Lake Chelan Watershed DDT and PCB Total Maximum Daily Load

Water Quality Improvement Report

June 2006
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Washington State Department of Ecology
Water Quality Program

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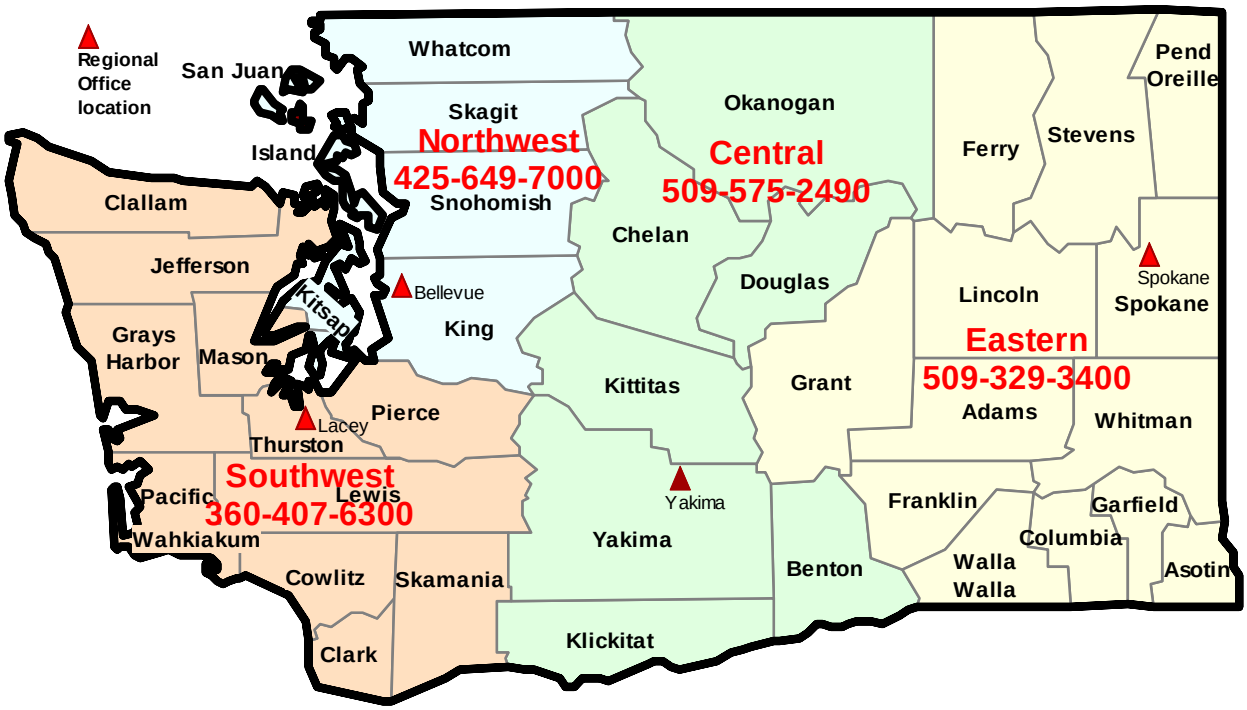

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Executive Summary

Introduction
Lake Chelan and Roses Lake, a small lake located adjacent to Lake Chelan, are included on Washington States 303(d) list as water quality impaired because of non-attainment of the U.S. Environmental Protection Agency (EPA) human health criteria for 4,4' DDT, DDT metabolites 4,4'-DDE and 4,4' DDD, PCB 1254 and 1260, in edible fish tissue. Roses Lake is listed for 4,4'-DDE only.

As required by the Clean Water Act a total maximum daily load assessment (TMDL) was conducted for Lake Chelan and Roses Lake to determine loading reductions needed to bring the lakes into compliance with water quality standards. In this effort the Washington State Department of Ecology collected fish tissue, water, and sediment samples during May through November of 2003 from Lake Chelan, Roses Lake, and their inflows. During the TMDL study, some tributaries and irrigation drains to Lake Chelan were discovered to exceed water quality standards for DDT, including First Creek, Knapp Coulee, Culvert near Crystal View, Purtteman Creek, Culvert at Veroske's, Cooper Drainage, Bennet Road, Keupkin Street, Buck Orchards, Joe Creek, and Stink Creek. Total DDT Loads and reductions needed in tributaries and irrigation drains are identified in Table 2. Actions identified in the Summary Implementation Strategy section will address tributary and irrigation drain exceedences.

The purpose of this submittal report to EPA is to: 1) provide an assessment of DDT, PCB, and pollution to the Lake Chelan watershed, including sources, loads and reductions needed to meet Federal and Washington State water quality standards; and 2) identify actions and monitoring to be implemented which will result in attainment of standards over time.

This report is organized to describe: the *Loading Capacity* that Lake Chelan can assimilate and still meet water quality standards; the *Load Allocations* or reductions needed from pollutant inputs; the *Margin of Safety* or conservative assumptions based on consideration of any lack of knowledge about causes of the water quality problem or its loading capacity; the *Summary Implementation Strategy* or actions and monitoring to be implemented that will reduce pollutant inputs; *Reasonable Assurance* that actions will achieve water quality standards by the target dates set and *Adaptive Management* that will be utilized to attain water quality standards.

Lake Chelan Basin
Lake Chelan is located in north-central Washington State (Figure 1). It is the longest and deepest natural lake in the state. The Lake Chelan watershed drains a 924-square-mile area. Ninety percent of the basin is forested or open lands, the

majority managed by U.S. Forest Service and National Park Service. The lake itself is divided into two distinct basins, the Lucerne and Wapato basins. Agriculture and orchard lands comprise 3 percent of the watershed's land area, almost all located in the more urbanized Wapato basin. Roses Lake, located about a mile north of the town of Manson, is one of a cluster of three small lakes which drain to Lake Chelan.

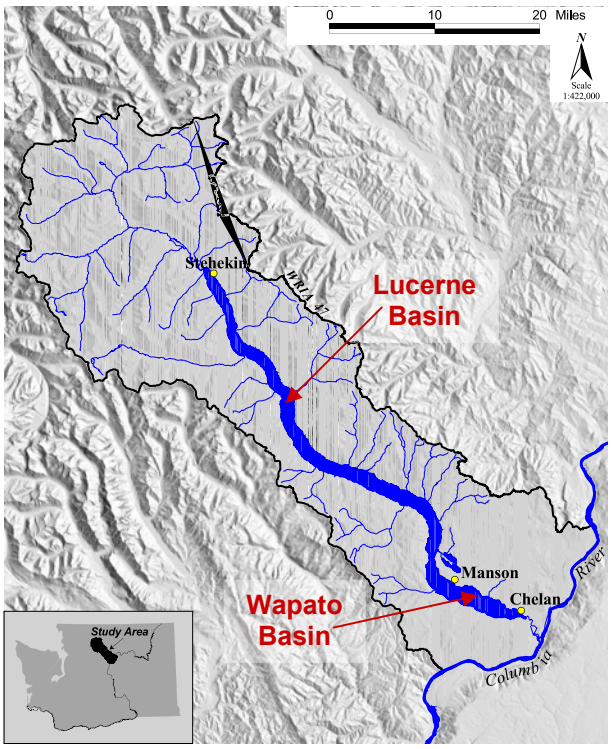

Figure 1: Study area map for the Lake Chelan basin DDT and PCB TMDL

Results of Field Study

WATER

Five water surveys from Lake Chelan tributaries and irrigation drains were conducted between May and November 2003. Total DDT in the Wapato basin discharges ranged from 0.13 to 36 ng/L. Human health and aquatic life (chronic exposure) criteria were routinely exceeded (Figure 2).

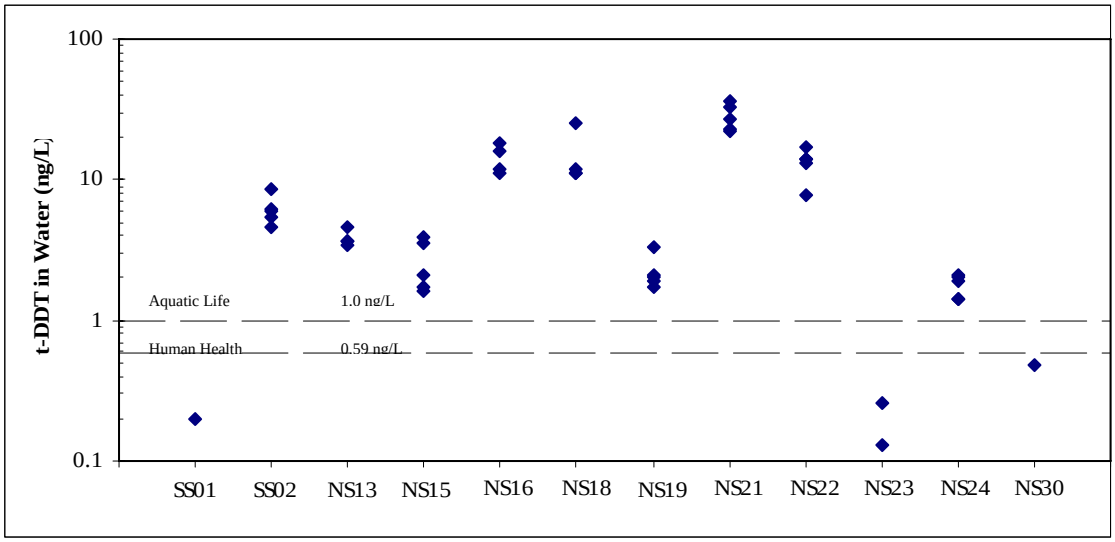

Figure 2: Exceedences of Human Health water quality criteria and Aquatic Life criteria in Lake Chelan Drainage, May – November 2003 (ng/L). Aquatic life criterion = 1.0 ng/L (parts per trillion). Human health criterion = 0.59 ng/L. See Figure 4 for sampling stations map.

- The highest DDT loads were from the Keupkin Street site (NS21) at 43 mg/day, followed by Buck Orchards (NS22), and Purtteman Creek (NS15) at 6.1 and 5.8 mg/day, respectively.
- Concentrations of DDT, DDE, DDD and PCBs, were determined in Lake Chelan waters using semipermeable membrane devices (SPMDs). SPMDs were deployed in each basin between 180 and 200 feet for a month in May, July and October. In Wapato basin total DDT was highest in spring (25 ng/L) followed by summer (18 ng/L), and fall (4.3 ng/L). Lake water concentrations during May and June for total DDT were two orders of magnitude higher in the Wapato basin than in the Lucerne basin. PCBs were generally not detected in SPMDs. Total DDT exceeded human health and aquatic life criteria (chronic) in Wapato basin through the sample period.

SEDIMENT

- Surface sediments were collected from 17 sites along a longitudinal transect within Lake Chelan. Three additional alluvial samples were collected below major tributaries to the lake. Total DDT concentrations in Wapato basin sediments averaged 560 *u*g/Kg, compared to 120 *u*g/Kg for Lucerne (Figure 3). Results for PCBs were low, ranging from 1.2 to 2.7 *u*g/Kg, and were mainly detected in the Wapato basin.

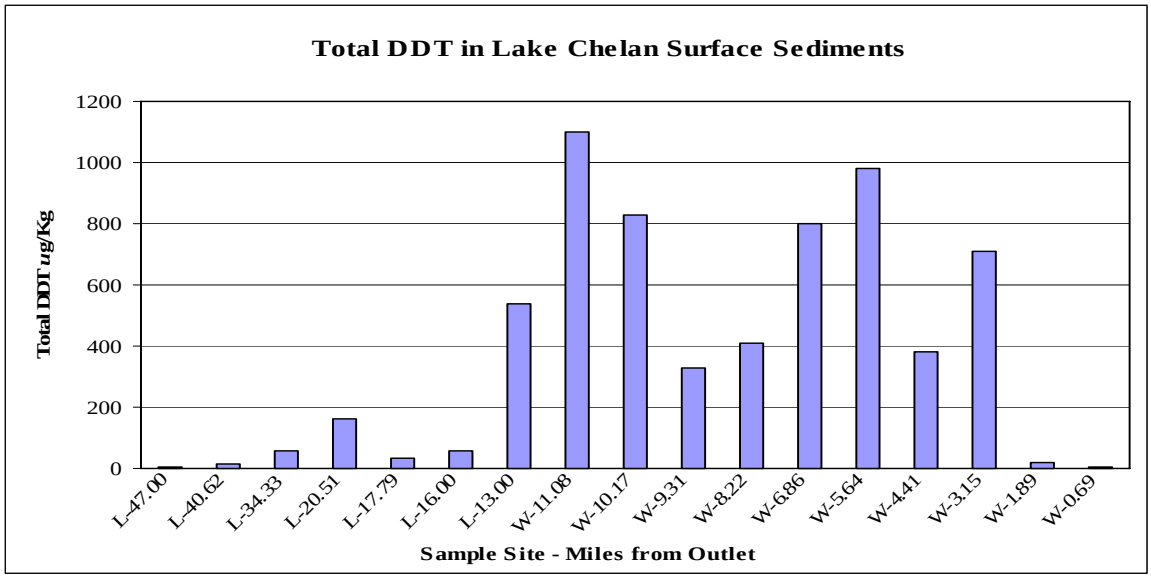

Figure 3: Total DDT levels in surface sediments of Lake Chelan June 2003.

The state of Washington has not promulgated standards for freshwater sediments. However, a number of guidance values are available in the scientific literature that can be used to evaluate the sediment results for DDT (see Table 1). The average sediment concentration of total DDT in both Lucerne and Wapato basins exceed threshold effects guidance levels. Concentrations of total DDT in several locations within Wapato Basin also exceed the consensus-based probable effects concentration for total DDT.

Table 1: Selected Freshwater Sediment Quality Guidance Values for Total DDT and Total PCBs (µg/Kg. dw)

Freshwater Sediment Quality Value	Total DDT	Total PCBs	Effects Level
Apparent Effects Threshold (AET)	NA	21[a]	Level above which biological effects have always been observed.
Floating Percentile Method (FPM)	NA	60[a]	Proposed level which optimizes reliability and sensitivity in predicting adverse biological effects.
Threshold Effects Level (TEL)	7[b]	34.1[b]	Represents the concentration below which adverse effects are expected to occur only rarely.
Consensus-Based Threshold Effect Concentration (TEC)	5.3[c]	59.8[c]	Concentration below which harmful effects on sediment-dwelling organisms are not expected.
Consensus-Based Probable Effect Concentration (PEC)	572[c]	676[c]	Concentration above which harmful effects on sediment-dwelling organisms are expected to occur frequently.

NA = Data not available
a = Avocet Consulting 2002; 2003
b = Smith et al. 1996
c = MacDonald et al. 2000

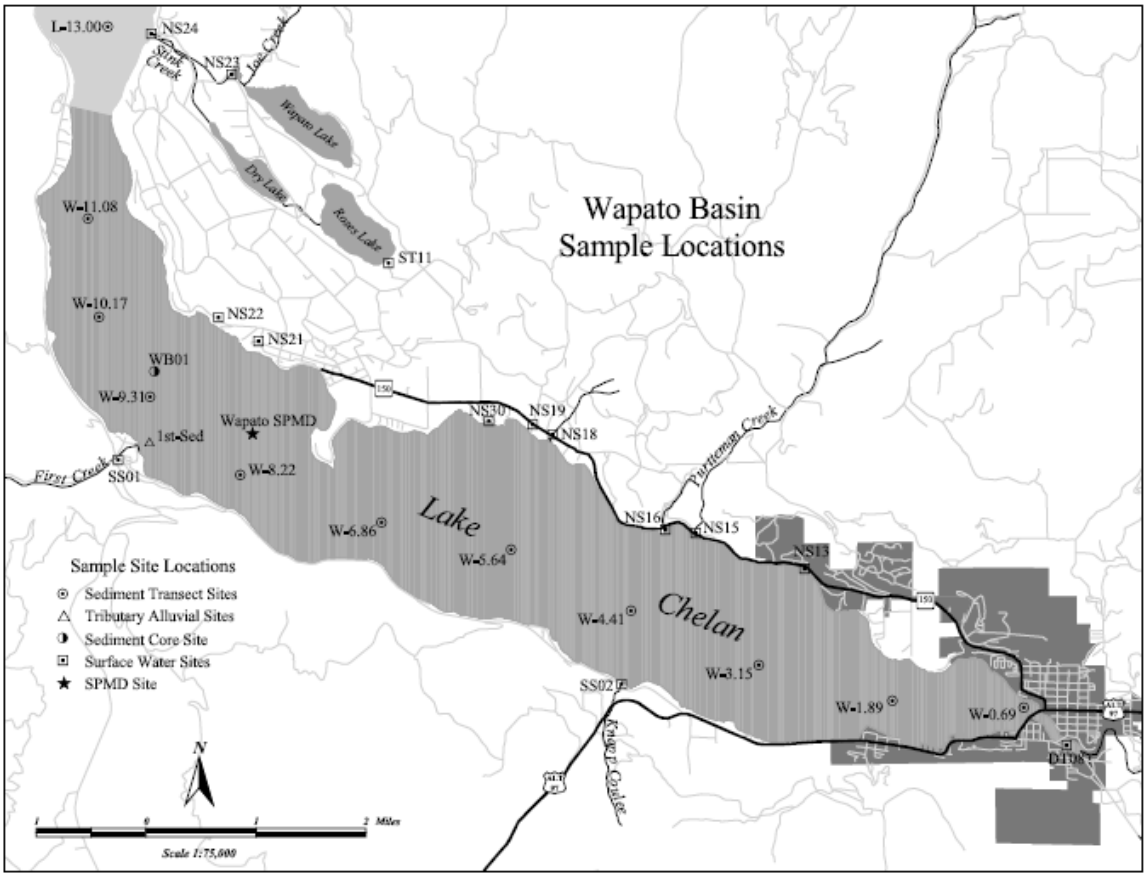

Figure 4: Wapato Basin Sampling Stations

- Two shallow (0-40 cm) sediment cores were collected, one from each basin. Sedimentation rates were estimated using Pb^{210} (lead) methods. Sedimentation rates were low compared to other Washington lakes, at 0.19 cm/yr for Lucerne basin, and 0.092 cm/yr for the Wapato basin although the results suggest possible disturbance to the sediment record. Concentrations of total DDT in the Wapato basin core were an order of magnitude higher than in the Lucerne basin core. The peak total DDT concentration in the Wapato basin core was 930 *u*g/Kg compared to the mean of 560 *u*g/Kg in transect surface sediments from the Wapato basin. PCBs were not detected. Because the sediment core results from the Wapato basin suggest disturbance to the record, further sediment core sampling in the Wapato basin is recommended to verify sedimentation rates.

FISH

- Roughly 200 game fish were collected and analyzed from Lake Chelan and Roses Lake. Species included burbot, mackinaw (lake trout), kokanee, rainbow trout, and black crappie. Concentrations of total DDT were measured up to 2,400 *u*g/Kg in Wapato basin fish. The

highest concentrations were found in mackinaw, followed by burbot, kokanee, and rainbow trout. Concentrations of total PCBs were much lower than total DDT ranging from <2 to 48 *u*g/Kg.

- A subset of mackinaw and burbot tissue samples was analyzed for polychlorinated dibenzo-p and polychlorinated dibenzofurans. Tissue analysis showed Dioxin 2,3,7,8 TCDD toxic equivalent quotients (TEQs) from mackinaw tissue were an order of magnitude above criterion, while Lucerne basin burbot were only slightly above. Lake Chelan has been listed for Dioxins on the 2004 303(d) list and will be addressed at a later date.

TMDL Target Reductions

Water quality targets for total DDT and total PCBs in edible fish tissue from Lake Chelan's Wapato basin and Roses Lake are the National Toxics Rule (NTR) human health criteria. NTR criteria establish that levels in edible fish tissue shall not exceed 32 *u*g/Kg for total DDT and 5.3 *u*g/Kg for total PCBs.

A percent reduction of current load approach was used to meet the water quality targets. These percent reductions represent the amount of pollutant load that must be reduced to meet the water quality targets. The needed reduction of total DDT and total PCBs in fish tissue was based on the fish species with the highest mean concentration from each lake. Mackinaw from Lake Chelan's Wapato basin and rainbow trout from Roses Lake were selected. Wapato basin fish will require a 97 percent reduction in total DDT and a 63 percent reduction in total PCBs to meet water quality targets. Roses Lake fish will require a 67 percent reduction in total DDT to meet water quality targets.

Tributaries and irrigation drains to the lakes also require reductions in current loading of total DDT. Target loads for discharges to the lakes were based on the Washington State standard (chronic) for protection of aquatic life from DDT and metabolites (1.0 ng/L) and the harmonic mean flow from discharge measurements completed when water samples were collected. Current loads, allowable loads, and reductions needed to meet criteria for the tributaries, irrigation drains, and Roses Lake orchard drain are shown in Table 2.

Table 2: Current Total DDT Loads and Reductions Needed in Tributaries and Irrigation Drains.

Lake Chelan Tributary or Irrigation Drain	Current Total DDT Load (mg/day)	Allowable Total DDT Load (mg/day)	Load Reduction Needed (mg/day)	Percent Reduction Needed
First Creek - SS01	2.2	12	0	0
Knapp Coulee - SS02	2.4	0.39	2.0	84
Culvert at Crystal View - NS13	0.14	0.04	0.10	71
Purtteman Creek - NS15	5.8	2.3	3.5	60
Culvert at Veroske's - NS16	3.00	0.21	2.8	93
Cooper drainage - NS18	1.5	0.10	1.4	93
Bennet Road - NS19	0.29	0.13	0.16	55
Keupkin Street - NS21	43	1.5	42	97
Buck Orchards - NS22	6.1	0.46	5.6	92
Wapato Lake/Joe Creek - NS23	0.04	0.22	0	0
Stink Creek - NS24	1.9	1.1	0.80	42
Mill Bay boat ramp - NS30	0.02	0.05	0	0
Totals	66.4	18.5	58.4	
Roses Lake Orchard Drain				
ST11	3.2	0.15	3.1	95

Conclusions and Recommendations

- Upon review of the Department of Ecology TMDL study, the Washington State Department of Health has continued a fish consumption advisory for mackinaw in Lake Chelan, which was initially issued in 2003 following a USEPA study.
- Fish tissue contaminant monitoring should be conducted every five years to track progress toward achieving targets. Mackinaw should be selected for collection and analysis, as they provide a worst case scenario for total DDT and PCB concentrations in fish.
- Natural attenuation is the best management strategy for total DDT in Lake Chelan and Roses Lake sediments. Active removal of total DDT laden sediments from Lake Chelan is probably not an option considering size, depth, and the disturbance to fish and invertebrate communities, and habitat.
- Developed wetlands could be a treatment option available for reducing DDT in tributaries and irrigation drains.
- An evaluation of total DDT concentrations in the water column in the Wapato basin should be conducted to better quantify spatial and temporal variations. PCBs were generally not detected in water column sampling.

- An evaluation of the potential contribution of total DDT loading from groundwater to the Wapato basin should be conducted.
- Further investigate fish uptake mechanisms of DDT and PCBs through the sediment, water, plants, and aquatic biota.

Components of the TMDL

The Washington State Department of Ecology (Ecology) is establishing a total maximum daily load (TMDL) for Lake Chelan, Roses (Alkali) Lake and their tributaries concerning the water quality pollutants of DDT and PCB. This TMDL will address potential impairments of beneficial uses as listed in the 1998 Section 303(d) list of Washington State's impaired surface waters for WRIA 47, Chelan Watershed. The five components of any TMDL as required by the Clean Water Act are defined as:

Loading Capacity: The maximum amount of pollutant loading that a receiving water can absorb without violating the respective state water quality standard.

Wasteload Allocation: That portion of a receiving water's loading capacity that is allocated, or attributed, to existing or potential point sources of pollution. There are no known point sources of DDT and PCB within the Lake Chelan watershed; therefore, the wasteload allocations for these pollutants are zero.

Load Allocation: That portion of a receiving water's loading capacity that is attributed either to one of its existing or potential non-point sources of pollution or to natural background sources. Non-point sources of DDT and PCBs are the only sources of these pollutants in the Lake Chelan watershed. Potential non-point sources include agricultural irrigation return waters, urban and rural runoff, stormwater discharges and aerial deposition.

Summary Implementation Strategy: The summary implementation strategy (SIS) identifies a strategy that will be developed into a detailed implementation plan for the watershed to address pollutants. Successful completion of the actions, effectiveness monitoring, and adaptive management are expected to result in water quality standards being met over time.

Margin of Safety: The TMDL must consider a margin of safety (MOS) that takes into account any lack of knowledge about causes of the water quality problem or its loading capacity. The sum of the individual allocations and the MOS must be equal to or less than the loading capacity. The size of the MOS is inversely proportional to the confidence in the data utilized in the calculations of load allocations. The MOS should list specific inherent conservative assumptions and critical conditions that demonstrate implicit and/or explicit margins of safety and list the specific allocations.

Seasonal Variation: The TMDL should take into account the seasonal variation of the parameters of concern.

Reasonable Assurance: The TMDL should describe how implementation actions, monitoring, and adaptive management will reasonably achieve water quality standards by the target dates set. Reasonable assurance is required only where point sources exceed the water standards, and therefore non-point sources must be consistently reduced in order to compensate for any such exceedances. Because this is not the case in the Lake Chelan watershed, reasonable assurances are not required. However, with the implementation actions identified in this TMDL, funding, ongoing monitoring, and adaptive management, Ecology and the Lake Chelan Water Quality Committee can provide reasonable assurance that non point source goals will be achieved within the timeline proposed in Table 12.

Adaptive Management: The TMDL should describe how Ecology and the participating entities will track progress over time and adaptively manage actions so that changes can be made where necessary to achieve water quality standards.

Introduction

Section 303(d) of the federal Clean Water Act (CWA) mandates that the state of Washington (state) establish Total Maximum Daily Loads (TMDLs) for surface waters that do not meet standards after application of technology-based pollution controls. The U.S. Environmental Protection Agency (EPA) has established regulations (40 CFR Part 130) and developed guidance (EPA, 1991) for setting TMDLs.

Under the CWA, 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 numeric standards, to achieve those uses. When a water body fails to meet water quality standards after application of required technology-based controls, the CWA requires that the state place the water body on a list of "impaired" water bodies and to prepare an analysis called a TMDL.

The goal of a total maximum daily load (TMDL) study is to ensure that an impaired water body attains water quality standards within a reasonable period of time. The Summary Implementation Strategy section identifies actions that should be implemented and potential contributing entities to reduce dichloro-diphenyl-trichloroethane (DDT) and polychlorinated biphenyl (PCB) inputs to achieve water quality standards. A phased monitoring approach should be used to assess the effectiveness of DDT and PCB reduction efforts. It is anticipated that implementation actions should be completed by 2018. At the present time, insufficient historical data and limited understanding of the dynamics of DDT and PCB cycling within Lake Chelan are available to accurately determine the time required to meet the state's water quality standards through natural attenuation and implementation of the TMDL's actions. Adaptive management and planned studies that will be conducted during the Detailed Implementation Plan will allow development of a more accurate estimate. Currently, based on best professional judgment, it is anticipated that state water quality standards will likely be met by 2055.

A TMDL includes a written, quantitative assessment of water quality problems and of the pollutant sources that cause the problem. The TMDL determines the amount of a given pollutant, called the **loading capacity**, which can be discharged to the water body and still meet water quality standards and, subsequently, 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 (WLA)**. If the pollution comes from a diffuse source (referred to as a **non-point source**) such as farms, stormwater runoff, yards and gardens, construction sites etc., that share is called a **load allocation (LA)**.

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

The general purposes of this submittal report are to:

- Provide data from water quality sampling from throughout the Lake Chelan watershed;
- Provide an analysis of such data including the loading capacities for the pollutants of concern and the load allocations and margin of safety that will protect water quality, aquatic life and human health;
- Identify potential point and non-point sources of pollution;
- Summarize actions recommended for meeting water quality standards and ongoing monitoring to verify whether standards are being met; and
- Fulfill requirements of the federal CWA.

A detailed implementation plan (DIP) must be developed within one year after TMDL approval by EPA and will be based on the information presented in this document.

Background

Lake Chelan and Roses Lake are located in Chelan County (WRIA 47) near the north central part of the state of Washington (state), approximately 32 miles north of the city of Wenatchee. Lake Chelan is the longest (approximately 51 miles) and deepest (1,486 feet) natural lake in the state and is the third deepest freshwater lake in the nation. The lake is also very narrow (average of 1.5 miles) and has an average surface area of 32,980 acres. Roses Lake is a comparatively smaller lake (130 acres) with a mean depth of only 23 feet. A map of the watershed is shown in Figure 1. The Lake Chelan watershed is bordered by the Cascade Mountains to the west, by the Sawtooth Mountain Range to the north, by the Entiat and Chelan Mountains and the Glacier Peak complex to the south, and by the Columbia Plateau to the east.

The climate of the area surrounding Lake Chelan and Roses Lake is predominantly semi-arid typical of Eastern Washington (hot, dry summers and mild to severe winters). However, significant variations in climate exist between the two ends of the lake. Average annual precipitation at the upper end of the lake is 35 inches, the majority of which is snowfall from November through March; whereas, the average annual precipitation at the lower end of the lake is

10.8 inches. Air temperatures fluctuate widely with the seasons, with a summer (July) average maximum temperature of 86.4°F and a winter (January) average minimum temperature of 19.8F. Extreme recorded temperatures range from a low of minus 15°F to a high of 106°F.

Lake Chelan was formed by glacial scouring action, which left a steep-sloped fjord formed into the area's granodiorite bedrock. Lake Chelan is divided into two distinct basins, partially separated by a glacial sill near Hollywood Beach that is commonly referred to as the "narrows". In fact, the two basins were created by two independent glaciers that met and then formed the sill as they retreated. The larger of the basins, the Lucerne Basin (northern basin), contains over 92 percent of the lake's total volume (74 percent of lake area) and reaches a maximum depth of 1,486 feet. The smaller basin, Wapato Basin (southern basin), receives most of its water input from the Lucerne Basin and has a maximum depth of only 400 feet.

Lake Chelan is considered pristine due to its ultra-oligotrophic conditions: relatively deep, nutrient poor, high clarity and little organic matter. The two major water sources to the lake are the Stehekin River (65 percent of inflow) and Railroad Creek (10 percent of inflow). In addition, there are more than 50 smaller tributaries to the lake, many of which are ephemeral. Due to the shape of the valley, most tributaries are steeply incised with cobble, boulder and large gravel substrate and relatively short in length.

The water in Lake Chelan is utilized for domestic and irrigation supply, fisheries, power production, transportation, and extensive water recreation, especially during the summer. Its hydroelectric dam was constructed in 1927 and raised the water level of the lake by 21 feet. Before that, beginning in 1892, a series of wooden structures were constructed for damming purposes so that boats could reach the town of Chelan.

The water level in Lake Chelan is replenished during May through June, when the lake is refilling from spring runoff. The highest water levels (maximum elevation of 1,100 feet) are maintained during July through September. The lake is drawn down beginning in early October to provide for the generation of electrical power to a potential minimum elevation of 1,079 feet. There has never been a need, however, for the water elevation to reach that minimum level.

The upper end of Lake Chelan is surrounded by mountainous terrain, often so steep that there are no beaches, with approximately 50 miles of shoreline in National Forest lands and 12 miles in National Park lands. The terrain of the lower end of the lake is much less severe and is primarily in private ownership and is a highly popular area for summertime recreation.

Table 3 details the existing land use within the Lake Chelan watershed. More than ninety percent of the watershed is surrounded by forests, with moderately dense Douglas fir forest along the upper end of the lake, and sparse mixed ponderosa pine and shrub-steppe (sage/bitter brush) vegetation along its lower end. Agriculture comprises approximately 3.5 percent of the land area, almost all of which is located around the southeastern lower end (Wapato Basin) of the lake. Urban areas comprise less than one percent and include the cities of Chelan and Manson in the Wapato Basin and the smaller towns of Stehekin, Lucerne, and Holden that are in the Lucerne Basin of the lake. The Wapato Basin has recently experienced a rapid and significant increase in development.

Table 3: Land Use within the Lake Chelan Watershed

LAND USE	AREA (KM^2)	PERCENT OF TOTAL
Lake Chelan	135	5.6
Other Water Bodies	4	0.2
Forested Public Lands	2,000	83.6
Forested Private Lands	163	6.8
Agriculture – Orchard	47	2.3
Agriculture – Non-Orchard	31	1.3
Urban	7	0.2
Roadways	6	0.2
Total	**2,393**	**100.0**

Lake Chelan supports a substantial variety of both cold-water and warm-water fish species, some of which were introduced by man. The native species are: cutthroat trout, bull trout, pygmy and mountain whitefish, burbot (freshwater ling cod), northern pikeminnow, redside shiners, slimy sculpin, lake chub, peamouth chub, bridgelip sucker, largescaler sucker, longnose sucker, and threespine stickleback. Introduced species include: rainbow trout, landlocked sockeye salmon (kokanee), landlocked Chinook salmon, lake trout (mackinaw), brook trout, grayling, smallmouth bass, black crappie, carp, tench and bluegill.

Roses Lake (also called Alkali Lake) is one of a cluster of three small lakes often referred to as Manson Lakes that are surrounded by many fruit orchards. These lakes are located about one mile north of the city of Manson, which itself is located near the division between the Lucerne Basin and the Wapato Basin. The other two lakes are Wapato Lake and Dry Lake. Roses Lake drains into Dry Lake, which then drains into Lake Chelan by way of Stink Creek.

Roses Lake has only one major surface water source, an irrigation drain. Ground water is a major source of water to Roses Lake. The Washington State Department of Fish and Wildlife (WDFW) stock the lake with rainbow trout, brown trout and black crappie; although, other warm water species exist

(bullhead and panfish). All of the climatic and geologic conditions associated with Roses Lake are similar to those associated with the Wapato Basin of Lake Chelan.

Applicable Water Quality Standards

Chapter 173-201A of the Washington Administrative Code (WAC) classifies the surface waters of Lake Chelan as "lake class". Under these standards, feeder streams to a lake are classified as Class AA (extraordinary). The characteristic uses defined in the WAC for lake class and Class AA waters, include but are not limited to the following (Chapter 173-201A-030[5] WAC):

(i) Water supply (domestic, industrial, 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.

Toxic substances are addressed in the water quality standards under WAC 173-201A-030(c)(vii):

> *Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristics water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).*

Other passages addressing toxic substances found in WAC 173-201A-040 are as follows:

(1) Toxic substances shall not be introduced above natural background levels in waters of the state which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic toxicity to the most sensitive biota dependent on those waters, or adversely affect public health, as determined by the department.

(2) The department shall employ or require chemical testing, acute and chronic toxicity testing, and biological assessments, as appropriate, to evaluate

compliance with subsection (1) of this section and to ensure that aquatic communities and the existing and characteristic beneficial uses of waters are being fully protected.

(5) Concentrations of toxic, and other substances with toxic propensities not listed in subsection (3) of this section shall be determined in consideration of USEPA Quality Criteria for Water, 1986, and as revised, and other relevant information as appropriate. Human health-based water quality criteria used by the state are contained in 40 CFR 131.36 (known as the National Toxics Rule).

(6) Risk-based criteria for carcinogenic substances shall be selected such that the upperbound excess cancer risk is less than or equal to one in one million.

In 1992, EPA issued water quality criteria for the protection of human health from priority pollutants in the National Toxics Rule (40 CFR 131.36). Washington's human health criteria are specified and contained in this federal rule. Human health criteria are calculated for an increased lifetime cancer risk of one in one million (10^{-6}) from the consumption of fish or water. Water quality criteria that apply to the 303(d) listed chemicals addressed in this TMDL for Lake Chelan basin are shown in Table 4.

Table 4: Chemical - Criteria for Protection of Aquatic Life – Criteria for Protection of Human Health

	Criteria for Protection of Aquatic Life		Criteria for Protection of Human Health		
Chemical	**Freshwater Acute (ng/L)**	**Freshwater Chronic (ng/L)**	**Water and Fish Consumption (ng/L)**	**Fish Consumption (ng/L)**	**Fish Tissue**
4,4'-DDT			0.59	0.59	32 ug/Kg
4,4'-DDE			0.59	0.59	32 ug/Kg
4,4-DDD			0.83	0.84	45 ug/Kg
DDT and metabolites	1,100	1.0			
PCBs	2,000	14	0.17	0.17	5.3 ug/Kg

The state of Washington has not promulgated standards for freshwater sediments. However, a number of guidance values are available in the scientific literature that can be used to evaluate the sediment results for DDT (see Table 5). The average sediment concentration of total DDT in both Lucerne and Wapato basins exceed threshold effects guidance levels. Concentrations of total DDT in several locations within Wapato Basin also exceed the consensus-based probable effects concentration for total DDT.

Table 5: Selected Freshwater Sediment Quality Guidance Values for Total DDT and Total PCBs (µg/Kg. dw)

Freshwater Sediment Quality Value	Total DDT	Total PCBs	Effects Level
Apparent Effects Threshold (AET)	NA	21[a]	Level above which biological effects have always been observed.
Floating Percentile Method (FPM)	NA	60[a]	Proposed level which optimizes reliability and sensitivity in predicting adverse biological effects.
Threshold Effects Level (TEL)	7[b]	34.1[b]	Represents the concentration below which adverse effects are expected to occur only rarely.
Consensus-Based Threshold Effect Concentration (TEC)	5.3[c]	59.8[c]	Concentration below which harmful effects on sediment-dwelling organisms are not expected.
Consensus-Based Probable Effect Concentration (PEC)	572[c]	676[c]	Concentration above which harmful effects on sediment-dwelling organisms are expected to occur frequently.

NA = Data not available
a = Avocet Consulting 2002; 2003
b = Smith et al. 1996
c = MacDonald et al. 2000

Water Quality and Resource Impairments

In 1998, Lake Chelan and Roses Lake were included on the state's 303(d) list of impaired waters due to water quality standard violations for 4,4'-DDE, PCB-1254 and PCB-1260. The *Lake Chelan Watershed DDT and PCB TMDL* covers all of the water bodies within the Lake Chelan watershed, including tributaries, from the headwaters of the Stehekin River to the point of discharge (Chelan River) to the Columbia River. Table 6 details all of the 1998 303(d) listings, for fish tissue, that will be addressed by the TMDL.

Table 6: 1998 303(d) Listings for Lake Chelan and Roses Lake

Water Body	Parameter	Listing #	Old Segment #	New Segment #	Water Body Class
Lake Chelan	4, 4'-DDE	8963	WA-47-9020	292NWR	Lake
Lake Chelan	Total PCBs	8964	WA-47-9020	292NWR	Lake
Roses (Alkali) Lake	4, 4'-DDE	8966	WA-47-9037	370XQC	Lake

Table 7 below details additional impaired water body listings from the 2004 303(d) list that were not contained in the 1998 303(d) listings above, and are addressed by the *Lake Chelan Watershed DDT, PCB, TMDL*.

Table 7: 2004 303(d) Listings for Lake Chelan

Water Body	Parameter	Listing #	Old Segment #	New Segment #	Water Body Class
Lake Chelan	4,4'-DDD	14325	WA-47-9020	292NWR	Lake
Lake Chelan	4,4'-DDE	14326	WA-47-9020	292NWR	Lake
Lake Chelan	4,4'-DDT	14324	WA-47-9020	292NWR	Lake
Lake Chelan	4,4'-DDT	36426	WA-47-9020	292NWR	Lake
Lake Chelan	Total PCBs	14328	WA-47-9020	292NWR	Lake

It should be noted that: (1) all of the additional impaired waterbody listings contained in Table 3 of the first draft of this report were mistakenly labeled as from the Chelan River, since later investigation determined that they actually were collected from Lake Chelan; (2) the Total PCBs listing in Table 3 of the first draft was removed from the present draft, as it represented a combined listing of PCB-1254 and PCB-1260 from Table 6, above, and therefore was not a true new listing; (3) the 4',4-DDE listing in Table 3 of the first draft was removed from the present draft, as it represented the same 4',4-DDE listing in Table 6, above, and therefore was not a true new listing.

Additionally, the following tributaries and irrigation drains were identified as exceeding DDT standards during the TMDL study and will be addressed in the TMDL:

Lake Chelan Tributary or Irrigation Drain	TMDL Study Site
Knapp Coulee	SS02
Culvert at Crystal View	NS13
Purtteman Creek	NS15
Culvert at Veroske's	NS16
Cooper Drainage	NS18
Bennet Road	NS19
Keupkin Street	NS21
Buck Orchards	NS22
Stink Creek	NS24
Roses lake Orchard Drain	ST11

DDT is a chlorinated insecticide that was heavily used in orchard lands throughout the state, including the Lake Chelan watershed, from the early 1940's when it was developed until it was banned in 1972.

PCBs are chlorinated compounds that were widely used in industrial applications as insulating fluids, plasticizers, carbonless paper ink, heat transfer and hydraulic fluids, as well as a variety of other uses (e.g. marine paints). EPA phased out the use and manufacture of PCBs in 1979. Specific sources of PCBs in the watershed are unknown but numerous sources are potential with atmospheric deposition extremely probable, since PCBs volatilize easily and have been known to travel great distances. In fact, they are routinely found in locations unassociated with its use, like the polar regions of earth.

DDT and PCB levels in the United States environment have been declining for the last 30 years due to reductions in manmade sources. However, these toxins break down so slowly that residue from past releases may still be in the environment many years from now. DDT and PCBs have also been shown to be highly persistent in the aquatic environment. In aquatic environments, these

pollutants are often found in greatest concentrations in sediment and in the fatty tissues of fish and other organisms. Concentrations of these pollutants can increase as they proceed through the food chain by a process known as biomagnification. Studies have shown that exposure to DDT and PCBs may cause a number of adverse health effects, including reproductive or developmental defects and cancer.

Seasonal Variation

Section 303(d)(1) of the CWA requires that TMDLs "be established at the level necessary to implement the applicable water quality standards with seasonal variations". The current regulation also states that determination of "TMDLs shall take into account critical conditions" [40 CFR 130.7(c)(1)]. Finally, Section 303(d)(1)(D) suggests consideration of normal conditions when no critical conditions exist.

A percent reduction approach in fish tissue contaminant concentrations was used for meeting water quality targets. The accumulation of DDT and PCBs in fish tissues is a time-integrative process. Both human health and chronic aquatic life criteria for DDT are driven by lifetime exposures (70 years). Therefore, there is no need to establish a "critical condition" season for DDT.

Although the data is limited, the total DDT concentrations measured in the Wapato basin water between 180 and 200 feet appear to follow a seasonal pattern. Average concentrations in the lake were highest in May and June, followed by July and August. The average concentration in October and November was less than a quarter of the level found in July and August. The higher springtime total DDT concentration likely results from a combination of the start of irrigation, wet season precipitation, increased ground water flows, and snowmelt.

The decline in total DDT from spring through fall suggests irrigation water may be associated with Wapato basin total DDT concentrations. One sample site in a water body the size of the Wapato basin is inadequate to draw any distinct conclusions about seasonal loading, but does suggest more study is needed. Concentrations of total DDT from tributaries and irrigation drains did not show the high to low response from spring to fall like in-lake concentrations.

The total DDT load estimates from tributaries and drains suggest there are other significant sources of DDT compounds in the basin, like groundwater entering the lake. This seasonal pattern for total DDT found in the Wapato basin was not seen in the Lucerne basin.

Technical Analysis

Historical Data

DDT

Water Column Data:

In June 2002, Ecology detected no DDT metabolites at concentrations in excess of 0.16 ng/L in water samples collected from the Lucerne Basin of Lake Chelan, nor in its respective tributaries. However, DDT was found in three small discharges to the Wapato Basin. In 1996 and 1997, the Chelan County Conservation District (CCCD) reported DDE concentrations as great as 110 ng/L, from Knapp Coulee, which is an order of magnitude higher than Ecology's 2003 data from the same site (SS02). The CCCD data was collected from agricultural irrigation return water draining from orchard land.

Sediment Data:

Historical (1994) sediment analyses from the Wapato Basin and Roses Lake have contained the highest concentrations (1,196 µg/Kg) in the watershed. However, more recent (2004) sampling by the Lake Chelan Reclamation District (LCRD) and Ecology determined DDT sediment concentrations to be two orders of magnitude lower, at 46 µg/Kg. The decrease in DDT concentrations over the past 10 years suggests that substantial sediment dilution or burial may have occurred in Roses Lake.

The most extensive sediment survey was conducted by the Lake Chelan Water Quality Assessment (LCWQA, January 1989). The study found DDT sediments concentrations 51 to 699 µg/Kg) approximately 20 times greater in Wapato Basin than in the Lucerne Basin. The DDT was concluded to have been transported from the surrounding orchard land into the nearby Wapato Basin, but has not moved up into the upper Lucerne Basin (Patmont et al., 1989).

Fish Tissue Data:

Ecology first discovered elevated concentrations of DDT compounds in fish from Lake Chelan in 1982 as part of the Basic Water Monitoring Program (Hopkins and Clark, 1985). Since then, Ecology studies have shown continued high DDT concentrations in fish from Lake Chelan and Roses Lake. Such concentrations continually exceeded the NTR human health criterion for DDT.

Patmont (1989) found fish tissue DDT concentrations from Lake Chelan to be roughly three times higher than the national average and comparable to other highly agricultural water bodies in the state. In 2002, the EPA found DDT concentrations in Lake Chelan to be greater than 140 other lakes in a National

Fish Tissue Study. The specific species was mackinaw with a DDT level averaging 1,481 µg/Kg.

Very little data is available for fish in Roses Lake. In 1992, Ecology found DDT concentrations in rainbow trout as great as 103 µg/Kg (Serdar et al., 1994). These findings led to the 303(d) listing for 4,4'-DDE in that lake.

PCBs

Water Column and Sediment Data:

No historical data has previously been collected for PCBs in water and sediment.

Fish Tissue Data:

Ecology in 1992 and 1994 found PCB concentrations in Lake Chelan fish tissue ranged from 12 to 99 µg/Kg. In 2002, the EPA found PCB concentrations in mackinaw as great as 32.6 µg/Kg. This exceeds NTR Human Health criteria of 5.3 ug/Kg for total PCBs.

Current Data

Lake Chelan DDT and PCBs in Fish –A Total Maximum Daily Load Study **(See Appendix A for complete assessment)**

Study overview

The *Lake Chelan DDT and PCBs in Fish – A Total Maximum Daily Load Study* was directed at DDT and PCB contamination and transport in the aquatic environment and in fish tissue of Lake Chelan, Roses Lake and their tributaries. DDT levels exceeded water and fish tissue standards in the Wapato basin. PCB levels exceeded fish tissue standards. Inputs of DDT and PCBs will likely be a management issue for years into the future as their persistence in the environment is well documented.

Assessment results

Water

Five water sample surveys from Lake Chelan tributaries and agricultural drains were conducted between May and November of 2003. Samples were analyzed for 4,4'-DDT and its metabolites 4,4'-DDE and 4,4'-DDD (*i.e.*, total DDT). Total DDT concentrations in the Wapato basin discharges ranged from 0.13 to 36 ng/L. DDT and its metabolites were not detected in discharges to the Lucerne basin. Human health and aquatic life (chronic exposure) water quality criteria for DDT (0.59 and 1.0 ng/L, respectively) were routinely exceeded in the Wapato basin. PCBs were not analyzed for in tributaries and agricultural drains.

Total DDT loads (mg/day) from Wapato basin discharges to Lake Chelan were calculated using total DDT concentrations and flows (i.e., total DDT concentration times instantaneous flow). The Keupkin Street site ranked highest at 43 mg/day, followed by Buck Orchards and Purtteman Creek at 6.1 and 5.8 mg/day, respectively. Water from the Keupkin Street site was collected from an irrigation drain manhole in an orchard area above Manson. The annual total DDT load to Lake Chelan from discharges sampled during the study was estimated at 25 grams per year.

The dissolved fraction (portion available for biological uptake) of DDT plus metabolites and PCBs in Lake Chelan was measured by use of semipermeable membrane devices (SPMDs). One SPMD was deployed in each basin for about a month during May, July, and October of 2003. Estimates of lake water concentrations between 180 and 200 feet depth found total DDT was higher in the Wapato basin than in the Lucerne basin. Total DDT concentrations were highest in May and June, followed by July and August, and October and November. During May and June, estimated concentrations of total DDT in the Wapato basin were two orders of magnitude higher than in the Lucerne basin. PCBs were generally not detected in SPMDs.

Estimated total DDT concentrations from SPMDs were compared to human health and aquatic life (chronic exposure) water quality criteria. Levels of total DDT estimated for the Wapato basin from SPMDs routinely exceeded human health and aquatic life criteria. The Lucerne basin results exceeded the human health criterion for DDT slightly in the October to November sample and were always within criterion for chronic exposure to aquatic life.

Sediment

Surface sediments were collected at 20 locations within Lake Chelan. Three of these sites were alluvial, collected at the mouths of Railroad Creek, First Creek, and the Stehekin River. First Creek had the only alluvium sample with detectable total DDT, at a concentration of 11 *u*g/Kg. Concentrations of total DDT in Wapato basin sediments averaged 560 *u*g/Kg, compared to 120 *u*g/Kg in the Lucerne basin. Results for PCBs were low, ranging from 1.2 to 2.7 *u*g/Kg, and were mainly detected in the Wapato basin.

Two shallow (0 – 40 cm) sediment cores were collected, one each from the Lucerne and Wapato basins. The sedimentation rate for the Lucerne basin was estimated at 0.19 cm/yr. The Wapato basin rate (0.092 cm/yr) was estimated at about half the rate estimated for the Lucerne basin, although study data suggest possible problems with the dating estimate from the Wapato basin. These sedimentation rates are at the low end of the range reported for other Washington lakes. Total DDT concentrations in the Wapato core were an order

of magnitude higher than sediment of roughly the same age from the Lucerne core. PCBs were not detected in cores.

The accumulation pattern for total DDT in the Lucerne basin core was similar to a recent core Ecology collected from Lake Osoyoos. Accumulation patterns for the Wapato core suggest sediment disturbance to the record or possibly changes in sedimentation rates.

Fish

A total of 200 fish were collected and analyzed from Lake Chelan and Roses Lake. The species were burbot, mackinaw (lake trout), rainbow trout, and kokanee from Lake Chelan, and rainbow trout and black crappie from Roses Lake. Fish tissue samples were analyzed as five-fish composites of fillet tissue. Some mackinaw and rainbow trout were also analyzed individually.

Average concentrations of total DDT found in Lake Chelan fish were about four times higher than other fish tissue studies conducted in eastern Washington. Concentrations of PCBs in Lake Chelan fish, though still above the stringent 5.3 ug/Kg human health criterion for fish tissue, were only a fraction of the levels found in other eastern Washington studies.

Bioaccumulation factors (BAFs) represent the ratio of the concentration of a chemical in the tissue of an aquatic organism, from both diet and water exposure, to the concentration of the chemical in water. BAFs were calculated for total DDT in Lake Chelan fish using tissue concentrations and estimated dissolved water concentrations from SPMDs. The mean Lake Chelan BAF for total DDT was calculated to be 41,450. In the development of the state adopted human health criteria for DDT in fish tissue, EPA used a related parameter called the bioaccumulation concentration factor (BCF), which is the ratio of the chemical concentration in tissue from only water exposure to the concentration of the chemical in water. The EPA BCF value for DDT is 53,600. Based on the data collected, the EPA BCF value may be overly conservative for Lake Chelan. A BAF which includes exposure from both diet and water should have a higher value than a BCF which only includes exposure from water. The mean BAF measured for Lake Chelan fish is 23 percent lower than EPA's BCF value.

Assessment Recommendations

Water

The water quality and fish tissue quality associated with Lake Chelan and Roses Lake are being negatively impacted by DDT and PCBs. These chemicals do not occur naturally in the environment and thus indicate that anthropogenic activities are the only sources. The primary focus of the *Lake Chelan Watershed DDT and PCB TMDL* is the concentration of such pollutants in fish tissue, due to the

biomagnification of those pollutants. Recommendations for actions to meet water quality standards are primarily targeted for the Wapato basin of Lake Chelan and its respective tributaries.

An evaluation of the potential contribution of total DDT loading from groundwater to the Wapato basin should be conducted.

An evaluation of total DDT concentrations in the water column in the Wapato basin should be conducted to better quantify spatial and temporal variations.

Pollutant input to the lakes of the watershed should be limited as much as possible. It has been shown that tributary and irrigation drain sources require substantial load reductions to meet water quality criteria. The discharge point approach to load reduction does not identify specific sources. Loading could come from multiple sources that were quantified as one. Investigations of sub-basins would be required to identify any specific sources for load reductions.

Load reductions could occur through developed wetland treatment, if and where feasible. Developed wetlands may be one of the few treatment options available for reducing total DDT. Data from the Joe Creek site in the Lake Chelan Reclamation District study (Burgoon and Cross, 2000) and data from the Wapato Lake + Joe Creek site from this TMDL study suggest loads of total DDT through wetlands may be reduced to acceptable levels.

Sediment

Natural attenuation is the best management strategy for total DDT in Lake Chelan and Roses Lake sediments. Active removal of total DDT laden sediments from Lake Chelan is probably not an option considering size, depth, cost, and the disturbance to fish and invertebrate communities, and habitat.

Developed wetlands may be a promising treatment option available for reducing DDT laden sediment in tributaries and irrigation drains.

Fish

Upon review of the Department of Ecology TMDL study, the Washington State Department of Health (WDOH) has continued a fish consumption advisory for Mackinaw in Lake Chelan, which was initially issued in 2003 following a USEPA study. The study data clearly shows that lake trout are efficient in the bioaccumulation of DDT and PCBs. The WDOH should continue its fish consumption advisory for mackinaw. Public notice and posting at all public boat launches to Lake Chelan and Roses Lake should be completed. The public should be aware of potential problems from consuming fish in excess of recommended levels.

Fish tissue contaminant monitoring should be conducted every five years to track progress toward achieving targets. Mackinaw should be selected for collection and analysis, as they provide a worst case scenario for total DDT, PCB, and /furan concentrations in fish. Evaluating fish tissue concentrations will be required for a long time into the future.

Loading Capacity

Identification of the loading capacity is an important step in developing TMDLs. The loading capacity is the amount of pollution a water body can absorb and still meet water quality standards. There are no known point sources of either DDT or PCBs in the Lake Chelan watershed. As there are no point sources in the watershed, a percent reduction approach in fish tissue contaminant concentrations was used for meeting water quality targets for total DDT and PCBs in Lake Chelan.

Water

DDT

Water column DDT concentrations were estimated by use of semi-permeable membrane devices (SPMDs). Total DDT found in SPMDs exceeded the National Toxics Rule (NTR) criteria (0.59 ng/L) and aquatic life criteria (1.0 ng/L). As evidenced in SPMDs, the DDT concentrations in Lake Chelan's Wapato basin ranged from about 40 times the standard during May and June 2003, to about seven times in October and November 2003. Low DDT levels were found in the Lucerne basin, at about half the NTR criterion during May and June and slightly above the standard in October and November.

Surface water samples were also taken from tributaries and drains flowing into Lake Chelan. The NTR human health and aquatic life criteria for total DDT were routinely exceeded in the tributaries discharging to the Wapato basin. Detected total DDT concentrations in tributaries to Lake Chelan ranged from an estimated 0.13 ng/L to 36 ng/L.

The original review draft of the technical report calculated the loading capacity and percent reductions needed from irrigation drains and tributaries using the NTR standard for human health of 0.59 ng. The Lake Chelan Water Quality Committee (LCWQC) disputed the use of the more stringent NTR standard of .59 ng/L for tributaries and drains, preferring to use the NTR criterion for aquatic life of 1.0 ng/L. The LCWQC reasoned that the TMDL study data suggests in-lake concentrations may relate to significant groundwater influences. Also, existing t-DDT concentrations in the lake sediments and through the food chain may be a significant source of t-DDT impacting fish. Additionally, the NTR

criterion is based on human exposure to both drinking water and eating fish that lived in the water, over a 70-year period. The irrigation drains are not used for drinking water or contact recreation. First Creek is the only tributary in the Wapato Basin observed being used for fish habitat and currently requires no management because water quality was within criteria.

Ecology agreed that tributaries and drains are not the only source with measurable adverse impact on chronic toxicity to Lake Chelan, and with arguments about their uses. Additionally, in consideration of the dilution these discharges receive from the lake, the state criterion of 1.0 ng/L was used as the target for tributaries and drains.

Table 8 details the individual DDT loading capacities for the various tributaries and discharges that enter into the Wapato Basin of Lake Chelan (the basin that consistently exceeds the DDT and metabolite human health criterion). Table 9 details the individual loading capacities for the single discharge that enters Roses Lake.

Table 8: Lake Chelan Tributary Total DDT Loading Capacities

Tributary or Drain Site	Harmonic Mean Flow (ft^3/sec)	Loading Capacity (mg/day)
SS01 - First Creek	4.90	12
SS02 – Knapp Coulee	0.16	0.39
NS13 - Culvert at Crystal View	0.015	0.04
NS15 – Purtteman Creek	0.93	2.3
NS16 – Culvert at Veroske's	0.087	0.21
NS18 – Cooper drainage	0.041	0.10
NS19 – Bennet Road	0.054	0.13
NS21 – Keupkin Street	0.62	1.5
NS22 – Buck Orchards	0.19	0.46
NS23 – Wapato Lake + Joe Creek	0.09	0.22
NS24 – Stink Creek	0.44	1.1
NS30 – Mill Bay boat ramp	0.02	0.05
Total	N/A	18.5

Table 9: Roses Lake Tributary DDT Loading Capacities

Tributary or Drain Site	Harmonic Mean Flow (ft^3/sec)	Loading Capacity (mg/day)
ST11 - Orchard drain	0.061	0.15

PCBs

Water column PCB concentrations were estimated by use of semi-permeable membrane devices (SPMDs). Only the Wapato Basin of Lake Chelan was found to contain a detectable PCB concentration (0.003 ng/L); however, it did not exceed the stringent NTR (human health) water column criterion of 0.17 ng/L. Accordingly, there will only be a PCB fish tissue loading capacity for the Wapato basin and no water column loading capacity applicable to the *Lake Chelan Watershed DDT, PCB, TMDL.*

PCBs were not analyzed from surface water samples due to the difficulty in achieving detection with normal analytical techniques.

Two PCB transformer sites have been identified in the TMDL, one in a Manson orchard and one in Stehekin. These sites have been remediated. Also, the Lake Chelan Reclamation District has identified and removed nine transformers containing PCBs in the Manson area. See Summary Implementation Strategy. It is unknown if there are other dump sites around the lake that contain PCBs.

Fish Tissue

DDT

Loading capacity for DDT in fish tissue is based on the National Toxics Rule (NTR) human health criteria for edible fish tissue. The NTR has separate criterion for DDT, DDE, and DDD in fish tissue (see Table 4). This TMDL used the DDT and DDE criterion as the target for reductions needed in fish tissue compared to the mean total DDT concentration. The levels not to exceed for edible fish tissue are 32 *u*g/Kg for total DDT, 32 ug/Kg for DDE, and 45 ug/Kg for DDD.

A percent reduction approach in fish tissue contaminant concentrations was used for meeting the NTR human health targets. The mean concentrations of total DDT (943 ug/Kg) in Lake Chelan mackinaw were calculated to represent the current contaminant load in fish tissue and the basis for load reductions. Mackinaw had the highest mean concentrations in fish tissue, so basing reductions on mackinaw will allow a greater level of protection for consumers of all other species. A 97 percent reduction in total DDT is needed in edible fish tissue to meet the human health criteria in Lake Chelan.

The concentration of total DDT in rainbow trout tissue from Roses Lake was 96 ug/Kg. A 67 percent reduction is needed in edible fish tissue to meet the human health criteria in Roses Lake fish.

PCBs

Loading capacity for PCBs in fish tissue is based on the National Toxics Rule (NTR) human health criteria for edible fish tissue (5.3 ug/Kg). A percent reduction approach in fish tissue contaminant concentrations was used for meeting the NTR human health targets. The mean concentrations of total PCBs (14.5 ug/Kg) in Lake Chelan mackinaw were calculated to represent the current contaminant load in fish tissue and the basis for load reductions. A 63 percent reduction in total PCBs concentrations is needed in edible fish tissue to meet the human health criteria in Lake Chelan.

Wasteload and Load Allocations

There are no point sources of DDT or PCBs discharging to Lake Chelan and Roses Lake, so there are no wasteload allocations. The only sources of these pollutants are non-point sources, so the Lake Chelan Watershed DDT and PCB TMDL will contain load allocations. Loading of DDT to the lakes and tributaries of the watershed has been an ongoing process, since its application to orchards (1940's - 1970's), through irrigation return, groundwater, runoff, and soil erosion. The sources of PCBs are not as obvious, but probably include soil erosion, surface run-off, and aerial transport and deposition.

Wasteload Allocations

DDT

The wasteload allocation for DDT and metabolites is zero, as there are no known point sources of these pollutants.

PCBs

The wasteload allocation for PCBs is zero, as there are no point sources of that pollutant.

Load Allocations

DDT

DDT water quality targets for Lake Chelan and Roses Lake TMDLs are the National Toxics Rule (NTR) human health criteria for edible fish tissue. The NTR has separate criterion for DDT, DDE, and DDD in fish tissue (see Table 4). This TMDL used the DDT and DDE criterion as the target for reductions needed in fish tissue compared to the mean total DDT concentration.

A percent reduction approach in fish tissue contaminant concentrations was used for meeting the NTR human health targets. Mackinaw and burbot from Lake Chelan and rainbow trout from Roses Lake were used to determine the

reductions needed to meet water quality targets. These fish represent the species with the highest mean concentration of total DDT sampled from each water body.

Percent reduction calculations for fish tissue from the Wapato basin and Roses Lake are as follows:

Wapato Basin Fish

% Reduction total DDT = [(943 *u*g/Kg – 32 *u*g/Kg) / (943 *u*g/Kg)] x 100 = **97** %

Roses Lake Fish

% Reduction total DDT = [(96 *u*g/Kg – 32 *u*g/Kg) / (96 *u*g/Kg)] x 100 = **67** %

Tributaries and agricultural drains to the Wapato basin were also assigned needed percent reductions of current loads to meet water quality targets. These percent reductions represent the amount of the total daily pollutant load that the tributaries and drains must be reduced to meet water quality criteria. Water quality targets for tributary and drain discharges to Lake Chelan and Roses Lake are based on Washington State's standard, 1.0 ng/L, for the protection of aquatic life from DDT in the water column.

To calculate current and allowable loads, it was assumed that all total DDT loads to the lake are available for uptake and bioaccumulation by fish. The twelve tributary and drain sites to Lake Chelan were sampled on five occasions between May and November 2003. Sampling was conducted at different times of the year to incorporate the range of total DDT concentrations found in discharges around the Wapato basin. To compare allowable loads to existing loads into Lake Chelan, and to quantify the needed percent reductions to meet criterion, the mean instream study loads were calculated at the harmonic mean flow developed from the range of flow conditions. See TMDL Calculations section, page 54, of the TMDL study.

The current mean DDT contaminant loads, allowable TMDL loads, and load reductions needed to meet water quality criteria for discharges to Lake Chelan and Roses Lake are shown in Table 10 and 11.

Table 10: Lake Chelan Tributary Total DDT Load Allocations

Tributary or Discharge Site	Current t-DDT Load (mg/day)	Allowable Load (mg/day)	Needed Load Reduction (mg/day)	Needed % Reduction
SS01 - First Creek	2.2	12	0	0
SS02 – Knapp Coulee	2.4	0.39	2.0	84
NS13 – Culvert at Crystal View	0.14	0.04	0.10	71
NS15 – Purtteman Creek	5.8	2.3	3.5	60
NS16 – Culvert at Veroske's	3.0	0.21	2.8	93
NS18 – Cooper Drainage	1.5	0.10	1.4	93
NS19 – Bennet Road	0.29	0.13	0.16	55
NS21 – Keupkin Street	43	1.5	42	97
NS22 – Buck Orchards	6.1	0.46	5.6	92
NS23 – Wapato Lake + Joe Creek	0.04	0.22	0	0
NS24 – Stink Creek	1.9	1.1	0.80	42
NS30 – Mill Bay boat ramp	0.02	0.05	0	0
Total	66.4	18.5	58.4	

Table 11: Roses Lake Tributary DDT Load Allocation

Discharge Site	Current t-DDT Load (mg/day)	Allowable Load (mg/day)	Needed Load Reduction (mg/day)	Needed % Reduction
ST11 - Orchard Drain	3.2	0.15	3.1	95

PCBs

PCB water quality targets for the Lake Chelan TMDL are the National Toxics Rule (NTR) human health criteria for edible fish tissue (see Table 4). This TMDL used the NTR criterion as the target for reductions needed in fish tissue. The levels not to exceed are 5.3 ug/Kg for total PCBs.

A percent reduction approach in fish tissue contaminant concentrations was used for meeting the NTR human health targets. Mackinaw from Lake Chelan was used to determine the reductions needed to meet water quality targets. Mackinaw represents the species with the highest mean concentration of total PCBs sampled.

Percent reduction calculations for PCBs in fish tissue from the Wapato basin are as follows:

% Reduction total PCBs = [(14.5 *u*g/Kg – 5.3 *u*g/Kg) / (14.5 *u*g/Kg)] x 100 = **63** %

Margin of Safety

The federal 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 *Lake Chelan Watershed DDT and PCB TMDL* includes the following implicit conservative assumptions in the calculated load allocations, targets and recommendations:

- The average total DDT and total PCB concentrations in mackinaw tissue from Lake Chelan and rainbow trout from Roses Lake were used in load reductions needed in fish tissue. Using the total concentrations from the most contaminated fish species would increase the MOS for other species.
- Load reductions for total DDT needed in fish tissue were based on the lower criteria for individual DDT metabolites (4,4'-DDT + 4,4'-DDE - 32ug/Kg) instead of the average concentration including the higher criteria for 4,4' DDD of 45 ug/Kg.
- The mass of tributary and irrigation drain associated total DDT was assumed to be completely conserved. The allocations to tributaries and drains assume no loss by volatilization, photolysis, or biodegradation.
- DDT loading from tributaries and irrigation drains was considered 100 percent available for uptake and bioaccumulation by fish. No sediment associated fraction was considered in load allocation calculations.
- The TMDL assumed the water column has no assimilative capacity for total DDT above the water quality standard.
- The legacy contaminants addressed in this TMDL should continue to decline even after all regulatory criteria have been met, due to the absence of new sources, local management of the resources, and keeping the public informed on issues so they can help reduce contaminants in the system.

Summary Implementation Strategy

Implementation Overview

The summary implementation strategy (SIS) described in this section identifies actions that will be implemented in the watershed to address DDT, PCB, and pollutants. The actions listed were developed in partnership by the Lake Chelan Water Quality Committee and Ecology. Successful completion of the actions, effectiveness monitoring, and adaptive management will result in water quality standards being met over time. The SIS complies with the federal mandate of the Clean Water Act, state laws to control point and non-point source pollution, and the 1997 Memorandum of Agreement between EPA and Ecology. It is anticipated that implementation actions should be completed by 2018. At the present time, insufficient historical data and limited understanding of the dynamics of DDT cycling within Lake Chelan are available to accurately determine the time required to meet the state's water quality standards through natural attenuation and implementation of the TMDL's actions. Adaptive management and planned studies that will be conducted during the Detailed Implementation Plan phase (see below) will allow development of a more accurate estimate. Currently, based on best professional judgment, it is anticipated that state's water quality standards will likely be met by 2055.

The strategy to implement the TMDL is based upon completion of actions that will be outlined in this SIS and, later, more specifically described in a Detailed Implementation Plan (DIP). The DIP will be prepared within one year after the *Lake Chelan Watershed DDT and PCB TMDL* Submittal Report has been approved by EPA. The DIP will describe the specific implementation activities that will need to be performed by all of the various stakeholders in order to achieve the TMDL targets. The plan will identify in more detail how, when, and where monitoring activities will be implemented. Ecology and other entities will provide technical assistance and seek additional funding for these monitoring activities and any restoration activities that may be identified as the body of data grows. Public input will be sought to help prepare the plan.

Implementation Plan Development

The SIS is an outline of the activities identified for implementation of the *Lake Chelan Watershed DDT and PCB TMDL*

A citizen's workgroup, the Lake Chelan Water Quality Committee, was formed as the technical advisory committee (TAC) for the *Lake Chelan Watershed DDT and PCB TMDL* in order to serve as citizen representatives in the development of the TMDL and its implementation strategy. Groups represented in the TAC include agriculture, conservation districts, irrigation districts, local government, sewer districts, state, and federal agencies, community organizations, as well as other

interested parties. There is a high level of cooperation and communication between project participants, and their continued active pursuit of the goals of the TMDL.

Implementation Activities

The following previous studies have resulted in a list of implementation actions being conducted over time, which the Lake Chelan Water Quality Committee has been involved in, and is building upon in this TMDL (see Appendix G for detailed list of study conclusions and recommendations):

- Lake Chelan Water Quality Plan, (1991, R.W. Beck)
- Water Quality Trends and Characteristics of Agricultural Drains (1998, Lake Chelan Reclamation District)
- DDT and Phosphorous Movement in the Manson Lakes Drainage Basin (2004, Lake Chelan Reclamation District)
- Lake Chelan Dam, Federal Energy Commission Relicensing and 401 Certification, (2004, Department of Ecology)

The following early implementation actions have been conducted specific to this TMDL:

- The Lake Chelan Reclamation District worked with Chelan PUD to recycle nine of its old electrical transformers containing PCBs, at a cost to the District of $450,000 dollars.
- The Chelan PUD is providing information from its studies on water quality, fish, food web modeling, etc. related the FERC relicensing of the Chelan Dam.
- Electrical transformers containing PCBs and contaminated soils identified at the old Stehekin power station and a Manson orchard have been cleaned up.
- A public health notice for mackinaw consumption in Lake Chelan was issued by the Washington State Department of Health and Chelan-Douglas Health District.
- Brochures have been distributed educating residents about ways to protect water quality, such as environmental landscaping, boating practices, etc.
- News articles and radio interviews have been provided by committee members and elected officials.

The following recommendations and actions have been identified and are being conducted based on the Lake Chelan Watershed DDT, PCB TMDL study:

Lake Chelan DDT and PCBs in Fish Total Maximum Daily Load Study Recommendations and Actions (2005)

1. ***Recommendation***: The Washington State Department of Health should evaluate the need for fish consumption advisories for Lake Chelan and Roses Lake. If advisories are recommended, public notices should be posted at all public boat launches to the lakes. The public should be aware of potential problems from consuming fish in excess of recommended levels.

   Action: Upon review of the Department of Ecology TMDL study, the Washington State Department of Health continued a fish consumption advisory for mackinaw in Lake Chelan, which was initially issued in 2004 following a USEPA study. Brochures that were developed and distributed by the Chelan-Douglas Health District in 2004 were updated and redistributed at Health District offices, the National Park Service, and the City of Chelan. A news release was issued in September, 2005 and the public was informed. See news articles in Appendix B.

2. ***Recommendati****on*: DDT levels should be the primary focus for water quality managers in the Lake Chelan basin. PCB levels should be followed, but management options are more limited.

   Action: Management activities are being targeted primarily for DDT. However, PCB actions are being implemented, such as education, PCB transformer recycling, cleanup of old PCB sites, pesticide pickup days, etc. See PCBs below. PCBs levels will also be followed.

3. ***Recommendation***: Monitoring pollutant levels in mackinaw tissue allows an evaluation of the worst-case scenario for total DDT and PCBs in fish tissue. Until total DDT and PCBs in fish tissue are within acceptable levels, tissue concentrations should continue to be monitored. Because lake sediments act as a large source pool for pollutants, evaluating tissue concentrations will be required far into the future.

   Action: Monitoring is continuing. The Lake Chelan Water Quality Committee is currently implementing a Department of Ecology Centennial grant to continue monitoring sediment, soil, surface water, groundwater, and fish uptake mechanisms (Grant G0400274 - Lake Chelan TMDL Support Project). The grant provides $267,000 in Centennial funds from Ecology. An additional $89,000 is provided in cash match through an interlocal agreement between Chelan County, City of Chelan, Lake Chelan Reclamation District, Chelan County PUD, and the Lake Chelan Sewer District.

4. ***Recommendation***: Natural attenuation is the best management strategy for total DDT in Lake Chelan and Roses Lake sediments. Active removal of total-DDT-laden sediments from Lake Chelan is not an option, considering size

and depth, disturbance to fish and invertebrate communities, and damage to habitat. Natural attenuation is also the least costly of management options. The rate of attenuation in Roses Lake may be much greater than would be expected in Lake Chelan because of differences in productivity. It seems that natural attenuation in Roses Lake has improved sediment conditions, although fish tissue concentrations have not responded well.

Action: Continued monitoring will be conducted to compare natural attenuation of current DDT and PCB levels in Lake Chelan and Roses Lake with applied actions to reduce further inputs.

5. ***Recommendation***: Pollutant input to the Wapato basin of Lake Chelan and to Roses Lake should be controlled to the extent possible, to help in recovery and to avoid exacerbating conditions. It has been shown that tributary and irrigation drain sources require substantial load reductions to meet water quality criteria. The discharge point approach to load reduction does not identify specific sources. Loading could come from multiple sources that were quantified as one. Investigations of sub-basins would be required to identify any specific sources for load reductions.

   Action: Pollutant input to the Wapato basin of Lake Chelan and to Roses Lake will be addressed through several activities, including the following:

   A. TMDL Support Grant - The Lake Chelan Water Quality Committee is currently implementing a Department of Ecology grant which includes further identification of sources contributing DDT and PCBs to tributaries, irrigation drains, ground water, Roses Lake and Lake Chelan. The grant funds actions and monitoring to address soil, sediment, surface water, groundwater, fish uptake mechanisms, and education/outreach. Monitoring will continue over time to see if load reductions are being met.

   B. Agriculture: Historical use of DDT on fruit crops in the Wapato basin has been the main source to Lake Chelan and Roses Lake. DDT has been transported through erosion of agricultural soils on the surface and percolation of water through orchard soils to groundwater. Historical improvements in irrigation delivery systems have reduced soil erosion and sediment transport. Activities to reduce erosion and groundwater transport will be implemented, including:
      - Irrigation water management – The LCWQC and participating entities will work with growers and irrigation districts to encourage and implement practices that utilize water efficiently, which will improve crops, reduce surface runoff and deep percolation and in turn reduce DDT transport to ground and surface waters. Examples of practices include soil moisture monitoring, monitoring micro climates with weather stations, on-farm irrigation system evaluations, irrigation

scheduling models, utilization of new LCWQC information, utilization of new technologies and other BMPs.

- Constructed wetlands – Several sites have been identified as good locations for constructed wetlands including the outlet area of Dry Lake, Stink Creek drainage, Joe Creek drainage, and Cooper drainage. Sites with the highest DDT loads include the Keupkin Street drainage, Buck Orchards drainage, and Purtteman Creek drainage. These sites are located in agricultural areas. A wetland plan will be developed and implemented. See #6 below.
- Riparian vegetation buffers along streams and lakes – Sites will be identified and actions implemented to create and protect riparian vegetative buffers on agricultural and other land that includes streams and lakes shoreline in the watershed.
- Outreach, education, and technical assistance to growers – Activities will be identified and undertaken to provide ongoing outreach, education, and technical assistance to growers.
- Funding – Funding sources will be identified and applications submitted to provide funding for ongoing activities. The Department of Ecology will provide funding assistance through its grants/loans programs to implement actions and ongoing monitoring.

C. Development: Measures will be implemented to prevent DDT laden orchard soils disturbed during construction from being transmitted to streams and lakes in the watershed. Language requiring measures to prevent DDT laden soils from entering the waterways during and after construction will be developed by the Lake Chelan Water Quality Committee and included in Development ordinances, comprehensive plans, and critical area ordinances. The Eastern Washington Storm Water Manual will be utilized in developing ordinances, and guiding municipal and construction storm water practices.

D. Storm water: The LCWQC will research city and county municipal storm water systems (plans, deigns, capacities, discharge points, etc.). The LCWQC will develop and implement a prioritized list of projects for storm water management and filtration (rerouting lines, mechanical filtration, settling basins, wetlands, etc.). Storm water monitoring will be conducted through G0400274, Lake Chelan TMDL Support grant. Monitoring will be conducted associated with implementation of BMPs to document environmental results.

E. Best management Practices (BMPs): The Lake Chelan Water Quality Committee will develop a plan to implement a list of BMPs and locations to prevent DDT and PCBs from entering surface and ground waters. The

LCWQC will work with the community, growers, Forest Service, agencies, and individuals. Actions planned will include riparian vegetation plantings, exclusion fencing, irrigation water management, developed wetlands, mechanical filtration, and other BMPs.

F. Education and outreach: The Lake Chelan Water Quality Committee will conduct education and outreach activities for the community, growers, schools, media, etc. Activities may include workshops, news releases, media interviews, brochures, posters, curriculum, presentations, technical assistance, community forums, etc. Utilize previously developed brochures, flyers, news releases, and posters (see Appendix B).

   The Lake Chelan Water Quality Committee is currently implementing a Centennial Clean Water grant through the Department of Ecology (Grant G0400274 - Lake Chelan TMDL Support Project). The education/outreach component of the grant requires the following activities:

   1. Continue public outreach efforts of the Lake Chelan Water Quality Committee
   2. Provide local coordination of education/outreach for the DDT/PCB TMDL Supplemental Implementation Strategy (SIS) and Detailed Implementation Plan (DIP).
   3. Coordinate education/outreach and implementation efforts associated with ongoing monitoring.
   4. Document environmental benefits relating to efforts conducted with this project.

G. Pesticide Pickup program: Programs for the collection of banned pesticides have been successfully implemented in the Lake Chelan Watershed and Chelan County. The Washington State Department of Agriculture's Waste Pesticide Program held the first pesticide pick-up event in Chelan on October 17, 1999. A total of 6,076 pounds of pesticides were collected and 144 pounds of DDT were brought in.

   Five pick-up events have also been held in nearby Wenatchee from 2000 to 2004. A total of 40,199 pounds of pesticides were collected and 330 pounds of DDT were brought in.

   Six pick-up events have been held in nearby Orondo from 1998 to 2005. A total of 34,627 pounds of pesticides were collected and 248 pounds of DDT were brought in. Totals on the amount of DDT returned are not currently available for two Orondo pick-up events in 2004 and 2005.

Chelan County held an event on October 17, 2005. A total of 2,000 pounds of pesticides were turned in. The Lake Chelan Water Quality Committee coordinated an event on October 19, 2005. A total of 5,500 pounds of pesticides were collected. Totals on the amount of DDT returned are not currently available for these collections.

The Lake Chelan Water Quality Committee will continue to work with the USDA Waste Pesticide Program and hold more pick-up events to reduce the potential for inappropriate disposal or accidental loss and/or catastrophic loss of pesticides, PCBs, and other chemicals in the watershed.

H. Transformer Recycling: The Chelan PUD and National Park Service conducted collection and disposal efforts on PCB transformers around Lake Chelan during the 1970s. The Lake Chelan Reclamation District worked with Chelan PUD in 2003 and 2005 to recycle nine of its irrigation system's electrical transformers containing PCBs, at a cost to the LCRD of $450,000. The old transformers were trucked to a certified recycling center in Phoenix, AZ and Chelan PUD provided technical assistance by acquiring and installing the new PCB-free transformers for the LCRD. Electrical transformers containing PCBs and contaminated soils identified at the old Stehekin power station and a Manson orchard have been cleaned up. Continuing education and awareness, pick-up programs, and technical assistance will be implemented in the watershed to address this issue.

6. ***Recommendation***: Load reductions of target contaminants could occur just prior to discharge through developed wetland treatment, if and where feasible. Developed wetlands may be one of the few treatment options available for reducing total DDT. Data from the Joe Creek site in the Lake Chelan Reclamation District study (Burgoon and Cross, 2000) and data from the Wapato Lake + Joe Creek site from this TMDL study suggest loads of total DDT may be reduced through wetlands.

   Actions: A wetland plan will be developed and implemented to construct wetlands. Sites that have thus far been identified as good locations for constructed wetlands include: 1) outlet area of Dry Lake, 2) Stink Creek drainage 3) Joe Creek drainage, and 4) Cooper drainage. Sites with the highest DDT loads include: 5) Keupkin Street drainage, 6) Buck Orchards drainage, and 7) Purtteman Creek drainage. Additional locations and means to filter DDT laden water will be researched. Locations will be prioritized and budgeted. Funding will be solicited. Implementation will be scheduled as funding becomes available.

7. ***Recommendation***: An evaluation of total DDT concentrations in the water column from the Wapato basin should be conducted to better quantify spatial and temporal variations.

   Actions: The Lake Chelan Water Quality Committee is currently implementing a Centennial Clean Water grant through the Department of Ecology (Grant G0400274 - Lake Chelan TMDL Support Project). Further evaluation of DDT concentrations and movement in the water column is a tasked element of the grant.

8. ***Recommendation***: An evaluation of the importance of total DDT loading from groundwater to the Wapato basin should be conducted.

   Actions: The Lake Chelan Water Quality Committee will utilize its Centennial Clean Water grant (Grant G0400274 - Lake Chelan TMDL Support Project) to conduct monitoring and analysis to further characterize DDT loading into Lake Chelan from ground water. Future actions will be implemented based on the groundwater characterization.

Table 12 lists a schedule of implementation actions and potential contributors for the *Lake Chelan Watershed DDT, PCB, TMDL*.

Table 12: TMDL Implementation Actions and Potential Contributors

Implementation Action Item	**Potential Contributors**	2005-06	2007	2008-13	2013-18	2013	2018	2023	2028	2032	2037	2042	2047	2052	2055
Early implementation actions	LCWQC, LCRD, Jean Peterson, Ecology, City of Chelan, Chelan County, CDHD, WDOH, Chelan PUD, USFS, NPS	X													
Complete DIP	Ecology, LCWQC, EPA		X												
Implement #1 Mackinaw fish consumption advisory	WDOH, CDHD, Ecology, LCWQC	X													
Implement #2 Prioritize DDT management	Ecology, LCWQC, LCRD, CDHD, WDOH, City of Chelan, Chelan County, Chelan PUD, USFS, NPS			X	X										
Implement #3 Monitor fish and sediment	Ecology, LCWQC, WDFW, Chelan PUD, WDOH, CDHD		X	X	X	X	X	X	X	X	X	X	X	X	X
Implement #4 Monitor natural attenuation and BMPs	Ecology, LCWQC		X	X	X	X	X	X	X	X	X	X	X	X	X

Implementation Action Item	Potential Contributors	2005-06	2007	2008-13	2013-18	2013	2018	2023	2028	2032	2037	2042	2047	2052	2055
Implement #5 Control pollutant loading	Ecology, LCWQC, LCRD, City of Chelan, Chelan County, Chelan PUD, USFS, NPS, WSDA			X	X										
Implement #6 Develop and implement a wetland plan	Ecology, LCWQC, LCRD, City of Chelan, Chelan County, Chelan PUD, USFS, NPS			X	X										
Implement #7 Evaluate DDT in the water column	Ecology, LCWQC, Chelan PUD			X	X										
Implement #8 Evaluate DDT loading from ground water	Ecology, LCWQC, Chelan PUD			X	X										
Collect data associated with actions and compliance points	Ecology, LCWQC, LCRD, City of Chelan, Chelan County, Chelan PUD, USFS, NPS, WSDA		X	X	X	X	X	X	X	X	X	X	X	X	X
Review targets and data	Ecology, LCWQC		X	X	X	X	X	X	X	X	X	X	X	X	X
Implement adaptive management changes	Ecology, LCWQC, LCRD, City of Chelan, Chelan County, Chelan PUD, USFS, NPS,			X	X	X	X	X	X	X	X	X	X	X	X
Water Quality standards met															X

BMPs - Best Management Practices
CDHD - Chelan-Douglas Health District
DIP - Detailed Implementation Plan
DNR - Washington Department of Natural Resources
Ecology - Washington State Department of Ecology
LCRD - Lake Chelan Reclamation District
LCWQC - Lake Chelan Water Quality Committee
NPS - National Park Service
USFS - United States Forest Service
WSDA - Washington State Department of Agriculture

Compliance with Water Quality Standards

Ecology is the responsible entity for determining compliance of interim and final targets associated with the *Lake Chelan Watershed DDT and PCB TMDL*.

The goal of the TMDL is to meet the state's water quality standards, specifically the National Toxics Rule (NTR) human health criteria for edible fish tissue, for total DDT, and total PCBs in Lake Chelan and Roses Lake. The specific numerical targets are 32 µg/Kg for total DDT and 5.3 µg/Kg for total PCBs in edible fish tissue. A percent reduction approach in fish tissue contaminant concentrations will be used for meeting the above targets, rather than a requirement to meet the specific load allocations. These target concentrations are expected to be reached by the 2055.

In addition to the fish tissue target, a water quality target concentration of 1.0 ng/L will be applied to tributaries and drains discharging to Lake Chelan and Roses Lake to assure that when tissue targets are eventually attained, they are not compromised by degrading inputs.

Table 13 details the percent reductions of total DDT and total PCB concentrations in fish tissue from Lake Chelan, Wapato Basin and Roses Lake that are required by the *Lake Chelan Watershed DDT and PCB TMDL*.

Table 13: Total DDT and Total PCB Percent Reduction Targets in Fish Tissue for Lake Chelan and Roses Lake

Water Body	Parameter	Formula	% Reduction Required
Lake Chelan, Wapato Basin	DDT	[(943 µg/Kg – 32 µg/Kg)/(943 µg/Kg)] x 100	96.6
Lake Chelan, Wapato Basin	PCB,	[(14.5 µg/Kg – 5.3 µg/Kg)/(14.5 µg/Kg)] x 100	63.4
Roses Lake	DDT	[(96 µg/Kg – 32 µg/Kg)/(96 µg/Kg)] x 100	66.7

Reasonable Assurance

Reasonable assurance is required only where point sources exceed the water standards, and therefore non-point sources must be consistently reduced in order to compensate for any such exceedances. Because this is not the case in the Lake Chelan watershed, reasonable assurances are not required. However, with the implementation actions identified in this TMDL, funding, ongoing monitoring, and adaptive management, Ecology and the Lake Chelan Water Quality Committee can provide reasonable assurance that non point source goals will be achieved within the timeline proposed in Table 12.

Adaptive Management

The implementation activities related to the *Lake Chelan Watershed DDT and PCB TMDL* are centered on the maintenance and improvement of long-term activities that have reduced water contamination levels since the banning of DDT and PCBs. The inclusion of long-term data collection and monitoring of fish tissue in the implementation activities is necessary due to the persistent nature of these legacy pollutants. Monitoring activities will serve to better define the rate that the water quality in the basin is improving. Re-evaluation of the long-term trends with additional data will allow the restoration timeframe to be determined with greater precision. If the water quality monitoring activities show unexpected long-term increases of DDT and PCBs in fish tissues, an examination of any potential new sources should also be undertaken. Additionally investigation should be conducted to identify significant events in the watershed that could resuspend sediments.

Persistent elevated values of total DDT and total PCB contamination, or data that does not show the expected gradual declines over time, will trigger additional investigation. This should include, but not be limited to, further the investigations of tributary streams and potential groundwater transport of DDT.

Implementation of the *Lake Chelan Watershed DDT and PCB TMDL* will be adaptively managed such that actions will be completed by 2018, and Lake Chelan, Roses Lake and their tributaries will meet the TMDL water quality targets by 2055. Adaptive management methods that may be used to implement this TMDL include:

- Adjusting non-point best management practices;
- Modifying stream sampling frequency and/or locations to further delineate DDT and PCB sources;
- Conducting site specific inspections in identified source areas;

- Helping develop and fund water quality projects that address DDT and PCB pollution;
- Local educational initiatives; and
- Other means of conforming management measures to current information on the impairment.

The requirements of the *Lake Chelan Watershed DDT and PCB TMDL* will be satisfied when adequate sampling is attained that shows that TMDL targets are being met after successful voluntary implementation of BMPs. If water quality standards are met without attaining the load allocation reductions specified in Table 11, then the objectives of the TMDL are met and no further reductions are needed. If the load allocation reductions in Table 10 and 11 are met, but the water bodies still do not meet TMDL targets, then adaptive management methods listed in the paragraph above, and any others, may be further employed to meet the objectives of the TMDL. Re-evaluation of the status of the TMDL will be conducted every five years.

TMDLs are living documents, which are intended to be revisited periodically to evaluate whether the measures to implement the needed reductions are achieving targets, and to be revised as conditions change and understanding of the problems in the watershed is broadened. Through implementation of the *Lake Chelan Watershed DDT and PCB TMDL*, participants will learn what actions will be needed to achieve the TMDL's targets. After all appropriate and practical BMPs have been implemented, then the TAC and Ecology will jointly re-evaluate whether or not the targets have been met, and how best to proceed.

On-going ambient monitoring conducted by Ecology and local entities will assist in enabling the implementing jurisdictions to revise and shift implementation efforts as necessary in order to bring all tributaries back into compliance with TMDL targets. Ecology encourages local organizations and governments to apply for grant funding for developing and implementing monitoring programs through Ecology's annual water quality grants program.

A Detailed Implementation Plan (DIP) will be prepared within one year following approval by EPA of this submittal report. Further public input will be sought to help prepare the plan. The plan will identify in more detail how, when, and where the activities listed in this plan will be implemented. Ecology and other entities will provide technical assistance and seek additional funding for these monitoring activities and any restoration activities that may be identified as the body of data grows. Milestones will be developed as part of the DIP and milestone evaluation is anticipated to occur at three to six-year intervals.

Summary of Public Involvement

A citizen's workgroup, the Lake Chelan Water Quality Committee, has served since 2001 as the Technical Advisory Committee (TAC) for the *Lake Chelan Watershed DDT and PCB TMDL*. Participants represented in the TAC include agriculture, conservation districts, irrigation districts, local government, sewer districts, utility districts, state and federal agencies, community organizations, and other interested parties. This workgroup met numerous times during the development of the TMDL. There is a high level of cooperation and communication between project participants, and their continued active pursuit of the goals of the TMDL.

The following education/outreach information was provided to the community (see Appendix B):

* September - October, 2002 News coverage on EPA National DDT fish tissue study results regarding Lake Chelan and follow-up responses with media and the public. The news release resulted in several newspaper articles and radio interviews.

* June, 2003 - "DDT and Lake Trout" brochure distributed by Chelan-Douglas Health District. Brochures were distributed at health clinics and other locations.

* Various dates - Other media coverage related to the Lake Chelan TMDL. Brochures developed and distributed on boating practices and environmental landscaping.

* September, 2005 - News release and coverage on results of monitoring study, TMDL allocations, and continuation of public health notice on mackinaw consumption.

* January, 2006 - News release and media coverage on continuation of Lake Chelan fish consumption advisory for mackinaw by the Department of Health.

* February, 2006 - Department of Ecology Environmental Excellence awards issued to Paul Cross and Jean Peterson for PCB transformer removal efforts.

The public comment period for this TMDL Submittal occurred from April 21, 2006 to May 21, 2006. See comments, responses, and public notice newspaper display ads (and affidavits of publication) in Appendix B.

Monitoring Strategy

Monitoring is included as part of the implementation strategy. It serves to track and evaluate the effectiveness of implementation measures. Ecology, the Lake Chelan Reclamation District, and the Chelan County Conservation District (CCCD) have conducted various monitoring of the waters in the Lake Chelan watershed as previously described in this report. Such data has been helpful for identifying specific water quality problem areas.

While DDT and PCBs continue to persist in the environment their effective levels are reduced over time through implementation actions, degradation, and by natural attenuation through dilution and capping. The natural processes resulting in the lower exposure of aquatic life to the pollutants will play a major role in the success of the *Lake Chelan Watershed DDT and PCB TMDL*. The Lake Chelan Water Quality Committee, funded through a Centennial Clean Water grant (previously described), is currently engaged in continued monitoring. Ongoing monitoring of the following areas is recommended, at least once every five years, using adaptive management from previously gained knowledge:

- fish tissue concentrations
- sediment
- soils
- surface water
- groundwater
- SIS and DIP implementation actions
- Other human actions

Potential Funding Sources

Potential funding for implementation of the SIS, DIP, and ongoing monitoring for Lake Chelan TMDL may be accomplished with project funding provided through the Department of Ecology. The Centennial Clean Water Fund, Section 319 grants under the federal Clean Water Act, and state Revolving Fund (SRF) loans comprise the current funding sources available. Ecology can provide technical assistance to Lake Chelan watershed stakeholders in applying for available grant and loan funds to implement this TMDL. Opportunities for the community to apply for external funding sources will also be explored and encouraged, including the following sources:

WSDA: Funding for the Washington Department of Agriculture's waste pesticide pickup program is currently sustained through Department of

Agriculture. The benefits of such a program to water quality are direct but difficult to quantify as it is a preventative program.

EQIP: The Natural Resources Conservation Service (NRCS) directs its Environmental Quality Incentives Program (EQIP). EQIP provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program is implemented through conservation plans that include structural, vegetative, and land management practices, and also includes nutrient management plans. Cost-share payments may be made to implement one or more eligible structural or vegetative practices, such as livestock exclusion fencing, riparian buffer zones (strips), tree planting, and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as grazing management or nutrient management.

CREP: The NRCS also sponsors the Conservation Reserve Enhancement Program (CREP) and the Continuous Conservation Reserve Program (CCRP), which are voluntary cost share programs designed to restore and enhance habitat and increase bank stability along waterways on private lands with a cropping history. The prior program offers payments for annual rental, signing, cost share, practice, and maintenance in exchange for removing land from production and grazing. The latter program provides funds for providing a sediment filtration around water sources near crop fields, such as: filter strips, riparian buffers, and grass waterways.

CCCD: The Chelan County Conservation District provides technical assistance and cost-share programs to irrigators and ranchers, including riparian restoration, fencing, farm plans, sprinkler conversion projects, etc., which helps keep soil on-farm and reduce DDT in agricultural runoff water.

FREP: Because most of the tributaries in the Lake Chelan watershed are categorized as Class AA and considered as critical salmon habitat, state and federal salmon restoration efforts and associated funding should support implementation under this TMDL. For example, the Washington State Legislature has authorized the creation of a Small Forest Landowner Office to provide technical assistance, develop standards for forest practice alternative plans, and administer a Forestry Riparian Easement Program (FREP). The FREP is a compensation program intended to partially compensate qualifying small forest landowners for leaving forest and fish riparian management zones in exchange for a fifty-year easement. The purpose of the program is to provide an incentive to small forest landowners to keep their lands in forest use.

Chelan PUD: Chelan PUD has funding available through its FERC relicensing agreement and other sources. The Lake Chelan Water Quality Committee will work with Chelan PUD to identify and utilize appropriate PUD funding.

BPA, EPA, other sources: The Lake Chelan Water Quality Committee will work with BPA, EPA, and other sources to identify and utilize appropriate funding as it becomes available.

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Appendix A

"Lake Chelan DDT and PCBs in Fish Total Maximum Daily Load Study"

June 2005
Ecology Publication Number 05-03-014

This publication may be viewed at the following website:
www.ecy.wa.gov/biblio/0503014.html

Paper copy may be obtained upon request.

Appendix B

Education and Outreach Materials, News Coverage

(Paper copies are available upon request)

May, 2002 – EPA national lakes study finds high levels of DDT in Lake Chelan fish tissue. Lake Chelan Water Quality Committee begins work with Ecology on DDT, PCB TMDL.

May, 2003 – Ecology Focus Sheet published and distributed, "Lake Chelan DDT/PCB Watershed Cleanup Plan."

June, 2003 - *DDT and Lake Trout* brochure distributed by Chelan-Douglas Health District. Brochures distributed at health clinics and other locations (brochure updated in 2006).

May, 2004 – Lake Chelan Mackinaw (Lake Trout) fishing derby. Fish caught in the derby are included in TMDL fish tissue sampling.

August, 2004 – Ecology Focus Sheet, *Lake Friendly Landscaping* distributed.

August, 2005 – News release and coverage on completion of the TMDL technical study.

September, 2005 - Department of Health advises people to limit the amount of Mackinaw (lake trout) consumption from Lake Chelan.

January, 2006 – Department of Health issues statewide fish consumption advisory and updated brochure, including consumption of Lake Chelan Mackinaw (lake trout).

March 13, 2006 – Ecology presents its *Environmental Excellence Award* to locals for cleaning up Lake Chelan PCBs.

April 21 – May 21, 2006 – Ecology issues news release and newspaper display ads for public notice and 30-day comment period on Draft Lake Chelan DDT, PCB TMDL Submittal.

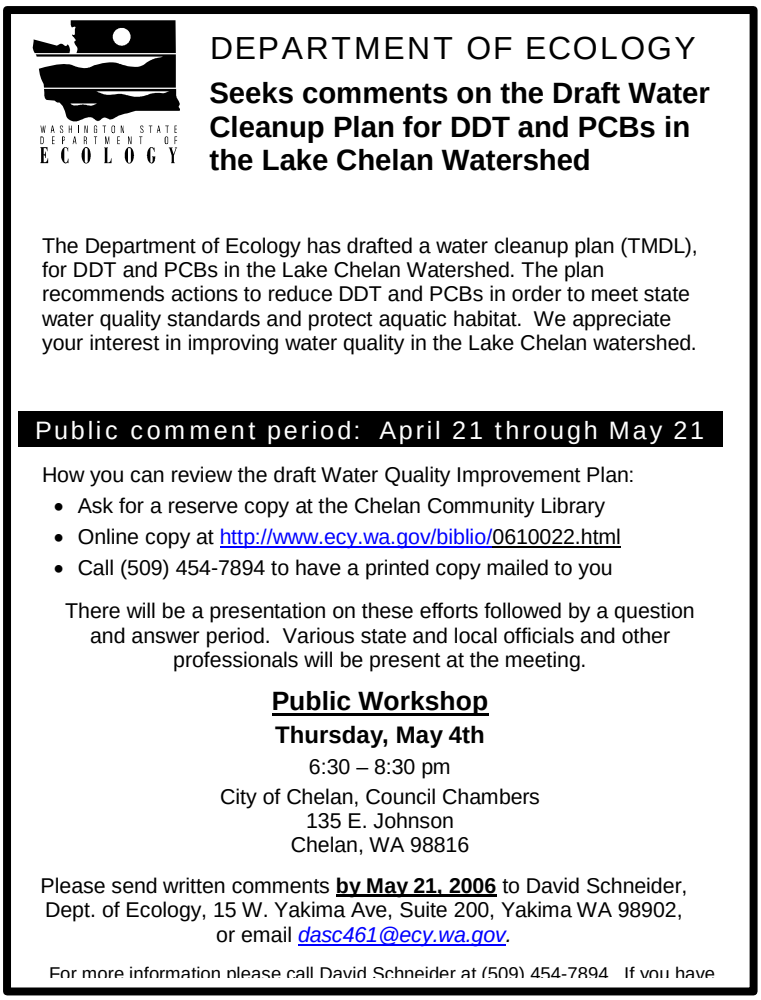
Appendix C

TMDL Public Notice, Public Comments and Responses

PUBLIC NOTICE

A public notice was printed in the following newspapers:

Newspaper		Issue Dates
Chelan Mirror	-	April 26 and May 3, 2006
Wenatchee World	-	April 21, 2006
Cashmere Record	-	April 26 and May 3, 2006
Leavenworth Echo	-	April 26 and May 3, 2006



WASHINGTON STATE DEPARTMENT OF ECOLOGY

DEPARTMENT OF ECOLOGY

Seeks comments on the Draft Water Cleanup Plan for DDT and PCBs in the Lake Chelan Watershed

The Department of Ecology has drafted a water cleanup plan (TMDL), for DDT and PCBs in the Lake Chelan Watershed. The plan recommends actions to reduce DDT and PCBs in order to meet state water quality standards and protect aquatic habitat. We appreciate your interest in improving water quality in the Lake Chelan watershed.

Public comment period: April 21 through May 21

How you can review the draft Water Quality Improvement Plan:

- Ask for a reserve copy at the Chelan Community Library
- Online copy at http://www.ecy.wa.gov/biblio/0610022.html
- Call (509) 454-7894 to have a printed copy mailed to you

There will be a presentation on these efforts followed by a question and answer period. Various state and local officials and other professionals will be present at the meeting.

Public Workshop

Thursday, May 4th

6:30 – 8:30 pm

City of Chelan, Council Chambers
135 E. Johnson
Chelan, WA 98816

Please send written comments **by May 21, 2006** to David Schneider, Dept. of Ecology, 15 W. Yakima Ave, Suite 200, Yakima WA 98902, or email *dasc461@ecy.wa.gov*.

For more information please call David Schneider at (509) 454-7894. If you have

Additionally, an Ecology news release was issued to all media outlets in Chelan County.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

News Release

FOR IMMEDIATE RELEASE – April 18, 2006
06-060

Lake Chelan water cleanup plan available for review

YAKIMA – A draft plan outlining ways to clean up Lake Chelan is available for review and comment from the Washington Department of Ecology.

Legacy affects from the historical use of the pesticide DDT and residual PCBs from electric transformers are water-quality concerns that have been identified in Lake Chelan. The plan drafted over the last several years recommends actions to improve water quality in order to meet state water quality standards and protect aquatic habitat.

There will be a workshop on Lake Chelan water quality efforts on May 4, from 6:30 to 8:30 p.m. at the City of Chelan Council Chambers, 135 East Johnson. There will be a presentation on these efforts, followed by a question and answer period. Various state and local officials and others will be present at the meeting.

A copy of the plan is available online at www.ecy.wa.gov/biblio/0610022.html. To request a copy, call (509) 454-7894.

Comments should be mailed to David Schneider, Dept. of Ecology, 15 W. Yakima Ave., Suite 200, Yakima, WA 98902; or by email to dasc461@ecy.wa.gov. Comments will be accepted through May 21.

# # #

Contact: Joyce Redfield-Wilder, public information manager, (509) 575-2610, or pager (509) 574-0490

Ecology's Web site: **http://www.ecy.wa.gov/**

PUBLIC COMMENTS

May 2, 2006

Dave Schneider
Water Quality Program
Washington State Department of Ecology
Yakima, Washington

RE: Lake Chelan Watershed DDT and PCB Total Maximum Daily Load
Water Quality Improvement Report (Draft)

Dear Mr. Schneider

Thank you for the draft **Lake Chelan Watershed DDT and PCB Total Maximum Daily Load Water Quality Improvement Report**. Washington State Department of Natural Resources (DNR) is a non-federal agency of interest, and is submitting comments through the public comment period.

The DNR manages over 2.4 million acres of state-owned aquatic lands. Resources include bedlands, shorelands, tidelands and lands with harbor areas; aquatic plants, aquatic animals; and valuable materials and minerals.

DNR's management authority derives from the State's Constitution (Articles XV, XVII, XXVII), Revised Code of Washington (Chapters 79.100 through 79.135) and the Washington Administrative Code (WAC 332-30). As proprietary manager of state-owned aquatic lands, the DNR has been directed to manage the lands *"...for the benefit of the public"* in a manner that provides *"...a balance of public benefits[1] for all citizens of the state."* that includes:

(1) Encouraging direct public use and access;
(2) Fostering water-dependant uses[2];
(3) Ensuring environmental protection; and
(4) Utilizing renewable resources. (RCW 79.105.455).

DNR is proprietary manager of many of the submerged lands and biological communities potentially affected by DDT/DDE and PCBs that Ecology has detected in the Lake Chelan watershed. DNR issues authorizations to the public for the use of state aquatic lands. Typical uses on Lake Chelan include the construction of recreational docks, boat ramps, piers, and other water-dependent projects. Given this, DNR is concerned by the report's details on the levels of DDT/DDE and PCBs in Lake Chelan, and would like to offer comments and support as cleanup options are pursued.

[1] WAC 332-30-106 defines public benefit as "...that all of the citizens of the state may derive a direct benefit from departmental actions..."
[2] Water dependent uses are those uses that "...cannot logically exist in any location but on the water." Examples include water-borne commerce; terminals; watercraft construction, repair or maintenance; moorage; aquaculture; and log booming. (RCW 79.105.060)

Encourage Ecology to develop and refine an environmental fate and transport model

The mechanism of loading and transport for both contaminants is unknown. DNR supports Ecology's recommendations to evaluate the potential contribution of total DDT/DDE from groundwater, and its transport through sediment, water plants and aquatic biota. Until sources are identified, and the rate of environmental fate understood, recovery options and an associated timeline cannot be defined.

Develop detailed recovery options and timelines

Once sources are identified, and an fate and transport model developed, DNR encourages Ecology to aggressively pursue a variety of options for improving water quality, cleaning up sediment contamination, and reducing bioaccumulation. Natural attenuation, although the least costly, could take decades with DDT/DDE and PCBs. The safety of the public will need to be taken into account when considering cleanup options, not just cost.

In summary, given that DNR issues use authorizations for activities involving water, it is imperative this agency has a clear understanding of the public health and safety issues associated with the aquatic land and waterbodies, and the timelines for recovery. Please keep DNR informed of the status of the Lake Chelan Watershed.

Should Ecology need to coordinate with DNR for sediment sampling or other recovery-associated efforts on state aquatic land, please contact Cindi Preston at our Rivers District, (509) 933 3847 x22.

Sincerely,

Elizabeth A. Ellis

Elizabeth A. Ellis
Environmental Review Coordinator

Washington State Department of Natural Resources
Aquatic Resources Program
1111 Washington St SE
PO Box 47027
Olympia, Washington
360-902-1074

cc: Tim Goodman, Sediment Quality Unit

ECOLOGY RESPONSE

June 6, 2006

Elizabeth A. Ellis
Washington State Department of Natural Resources
Aquatic Resources Program
1111 Washington St SE
PO Box 47027
Olympia, WA 98504-7027

Dear Ms. Ellis:

Thank you for commenting on the *Lake Chelan Watershed DDT and PCB Total Maximum Daily Load Water Quality Improvement Report*. The following are responses to your comments:

DNR Comment #1: Encourage Ecology to develop and refine an environmental fate and transport model. The mechanism of loading and transport for both contaminants is unknown. DNR supports Ecology's recommendations to evaluate the potential contribution of total DDT/DDE from groundwater, and its transport through sediment, water, plants and aquatic biota. Until sources are identified, and the rate of environmental fate understood, recovery options and an associated timeline cannot be identified.

> **Ecology Response, Comment #1:** Ecology appreciates DNR support with our efforts in developing and refining an environmental fate and transport model. Work on this has already begun. Through an Ecology grant, the Lake Chelan Water Quality Committee has hired Geomatrix to develop a hydrologic characterization report, conduct preliminary groundwater monitoring, and develop a food web bioaccumulation model. Answers from these studies will help to further identify pollutant sources, fate and transport, and recovery options.

DNR Comment #2: Develop detailed recovery options and timelines. Once sources are identified, and a fate and transport model developed, DNR encourages Ecology to aggressively pursue a variety of options for improving water quality, cleaning up sediment contamination, and reducing bioaccumulation. Natural attenuation, although the least costly, could take decades with DDT/DDE and PCBs. The safety of the public will need to be taken into account when considering cleanup options, not just cost.

In summary, given that DNR issues use authorizations for activities involving water, it is imperative this agency has a clear understanding of the public health and safety issues associated with the aquatic land and water bodies, and the timelines for recovery. Please keep DNR informed of the status of the Lake Chelan watershed.

Should Ecology need to coordinate with DNR for sediment sampling or other recovery-associated efforts on state aquatic land, please contact Cindi Preston at our Rivers District, (509) 933 3847 x22.

Ecology Response, Comment #2: When this TMDL is submitted and approved by the Environmental Protection Agency (EPA), Ecology and the Lake Chelan Water Quality Committee (LCWQC) will use the TMDL, its technical report, and current fate and transport studies to develop a Detailed Implementation Plan (DIP) in one year. The DIP will specify and schedule a detailed list of activities to improve water quality, reduce sediment contamination, and prevent food web bioaccumulation of DDT and PCBs. Ecology will continue to work with DNR and the Lake Chelan watershed community to protect the safety of the public.

Ecology has been in contact with Cindi Preston and Tim Goodman, and has encouraged them to attend LCWQC meetings as we move forward with this process. Ms. Preston has indicated that she will attend and participate. We look forward to working more closely with the DNR regarding DDT and PCB issues in Lake Chelan, and authorizations under its purview, such as state-owned aquatic lands, recreational docks, boat ramps, piers, and other water-dependant projects.

Should you have any further questions or comments, please feel free to contact me at (509) 454-7894.

Sincerely,

David Schneider
Department of Ecology
Water Quality Program

cc: Cindi Preston, DNR Rivers District
Tim Goodman, DNR Sediment Quality Unit

Appendix D

Previous Studies and Recommendations Related to DDT and PCBs

"DDT and Phosphorous Movement in the Manson Lakes Drainage Basin" (2004, Lake Chelan Reclamation District):

A. Improve hydraulic regime in effluent area of Manson Lakes to reduce velocities and improve effectiveness of existing wetlands.

B. Construct additional wetland areas to enhance wetland treatment capacity.

C. Install control structures in Dry and Roses Lake to reduce peak and spring flows through the lakes and into Stink Creek.

D. Improve riparian corridors of Stink Creek and Joe Creek to reduce erosion.

E. Convert available land in outlet area of Dry Lake to wetlands.

F. Evaluate cost effectiveness of alum dosing in effluent from Roses and Dry Lakes to sequester TP in sedimentation ponds or wetlands.

G. Evaluate cost effectiveness of alum addition to the lakes to reduce mixing and diffusion of TP from sediment into the water column.

H. Implement a Lake Management Plan, including future residential development

"Water Quality Trends and Characteristics of Agricultural Drains" (1998, Lake Chelan Reclamation District):

Toxic substances and pesticides were found in all eight drains. As technology advances, it would be useful to consider structural alternatives to treat the drain water some or all of the time. A study of the potential for constructed wetlands or small packaged treatment plants to treat a background level of water would be of interest. The fact that all of the drains are influenced by storm water runoff would require the bypassing of some of the water during larger hydrologic events.

"Lake Chelan Water Quality Plan" (1991, R.W. Beck):

(1) Adoption of consistent clearing, grading, and drainage plan ordinances for the entire Lake Chelan basin.

(2) Adoption of rigid design standards for all new drainage facilities using either the Department of Ecology manual or the King County manual as revised by the City of Chelan.

(3) Preparation of a comprehensive drainage plan for the lower Lake Chelan Basin.

Chelan PUD, Lake Chelan Dam, Federal Energy Commission Relicensing and 401 Certification process (2005, Dept. of Ecology):

Erosion: U.S. Forest Service (USFS) erosion control, National Park Service (NPS) erosion control, NPS Stehekin area implementation plan, large woody debris management plan.

Fisheries: Comprehensive fish management plan, food web model, fish creel survey, water quality monitoring plan, funding for bull trout recovery plan, fish stocking, collection and stocking of fish eggs, tributary barrier improvements.

Chelan River Comprehensive Management Plan: Minimum flows, Chelan River temperature, flow security (flows in tailrace during non-power operation), tailrace and Reach 4 habitat improvements, and lake level management.

Wildlife Habitat Plan: Wildlife habitat restoration, upland habitat improvements, riparian habitat improvements, conservation easements.

Recreation Resources: Docks and recreation facilities (USFS and NPS), operation and maintenance of Riverwalk, Old Mill, and Manson Bay parks, Reach 1 access trail, Riverwalk trail loop extension, operation and maintenance under Don Gordon bridge, reservation of lands, micro parks, utility improvements for local trail, trail linkage to PUD parks, Don Morse Park erosion, community recreation fund.

Cultural Resources: Public education, consultation, cultural resources management, survey of the Lake Chelan National Recreation Area, site protection.