WATER QUALITY STATUS AND TRENDS IN THE CLARK FORK-PEND OREILLE WATERSHED

TRENDS ANALYSIS FROM 1984-2002

EXECUTIVE SUMMARY

This report summarizes water quality data collected in the Clark Fork-Pend Oreille Basin from 1984-2002. Data were collected by Montana Department of Environmental Quality (formerly MDHES) and more recently the Tri-State Water Quality Council. Analyses presented in this study describe the temporal and spatial variability in concentrations of algal nutrients, heavy metals and periphyton (attached algae) in the Clark Fork-Pend Oreille watershed.

The Tri-State Water Quality Council established seven priority water quality monitoring objectives for the Clark Fork-Pend Oreille watershed. These include:

1) Evaluating time trends for nutrient concentrations in the mainstem Clark Fork River and selected tributaries,
2) Evaluating time trends for algal standing crops in the Clark Fork mainstem,
3) Monitoring compliance with established summer nutrient concentration targets for the Clark Fork River,
4) Estimating nutrient loads to Pend Oreille Lake from the Clark Fork River,
5) Evaluating time trends for algal standing crops in near-shore areas of Pend Oreille Lake,
6) Evaluating time trends for Secchi disk transparency in Pend Oreille Lake, and
7) Evaluating time trends for nutrient concentrations in the Pend Oreille River.

Nutrient constituents include total phosphorus, total nitrogen (total Kjeldahl plus nitrite + nitrate nitrogen), soluble reactive phosphorus (dissolved ortho phosphorus), and total soluble inorganic nitrogen (nitrate + nitrite plus ammonia nitrogen). Heavy metal constituents include total recoverable fractions of copper and zinc. Attached algae biomass is measured in terms of ash free dry weight and Chlorophyll *a* from natural substrate samples.

Water quality and algae sampling was conducted at 32 stations located along the Clark Fork River and tributary streams in Montana and Idaho, at two stations on the Pend Oreille River in Washington and at seven stations located in Pend Oreille Lake in Idaho. Of the Clark Fork River stations, five mainstem stations were selected for more intensive summer nutrient monitoring, and seven were sampled for algae. The Pend Oreille Lake stations were sampled for algal constituents only. The Pend Oreille River stations were sampled for water quality constituents only.

In general, nutrient concentrations are highest in the upper watershed and decrease downstream to the Pend Oreille River in Idaho. Increased nutrient concentrations typically occur below wastewater treatment plant outfalls, especially below the cities of Deer Lodge and Missoula. In the lower reaches of the Clark Fork River, nutrient concentrations are

relatively low due to the large discharge and limited source areas. This pattern holds true for total phosphorus, total nitrogen, soluble reactive phosphorus and total soluble inorganic nitrogen.

Recoverable metal concentrations, including copper and zinc, are typically highest in the upper watershed and decrease downstream. The highest median concentrations occur at the two Silver Bow Creek sites, but decrease sharply below the Warm Springs Ponds treatment area. Median concentrations increase at the Clark Fork River above Deer Lodge, but steadily decrease downstream.

The spatial variability of field constituents, including temperature, dissolved oxygen, pH, specific conductivity and turbidity have been consistent throughout the sampling period. Several field constituents, including temperature, dissolved oxygen and pH, fluctuate greatly throughout the day and differences between stations can often be explained by time of day the sampling occurred. Conductivity and turbidity are more resistant to diurnal fluctuations, and do exhibit some spatial patterns. Conductivity is typically highest in the upper watershed above the confluence of the Little Blackfoot River and decreases downstream. Turbidity displays a similar pattern, with the moderately high values in the upper watershed increasing to the Clark Fork River at Gold Creek, and then decreasing downstream. Field constituents were not analyzed for trends.

Laboratory data was analyzed to assess the effect of flow on the concentration of constituents. This was performed for each constituent at all stations. Roughly half of the station/constituent combinations showed flow dependence. Data were adjusted for the effect of flow where flow dependence was found; otherwise raw data were used for analysis of trends. Typically, total phosphorus, total nitrogen, total recoverable copper and total recoverable zinc were positively correlated to flow (high flows correspond with high concentrations), while total soluble inorganic nitrogen was negatively correlated with flow (high flows correspond with low concentrations). Additionally, the trend in flow was examined for each station. Nine stations displayed statistically significant decreasing flows throughout the sampling period, while three stations displayed increasing flows, particularly in tributary streams where the flow regime has been augmented by management activities.

Data were also analyzed to assess the effect of seasonality on concentrations. A large majority of total and soluble nutrient station/constituent combinations showed statistically significant seasonality, while seasonality was less common with heavy metal constituents. Datasets that displayed statistically significant seasonality were adjusted before performing trend analysis.

Adjusted datasets were analyzed for temporal trends using the nonparametric Sen slope method. Statistically significant decreasing trends were detected for total phosphorus, total nitrogen and soluble reactive phosphorus at approximately half the stations, but less often for heavy metal constituents. The only constituent that showed a tendency for increasing was total soluble inorganic nitrogen, which displayed a significant increasing trend at 14 stations, primarily at sites below Missoula.

Results of the trend analysis suggest that overall water quality improved from 1984 to 2002 with respect to total nitrogen, total phosphorus, soluble reactive phosphorus, total copper and total zinc, but not for total soluble inorganic nitrogen, which may be the most limited constituent. The reduction in total and soluble reactive phosphorus is a direct result of the phosphate detergent ban established in 1989, along with improvements at the wastewater treatment plants in Butte, Deer Lodge and Missoula. Stations that displayed significant decreasing trends in heavy metal constituents were primarily in the upper watershed above Deer Lodge. This is likely a result of the ongoing efforts at the Warm Springs Pond treatment area and recent reclamation along Silver Bow Creek. Total soluble inorganic nitrogen is often associated with non-point sources, such as fertilizers and septic systems, and generally reaches the river through groundwater sources. The increasing trends in total soluble inorganic nitrogen are likely caused by a number of factors, including the effects of other nutrient constituents, fluctuations in algal biomass, improved laboratory precision or changes in laboratory methods.

In addition to regular monthly monitoring, intensive summer monitoring was conducted at five stations, including Silver Bow Creek at Opportunity, Clark Fork River below Warm Springs, Clark Fork River above the Little Blackfoot River, Clark Fork River below Missoula and Clark Fork River at Huson. Trend analysis performed on summer data yielded similar results to monthly data, with a few exceptions. Total nitrogen displayed decreasing trends at two stations, while total and soluble reactive phosphorus displayed decreasing trends at four stations. Total soluble inorganic nitrogen displayed a decreasing trend at two stations, but an increasing trend at Clark Fork River at Huson. A decreasing trend in copper was present at Silver Bow Creek at Opportunity. This was the only significant summer trend for heavy metals.

Formal summer nutrient targets were adopted for total nitrogen and total phosphorus, with secondary targets for total soluble inorganic nitrogen and soluble reactive phosphorus. Targets were established as part of the Voluntary Nutrient Reduction Program and adopted as state standards in 2002. Silver Bow Creek is of poor quality with respect to nutrients, and has had no individual sample results below targets. Individual samples at the Clark Fork River stations at Warm Springs and above Little Blackfoot have had relatively good compliance with total nitrogen and total soluble inorganic nitrogen, and low compliance with total phosphorus and soluble reactive phosphorus. The Clark Fork River station below Missoula met total phosphorus targets most frequently, but less often for total nitrogen. Soluble components—total soluble inorganic nitrogen and soluble reactive phosphorus—met targets infrequently. The Clark Fork below Huson had the highest percentage of samples overall that were within target values. Although numerical targets are not yet being consistently achieved, water quality continues to improve with respect to phosphorus (and to a lesser extent nitrogen). It should be reiterated that 4 of the 5 summer monitoring stations showed statistically significant decreasing trends over the long term in total phosphorus and soluble reactive phosphorus concentrations.

Seven Clark Fork River stations were monitored for periphyton from 1998-2002. Sites included Clark Fork River at Deer Lodge, above the Little Blackfoot River, at Bonita, above Missoula, below Missoula, at Huson, and above the Flathead River. Samples were analyzed for Chlorophyll *a* and ash free dry weight. Trends analysis performed on periphyton data suggests that standing crop is increasing at most river sites. The presence of increasing trends for periphyton is somewhat unusual since summer nutrient concentrations have generally shown a decreasing trend at most of these same stations. This may be a function of several factors, including increased nutrient uptake by periphyton, effects of heavy metals on periphyton growth, changes in ambient temperature or effects of the flow regime. Detailed analyses of these factors are beyond the scope of this study.

Periphyton data were also analyzed for compliance with targets. In general, target compliance improves downstream from the Clark Fork River at Deer Lodge to the Clark Fork River above the Flathead River, although percent compliance drops at the station below Missoula.

The relationship between nutrients and periphyton growth was examined, and although the results show considerable variability, several key relationships exist. We looked at the effect of both summer and winter nutrients on periphyton growth, and while nutrient concentrations are typically highest in the winter, the summer nutrient concentrations, especially soluble reactive phosphorus and total soluble inorganic nitrogen, correlate best with periphyton productivity. Even though a strong correlation between nutrients and algae is challenging to demonstrate based on limited sampling at any one site or year, plots of nutrients versus algal biomass reveal that algae production does track well with nutrient components in a spatial sense throughout the period of record.

Five Pend Oreille Lake stations were monitored for periphyton from 1998-2002, including sites at Bayview, Kootenai, Springy Point, Sunnyside and Trestle. The Bayview and Trestle sites have yielded the lowest values of periphyton productivity during this study period, while the Springy Point and Sunnyside sites have displayed the highest periphyton growth. Periphyton data in Pend Oreille Lake were also analyzed for temporal trends. All sites displayed significant trends for either Chlorophyll A or ash free dry weight, except Sunnyside. The Bayview and Trestle sites, which typically exhibit the lowest productivity, have significant decreasing trends for both algal metrics. The Kootenai site, which has displayed a large increase in productivity over the sample period, has significant increasing trends for both algal metrics. The Springy Point site has a significant decreasing trend for ash free dry weight only.

Nutrient loading into Pend Oreille Lake was evaluated for each nutrient constituent over the study period of 1984-2002. Trend analysis of nutrient load indicated that only total soluble inorganic nitrogen showed a statistically significant increasing trend. Other constituents did not have significant trends. It should be noted that the Cabinet Gorge Station did have a statistically significant increasing trend for total soluble inorganic nitrogen, but a decreasing trend for total nitrogen concentration. Nutrient targets for apportioning loads to Pend Oreille Lake have been recommended for an agreement between the states of Montana and Idaho. Targets have been recommended for both total yearly phosphorus load and nitrogen:phosphorus ratio. The target for total phosphorus load was exceeded three times over the study period, including 1986, 1989 and 1999. The target for nitrogen:phosphorus ratio was not met four times over the sampling period, including 1989, 1996, 1998 and 2002.

Secchi disk measurements have been collected on Lake Pend Oreille periodically since 1952. Bayview, Hope and Granite Point are currently the only stations monitored. Generally speaking, maximum Secchi depths occurred in the 1950's, and minimum depths in the 1980's. Maximum Secchi depths typically occur in winter, with minimum depths in spring. The Bayview station has experienced the greatest transparency and Dover has shown the least transparency. No trends in Secchi disk measures were apparent, either at individual stations, or for all stations pooled. No temporal trends were observed at individual stations. This suggested that pelagic water quality and trophic condition remained unchanged in Lake Pend Oreille from the period from 1952-2002.

The Pend Oreille River station at Newport showed statistically significant decreasing trends for total phosphorus, soluble reactive phosphorus, total nitrogen, and total soluble inorganic nitrogen. However, the decreasing trend in total phosphorus and soluble reactive phosphorus was due to a reduction in analytical detection limits during the monitoring period, and does not reflect a true reduction in constituent concentrations. The Pend Oreille River station at Metaline Falls did not show any statistically significant trends.

This report provides an analysis of water quality and algae data collected from 1984-2002. The 2002 monitoring year represents the final year of the 5-year collection period for Tri-State Water Quality Council. Results of this analysis will help provide recommendations for modification and optimization of the existing monitoring network, and provide justification for the 2003-2007 collection period. A similar analysis of water quality and algae data is planned for 2007.