition monthly data into a wet and dry season.

2. Calculate the GM of the data for each of the major mainstem and subbasin sampling sites for each season.

3. Determine the (log) distribution statistics for each season at each site and calculate the 90th percentile based on the mean, standard deviation, and Z-score. Adjust the distribution such that no more than 10% of the values exceed 200 colonies/100 mL. Then calculate the GM of the adjusted data. If the adjusted GM for a site is <100 colonies/mL, it will be the site Load Allocation. If the GM is >100 colonies/100 mL, the Load Allocation will then be 100 colonies/100 mL. Divide by the GM from step 2 and multiply times 100 to obtain the percent reduction required to meet the site specific LAs.

Figure 11 in appendix C shows how the estimated sample distribution was adjusted to the target distribution based on the above procedure for wet season data at site 1. The adjusted frequency distribution has a 90th percentile of 200 colonies/100 mL, and a GM of 33 colonies/100 mL. The percent reduction in this case is 89%.

In summary, the fecal coliform TMDL is simply the concentration-based freshwater Class A water quality criteria. Load allocations are the site-specific geometric means needed to meet both parts of the water quality criteria. These site-specific Load Allocations can be used as control points to monitor the success of management measures taken in the subbasins or along the mainstem of the Salmon Creek drainage.

Table 3

Salmon Creek and its Major Tributaries Station Name	Site #	First Criterion: Geometric Mean < 100				Second Criterion: 90% of Samples < 200				Recommended Target Levels			
		Existing Geometric Mean		Percent Reduction needed (mean <100)		Existing Upper Tenth Percentile		Percent Reduction needed (90%<200)		Target Geometric Mean		Target Percent Reduction	
		Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
Salmon Creek (mouth)	1	313	129	68	23	1917	301	89	34	33	86	89	34
Cougar Creek	2	722	899	86	89	9243	1803	98	89	16	100	98	89
Salmon Creek (lower)	3	182	281	45	64	1261	806	84	75	29	70	84	75
Mill Creek	4	839	282	88	65	8763	1121	98	82	19	50	98	82
Curtin Creek	5	1155	743	91	87	4409	2608	96	92	52	57	96	92
Salmon Creek (middle)	6	257	453	61	78	1162	869	83	77	44	100	83	78
Weaver Creek	7	534	857	81	88	9204	6509	98	97	12	26	98	97
Salmon Creek (upper)	8	234	751	57	87	1125	1404	82	86	42	100	82	87
Salmon (headwaters)	9	28	54	0	0	200	318	0	37	28	34	0	37

Table 3. Salmon Creek drainage wet and dry season fecal coliform geometric means, 90th percentiles, and recommended reductions.

Turbidity

To meet the TMDL, numeric Load Allocations were established for monitoring stations 1-9 annotated in Figure 1. Background turbidity was assumed to be equal to turbidity at the headwater sampling site, which was always less than 50 NTU. Load Allocations were established such that turbidity levels would not exceed 5 NTU over background 90% of the time. The 90th percentile was chosen as a control level for turbidity because allowing 10% of the values to exceed water quality standards for conventional parameters is supported by EPA (EPA 1995). The turbidity Load Allocation for each site is the background level plus 5 NTU, and the target percent reduction is the percent reduction required for the 90th percentile of the data to meet the LA. Table 5 lists the 90th percentile of background adjusted data (as discussed below) and target percent reductions to meet the Load Allocation. The allocations and percent reductions were calculated as follows:

1. Partitioned monthly data into a wet and dry season.

2. Set background turbidity equal to the turbidity level at the headwater sampling site (#9). For each sampling event, subtract background turbidity from downstream site values, including tributaries. Because the criterion applies only to positive differences between background and downstream sites, all remainders <0 were set to 0 NTU.

3. Load Allocations for each site are 5 NTU.

4. Determine the (log) distribution statistics for each site during each season for the adjusted data calculated in step 2. Calculate the 90th percentile based on the mean, standard deviation, and Z-score. Subtract 5 NTU (LA) from the 90th percentile. If the remainder is ≤0 NTU, no reduction is necessary. If the remainder is >0, then divide the remainder by the 90th percentile value of the adjusted data and multiply by 100 to establish the percent reduction necessary to meet the LA.

Table 4

Salmon Creek and its Major Tributaries	Site #	90th %tile of Adjusted Data[a]		90th %tile of Adjusted Data minus LA of 5 NTU		Target Percent Reduction[b]	
Station Name		**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**
Salmon Creek (mouth)	1	13.4	3.7	8.4	-1.3	63	0
Cougar Creek	2	20.1	1.9	15.1	-3.1	75	0
Salmon Creek (lower)	3	12.8	1.8	7.8	-3.2	61	0
Mill Creek	4	21.1	3.5	16.1	-1.5	76	0
Curtin Creek	5	5.9	2.8	0..9	-2.2	16	0
Salmon Creek (middle)	6	17.9	2.8	12.9	-2.2	72	0
Weaver Creek	7	10.1	2.0	5.1	-3.0	51	0
Salmon Creek (upper)	8	8.2	3.2	3.2	-1.8	39	0
Salmon Creek (headwaters)	9	NA	NA	NA	NA	NA	NA

Table 4. Salmon Creek drainage wet and dry season average turbidity, 90th percentiles, and recommended reductions

[a] Adjusted data equals each site value minus background (site 9) value for each sampling event.

[b] Target reduction is the percent reduction required to reduce the 90th percentile of the adjusted data to 5 above background.

Margin of Safety

The Clean Water Act requires that a margin of safety be identified to account for uncertainty when establishing a TMDL. The margin of safety can be explicit in the form of an allocation, or implicit in the use of conservative assumptions in the analysis.

The statistical rollback method used to establish the target geometric means for the concentration-based allocations provides a more restrictive geometric mean count, in most cases, than the Class A geometric mean criteria. The lower geometric means provide an implicit margin-of-safety for meeting the fecal coliform concentration-based nonpoint TMDL

Summary Implementation Strategy

Introduction

The purpose of this implementation strategy is to present a clear, concise, and sequential concept (i.e. vision statement) of how agencies will achieve water quality standards in the Salmon Creek watershed over time.

This strategy meets the requirements of a TMDL submittal for approval as outlined in the 1997 Memorandum of Agreement between the U.S. Environmental Protection Agency and the Washington State Department of Ecology.

- **Implementation Plan Development**

The following is a description of the key agencies, and other groups that have influence, regulatory authority, involvement, or other controls that will be incorporated into a coordinated effort to implement the Water Cleanup Plan. Ecology will lead the coordination effort as needed to affect Plan implementation. Considerable work will be needed by all parties especially in the heavily urbanized section of Salmon Creek in order to meet water quality standards. Regular reviews of monitoring data, leading to changes in management regimes if standards are not being met will need to be conducted. A reasonable expectation of when the stream might meet these standards for bacteria and turbidity is difficult to determine. The most reasonable expectation given the excessive population growth in the watershed, is that by 2010 a sizable reduction in violations of the water quality standards for bacteria and turbidity will occur (see reasonable assurance paragraph below).

- **Clark Public Utilities**

In 1992, Washington State Departments of Ecology and Health, Clark Public Utilities, and Clark County entered into a *memorandum of understanding* to develop and implement a water resource management plan for the Salmon Creek basin. The memorandum created a partnership between state and local public agencies to evaluate the water resource management needs and craft a program that furthers state and local water resource management objectives and legal requirements. *The Salmon Creek Basin Monitoring & Management Implementation Plan* noted in the Monitoring section of this Summary was developed as a result of this *memorandum.*

For the past few years Clark Public Utilities has taken the lead in developing a number of programs that impact water quality in Salmon Creek in conjunction with other agencies.

The list of these programs is as follows:

- *Water System Planning*
- *Water Conservation*
- *Ground Water Management*
- *Wellhead Protection*
- *Streamside Rehabilitation*
- *Streamflow Augmentation*
- *Wastewater Reuse*
- *Fisheries Enhancement*
- *School Salmon Rearing Aquarium*
- *Recreation and Park Planning*
- *Stormwater Management*
- *Septic Tank Maintenance*
- *Watershed Protection Planning*
- *Public Information and Education*
- *Environmental Information Center*
- *Salmon Creek Water Festival*

The Utility agreed in May 2000 to conduct the necessary planning to develop a Phase 2 and Phase 3 Watershed Plan that would meet all the requirements of the Watershed Management Act (HB 2514, RCW 90.82). In addition, the Utility has contracted with the Corps of Engineers to conduct a Limiting Factors Analysis in conjunction with the Conservation Commission. Both of these efforts are scheduled to be completed by January, 2003.

- **Clark County**

Clark County was granted a National Pollution Discharge Elimination Permit (NPDES) in 1999 for stormwater. EPA rules require local governments to develop stormwater programs that address the following six main elements:

- Public Education and Outreach
- Illicit Discharge, Detection and Elimination
- Post-Construction Runoff Control
- Public Participation/Involvement
- Construction Site Runoff Control
- Pollution Prevention/Good Housekeeping

Current and anticipated federal Endangered Species Act (ESA) and Clean Water Act stormwater requirements are placing more demands on state and local governments for staffing and resources. Urban stormwater management represents a significant funding challenge for local and state governments, as well as a potential outstanding liability due to third party actions.

The municipal stormwater permits require the implementation of a Stormwater Management Program. The Stormwater Management Program is a plan for the term of the permit to reduce the discharge of

pollutants, reduce impacts to receiving waters, eliminate illicit discharges, and make progress towards compliance with surface water, ground water, and sediment standards. Ecology is in the process of reissuing the municipal stormwater permits. Ecology's proposal is to issue a single statewide general permit for Phase I municipal stormwater permit holders by early summer of 2001.

Clark County has developed the storm water program required by the Permit. They will produce their first annual report in July 2001. Staff is being hired to carry out the items noted above. Funding for these activities is provided by the storm water utility created by the Clark County Commission in December 1999.

- **Southwest Washington Health District**

The Southwest Washington Health District (SWHD) has the specific requirement to: "Identify failing septic tank drainfield systems in the normal manner and will use reasonable effort to determine new failures." (RCW 70.118.030)

"The normal manner" implies the use of inspections and responses to citizen complaints. These inspections are to take place in areas where water quality standards have been violated. SWHD has developed an administrative plan to respond to on-site sewage system failures, including, where appropriate, inspection of these systems. The outline below shows the steps that will be taken to implement the plan.

A. Identify Sources
- Phased Approach
- Develop Complete and Accurate List of Septic Systems in Basin
- Septic Maintenance Inspection Program (Statewide Requirement for Homeowners)
- Use monitoring Results to Focus Efforts
- Hold educational meetings for communities in various subbasins of the Watershed.

B. Identify Control Measures
- Provide List of certified/licensed inspection contractors
- Provide List of certified pumpers and repair contractors
- Provide educational materials
- Require Repairs or Replacements if necessary

A Memorandum of Agreement between Ecology and the Health District to carry out this program was signed on November 8, 2000 (see Appendix A).

- **Ecology**

Ecology has been delegated authority under the Federal Clean Water Act by EPA to establish water quality standards, administer the NPDES program, and enforce water quality regulations.

As part of those duties, Ecology inspects dairy farms and manages dairy permits in the Salmon Creek Watershed. In 1998, Washington State passed the Dairy Nutrient Management Act (DNMA). The act requires all Class A dairies to have a farm plan by July 1, 2002. After receiving a farm plan, dairies must implement them by December 31, 2003. All of the dairies in the Salmon Creek basin have been

inspected once. The dairies with probable pollution problems have received a notice of correction and follow up inspections. Additional inspections by the Department of Ecology dairy inspectors will be made during the wet season. Over the next two years, these actions should result in control of dairy waste causing FC and BOD loading from entering the streams emptying into Salmon Creek. If voluntary compliance is not obtained from the landowners, enforcement and fines may be employed under the DNMA, Chapter 90.48 and the Clean Water Act.

- **Clark Conservation District**

The Clark Conservation District (CCD) works closely with Ecology and National Resource Conservation Service (NRCS) in developing resources management plans. The CCD also provides education and technical assistance to landowners. Landowners receiving a Notice of Correction or a formal enforcement action frequently get assistance from the CCD to assist coming into compliance. Ecology will work closely with the CCD and NRCS by identifying and prioritizing referrals in the Salmon Creek area for resources management planning.

Ecology and CCD have developed the Small Farm Water Quality Improvement Project. The goals of this project are to provide people with small acreage farms technical assistance in controlling water pollution from their farm. The main focus of this grant is on providing educational efforts such as mud and manure workshops, septic tank workshops, and informational brochures for people with just a few livestock on their property. Salmon Creek has been targeted as the first watershed to have this program. Workshops have been held over the past two years. An informational brochure will be distributed in the spring of 2001 to several thousand property owners adjacent to Salmon Creek and its tributaries.

- **USDA Natural Resource Conservation Service**

The USDA Natural Resource Conservation Service (NRCS) provides the guidance and general standards and specifications used in developing farm plans. NRCS also does research used to develop the best management practices (BMP) used on farms to protect water quality. The NRCS administers cost-share money that is frequently used by farmers to do farm improvements. Many of the costly farm improvements required for water quality protection, such as lagoons, are constructed according to designs approved by NRCS and funded in part by grants administered by NRCS. The NRCS will help Ecology and WCD evaluate the effectiveness of the BMPs as they are implemented in the Salmon Creek Watershed. This work will occur during the same time frame as the CCD work.

- **Lower Columbia Fish Recovery Board**

Established in 1998 by state law, the Lower Columbia Fish Recovery Board (LCFRB) encompasses five counties in southwest Washington: Clark, Cowlitz, Lewis, Skamania, and Wahkiakum. The 15-member Board is comprised of representatives from the Legislature, city and county governments, the Cowlitz Tribe, private property owners, hydro-project operators, the environmental community, and concerned citizens. Its goal is to forge a broadly based regional partnership to return fish populations to healthy levels.

State law directs the Board to:

- Participate in the development of a regional fish recovery plan, particularly habitat recovery measures. In doing so the Board is to coordinate with local governments, the state, and the National Marine Fisheries Service.

- Assess the factors for decline of salmon and steelhead on a "stream-by-stream" basis.

- Implement the local government responsibilities for habitat restoration and preservation, including prioritizing and approving projects and programs, and receiving and disbursing funds.

The LCFRB has received a grant from Ecology to carry out the watershed planning authorized by RCW 90.82. This law established the watershed planning process including water quantity, quality, habitat, and in-stream flow issues. Salmon Creek will have such a plan developed by Clark Public Utilities in conjunction with this process by 2003.

- **Approaches to be used to meet load allocations**

As part of the Ecology dairy inspection program, dairies with a potential to pollute will be instructed to correct the problem. The services of the CCD will be recommended. CCD will develop or modify an existing farm plan to eliminate the potential to pollute under the guidance of NRCS. At that point, all three entities will then develop a monitoring plan to measure the effectiveness of the BMPs.

If agricultural sources that are not associated with dairies are identified to be causing pollution, they will be referred to CCD. The CCD will develop or modify an existing farm plan to eliminate the potential to pollute under the guidance of NRCS. At that point, all three entities will then develop a monitoring plan to measure the effectiveness of the BMPs. During the first half of 2001, CCD will continue to work with small farm owners to implement BMPs using the existing Ecology Centennial Grant for funding. A funding source for this work will be explored with the Salmon Creek Management Team early in 2001.

- **Reasonable Assurance**

Local involvement in restoring Salmon Creek is considerable. The following list is a summary of actions currently under way or scheduled to occur soon. This list is based on the detailed information in paragraphs above.

- If OSS failures are identified, the owners will be referred to SWHD. SWHD will implement the provisions of their OSS program.

- Clark Public Utilities will continue stream restoration measures such as tree planting and public education.

- Clark Public Utilities agreed in May 2000 to conduct the necessary planning to develop a Phase 2 and Phase 3 Watershed Plan that would meet all the requirements of the Watershed Management Act (HB 2514, RCW 90.82). In addition, the Utility has contracted with the Corps of Engineers to

conduct a Limiting Factors Analysis in conjunction with the Conservation Commission. Both of these efforts are scheduled to be completed by January 2003.

- The LCFRB has received a grant from Ecology to carry out the watershed planning authorized by RCW 90.82. This law established the watershed planning process including water quantity, quality, habitat, and in-stream flow issues. Salmon Creek will have such a plan developed by Clark Public Utilities in conjunction with this process by 2003.

- Clark County will continue to implement their storm water program as required by their Phase 1 Storm Water Permit under NPDES.

- Clark Conservation District will continue to implement their small farm outreach program.

- In 1998, Washington State passed the Dairy Nutrient Management Act (DNMA). The act requires all Class A dairies to have a farm plan by July 1, 2002. After receiving a farm plan, dairies must implement them by Dec 31, 2003.

- **Adaptive Management**

However, if water quality standards are not being met, regular reviews of the water quality data will be conducted and adaptive management strategies will be developed.. Ecology will again conduct its TMDL Scoping of the WQMA in 2004. An intensive review of how effective this TMDL has been will be conducted as part of scoping. At that time, Ecology will work with the Salmon Creek Management Team to identify further actions that need to be taken to achieve water quality standards. This work will continue on an ongoing basis until water quality standards are achieved.

Monitoring Strategy

The Salmon Creek Monitoring and Management Implementation Plan was agreed on by Clark Public Utilities, Washington State Departments of Health and Ecology and Clark County in 1995. Clark Public Utilities performs most of the functions called for in the Plan, and prepares the annual reports on the Program. Clark Public Utilities is committed to continuing this work.

- **Summary of Public Involvement**

Ecology will be working with Clark County Public Works, Clark Public Utilities, Clark Conservation District, Southwest Washington Health District, and the Lower Columbia River Fish Recovery Board to develop the Detailed Implementation Strategy, through a process of peer review. General public meetings and consultation with interest groups will occur before corrective actions are determined and finalized.

Public meetings will be used to keep all of the units noted above apprised of the other's activities and to reach consensus on appropriate corrective actions and timelines.

- **Potential Funding Sources**

The Centennial Clean Water Fund, Section 319, and SRF grant funds are available from Ecology to fund activities by jurisdictions to help implementation of the water cleanup plan. Ecology will assist with identifying numerous other sources of state and federal monies for which applications may be

prepared. Non-government organizations may apply to be funded by a 319 grant fund to provide additional assistance. Ecology will work with the stakeholders to prepare appropriate scopes of work, to implement this plan, and to assist with applying for grant opportunities as they arise. In order to strengthen the implementation response, other state agency funding sources, such as salmon recovery funding, and watershed grants will be pursued as they become available.

- **Acronyms and Abbreviations**

BMP	Best Management Practice
CCD	Clark Conservation District
DNMP	Dairy Nutrient Management Plan
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
LCFRB	Lower Columbia Fish Recovery Board
NPDES	National Pollution Discharge Elimination System
NRCS	USDA Natural Resources Conservation Service
OSS	On-Site Sewage System
SWHD	Southwest Washington Health District

Appendix A

Public Participation Materials

This appendix contains:

- Memorandum of Agreement between Southwest Washington Health District and the Washington Department of Ecology.

- Public Participation Materials for Salmon Creek

Summary of Public Participation and Materials

The public outreach process for the Salmon Creek TMDL was formally started with a Kick-Off meeting on October 6, 1999 (see attached agenda). At this Kick-Off Meeting it was agreed that Dave Howard, acting as the Watershed Coordinator for the Columbia Gorge Water Quality Management Area in Ecology's Vancouver Office would meet with interested groups over the next six months. During that time he would discuss the reasons for establishing a TMDL for Salmon Creek, what the implementation steps would be, and how people could be involved in the process.

During subsequent months, presentations on these items were made at meetings of the Lower Columbia Salmon Recovery Board, Clark Conservation District Board, Clark County Commissioners Board, Salmon Creek Management Team, and Water Resource Inventory Area 27/28 Planning Unit. All of these groups are identified in the Summary Implementation Strategy (SIS) within this document. All groups were presented with a copy of an Ecology Focus Sheet (attached), and a copy of Process for a typical Water Cleanup Plan (attached).

As noted in the Focus Sheet, the general public was invited to a public meeting with notices distributed wildly throughout the basin and press releases printed in a local daily and weekly paper along with coverage on local television stations. This meeting was held at Battleground High School in the center of the watershed on April 10, 2000 from 6 to 9 PM. Over 15 members of the public attended. Participating agencies sent representatives who presented what they were going to do as outlined in a draft SIS that was reviewed at the meeting. A public comment period of 30 days was opened and only few comments were received (Meeting Agenda attached). No substantive comments were received.

Most concerns voiced at the meeting focused on a fish kill that was occurring in a minor tributary to Salmon Creek. Follow up monitoring has occurred during the ensuing months and no contributing factors for the fish kill have been determined.

Clark Public Utilities has continued to conduct their stream and habitat restoration program. This program consists of a mailing in utility bills once a year outlining their Environmental Services and a Stream Wheel that they give out at various fairs (see attachments)

Recently, The Columbian newspaper ran a four page special on Salmon Creek that continues to keep the issues of water quality before the public (The Columbian, Sunday, December 17, 2000, pp. A6-A10). This article included photographs and a color display of the area and discussed the issues concerning pollution and sources impacting Salmon Creek and its tributaries. This article may be located by contacting The Columbian. A hard-copy is also part of the official Salmon Creek TMDL file at the Department of Ecology.

APPENDIX B

Quality Assurance Project Plan

Salmon Creek
Nonpoint Source Pollution TMDL

Final Quality Assurance Project Plan

by
Bob Cusimano
January 30, 1995

Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
Watershed Assessments Section

Approvals:

Bob Cusimano
Project Lead
Watershed Assessments Section

Nora Jewett
Client Staff Contact
WQ Section, Southwest Regional Office

Will Kendra
Supervisor
Watershed Assessments Section

Bill Backous
Supervisor
WQ Section, Southwest Regional Office

Bill Kammin
Director
Ecology Manchester Laboratory

Cliff Kirchmer
Ecology QA Officer
Quality Assurance Section

Introduction

The Clean Water Act (CWA) Section 303(d) requires states to effect pollution controls on waterbody segments where technology-based controls are insufficient to reach water quality standards. To meet this requirement, a total maximum daily load (TMDL) must be established for each pollutant violating water quality criteria. The TMDL is then apportioned between point and nonpoint sources as wasteload (WLA) and load (LA) allocations, respectively. Allocations are implemented through NPDES permits, grant projects, and nonpoint source controls. Thus, the TMDL process helps bring problem waterbodies into compliance with water quality standards.

Ecology's Southwest Regional Office (SWRO) is concerned about nonpoint pollutant loading to Salmon Creek, a Class A waterbody, due to anthropogenic activities in the watershed. They have requested that the Watershed Assessment Section (WAS) assess the water quality of the drainage system and establish appropriate TMDLs and LAs. (Since there are no permitted point source discharges, WLAs are not needed.) Figure 1 is a map of the proposed study area.

Problem Description

Salmon Creek has experienced gradual water quality degradation from historic and recent development and urbanization. Forestry, small-scale farming, dairies, urban, and industrial land uses have resulted in numerous violations of state water quality standards (Clark County Department of Public Works, 1989; Meyer, 1981; Southwest Washington Health District, 1990; Wille, 1990). Stream monitoring by Clark County has identified violations of Class A criteria for fecal coliform, turbidity, dissolved oxygen, and temperature (Southwest Washington Health District, 1990). Nutrient levels, while not regulated, are also high. Currently, five segments of the basin are on the §303(d) list (Table 1).

Table 1. 1994 §303(d) List for the Salmon Creek Drainage

Parameter:	Fecal Coliform	Temperature	Dissolved Oxygen
Salmon Creek	X	X	
Cougar Canyon Creek	X		X
Mill Creek	X		
Curtin Creek	X		
Woodin Creek	X		

Previous studies have documented the roles of septic tanks (Southwest Washington Health District, 1981; Newman, 1989), dairy waste (Clark County Conservation District, 1990;

Southwest Washington Health District, 1990), and wastewater (Moore and Anderson, 1978; Crawford, 1986) in the basin's pollution. The leading point source of contamination in the basin historically was the Battle Ground wastewater treatment plant (WTP). Because of its effects on water quality in Woodin Creek, the WTP discharge was diverted away from the Salmon Creek basin in March 1993. Since then, pollutant loading has been limited to non-point sources. Fecal coliform bacteria, the most consistent violator of state water quality standards in the basin, exceeds standards along the mainstem of Salmon Creek and in every sub-basin. Newman (1989) suggested that the widespread coliform contamination is likely the result of animal wastes entering streams, not failing septic systems as once suspected.

Study Objectives:

Objectives for the Salmon Creek basin Total Maximum Daily Load (TMDL) study include:

1. Assess the quality of existing water quality data on Salmon Creek and its tributaries for use in assessment of §303(d) listed parameters.

2. Establish wet and dry season concentration-based load allocations (LAs) for fecal coliform and turbidity.

3. Relate LAs and concentration-reduction targets to land-use.

4. Propose a non-point source pollution reduction strategy that incorporates use of Best Management Practices in the drainage.

5 Propose a follow-up monitoring program to evaluate the effectiveness of the pollution reduction strategy(s).

Existing Data

Water quality data have been collected as part of monitoring programs, as well as special studies. The Clark County Conservation District and Clark County Public Services Division conducted monthly water quality sampling for the Southwest Washington Health District. Four sites on mainstem Salmon Creek were sampled from October 1988 through September 1989 as part of a Centennial Clean Water Fund grant. This study also included storm event sampling from 26 sites within the basin on November 2, 1988. From May 1991 through February 1994, the SWHD also sampled monthly water quality at up to ten sites on the mainstem and major tributaries of Salmon Creek (as annotated on Figure 1). Additionally, several diurnal samples were collected during this period. Because these studies have all been conducted by Carl Addy of the Southwest Washington Health District, using acceptable Quality Assurance, the information is being treated as one body of data.

A Quality Assurance Project Plan (QAPP) was submitted to and approved by Ecology for the 1991 Health District study. All field measurements followed manufacturer's

recommendations and all laboratory tests were performed at Clark County Water Quality Laboratory, accredited by Ecology. Twenty-three pairs of field replicates were collected as part of the sampling program; replicate results demonstrate acceptable precision. A pooled precision estimated for variables was made by taking the root mean square (RMS) of the Coefficient of Variation (CV) for each replicate pair (Table 2). To compensate for differences in variation over the analytical range, coliform and turbidity replicates were divided into categories (above or below water quality standards).

Given the quantity and quality of the existing data, WAS is proposing to use the data to develop appropriate TMDLs for the Salmon Creek watershed. Additional field sampling will not be needed to establish allocation targets, but follow-up monitoring will be proposed to evaluate the effectiveness of the pollution reduction strategies employed in the watershed.

Table 2. Field Replicate Precision

Parameter	# of Replicates	Root Mean Square of the Coefficient of Variation (%)
Fecal Coliform, Mean MPN < 100	10	49.9
Fecal Coliform, Mean MPN > 100	13	42.8
Temperature	22	1.6
Dissolved Oxygen	22	0.8
Turbidity, Mean NTU < 5.0	16	5.4
Turbidity, Mean NTU > 5.0	7	3.0
Ammonia	23	22.6
Nitrates-Nitrites	23	4.5
Total Phosphorus	22[a]	7.5
pH	23	0.8

[a] One pair of phosphorus samples was excluded because of a suspected error. Were it included, the pooled precision would be 25.2.

Data Management:

SWHD sampling data was obtained as hard copy and entered into the Excel spreadsheet software program. Data were verified by Clark County, and 100% of data entry was reviewed for errors by WAS.

Data Analysis and Presentation:

The major water quality variable of concern in the watershed is fecal coliform from nonpoint sources (Table 1). The fecal coliform concentration-based nonpoint TMDL is simply the Freshwater Class A fecal coliform standard (WAC 173-201A-030-2):

> Fecal coliform organism levels shall both not exceed a geometric mean (GM) value of 100 cfu / 100 mL and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 cfu / 100 mL.

To meet the TMDL, LAs will be established at sampling sites in the watershed as follows:

1. Partition monthly data into a wet and dry season using historical flow and precipitation data.

2. Calculate the GM of the data for each of the major mainstem and subbasin sampling sites for each season.

3. Determine the cumulative frequency distribution of fecal coliform data for each season at each site and adjust the distribution such that no more than 10% of the values exceed 200 cfu / 100 mL. Then calculate the GM of the adjusted data. If the adjusted GM for a site is <100 cfu / mL, it will be the site LA. If the GM is >100 cfu / 100 mL, the LA will then be 100 cfu / 100 mL.

4. Subtract the GM for each site established in step 3 from the GM calculated in step 2. Each remainder divided by the GM from step 2 times 100 will be the percent reduction required to meet the site specific LAs.

The existing data suggest that waterbodies in the Salmon Creek drainage also consistently violate the state turbidity standard. A turbidity concentration-based nonpoint TMDL is the Freshwater Class A turbidity standard (WAC 173-201A-030-2):

> Turbidity shall not exceed 5 NTU over background turbidity when background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

To meet the turbidity TMDL for background levels <50 NTUs, LAs will be established at sampling sites in the watershed as follows:

1. Partition monthly data into a wet and dry season using historical flow and precipitation data.

2. Set background turbidity equal to data collected from the furthest upstream sampling site. Subtract background turbidity for each sampling event from downstream site values. The remainders are the background adjusted turbidity values.

3. LAs for each site are 5 NTUs.

4. Subtract 5 NTUs from the 90th percentile value of the adjusted seasonal data set calculated in step 2. If the remainder is >0, then divide the remainder by the 90th percentile value of the adjusted data and multiply by 100 to establish the percent reduction necessary to meet the LA. If the remainder is ≤0 NTUs no reduction is necessary.

In addition to the analysis presented above, all data will be presented with plots that show the relative concentrations of water quality variables through the sampling period (*i.e.*, concentration versus time by site for monthly data; concentration versus site for storm event samples). A step trend analysis will be performed on data collected from Woodin Creek in order to assess changes associated with removing the Battle Ground WTP discharge.

Land-use and Best Management Practices

Clark County Public Works Department has a geographic information system (GIS) with land-use layers for the county available. WAS is currently planning to request that Clark County provide GIS maps for the Salmon Creek watershed that have, at a minimum, the following characteristics annotated: residential homes, commercial buildings / properties, towns / cities, small scale farms, dairy farms, forest, and subbasin drainages.

SWRO, Clark County Conservation District, and Southwest Health District personnel will provide a nonpoint source pollution mitigation strategy plan. Their recommendations and proposed Best Management Practices for the watershed will be included in the final report.

Project Schedule:

Submit draft QAPP for internal review:	January 31, 1995
Submit draft QAPP to client:	February 14, 1995
Finalize QAPP:	February 28, 1995
Submit draft report for internal review:	June 30, 1995
Submit draft report to client:	August 15, 1995
Final report to printer:	October 15, 1995

Data Sources:

GIS land-use data will be obtained through Clark County.

BMP information will come from Clark County Conservation District (contact: Gordon Douglas) and Southwest Washington Health District (contact: Steven Kurd and Carl Addy).

Project Responsibilities:

Bob Cusimano - project lead, and David Giglio (Ecology): responsible for project design, collecting and analyzing data, developing graphs and figures, writing and editing draft and final reports.

Nora Jewett (Ecology): responsible for reviewing draft report and coordinating development and implementation of BMP strategies.

Gordon Douglas (Clark County Conservation District): participate in developing and implementing BMP strategies.

Steven Kurd and Carl Addy (Southwest Washington Health District): participate in developing and implementing BMP strategies.

References

CCCD (Clark County Conservation District), 1990. *Agriculture's Contribution to Non-Point Pollution in the Salmon Creek Basin*.

CCDPW (Clark County Department of Public Works), 1989. *Salmon Drainage Master Plan*.

Crawford, P., 1986. "Weaver (Woodin) Creek Low-Flow, Point-Source Reconnaissance," memo to Jon Neel. Washington State Department of Ecology, Olympia WA.

Meyer, Robert E., Consultants, 1981. *Salmon Creek Basin Master Plan*. Beaverton, OR. Prepared for Clark County Board of Commissioners.

Moore, A. and D. Anderson, 1978. *Weaver (Woodin) Creek-Battleground Sewage Treatment Plant Impact Study*. Project Report PR-4, Washington State Department of Ecology, Olympia, WA.

Newman, T., 1989. *Septic Systems in the Salmon Creek Basin: A Sanitary Survey*. Southwest Washington Health District, Vancouver, WA.

SWHD (Southwest Washington Health District), 1981. *Non-Point Source Water Pollution from Septic Tank Systems in the Salmon Creek Basin*. Vancouver, WA.

SWHD (Southwest Washington Health District), 1990. *Salmon Creek Water Quality Monitoring Report: Final Report*. Clark County, WA.

Wille, S. A., 1990. *Wetland Resources of the Salmon Creek Basin*. Clark County Conservation District, Vancouver, WA.

APPENDIX C

Technical Report

Salmon Creek Nonpoint Source Pollution TMDL
Publication No. 95-355
October 1995

(Published Separately)

http://www.ecy.wa.gov/biblio/95355.html