

## Lower Clark Fork River Water Quality Monitoring

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### Introduction

A large amount of public concern has been expressed in recent months over the general health of the lower Clark Fork River. Modification of the waste-water discharge permit for the Champion International kraft paper mill at Frenchtown has generated much of this concern. Other sources of wastewater, namely the City of Missoula wastewater treatment plant (WWTP) and historic metals deposits originating upstream from Milltown Dam, have also been mentioned as possible sources of stress on the lower river.

The preliminary environmental review of the proposed permit modification for Champion International (Water Quality Bureau, January 1984) outlined a water quality and biological monitoring program that would establish existing conditions and attempt to measure any changes that may result from the permit modification. This paper gives a brief description of the 2-year monitoring program that the Water Quality Bureau initiated in March 1984 and a summary of significant findings to date. Data from this monitoring program will be the technical basis of an environmental impact statement that will address the decision whether to renew the modified permit when it expires in April 1986.

### Objectives

1. To establish a chemical, physical, and biological water quality baseline for the lower Clark Fork River in Montana.
2. To determine changes in water quality that may result from a year-round discharge of treated kraft mill wastewater from Champion International.
3. To determine the contributions, environmental effects, and downstream fate of water quality contaminants from various wastewater sources and tributaries along the river.

### Monitoring Approach

The monitoring plan encompasses about 225 miles of the lower Clark Fork River from Turah (upstream of Milltown Dam) to the Idaho border, including the Blackfoot, Bitterroot and Flathead Rivers (fig.1). In addition to 31 fixed water quality stations on the river, its four-mainstem reservoirs and three major tributaries, the Bureau has collected samples from 11 deepwater pools between Frenchtown and Thompson Falls Reservoir. Sampling is conducted at least monthly and more frequently during spring runoff (table 1). A variety of chemical, physical and biological water quality variables are being measured in several hundred samples collected from river stations and from the surface and bottom waters of deepwater pools and reservoirs. Nine types of samples are being collected and more than 30 water quality variables are being measured (table 2). The following narrative explains the reasons for collecting each type of sample and for measuring some of the more significant water quality variables.

### *Surface Grabs (Seasonal)*

From these samples we will attempt to quantify the contributions of water quality contaminants from various waste sources and the major tributaries. Together with the monthly samples (below), they will help to establish nutrient, suspended solids, and heavy metals budgets for the river and assess the instream consequences of cumulative contaminant loading. Existing stream flow gaging stations will be used to measure or estimate river and tributary discharge. Using estimates of river travel time between stations, attempt is being made to follow downstream and to sample at each station the same "slug" of water. This is called synoptic water quality monitoring. Seasonal samples

### *Surface Grabs (Monthly)*

Additional samples for total suspended solids (TSS), volatile suspended solids (VSS), algal nutrients, and heavy metals are being collected at 16 stations, monthly during base flow and more frequently during snowmelt runoff. Besides helping to establish loads and budgets, the high-flow samples will help to estimate the amount of deposition of organic and inorganic solids in the mainstem reservoirs when retention time is shortest and when Champion International is discharging directly to the river at its maximum rate.

### *Bottom and Surface Grabs*

Water samples are being collected at the same time from the surface and near the bottom of the four mainstem impoundments (Milltown, Thompson Falls, Noxon Rapids, and Cabinet Gorge Reservoirs) and from 11 deepwater pools between Frenchtown and Thompson Falls. This type of sampling is designed to determine whether dissolved oxygen and pH are depressed near the bottom in deepwater areas, and whether such depressions result in mobilization (solution) of heavy metals that may be contained in the bottom sediments. Water is brought up from the bottom using a Kemmerer sampler lowered from a boat. The key variables here are dissolved oxygen, pH, and selected heavy metals (total and dissolved). The measurement of dissolved (and biologically effective) metals required filtering one set of metals samples in the field.

### *Bottom Sediment*

In light of the quantities of heavy metals that have been reported in the sediments behind Milltown Dam, it is reasonable to assume that there are elevated levels of heavy metals in the sediments of downstream pools and reservoirs. Samples of sediment are being collected with a Petite Ponar Grab (bottom dredge) from deepwater pools and reservoirs. The sediment is analyzed for concentrations of heavy metals, percent organic content and the presence or absence of hydrogen sulfide. Comparing the organic content of sediments from behind Milltown Dam to those of still, deep waters downstream may indicate whether there is appreciable deposition and accumulation of organic solids originating from the Missoula WWTP and Champion International.

### *Deepwater Biology*

From these same reservoirs and pools, replicate samples of benthic macroinvertebrates are also brought up with a Petite Ponar Grab. These benthic biology samples will be used to assess environmental

conditions in the bottom sediments, including the biological effects of heavy metals and organic deposits and the presence or absence of dissolved oxygen.

#### *Shallow-water Biology*

Riffles are the most productive habitat in rivers for benthic algae and macroinvertebrates (fish food). The kinds and diversity of organisms living in these habitats tell a great deal about the nature and degree of stress placed upon a river by various water quality contaminants. Analysis of chlorophyll and biomass in grab samples of the slime layers ("aufwuchs") from rocks on the river bottom will indicate the relative importance of producers (algae) and consumers (bacteria, fungi, etc.) in the microbial community, and in turn the significance and cumulative effects of organic loading to the river. Measurements of algae production on artificial substrates (glass slides) will indicate the biostimulation effects of nutrients discharged by the Missoula WWTP and Champion International.

#### *Open-water Biology*

The concentration of chlorophyll and the kinds and density of algae in the phytoplankton communities of the four mainstem reservoirs are measured during spring, summer, and fall. Chlorophyll concentrations will be converted to algal biomass and compared to ambient nutrient concentrations in order to assess eutrophication potential in Clark Fork River reservoirs according to criteria published by the U.S. Environmental Protection Agency. Secchi disk transparency is measured on each visit.

#### *Surface Diurnal Dissolved Oxygen*

Dissolved oxygen and water temperature are measured every 3 hours over a 24-hour period at low flow in midsummer. The 12 stations bracket the Missoula WWTP and Champion International, with eight stations clustered below the latter facility in order to pinpoint the reach of river subject to the maximum depression in dissolved oxygen. The data collected from this intensive effort will help to model and predict dissolved oxygen concentrations at different stations under varying conditions and to determine the probability of violation of the State's dissolved oxygen standard at different levels of organic loading.

#### *Water Quality Reconnaissance*

During the course of the monitoring program, field personnel look for and record any incidental evidence of water quality degradation and environmental stress. They make detailed written and photographic records of their observations.

#### **Preliminary Results**

As of July 1, 1985, 24 monitoring runs have been completed on the lower Clark Fork. This includes 20 routine monthly runs and four comprehensive seasonal runs. Most of the water chemistry analyses have been completed and reviewed for trends. Most of the biological samples remain to be analyzed and interpreted. Analysis of river pool and reservoir sediments has begun but the results are not yet available. All of the samples collected as of August 1985 will be analyzed by October and the data will be included in a report to be released shortly thereafter.

The following are significant findings based on the available data:

1. Heavy metals are transported downstream in the lower Clark Fork primarily during the high flows. Exceedances of aquatic life criteria are almost exclusively limited to high flow periods (Milltown drawdown is the exception), and such events are relatively short-lived.
2. Of the lower Clark Fork monitoring sites, metals levels are consistently highest at Turah and decrease with increasing distance downstream from Turah. The Blackfoot, Bitterroot and Flathead Rivers have very small concentrations of metals and they provide clean dilution water to the Clark Fork.
3. The Missoula WWTP 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 WWTP discharge for the period of March 1984 to February 1985. The WWTP discharge does not contribute measurably to the river's sediment concentration.
4. The State unionized ammonia criterion of 0.03 mg/L is usually exceeded in the Clark Fork immediately below the Missoula WWTP, but only prior to complete mixing of the effluent in the river.
5. The Champion wastewater contains both solid and dissolved materials. Solids consist mostly of common nonpathogenic bacteria, fungi, and algae. Wood or paper fibers have yet to be observed. Dissolved materials consist of relatively high levels of phosphorus, nitrogen, and common salts. Total phosphorus averages 3.4 mg/L, total nitrogen 16.4 mg/L, TSS 95.6 mg/L, VSS 88.9 mg/L, and specific conductance 2792 micromhos. Several organic compounds also have been identified, the potential toxicity of which will be examined.
6. Because of the nature of the solid materials in the Champion wastewater, appreciable settling of the solids in slow areas of the Clark Fork is unlikely. Significant deposits of organic solids have not been found on the bottoms of Clark Fork reservoirs or river pools.
7. The modified Champion discharge permit allows for a nearly year-round surface discharge of wastewater to the Clark Fork. Under the old permit, Champion discharged only when river flows exceeded 4000 ft<sup>3</sup>/s, or roughly from mid-April to mid-July. Our first year of data seems to show that the Champion discharge had a minimal if not immeasurable impact on Clark Fork water quality during the period from mid-July to mid-April (the period with no discharge in the past), due to low wastewater discharge rates and high dilution ratios. Conversely, during the higher water period of mid-April to mid-July (the period during which Champion has historically discharged), significant increases in nutrients and especially sediment were measured in the Clark Fork from above to below Champion. Flow-dilution calculations using river and wastewater quality and flow rates indicate that the Champion discharge is an insignificant source of sediment and nutrients in this reach. The presumed major source is material scoured from the riverbanks and riverbed during high flows. A Soil Conservation Service (SCS) stream bank inventory is available and will be consulted.
8. Unesthetic accumulations of foam periodically appear on the surface of the Clark Fork both above and below Champion and on the Bitterroot, Blackfoot, and Flathead Rivers. The foaming appears to peak at water temperatures in the 4-6 °C range (spring and fall). We feel that the Champion discharge contributes to foam in the river below the mill.
9. Water in Milltown, Thompson Falls, and Cabinet Gorge Reservoirs and in even the deepest river pools is well mixed. Water quality is similar at surface and bottom.
10. Noxon Rapids Reservoir is over 170 feet deep and may completely or partially stratify in summer. Dissolved oxygen levels below the State B-1 standard have been measured in the depths of the reservoir on several occasions. Because the penstock at Noxon Dam draws water from 86 feet, similarly low levels have been recorded in the Clark Fork below the dam.

11. There are no obvious pollutants in the lower Clark Fork Reservoir system that would preclude a healthy fishery.
12. Our study reach on the lower Clark Fork supports an apparently healthy and highly diverse community of macroinvertebrates. Over 165 insect species have been identified. The Missoula and Champion discharges do not appear to significantly disrupt macroinvertebrate community structure. The Clark Fork benthic community does change markedly below the mouth of the Flathead. Possible causes are higher temperatures, differences in substrate composition, and water level fluctuations due to the operation of hydroelectric facilities.
13. Nutrient concentrations in the Clark Fork below Cabinet Gorge Dam are generally very low, but the total load could be substantial due to the large flow. There is a need to determine what percentage of the nutrient load entering Lake Pend Oreille is contributed by point source discharges in Montana and what effect the lower Clark Fork reservoirs have on loading rates.

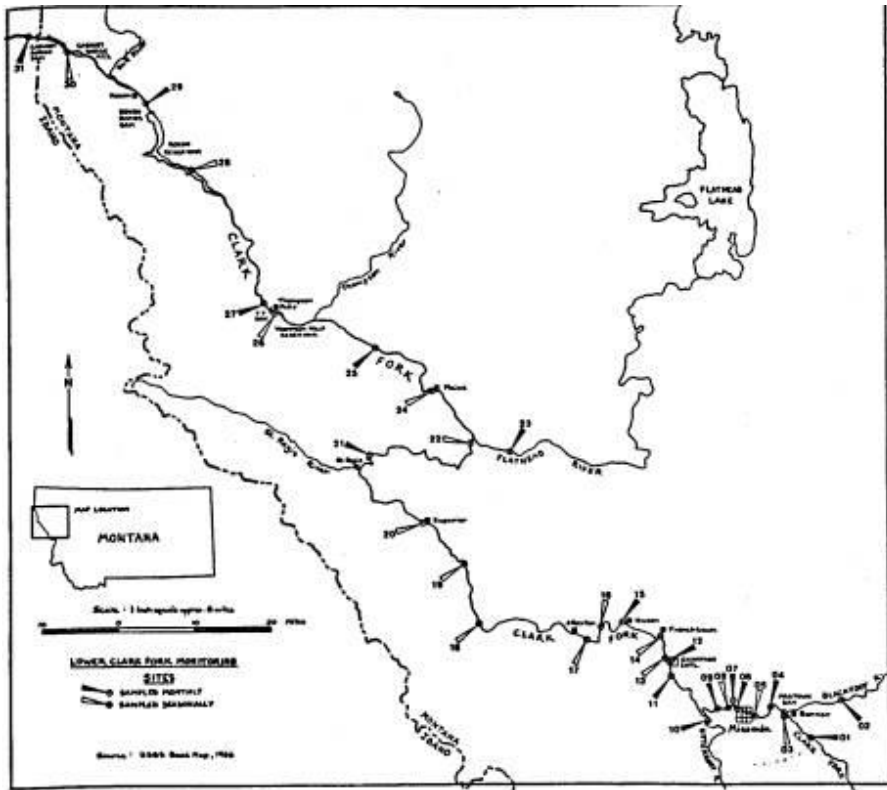


Figure 1. Water quality monitoring stations on the lower Clark Fork River.

Table 1.--Water quality stations and sampling frequency

Stations	Discharge*	FREQUENCY**								
		S	M	S	S	O	S	O		
		Surface Grabs (seasonal)	Surface Grabs (monthly)	Bottom and Surface Grabs	Bottom Sediment	Deepwater Biology	Shallow-water Biology (Natural Substrates)	Shallow-water Biology (Artificial Substrates)	Open-water Biology	Surface Diurnal Dissolved Oxygen
01 CFR at Turah	E	X	X				X	X		X
02 Blackfoot River nr. mouth	M	X	X				X	X		
03 Milltown Reservoir		X		X					X	
04 CFR blw. Milltown Dam	M	X	X				X	X		
05 CFR abv. Missoula	M	X					X			
06 CFR abv. Missoula WWTP	E	X	X				X	X		X
07 Missoula WWTP Effluent	M	X	X							
08 CFR blw. Missoula WWTP	E	X					X	X		X
09 CFR at Sneffields	E	X	X				X	X		
10 Bitterroot River nr. mouth	E	X	X				X	X		
11 CFR at Harper Bridge	M	X	X				X	X		X
12 Champion Outfall (or pond water)	M	X	X							
13 CFR .5 mi blw. Outfall	E	X					X	X		
14 CFR 4 mi blw. Outfall	E	X					X			
15 CFR at Huson	E	X	X				X	X		X
16 CFR at Ninemile	E	X								
17 CFR at Alberton	E	X								
18 CFR at Tarkio	E	X								X
19 CFR at Lozeau	E	X					X			X
20 CFR at Superior	E	X								X
21 CFR blw. St. Regis River	M	X	X				X			X
22 CFR abv. Flathead River	E	X					X			X
23 Flathead River nr. mouth	E	X	X				X			X
24 CFR at Plains	M	X					X			X
25 CFR abv. Thompson Falls Res.	E	X	X				X		X	
26 CFR in Thompson Falls Reservoir		X		X					X	
27 CFR blw. Thompson Falls Dam	M	X	X				X			
28 CFR in Noxon Reservoir		X		X				X		
29 CFR blw. Noxon Dam	M	X	X				X			
30 CFR in Cabinet Gorge Reservoir		X		X				X		
31 CFR blw. Cabinet Gorge Dam	M	X	X				X			
Total Stations		31	16	10		20	7	5		12

\* E = Estimated  
M = Measured

\*\* M - Monthly (more frequently during runoff)  
S - Seasonally (three times per year)  
O - Once annually (in the summer)

Table 2.--Sample types and water quality variables

Surface Grabs (Seasonal)

Field dissolved oxygen  
Field temperature  
Field pH  
Biochemical oxygen demand  
Chemical oxygen demand  
Color (natural pH and pH adjusted)  
Metals (total recoverable Fe, Cu, Zn, Mn, Cd, As)  
Total suspended solids (depth-integrated sample)  
Volatile suspended solids (depth-integrated sample)  
Nutrients (nitrate, nitrite, ammonia and Kjeldahl nitrogen, ortho-phosphorus and total phosphorus)  
Lab pH  
Specific conductance  
Hardness

Surface Grabs (Monthly)

Total suspended solids (depth-integrated sample)  
Volatile suspended solids (depth-integrated sample)  
Nutrients (same as seasonal)  
Metals (same as seasonal)

Bottom and Surface Grabs

Field dissolved oxygen  
Field pH  
Field temperature  
Metals (Fe, Cu, Zn, Mn, Cd, As, Pb, Cr, Ag - dissolved and total recoverable)  
Hardness  
Lab pH  
Specific conductance

Bottom Sediment (3 replicate samples per station)

Field hydrogen sulfide (qualitative)  
Percent organic content  
Metals (same as list above - total and total recoverable)

Deepwater Biology (3 replicate samples per station)

Benthic macroinvertebrates (Ponar grab)

Shallow-water Biology (natural substrates)

Macroinvertebrate traveling kicknet samples  
Composite periphyton collections  
Periphyton chlorophyll/biomass grab samples

Shallow-water Biology (artificial substrates)

Periphyton chlorophyll/biomass accrual (3 replicates per station - summer only)

Open-water Biology

Phytoplankton composition and density  
Phytoplankton chlorophyll  
Secchi disk transparency

Surface Diurnal Dissolved Oxygen (summer only)

Dissolved Oxygen  
Field temperature  
(every 3 hours for 24 hours)

for all variables are collected in March, August, and November at the 31 stations listed in table 1.