A LITERATURE REVIEW OF WATER QUALITY IN THE CLARK FORK RIVER, WITH AN EMPHASIS ON THE NUTRIENT LEVELS IN THE MIDDLE AND LOWER PORTIONS OF THE RIVER

Prepared for The Soap and Detergent Association

25 April, 1988

by

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I. INTRODUCTION.

The Clark Fork River, occupying a major drainage area in western Montana, leaves the State as Montana's largest river (Brosten and Jacobsen 1985). Historically, water quality problems in the Clark Fork River have been concerned with metal deposits associated with the mines in Butte, MT. Three superfund sites and a major reclamation project had been created to deal with the spoils and derelict machinery left over from a century of mining in the river's headwaters. These projects have apparently alleviated much of the metal problem, at least in the lower river, but it has been suggested that metal contaminants reside in the sediments of Lake Pend Oreille, 350 miles downstream (Johns and Moore 1985).

Recently, a modified discharge permit issued by the Montana Department of Health and Environmental Sciences (DHES) Water Quality Bureau (WQB) in April 1984, allowed the Champion International (now the Stone Container Company) Frenchtown (paper) mill to release secondary treated wastewater to the Clark Fork River year round. Previously the mill was only allowed to discharge wastewater in the spring when flows were maximal. This decision created a large amount of controversy among people in western Montana, northern Idaho and eastern Washington who were worried that discharges, along with other sources of contamination, will cause irreparable harm to the lower Clark Fork River and Lake Pend Oreille. In fact, the people living near Lake Pend Oreille have begun to complain that the water quality of the lake is noticeably deteriorating and that their property values and tourist revenues will decrease because of this deterioration (DHES 1986a).

Much of the controversy was fueled by the Clark Fork Coalition, a recently formed pro-river citizens group. A great deal of the public concern was over the lack of scientific information to support Champions' discharge of wastewater into the river on a year-round basis. This concern initiated planning for several hundred thousand dollars worth of water quality studies during the next few years, plus the establishment of a new position in the Governor's office to coordinate water quality management activities throughout the river basin (Johnson and Knudson 1985). As a consequence, the Clark Fork River has been designated as a priority water body by DHES (DHES 1984a). The effort to define the water quality of the Clark Fork River and the sources of pollution has mounted in terms of direct funds and manpower devoted to the project. Currently, the Champion mill and Missoula's sewage treatment plant have been implicated as the two major point sources of pollution to the river. Much of the data that has been collected since 1984 by the DHES study has not been released to the public. Apparently, some of the preliminary conclusions (which may be premature) have leaked to the public, in particular to members of the Clark Fork Coalition.

This report will (i) provide a geographical and water-quality oriented overview of the system, (ii) present a chronology of political events related to the system, (iii) present what has been published on N and P limitation and (iv) evaluate published material on nutrient (N and P) contributions by Champion mill and the city of Missoula. The information in this report is based entirely on published material. Apparently, most of the current DHES data is not available to the public.

II. THE CLARK FORK SYSTEM AND ASSOCIATED PROBLEMS.

The Clark Fork River is a large and complex system draining much of western Montana (Fig. 1). Because of the size and complexity of this system, I will divide it into three regions for the purpose of discussion. A section is also included on Lake Pend Oreille, Idaho because it is the potential repository for any pollutant entering the system. The information presented in this section was gleaned from various sources listed in section V of this report.

Upper River

The upper river begins as little more than a creek (160 ft^3/s mean daily flow) born of the union of several smaller creeks. It grows to a medium sized river (3,000 ft^3/s), by the time it reaches Milltown Reservoir near Missoula. The major tributaries entering the Clark Fork above Missoula are the Little Blackfoot River, Rock Creek and the Blackfoot River. The principal problem of the upper river is the toxicity associated with heavy metals leaching and eroding from sites contaminated by historical mining and smelting operations in the headwaters. The present situation is greatly improved over the past as a result of treatment systems and settling ponds installed in the upper river over the past 30 years. Before these control efforts, the upper river supported virtually no aquatic life. With reductions in metal loads, the dilution provided by tributaries allowed Clark Fork water quality to improve to the point that organisms from the tributaries could recolonize the mainstream. Populations of aquatic insects (Canton and Chadwick 1985) and fish (Phillips 1985) have shown considerable recovery. Two superfund sites in the headwaters of the river have apparently lead to much of this recovery (Carlson and Bahls 1985).

Middle River

Water from the Blackfoot, Bitteroot, and St. Regis Rivers increase the Clark Fork's discharge to nearly 10,000 ft^3/s just above its confluence with the Flathead River. Past water quality problems concerns in this section focused on organic wastes originating from the Missoula Sewage Treatment Plant (MSTP) and the Champion International Pulp and Paper mill (Watson 1985). Historically, loading's of organic matter and nutrients exceeded the river's assimilative capacity and produced excessive foaming and discoloration of the river (DHES 1985a). The nutrient contributions by the MSTP and mill effluent remains controversial and will be discussed in greater depth in section (IV) of this report. DHES (1985a) concluded that the foaming and

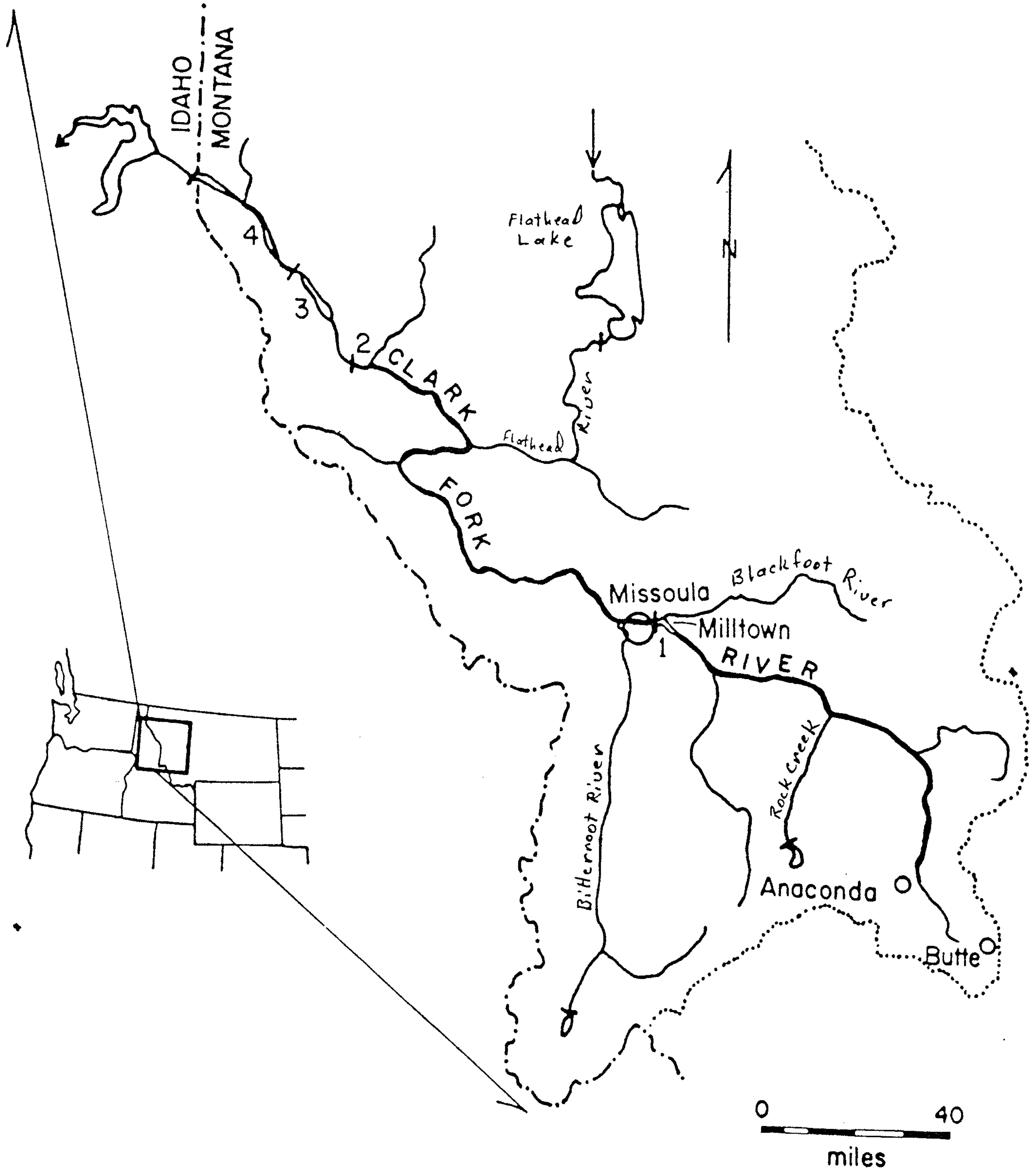


Fig. 1. Clark Fork River System. 1. Milltown Reservoir; 2. Thompson Falls Reservoir; 3. Noxon Rapids Reservoir; 4. Cabinet Gorge Reservoir.

discoloration was caused primarily by the Champion mill. Pollution by untreated mill wastes during the first year of operation apparently caused a major fish kill during the summer of 1957 before treatment facilities were installed at the mill. The mill added primary treatment (settling ponds) and secondary treatment facilities by 1974. The MSTP added secondary treatment to their operation in 1978 (Watson 1985). The installation of secondary treatment to these facilities apparently reduced many of these problems. Monitoring of aquatic insect populations in the middle river over the past 30 years by The Institute of Paper Chemistry (Rades 1985) suggests that the river has recovered from the earlier "pre-treatment" pollution problems although there is an indication that it is becoming more productive (Rades 1985). Watson (1985) suggests that the apparent increase in productivity of stream insects may be the result of continued urban growth in the Missoula Valley. Given the fact that fish kills existed and invertebrate numbers were lower before the Champion mill initiated wastewater treatment, Champion's request to increase its discharge and to discharge year-round caused much public concern which has developed into the current situation existing today (see sections I, III and IV of this report).

The following is paraphrased from a paper presented by Watson (1985) during a recent symposium on the Clark Fork River. It summarizes the public's concern over the middle river:

> It seems that the three issues of primary concern on the middle river are aesthetics, nutrients and the fishery. Year-round discharge means that the highly colored mill effluent is entering the river when it is having its greatest recreational use. Since it takes several miles for the effluent to mix and become unnoticeable, the esthetic impact may be greater than that associated with seepage alone. Nutrients are a concern because of their potential contribution to enrichment of reservoirs and lakes downstream and because the point sources in this stretch of river (sewage plant and mill) may be among the most controlable sources of nutrients to the river. Finally, the fishery is less than that expected for a river with the characteristics of the middle Clark Fork according to fishery biologists with the Montana Department of Fish, Wildlife and Parks. Several explanations can be offered: the occasional water quality criteria violations for metals are sufficient to reduce fish populations; water quality parameters not presently monitored (such as toxic organics) are limiting the fishery.

Lower River

The lower river, formed by the union of the Flathead River and the Clark Fork River, is the largest (flow ~20,000 ft^3/s) river draining Montana. The river flows into Lake Pend Oreille in Idaho. Many of the water quality problems of the lower river apparently result from the flow regimes of reservoirs. The Noxon and Cabinet Gorge Reservoirs have low hydraulic retention times (i.e. they are flushed rapidly) and support a poor fishery for both river and lake species (Rumsey and Huston 1985). Bahls and Ingman (1985) found that there are no obvious pollutants in the lower Clark Fork Reservoir system that would preclude a healthy fishery. The reduced flow in these reservoirs causes suspended particles to settle resulting in muddy and unstable bottom sediments which are poor habitats for riverine bottom dwelling insects that support a river fishery. At the same time, the flow seems to be too great for the successful development of stable zooplankton and phytoplankton populations which can support a lake fishery. Drastic drawdowns leave potential spawning and rearing areas dry which further effects the development of a stable fishery. Early attempts to establish a river fishery in Noxon, the largest reservoir, were unsuccessful (Rumsey and Huston 1985). Maintenance of more stable water levels in recent years has permitted the development of a bass and perch fishery (Rumsey and Huston 1895).

Other conditions, apparently associated with the reservoirs, include the settling of metals from the upper river, eutrophic conditions associated with nutrient loading, and possible synergistic interactions between these (Watson 1985). Sediments in the lower river reservoirs seem to have higher metal concentrations than do the sediments of tributaries of the Clark Fork Johns and Moore (1985). Watson (1985) warned that if the oxygen potential and pH in the lower water layers of these reservoirs decreases below present values the metals could enter the water column and become a problem.

There is concern as to whether water quality in the lower reservoirs will deteriorate as a result of increased nutrient loading from Missoula or the Champion mill. Excessive algal growth resulting from nutrient loading will depend upon growth rate vs. flushing time, i.e. if the flushing time is greater than algal growth rates then algal populations cannot become established (biomass will not accumulate). Based on information given in Rumsey and Huston (1985), the theoretical hydraulic retention times for Noxon and Cabinet Gorge Reservoirs averages 12 days (range 2-64 days) and 5 days (range 1-26 days), respectively. An average phytoplankton doubling time is on the order of 3-7 days (personal observation). Consequently, excessive phytoplankton biomass accumulation resulting from upstream nutrient loading is possible in Noxon Reservoir but unlikely in Cabinet Gorge Reservoir given the average hydraulic retention times. Watson (1985) suggested that the state monitor Noxon Reservoir for several years to determine if water quality is acceptable. She further suggested that "...if water quality in this reservoir is unacceptable, or if it appears to be degrading, or if nutrients in the reservoir's sediments appear to be increasing, it would be appropriate to determine what sources of nutrients could be reduced".

Macrophyte ("weed") beds have elicited complaints from boaters in Cabinet Gorge Reservoir (Watson 1985). Noxon Reservoir has some weed beds, but they do not appear to be a major environmental problem.

One of the major concerns on the lower Clark Fork is the potential impact of proposed mining in the Cabinet Mountains. Several mining companies (ASARCO and U.S. Borax) have filed claims for as many of nine mines (DHES 1984a). A primary environmental interest is the effect that heavy metals would have on the lower river.

Lake Pend Oreille

Lake Pend Oreille is a large (148 mi^2; 43.2 $x10^6$ ac-ft), deep (1,200 ft, 350 m), highly oligotrophic lake located in northern Idaho just west of the Montana border (Fig. 2). The primary source of water for the lake is the Clark Fork River which drains much of western Montana. The Clark Fork River terminates, in name, at Lake Pend Oreille; from here it flows as the Pend Oreille River. One of the greatest water quality concerns on the lower river is the long-term quality of this lake. Lake area residents perceive that the lake's water quality is degrading, citing as evidence increased growth of periphyton on boats and increased growth of algae and aquatic plants in shallow areas. According to Watson (1985) lake residents feel that nutrient loading from the Clark Fork River is responsible, although such phenomenon might be explained by natural variation or by increases in shoreline loading associated with increased development. Watson (citing a personal reference with Mike Beckworth, Idaho Department of Health and Welfare) further stated that measurements of midlake water clarity over a number of years show a disturbing downward trend though the data are insufficient to give a high level of confidence in this trend. Limited studies in 1984 and 1985 by the State of Idaho Department of Health and Welfare Division of Environment (IDHW-DOE) indicate that the Lake has generally retained its oligotrophic status except for localized algal blooms and patches of floating scum (DHES 1985b). In 1984 and 1985, water clarity (secchi depth) and phosphorus concentrations in Lake Pend Oreille were virtually unchanged from the years before Champion was granted its current permit to discharge wastewater.

Watson (1985), in her paper published in the Clark Fork River Symposium, stated "The algal productivity of such a lake is almost certainly limited by phosphorus loading to the lake." She qualified this statement by saying that the magnitude and timing of the response of a lake to a given change in phosphorus loading depends largely on its flushing time. The theoretical flushing time of Lake Pend Oreille is about 3 years. She also made the point that the actual flushing time is difficult to estimate because the northern part of the lake, which receives the Clark Fork inflow, also contains the outlet; the deep main body of the lake is apparently more stagnant than the northern portion (DHES 1985a). Thus the lakes behavior to nutrient loading may be hard to predict. Despite the fact that no published evidence which I could find indicates that the lake is phosphorus deficient, Watson (1985) strongly contents that,

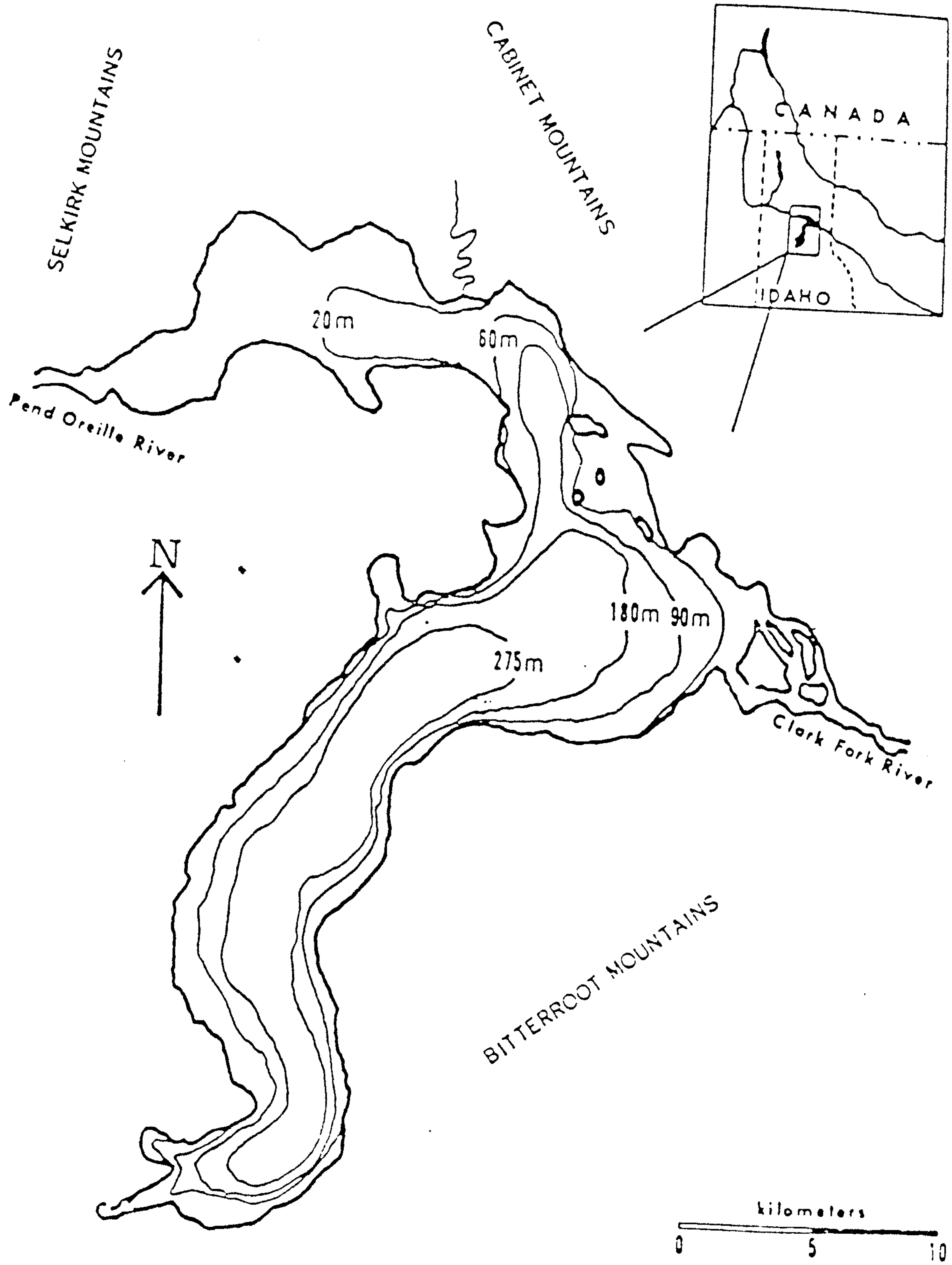


Fig. 2A Pend Oreille Lake, Idaho, with depth contours in meters (m)

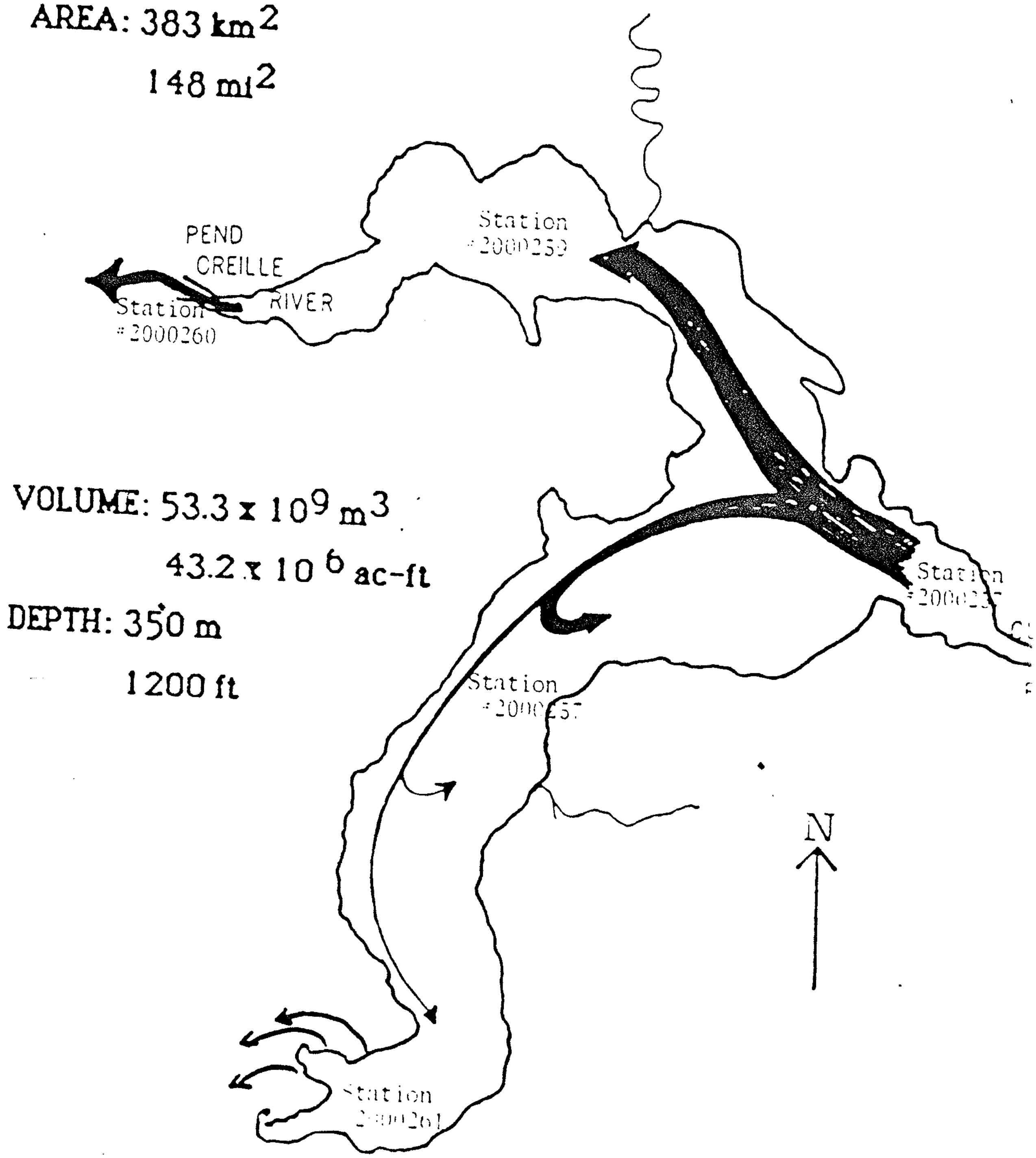


Fig. 2B Probable Clark Fork River influence and water exchange patterns in Pend Oreille Lake, Idaho and sampling stations.

"...(our) first objective (as citizens) should be to determine the phosphorus load to the lake and to predict the likely extent and rate of change in water quality from existing models. If these models suggest that the lake is in no imminent danger, drastic nutrient control actions could await several years of frequent assessments of water clarity (chlorophyll content) over the summer; this information should help to determine whether a trend in water quality degradation is discernible. Additionally, loading should continue to be assessed to determine the response of this lake to various loading levels. If models suggest that the lake may be receiving excess loading, control efforts could begin while the studies are conducted. By the time any substantial loading is achieved, several years of monitoring of the lake's conditions under present loading should be available to compare to its condition after load reduction."

I find several problems and inconsistencies with Watson's statement. Firstly, no evidence exists for phosphorus limitation in Lake Pend Oreille; only scanty data exist on nutrient deficiencies in the Clark Fork River and these show that both N and P are important regulators of algal growth (N and P deficiencies will be discussed in section IV of this report). Secondly, Watson states that the lakes behavior (in response to P loading) "...may not be predictable simply from models that relate loading to trophic state." Yet in the next several sentences she ignores this problem and states "...our first objective should be to determine the phosphorus load to the lake and to predict the likely extent and rate of change in water quality from existing models." Finally, her statement "If these models suggest that the lake is in no imminent danger, drastic nutrient control actions could await several years of frequent assessments..." assumes "a priori" that the lake is going to be effected.

III. CHRONOLOGY OF POLITICAL EVENTS

Some of the political events related to matters on the Clark Fork River have already been mentioned in various parts of this review. In this section I will present a succinct chronology of events which have led to the present concern regarding nutrient loading in the middle and lower Clark Fork River.

1. Champion International's Frenchtown paper and pulp mill, 15 miles west of Missoula, began operation in 1957. No wastewater treatment was provided during the first year of operation. A fish kill occurred that summer, and treatment ponds were constructed soon after. Some of the wastewater seeped from the ponds into the river, and the rest was stored and discharged directly into the river during high spring flows.

2. The DHES has had stream water quality standards since 1958, and a wastewater discharge permit program since 1968. The mill was issued a discharge permit in 1968. Before that, the DHES and Champion negotiated on when to discharge wastewater. Permits that were issued to Champion between 1968 and 1984 allowed direct discharges to the Clark Fork only in the spring during high river flows. The amount was initially based on the toxicity of the effluent as determined by static bioassays, with a safety factor then applied. After aeration was installed in 1974, toxicity was greatly reduced and meeting the instream standard for color became the primary limitation to discharging.

3. In 1983, Champion applied for a permit which would allow it to directly discharge a portion of the wastewater into the river throughout the year, instead of only during high flows in the spring. This resulted in public concern, mostly over the lack of scientific information available to support discharging on a year-round basis.

4. In response the concern, the DHES prepared a Preliminary Environmental Review (DHES 1984b) of the potential problems which could occur. Based on available water quality information, the DHES could find no significant potential impacts which would occur from the proposed modification. However, owing to public concern, the DHES initiated a two year monitoring program (financially supported by Champion) on March 6, 1984 to determine the effects of discharging throughout the year during the term of a two-year permit, which was issued in April 1984.

5. The DHES analyzed the information collected during the two-year study period and issued a Draft Environmental Impact Statement (DEIS) December 26, 1985 (DHES 1985b). Of the alternatives decided upon in the DEIS, the DHES recommended renewing the permit for a five-year period.

A public hearing was held January 28, 1986 in Missoula to allow interested persons and groups to comment on the DEIS. Data collected during the initial two year study led the DHES to conclude the following regarding nutrient loading:

> The highest nutrient concentrations occur at Turah (above Missoula). However, dilution occurs when the Clark Fork is joined by the Blackfoot and Bitteroot Rivers. But, discharges from the Missoula Sewage Treatment Plant (MSTP) and Champion mill increase the nutrient levels to nearly the concentrations at Turah. Downstream, the Flathead River dilutes the river more, and by the time the water flows through the Thomson Falls, Noxon and Cabinet Gorge reservoirs, most of the nutrients have settled out or dissipated. Only a small percentage of the nutrients reach Lake Pend Oreille, and the lake does not show signs of becoming eutrophied.

In addition to nutrients, the DEIS concluded that wastewater disposal under the permit would have little impact on algae or aquatic macrophytes; water color and foam (i.e. aesthetics) would be the most notable problems. The DEIS was one of the first documents to discuss the nutrient levels in the Champion mill wastewater. When the mill added biological (i.e. secondary) treatment to their wastewater system in 1974, they had to enrich their oxidation ponds with N and P to satisfy the needs of the microorganisms involved in the oxidation process (wood does not contain adequate N and P to support bacterial growth). The consultant who designed Champion's wastewater treatment system predicted that the company would need to apply 1,870 pounds of N per day and 485 pounds of P per day to achieve optimum treatment.

In 1984, Champion added a daily average of 1,833 pounds of N and 784 pounds of P to its aeration basin (Figs. 3,4). The figures for 1984 represent an all-time high in nutrient application rates. In 1985 (January through September), the added nutrients were reduced to 1,339 pounds of N and 533 pounds of P per day. Champions discharge increased after 1982 because of the gradual loss of nutrient removal efficiency in its rapid infiltration ponds. This required the mill to discharge more wastewater through its aeration pond system which is much less efficient at removing nutrients than the rapid infiltration beds. Extra N and P loading in the aeration ponds was also necessary to keep B.O.D. levels within state mandated limits.

6. Based on comments received at the public hearing and during the public review period, the DHES made a decision to write and Addendum to the DEIS (DHES 1986b). The Addendum enabled the department to enlarge upon some aspects in the draft and provide clarification on issues raised during the review process. The Addendum was released for public comment on March 17, 1986, and another public meeting was held in Missoula on April 17, 1986, to discuss that document.

With respect to nutrients, the addendum stated:

> Nutrient concentrations decrease downstream along the course of the Clark Fork due to dilution by the Blackfoot, Bitteroot and Flathead Rivers. However, discharges from the MSTP and Champion mill add measurable to the load of nutrients carried by the Clark Fork River.
> The potential exists for water quality degradation and accelerated eutrophication of Lake Pend Oreille resulting from activities in the Clark Fork River drainage. However, a perceived decline in lake water quality cannot be directly or conclusively linked to the Champion discharge given the present information and the absence of a comprehensive limnological investigation of the lake.

Conclusions regarding the effect on macrophytes, algae, color and foaming were the same as given in the DEIS.

The alternatives presented by DHES in the Addendum were

Figure 3 Nitrogen (N) application and loading rates at Champion International since 1975.

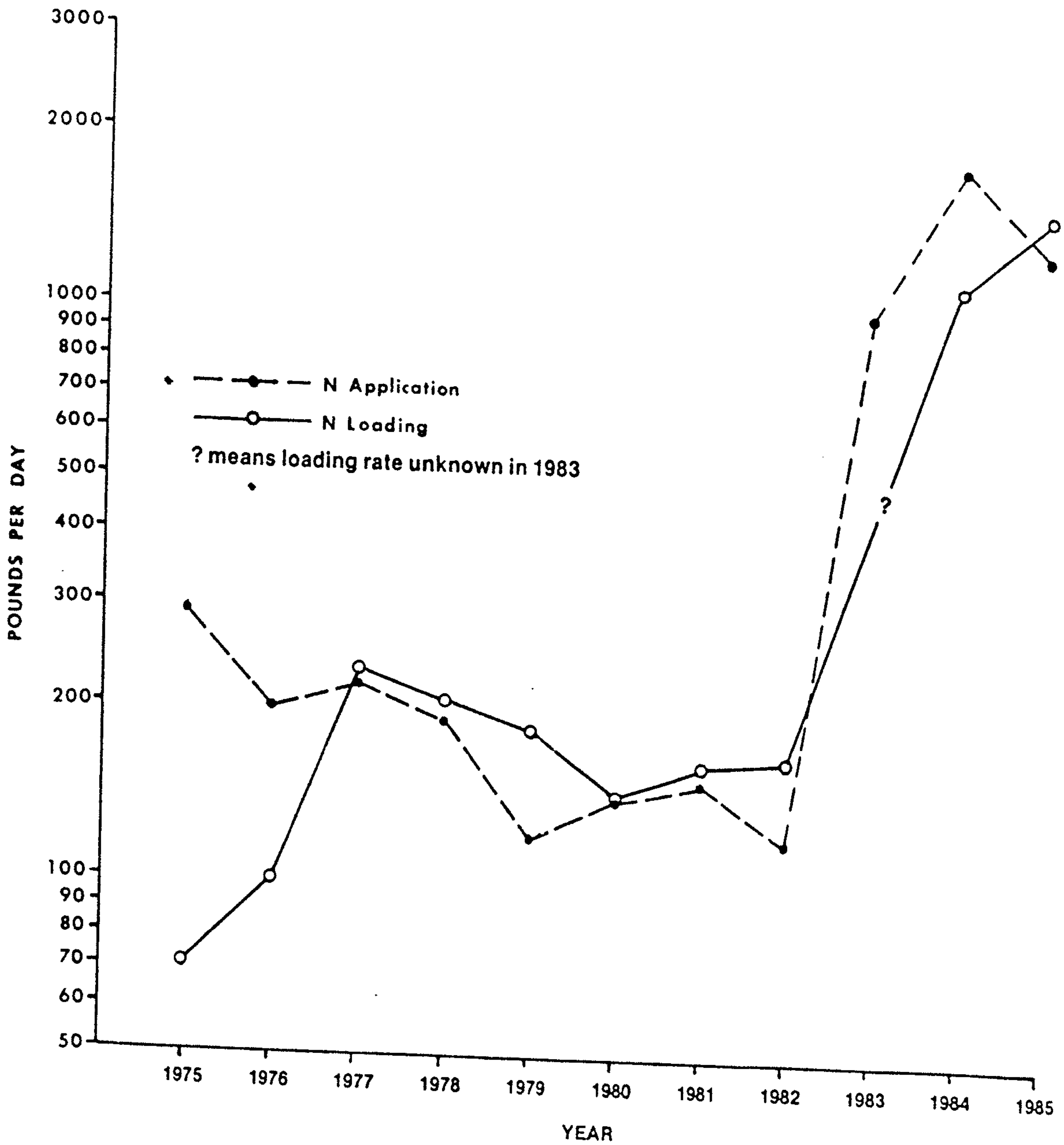
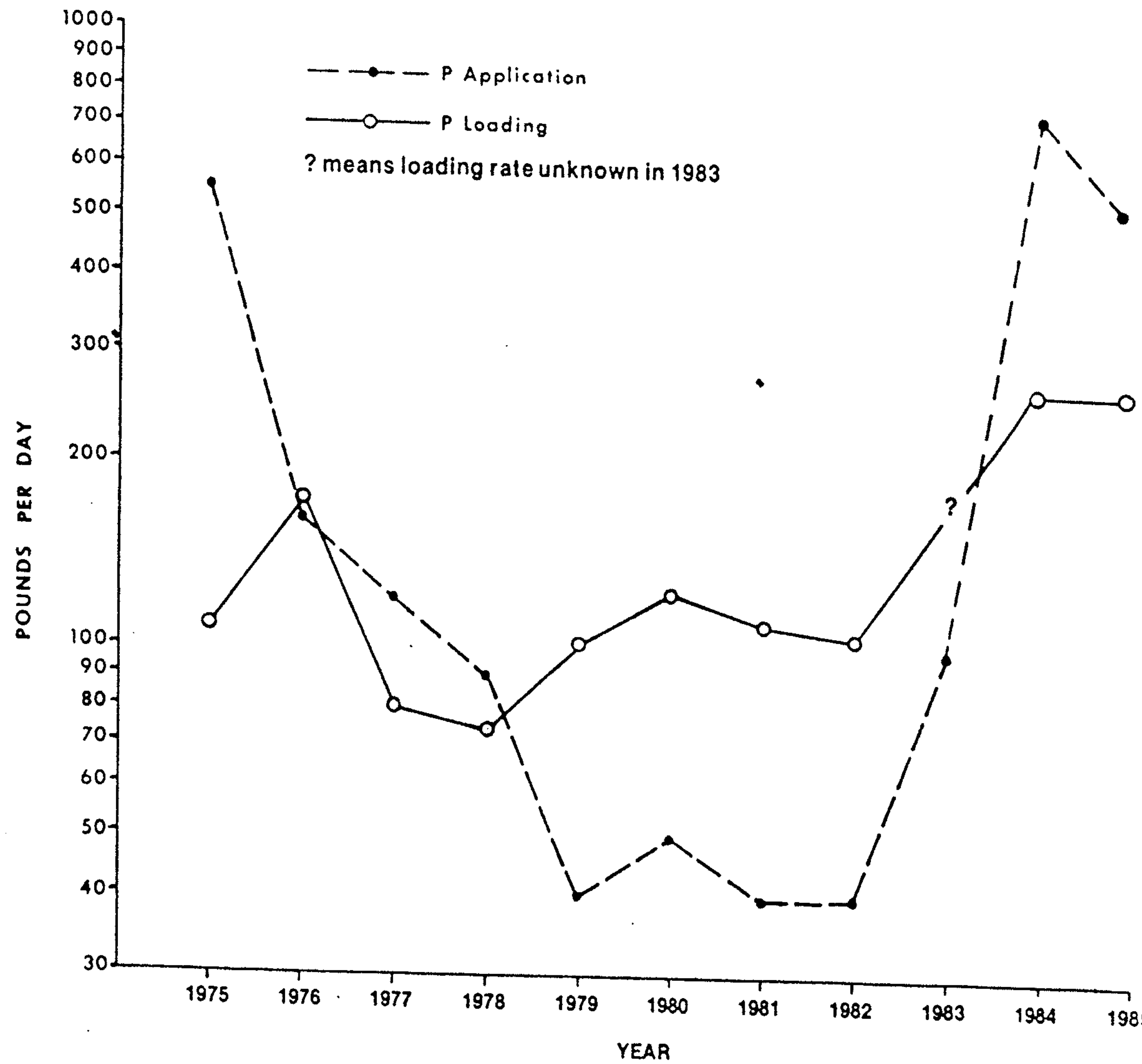


Figure 4 Phosphorus (P) application and loading rates at Champion International since 1975.



radically different than those given in the DEIS. Specifically, the Addendum included an alternative proposed by the Clark Fork Coalition Citizens' Group. Their alternative was stated as follows:

> The Clark Fork Coalition "Citizens Alternative" called for the issuance of a five-year temporary permit, with a complete review of certain parameters in two years by the public, a technical advisory committee and the DHES. The alternative also included recommendations for specific permit conditions. Total suspended solids would be limited to 2 million pounds per year, but would be calculated as a three-year running average. Dissolved oxygen changes in the mixing zone would be limited to 1.0 mg/l, with surface discharge to cease if the level reaches 7.0 mg/l. Direct discharge would also cease when instream water temperature reached 65 ^{o}F. Limitations for color and BOD would be the same as in the existing permit. The source of foam would be assessed and foam measures implemented, if necessary. Nutrient loading would be reduced to pre-1984 levels. The present mixing zone should be reassessed and adjusted as necessary. Additional instream monitoring as recommended by the Technical Advisory Committee should be conducted at Champion's expense.

After review, the DHES recommended a combination of the Coalition's alternative and one opting for the renewal of the permit for five years with additional conditions to require a study of nutrients and foam sources within the plant followed by development of a contingency plan to reduce nutrients and foaming agents in the discharge if necessary. In essence the DHES recommended that the permit should be renewed for five years, but on-going technical water quality review should continue. If the reviews show degradation in water quality, the permit can be reopened and changed at any time to address problems with water quality standards caused by discharge. The DHES also recommended a dissolved oxygen cutoff of 7.1 mg/l.

7. The Final Environmental Impact Statement (FEIS) issued in August 1986 by DHES maintained the same conclusions on nutrients as stated in the Addendum to the DEIS. The FEIS recommended the issuance of a nondegradation-based waste discharge permit that contains final effluent limits similar to those in effect in 1982 (see Figs. 3 and 4). The permit would require submittal of a compliance schedule which would ensure that final effluent limits are met by 1991 (see section VI of this report).

In summary, the nutrient controversy which now exists on the Clark Fork River was spawned by Champion mill's request to discharge wastewater on a year-round basis into the river. The DHES was ready to comply with this request until the Clark Fork

Coalition became involved. The nutrient issues that were initiated by the Champion mill request have now brought other point sources of nutrients on the Clark Fork under scrutiny, in particular the Missoula Sewage Treatment Plant. The nutrient issue was further compounded by the fact that all of the waste discharged into the river ends up across the state line in Lake Pend Oreille, Idaho. Awareness of this potential problem by Idaho residents living near Lake Pend Oreille has put pressure on Montana legislators (as evidenced by the initiation of the Governor of Montana's Clark Fork River Basin Project and the large amount of money being spent on monitoring the system). A major issue that exists today regarding point source N and P loading concerns (i) how much N and P is derived from the MSTP and how much from the mill, (ii) how much of these nutrients reach Lake Pend Oreille and (iii) what impacts will these nutrients have on Lake Pend Oreille. A summary of information available on nutrient limitation is given in the following section of this report.

IV. NUTRIENT RELATED ISSUES.

Unfortunately, adequate information has not been published for me to determine, with any degree of accuracy, the limiting nutrients, their exact sources (i.e. Missoula STP or Champion mill), or their effects on the Clark Fork River or Lake Pend Oreille. For example, the USGS apparently did not collect N and P immediately above Missoula after 1971 and did not initiate nutrient collection immediately below Missoula until 1978. Consequently, I could not construct a contemporaneous nutrient budget with USGS data. It appears that data collected by DHES starting in 1984, as part of their Champion mill discharge study, are now starting to become available. The raw data, to my knowledge, have not been published. However, according to the work plan prepared by the Governor's Clark Fork River/Lake Pend Oreille Basin Project, the information is due to be released to the public sometime in 1988. Presumably, many of the recent newspaper reports on nutrient contributions to the Clark Fork should be regarded as tentative; they probably represent "word of mouth" information which had "leaked" from DHES.

In this section I will present information that has been published on various aspects of nutrient interactions in the Clark Fork and their relationship to water quality. The information will be presented chronologically, and grouped according to the document (see section V for specific references) in which they were published. A short summary will be given at the end of each subsection.

1. <u>Nutrient</u> <u>Limitation</u>.

<u>Document</u>: DHES, Preliminary Environmental Review.

The DHES analyzed USGS measurements of TN and TP collected a total of 25 times in water years 1980 through 1982 at a station just below Missoula. They estimated an average TN:TP ratio of 10 (range 3.5-77). Sixteen of the ratios were larger than 10, seven fell between 5 and 10, and two were less than 5. Based on these ratios, the DHES felt that either N or P may limit the growth of algae in the Clark Fork River.

Baseline biological conditions in the Clark Fork River before and after the Champion mill began operating are described in reports by others and are presented in the PER. The results of these reports (with respect to limiting nutrients) are given below:

(a) The river was heavily fertilized by raw sewage discharged at Missoula and the recovery zone extended downstream to St Regis.

(b) The Clark Fork below Missoula is one of the most productive rivers in the northwest in terms of periphyton chlorophyll and biomass accrual.

(c) The production of algae in the river below Missoula is limited by the concentration of soluble inorganic nitrogen in the water; in other words, the river is N limited. It was later demonstrated that either N or P can be limiting.

(d) Concentrations of total soluble inorganic nitrogen in the river below Champion are below those required to produce nuisance algal growths.

<u>Document</u>: DHES Data Report-Vol. II.

The EPA conducted their standard <u>S. capricornutum</u> bioassay on 10-14 December, 1984 and 10-16 May, 1985. The December assay indicated P limitation whereas the May experiment showed N limitation. Samples collected downriver from Thompson Falls Reservoir showed limitation by chelating agents (e.g. EDTA). Interestingly, growth potential estimates indicated that not enough dissolved inorganic N (NO_3+NH_4) existed to satisfy the biomass accumulation. EPA concluded that dissolved organic N (DON) would have to be utilized to balance the N demand. This fact would imply that the river was deficient in inorganic N during both sampling periods.

<u>Document</u>: DHES Draft Environmental Impact Statement.

The results of the EPA bioassays which showed that either N or P, or both, may limit algal growth are mentioned. It is stated that the EPA findings support the conclusions of DHES (based on USGS N:P ratio data) as presented in the PER (discussed above).

The DHES, on recommendation from the USEPA (DHES 1984b), adopted the following nutrient concentration guidelines for assessing the potential for producing nuisance growths of attached algae in flowing waters:

--1.0 mg/l total inorganic N (I presume they mean total N not total inorganic N)

--0.1 mg/l total P

They concluded that average concentrations of TN and TP in the lower Clark Fork River were all well below these guidelines.

Interestingly, the summary section of this document contains the following statement: "The Clark Fork River is primarily P-limited where it passes the Champion mill." This conclusion is not supported by either USEPA or DHES data discussed above and in an earlier section of the report.

Document: Addendum to the Draft EIS.

The statement is made (p.16): "The Clark Fork is primarily phosphorus-limited in terms of algal growth potential where it passes the Champion mill."

Again this conclusion is not supported by either USEPA of DHES data discussed in previous documents.

Document: Final EIS.

Much of this document presents responses to common comments raised by reviewers to the DEIS and the Addendum to the DEIS. Listed below are 5 such comments which "a priori" assume that the system is P-limited:

(a) Champion should pay for P removal elsewhere to compensate for the degradation which has occurred as a result of its discharge.

(b) Because the rapid infiltration basins reduce P concentration by about 80% they or an equivalent system should be retained.

(c) Algal growth increases proportionately with phosphorus concentration increases.

(d) The P concentrations below the facility (Champion mill) are above the problem threshold for algal growth 36% of the time.

(e) The impacts of increased P loads on Lake Pend Oreille should be predicted.

Presumably, these comments represent the general feeling of the local citizens and legislators concerned with the Clark Fork.

Of interest is the response by DHES to the Lake Pend Oreille comment (e, above). DHES states that "In Lake Pend Oreille phosphorus is apparently much less abundant compared to what is needed by algae than is nitrogen, thus the amount of phosphorus is at least potentially limiting the growth of algae in the lake." To help substantiate this statement they plotted areal P loading rates (I am not sure where they obtained the data, and it is not clear what form of P was used--presumably is was total P).

These plots are given in Figure 5. The DHES concluded that "...differences in the curves are considerably greater than the possible P increase of 6 % (the amount which the mill and MSTP are each supposed to contribute to Lake Pend Oreille--discussed below), it is not worthwhile to predict the increase in algal abundance that might result from the 6 % P increase from upstream point-source loading."

DHES further concluded that, although the present algal density is very low, and it is unlikely that a 6% increase in loading would affect any beneficial use, the inlake P and chlorophyll concentrations and the P loads coming into the lake should be more carefully determined.

SUMMARY.

The stand on nutrient limitation in the Clark Fork System took a radical change in the Draft EIS (DHES 1985b). Reports in earlier documents concluded that the system was N-limited. However, the Draft EIS concludes that the system is P-limited, despite comments in the earlier pages of this same document that mention the facts presented about N-limitation. Reports issued after the Draft EIS all support the P-limitation statements made in the Draft EIS. These latter feelings have now been incorporated by the general public as reflected in the comments to the Final EIS. The change of support from N to P-limitation occurred when the Clark Fork Coalition became involved; their influence was first evident in the the Addendum to the Draft EIS. Irregardless of current feelings, the published data indicate that both N and P must be considered as potential nutrients influencing the productivity of the river.

2. Nutrient Contributions from the Champion Mill and the Missoula Sewage Treatment Plant.

Document: Clark Fork River Symposium (1985).

The manuscript by Bahls and Ingman (from the Montana DHES) presents preliminary results from the DHES monitoring study initiated in 1984 (as far as I can tell the raw data are still unpublished). With respect to nutrient contributions by the Champion mill and the MSTP they conclude:

> "The MSTP discharges large concentrations of nutrients to the Clark Fork. There was an observed average increase of about 80% in total phosphorus and about 30% in total nitrogen in the Clark Fork from above to below the MSTP discharge for the period March 1984 to February 1985. The MSTP discharge does not contribute measurably to the river's sediment concentration."

An additional conclusion regarding ammonium was:

> "The state of un-ionized ammonium criterion of

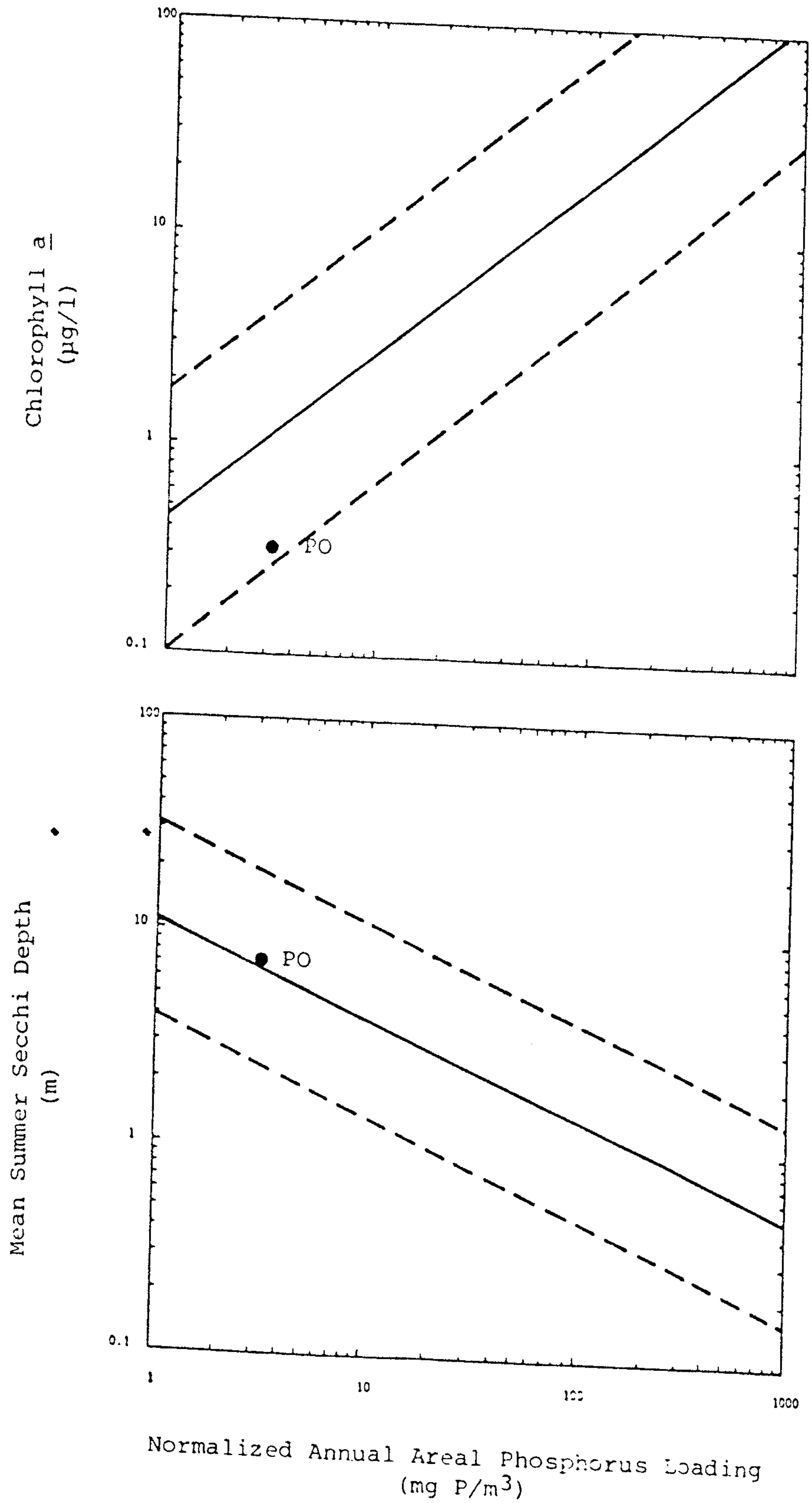


Figure 5. Phosphorus load - eutrophication - related water quality response relationship for U.S. waterbodies. (After Jones, R.A. and Lee, G.F., "Recent Advances in Assessing Impact of Phosphorus Loads on Eutrophication - Related Water Quality", Water Res. Vol. 16, pp. 503-515, 1982.)

0.03 mg/l is usually exceeded in the Clark Fork immediately below the MSTP, but only prior to complete mixing of the effluent in the river.

Document: Preliminary Environmental Review (DHES 1984).

This document presents the nutrient contributions from the mill and MSTP which are apparently based on DHES unpublished data. Recent and projected nutrient loading rates by the two major discharges (i.e. mill and MSTP) on the lower Clark Fork, as presented in this document, are shown in Table 1.

From the information in Table 1, the DHES concluded that until about 1984, "...the MSTP has contributed three times as much N and half again as much P as the Champion International paper mill." They further indicated that, "while nutrient loads from the MSTP are not expected to increase significantly in the near future, loads from the Champion mill will. At some point, nutrient loads from the paper mill are expected to double or even quadruple those from the MSTP."

The DHES estimates of the percentages these sources contribute to the total nutrient loads in the Clark Fork River downstream from the Champion mill are presented in Table 2. In computing these percentages, the DHES assumed that all of the loadings from the MSTP will remain the same in the near future.

Document: Governor's Clark Fork River-Lake Pend Oreille Basin Project (1985).

This report bases their estimates of nutrient loading on Montana Water Quality Bureau data. The report concludes that "...the MSTP and the Champion mill may account for as much as 15% of the total nutrient load to the Clark Fork River. Non-point sources of nutrients are widespread and diffuse."

Document: Draft EIS (DHES 1985b).

The following is quoted or paraphrased from this document. The data are from a 2 year study (1984-1985) of the Champion mill effluent (data given in Figs. 6 and 7).

"Nutrients in the City of Missoula effluent represent 16% of the N and 34% of the P that was present in the river below the MSTP. It appears that the MSTP discharged considerably more N and P in 1984 and 1985 than it did in 1981 or 1982" (data compiled in Table 3).

"Nutrients in the Champion discharge represented 12% of the N and 20% of the P that was present in the river below the mill. Approximately 23% of the N load and 43% of the P load in the river above Thomson Falls is removed ("trapped") in Thomson Falls and Noxon Reservoirs."

The DHES summarized their findings by concluding that "nutrient applications and loading rates at Champion were at all time highs during the Clark Fork study. At the same time, nutrient loading rates by the MSTP were higher than the rates measured in 1981 and 1982."

Document: Addendum to the Draft EIS (DHES 1986b).

Data in this report are from the same 2 year DHES monitoring program as those presented in the Draft EIS (discussed above). Apparently the DHES "refined" their data analysis for the current document.

The DHES concludes "Nitrogen and Phosphorus from the MSTP and Champion discharges represented on the average 16 and 34 percent and 12 and 19 percent, respectively, of the loads present in the river below each of those discharges." This conclusion is in line with those made in the Draft EIS. However, they are much lower than those reported by Bahls and Ingman (1985) in the Clark Fork River Symposium (discussed above).

The 34% contribution by the MSTP presented in the latter documents has been quoted by members of the Clark Fork Coalition in the media (e.g. The Missoulian, March 11, 1988).

SUMMARY.

Using measurements made during a 2 year study on the lower Clark Fork River, the DHES has settled on N and P contributions of 16% and 34% for the MSTP. They also noted an increase in the contribution from the MSTP from a 1981-1982 study. They further concluded that the contribution from the MSTP exceeded those from the mill during their 1984-1985 study period, although they felt that increased mill effluent would eventually increase the relative contribution by the mill (it was assumed that the MSTP effluent would remain relatively constant). However, with the recommendations made in the Final EIS (see section VI of this report) that the mill is to return to pre-1982 nutrient loadings, it would appear that the MSTP will contribute an even greater proportion of the N and P to the river. Furthermore, the Clark Fork Coalition is contending that growth in the Missoula valley will continue to increase the contribution of P so that the MSTP's contribution to the river (and Lake Pend Oreille) will increase even further.

3. Fate of Nutrients Discharged into the Clark Fork by the Mill and MSTP.

Document: Governor's Clark Fork River-Lake Pend Oreille Basin Project (1985).

This document concludes that "The greatest single threat to the quality of Lake Pend Oreille is increased nutrient loading both from upstream and shoreline sources. The corresponding increase in algae populations would not only degrade the appearance of the lake, but would eventually effect the fishery." It is further concluded that the nutrient impacts on Lake Pend Oreille remain largely unquantified.

Document: Draft EIS (DHES 1985b).

This document concludes that "A large portion of the

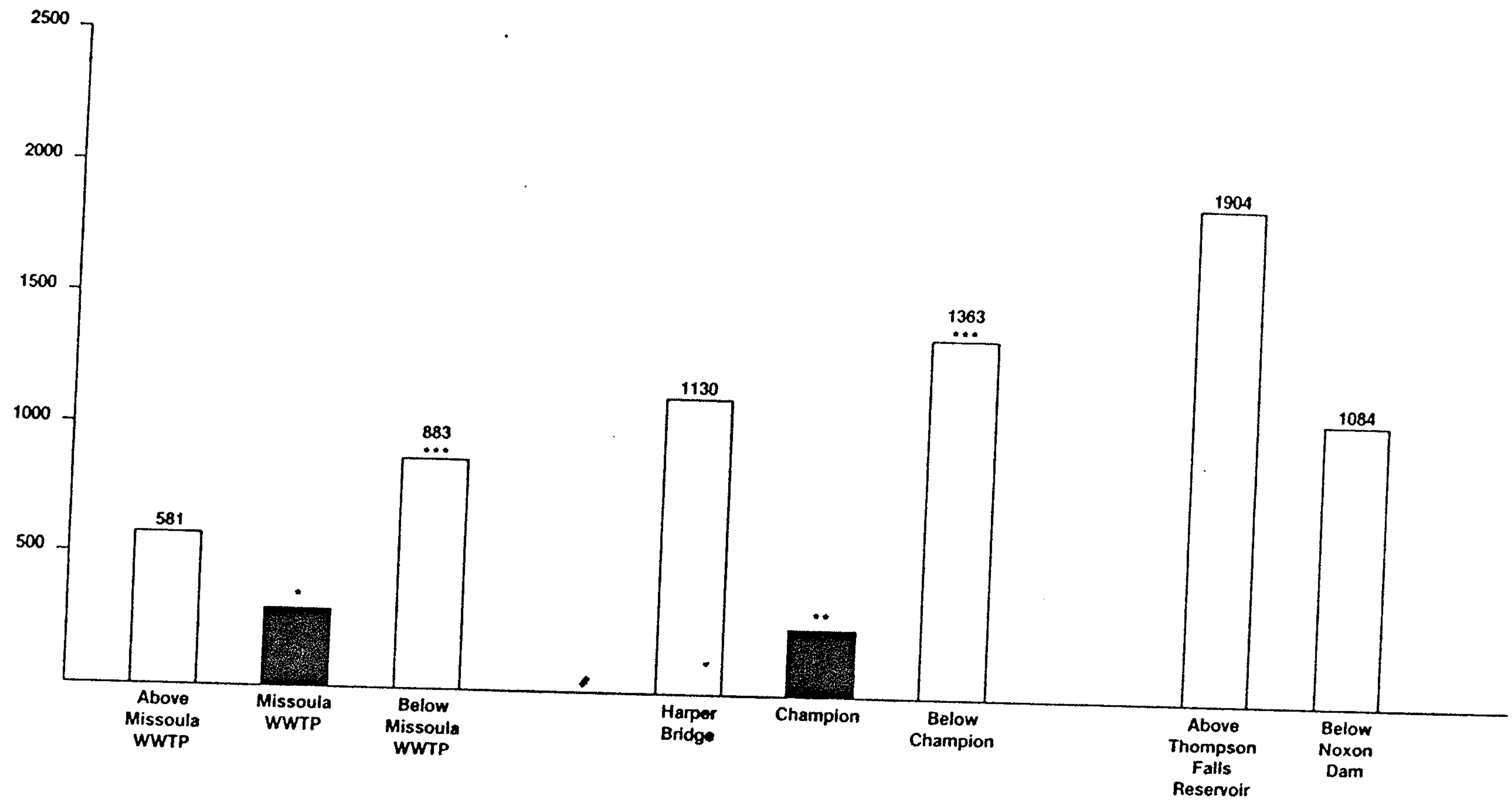
Table 1. Recent and predicted nutrient loading rates by Champion International and the City of Missoula wastewater treatment plant (average annual lb/day).

	TN		TP	
	Missoula	Champion	Missoula	Champion
1980	——	142	——	123
1981	472	161	167	110
1982	513	168	158	105
Present	——	1200	——	260
Future	——	2400	——	520

Table 2. Nutrient loads from Champion International and the City of Missoula wastewater treatment plant as percentages of total nutrient loads in the Clark Fork River downstream from the Champion mill.

	TN		TP	
	Missoula	Champion	Missoula	Champion
1980 - 1982	4.6	1.5	15.6	10.8
Present	4.2	10.3	12.5	19.9
Future	3.8	18.7	10.4	33.2

Figure 6 Average daily phosphorus loads carried by the Clark Fork River at selected stations, March 1984 through August 1985.



* 301 lbs/day

** 267 lbs/day (70 lbs/day seepage; 197 lbs/day direct discharge)

*** Predicted value based on instantaneous mixing and no instream attenuation