PHOSPHORUS
AND
WATER QUALITY

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EXECUTIVE SUMMARY

A Task Force was appointed by the Director of the Department of Environmental Quality, as requested in Senate Bill 1079 (1989), to identify sources of phosphorus and other nutrients contributing to growth of algae, and to identify the potential impacts of regulating phosphorus in detergents and other sources. The Task Force used the specific knowledge of its members and available information, including knowledge of the general biology of algal growth in water, published reports from other regions on algal growth control strategies, and the limited Oregon data that were available.

Excessive growth of algae interferes with beneficial uses in several Oregon water bodies. Controlling algal growth requires controlling one or more of the factors necessary for growth. The concentration of the nutrient phosphorus is the growth factor that is most practical to control in fresh waters. Other nutrients have relatively larger natural and nonpoint sources, which makes them more difficult to control. The phosphorus concentration in surface water must be decreased to the level where it becomes the nutrient limiting the growth of algae. Concentrations of phosphorus that prevent unacceptable algal growth are estimated from general studies and field investigations conducted nationally and in Oregon, and from EPA criteria.

Sources of phosphorus to Oregon waterways include municipal wastewater treatment plants, septic system drainage, and the runoff of animal waste and fertilizers from agricultural, forestry and urban lands. The Task Force focused on the control of phosphorus in municipal wastewater. Laundry detergents contribute about one third of the phosphorus discharged from municipal wastewater treatment plants that do not remove phosphorus.

There will be economic benefits from decreased phosphorus levels entering those municipal treatment plants that remove phosphorus from their wastewater by the use of chemicals. These cost savings result from the need to purchase fewer chemicals and handle and

dispose of less sludge. The savings are typically proportional to the decrease in the amount of phosphorus that must be removed.

The decrease in phosphorus resulting from a phosphorus laundry detergent ban alone, will not be sufficient to reach the low levels of phosphorus required by the Total Maximum Daily Loads (TMDL) established for three Oregon rivers to date. A phosphate detergent ban is one control strategy; others must also be used. Land application, removal through chemical or biological processes and decreased industrial discharge are other potential strategies to control point sources of phosphorus. The task force did not determine in which waterbodies a ban on phosphorus detergents would eliminate or delay the need for other phosphorus control strategies. This delay could also result in economic benefits.

Phosphate detergent bans are easily implemented and enforced at minimal cost to public agencies. The cost to consumers of an Oregon ban would be negligible. Companies currently manufacture many types of non-phosphate products and make these products available to Oregon residents. Over one-third of the population in the United States now resides in areas where phosphorus laundry detergents are banned. Some European countries also have such bans. METRO has recently adopted a ban for the Portland area. Current bans typically exempt those cleaning products containing phosphorus for which no substitutes are available.

The elimination of phosphorus laundry detergents is an economical way to decrease the amount of phosphorus in Oregon wastewaters. A reduction in phosphorus discharged to lakes and streams will help maintain algae at acceptable levels.

SUMMARY OF FINDINGS

NUTRIENTS, ALGAL GROWTH AND WATER QUALITY

1. Excessive algal growth produces widespread water quality problems in Oregon. Sixteen of Oregon's 18 river basins have some waterbody segments that do not support beneficial uses due to excessive algal growth.

2. Beneficial uses that may be impaired by excessive algal growth include: domestic drinking water supply, aesthetics, swimming, boating, salmonid fish spawning and rearing, resident fish and aquatic life, wildlife, fishing, and livestock watering.

3. The potential water quality impacts of excessive algal growth include: unpleasant taste and odor, dissolved oxygen depletion, the formation of unsightly algal mats, discoloration of the water, and high pH levels. The impacts on dissolved oxygen and pH in turn affect the health of aquatic ecosystems.

4. Algae need sunlight, nutrients and a favorable physical environment in order to grow. Phosphorus, nitrogen and carbon are the major nutrients that contribute to algal growth.

5. Studies of a large number of lakes in North America and worldwide show that high levels of phosphorus are more often found in lakes having excessive algae and aquatic plant growth.

6. Phosphorus generally restricts algal growth in fresh waters (streams and lakes), while nitrogen generally restricts algal growth in marine waters. Algal growth in fresh waters can be controlled by restricting the availability of phosphorus.

7. The U.S. Environmental Protection Agency has identified phosphorus concentrations above which excessive algal growth

generally occurs. EPA has recommended phosphorus criteria for streams and lakes based on these concentrations. The Oregon Environmental Quality Commission has adopted phosphorus standards for individual waterbodies based on their specific characteristics.

8. To date, the Department of Environmental Quality has established or identified a need for phosphorus TMDLs (total maximum daily loads) for 8 rivers and 3 lakes (see Appendix D, Table D-1 for list). Phosphorus TMDLs are established to eliminate excessive algal growth and resulting water quality standards violations.

9. There is limited experimental information for Oregon waterbodies relating phosphorus concentrations to the growth of algae.

10. Water quality managers do not typically attempt to limit nitrogen for controlling algal growth in fresh waters. Nitrogen deficient waterbodies can favor the growth of algal species capable of using atmospheric nitrogen, a source which can not be controlled.

SOURCES OF NUTRIENTS IN SURFACE WATER AND MUNICIPAL WASTEWATER

11. Sources of nutrients to water quality limited waterbodies in Oregon include:

    a. Point sources, such as municipal wastewater treatment plants, direct industrial discharges, and combined sewer overflows;

    b. Nonpoint sources, such as runoff from agricultural, forestry and urban lands, and on-site sewage disposal systems; and

    c. Natural sources.

12. The proportions of the phosphorus load originating from point versus nonpoint sources will vary by basin, depending on the sources, land uses and physical characteristics of a particular basin.

13. In the three river basins for which phosphorus TMDLs have been established (the Tualatin River, the Yamhill River and Bear Creek), the largest phosphorus contributors are the municipal wastewater treatment plants.

14. Residential, commercial and industrial sources contribute phosphorus to wastewater treatment plants (WWTPs). The proportion of the phosphorus load generated from each source varies according to the population size and industrial distribution in the service area. Typically, residential sources contribute more phosphorus to municipal WWTPs than commercial or industrial sources. The phosphorus from residential sources is primarily from human sewage and from detergents containing phosphate.

15. Laundry detergents typically account for one-third of the total phosphorus entering municipal wastewater treatment plants.

16. The primary source of nitrogen to WWTPs is residential wastewater. There are some industrial sources. The nitrogen in residential sources originates primarily from human waste.

CONTROL OF PHOSPHORUS IN WASTEWATER

17. The two primary methods to remove phosphorus in a wastewater treatment system are: a) chemical/physical removal, such as treatment with aluminum or iron compounds, where the phosphorus is precipitated out of the waste stream and a sludge is created and removed; and b) biological removal, where microorganisms are used to take up the phosphorus. Chemical removal is most commonly used.

18. There are approximately 275 wastewater treatment plants in Oregon that discharge to surface waters. Two of these currently remove phosphorus with chemicals (the Rock Creek and Durham plants in the Tualatin basin). Three additional plants (Lafayette, McMinnville, Ashland) are considering various phosphorus removal systems to achieve new permit limits. Port Orford must also find an alternative to its current effluent disposal as the result of a phosphorus TMDL. As more Total Maximum Daily Loads are established, phosphorus

limits will be included in the permits of additional plants (e.g., La Grande and Hermiston are anticipating phosphorus limits as they develop facility plans).

19. The 2 Oregon WWTPs (Rock Creek and Durham) that currently remove phosphorus with chemicals are subject to the phosphate detergent ban recently adopted by METRO.

20. Other potential methods for treatment plants to prevent the discharge of phosphorus to streams include applying effluent to land, reusing effluent for irrigation, and using constructed wetlands for treatment. These practices may become a preferred method where suitable land is available.

21. A reduction in the phosphorus load entering wastewater treatment plants that chemically remove phosphorus results in cost savings. The cost savings are from reduced chemical use and sludge handling. The estimated savings from a 30 percent reduction in influent phosphorus range from approximately $100,000 to $200,000 per year per 10 million gallons daily plant discharge.

22. Source reduction of phosphorus would aid in improving water quality if concentrations are reduced to the levels required to prevent excessive algal growth.

EFFECTS OF A PHOSPHATE DETERGENT BAN

23. Phosphate in detergents is a source of phosphorus identified as being easily reduced at the source through statewide regulation. Statewide regulation of industrial discharges and nonpoint sources were not analyzed in this report due to their complexity and study resource limitations.

24. Phosphate detergent bans significantly reduce effluent phosphorus loads from WWTPs that do not practice phosphorus removal. Data from eight states and one region that have imposed phosphate detergent bans show 24-51% phosphorus reductions in effluent from these types of plants.

25. For the 3 Oregon river basins that currently have TMDLs, eliminating detergent phosphates alone will not reduce instream phosphorus concentrations to the levels required by

the TMDLs. A phosphate detergent ban would be only one component of a complete strategy for the control of algal growth in these basins.

26. In areas where WWTPs remove phosphorus through chemical treatment, a detergent phosphate ban would produce an economic benefit because of lower amounts of chemicals used and less sludge generated.

27. A detergent phosphate ban is not expected to result in the elimination of detergent products or brands. All major detergent producers manufacture non-phosphate laundry detergents formulations. An estimated 37 percent of the U.S. population lives in areas (12 states and 5 regions) where phosphate laundry detergents are not sold. Products without substitutes, such as automatic dish-washing detergents, are exempted from current bans.

28. A statewide ban will minimize the possibility of consumers unintentionally bringing phosphate detergents into areas with local bans.

29. Detergent phosphate bans do not appear to increase costs of laundry detergents to the consumer.

30. A detergent phosphate ban is a pollution prevention measure, which reduces phosphorus from the source.

31. Despite the lack of experimental verification in Oregon, the best available information indicates that a statewide phosphate detergent ban could be a valuable component of an overall strategy for water quality management in Oregon lakes and rivers.

PHOSPHORUS AND WATER QUALITY

I. INTRODUCTION

Concern over the growth of algae in Oregon waters and the water quality impacts that may result led the 1989 Legislature to adopt Senate Bill 1079 (shown in Appendix B). The bill directs the Department of Environmental Quality (Department, DEQ) to appoint a task force to study potential sources and control of the problem. This report of the Task Force summarizes the impacts of controlling phosphorus and other nutrients for the purpose of reducing or preventing algal growth in Oregon waters. In particular, the Task Force evaluated the effects of regulating or eliminating phosphorus in detergents.

A glossary is provided in Appendix A to help the reader with terms used in this report.

SB 1079 asked the Task Force to conduct the following tasks:

1. Identify the sources of phosphorus and other nutrients contributing to the growth of algae in waters where algal growth is adversely affecting water quality.

2. Identify the sources of nutrients to wastewater treatment plant (WWTP) influent and the relative contribution of those sources to WWTP effluent.

3. Identify the potential impacts of regulating or eliminating phosphorus from detergents and other sources.

4. Report the findings to the 66th Legislature (1991).

The Task Force focused its efforts on the nutrient phosphorus and on phosphate detergents as a source for possible control. These topics were selected because they are specifically identified in Senate Bill 1079, because of time and resource limitations, and for the reasons explained in Sections II & III below.

TASK FORCE

The Phosphorus Task Force was appointed in July, 1990 as a working group. The members researched and summarized information on the control of algal growth in surface waters. The Task Force met four times between August, 1990 and January, 1991.

Dr. Benno Warkentin, Director of the Water Resources Research Institute at Oregon State University, chaired the Task Force. Representatives of the following agencies and organizations participated:

- The Association of Oregon Sewerage Agencies.
- The Oregon Department of Forestry.
- The Metropolitan Service District of Oregon (METRO).
- The Conference of Local Health Officials.
- Devils Lake Water Improvement District.
- Associated Oregon Industries.
- The Soap and Detergent Association.
- Oregonians for Food and Shelter (agriculture).
- The Oregon Environmental Council.
- River Watch.

A list of Task Force members is included in Appendix B.

METHODOLOGY

The Task Force relied on literature review, existing data, Task Force expertise, DEQ expertise, and the legislation and experiences of states and regions which have already imposed phosphate detergent bans, to develop this report. The Task Force did not conduct new water quality field studies.

Considerable literature is available on phosphate detergent bans and their results. Twelve states and 5 regions across the country have banned phosphate detergents since the early 1970's. The Portland metropolitan area and 2 other regions in the Northwest U.S. are among those which have recently adopted bans.

The major sources of existing Oregon data available at the Department include ambient water quality monitoring data, Biennial Water Quality Assessment reports, the 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution, and DEQ water quality studies such as those conducted to establish total maximum daily loads (TMDLs).

II. NUTRIENTS, ALGAL GROWTH AND WATER QUALITY

THE IMPACTS OF ALGAL GROWTH ON WATER QUALITY AND BENEFICIAL USES

Oregon's water quality program and standards are designed to protect the "beneficial uses" of our waters. Beneficial uses include domestic water supply, industrial water supply, irrigation, livestock watering, salmonid fish rearing and spawning, resident fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, aesthetic quality, hydroelectric power, and commercial navigation and transportation (Oregon Administrative Rules, Chapter 340, Division 41).

Algae, like other plants, are a natural component of a healthy ecosystem. Algae are primary producers, the foundation of the food chain, which transform the energy of the sun, through photosynthesis, into matter which can be consumed by higher organisms. In low amounts, they do not interfere with beneficial uses of water.

An over-abundance of algae, however, harms water quality, aquatic ecosystems, and the ability of rivers and lakes to support beneficial uses. One beneficial use directly affected is aesthetics. Algae blooms may occur, causing domestic water supplies to have unpleasant taste and odor problems, decreasing water clarity, causing the water to turn a murky greenish-brown color, and forming unsightly floating mats on the water surface. An attached form of algae, called periphyton, may cover streambeds, and aquatic plants may overgrow lakes, interfering with boating and swimming.

In addition, excessive algal growth affects the dissolved oxygen and pH of streams and lakes, sometimes damaging the health of aquatic ecosystems and causing water quality standards violations. When this occurs, additional beneficial uses are not supported, potentially including: drinking water supply, salmonid fish rearing and spawning, resident fish and aquatic life, wildlife, fishing, and livestock watering.

NUTRIENTS AND ALGAL GROWTH

Algae need nutrients, light and a favorable physical environment in order to grow. Nitrogen, carbon and phosphorus are the nutrients required in relatively large amounts. Algae also need a variety of other nutrients in small or trace amounts. Given adequate nutrients and physical conditions, excessive or nuisance levels of algae can accumulate in lakes and streams if water flow is slow relative to the algal growth rate.

Any one of the required nutrients may be present in such low concentrations that growth is limited, regardless of the availability of light or other nutrients. This nutrient then controls the rate at which algae grow. This is called the "limiting nutrient" concept (Ryding, 1989). As nutrient concentrations in water increase from low values, growth of algae increases proportionally until some other factor becomes limiting. This is most clearly seen in experiments where one limiting nutrient is added in successive increments. Carbon seldom limits overall algal production. Phosphorus, nitrogen and sometimes nutrients needed in smaller amounts, such as silicon or iron, can limit growth. Additional information on the relationship between algal growth and nutrients is provided in Appendix C.

A considerable body of scientific literature has accumulated over the past 50 years on the growth of algae in surface waters. The overwhelming evidence from the literature allows a general conclusion. In those waterbodies where a nutrient limits growth, the limiting nutrient in marine environments is generally nitrogen, and the limiting nutrient in fresh water is generally phosphorus. Field studies attempting to quantify the relationship between phosphorus and algal mass have not shown consistent results, probably due to the large number of other variables in the natural environment.

Algae require larger amounts of nitrogen than phosphorus, but nitrogen is also more abundant in the natural environment. Some species of algae can use nitrogen from the atmosphere. These "nitrogen-fixing" algae are blue-green species and are less desirable. Nitrogen is also available from soils, and in the soluble form it moves readily through soils. Multiple sources and solubility make it difficult to control nitrogen additions to waterbodies.

Phosphorus is adsorbed readily on soil particles, so soluble phosphorus is found in only low concentrations in nature. It does not move readily through soil. Nonpoint sources, such as runoff, contain both soluble and adsorbed phosphorus. Additions of high concentrations of soluble phosphorus to waterbodies are largely from wastewater. Discharges from wastewater treatment plants (WWTPs) contain predominantly soluble phosphorus, which is readily available to algae for growth.

The phosphorus concentration in waterbodies is therefore more controllable or manageable than nitrogen. Phosphorus has been selected as the focus for control of algae in fresh waters.

The Environmental Protection Agency (EPA, 1986) recommends that for the prevention of nuisance algal growth, phosphorus concentrations should not exceed:

- 0.025 mg/l in lakes and reservoirs,
- 0.05 mg/l in streams entering lakes or reservoirs, and
- 0.10 mg/l in other flowing waters.

There are no nitrogen criteria recommended by EPA for this purpose.—

In-stream phosphorus standards have been adopted by the Oregon Environmental Quality Commission for some rivers and lakes in Oregon. These standards were established following intensive water quality investigations of the following waterbodies:

- Tualatin River -- 0.07 mg/l Total Phosphorus.
- Yamhill River -- 0.07 mg/l Total Phosphorus.
- Bear Creek -- 0.08 mg/l Total Phosphorus.
- Clear Lake (near Florence) -- 0.009 mg/l Total Phosphorus.

ALGAL GROWTH PROBLEMS IN OREGON

Excessive algal growth is a widespread water quality problem in Oregon. Sixteen of Oregon's 18 river basins have some waterbodies that do not support beneficial uses due to excessive algae and aquatic plants (DEQ, 1990). According to DEQ's 1990 Water Quality Assessment Report, 745 river miles only partially support or do not support their designated beneficial uses due to excessive nutrients or plant growth. Many lakes across the state also have excessive algae or plant growth problems. Water quality data are shown below and in Appendix D.

The Task Force recognizes that we do not have sufficient data to know precisely how many waterbodies in Oregon have algal growth problems caused by excess nutrients. Nor do we know how many of Oregon's algal growth problems could be corrected through phosphorus reduction and how many could be corrected through nitrogen control.

To date, the Department of Environmental Quality has established phosphorus standards and TMDLs, and Oregon lake restoration projects have identified phosphorus control, as the means to solve algal growth problems. This strategy is consistent with EPA recommendations and with similar efforts and studies conducted around the country and around the world.

Statewide Data

Tables 1 and 2 list the Oregon waterbodies assessed as "water quality limited" due to dissolved oxygen, pH or aesthetic problems where these problems result at least in part from algal growth (DEQ, 1990). A waterbody is "water quality limited" (as defined by the Federal Clean Water Act) if it does not meet water quality standards even though all the point sources discharging to the waterbody are permitted and meet the current technology-based standards. A waterbody may also be designated water quality limited due to a lack of data or because the minimum technology based standards have not yet been fully implemented.

Table 1 shows the water quality limited waterbodies which DEQ has identified as priorities for receiving total maximum daily loads (TMDLs). Table 2 lists additional "water quality limited" streams which have a potential algal growth problem, and septic system drainage or municipal sewage treatment discharge as a suspected source. Table 3 lists Oregon lakes which do not fully support their designated beneficial uses due to algae or weed growth, and with septic drainage as a suspected source of nutrients.

Table 1

Water Quality Limited (303d1) Waterbodies in Oregon with Algal Growth or Related Problems

(Continued)

Waterbody	Basin	Parameters of Concern	Suspected or Known Sources	Status
Tualatin R. RM 0-39	Willamette	Bact, Nutrients, pH, DO, Algae	Municipal, Agric, Urban, Natural	TMDL Established
Tualatin R. RM 39-63	Willamette	Bacteria, Nutrients	Agric, Urban, Septic	TMDL Established
Lake Oswego	Willamette	DO, pH, Algae, Nutrients	Municipal, Agric, Urban, Natural	TMDL Established
Columbia Slough RM 0-15	Willamette	Bacteria, Nutrients, Algae, pH, Organics, Metals	Municipal, Urban, Industrial, Nat.	TMDL Proposed
Umatilla RM 0-79	Umatilla	pH, Solids, Nutrients, Bacteria	Municipal, Agric, Septic, Natural	TMDL Proposed, RM 35-79 (Est. TMDL Needed RM 0-35)
Grande Ronde RM 82-179	Grande Ronde	pH, Bacteria, Nutrients	Municipal, Agric, Septic, Natural	TMDL Proposed
Klamath River & Lake Ewauna RM 209-250	Klamath	pH, Algae, Nutrients, Metals	Municipal, Agric, Indust, Natural	TMDL Proposed
Link River RM 250-255	Klamath	pH, Algae, Nutrients	Agric, Natural	TMDL Proposed
J.C. Boyle Reservoir	Klamath	DO, pH, Algae, Nutrients	Municipal, Agric, Indust, Natural	TMDL Proposed

NOTE:

These waterbodies are "water quality limited" as defined by Section 303d1 of the Federal Clean Water Act.

SOURCE: Draft 1990 Water Quality Status Assessment Report (305b), DEQ, Portland, Oregon, Appendix A.

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Table 1

Water Quality Limited (303d1) Waterbodies In Oregon with Algal Growth or Related Problems

Waterbody	Basin	Parameters of Concern	Suspected or Known Sources	Status
Garrison Lake	S. Coast	Weeds, Nutrients, Algae, pH	Municipal, Septic, Natural	TMDL Established
N.F. Coquille RM 0-10	S. Coast	DO	Municipal, Natural	TMDL Proposed
Coquille R./ Estuary, RM0-39	S. Coast	DO, Bacteria	Municipal, Agric, Forest, Natural	TMDL Proposed
South Umpqua RM 0-15	Umpqua	pH, DO, Ammonia, Bact, Nutrients	Municipal, Agric, Indust, Low Flow	TMDL Proposed
Bear Creek RM 0-27	Rogue	pH, Nutrients, Bact. Algae, pH	Municipal, Agric, Septic, Low Flow	TMDL Established
C.F. Willamette RM 0-29	Willamette	DO, pH	Municipal, Agric, Septic	TMDL Proposed
Rickreall Creek RM 0-20	Willamette	DO	Municipal	TMDL Needed
S. Yamhill RM 0-05	Willamette	Algae, Nutrients	Municipal, Agric, Septic	TMDL Established
Yamhill R RM 0-11	Willamette	Algae, Nutrients, pH	Municipal, Agric, Septic	TMDL Established
Pudding R. RM 0-30	Willamette	DO, Bacteria	Municipal, Agric, Septic, Natural, Industrial	TMDL Proposed

NOTE:

These waterbodies are "water quality limited" as defined by Section 303d1 of the Federal Clean Water Act.

SOURCE: Draft 1990 Water Quality Status Assessment Report (305b), DEQ, Portland, Oregon, Appendix A.

(Continued Below)

Table 2

Water Quality Limited Streams (303d3)
with Municipal or Septic Sources Contributing

Waterbody	Basin	Parameters of Concern	Suspected or Known Sources	Status
S.F. Coquille RM 0-62	S. Coast	DO, Bacteria	Municipal, Septic	TMDL Proposed (Part of Segment)
Cow Creek RM 0-27	Umpqua	pH	Municipal, Indust, Natural	--
Umpqua River RM 103-112	Umpqua	Bacteria	Municipal, Urban, Indust, Natural	Estimated TMDL Needed
Elk Creek RM 0-27	Umpqua	DO, Bacteria, pH, Nutrients	Municipal, Agric, Septic	Estimated TMDL Needed
Rogue River RM 95-132	Rogue	Bacteria, Nutrients	Municipal, Agric, Septic	Estimated TMDL Needed
Rogue River RM 29-95	Rogue (Wild & Scenic)	Nutrients	Municipal, Agric, Natural	Use Threatened
Willamette R. RM 0-26	Willamette	Bacteria, Organics, Metals, Pest.	Municipal, Urban, Agric, Septic	Estimated TMDL Needed
Willamette R. RM 26-80	Willamette	Bacteria, Organics	Municipal, Urban, Agric, Septic, Industrial	Estimated TMDL Needed
Salt Creek RM 0-35	Willamette	Bacteria, DO, Algae, Nutrients	Municipal, Agric, Septic, Natural	Estimated TMDL Needed
Crooked River RM 0-70	Deschutes	Bacteria, Nutrients, Solids	Municipal, Septic, Natural	Estimated TMDL Needed
John Day RM 185-212	John Day	pH, Bacteria, Solids	Agric, Septic, Municipal, Natural	Estimated TMDL Needed
Umatilla RM 0-35	Umatilla	Solids, Bacteria, Nutrients	Municipal, Agric, Septic, Natural	TMDL Proposed RM 35-57 (Est. TMDL Needed RM 0-35)

NOTE:

Waterbodies with bacteria problem only not included. These waterbodies are "water quality limited" as defined by section 303d3 of the Federal Clean Act.

SOURCE: Draft 1990 Water Quality Status Assessment Report (305b), DEQ, Appendix A.

Waterbodies affected by municipal and septic sources are shown in the affected by a phosphate detergent ban, the focus of this report. It should be recognized that there are also waterbodies experiencing algae-related water quality problems that do not have municipal or septic sources. The nutrient inputs in these cases are from nonpoint, natural or industrial point sources.

Table 3

Oregon Lakes with Algae or Weed Growth Problems and Septic Systems as a Suspected Source of Nutrients

Basin	Lake	
North Coast	• Cullaby Lake	• Sunset Lake
Mid Coast	• Devils Lake • Sutton Lake • Collard Lake • Tahkenitch Lake	• Eckman Lake • Mercer Lake • Siltcoos Lake
South Coast	• North Tenmile L.	• Tenmile Lake
Umpqua	Diamond Lake	
Rogue	Willow Reservoir	
Willamette	Blue Lake	
Deschutes	Suttle Lake	
SOURCE: "1990 Water Quality Status Assessment Report", Appendix A, Department of Environmental Quality, Portland, Oregon, 1990.		

Several water quality parameters may indicate excessive algal growth, including chlorophyll a, dissolved oxygen, pH and phosphorus. Chlorophyll a is a measure of phytoplankton or "floating" algae. The chlorophyll a criteria for the purpose of preventing nuisance phytoplankton growth is 0.010 or 0.015 mg/l, depending on the type of waterbody (OAR 340-41-150). If a waterbody exceeds the criteria, it may not support beneficial uses and the Department is to conduct an investigation.

Dissolved oxygen (DO) and pH measurements can also be used to detect algal growth. Excessive algal growth may cause large fluctuations in DO or pH throughout the day, and DO supersaturation (i.e., greater than approximately 110-130 percent saturation). As photosynthesis occurs during daylight hours, dissolved oxygen increases, carbon dioxide is taken up and pH rises. Then, during the night, respiration and decomposition deplete the dissolved oxygen so that by early morning DO and pH may be quite low.

High nutrient levels, particularly phosphorus, also indicate a potential algae or plant growth problem. The phosphorus criteria recommended by EPA and DEQ to prevent nuisance algal growth are discussed above.

The 1990 Water Quality Assessment (DEQ) summarizes the water quality monitoring data collected by the Department from 1979-1989. These data are on streams because the Department does not routinely monitor lakes. Chlorophyll a and phosphorus samples were collected primarily between April and October. Phosphorus values in the following streams exceeded the 0.10 mg/l criteria in at least 25-percent of the samples (only sites with at least 10 samples are included here):

- Little Butte Creek
- Elk Creek
- Bear Creek
- Rogue River
- Coast Fork Willamette R.
- Willamette River
- Pudding River
- S. Yamhill & Yamhill R.
- Tualatin River & tribs.
- Columbia Slough
- Deschutes River
- Owyhee River
- Malheur River
- Powder River
- Grande Ronde River
- Umatilla River & tributaries
- Crooked River
- Klamath River & tributaries
- S. Umpqua & Umpqua Rivers

Cholorphyll a concentrations in the following streams exceeded the 0.015 mg/l criteria in at least 10 percent of the samples taken (only sites with at least 10 samples are included here):

- Yamhill River
- Tualatin River & tribs.
- Columbia Slough
- Malheur River
- Calapooia River
- Willamette River
- Klamath River & tributaries

If streams with at least 5 samples taken are included, the Owyhee and Miami Rivers would be added to this list.

High chlorophyll a concentrations are less frequently detected than high phosphorus levels for several reasons. First, water monitoring samples are taken from the water column and, therefore, measure only phytoplankton algae, not periphyton algae or macrophytes, which grow attached to stream bottoms. Therefore, if a stream is dominated by periphyton algae, this will not show up in chlorophyll a measurements. Periphyton algae are more common in shallow, moving streams. Some water quality limited streams in Oregon dominated by periphytons include the South Umpqua River, Umatilla River, Grande Ronde River and Bear Creek.

Second, the Department does not test for chlorophyll a as frequently and there is simply not as much data available. Unlike nutrient concentrations, chlorophyll a has not historically been a standard ambient monitoring test. Finally, some rivers have high phosphorus but do not experience excessive algal growth due to turbidity or shade, which limit the availability of light, or due to the speed of the water movement which prevents the algae from accumulating.

Nitrogen-fixing algae are abundant or dominant in the Klamath, Umatilla, South Umpqua, Tualatin, and Grande Ronde Rivers, and many lakes (Sweet, 1985). When this occurs, phosphorus must be controlled to limit algal growth. The algae are obtaining the nitrogen they need from the atmosphere.

Total Maximum Daily Loads

The Department of Environmental Quality has identified 13 streams and Garrison Lake as priority waterbodies to receive total maximum daily loads (TMDLs). These waterbodies, listed in Appendix D, Table D-1, are water quality limited as defined by the Federal Clean Water Act. To date, phosphorus TMDLs have been established, or identified as being needed, for 8 of the 13 streams and Garrison Lake. These phosphorus TMDLs are being established to eliminate violations of dissolved oxygen and pH standards caused by excessive algal growth. In addition, the Department has established phosphorus TMDLs for Clear and Collard Lakes (near Florence) to control the potential impacts of future development. After the priority TMDLs are completed, the Department will begin work on the remaining water quality limited waterbodies in the state.

Phosphorus TMDLs have been established for three streams, the Yamhill and Tualatin Rivers and Bear Creek. The largest sources of phosphorus in these basins are the wastewater treatment plants. In the Tualatin and Bear Creek, phosphorus allocations were also given to nonpoint sources, including runoff from urban, agricultural and forest lands. The Department has also established phosphorus TMDLs for Clear Lake and Garrison Lake. The sources being regulated in these basins include WWTP effluent, septic systems and urban runoff.

Nutrient Limitation in Oregon Waters

A few studies of nutrient limitation have been conducted on Oregon waterbodies. A study of Devils Lake (KCM, 1983) stated that phosphorus was probably the limiting nutrient. Algal assays (biological tests) in Garrison Lake found that both nitrogen and phosphorus were limiting in August of 1988 (SRI, 1990). Algal assays conducted in Clear Lake (Cooper Consultants, 1985) found that phosphorus was limiting algal growth. EPA research in several Oregon bays shows that phosphorus is typically the limiting nutrient in riverine portions of estuaries.

In Bear Creek, phosphorus appears to be the nutrient in limiting proportions in nonpoint loads and background conditions. Below the City of Ashland's wastewater treatment plant (WWTP), neither nutrient is limiting. Nitrogen appears to be the nutrient in limiting proportions (the nitrogen to phosphorus ratio is low). This situation results from the discharge of relatively large amounts of phosphorus from the WWTP.

Algal assays conducted for the Tualatin River indicate that a target concentration of 0.05 to 0.10 mg/l total phosphorus is needed to reduce algal growth. The instream phosphorus criteria established by the Environmental Quality Commission is 0.07 mg/l.

A US Geological Survey study of the Willamette River in 1977 (Hines et al.) found that phosphorus was the nutrient in limiting proportions in the Willamette River, but that algal growth was not being limited by a nutrient at that time.

III. NUTRIENT SOURCES

SOURCES OF PHOSPHORUS AND NITROGEN TO OREGON WATERWAYS

Nitrogen and phosphorus sources can be placed into three general categories: point sources, nonpoint sources and natural sources. Point sources include wastewater treatment plants (WWTPs), combined sewer overflows (CSOs), and direct industrial discharges. Nonpoint sources are diffuse and are carried to a stream or lake by overland runoff rather than through a pipe or ditch. Nonpoint sources include agricultural, forestry and urban runoff and septic system drainage.

It is difficult to quantify how much of the nutrient load to a particular stream is from point sources and how much is from nonpoint sources. The DEQ has estimated that in the Tualatin basin, less than 15-20 percent of the total phosphorus load to the Tualatin River is from nonpoint sources. The proportions will vary from basin to basin, however, depending on the physical characteristics, land uses and point sources present in a particular basin.

WWTPs are the largest point sources of phosphorus discharges to Oregon waters. There are over 275 WWTPs in Oregon, with a total design capacity of approximately 300 million gallons per day, that discharge effluent to surface waters. WWTP effluent contains an average of 5 - 7 mg/l phosphorus. The sources of nutrients to WWTPs are discussed in more detail below.

The types of industries that typically discharge nutrients include food processors, log ponds, and manufacturers using phosphorus compounds for metals cleaning. These direct industrial discharges are a relatively small portion of the total phosphorus load in Oregon. Direct industrial discharges are suspected pollution sources for four of the 15 priority rivers and lakes to receive TMDLs. Municipal WWTPs are suspected sources for all 15 waterbodies.

There are a variety of nonpoint sources of nutrients. Agricultural nonpoint sources include the runoff of animal waste and fertilizer, and the erosion of soil particles which may have phosphorus adsorbed to them. Another agricultural source is irrigation return flow. Some forestry practices cause phosphorus from decomposing vegetation or soil erosion to be carried to surface waters. Forestry fertilizers may be a source of nitrogen, but do not typically contain phosphorus. Urban fertilizer use also contributes nutrients to runoff.

On-site sewage treatment systems, such as septic system drain fields, can be a nonpoint source of nutrients. It is commonly understood that septic systems can be a source of nitrogen to groundwater and surface waters; in some situations they can also be a source of phosphorus. This may occur when a system is failing (the sewage is seeping to the surface of the ground). It may also occur when septic systems exist close to a waterbody, such as development along the shoreline of a lake, in sandy soils. Phosphorus readily adsorbs to soil particles, but the soils between the drain field and the lake may become saturated with phosphorus. As the soils become saturated with phosphorus, the concentrations of phosphorus passing through the soil would increase.

SOURCES OF PHOSPHORUS TO WWTP INFLUENT AND EFFLUENT

Phosphorus loads entering municipal WWTPs come from residential, industrial and commercial sources. Residential sources of phosphorus include human waste, laundry detergent, automatic dishwashing detergent, garbage disposals and other household cleaners. Industrial and commercial sources usually originate from food or forest product processing wastes, or some type of detergent or cleaner.

The relative proportion of phosphorus coming from various sources is assumed to be the same in the WWTP effluent as in the influent. Once the wastewaters are mixed in the plant, it is not possible to determine the source of the phosphorus. Therefore, estimates of the relative contribution of sources to effluent phosphorus are based on the influent sources.

The Unified Sewerage Agency (USA) estimates that an average of 85 percent of the phosphorus entering four of their plants in the Tualatin River basin is from residential and commercial sources.

An average of 15 percent of the influent phosphorus load is from industrial sources (Tualatin Basin Consultants, 1990).

Table 4 presents general estimates of the current phosphorus loads entering municipal wastewater treatment plants in areas without restrictions on phosphate detergent use. The percentage of the influent phosphorus contributed by each source is also shown.

Table 4 shows that household laundry detergents contribute approximately 27 percent of the total phosphorus load to WWTPs. This estimate was calculated based on the typical amount of phosphorus found in detergents today. Manufacturers have reduced the amount of phosphorus in their detergents since the 1970's and, therefore, this source represents a smaller proportion of the total phosphorus load today than it did 15-20 years ago.

Observed reductions in influent phosphorus resulting from the elimination of a particular source may also be used to estimate the contribution of phosphorus from that source. This method is primarily available for laundry detergents. Twelve states and five regions have restricted phosphate detergents from 1972 to present. Since the late 1970's these bans have resulted in 23 to 38 percent reductions in influent phosphorus loads, with an average reduction of 29 percent observed (see Table 5).

The Unified Sewerage Agency estimates that the METRO phosphate detergent ban, effective February 1, 1991, will reduce the phosphorus loads to their plants in the Tualatin River basin approximately 30 percent.

The calculated estimates and results of prior bans support the conclusion that household laundry detergents account for approximately one-third of the total phosphorus load entering municipal wastewater treatment plants, and being discharged from plants that do not remove phosphorus.

SOURCES OF NITROGEN TO WWTPS

The primary source of nitrogen to municipal wastewater is human waste. This source generates an average of approximately 4.4 kilograms of nitrogen per capita per year in organic and ammonium forms (Organization for Economic Cooperation and Development, 1971).

Table 4

Estimated Phosphorus Loads to Municipal Wastewater Treatment Plants

Source	Phosphorus Load* (kg/capita/yr)	Percent of Total Load
Human Waste	0.6	44
Laundry Detergents	0.37	27
Automatic Dishwashing Detergent	0.098	7
Other Household Cleaners	0.013	1
Industrial & Institutional:		
• Cleaners	0.16**	12
• Finishers	0.05**	4
• Water Treatment Chemicals	0.05**	4
Denitrifices	0.005	0.4
TOTAL	1.35	

* These estimates are based on current detergent formulations.

** Industrial loads vary widely. These values are national averages, assuming that all the industrial phosphorus loads enter municipal treatment plants. In many cases, however, these sources will either not exist in a service area, be treated and discharged directly rather than entering a municipal plant, or they will undergo pretreatment before entering the plant.

SOURCE: Personal communication with Richard Sedlak, Soap and Detergent Association, New York, December 1990.

Table 5
Phosphate Detergent Ban Effects on Municipal Wastewater

State/Region	Influent P Reduction	Effluent P Reduction	Year Ban Effective
Indiana	60%	60%	1972
New York	48	--	1972
Michigan	23	24	1977
Minnesota	38 (Loading)	42 (Loading)	1978
Vermont	--	40 (Loading)	1978
Wisconsin	22	--	1983
Maryland	32	42 (Loading)	1985
Washington, DC	25	--	1986
North Carolina	23	44	1988
Virginia	30	51	1988
Missoula, MT	--	40 (Loading)	1988
Atlanta, GA/Georgia	35 (Loading)	40 (Loading)	1989/1990
Pennsylvania	Not Yet Available	Not Yet Available	1990
Ohio	Not Yet Available	Not Yet Available	1990
Spokane River Basin, WA	Not Yet Available	Not Yet Available	1990
Portland, OR	Not Yet Available	Not Yet Available	1991

NOTE:
Reductions were figured as a percent decrease in either concentration or mass load (which accounts for the discharge flow), as indicated.

SOURCE: Updated information from Findings of the Region-Wide Phosphate Detergent Ban Study. Staff report to the Council of the Metropolitan Service District of Oregon, Jim Morgan, Portland, Oregon, May 22, 1990.

Industries can also be sources of nitrogen to municipal WWTPs. For example, the Unified Sewerage Agency estimates that industrial sources contribute 2, 5, 6 and 19 percent of the ammonia nitrogen loads to four plants in the Tualatin basin (Tualatin Basin Consultants, 1990).

The largest source of nitrogen to WWTPs is residential, and the primary residential source of nitrogen is human waste. Therefore, there is limited opportunity to regulate or eliminate nitrogen loads to the plants.

SOURCES FOR POSSIBLE REGULATION OR ELIMINATION

Phosphate in detergents is a significant source of phosphorus which could be eliminated or greatly reduced through statewide regulation. The following portions of this report discuss the potential benefits and impacts of such a regulation.

The Task Force recognizes that for many waterbodies, a phosphate detergent ban would be only one component of a successful program to control algal growth. Other components could include water quality based permitting (TMDLs), the permitting of combined sewer overflows, and the control of nonpoint sources. Each of these activities is in an early stage, but making progress as part of the Department's water quality program.

Industrial sources of nitrogen to WWTPs could potentially be controlled at the source. This control option is not analyzed below because industrial sources of nitrogen to WWTPs are relatively small. The primary residential source of nitrogen, human waste, could not feasibly be reduced at the source. Nonpoint sources of nitrogen could also be controlled at the source. See Appendix E and F for information on nutrient control technologies and programs.

IV. THE IMPACTS OF ELIMINATING PHOSPHORUS FROM DETERGENTS

IMPACTS ON WATER QUALITY

Table 5 above shows that the amount of phosphorus in municipal treatment plant discharges to receiving waters (effluent) has decreased an average of 40 percent as the result of phosphate detergent bans implemented since the late 1970's. These figures represent results at plants that do not treat for phosphorus removal. Phosphorus load reductions will aid in improving water quality if in-stream concentrations are reduced to the levels required to prevent excessive algal growth.

While there have been many studies following detergent phosphate bans which document the reduction in phosphorus in the influent and effluent of wastewater treatment plants, fewer studies have been done on the resultant change in instream or in-lake phosphorus concentrations and other related water quality parameters. The literature that is available varies in its conclusions.

The effect of a reduced phosphorus load on water quality is difficult to predict quantitatively because of the variety among waterbodies and the many other environmental variables that influence the outcome. There are models which can be used to estimate the response of a given waterbody to a change in one factor, such as its phosphorus load. This requires that a set of data on a specific water body be collected and used to assemble the model. Studies and modelling of individual waterbodies to quantify the results of phosphorus control require time and expense.

IMPACTS ON OTHER NUTRIENT CONTROL STRATEGIES

In some waterbodies, a decrease in phosphorus loads from a phosphate detergent ban could be sufficient to allow discharge of WWTP effluent without prior phosphorus removal, or to delay the time when removal becomes necessary. Where nutrient and algal growth problems are severe, however, WWTPs will need to reduce their phosphorus loads by a very large amount. In these situations, detergent bans alone will not produce the required reduction and other measures must also be implemented. Additional information on nutrient control practices is provided in Appendix E.

There are over 420 wastewater treatment facilities in Oregon. More than 275 of these discharge effluent to surface waters and these facilities have a combined treatment capacity of over 300 million gallons per day (MGD). Currently, two plants (USA's Rock Creek and Durham), with a combined capacity of approximately 30 MGD, chemically remove phosphorus. Three additional plants (Lafayette, McMinnville and Ashland) are considering various phosphorus removal alternatives to achieve new discharge limits. As TMDLs continue to be established, phosphorus limits will be included in the permits of additional plants.

Phosphorus Removal at Treatment Plants

Phosphorus removal at the treatment plant is one method to reduce effluent phosphorus. This removal is typically accomplished by a chemical addition process using iron or alum which precipitates the phosphorus. The chemical treatment process generates additional sludge, which must then be removed and disposed.

Reduced influent phosphorus resulting from phosphate detergent bans typically affects the chemical removal process in the following ways:

1. The quantity of chemicals required for phosphorus removal is reduced in proportion to the decrease in influent phosphorus.

2. The quantity of sludge generated from the phosphorus removal process is reduced.

5. The need to add chemicals to correct for pH depression caused by alum treatment is reduced.

4. Biological rather than chemical removal may become more feasible.

5. Reduced chemical use would reduce the concentration of total dissolved solids (TDS) in the effluent. The Oregon Administrative rules for some basins

state that instream TDS shall not exceed 100 mg/l. Potential exceedence of this standard is a concern in the Tualatin basin, for example, where it is anticipated that chemical removal will cause effluent TDS levels to increase by 100-300 mg/l (HDR Engineering, 1990).

WWTPs practicing phosphorus removal in other states reduced their chemical use, and therefore chemical costs, by an average of about 29-43 percent following the implementation of phosphate detergent bans. Based on the USA estimates below and additional information reported in Appendix G, the estimated savings from a 30 percent reduction in influent phosphorus range from approximately $100,000 to over $200,000 per year per 10 MGD.

The Unified Sewerage Agency of the Tualatin River basin estimates that it will save $389,000 per year in operating costs from a phosphate detergent ban (HDR Engineering, 1990). These savings, based on 1995 flow conditions, will be incurred at 2 plants having a planned 1995 capacity of 35 MGD. The estimate is based on a predicted 25 percent reduction in chemical use ($308,000), and reduced sludge handling ($81,000).

Biological nutrient removal (BNR) is being developed as an alternative to chemical removal. There are BNR systems operating in the eastern U.S. Typically, chemical treatment capabilities are constructed as backup at plants using biological removal.

Wetlands Polishing

The capacity of a wetland to assimilate inputs is finite (see Appendix E for information). As the sediment adsorption of phosphorus approaches saturation, the ability of the wetland to retain additional phosphorus will be reduced. If the load of phosphorus introduced to a wetland is decreased, the ability of the wetland to retain the nutrient will be prolonged.

Wastewater Reuse -- Irrigation

The value of wastewater for irrigation is not affected by decreasing the phosphorus concentration by approximately one-third, the expected reduction from a phosphate detergent ban. This would not influence a farmer's decision to use or not to use the water because the water itself is the primary value to the farmer (Jackson, 1990). (See Appendix E for additional information).

ECONOMIC IMPACTS

A phosphate detergent ban will yield an economic benefit through cost savings to WWTPs using chemical treatment to comply with a phosphorus discharge limit. These cost savings, associated with reduced chemical use and sludge handling, are discussed above and in Appendix G.

In addition, if the need for a treatment plant to add phosphorus removal facilities can be avoided or delayed, there would also be savings from avoided capital construction and operating costs. The potential for this as the result of a detergent phosphate ban has not been reliably predicted or quantified for Oregon.

A phosphate detergent ban could potentially increase the cost of distributing products to Oregon. No cost estimates on the effects of a phosphate detergent ban on the detergent industry are available. Such estimates are difficult to develop and include proprietary market information.

Based on reports from areas currently with phosphate detergent bans, these bans do not appear to increase the costs of laundry detergents to consumers. Consumer Reports (1987) rated the performance of laundry detergents across the country based on laboratory tests in hard water. Of the top 10 performers:

- 3 were liquids (non-phosphate), with an average cost of \$0.23 per dose,
- 4 were phosphate containing powders, with an average cost of \$0.20 per dose, and
- 3 were non-phosphate powders, with an average cost of \$0.17 per dose.

Of all the laundry detergents rated, the average cost per dose for non-phosphate powders was 15.8 cents, for phosphate powders was 17.7 cents, and for liquids (non-phosphate) was 18.4 cents.

The cost to public agencies to implement and enforce a phosphate detergent ban is minimal. The implementation is primarily carried out by the product suppliers and enforcement has not been a problem in areas of existing bans.

See Appendix G for additional information on the economic impacts of a detergent ban.

IMPACTS ON THE FUNCTION AND EFFECTIVENESS OF DETERGENTS

Approximately 37 percent of the United States population now lives in areas where laundry detergent phosphates have been banned. The Task Force has found no reports or survey results that indicate that these citizens are dissatisfied with the effectiveness of the non-phosphate detergents they are now using.

OTHER ENVIRONMENTAL IMPACTS

Reducing concentrations of toxic metals in wastewaters is becoming a priority for WWTP operators. Metals in wastewater can settle into sludge or be discharged to surface waters with the plant effluent (EPA, 1982). A study of Seattle's municipal wastewater indicates that a significant proportion of many heavy metals originate from residential sources (Galvin, 1988).

A second study conducted for Seattle METRO considered whether laundry detergents were potential sources of heavy metals (Dickey, 1990). This study determined that increasing levels of phosphates in detergents correlated with increasing levels of heavy metals, although the relationship was statistically significant for only one metal, arsenic. The study concluded that laundry detergents were a significant source of arsenic to municipal wastewater.

Another study concluded that heavy metals contributed by a range of cleaning products contributed less than 1 percent of the current effluent limit for selected heavy metals other than arsenic (REED Corporation, 1990). The cleaners contributed in total, 0.5 parts per billion of arsenic to sewage effluent at an assumed sewage production rate of 100 gallons per capita per day. The presence of this amount of arsenic in sewage does not impair the ability of municipal discharges to meet water quality standards for arsenic.

SOCIAL IMPACTS

Oregonians are proud of the quality of their environment and publicly declare their commitment to preserving the state's natural resources. If a phosphate detergent ban is perceived to have an environmental benefit, it is likely to have strong public support.

A phosphate detergent ban may promote public awareness of the need for pollution control. It is a pollution prevention measure at the consumer or household level, an approach that should be encouraged. To the extent that consumers are aware of such measures, they will be able to recognize that they are part of a society which made this decision, and that they are contributing to the solution of an environmental problem.

POLLUTION PREVENTION

A phosphate detergent ban is a pollution prevention measure. Environmental foresight has proved prudent in the past, and has taught us to appreciate the value of pollution prevention over the treatment or cleanup of problems after they occur. While a phosphate detergent ban is only one component of a strategy to eliminate algal growth, it reduces human contributions to the wastestream.

In June, 1990, the Environmental Quality Commission adopted a Strategic Plan. One of the plan's nine goals is to:

> *Aggressively identify threats to public health or the environment and take steps to prevent problems which may be created.*

Similarly, one of the three high priorities identified for the DEQ's Water quality Program is to:

> *Implement aggressive source control and problem prevention programs based on the priorities established that explore and encourage use of environmentally sound alternatives for disposal of treated wastewater which do not adversely affect air, land, stream and groundwater quality.*

A ban on phosphates in detergents is consistent with these goals.

V. PHOSPHORUS CONTROL POLICY AND LEGISLATION

OREGON PHOSPHATE DETERGENT LAWS

In June of 1990, the Metropolitan Service District of Oregon passed a regional ban on detergent phosphates which will become effective on February 1, 1991 and will sunset on December 31, 1994. The METRO ban is similar to existing bans in other locations. It prohibits the sale of any cleaning agent with more than 0.5 percent phosphorus by weight, with listed exceptions. Automatic dishwashing detergents shall not exceed 8.7 percent phosphorus by weight.

The City of Ashland is considering a similar ordinance. Current Oregon law (ORS 468.760) requires the phosphorus content of synthetic cleansers to be labeled.

A statewide ban on the sale of phosphate detergents will be more manageable than local or regional bans. It would minimize the possibility of consumers unintentionally bringing phosphate detergents into areas with local bans.

AN OVERVIEW OF PHOSPHATE DETERGENT LAWS

A chart summarizing phosphate detergent ban legislation in other states and regions is provided in Appendix G. Many of the bans include similar provisions. Most prohibit the sale or distribution of household laundry detergents containing phosphates, although 7 areas also prohibit the use of these products. Many of the regulations prohibit phosphates in cleaning products and list exceptions. Most allow up to 0.5 percent incidental phosphorus in laundry detergents. All the laws allow dishwashing detergents to contain phosphorus, typically limiting them to 8.7 percent. Some bans include fines for violations.

Typical products exempted from the phosphate bans include detergents used to clean dairy and food processing equipment, detergents used in hospitals and health care facilities, and industrial cleaning products. Some of the bans exempt all detergents used for cleaning hard surfaces.

OTHER PHOSPHORUS CONTROL POLICIES AND REGULATION

There are a multitude of federal, state and local regulations aimed at controlling nutrient inputs to surface waters for the purpose of limiting algae and weed growth. These policies, some of which are described in Appendix F, range from point source discharge limits to technologies and management practices designed to reduce nonpoint sources of nutrients.

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APPENDIX A

GLOSSARY OF TERMS

activated sludge:	biologically active solids produced in wastewater treatment systems, which grow through the consumption of organic wastes and nutrients present in the wastewater.
algal assay:	studies in which algae are exposed to a substance and the response of the algae is monitored over time; the studies are used to identify substances that affect algal growth.
alum:	a common name for commercial-grade aluminum sulfate, a material used to remove impurities from drinking water and wastewater.
biological phosphorus removal:	use of selected bacteria to incorporate high concentrations of phosphorus during wastewater treatment, often such processes can be operated to remove other nutrients besides phosphorus, in which case they are generically referred to as "biological nutrient removal."
chemical phosphorus removal:	use of chemicals to precipitate phosphate out of wastewater during treatment.
chlorophyll-a:	a pigment present in all green plants and algae; measurements of this pigment are used as an indicator of plant and algal biomass.
combined sewer overflow:	in municipal wastewater systems that collect both sewage and storm runoff, these are discharges of combined wastewater and storm runoff that occur prior to treatment as a result of storm events which cause flows to exceed the capacity of the treatment plant.
dissolved oxygen:	oxygen dissolved in water.
effluent:	treated wastewater discharged <u>out</u> of a wastewater treatment plant.
eutrophication:	the process occurring in bodies of water particularly lakes, characterized by nutrient richness, luxurious aquatic plant growth, and low oxygen levels.

heavy metals: metals with high atomic weight, such as lead, cadmium, or arsenic; these are often toxic at higher concentrations.

influent: wastewater flowing <u>into</u> a wastewater treatment plant.

irrigation return flow: irrigation water that runs off irrigated fields and is collected in channels for discharge.

loading: the quantity of material carried into a body of water or a treatment plant. Expressed as mass per unit time (e.g. pounds per day), rather than concentration (e.g. milligrams per liter).

nitrogen-fixing algae: algae that can take nitrogen gas from the atmosphere and change it into nitrogen-containing compounds necessary for growth.

nutrient: any substance assimilated by an organism which promotes growth and replacement of cellular constituents.

nonpoint source: diffuse sources of pollution, or a large number of small dispersed sources, carried to surface waters via overland or subsurface flow.

orthophosphate: a common form of phosphate that is considered more biologically-available.

periphyton: algae attached to streambeds and rocks in fresh waters.

pH: a term used to describe the hydrogen-ion activity of a system; pH 0 to 7 is acid, pH of 7 is neutral, pH 7 to 14 is alkaline.

phosphate: a generic term for any compound containing the phosphorus and oxygen group (PO_4^{-3}); in nature, phosphorus always exists as a form of phosphate.

phosphorus: a naturally occurring element essential to all plant and animal life that can, when in excess in surface waters, lead to excessive plant growth; phosphorus usually infers 'total phosphorus' which includes all of its forms.

phytoplankton: algae floating on the surface or in the water column.

point source:	a source of pollution where a single discharge point can be identified, such as municipal or industrial wastewater discharge pipe.
precipitate:	the solid material formed in a water or wastewater treatment process which can then be separated from the water.
sludge:	the accumulated solids separated from wastewater during treatment.
standard:	see "water quality standard"
TMDL:	a Total Maximum Daily Load is the maximum load of a particular substance allowed to be discharged into a receiving body of water; these are set by environmental management agencies for a water body designated as "water quality limited".
total dissolved solids (TDS):	the total amount of solids in water or wastewater that is in solution or is non-filterable.
water quality standard:	provisions of State law which consist of designated uses for the waters of the State and water quality criteria necessary to protect the uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the Federal Clean Water Act (40 CFR 130.2-3).

APPENDIX B

TASK FORCE MEMBERS LIST

Mr. Jim Buckley
Clackamas County Public Health, Oregon City
representing the Conference of Local Health Officials

Mr. Dave Degenhardt
Oregon Dept. of Forestry, Salem

Mr. Tom Donaca
Associated Oregon Industries, Portland/Salem

Mr. Dell Isham
Devils Lake Water Improvement District, Lincoln City

Mr. Francis Kessler
Willow Lake Treatment Plant, Salem
representing the Association of Oregon Sewerage Agencies

Ms. Sue Knight
representing the Oregon Environmental Council, Portland

Mr. Jim Morgan
Metropolitan Service District, Portland

Ms. Eleanor Phinney
River Watch, West Linn

Mr. Chris Reive
Bogle & Gates
representing Oregonians for Food & Shelter, Portland

Mr. Richard Sedlak
Soap & Detergent Association, New York, New York

Dr. Benno Warkentin, Chair
Water Resources Research Institute, Oregon State University, Corvallis

ALTERNATES:

Paul Cosgrove
Lindsay, Hart, Neil & Weigler, Portland
representing the Soap & Detergent Association

Mr. Jim Whitty
Associated Oregon Industries, Portland/Salem

A-Engrossed

Senate Bill 1079

Ordered by the Senate May 9
Including Senate Amendments dated May 9

Sponsored by Senators COHEN, ROBERTS, SHOEMAKER, Representatives BAUMAN, CARTER, STEIN

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure.

[*Prohibits sale of laundry detergent containing phosphate. Prescribes exemptions. Defines "cleaning agent".*]

[*Prescribes effective date.*]

Requires Department of Environmental Quality to establish task force on phosphorus and other nutrients in state waters. Prescribes membership and duties. Requires department to report findings to Sixty-sixth Legislative Assembly. Requires Legislative Assembly to determine whether to ban phosphates in detergents.

A BILL FOR AN ACT

Relating to phosphate.

Be It Enacted by the People of the State of Oregon:

SECTION 1. (1) The Department of Environmental Quality shall establish a task force on phosphorus and other nutrients in the waters of the state. The task force shall include representatives of municipal waste water treatment agencies, nonmunicipal point source dischargers, agriculture, forestry, manufacturers of consumer cleansing products and citizens. The task force shall assist the Department of Environmental Quality in identifying the sources of phosphorus and other nutrients contributing to the growth of algae in the waters of the state that the Department of Environmental Quality identifies in which algae growth is adversely affecting water quality. When appropriate, the task force shall assist the Department of Environmental Quality in identifying:

(a) Nutrient sources in waste ater treatment plant influent;

(b) The relative contribution of these nutrient sources on waste water treatment plant effluent; and

(c) The potential impact of regulating or eliminating phosphorus from detergents and other sources on potential nutrient control strategies and water quality.

(2) The Department of Environmental Quality shall report to the Sixty-sixth Legislative Assembly regarding the findings of the task force established under subsection (1) of this section. Based on the findings of the report, the Legislative Assembly shall determine whether it is appropriate to eliminate specific sources of phosphorus, including but not limited to, imposing a ban on phosphates in detergents.

NOTE: Matter in bold face in an amended section is new; matter [*italic and bracketed*] is existing law to be omitted.

APPENDIX C

STUDIES OF THE RELATION OF ALGAL GROWTH TO NUTRIENTS

Laboratory studies have shown the relationship between phosphorus concentration and algal growth when other factors are not limiting. These controlled experiments generally show that when phosphorus concentrations are below 0.07 mg/l, algal growth is very low. Between 0.07 and 0.15 mg/l, there is a linear relationship between the two factors; as the phosphorus concentration increases, so does algal mass. Above 0.15 mg/l, further increases in phosphorus produce no further increase in algal mass. Growth is then limited by other factors.

Field studies attempting to quantify the relationship between phosphorus and algal growth have not been consistent in their results, probably due to the large number of variables present in the natural environment.

Algae use nutrients in approximate atomic ratios of 106 C (carbon) to 16 N (nitrogen) to 1 P (phosphorus). This reduces to 7.2 N:P on a concentration basis. Ratios and absolute concentrations both need to be evaluated to determine potential limiting nutrients. The ratio of N:P measured in water should indicate whether N or P would limit growth. The concentrations indicate whether both or neither one are actually limiting growth. If the N:P ratio is less than 7:1, N is potentially limiting, if it is greater than 7:1, P is potentially limiting. Blue-green algae (cyanobacter), that fix their own nitrogen from the atmosphere, are rare where N:P ratios exceed 30:1. They grow competitively at low nitrogen concentrations.

The N and P fractions that should be measured are those that are biologically available, generally considered to be the soluble fractions. These are dissolved phosphate, and the ammonia, nitrate and nitrite forms of nitrogen. Phosphate is generally measured as "soluble" and "particulate" fractions, separated by passing through 0.05 um filter. It is assumed that soluble phosphate is biologically available, and that the particulate fraction replenishes the soluble fraction when the later is used. Phosphate concentrations are usually much larger in sediments than in water because of the strong adsorption of phosphate to clays.

The proportion of total phosphorus that is in a biologically available form is: 70 to 90 percent in wastewater effluent, 3-10 percent in eroded sediments, 10-90 percent in runoff as a whole, and 25-90 percent in atmospheric phosphorus. Sewage effluents have N:P ratios of about 5:1, while nonpoint sources range from 15:1 to 30:1.

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This contains a paper by Duthrie on detergents and several papers relating algal growth and eutrophication to phosphorus concentrations.

Middlebrooks, E.J. et al. (eds), 1984. Modeling the Eutrophication Process. Ann Arbor Science Publ., Ann Arbor, Michigan.

This contains some background material on phosphorus as well as information on modeling.

Ryding, S.O. and W. Rast (eds), 1989. The Control of Eutrophication of Lakes and Reservoirs. Man and the Biosphere Series, Volume 1, Parthenon Publishing Group, UNESCO, 314 pages.

This book takes a management approach and interprets the available information in terms of management alternatives.

Sandgren, C.D. (ed), 1984. Growth and Reproductive Strategies of Freshwater Photoplankton. Cambridge Univ. Press, New York.

This has more detail on bluegreen algae growth and a set of good references.

Schindler, D.W., 1977. Evolution of Phosphorus Limitation in Lakes. Science 195, 260-267.

This is a paper on which a lot of the thinking about phosphorus and algal growth is based. It shows the relationship of phosphate concentration to chlorophyll-a for a number of lakes and establishes the limit of approximately 8 milligrams per cubic meter.

APPENDIX D

WATER QUALITY DATA FOR OREGON - NUTRIENTS AND ALGAL GROWTH

This Appendix provides water quality data for Oregon supplemental to that provided in Section II of this report.

Statewide Data

Table D-1 lists the priority waterbodies to receive TMDLs in Oregon, the identified or potential TMDL parameters, and additional information. Phosphorus is a parameter identified for 8 of the 10 rivers and both lakes included on this list. Five phosphorus TMDLs (3 rivers and 2 lakes) have been established to date.

Figures D-1 & D-2 are maps from the 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution (DEQ, 1988). Figure D-1 shows the stream segments and lakes in the State identified as having moderate or severe nutrient problems. Phosphorus was the parameter used for the nutrient assessment. Figure D-2 shows the stream segments and lakes identified as having moderate or severe plant growth problems. Plant growth problems were identified based on either chlorophyll-a measurements or observations completed by DEQ staff or others.

Of the total stream miles in the State, 45 percent either had no water quality problem or had no information available. The remaining 55 percent were found to have some type of water quality problem, 24 percent based on data and 31 percent based on observation. Due to the fact that not all the stream miles were evaluated, and due to the limitations of chlorophyll-a as a measure of algal growth (discussed in the Section II of the report), Figure D-2 does not necessarily show all waterbodies experiencing excessive algal growth.

Water Quality Trends

As part of the 1990 statewide water quality assessment, the Department performed trend analyses on 62 stream sites (DEQ, 1990, Appendix I). To be selected for analysis, a stream site had to have a minimum of 5 years of data with continuity.

Statistically significant phosphorus and chlorophyll-a trends were found at some sites, but no statewide conclusion can be made due to the limited number of sites and the varied results. Figure D-3 is an example, the Deschutes River, where chlorophyll-a levels have increased significantly over the last ten years.

Longitudinal Data

DEQ has longitudinal data available for the Willamette River and some of the water quality limited rivers for which the Department has conducted water quality studies. Longitudinal data are data for a number of sites along the river by river mile.

Figure D-4 shows the total phosphorus concentration by river mile for the Willamette River as a "box plot." Each box represents the data collected at a particular site and the width of the box represents the number of samples collected at that site. The dotted line is the median data point, half of the data points fell above and half below this value. The height of the box represents the range of the middle 50 percent of the samples, and the lines extending from the boxes represent the range of all the data points.

As can be seen in Figure D-4, the total phosphorus concentration in the Willamette River increases downstream and exceeds the 0.10 mg/l criteria frequently below approximately river mile 50. Plots for additional rivers are shown in Figures D-5 to D-7.

Lake Data

Table 3, shown in Section II of the report, lists the Oregon lakes identified in DEQ's 1990 Water Quality Assessment as having algae, weed or related problems and septic drainage as a suspected source.

Diagnostic studies have been completed on 5 Oregon lakes as part of EPA's Clean Lakes Program: Garrison Lake (SRI, 1990), Blue Lake (Beak Consultants, 1983), Devils Lake (KCM, 1983), Klamath Lake (Klamath Consulting Service, 1983) and Lake Oswego (SRI, 1986). The studies show that all the lakes have algal growth problems and phosphorus concentrations exceeding the criteria level for lakes (0.025 mg/l). Nitrogen-fixing blue-green algae species were abundant or dominant in the lakes at least part of the year. Lake restoration plans for all these lakes recommended phosphorus reduction as the means by which to control the algal growth and eutrophic conditions.

Clear Lake, near the Oregon Coast, is not a eutrophic lake, but was studied in order to assess the potential impacts of future development on the lake. As a result, a TMDL was recently established for the amount of phosphorus entering Clear Lake.

The Department has also established a phosphorus TMDL for Garrison Lake, located on the Oregon coast. Garrison Lake is a heavily enriched lake with excessive phytoplankton populations (SRI, 1990). Municipal wastewater effluent and septic system drainage will be controlled in order to reduce the phosphorus loading to the lake.

Figure D-8 is a graph from the study by SRI (1990) showing how phosphorus, depth and residence time are related to trophic status for a number of Pacific Northwest lakes. Lakes above the permissible and excessive lines on the graph tend to be highly enriched and have algal and plant growth problems (eutrophic).

In 1974-75, the U.S. Environmental Protection Agency surveyed 8 Oregon lakes and reservoirs: Brownlee Reservoir, Diamond Lake, Hells Canyon Reservoir, Hills Creek Reservoir, Lake Owyhee, Oxbow Reservoir, Suttle Lake and Waldo Lake (EPA, 1978). Nitrogen was found most often to be the limiting nutrient based on lake data collected during the spring, summer and fall. Four of the lakes were phosphorus limited during one season. Algal assays were performed for three lakes. The assays indicated that nitrogen was the limiting nutrient in two lakes and phosphorus in the third.

References:

Beak Consultants Inc., 1983. Blue Lake Clean Lakes Program Phase I Diagnostic/Feasibility Study. Portland, Oregon.

Department of Environmental Quality (DEQ), 1988. 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution. Portland, Oregon.

DEQ, 1990. Draft Water Quality Status Assessment Report (305b Report). Portland, Oregon.

Klamath Consulting Service, Inc., 1983. The Upper Klamath Lake EPA 314 Clean Lakes Program 1981-1983.

Kramer, Chin and Mayo, Inc. (KCM), 1983. Devils Lake Diagnostic and Feasibility Study. Portland, Oregon.

Scientific Resources, Inc. (SRI), 1986. Oswego Lake Improvement Project: Preliminary Analysis. Portland, Oregon.

SRI, 1990. Garrison Lake and Watershed Assessment 1988-1989, Volume I: Diagnostic and Restoration Analysis. Lake Oswego, Oregon.

U.S. Environmental Protection Agency (EPA), 1978. National Eutrophication Survey, Working Papers 287-834. Washington, D.C.

Table D-1. Oregon TMDL Parameters and Status, 1990

RIVER/LAKE	INTENSIVE WQ STUDY	TMDL STATUS	PARAMETERS OF CONCERN	TMDL PARAMETERS	SOURCES
Tualatin	Yes	Final	DO, pH, algae	Phosphate Ammonia Nitrogen	STPs nonpoint
Yamhill	Yes	Final	pH, algae fecal bacteria turbidity	Phosphate	STPs nonpoint
Bear Creek	Yes	Final	DO, pH, algae fecal bacteria ammonia toxicity	Ammonia Nitrogen BOD Phosphate	STP log ponds nonpoint
Umatilla	Yes	Preliminary	pH, algae fecal bacteria	Phosphate	STPs nonpoint
Pudding	In Progress	Preliminary	DO fecal bacteria	BOD	STP, Agripac, nonpoint
S. Umpqua	No	Preliminary	DO, algae fecal bacteria	Phosphate Ammonia Nitrogen	STP nonpoint
Grande Ronde	No	Preliminary	algae fecal bacteria	Phosphate	STPs, nonpoint, log ponds
Klamath	In Progress	Preliminary	DO pH, algae	BOD Ammonia Nitrogen	STP, Weyerhauser, Klamath Lake, nonpoint
Columbia Slough	In Progress	Preliminary	pH, algae, bacteria, toxins	Bacteria Ortho-Phosphorus Toxins [a]	nonpoint, landfill, CSOs, point sources
Coquille	In Progress	Preliminary	DO fecal bacteria algae	BOD	STPs log ponds nonpoint
Coast Fork Willamette	Yes	Preliminary	DO, pH, algae, bacteria	BOD Phosphorus	STPs, nonpoint misc. point sources

(continued next page)

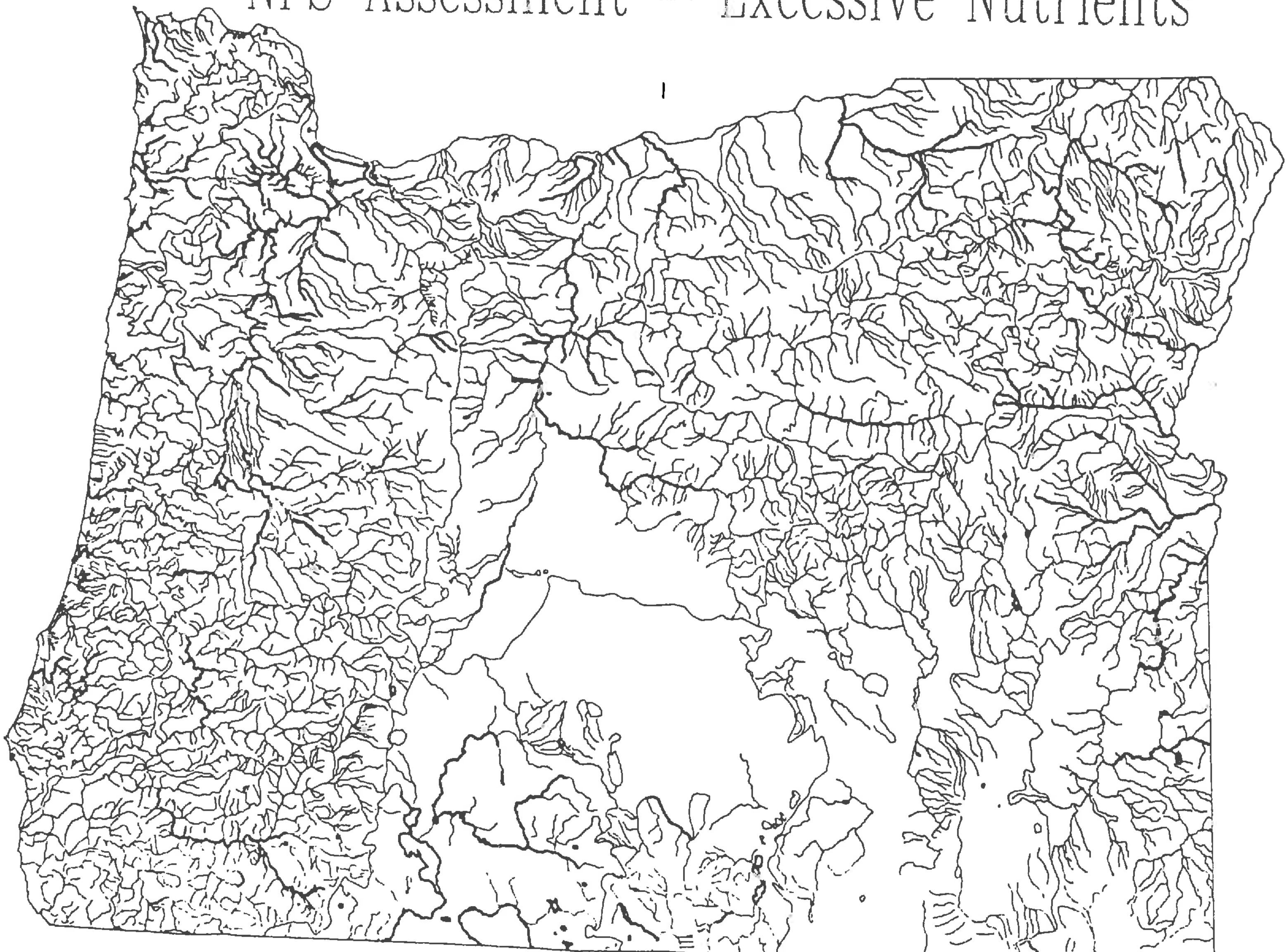
Table D-1. Oregon TMDL Parameters and Status, 1990

RIVER/LAKE	INTENSIVE WQ STUDY	TMDL STATUS	PARAMETERS OF CONCERN	TMDL PARAMETERS	SOURCES
Rickreall Cr.	In Progress	Preliminary	DO	BOD	STPs
Columbia River	No	Preliminary	TCDD	TCDD	pulp & paper mills, STPs, nonpoint
Clear Lake	Yes	Final	algae	Phosphorus	septic systems
Garrison Lake	Yes	Final	pH, algae macrophytes	Phosphate	STP nonpoint

[a] Preliminary TMDLs are proposed for toxins: PCBs, lead, zinc, mercury, arsenic, dioxin, copper, cadmium and chromium.

FIGURE D-1

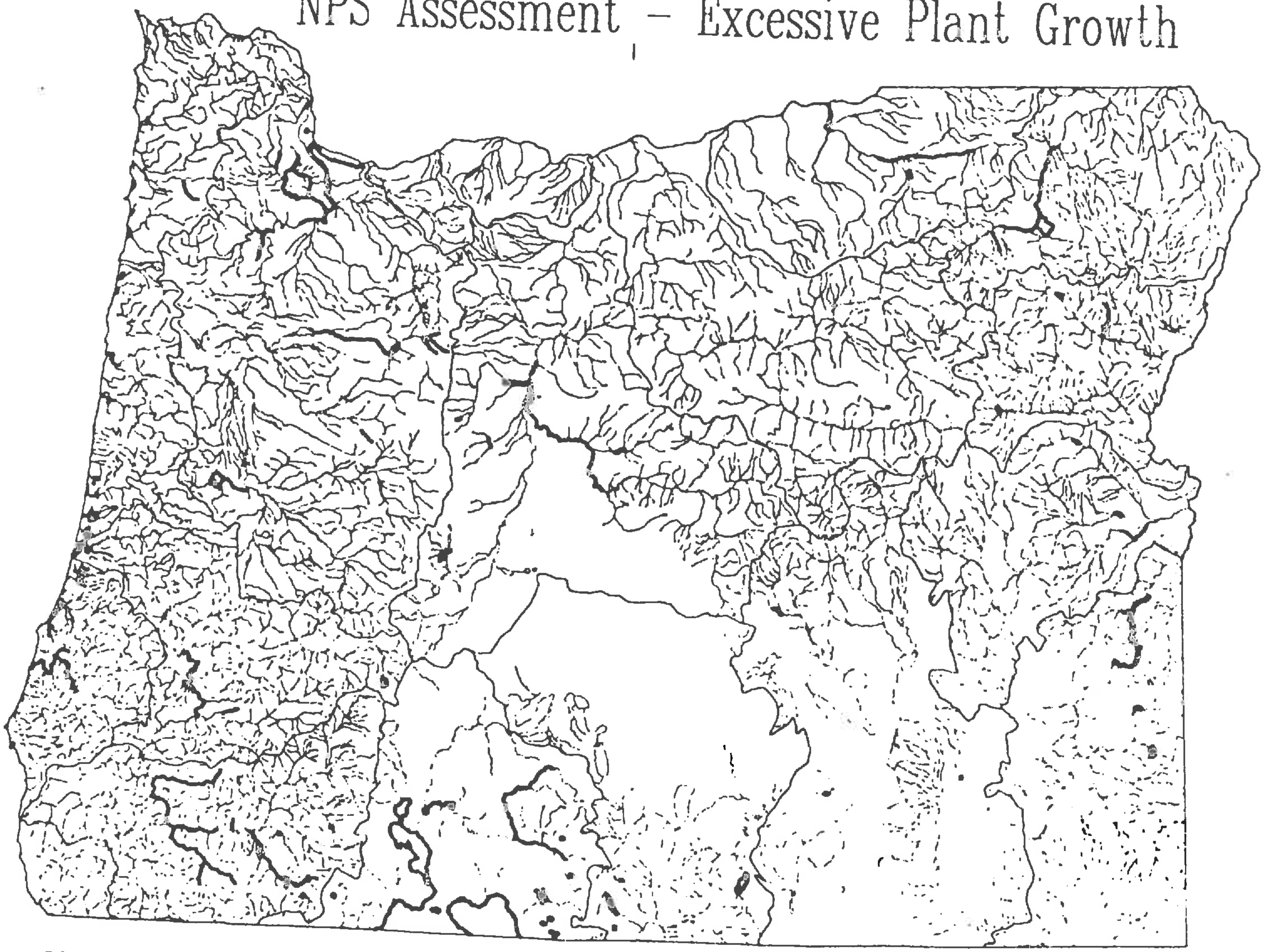
NPS Assessment - Excessive Nutrients



SOURCE: 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution - Department of Environmental Quality - August 1988

FIGURE D-2

NPS Assessment - Excessive Plant Growth



SOURCE: 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution - Department of Environmental Quality - August 1988

FIGURE D-3

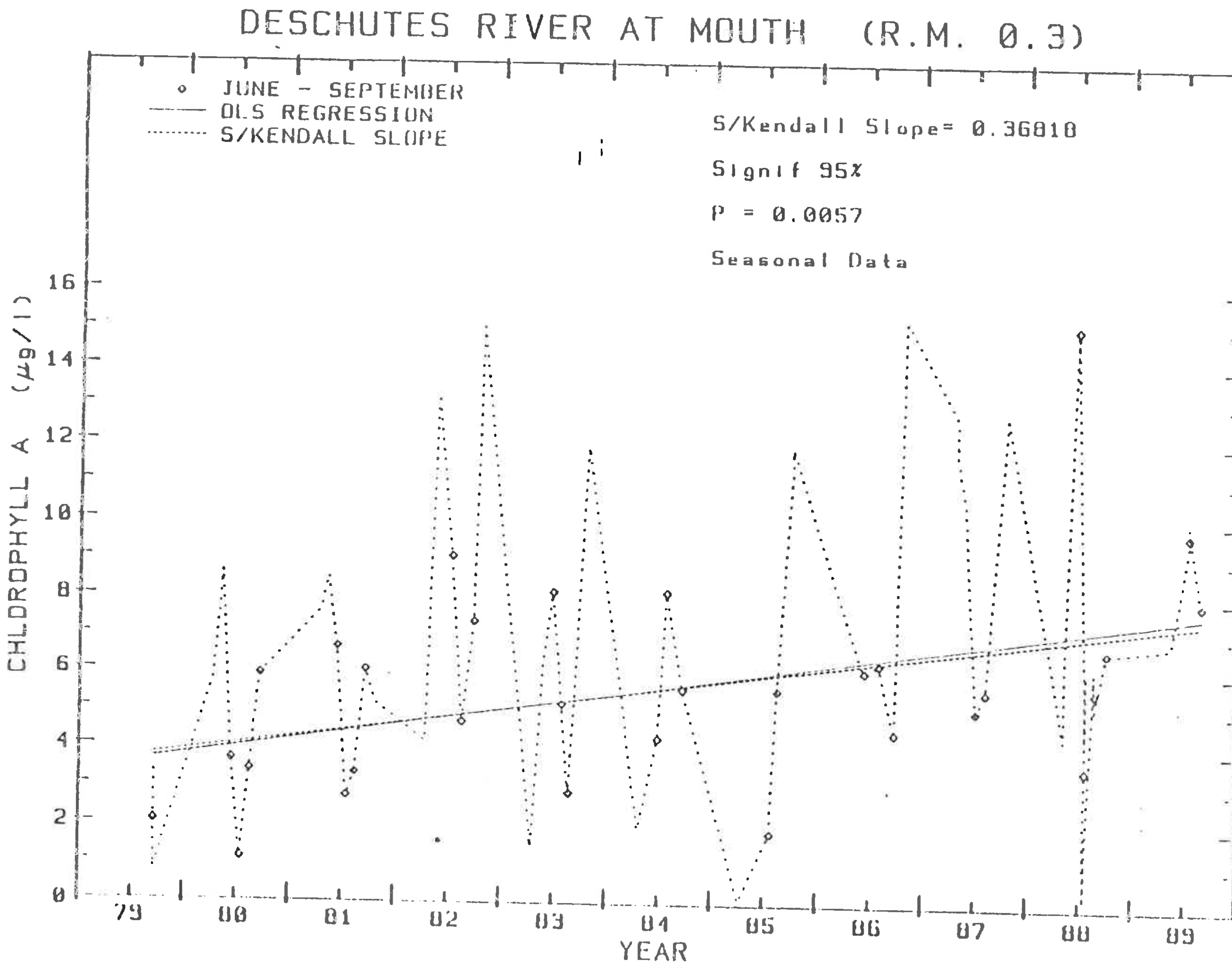

DESCHUTES RIVER AT MOUTH (R.M. 0.3)
JUNE - SEPTEMBER
OLS REGRESSION
S/KENDALL SLOPE
S/Kendall Slope= 0.36818
Signif 95%
P = 0.0057
Seasonal Data
CHLOROPHYLL A (µg/l)
0
2
4
6
8
10
12
14
16
79
80
81
82
83
84
85
86
87
88
89
YEAR

FIGURE D-4

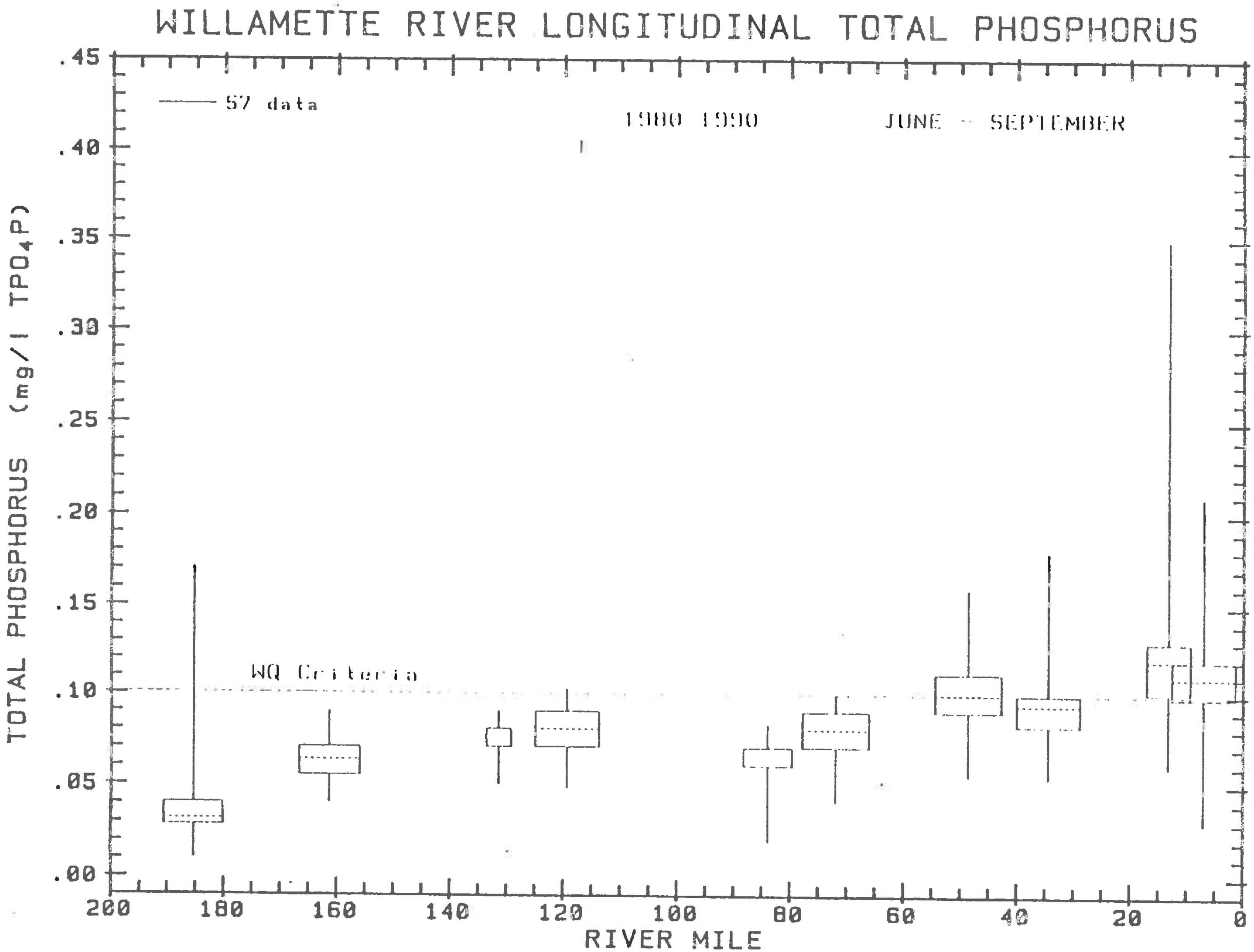
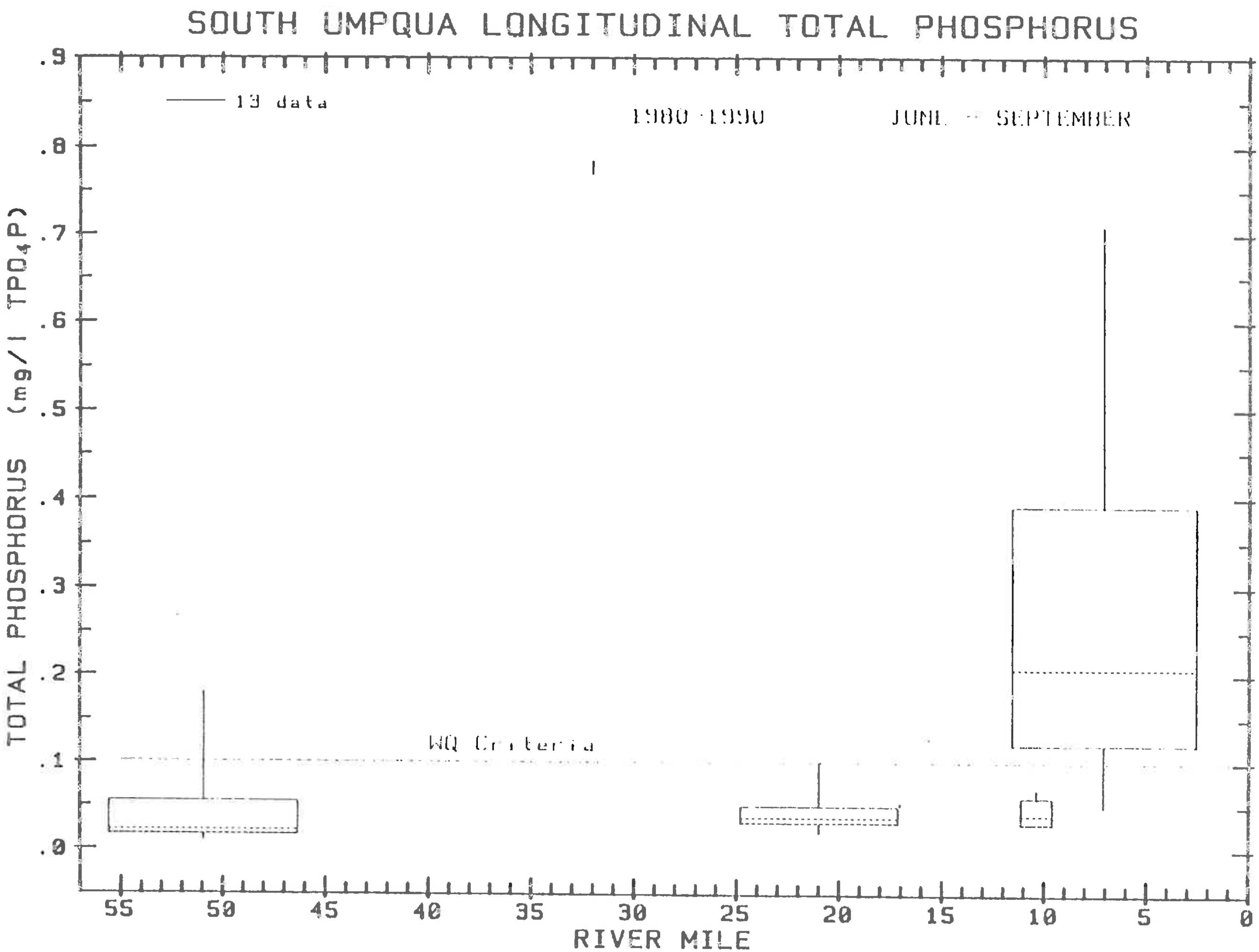

WILLAMETTE RIVER LONGITUDINAL TOTAL PHOSPHORUS
57 data
1980 1990
JUNE - SEPTEMBER
WQ Criteria
TOTAL PHOSPHORUS (mg/l TPO4P)
.45
.40
.35
.30
.25
.20
.15
.10
.05
.00
200
180
160
140
120
100
80
60
40
20
0
RIVER MILE

FIGURE D-5



SOUTH UMPQUA LONGITUDINAL TOTAL PHOSPHORUS
13 data
1980-1990
JUNE - SEPTEMBER
WQ Criteria
TOTAL PHOSPHORUS (mg/l TPO4P)
.9
.8
.7
.6
.5
.4
.3
.2
.1
.0
55
50
45
40
35
30
25
20
15
10
5
0
RIVER MILE

FIGURE D-6

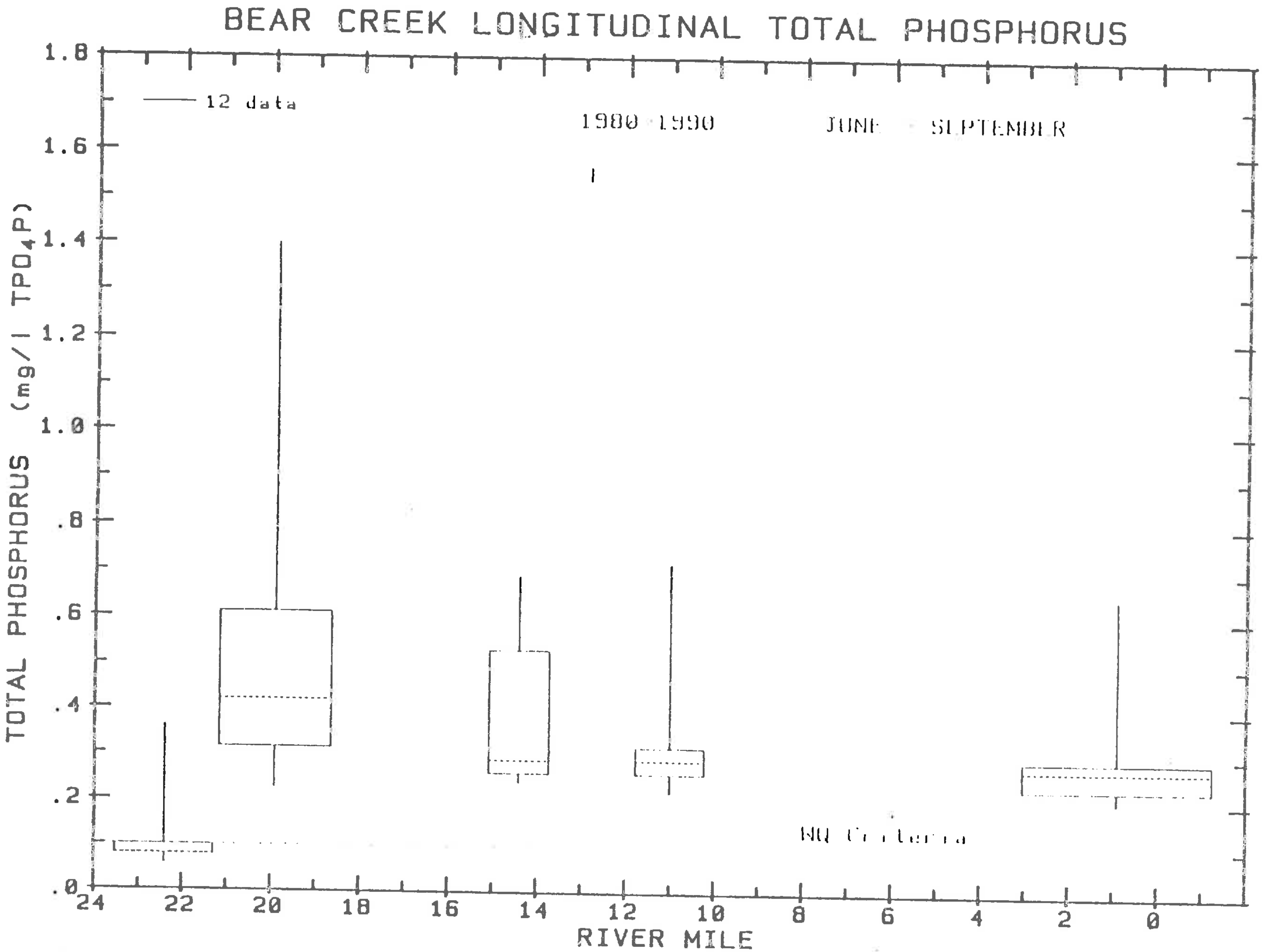

BEAR CREEK LONGITUDINAL TOTAL PHOSPHORUS
12 data
1980 1990
JUNE SEPTEMBER
TOTAL PHOSPHORUS (mg/l TPO4P)
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
24
22
20
18
16
14
12
10
8
6
4
2
0
RIVER MILE

FIGURE D-7

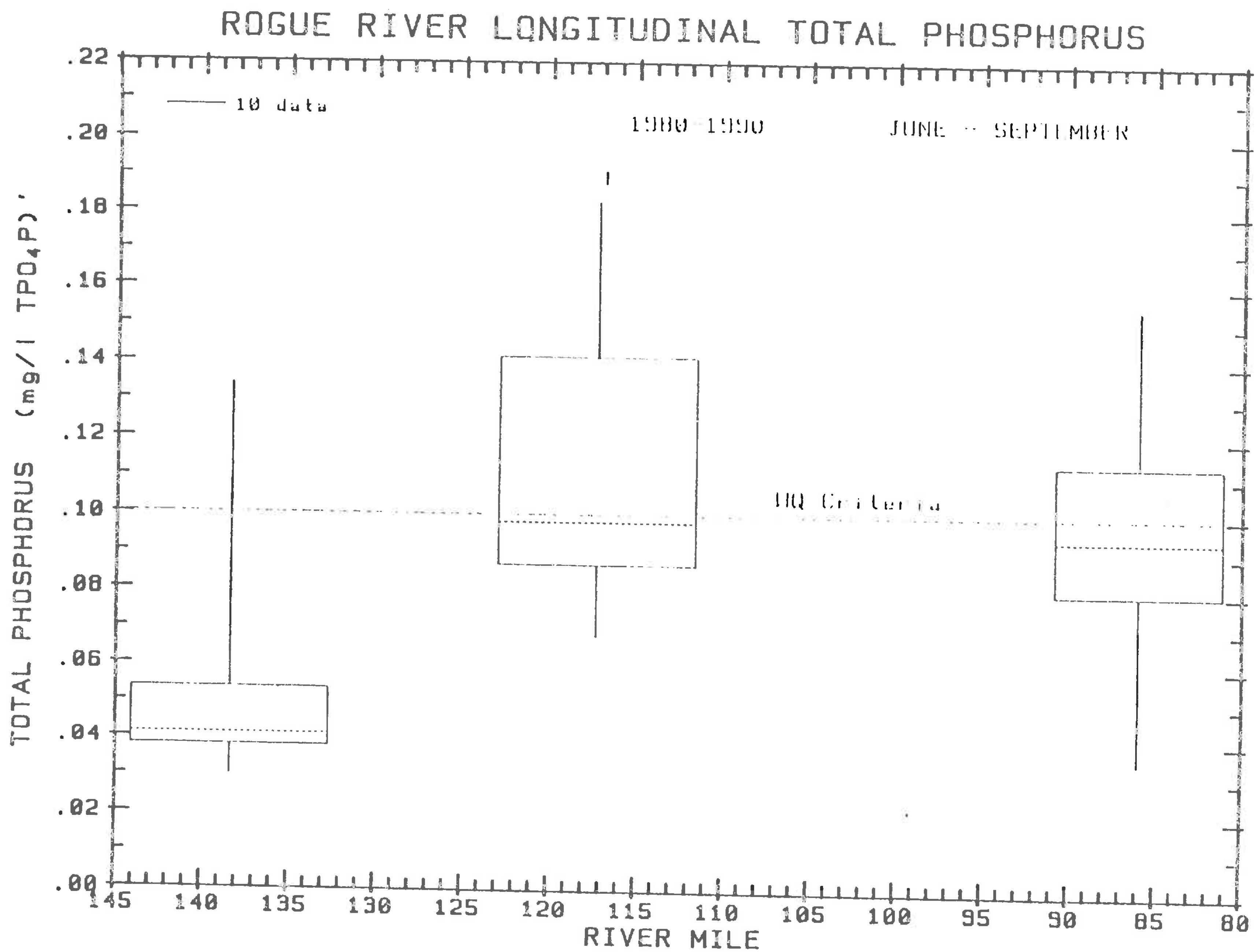
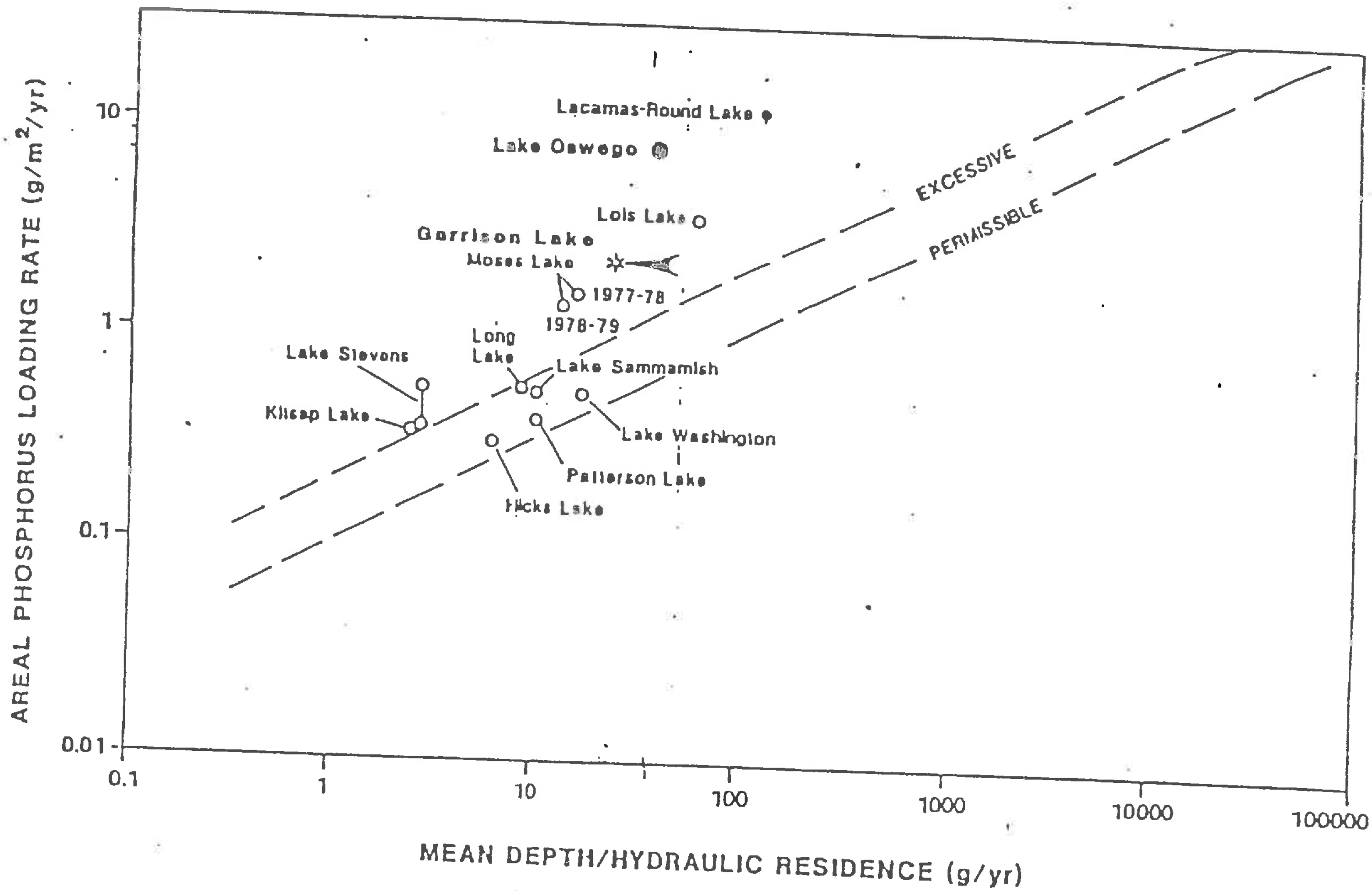

ROGUE RIVER LONGITUDINAL TOTAL PHOSPHORUS
10 data
1980-1990
JUNE - SEPTEMBER
WQ Criteria
TOTAL PHOSPHORUS (mg/l TPO4P)
.22
.20
.18
.16
.14
.12
.10
.08
.06
.04
.02
.00
145
140
135
130
125
120
115
110
105
100
95
90
85
80
RIVER MILE

FIGURE D-8

Vollenweider graph (1976) showing the relative position of Garrison Lake in relation to other Northwestern lakes with respect to annual total phosphorus loading.



SOURCE: Garrison Lake and Watershed Assessment 1988-89.

Scientific Resources, Inc., Portland, Oregon, 1990.

APPENDIX E

NUTRIENT TREATMENT AND CONTROL PRACTICES

Phosphorus Control Alternatives for Wastewater Treatment Plants

There are currently two general methods of process control employed for the removal of phosphorus at wastewater treatment plants. These are chemical/physical and biological nutrient removal. The following are the common chemical removal systems:

a. Precipitation with aluminum salts - precipitation of phosphorus compounds can be accomplished through the addition of aluminum salts such as aluminum sulfate. The resulting aluminum phosphate compound is allowed to thicken and settle in tanks for later processing. Aluminum salts are the most commonly used and are the most effective at removing phosphorus to very low levels.

b. Precipitation with iron salts - phosphorus can be removed through precipitation with iron salts such as ferric chloride. The reaction results in a sludge which is thickened in tanks for later processing.

c. Precipitation with lime - calcium carbonate (lime) can be used to remove phosphorus through a two stage addition to the waste stream. This addition raises the pH of the wastewater and forms a precipitate which will settle in tanks. The waste stream will then typically need to have the pH adjusted to a more neutral level. The sludge that is generated is typically different than the sludges generated through alum or ferric chloride addition and may require a different type of processing.

Biological nutrient removal systems are also used to remove phosphorus from the waste stream. These are typically not as efficient as chemical removal systems in removing phosphorus to very low levels. This process involves the selection of microorganisms capable of accumulating excess quantities of phosphorus during cellular metabolism. This selection process requires special tanks where varying environmental conditions can be maintained. These environmental conditions are required to stimulate the phosphorus uptake and microorganism selection.

In addition to removal during the wastewater treatment plant processes, phosphorus can be removed through post treatment use. The following methods may be employed:

a. Wetlands polishing - Wastewater treatment plant effluent may be polished, and phosphorus removed, through circulation across constructed or natural wetlands. The capacity to remove phosphorus is dependent on the size of the wetland, various plant species in the wetland, and the detention time of the wastewater in the wetland. Wetlands have a finite capacity to remove inputs and can reach a saturation level at which the wetland will have a reduced ability to assimilate pollutants. The large amount of land required for wetlands and the difficulty in insuring high levels of phosphorus removal will prevent the use of wetlands in many instances.

b. Wastewater effluent reuse for irrigation - The use of treated municipal wastewater for irrigation is both practical and safe. Wastewater effluent phosphorus levels should not present a problem in overloading the soil when the effluent is used for irrigation. Phosphates added to the soil may be taken up by the crop, accumulated by the solid phase of the soil in sorption or precipitation reactions, or lost from the system in percolation and runoff waters or by erosion. Reactions with the soil, and crop removal, account for the largest fraction of the phosphorus removed.

Management Practices to Control Nonpoint Sources of Phosphorus

In addition to point source contributions, such as wastewater treatment plants, of phosphorus to waterbodies, there are less easily quantifiable and controllable nonpoint sources. Phosphorus contribution percentages from point to nonpoint sources vary depending on land use but both can have detrimental water quality effects. Nonpoint sources include runoff from agricultural and forest lands, stormwater runoff, and erosion. The following are management practices used to control nonpoint sources of phosphorus.

a. Agriculture - Control of pollution from fertilizers and concentrated animal feeding operations reduces nonpoint sources. Management of discharges from feedlots, liquid wastes, runoff, and land application of wastes reduces contributions of phosphorus to water bodies. Also helpful in managing agricultural nonpoint sources are farm specific nutrient management plans and the establishment of forested buffer strips along stream channels adjoining croplands.

b. Forestry - Best management practices on forest lands include erosion control involving road construction, unstable slopes, and streamside areas. Good management during fertilization programs on forest lands must also be practiced.

c. Stormwater - Best management practices for stormwater runoff, and sediment deposition, include capturing the runoff in retention basins or detention facilities. Discharge from these detention facilities must then meet specific criteria.

d. Rangeland - Best management practices for rangeland have the dual objectives of maintaining and improving desirable vegetation for grazing and providing adequate cover to prevent soil erosion. Practices include timing of animal grazing, streambank protection and grass seeding.

General References:

Hetling, L.J. and I.G. Carcich, 1973. Phosphorus in waste water. Water and Sewage Works, Vol. 120, No. 2, pp. 59-62.

Porcella, D.B., P.A. Cowan and E.J. Middlebrooks, 1973. Detergent and nondetergent phosphorous in sewage. Public Works, Vol. 104, No. 9, pp. 126-128.

APPENDIX F

NUTRIENT CONTROL PROGRAMS AND POLICIES

This appendix provides examples of nutrient control programs and policies outside of Oregon. This is not an exhaustive summary of all programs. Programs and policies being implemented in Oregon are not included.

Comprehensive Programs

Regional Programs

The United States and Canada agreed in 1978 to establish phosphorus target loads for each of the Great Lakes. First, the emphasis was placed on a 1 mg/L total phosphorus discharge limit for point sources and phosphorus reductions in laundry detergents, but it later became apparent non-point source control measures were also needed. Non-point management techniques emphasized include accelerated adoption of conservation tillage, better management of livestock waste, and better management of nutrients used for crop production (Great Lakes Water Quality Board Report to the Intentional Commission - 1981).

The Chesapeake Bay states and the District of Columbia agreed in 1987 to achieve by 2000 at least a 40 percent reduction in both nitrogen and phosphorus entering the Bay. (Chesapeake Bay Agreement - December 14, 1987). Each jurisdiction is responsible for reducing its own nitrogen and phosphorus inputs by 40% each. Each state has determined its own "mix" of point and non-point controls to achieve the required reductions.

State Programs

North Carolina - The Nutrient Sensitive Waterway (NSW) designation has been established for waterways subject to excessive growths of vegetation which substantially impair the use of the water (NCAC 2B.0214). The NSW designation requires the development and implementation of a nutrient management strategy. The process involves identification of nutrient sources, establishment of nutrient reduction goals, and development and implementation of a nutrient reduction strategy.

Innovative approaches are being utilized in these strategies. For example, the Tar-Pamlico River Basin NSW experimental implementation strategy will provide the option of allowing operators of expanding wastewater treatment plants to meet nutrient load reduction goals by funding the implementation of Best Management Practices (BMPs) for agricultural non-point source (NPS) runoff (EPA Non-point Source News - Notes, 1990).

Idaho - Legislation adopted in 1989 requires the Department of Health and Welfare to develop a comprehensive nutrient management plan on a hydrologic basin unit basis (Nutrient Management Act - Chapter 308). Each plan will identify nutrient sources, the dynamics of nutrient removal, nutrient use and dispersal, and preventative or remedial actions to protect surface water. The plan will guide the state agencies in developing programs for nutrient management. Local management plans must be consistent with the state plan.

Florida - Under the Surface Water Improvement and Management Act, enacted in 1987, each water management district prioritizes water bodies based on criteria that consider violations of water quality standards, amounts of nutrients entering the water body, trophic state, etc. Surface water improvement and management plans are then developed. The plans include a list of all point and non-point source owners, recommendations and schedules for bringing all sources into compliance with state standards, a description of strategies for restoring and then maintaining the quality of the water body and funding estimates. All plans are reviewed by the Departments of Game and Fresh Water Fish, Agriculture, Consumer Services, Community Affairs and Natural Resources.

<u>Nonpoint Source Programs</u>

Federal

The Water Quality Act of 1987 authorized the expenditure of up to $400 million in federal funds to assist the states in designing and implementing programs to reduce non-point source pollution.

The Conservation Title of the 1985 Food Security Act established the Conservation Reserve Program, which retires highly erodible land from production for ten years in return for rental payments to farmers to compensate for lost income. The Act also requires farmers producing on highly erodible land to develop and implement conservation programs to reduce soil erosion or else lose farm program benefits.

State Programs

Kansas - Legislation adopted in 1989 authorized a dedicated source of funding for the State Water Plan. Implementation Guidelines and Procedures for the NPS Pollution Control Fund were issued in January, 1990 and set forth local non-point source pollution management plan requirements. Plans are to be prepared on a watershed or drainage area basis. All sources of non-point source pollution must be considered, and anyone affected should participate in the development of the plans. Work plans are to be prepared for waters needing protection or restoration. Work plans can include planning, designing, monitoring, evaluation, assessment, demonstration projects, and educational programs as well as implementation activities involving construction of NPS pollution control practices. Technical and financial assistance is available.

State Programs Directed at Specific Nonpoint Sources

Agricultural Sources

Arizona - Best management practices are required to reduce pollution from nitrogen fertilizers and concentrated animal feeding operations (Regulated Agricultural Activities Program - 1986). BMPs have been established for managing discharges from feed lots, liquid wastes, the management of runoff, and land disposal of wastes. Failure to comply could subject individuals to enforcement actions and extensive permitting procedures. Technical assistance and training is available.

Maryland - the Maryland Agricultural Water Quality Management Program, published in 1987 as the state's revised 208 plan, included outreach and technical assistance to farmers, information and education, cost-share funding for BMPs, research, and enforcement. Farm-specific management plans are developed to address all nutrient input to farmland, including fertilizers, animal wastes, sewage sludge, etc. Programs will encourage the widespread use of farm specific nutrient management plans and the establishment of forested buffer strips along stream channels adjoining cropland.

Pennsylvania - The non-point source control program consists of financial, technical, educational and planning assistance (Chesapeake Bay Non-point Source Programs - January, 1988). Program eligibility is established by conducting a watershed assessment to identify non-point nutrient sources and prioritize areas for financial assistance. Fifteen BMPs had been approved by January 1988 to reduce nutrient loadings, including BMPs for animal waste management, soil and manure analysis, fertilizer management, soil erosion, etc. Manure management practices are regulated and enforced. (Clean Streams Law - 25 PA Code, Chapters 101 and 102).

Virginia - The Chesapeake Bay Preservation Act (Sec. 10-313 et seq, Code of Virginia) requires farmers within designated preservation areas to develop soil and water quality conservation plans on their farms by 1995. The plans will address proper nutrient management and integrated pest management as well as traditional soil erosion concerns. Buffer strips are required along permanent watercourses. Soil and Water Conservation personnel will assist land owners in meeting the requirements.

Forestry

Washington - The Forest Practices Act (1974) provides both voluntary and regulatory tools to protect water quality. BMPs address road construction, maintenance and abandonment, unstable slopes, streamside areas, etc.

Urban Growth

District of Columbia - In January 1988, the District adopted regulations requiring BMPs for all new development and redevelopment (Chesapeake Bay Program - District of Columbia Nutrient Reduction Strategy - July 1988.)

Virginia - The Chesapeake Bay Preservation Act (Sec.,10-313 et seq. Code of Virginia) called for a determination of the ecological and geographic extent of Chesapeake Bay Preservation Areas and called for criteria to be established for use by local governments in granting, denying or modifying requests to rezone, subdivide or to use and develop land in these areas. Funding was provided to encourage landowners to convert lands having high pollution potential.

Stormwater

Florida - Under the Florida Stormwater Rule, stormwater runoff is now being captured in retention basins or detention facilities in urban areas across the state. To release stormwater to a surface water body, developers must apply for a state discharge permit, assuring the state that the discharge will not cause a violation of water quality standards.

Maryland - State Stormwater Management regulations were implemented in 1983, and counties and municipalities were required to enact ordinances to require that post-development runoff rates and volumes meet specific criteria. The program has been expanded to cover existing development and maintenance of stormwater management BMPs.

Virginia - Legislation was enacted that established permit requirements for stormwater discharges from certain systems, based on population served (Public Law. 100-1, Section 405).

Stormwater/Sediment

Delaware - The Stormwater and Sediment Control law enacted in June 1990 provides for stormwater and sediment control. The stormwater component provides for the management of water quantity and water quality. The program will be integrated with sediment control and will include regulatory and fee structure elements. Designated watersheds or subwatersheds may be established to promote a watershed plan and provide for implementation of practices to reduce existing flooding problems or improve existing water quality. The development or stormwater utilities by local governments, Conservation Districts or the state is authorized. Utility charges are to be reasonable and equitable so that each contributor of runoff to the system, including state agencies, shall pay to the extent to which runoff is contributed.

Rangeland

Washington - BMPs for rangeland focus on the dual objectives of maintaining and improving desirable vegetation for grazing and providing adequate cover to prevent soil erosion (Washington Nonpoint Source Assessment and Management Program - October 1989). Practices include timing of animal grazing to allow vegetation to become well established, streambank protection, seeding, etc.

Point Source Programs

Pennsylvania - A 2.0 mg/L total phosphorus effluent limit was established in 1970 for all new and modified point sources discharging to the Susquehanna River and its tributaries (Chesapeake Bay Program - Pennsylvania Nutrient Reduction Strategy - July 1988).

Maryland - The state's projected approach to achieve a 40% reduction in point source nutrients is to require biological nutrient removal at all sewage treatment plants larger than 0.5 million gallons per day, which should achieve 2 mg/L phosphorus and 8 mg/L nitrogen effluent levels (Chesapeake Bay Program - Maryland Nutrient Reduction Strategy - July 1988).

Virginia - In 1987, funding was provided for three nutrient removal demonstration projects at wastewater treatment plants. A Point Source Policy for Nutrient Enriched Waters was approved, which established a 2 mg/L phosphorus effluent limit for existing dischargers authorized to discharge 1 million gallons per day or more and new dischargers greater than 0.05 million gallons per day. Nitrogen removal will be required at all of Virginia's major municipal treatment plants below the fall line. Both phosphorus and nitrogen removal projects will be given priority for funds available from the State Revolving Loan Fund (Chesapeake Bay Program - Virginia Nutrient Management Strategy - July 1988).

APPENDIX G

ECONOMIC AND ENVIRONMENTAL IMPACTS OF A PHOSPHATE DETERGENT BAN

This appendix provides additional information on the potential economic and environmental impacts of implementing a ban on detergent phosphates.

Economic Impacts on Wastewater Treatment Plants

The economic benefit to a wastewater treatment plant (WWTP) resulting from a phosphorus detergent ban will vary with the method of phosphorus removal used at the plant. Plants that use iron or aluminum salts to remove phosphorus will experience the greatest reduction in operating costs when influent phosphorus is reduced. These are the most common methods of removal used today.

Wastewater treatment plants that remove phosphorus through only biological means, with the addition of lime, or through land disposal of the effluent, do not have costs proportional to the amount of phosphorus in their influent. Therefore, there will be essentially no economic benefit from reduced influent phosphorus at these plants.

Permit requirements also affect the amount of economic benefit resulting from a phosphate detergent ban. For example, there is uncertainty about the degree to which chemical dose is dependent on the amount of phosphorus to be removed when plants must meet very low effluent phosphorus levels (i.e. <0.5 mg/l).

Operational Expenses

Operational expenses are driven by the cost of chemicals, how the chemicals are added to the wastestream, and how the chemicals and precipitated phosphorus are removed from the wastestream prior to discharge. Cost savings result from reductions in the quantity of chemicals purchased, the quantity of chemical/phosphorus solids to be removed, and quantity of sludge requiring treatment and disposal. Chemical addition during treatment increases the amount of sludge and can change its chemical character, making it more difficult to dispose. Phosphorus removal generates an estimated additional 25 to 40 percent more sludge than typically produced through secondary wastewater treatment (EPA, 1987).

Some examples of operational cost savings following the implementation of bans include the following. Four WWTPs in Maryland reported 30 to 57 percent reductions in average monthly chemical dose requirements (Jones and Hubbard, 1986). Calculated estimates of Maryland's chemical cost savings statewide are $4.5 million annually (Sellars et al., 1987). Similarly, Michigan reported chemical use reductions at 9 WWTPs ranging from 12 to 49 percent with an average reduction of 29 percent (Hartig and

Horvath, 1982). Washington D.C. reported an actual chemical use reduction of 40 percent and an estimated annual cost savings of $6.5 million from chemical use and sludge processing reductions (Bailey, 1988). The Washington D.C. plant processes 306 million gallons of wastewater per day. Observed cost savings at Wisconsin plants were equivalent to $0.05 to 0.26 per capita per year (Foth and Van Dyke, 1981, 1984). North Carolina also projected operations cost savings (DiFiore, 1988).

Cost savings from reduced influent phosphorus can also be realized at biological treatment systems, although they may be less direct. Biological systems usually have chemical systems as backup. By reducing phosphorus loads, it is possible that reliance on the chemical backup systems could be reduced or eliminated. There are no biological treatment systems operating in Oregon.

Construction Expenses

The phosphorus removal system at a wastewater treatment plant is designed based on a number of factors, including: the volume of water to be treated, the quantity of phosphorus to be removed, and the discharge limits. To date, designs have been based primarily on the volume of water to be treated. A phosphate detergent ban will reduce the quantity of phosphorus that must be treated, but will not affect the other factors.

It is possible that a phosphate detergent ban may reduce the concentration of phosphorus in the wastewater enough to delay or prevent the need for phosphorus removal. Because of the expense of capital improvements, such a delay could result in cost savings.

Other Potential Impacts

Potential additional economic and environmental impacts from reduced influent phosphorus include:

- Reducing the volume of sludge to be landfilled, thus increasing existing landfill life and allocating that volume of landfill space for other beneficial purposes.

- Increasing sludge disposal options due to the removal or reduction of potential contaminants (i.e. the metals used in chemical removal) from the sludge.

- Decreasing the long-term environmental costs associated with chemical production and increased sludge generation, such as fuel for sludge transport and possible air contamination during disposal.

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APPENDIX H

A SUMMARY OF PHOSPHATE DETERGENT LAWS

Table H-1 provides a summary of phosphate detergent laws in the United States. To date, 12 states and 5 regions have banned or restricted the use of phosphates in detergents. Most of the bans include similar provisions as discussed in section 5 of this report. Table H-1 may not be complete.

Table H-1: Phosphate Detergent Laws in the United States

Jurisdiction: State/Locality	Date Effective	Definition	Exemptions	Fine
Metropolitan Service Districts Portland, OR	1991 Sunset 1994	No person may sell of distribute for sale within the MSD any cleaning agents containing more than 0.5 percent phosphorus, by weight, except agents used in automatic dishwashing machines. Dishwashing products are limited to 8.7 percent phosphorus.	• Dairy, beverage, food processing products. • Detergents used in hospitals, vet hospitals, health care facilities, or used in commercial laundries serving hospitals and health care facilities. • Agricultural and electronic production. • Detergents for metal cleaning and conditioning. • Cleaning hard surfaces — windows, sinks, counters, and food preparation areas. • Water softners used in heating and cooling boilers.	May levy fine of up to $500 a day for violation of this ordinance.
Connecticut	1972	No person, firm, or corporation shall sell, offer, or expose for sale, give or furnish and synthetic detergent or detergent in any form that contains more than 7 grams of phosphrus per recommended dose.	• Detergent used for medical, scientific, or special engineering purposes and for use in machine dishwashers. • Detergents for dairy equipment, beverage equipment, food processing equipment. • Industrial cleaning equipment.	Information not available.
Georgia	1989	Mandate the use of low phosphate detergents. Allows 0.5 percent phosphorus (incidental to manufacturing) or more. Dishwashing products limited to 8.7 percent phosphorus.	Same as Maryland, except industrial and institutional detergent provisions.	Any violations of ordinance shall result in fine not to exceed $500. Each sale shall be a separate offense.
Indiana	1972	It is unlawful to use, sell, or otherwise dispose of detergent containing phosphorus, except for up to 0.5 percent incidental to manufacturing.	• Detergents for cleaning in places of food processing, and dairy equipment. • Sanitizers, brighteners, acid cleaners, and metal conditoners. • Detergents for use in dishwashing equipment — household or commercial. • Institutional laundry detergents.	Not Available.
Maryland	1985	Prohibit the sale, use distribution, manufacturing of cleaning products that contain phosphates of 0.5 percent (incidental to manufacturing) or more. Dishwashing products may contain 8.7 percent phosphorus or less.	• Detergents used in dairy, food, beverage processing equipment. • Metal sanitizers, brighteners, acid cleaners, or metal conditioners. • Detergents used in hospitals, vet hospitals, health care facilities, clinics, agricultural products. • Industrial detergents for metal conditioning or cleaning. • Detergent stored, manufactured, or distributed for use outside the state. • Detergent used in biological, chemical, engineering labs.	• User-fine not to exceed $100. • Seller/Manufacture not to exceed $1,000.

Table H-1: Phosphate Detergent Laws in the United States (Continued)

Jurisdiction: State/Locality	Date Effective	Definition	Exemptions	Fine
Maryland (Continued)			• Commercial laundries serving hospitals, health care facilities.	
Michigan	1977	A person shall not sell or distribute a household landry detergent which contains phosphorus in any form in excess of 0.5 percent by weight. Dishwashing products are limited to 8.7 percent phosphorus.	Same as Pennsylvania, except industrial and institutional provisions.	None.
Minnesota	1977	No person shall sell, offer expose for sale, or use in Minnesota a cleaning agent or chemical water conditoner that contains 0.5 percent or more phosphate (incidental to manufacturing). Machine dishwashing detergents not to exceed 11.0 percent. Chemical water conditioners not to exceed 20.0 percent phosphorus.		None.
Missoula, Montana	1989	Prohibits sale of certain products containing phosphorus within city limits (or 3 miles of city) of 0.5 percent (incidental to manufacturing or more). Dishwashing products — 8.7 percent or less. Metal conditioning — 20.0 percent or less.	• Detergents used in food or beverage processing. • Detergents used in medical or surgical cleaning or dairy equipment. • Existing stocks may be sold for 6 months after ordinance in passed.	Upon discovery of sale or district, offender shall be notified of noncompliance. If situation still persists after 10 days, a fine will be levied of $50 to $500.
North Carolina	1988	Prohibit the sale, use, distribution, or manufacturing of cleaning products that contain phosphate of 0.5 percent (incidental to manufacturing or more). Dishwashing products are limited to 8.7 percent phosphorus.	Same as Georgia and Pennsylvania. Detergents used for cleaning hard surfaces, sinks, windows, counters, and food preparation surfaces.	• User-Fine not to exceed $10. • Seller/Manufacture not to exceed $50.
New York	1973	Prohibition and restriction of the distribution, sale, offering or exposing for sale cleaning products containing phosphate of 0.5 percent (incidental to manufacturing) or more. All products may contain 0.1 percent or less. Dishwashing products -- 8.7 percent or less.	• Detergents used in food and beverage. • Detergents used in dairy equipment.	None.
Ohio Counties (applies to approximately 50 percent of the counties in the State)	1990	No person shall sell, offer for sale, or distribution for sale in listed counties any household laundry detergent containing phosphorus in any form in excess of 0.5 percent.	• A cleanser, rinsing aid, or sanitizer agent intended primarily for use in automatic machine dishwashers. • A metal brightener, rust inhibitor, etchant, surface conditioner.	Not Available.

Jurisdiction: State/Locality	Date Effective	Definition	Exemptions	Fine
Ohio Counties (Continued)			• A disinfectant or detergent used in hospitals or clinics or commercial laundries that serve them. • Detergents used in food processing.	
Pennylvania	Partial 1990 Statewide 1991 Sunset 1992	Prohibit the sale, use, or distribution of cleaning products that contain phosphates of 0.5 percent (incidental to manufacturing) or more. Dishwashing products limited to 8.7 percent phosphorus.	Same as Maryland. Water softners, antiscale agents, and corrosion inhibitors.	• User-Fine not to exceed $100. • Seller/Manufacture not
Vermont	1978	Applies to commercial establishments, household cleansing productgs that contain phosphates of 0.5 percent (incidental manufacturing). 8.7 percent phosphorus limit in automatic dishwashing detergent.	• Food, drug, and cosmetics, including personal care items, such as toothpaste, shampoo and handsoap. • Products labeled, advertised, marketed, and distributed for use primarily as economic poisons as defined in Section 911(5) of Title 6.	None.
Virginia	1988	Prohibits the use, sale, manufacture, or distribution of any cleaning agent that contains phosphorus; allows up to 0.5 percent incidental to manufacturing. Dishwashing products limited to 8.7 percent phosphorus.	• Cleansers used in dairy beverage or food processing.	Not Available.
Washington, DC	1986	Ban the use, sale or furnishing of detergents that contain more than a trace amount of phosphorus. 8.7 percent phosphorus limit for machine dishwashing detergent.	• Surface cleaning — counters, sinks, and windows. • Detergents for use in hospitals, vet hospitals, and health care facilities. • Detergents for metal cleaning and conditioning. • Lab use — biological, chemical, engineering.	Fines for sale or furnishing: $500, 1st offense; $1,000, 2nd offense.
Spokane, WA	1990	No person may sell, offer, or expose for sale or distribute any laundry cleaning product that exceeds 0.5 percent (incidental to manufacturing) or more.	Allow for depletion of existing stocks.	None.
Wisconsin	1983	Restrict sale of cleaning agents containing phosphorus of 0.5 percent (incidental to manufacturing) or more. Agents for machine dishwashing or cleansing of medical equipment restricted to 8.7 percent phosphorus. Water conditioners restricted to 20 percent phosphorus.	Detergents used in industrial processes and dairy equipment.	Any violation of this ordinance shall result in a fine not to exceed $100.