CLARK FORK – PEND OREILLE WATERSHED WATER QUALITY MONITORING PROGRAM

FINAL MONITORING REPORT 2010

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EXECUTIVE SUMMARY

This annual monitoring report summarizes water quality results collected by the Tri-State Water Quality Council's Monitoring Committee from monitoring stations located in the Clark Fork-Pend Oreille watershed in calendar year 2010. This report describes the spatial trends of field parameters and laboratory analytical results for nutrients, heavy metals, and periphyton reported concentrations and represents the completion of the second year of a five-year monitoring cycle. The five-year monitoring cycle culminates in 2013 with a comprehensive five-year trends analysis of water quality in the watershed.

The Tri-State Water Quality Council (Council) established seven priority water quality objectives for the Clark Fork – Pend Oreille watershed. Those objectives are to:

1. Evaluate time trends in nutrient concentrations in the mainstem Clark Fork River and selected tributaries;
2. Evaluate time trends for periphyton (algae) standing crops in the Clark Fork River;
3. Monitor summer nutrient and periphyton target levels in the Clark Fork River;
4. Estimate nutrient loading rates to Lake Pend Oreille from the Clark Fork River;
5. Evaluate time trends for periphyton densities in near-shore areas of Lake Pend Oreille;
6. Evaluate time trends for Secchi depth transparency in Lake Pend Oreille; and
7. Evaluate time trends for nutrient concentrations in the Pend Oreille River.

In completion of these objectives, the monitoring program consists of measuring field parameters and collecting samples at monitoring locations on the Clark Fork River and selected tributaries, Lake Pend Oreille, and the Pend Oreille River within the Clark Fork-Pend Oreille watershed of western Montana, northern Idaho, and northeastern Washington. The monitoring stations are divided among multiple organizations and agencies that form the Council's Monitoring Committee. In 2010 monitoring occurred at 13 monitoring stations on the Clark Fork River and selected tributaries, at 8 monitoring stations on Lake Pend Oreille, and at two monitoring stations on the Pend Oreille River. Monitored nutrient parameters include total phosphorus (TP), soluble reactive phosphorus (SRP), total persulfate nitrogen (TN), and total soluble inorganic nitrogen (TSIN), consisting of soluble ammonia nitrogen as N and soluble nitrate and nitrite as N. Monitored metals include total recoverable and dissolved copper and zinc and dissolved cadmium. Concentrations of attached algae (periphyton) in the Clark Fork River were monitored for chlorophyll-a and ash free dry weight (AFDW) concentrations. During the summer months, locations on the Clark Fork River were monitored for nutrients and attached algae for compliance with state of Montana nutrient standards and Voluntary Nutrient Reduction Program (VNRP) nutrient targets.

The Council's Monitoring Committee oversees water quality monitoring in the Clark Fork – Pend Oreille watershed through the collection efforts of the following six monitoring activities: 1) Clark Fork River monthly monitoring, 2) Clark Fork River peak flow monitoring, 3) Clark Fork River summer nutrient monitoring, 4) Clark Fork River periphyton monitoring, 5) Lake Pend Oreille monitoring, and 6) Pend Oreille River monthly monitoring.

Water quality results for each of the activities undergoes data quality control review by a designated organization. The results are further compiled, statistically evaluated, and summarized by HydroSolutions Inc (HydroSolutions), the Council's environmental consultant. Nutrient results collected during summer nutrient monitoring are compared with state of Montana nutrient standards and VNRP target concentrations specific for that reach. Metals results collected during Clark Fork River monthly monitoring and Clark Fork River peak flow monitoring are compared to Montana and Idaho state heavy metals standards.

There were a number of activities that occurred in 2010 with potential to affect the long-term water quality in the Clark Fork River. At the end of 2009 the final railcar of contaminated sediments was removed from the Milltown Dam Superfund site. Channel improvements and floodplain restoration continue at the Milltown Dam site and upstream in the Clark Fork River corridor. By the end of 2010, after five-years of being diverted through a bypass channel, the final dike was breached and Clark Fork River flowed into its new channel near its confluence with the Blackfoot River. Remediation and restoration activities continued in the Upper Clark Fork River Superfund site. Also at the beginning of 2010 Smurfit-Stone Container Corporation closed its linerboard plant in Frenchtown. The paper mill operated along the banks of the Clark Fork River for over 50 years and processed up to 25 million gallons of water a day during peak paper making production.

The Council's Clark Fork – Pend Oreille watershed 2010 water quality monitoring results are summarized below.

Total Nitrogen

In monthly monitoring, the highest median TN concentration was at station 28, Clark Fork River below Thompson Falls, at 132 micrograms per liter (µg/L). Median TN concentrations in the Clark Fork River decreased downstream at station 30, Clark Fork River below Cabinet Gorge Dam, to 119 µg/L. In the Pend Oreille River median TN concentrations were less, varying from 111 µg/L at station 50, Pend Oreille River at Newport to 101 µg/L at station 55, Pend Oreille River at Metaline Falls.

During peak flow monitoring at station 30, Clark Fork River below Cabinet Gorge Dam, the median TN concentration (156 µg/L) exceeded the median monthly concentration (119 µg/L) at that station. Higher concentrations during the peak flow period indicate that a larger percentage of the annual nutrient load to Lake Pend Oreille is delivered during a short period of time when flows and nutrient concentrations are higher.

During Clark Fork River summer nutrient monitoring, median TN concentrations exceeded the nutrient standard value of 300 µg/L at three stations. Station 2.5, Silver Bow Creek at Opportunity, had the highest median concentration at 1,634 µg/L. Station 9, Clark Fork River at Deer Lodge, with a median concentration of 316 µg/L, and station 10, Clark Fork River above Little Blackfoot, with a median concentration of 304 µg/L slightly exceeded the standard. Median summer TN concentrations generally decreased in the downstream direction with an exception of an increase at station 18, Clark Fork River below Missoula. Station 25, Clark Fork River above Flathead River, had the lowest median TN concentration at 155 µg/L.

Total Soluble Inorganic Nitrogen

Median monthly monitoring TSIN concentrations increased from a calculated value of 8.3 µg/L at station 27.5, Thompson River near mouth, and peaked at station 29, Clark Fork River at Noxon Bridge, with a calculated value of 43.5 µg/L. Median concentrations decreased in the Pend Oreille River at station 55, Pend Oreille River at Metaline Falls, to concentrations less than analytical reporting limits. Most of the soluble nitrate and nitrite as N and soluble ammonia nitrogen as N samples collected from the Pend Oreille River were reported as non-detect (less than the laboratory reporting limit of 10 µg/L reported by WDOE) and were statistically and spatially evaluated using a value of one half of the laboratory reporting limit reported by WDOE.

During peak flow monitoring at station 30, Clark Fork River below Cabinet Gorge Dam, the median TSIN concentration exceeded the median monthly concentration at that station.

During Clark Fork River summer nutrient monitoring, median TSIN concentrations exceeded the nutrient target concentration of 30 µg/L at four stations. Station 2.5, Silver Bow Creek at Opportunity, had the highest median concentration at 1,264 µg/L. Station 7, Clark Fork River below Warm Springs Creek (49 µg/L), station 9, Clark Fork River at Deer Lodge (61 µg/L), and station 18, Clark Fork River below Missoula (59 µg/L) all exceeded the target TSIN concentration.

Total Phosphorus

In monthly monitoring, median TP concentrations were generally consistent at all of the monthly monitoring stations. Median TP concentrations varied from a low of 7.0 µg/L at station 29, Clark Fork River at Noxon Bridge, to a high of 8.3 µg/L at station 55, Pend Oreille River at Metaline Falls.

During peak flow monitoring at station 30, Clark Fork River below Cabinet Gorge Dam, the median TP concentration (7.6 µg/L) was similar to the median monthly concentration (7.3 µg/L) at that station.

During Clark Fork River summer nutrient monitoring, median TP concentrations exceeded the nutrient standard in each of the five monitoring stations in the upper Clark Fork River and attained the standard below the Clark Fork River-Blackfoot River confluence. Generally median summer TP concentrations decreased in the downstream direction.

Soluble Reactive Phosphorus

In monthly monitoring, the highest median SRP concentration was at station 27.5, Thompson River near mouth, (5.2 µg/L). Median SRP concentrations decreased downstream to concentrations less than analytical reporting limits at station 55, Pend Oreille River at Metaline Falls.

During peak flow monitoring at station 30, Clark Fork River below Cabinet Gorge Dam, the median SRP concentration (3.1 µg/L) was slightly higher than the median monthly concentration (2.5 µg/L) at that station.

During Clark Fork River summer nutrient monitoring, median SRP concentrations exceeded the SRP target concentration of 6 µg/L at seven of nine stations. The highest median SRP concentration was at station 2.5, Silver Bow Creek at Opportunity, with a concentration of 146.0 µg/L. Median SRP concentrations decreased in the downstream direction. Other Clark Fork River stations that exceeded the SRP target concentration include 1) station 7, Clark Fork River below Warm Springs Creek, with a concentration of 44.5 µg/L; 2) station 9, Clark Fork River at Deer Lodge, with a concentration of 24.6 µg/L; 3) station 10, Clark Fork River above Little Blackfoot, with a concentration of 26.2 µg/L; 4) station 12 Clark Fork River at Bonita, with a concentration of 21.2 µg/L; 5) station 15.5 Clark Fork River above Missoula with a concentration of 6.8 µg/L; and 6) station 18, Clark Fork River below Missoula, with median SRP concentration of 7.5 µg/L.

Total Recoverable Copper

During Clark Fork River monthly monitoring, median total recoverable copper concentrations were 1 µg/L at each of the three Clark Fork River monthly metals monitoring stations: station 28, Clark Fork River below Thompson Falls, station 29, Clark Fork River at Noxon Bridge, and at station 30, Clark Fork River below Cabinet Gorge Dam. No sample results exceeded Montana acute and chronic metals toxicity standards.

During peak flow monitoring at station 30, Clark Fork River below Cabinet Gorge Dam, the median total recoverable copper concentration equaled the median monthly concentration at that station.

Total Recoverable Zinc

During Clark Fork River monthly and peak flow monitoring, median total recoverable zinc concentrations were at or below the laboratory reporting limit of 5 µg/L at each of the monitoring stations.

During peak flow monitoring at station 30, Clark Fork River below Cabinet Gorge Dam, the median total recoverable zinc concentration exceeded the median monthly concentration at that station.

Dissolved Metals

Dissolved cadmium, copper, and zinc samples were collected at station 30, Clark Fork River below Cabinet Gorge Dam, in 2010. Median dissolved cadmium and zinc concentrations were less than the laboratory reporting limits, and all of the dissolved cadmium and dissolved zinc sample results were less than the laboratory reporting limits. The median dissolved copper concentration was 2 µg/L.

During peak flow monitoring at station 30, Clark Fork River below Cabinet Gorge Dam, the median dissolved copper, zinc and cadmium concentrations were the same as the median monthly concentration.

Clark Fork River Periphyton

During Clark Fork River periphyton monitoring, chlorophyll-a concentrations were greater in September than in August at each station except at station 15.5, Clark Fork River above Missoula. This station had the highest measured algal concentration in August, but decreased nearly 50 milligrams per square meter (mg/m^2) in September. The greatest algal concentration increase was measured at station 9, Clark Fork River at Deer Lodge, where concentrations increased from 50 mg/m^2 in August to 156 mg/m^2 in September.

Spatially, chlorophyll-a concentrations were nearly constant (ranging from 89 to 103 mg/m^2) at the five upstream stations and decreased downstream at station 22, Clark Fork River at Huson (79 mg/m^2), and station 25, Clark Fork River above Flathead (38 mg/m^2). The lowest concentration for any one month and summer mean occurred furthest downstream at station 25, the Clark Fork River above Flathead.

The summer maximum chlorophyll-a standard of 150 mg/m^2 was attained at all stations in August and exceeded at only station 9, Clark Fork River at Deer Lodge, in September (156 mg/m^2). The summer mean chlorophyll-a standard of 100 mg/m^2 was exceeded at two of the seven monitoring stations in 2010: station 9 Clark Fork River at Deer Lodge, and station 18 Clark Fork River below Missoula, each with summer mean chlorophyll-a concentration of 103 mg/m^2. All other monitoring stations attained the summer mean standard. (Note that mean or average values are used when discussing periphyton results since the mean is most representative and is used for comparing benthic algal chlorophyll-a standard concentrations established by the Administrative Rules of Montana).

Lake Pend Oreille Field Parameters, Secchi Depth, and Nutrients

The Idaho Department of Environmental Quality (IDEQ) completed one Lake Pend Oreille water quality monitoring event in June 2010. Water quality monitoring was completed at six nearshore and two open water locations and included field parameters, Secchi depth measurements and nutrient sample collection.

Based on water temperature and dissolved oxygen measurements, lake stratification was observed at three monitoring locations including Bayview Nearshore, Bayview Open water, and Pend Oreille North.

Secchi depth measurements were collected at six monitoring locations. Data ranged from 3.25 meters at Pend Oreille North to 5.5 meters at Bayview Open water. Secchi Depth measurements could not be collected at Oden Bay and Sunnyside monitoring locations due to depth to bottom limitation (less than 3 meters).

The average June nutrient concentrations in the epilimnion were 7.9 µg/L TP and 86 µg/L TN. The average June nutrient concentrations in the hypolimnion were 5.6 µg/L TP and 134 µg/L

TN. The analytical detection limit for June 2010 Lake Pend Oreille TN results is 90 µg/L. The project required quanitation limit as specified in the Lake Pend Oreille water quality monitoring Quality Assurance Project Plan (TSWQC, 2009) is 100 µg/L. As presented by IDEQ, concentrations below analytical detection limits are evaluated using one half the project required quanitation limit (50 µg/L).

Due to lack of available funding the following 2010 IDEQ Lake Pend Oreille monitoring program components were not completed: 1) monitoring at one open water location (monitoring was completed at only two of three open water locations during the June monitoring event), 2) laboratory analysis of chlorophyll-a samples, 3) periphyton monitoring, and 4) monthly monitoring July through September.

As recommended in this report the Council will continue to work with IDEQ to secure adequate funding to complete regular annual water quality monitoring in Lake Pend Oreille. A water quality monitoring program that includes annual evaluation of in-lake TP concentrations is essential to determine if the goal of maintaining open lake water quality is being met (TSWQC, 2001). Monitoring will also provide means to detect long-term trends in trophic status of the lake, since it is critical to detect real trends early enough so that appropriate and effective actions can be taken to protect Lake Pend Oreille water quality (TSWQC, 2001).

Priority Water Quality Objectives

Two of the Council's seven priority water quality objectives for the Clark Fork—Pend Oreille watershed are assessed in this annual monitoring report. Results from 2010 Clark Fork River summer nutrient and periphyton monitoring in achieving target levels (priority water quality objective number three) are summarized below:

- Median TN concentrations exceeded the nutrient standard value of 300 µg/L at three of nine stations.
- Median TSIN concentrations exceeded the nutrient target concentration of 30 µg/L at four of nine stations.
- Median TP concentrations exceeded the nutrient standard of 20 µg/L in five of nine monitoring stations.
- Median SRP concentrations exceeded the SRP target concentration of 6 µg/L at seven of nine stations.
- The summer maximum chlorophyll-a standard of 150 mg/m^2 was not exceeded at any of the seven monitoring stations in August and exceeded at only one monitoring station in September. The summer mean chlorophyll-a standard of 100 mg/m^2 was exceeded at two of the seven monitoring stations in 2010.

Nutrient loading rates to Lake Pend Oreille from the Clark Fork River in 2010 were estimated for priority water quality objective number four. This objective serves to fulfill a portion of the Montana and Idaho Border Nutrient Load Agreement (Border Agreement) for Lake Pend Oreille Open Water. Key components in evaluating the nutrient loading to Lake Pend Oreille are the Clark Fork River monthly monitoring and Clark Fork River Peak Flow monitoring activities. Nutrient parameter results from station 30, Clark Fork River below Cabinet Gorge Dam, are used to estimate nutrient loading rates. Nutrient loading to Lake Pend Oreille from the Clark Fork River was calculated using the FLUX model applying nutrient concentration-flow regressions to daily flow values (Walker 1999).

Nutrient loading estimates to Lake Pend Oreille from the Clark Fork River in 2010 are provided below:

- Clark Fork River inflow 16,072 hm^3 or 13,029,731 acre-feet
- Total phosphorus loading 139,054 kilograms or 306,562 pounds
- Total nitrogen loading 2,234,235 kilograms or 4,925,645 pounds

The estimated TP load to Lake Pend Oreille from the Clark Fork River in 2010 is less than the Clark Fork River allocated target load of 259,500 kilograms per year. The area-weighted average in-lake TP concentration and the TN to TP ratio was not evaluated in 2010 due to the limited Lake Pend Oreille monitoring data available.

The remaining five priority water quality objectives will be assessed at the culmination of the current five-year monitoring cycle with a comprehensive five-year trends analysis of water quality in the watershed. The five-year trends analysis report is intended to provide in-depth assessment of long-term time trends in the data sets, and appraisal of nutrient loading to Lake Pend Oreille. The current monitoring cycle culminates in 2013.

Data Validation and Upload

Clark Fork-Pend Oreille water quality results discussed in this report have been reviewed for data quality. Data quality assurance for each monitoring activity in the watershed has been reviewed by the sponsoring or collecting organization. The data quality assurance review completed by HydroSolutions for Clark Fork River monthly monitoring, peak flow monitoring, and portions of Clark Fork River summer nutrient monitoring is detailed in this report. The data quality assurance review was completed using methods outlined in the latest Clark Fork River Watershed Monitoring Program QAPP and follows the Montana Department of Environmental Quality (MDEQ) Quality Assurance Quality Control (QA/QC) Checklist (TSWQC, 2010a). Data quality assurance included review of sample handling, field and analytical methodology, Data Quality Objectives, and data logic checks. The reader should refer to the final Montana Equis Water Quality Exchange database to review the complete 2010 Tri-State Water Quality Council Monitoring Program dataset including data qualifiers for this report. A condensed summary of the final 2010 Tri-State Water Quality Council Monitoring Program dataset submitted to the Montana Equis Water Quality Exchange database is included in this report as Appendix K.

Following data validation and acceptance by Montana DEQ and the Council's Monitoring Committee, the 2010 Clark Fork—Pend Oreille water quality data was submitted to the National Water Quality Exchange (WQX) Warehouse on May 3, 2010, with WQX Transaction ID: 8a85ba1c-7e6f-48db-a50f-59742a8479e0.

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1.0 INTRODUCTION

This document was completed for the Tri-State Water Quality Council (Council) by HydroSolutions Inc (HydroSolutions) to review water quality constituents in the Clark Fork-Pend Oreille watershed monitored by the Council for calendar year 2010. This annual report presents water quality results monitored at locations in the Clark Fork-Pend Oreille watershed. This report describes results of field parameters measured and laboratory analytical results of nutrients, heavy metals, and periphyton concentrations. Applicable results are compared with established nutrient standards and targets, algal standards, and heavy metal standards, and used to evaluate the overall water quality of the watershed in the year 2010. The document also describes the quality assurance quality control (QA/QC) procedures that were completed to review and validate the water quality results.

This report represents the completion of the second year of a five-year monitoring cycle. The five-year monitoring cycle culminates in 2013 with a comprehensive five-year trends analysis of water quality in the watershed. The five-year trends analysis report is intended to provide in-depth assessment of long-term time trends in the data sets, and appraisal of nutrient loading to Lake Pend Oreille.

1.1 BACKGROUND

1.1.1 HISTORY

The Council is a partnership of citizens, businesses, industry, tribes, government, and environmental groups, working together to improve and protect water quality throughout the Clark Fork-Pend Oreille watershed. In 1993, the states of Montana, Idaho, and Washington, in conjunction with the US Environmental Protection Agency (EPA) Regions 8 and 10, released the Clark Fork-Pend Oreille Watershed Management Plan (Watershed Management Plan), based on studies mandated by Congress under Section 525 of the Amendments to the 1987 Clean Water Act. The mandate was a direct result of the concerns of citizens regarding increased aquatic vegetation and attached algae in the Clark Fork River and Lake Pend Oreille. The main objectives of the study were to characterize water quality concerns, identify sources of, and recommend actions for maintaining and enhancing water quality throughout the watershed. The findings and recommendations were reported back to Congress and formed the basis for the Watershed Management Plan, adopted in 1993 and last updated in 2007.

The Clean Water Act is the primary federal law in the United States governing water pollution and established the objective of restoring and maintaining the chemical, physical, and biological integrity of the nation’s waters.

The formation of the Council was a direct result of the Watershed Management Plan. One of the first tasks of the Council was to create a Monitoring Committee that would oversee and implement a long-term, basin-wide monitoring strategy. The monitoring program was started in 1998 and continues today. The Watershed Management Plan focused efforts on controlling eutrophication and associated water use impairment problems that were identified as the most important interstate water quality problem. The goal of the Watershed Management Plan is to restore and protect designated beneficial water uses. The Watershed Management Plan further identified water quality objectives and emerging new water quality challenges.

The Council's Monitoring Committee oversees the collection of basin-wide monitoring data intended to support sound, scientifically-based water management decisions. The monitoring program employs a statistically-based sampling design of historic watershed-specific nutrient and periphyton data. The current sampling protocol has been designed to be cost-effective and scientifically defensible.

The 2009-2013 monitoring program represents the third continuous five-year monitoring cycle managed by the Council. The previous five-year monitoring programs, conducted from 1998-2002 and 2003-2007, provided the basis for a statistical analysis of water quality time trends reflected in the Council's and the state agencies' data (Tri-State Water Quality Council {TSWQC}, 2009). Monitoring was also conducted in 2008, but results were not summarized in a final report. The 2008 data will be included in a trends analysis reports. Supporters of the Council's Monitoring Program include the City of Missoula, City of Sandpoint, Missoula Water Quality District, University of Montana (UM), Montana Department of Environmental Quality (MDEQ), Idaho Department of Environmental Quality (IDEQ), Washington Department of Ecology (WDOE), Avista Corporation (Avista), U.S. Forest Service (USFS) Region 1, Stimson Lumber, and Plum Creek Timber Company.

1.1.2 MONITORING PROGRAM GOALS AND OBJECTIVES

The Council has established four primary water quality management goals and seven associated water quality monitoring program objectives for the Clark Fork-Pend Oreille watershed, which conforms to specific watershed management goals identified in the Watershed Management Plan (EPA 1993; 2007). The monitoring objectives for the Clark Fork River, Lake Pend Oreille, and the Pend Oreille River are achieved under separate project-specific sampling programs and associated quality assurance project plans (QAPPs). These sampling programs are managed inclusively by the Council. Each of the separate project-specific sampling programs and monitoring activities are discussed in the next section.

MANAGEMENT GOALS

The following management goals are identified by the Council:

- Control nuisance algae in the Clark Fork River by reducing nutrient concentrations
- Protect Lake Pend Oreille water quality by maintaining or reducing current rates of nutrient loading from the Clark Fork River
- Reduce near-shore eutrophication in Lake Pend Oreille by reducing nutrient loading from local sources
- Improve Pend Oreille River water quality through macrophyte management and tributary non-point source controls

MONITORING OBJECTIVES

The Council established seven priority water quality objectives for the Clark Fork – Pend Oreille watershed. These objectives are to:

1) Evaluate time trends in nutrient concentrations in the mainstem Clark Fork River and selected tributaries;
2) Evaluate time trends for periphyton (algae) standing crops in the Clark Fork River;
3) Monitor summer nutrient and periphyton target levels in the Clark Fork River;
4) Estimate nutrient loading rates to Lake Pend Oreille from the Clark Fork River;
5) Evaluate time trends for periphyton densities in near-shore areas of Lake Pend Oreille;
6) Evaluate time trends for Secchi depth transparency in Lake Pend Oreille; and
7) Evaluate time trends for nutrient concentrations in the Pend Oreille River.

CLARK FORK RIVER NUTRIENT STANDARDS AND TARGET CONCENTRATIONS

The Council worked to develop target nutrient concentrations for the Clark Fork River watershed through the Watershed Management Plan and creation of the Voluntary Nutrient Reduction Program (VNRP). The state of Montana in 2002 subsequently adopted the VNRP targets as nutrient standards for total phosphorus as P, total nitrogen as N, and mean and maximum benthic algal chlorophyll-a concentrations in the Administrative Rules of Montana (ARM) 17.30.631. The standards are applicable in the mainstem Clark Fork River below Warm Springs Creek to the confluence with the Flathead River during the summertime months from June 21 to September 21. Nutrient target concentrations for soluble constituents (total soluble inorganic nitrogen and soluble reactive phosphorus) established by the VNRP are used as target concentrations by the Council. The Clark Fork River mainstem nutrient standards and target concentrations are summarized in Table 1-1:

Table 1-1. Clark Fork River Nutrient Standards and Nutrient Targets

<table>
<tr><th>River Reach</th><th>Nutrient Parameter</th><th>Concentration</th></tr>
<tr><td rowspan="2">Clark Fork River: Warm Springs Creek to Blackfoot River</td><td>Total Phosphorus as P (Standard) [1]</td><td>20 μg/L</td></tr>
<tr><td>Total Nitrogen as N (Standard) [1]</td><td>300 μg/L</td></tr>
<tr><td rowspan="2">Clark Fork River: Blackfoot River to Flathead River</td><td>Total Phosphorus as P (Standard) [1]</td><td>39 μg/L</td></tr>
<tr><td>Total Nitrogen as N (Standard) [1]</td><td>300 μg/L</td></tr>
<tr><td rowspan="4">Clark Fork River: Warm Springs Creek to Flathead River</td><td>Benthic algal chlorophyll-a (Summer Mean Standard) [1]</td><td>100 mg/m^2</td></tr>
<tr><td>Benthic algal chlorophyll-a (Summer Maximum Standard) [1]</td><td>150 mg/m^2</td></tr>
<tr><td>Total Soluble Inorganic Nitrogen (Target) [2]</td><td>30 μg/L</td></tr>
<tr><td>Soluble Reactive Phosphorus (Target) [2]</td><td>6 μg/L</td></tr>
</table>

Notes:
1. Standards established by Administrative Rules of Montana (ARM) 17.30.631, applicable June 21 to September 21
2. Target concentrations established by the Clark Fork River Voluntary Nutrient Reduction Program (VNRP)
μg/L-microgram per liter; mg/m^2-milligram per square meter

MONTANA AND IDAHO BORDER NUTRIENT LOAD AGREEMENT

The Montana and Idaho Border Nutrient Load Memorandum of Agreement (Border Agreement) was established In 2002, based on the Council's recommended nutrient targets and apportioning nutrient loads to Lake Pend Oreille. Nutrient targets established in the Border Agreement were developed to maintain water quality in the open waters of Lake Pend Oreille from the mouth of the Clark Fork River to the Long Bridge (Highway 95). In the Border Agreement open water is defined as water where the maximum depth is greater than 2.5 times water transparency as measured by Secchi depth. Nutrient targets are outlined in section VII of the Border Agreement as follows (TSWQC, 2001):

- An area-weighted euphotic-zone average concentration of 7.3 µg/L total phosphorus for Lake Pend Oreille
- Total loading to Lake Pend Oreille of 328,651 kilograms per year (kg/year) total phosphorus
- 259,500 kg/year total phosphorus from Montana (as measured at Clark Fork River below Cabinet Gorge Dam),
- 69,151 kg/year total phosphorus from Lake Pend Oreille watershed in Idaho.
- Greater than 15:1 total nitrogen to total phosphorus ratio

The Border Agreement establishes short-term and long-term exceedances of the established nutrient targets. As stated in the Border Agreement an exceedance of the target exists when either of the following conditions are documented:

(a) A short-term exceedance of the targets (three consecutive years of total phosphorus load increases at the border that are above the targets by greater than 10%); or

(b) A long-term exceedance of the targets (a ten year average total phosphorus concentration in the lake greater than 7.3 µg/L).

In support of the Border Agreement and in achieving the Council's priority water quality objective number four, estimates of annual nutrient loads from the Clark Fork River are provided in this monitoring report. The annual total phosphorus load estimated from the Clark Fork River below Cabinet Gorge Dam is evaluated against the Border Agreement's nutrient load target apportioned to the Clark Fork River. Estimates of thenutrient loads are provided in Section 2.8 of this report.

1.2 MONITORING PROGRAM ACTIVITIES IN 2010

In accomplishing the Council's goals and objectives, the Council's Monitoring Committee manages basin-wide water quality monitoring and reporting through the cooperation of a network of agencies and organizations. The following list summarizes water quality monitoring activities throughout the watershed completed in calendar year 2010:

1) Monthly collection of nutrient and heavy metals samples and field measurements at three lower Clark Fork River sites, and monthly collection of nutrient samples and field measurements in Thompson River near mouth completed January through December by HydroSolutions;
2) Collection of nutrient and heavy metals samples at the Clark Fork River below Cabinet Gorge Dam during spring peak flow conditions completed in six sampling events over about a one-month period, May to June, by Avista;
3) Collection of summer nutrient samples and field measurements at nine Clark Fork River and tributary stations completed during ten sampling events, June through September, by the Missoula Wastewater Treatment Plant;
4) Collection of summer periphyton standing crop samples at seven Clark Fork River stations, completed twice: once in August and once in September by University of Montana Watershed Health Clinic research personnel;
5) Collection of nutrient samples, field measurements and Secchi depth readings at six nearshore and two open water locations on Lake Pend Oreille completed once in June, by IDEQ and;
6) Monthly collection of nutrients and field constituents at two Pend Oreille River stations completed January through December by WDOE.

Portions of the Lake Pend Oreille monitoring were not completed by IDEQ in 2010 due to lack of available funding. Maps of the Clark Fork-Pend Oreille watershed and locations of all monitoring stations are provided in Appendix A. The 2010 monitoring program is summarized in Table A-1 in Appendix A. The summary chart provides an overview of each of the monitoring program activities including monitoring locations, specific nutrient and metal constituents and field parameters collected, sampling frequency and dates of collection, the identification of the sampler, and the analytical laboratory used.

The Council's water quality monitoring program activities are conducted under quality assurance project plans (QAPPs). The QAPPs provide a consistent and acceptable approach to data collection and management that facilitates achievement of program objectives, provides the framework for conducting the activity, and provides the guidelines for reviewing analytical results to assure quality data. A sampling and analysis plan (SAP) is developed for each activity to provide the structure and protocol of the activity, defining what, where, when, and the protocols for accomplishing the monitoring event. A QAPP for the Clark Fork River watershed was revised in 2009 and is currently being finalized (TSWQC, 2010a). A separate SAP is provided for Clark Fork River peak flow monitoring, while each of the SAPs for the other activities are incorporated into their respective QAPP. The Council's Monitoring Committee, which oversees all of the monitoring program activities, reviews the QAPPs and SAPs to ensure consistency and unbiased quality data for the program. Table 1-2 summarizes monitoring activities, a contact responsible for that activity, and the QAPP and SAP that the 2010 monitoring activity was completed under.

Table 1-2. Tri-State Water Quality Council Monitoring Program Activities

Monitoring Activity	Contact	QAPP	SAP
CFR Monthly Monitoring	HydroSolutions Inc, Luke Osborne	TSWQC, 2010a	TSWQC, 2010a
CFR Peak Flow Monitoring	Avista, Joe DosSantos	TSWQC, 2010a	TSWQC, 2010b
CFR Summer Nutrient Monitoring	Missoula WWTP, Sherri Kenyon	TSWQC, 2010a	TSWQC, 2010a
CFR Periphyton Monitoring	University of Montana, Vicki Watson	TSWQC, 2010a	TSWQC, 2010a
Lake Pend Oreille Monitoring	Idaho DEQ, Robert Steed	TSWQC, 2006, 2009	TSWQC, 2006
Pend Oreille River Monthly Monitoring	WDOE, Jean Parodi	WDOE, 2003	WDOE, 2003

Notes:

CFR Clark Fork River
DEQ Department of Environmental Quality
TSWQC Tri-State Water Quality Council
WDOE Washington Department of Ecology
QAPP Quality Assurance Project Plan
SAP Sampling and Analysis Plan
WWTP Wastewater Treatment Plant

WATERSHED WATER QUALITY ACTION AND NEWS

There were a number of activities that occurred in 2010 with potential to affect the long-term water quality in the Clark Fork River. At the end of 2009 the final railcar of contaminated sediments was removed from the Milltown Dam Superfund site. Channel improvements and floodplain restoration continue at the Milltown Dam site and upstream in the Clark Fork River corridor. By the end of 2010, after five-years of being diverted through a bypass channel, the final dike was breached and the Clark Fork River flowed into its new channel near its confluence with the Blackfoot River. Remediation and restoration activities continued in the Upper Clark Fork River Superfund site. Also at the beginning of 2010, Smurfit-Stone Container Corporation closed its linerboard plant in Frenchtown. The paper mill operated along the banks of the Clark Fork River for over 50 years and processed up to 25 million gallons of water a day during peak paper making production.

1.3 MONITORING LOCATIONS

Monitoring in 2010 occurred at 13 monitoring stations on the Clark Fork River and selected tributaries, at 8 monitoring stations on Lake Pend Oreille, and at 2 monitoring stations on the Pend Oreille River within the Clark Fork-Pend Oreille watershed of western Montana, northern Idaho, and northeastern Washington. Maps showing all monitoring stations are included in Appendix A. The locations selected for water quality monitoring provide distributed spatial coverage for evaluating the effects of point and non-point pollution sources and the influences of major population centers and tributary inflows. This design provides for a cost effective and scientifically-based assessment of nutrient and metals inputs and effects throughout the watershed. A summary of monitoring locations, the sampling organization, and associated sampling frequencies for the Council’s typical monitoring program are provided in Table 1-3.

Table 1-3. Monitoring Locations, Sampling Organization, and Sampling Frequency

Station	Name	Sampling Organization	Sampling Frequency
2.5	Silver Bow Creek at Opportunity	M-WWTP	S10
07	Clark Fork below Warm Springs Creek	M-WWTP	S10
09	Clark Fork at Deer Lodge	UM-WHC, M-WWTP	P10, S10
10	Clark Fork above Little Blackfoot River	UM-WHC, M-WWTP	P10, S10
12	Clark Fork at Bonita	UM-WHC, M-WWTP	P10, S10
15.5	Clark Fork above Missoula	UM-WHC, M-WWTP	P10, S10
18	Clark Fork below Missoula (Shuffields)	UM-WHC, M-WWTP	P10, S10
22	Clark Fork at Huson	UM-WHC, M-WWTP	P10, S10
25	Clark Fork above Flathead	UM-WHC, M-WWTP	P10, S10
27.5*	Thompson River near mouth	HydroSolutions Inc	N12
28**	Clark Fork below Thompson Falls	HydroSolutions Inc	NM12
29**	Clark Fork at Noxon Bridge	HydroSolutions Inc	NM12
30**	Clark Fork below Cabinet Gorge Dam	HydroSolutions Inc, Avista	NM18
50	Pend Oreille River at Newport, WA	WDOE	N12
55	Pend Oreille River at Metaline Falls, WA	WDOE	N12
	Lake Pend Oreille: Lakeview	IDEQ	P10, SD
	Lake Pend Oreille: Talache	IDEQ	P10, SD
	Lake Pend Oreille: Garfield Bay	IDEQ	P10, SD
	Lake Pend Oreille: Bayview nearshore	IDEQ	P10, SD
	Lake Pend Oreille: Oden Bay	IDEQ	P10, SD
	Lake Pend Oreille: Sunnyside	IDEQ	P10, SD
	Lake Pend Oreille: Trestle	IDEQ	P10
	Lake Pend Oreille: Springy Point	IDEQ	P10
	Lake Pend Oreille: Kootenai	IDEQ	P10
	Lake Pend Oreille: Bayview open water	IDEQ	SD
	Lake Pend Oreille: Hope open water	IDEQ	SD
	Lake Pend Oreille: Granite open water	IDEQ	SD
	Lake Pend Oreille: Midlake	IDEQ	SD
	Lake Pend Oreille: PDO north	IDEQ	SD

Notes:

M-WWTP	Missoula Waste Water Treatment Plant
UM-WHC	University of Montana Watershed Health Clinic
Avista	Avista Corporation
WDOE	Washington Department of Ecology
IDEQ	Idaho Department of Environmental Quality
N12	Nutrient and field constituents, 12 monthly samples
NM12	Nutrient, metal and field constituents, 12 monthly samples
NM18	Nutrient, metal and field constituents, 12 monthly samples and 6 peak flow samples
P10	Periphyton collected in August and September at Clark Fork stations, September for Lake Pend Oreille stations
S10	Summer nutrient and field constituents, 10 samples during 3 months in summer
SD	Secchi depth, nutrient samples and field constituents collected monthly June to September
Clark Fork	Clark Fork River
*	Site sponsored by Plum Creek
**	Sites sponsored by Avista Corporation

1.4 MONITORING SCHEDULE

The schedule of monitoring program activities accomplished for 2010 are summarized below in Table 1-4 and are also provided in the monitoring program summary chart in Appendix A.

Table 1-4. Tri-State Water Quality Council 2010 Monitoring Schedule

Monitoring Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. CFR Monthly Monitoring	■	■	■	■	■	■	■	■	■	■	■	■
2. CFR Peak Flow Monitoring					■	■						
3. CFR Summer Nutrients Monitoring						■	■	■	■			
4. CFR Periphyton Monitoring								■	■			
5. LPO Monitoring						■						
6. LPO Periphyton Monitoring												
7. POR Monthly Monitoring	■	■	■	■	■	■	■	■	■	■	■	■

Note:
CFR Clark Fork River
LPO Lake Pend Oreille
POR Pend Oreille River

1.5 MONITORING CONSTITUENTS

The 2010 monitoring program consists of the collection of the following nutrient and metal constituents, field parameters, and periphyton measurements. Monitored constituents differ between monitoring activities and individual monitoring stations. The monitoring program summary chart in Appendix A defines the specific constituents monitored for in each activity. Primary and alternate names are provided for monitored nutrient constituents due to differences in laboratory reporting and Montana Equis Water Quality Exchange (MT-eWQX) database submittal requirements.

NUTRIENT CONSTITUENTS

- Total phosphorus (TP), or phosphate-phosphorus as P
- Soluble reactive phosphorus (SRP), or Orthophosphate as P
- Total (persulfate) nitrogen (TN), or nutrient nitrogen
- Soluble nitrate and nitrite as N (NO_2+NO_3 as N), or inorganic nitrogen as N
- Soluble ammonia nitrogen as N (NH_3+NH_4 as N), total ammonia nitrogen as N

METAL CONSTITUENTS

- Total recoverable copper (Cu)
- Total recoverable zinc (Zn)
- Hardness
- Dissolved cadmium (diss Cd)
- Dissolved copper (diss Cu)
- Dissolved zinc (diss Zn)

FIELD PARAMETERS

- water temperature in degrees Celsius (˚C)
- dissolved oxygen (DO) in milligrams per liter (mg/L)
- pH (standard units)
- oxidation reduction (ORP) potential in millivolts (mV)
- specific conductance (SC) in microSiemens per centimeter (µS/cm)
- total dissolved solids (TDS) in mg/L
- turbidity in Nephelometric Turbidity Units (NTU)
- Secchi depth measurements in meters (m)

Instantaneous stream flow in cubic feet per second (cfs) and river stage (ft) were also recorded, where available, at established stream gage stations.

PERIPHYTON

Periphyton samples were analyzed for chlorophyll-a in milligrams per square meter (mg/m^2) and ash-free dry weight (AFDW) in grams per square meter (g/m^2).

1.6 SAMPLING AND ANALYTICAL METHODS

Specific methods of sample collection, preservation, and handling, followed by each of the Council's monitoring program activities can be found in their respective SAPs or QAPPs. References for these plans can be found in Table 1-2. Field measurements for Clark Fork River monthly monitoring were collected with YSI-556 Multi-Probe System and HACH 2100P Turbidimeter. The instruments were calibrated each month prior to data collection or as recommended by the manufacturer.

All nutrient and metals analyses were performed by state-certified laboratories using standard analytical methods. Details regarding these methods are described in *Standard Methods for the Examination of Water and Wastewater, 20th Ed* (APHA, 1999) and various EPA documents. Further information regarding analytical methods may be found in the various laboratories' quality assurance plans which are part of respective monitoring activity QAPPs. The analytical methods, laboratory lower reporting limits, project required quantitation limits (established in the QAPP), and the laboratory used in the Clark Fork River monitoring activities are summarized in Table 1-5. For the Clark Fork River monthly monitoring, peak flow monitoring, and summer nutrient monitoring activities, the City of Missoula Wastewater Treatment Plant Laboratory (Missoula Laboratory) and the Montana Department of Public Health and Human Services

Laboratory (State Laboratory) performed the nutrients and metals analysis. For Clark Fork River periphyton monitoring, the University of Montana Watershed Health Clinic performed chlorophyll-a and AFDW analysis.

Table 1-5. Summary of Analytical Methods, Reporting Limits, and Laboratories for Clark Fork River Monitoring Activities

Analyte	Method	Laboratory Lower Reporting Limit	Project Required Quantitation Limit	Laboratory
Total Phosphorus (TP)	EPA 365.3	4 µg/L	10 µg/L	M-WWTP
Soluble Nitrate and Nitrite as N (NO_2+NO_3 as N)	EPA 353.2	2 µg/L	30 µg/L	M-WWTP
Soluble Ammonia Nitrogen as N (NH_3+NH_4 as N)	EPA 350.1	10 µg/L	30 µg/L	M-WWTP
Soluble Reactive Phosphorus (SRP)	EPA 365.3	2 µg/L	5 µg/L	M-WWTP
Total (Persulfate) Nitrogen (TN)	SM 4500-N B or C	10 µg/L	50 µg/L	*
Copper, total recoverable	EPA 200.7	1 µg/L	1 µg/L	MT-DPHHS
Zinc, total recoverable	EPA 200.7	5 µg/L	10 µg/L	MT-DPHHS
Dissolved Copper	EPA 200.8	1 µg/L	1 µg/L	MT-DPHHS
Dissolved Zinc	EPA 200._8	5 µg/L	10 µg/L	MT-DPHHS
Dissolved Cadmium**	EPA 200.8	1 µg/L	1 µg/L	MT-DPHHS
Chlorophyll-a	(UM-WHC, 2009)	4 mg/m^2	Not established	UM-WHC
Ash Free Dry Weight (AFDW)	(UM-WHC, 2009)	0.4 g/m^2	Not established	UM-WHC

Notes:

µg/L micrograms per liter
mg/m^2 ,g/m^2 milligrams per square meter and grams per square meter
M-WWTP Missoula Waste Water Treatment Plant Laboratory (Missoula Laboratory)
MT-DPHHS Montana Department of Public Health and Human Services (State Laboratory)
UM-WHC University of Montana Watershed Health Clinic
*TN analyzed at the State Laboratory in January and at the Missoula Laboratory the rest of the year;
**Beginning August 2010 dissolved Cadmium samples analyzed at laboratory detection limit of 0.08 µg/L

The project required quantitation limits for Clark Fork River monitoring activities shown in Table 1-5 are established in the QAPP (TSWQC, 2010a) for each analyte. The laboratory lower reporting limits shown in Table 1-5 are established by the laboratories for each analyte as the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. Method detection limits (MDLs) are calculated by the laboratories and are a value less than the lower reporting limit. MDLs were not consistently provided by the laboratories and were only reported by the Missoula Laboratory. A result greater than the MDL but less than the lower reporting limit indicates the presence of the analyte was detected, but could not be accurately quantified; therefore, it is an estimated value. The terms project required quantitation limit, laboratory lower reporting limit (laboratory reporting limit), and MDL are used throughout this report and in supporting appendices consistent with the QAPP, as appropriate.

1.7 STATISTICAL METHODS

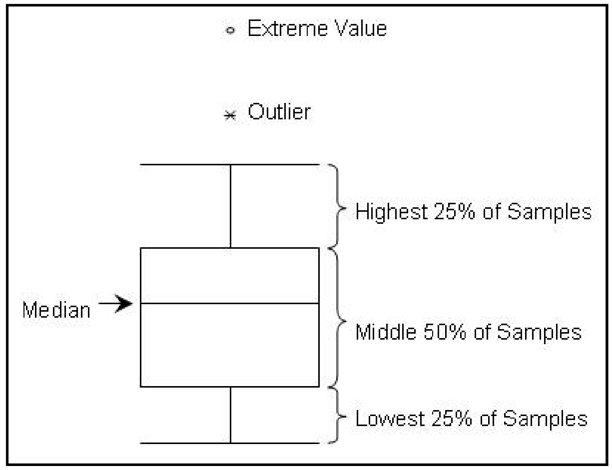


Figure 1-1. Box and Whisker Plot Construction Diagram.

Box and whisker plots and summary statistics were prepared to evaluate 2010 water quality results in the Clark Fork – Pend Oreille watershed. In descriptive statistics, box and whisker plots visually compare water quality constituents from different monitoring stations. These plots are used to provide a spatial comparison of the data as the stations are lined up (left to right) upstream to downstream on the plot. The shapes of the box and whisker plots are based on the median, interquartile, and extreme values of the data, as shown in Figure 1-1. The box portion of the plot encloses the interquartile range which contains the middle 50 percent of the values. The median value is displayed as the thick centerline within the box. The top and bottom whiskers display the maximum and minimum observed values, excluding outliers or extreme values. Outliers, defined as values that are 1.5 to 3 times greater or less than the values in the interquartile range, are displayed with an asterisk (*). Extreme values are those values greater or less than 3 times the values in the interquartile range, and are displayed with a circle (o). The plots were made using Peltier Technical Services, Inc. Box and Whisker Chart Utility program that is an add-on in Microsoft Excel. Quartiles were computed using the “Minitab” method, since this method provided the best quartile distribution for the data sets. Minitab and other methods for computing quartile options are described in Langford (2006). For the purpose of box and whisker plot construction, water quality results that were less than reporting limits, or non-detect, are assumed to be one half the lower laboratory reporting limit. Box and whisker plots were prepared for each of the monthly and summer monitoring program activities.

Summary statistics including mean value, median value, minimum value, maximum value, standard deviation, and number of samples are summarized by monitoring station and are presented in various appendices described later. Summary statistics were computed using Microsoft Excel. For the purpose of preparing the summary statistics tables, water quality results that were non-detect are assumed to be one half of the lower laboratory reporting limit. Mean and standard deviation were not calculated for pH values since pH is on a logarithmic scale. Laboratory reports from the State, Missoula, and University of Montana Watershed Health Clinic Laboratories, and summarized data from Washington Department of Ecology, are provided in Appendix F. The reader should refer to the final 2010 Tri-State Water Quality Council Monitoring Program Clark Fork—Pend Oreille water quality dataset that was submitted to the National Water Quality Exchange Warehouse to review the complete dataset and associated data qualifiers. A condensed version of the 2010 data submittal is included as Appendix K for the reader to review all data results and any applicable data qualifiers.

Note that within this report, median values are primarily used to compare values of the same analyte since they are the most representative of multiple data collected over the different monitoring periods. In the case of periphyton monitoring and chlorophyll-a result reporting, the mean or average value is the most representative and appropriate value to compare. Due to the collection method, the mean chlorophyll-a value is the value that best characterizes the overall chlorophyll-a concentration at the monitoring station (V. Watson, personal communication 18 January 2010). Also as presented in Table 1-1, the state of Montana has adopted a standard for the summer mean chlorophyll-a concentration for portions of the Clark Fork River. For these reasons the mean chlorophyll-a and AFDW concentration values are discussed in this report.

2.0 WATER QUALITY REVIEW

This section reviews the Council's monitoring program water quality data collected in the Clark Fork-Pend Oreille watershed during 2010. Data was reviewed and statistically analyzed for each of the monitoring program activities. Presented in this section are:

- Review of Clark Fork River and Pend Oreille River monthly monitoring activities at six stations including statistics and spatial comparison of water quality data for field and nutrient constituents;
- Review of Clark Fork River monthly and peak flow monitoring results at three stations of heavy metals constituents including review of water quality statistics, spatial comparison, and comparison of results to acute and chronic metals toxicity standards for Montana and Idaho;
- Review of Clark Fork River summer nutrient monitoring activities at nine stations including statistics and spatial comparison of water quality results, and comparison of results to Montana water quality nutrient standards and VNRP target concentrations;
- Review of Clark Fork River below Cabinet Gorge Dam peak flow monitoring results including review of water quality summary statistics and comparison of results to monthly water quality data;
- Review of Clark Fork River periphyton monitoring results at seven stations including statistics, temporal, and spatial comparisons and review of algal standards attainment.
- Review of Lake Pend Oreille nutrient and field parameters collected at eight lake monitoring stations in June.

2.1 FIELD CONSTITUENTS SPATIAL COMPARISON

Field constituents were recorded monthly at six monitoring stations in the Washington and Montana portions of the Clark Fork-Pend Oreille watershed. The monitoring stations include those identified in Table 1-3 with a sampling frequency of "N12, NM12, and NM18." Measured constituents include stream temperature (°C), pH (standard units), SC (µS/cm), DO (mg/L), and turbidity (NTU). ORP (mV) and TDS (mg/L) were also recorded, but only at the four stations in the lower Clark Fork River. Box and whisker plots presenting spatial patterns of 2010 field constituent data are provided in Appendix B, and summary statistics of water quality results are provided in Appendix C.

2.1.1 TEMPERATURE

Median instream temperature at the Clark Fork River monitoring stations varied from 6.7 °C at station 27.5, Thompson River near mouth, to 9.7 °C at station 28 and station 30, Clark Fork River below Thompson Falls and Clark Fork River below Cabinet Gorge Dam, respectively. Median instream temperature in the Pend Oreille River varied from 10.9 °C at station 50, Pend Oreille River at Newport to 12.1 °C at station 55.5, Pend Oreille River at Metaline Falls. Station 55, Pend Oreille River at Metaline Falls had the highest individual temperature reading in the watershed at 22.9 °C, which occurred in August. Differences between stations may partially be due to diurnal differences and the time of day sampling occurred.

2.1.2 pH

Median pH values at the four monthly Clark Fork River monitoring stations varied from 7.7 at station 27.5, Thompson River near mouth and at station 29, Clark Fork River at Noxon Bridge to 8.0 at station 28, Clark Fork River below Thompson Falls. Median pH values were slightly higher in the Pend Oreille River varying from 8.4 at station 50, Pend Oreille River at Newport, to 8.3 at station 55, Pend Oreille River at Metaline Falls. Differences in pH at each station may be due to diurnal and seasonal variations, flow rate, temperature, and other factors.

2.1.3 SPECIFIC CONDUCTIVITY

Median SC was lowest at station 27.5, Thompson River near mouth, at 151 µS/cm and highest at station 28, Clark Fork River below Thompson Falls, at 200 µS/cm. Median SC values at station 29, Clark Fork River at the Noxon Bridge, and at station 30, Clark Fork River below Cabinet Gorge Dam were similar at 196.5 and 194.5 µS/cm respectively. Downstream in the Pend Oreille River SC values were less. At station 50, Pend Oreille River at Newport and at station 55, Pend Oreille River at Metaline Falls, SC values were similar ranging from 164 µS/cm to 166 µS/cm, respectively. Differences in measured SC may be affected by seasonal variations, flow rate, and other factors.

2.1.4 DISSOLVED OXYGEN

Median DO concentrations were similar at all monthly monitoring stations. The highest median concentration was as at station 27.5, Thompson River near mouth, at 11.8 mg/L, and lowest was at station 29, Clark Fork River at Noxon Bridge at 10.0 mg/L. This station also had the lowest individual DO concentration at 5.7 mg/L occurring in October. Median DO concentrations in the Pend Oreille River varied from 10.5 to 10.9 mg/L at the two monthly monitoring stations. Differences in measured DO concentrations may also be affected by diurnal and seasonal variations, flow rate, temperature, and other factors.

2.1.5 TURBIDITY

Median turbidity values were low at all stations in the watershed. Median turbidity values varied from 0.9 NTU at station 27.5, Thompson River near mouth and at station 29, Clark Fork River at Noxon Bridge, to 1.7 NTU at station 28, Clark Fork River below Thompson Falls. Pend Oreille River stations were also similar ranging from 1.5 NTU at station 50, Pend Oreille River at Newport to 1.3 NTU at station 55, Pend Oreille River at Metaline Falls. Differences in measured turbidity may be affected by seasonal variations, flow rate, and other factors.

2.1.6 OXIDATION REDUCTION POTENTIAL

Median ORP measurements at the four monthly stations in the Clark Fork River were all near zero ranging from -11.3 mV at station 28 Clark Fork River below Thompson Falls to 8.7 mV at station 30, Clark Fork River below Cabinet Gorge Dam. ORP was not measured in the Pend Oreille River. Differences in measured ORP may also be affected by diurnal and seasonal variations, flow rate, temperature, and other factors.

2.1.7 TOTAL DISSOLVED SOLIDS

The TDS concentration was measured at the four monthly stations in the Clark Fork River. The lowest median concentration was at station 27.5, Thompson River near mouth, at 98.5 mg/L, while the other three Clark Fork River stations were nearly equal and varied from 130.0 mg/L at station 28 Clark Fork River below Thompson Falls, to 126.5 mg/L at station 30, Clark Fork River below the Cabinet Gorge Dam. TDS is an indirect measurement, calculated from SC field readings, using a conversion factor of 0.6 times the SC. Differences in measured TDS would be affected by the same variables as SC. TDS was not evaluated in the Pend Oreille River.

2.2 NUTRIENT CONSTITUENTS SPATIAL COMPARISON

Nutrient samples were collected monthly at six monitoring stations in the Clark Fork-Pend Oreille watershed. The monitoring stations include those identified in Table 1-3 with a sampling frequency of “N12, NM12, and NM18.” Nutrient samples were collected at each monitoring station and analyzed for constituents outlined in section 1.5 and more specifically in the monitoring program summary chart in Appendix A. Box and whisker plots presenting spatial patterns of 2010 monthly monitoring nutrient concentrations are provided in Appendix B, and summary statistics of the water quality data are provided in Appendix C.

2.2.1 TOTAL NITROGEN

The lowest median TN concentration in the watershed was at station 27.5, Thompson River near mouth, with a concentration of 87.8 µg/L. The highest median TN concentration was at station 28, Clark Fork River below Thompson Falls, at 132 micrograms per liter (µg/L). Median TN concentrations in the Clark Fork River decreased downstream at station 30, Clark Fork River below Cabinet Gorge Dam, to 119 µg/L. In the Pend Oreille River median TN concentrations were less, varying from 111 µg/L at station 50, Pend Oreille River at Newport to 101 µg/L at station 55, Pend Oreille River at Metaline Falls.

2.2.2 TOTAL SOLUBLE INORGANIC NITROGEN

Total soluble inorganic nitrogen (TSIN) is a calculated nutrient constituent and is equal to the sum of the concentration of soluble nitrate and nitrite as N (NO_2+NO_3 as N) and soluble ammonia nitrogen as N (NH_3+NH_4 as N), or:

$$\boldsymbol{TSIN = NO_2+NO_3 \text{ as } N + NH_3+NH_4^+ \text{ as } N}$$

Median 2010 TSIN concentrations increased from a calculated value of 8.3 µg/L at station 27.5, Thompson River near mouth, and peaked at station 29, Clark Fork River at Noxon Bridge, with a calculated value of 43.5 µg/L. Median TSIN concentrations decreased in the Pend Oreille River ranging from 17.5 µg/L at station 50, Pend Oreille River at Newport to concentrations less than analytical reporting limits at station 55, Pend Oreille River at Metaline Falls. Most of the soluble nitrate and nitrite as N and soluble ammonia nitrogen as N samples collected from the Pend Oreille River were reported at concentrations less than the analytical reporting limit of 10 µg/L reported by WDOE and were statistically and spatially evaluated using a value of one half of the laboratory reporting limit reported by WDOE.

2.2.3 TOTAL PHOSPHORUS

Median TP concentrations were generally consistent at all of the monthly Clark Fork River and Pend Oreille River monitoring stations. Median concentrations varied from a low of 7.0 µg/L at station 29, Clark Fork River at Noxon Bridge, to a high of 8.3 µg/L at station 55, Pend Oreille River at Metaline Falls.

2.2.4 SOLUBLE REACTIVE PHOSPHORUS

SRP was monitored at two of the monthly Clark Fork River monitoring stations: station 27.5, Thompson River near mouth and station 30 Clark Fork River below Cabinet Gorge Dam; and at the two monthly Pend Oreille River monitoring stations. The highest median SRP concentration was at station 27.5, Thompson River near mouth, at 5.2 µg/L. Median SRP concentrations decreased downstream in the Clark Fork River to 2.5 µg/L at station 30, Clark Fork River below Cabinet Gorge Dam. In the Pend Oreille River at station 55, Pend Oreille River at Metaline Falls median SRP concentrations were less than the laboratory reporting limit (3.0 µg/L reported by WDOE). Most of the SRP results from samples collected from the Pend Oreille River were less than laboratory reporting limits and were statistically and spatially evaluated using a value of one half of the laboratory reporting limit reported by WDOE.

2.3 HEAVY METALS SPATIAL COMPARISON

Heavy metals (total recoverable) samples were collected monthly at three monitoring stations in the Clark Fork River. Dissolved heavy metals samples were collected only at station 30, Clark Fork River below Cabinet Gorge Dam. Metals samples were collected at stations listed in Table 1-3 with a sampling frequency of "NM12 and NM18." Samples were analyzed for constituents outlined in Section 1.5 and more specifically in the monitoring program summary chart in Appendix A. Box and whisker plots presenting the spatial distribution of 2010 heavy metals concentrations are provided in Appendix B, and summary statistics of the water quality data are provided in Appendix C.

2.3.1 TOTAL RECOVERABLE COPPER

During Clark Fork River monthly monitoring, median total recoverable copper concentrations were 1 µg/L at each of the three Clark Fork River monthly metals monitoring stations: station 28, Clark Fork River below Thompson Falls, station 29, Clark Fork River at Noxon Bridge, and at station 30, Clark Fork River below Cabinet Gorge Dam. Station 28, Clark Fork River below Thompson Falls, had the highest reported concentration at 5 µg/L, which occurred in June. No results exceeded acute or chronic toxicity standards.

2.3.2 TOTAL RECOVERABLE ZINC

Median 2010 total recoverable zinc concentrations were at or below the laboratory reporting limit of 5 µg/L at each of the three monthly metals monitoring stations. Station 28, Clark Fork River below Thompson Falls, had one result that exceeded laboratory reporting limits at 8 µg/L collected in June. Station 29, Clark Fork River at Noxon Bridge, and station 30, Clark Fork River below Cabinet Gorge Dam, had no results exceeding the laboratory reporting limit. No results exceeded acute and chronic metals toxicity standards.

2.3.3 DISSOLVED METALS

Dissolved cadmium, copper, and zinc samples were collected at station 30, Clark Fork River below Cabinet Gorge Dam, in 2010. Median dissolved cadmium and zinc concentrations were less than the laboratory reporting limits, and all of the dissolved cadmium and dissolved zinc sample results were less than the laboratory reporting limits. The median dissolved copper concentration was 2 µg/L.

2.3.4 HEAVY METALS STANDARDS COMPARISON

Acute and chronic aquatic life toxicity standards for the heavy metals cadmium, copper and zinc, were compared with sample results collected in 2010. Total recoverable copper and zinc concentrations at stations 28 and 29, Clark Fork River below Thompson Falls and Clark Fork River at Noxon Bridge, were compared to acute and chronic aquatic life toxicity standards in the Montana Numeric Water Quality Standards, DEQ Circular-7 (Montana DEQ, 2008). Dissolved

cadmium, copper and zinc concentrations at station 30, Clark Fork River below Cabinet Gorge Dam, were compared to the Idaho Numeric Criteria for Toxic Substances For Waters Designated for Aquatic Life, Recreation, or Domestic Water Supply Use (Idaho Administrative Procedures Act, 2010). The standards are different for Montana and Idaho since the state of Montana uses total recoverable metals concentrations in their numeric water quality criteria for most heavy metals, and the state of Idaho uses dissolved metals concentrations. Both the Montana and Idaho standards use surface water hardness at the time of sampling to calculate the acute and chronic aquatic life toxicity standards for these parameters.

Of the 102 total recoverable and dissolved metals sample results reviewed, there were no samples that exceeded either acute or chronic toxicity standards for Montana or Idaho. All 2010 Clark Fork River monthly monitoring total recoverable copper and zinc sample results were below the calculated acute and chronic standards for metals toxicity in Montana. All 2010 Clark Fork River monthly and peak flow monitoring dissolved copper and zinc sample results were below the calculated acute and chronic standards for metals toxicity in Idaho. All 2010 Clark Fork River monthly and peak flow monitoring dissolved cadmium sample results were reported at concentrations less than analytical reporting limits. The dissolved cadmium method detection limit identified in the QAPP for monthly and peak flow samples collected January through July 2010 was 1 µg/l p (TSWQC 2010a). There were four instances in which the calculated acute metals toxicity for dissolved cadmium was less than 1 µg/l and 13 instances in which the calculated chronic metals toxicity was less than 1 µg/l. Following 2009 data reporting review response actions and recommendations, the method detection limit for dissolved cadmium was set at 0.08 µg/l. This method detection limit was used for samples beginning in August through December 2010. There were no instances in which the calculated acute or chronic metals toxicity was less than 0.08 µg/l. A comparison of total recoverable and dissolved metals concentrations and their calculated standards is provided in Appendix C.

2.4 SUMMER NUTRIENT MONITORING

Intensive summer nutrient monitoring was conducted in the upper and middle portions of the Clark Fork River to evaluate attainment of Clark Fork River watershed nutrient standards and targets provided in Table 1-1. Monitoring stations from Silver Bow Creek at Opportunity to the Clark Fork River at Bonita represent the upper Clark Fork River watershed, and the stations from the Clark Fork above Missoula to the Clark Fork River above the Flathead River represent the middle Clark Fork River watershed. Monitoring was conducted ten times during the compliance period (June 21 and September 21) at nine stations from Silver Bow Creek at

Opportunity downstream to the Clark Fork River above the confluence with the Flathead River. The monitoring stations include those identified in Table 1-3 with a sampling frequency of “S10.” Nutrient samples were collected at each monitoring station and analyzed for constituents outlined in section 1.5 and more specifically in the monitoring program summary chart in Appendix A. Summer nutrient monitoring activities including field parameter measurements and water quality sample collection, analysis, and data quality assurance review were conducted by Missoula Wastewater Treatment Plant personnel. Hydrographs of the Clark Fork River at Deer Lodge and the Clark Fork River above Missoula depicting stream flows during the summer sampling dates are provided in Figures H-1 and H-2 in Appendix H. As shown in these figures, the first three sampling events were conducted during the falling limb of the hydrograph, with the majority of samples being collected during base flow conditions.

2.4.1 SUMMER NUTRIENT SPATIAL COMPARISON

Box and whisker plots presenting spatial patterns of 2010 summer nutrient concentrations are provided in Appendix D. Where appropriate, box and whisker plots are shown on two scales to better display the data. Applicable nutrient standards and target concentrations are displayed as horizontal lines on the plots. Summary statistics for all of the 2010 summer nutrient monitoring are provided in Appendix E. Review of Clark Fork River summer nutrient monitoring water quality results including summary statistics and nutrient standards and target concentrations attainment at individual stations is discussed below.

TOTAL NITROGEN

Median summer TN concentrations exceeded the nutrient standard value of 300 µg/L at three stations. Station 2.5, Silver Bow Creek at Opportunity had the highest median concentration at 1,634 µg/L. All nine TN results at this station exceeded the TN standard. Station 9, Clark Fork River at Deer Lodge, with a median concentration of 316 µg/L, and station 10, Clark Fork River above Little Blackfoot, with a median concentration of 304 µg/L, also exceeded the standard. Median summer TN concentrations generally decreased in the downstream direction with the exception of an increase in median concentration at station 18, Clark Fork River below Missoula. Station 25, Clark Fork River above Flathead, had the lowest median TN concentration at 155 µg/L.

TOTAL SOLUBLE INORGANIC NITROGEN

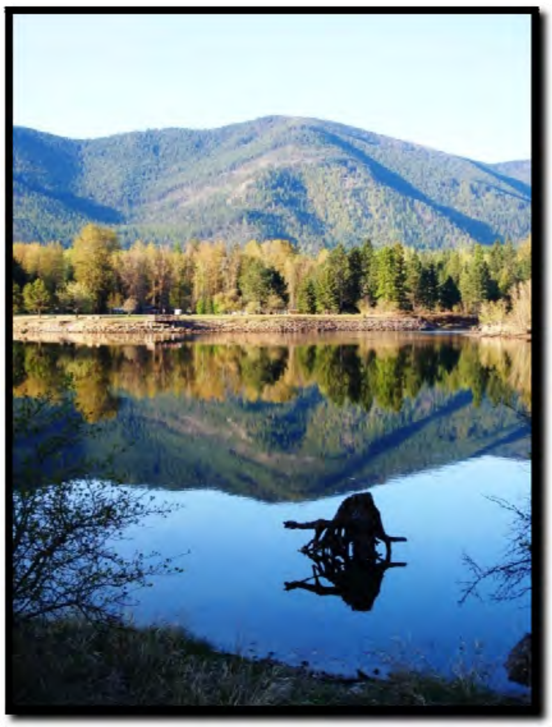
Calculated median summer TSIN concentrations exceeded the target nutrient concentration of 30 µg/L at four stations. Station 2.5, Silver Bow Creek at Opportunity, had the highest median concentration at 1,264 µg/L and exceeded the target TSIN concentrations ten of ten samples.

Station 7, Clark Fork below Warm Springs Creek, with a median concentration of 49 µg/L, exceeded the target TSIN concentrations nine of ten times. Station 9, Clark Fork River at Deer Lodge, with a median concentration of 61 µg/L also exceeded the target TSIN concentrations ten of ten samples. Station 18, Clark Fork River below Missoula, with a median concentration of 59 µg/L exceeded the target TSIN concentration nine of ten samples. Stations 9 and 18 had the two highest median TSIN concentrations. Station 15.5, the Clark Fork River above Missoula had the lowest median TSIN concentration at 9 µg/L.

TOTAL PHOSPHORUS

Median TP concentrations exceeded the nutrient standard in each of the five monitoring stations in the upper Clark Fork River and attained the standard at the four monitoring stations in the middle Clark Fork River, below the Clark Fork River-Blackfoot River confluence. Generally median summer TP concentrations decreased in the downstream direction

Median summer TP concentrations in the upper Clark Fork River exceeded the 20 µg/L nutrient standard at each of the five stations from Silver Bow Creek at Opportunity to the Clark Fork River at Bonita. Of the stations in the upper Clark Fork River, station 2.5, Silver Bow Creek at Opportunity, had the highest median TP concentration at 214 µg/L exceeding the TP standard ten of ten samples. The next highest median concentration in the upper Clark Fork River was at Station 7, Clark Fork River below Warm Springs Creek, which had a median TP concentration of 71 µg/L, exceeding the standard ten of ten samples. Station 12, Clark Fork River at Bonita, had the lowest median concentration in the upper Clark Fork River at 38 µg/L, exceeding the standard eight of ten samples.



In the middle Clark Fork River, median summer TP concentrations varied from 9 µg/L to 20 µg/L. There were two sample results that exceeded the TP nutrient standard of 39 µg/L. They occurred at station 15.5, Clark Fork River above Missoula, with a concentration of 61 µg/L; and at station 18, Clark Fork River below Missoula, with a concentration of 55 µg/L. Both occurred in June during the falling leg of the hydrograph, which likely contained more sediment than during base flow conditions. Station 25, Clark Fork River above the Flathead River, had the lowest median TP concentration during summer nutrient monitoring with a concentration of 10 µg/L.

SOLUBLE REACTIVE PHOSPHORUS

During Clark Fork River summer nutrient monitoring, median SRP concentrations exceeded the SRP target concentration of 6 µg/L at seven of nine stations. The highest median SRP concentration was at station 2.5, Silver Bow Creek at Opportunity, with a concentration of 146 µg/L. Median SRP concentrations generally decreased in the downstream direction. Other Clark Fork River stations that exceeded the SRP target concentration include 1) station 7, Clark Fork River below Warm Springs Creek, with a concentration of 45 µg/L; 2) station 9, Clark Fork River at Deer Lodge, with a concentration of 25 µg/L; 3) station 10, Clark Fork River above Little Blackfoot, with a concentration of 26 µg/L; 4) station 12, Clark Fork River at Bonita, with a concentration of 21 µg/L; 5) station 15.5, Clark Fork River above Missoula with a concentration of 7; and 6) station 18, Clark Fork River below Missoula, with median SRP concentration of 8 µg/L. Of those stations exceeding the target concentration, stations 15.5 and 18 had the median concentrations closest to attaining the SRP target. Station 15.5, Clark Fork River above Missoula, exceeded the SRP target concentration seven of ten samples. Station 18, Clark Fork River below Missoula, exceeded the SRP target concentration eight of ten samples. The lowest median SRP concentration was at station 25, Clark Fork River above the Flathead River, with a concentration of 4 µg/L, where the target concentration was exceeded in only one of ten samples.

2.4.2 SUMMER NUTRIENT STANDARD AND TARGET ATTAINMENT

Individual sample results of the 2010 summer nutrient monitoring were reviewed to evaluate the attainment of nutrient standards and target concentrations in the Clark Fork River watershed presented in Table 1-1. The number and percentage of samples exceeding the nutrient standards and target concentrations at each of the summer monitoring stations are summarized in Table 2-1. Although station 2.5, Silver Bow Creek at Opportunity, is upstream of the regulated Clark Fork River watershed nutrient standards in ARM 17.30.631, it is discussed above and results of nutrient attainment are summarized below since it is a direct source to the upper Clark Fork River.

Generally, 2010 summer nutrient monitoring results for TN, TSIN, TP, and SRP exceeded state of Montana nutrient standards and VNRP target concentrations more in the upper Clark Fork River (upstream of the Clark Fork River – Blackfoot River confluence) than in the middle Clark Fork River below the Clark Fork River – Blackfoot River confluence to above the Flathead River. Nutrient concentrations generally decreased in the downstream direction.

Table 2-1. Summer Monitoring 2010 Nutrient Standards and Target Concentrations Attainment Summary

Station	Total Nitrogen		Total Soluble Inorganic Nitrogen		Total Phosphorus		Soluble Reactive Phosphorus	
	# above target	% above target	# above target	% above target	# above target	% above target	# above target	% above target
Silver Bow Ck at Opportunity	10	100%	10	100%	9	90%	9	90%
Clark Fork below Warm Springs Ck	4	40%	9	90%	10	100%	10	100%
Clark Fork at Deer Lodge	6	60%	10	100%	9	90%	10	100%
Clark Fork above Little Blackfoot	6	60%	3	30%	10	100%	10	100%
Clark Fork at Bonita	1	10%	1	10%	10	100%	10	100%
Clark Fork above Missoula	1	10%	1	10%	1	10%	7	70%
Clark Fork below Missoula	0	0%	9	90%	1	10%	9	90%
Clark Fork at Huson	0	0%	4	40%	0	0%	2	20%
Clark Fork above Flathead	1	10%	1	10%	0	0%	1	10%

Notes:
Ck Creek
Clark Fork Clark Fork River

2.5 CLARK FORK RIVER PEAK FLOW MONITORING

In support of the Border Agreement, additional water quality monitoring was conducted in the Clark Fork River as it leaves Montana during annual peak flow conditions. Clark Fork River peak flow monitoring is a key component in evaluating annual nutrient loading rates to Lake Pend Oreille from the Clark Fork River. During the peak flow monitoring six samples were collected by Avista personnel between May 25 and June 12, 2010, and analyzed for constituents provided on the monitoring program summary chart in Appendix A. All samples are collected at station 30, Clark Fork River below Cabinet Gorge Dam. A hydrograph of the Clark Fork River below Cabinet Gorge Dam depicting stream flows during the peak flow sampling dates are provided in Figure H-3 in

Appendix H. As shown in the figure, most of the samples were collected early on during the rising limb of the hydrograph and one sample was collected at the first peak of the hydrograph. Sample collection is intended to be focused on the rising limb and peak of the hydrograph.

Median nutrient and metals concentrations collected during peak flow monitoring and comparison of those values with median monthly monitoring concentrations are summarized in Table 2-2. Median nutrient and metals concentrations collected during 2010 peak flow monitoring were similar for all constituents to those collected during the monthly monitoring except for soluble ammonia nitrogen, TN, and hardness. Median concentrations for these constituents were higher during peak flow than in monthly monitoring. Summary statistics for all of the 2010 Cabinet Gorge Dam peak flow monitoring results are provided in Appendix C. Comparison of metals concentrations to acute and chronic toxicity standards is provided in section 2.3.4. Estimates of nutrient loads are provided in Section 2.8 of this report.

Table 2-2. Summary of 2010 Clark Fork River Peak Flow Monitoring Median Nutrient and Metal Concentrations in the Clark Fork River below Cabinet Gorge Dam

Constituent	Monthly Monitoring Median Concentration[1]	Peak Flow Monitoring Median Concentration[1]
Soluble ammonia nitrogen as N (µg/L)	3	11
Soluble nitrate and Nitrite as N (µg/L)	34	30
Total Soluble Inorganic Nitrogen as N (µg/L)	37	42
Total (Persulfate) Nitrogen (µg/L)	119	156
Soluble Reactive Phosphorus (µg/L)	2.5	3.1
Total Phosphorus (µg/L)	7.3	7.6
Total Hardness as $CaCO_3$ (mg/L)	96	72
Cadmium Dissolved (µg/L)	<1	<1
Copper Dissolved (µg/L)[2]	2	2
Copper Total Recoverable (µg/L)[2]	1	1
Zinc Dissolved (µg/L)	<5	<5
Zinc Total Recoverable (µg/L)	<5	<5

[1] For the purpose of preparing summary statistics, concentrations less than analytical reporting limits are assumed to be one half of the laboratory reporting limit, and here reported as "<" the laboratory reporting limit.

[2] There were 12 monthly and peak flow total recoverable-dissolved pairs in which the dissolved copper concentration exceeded the total recoverable copper concentration. Each result is at or near the detection limit and within the expected analytical error. None of these results have been qualified.

µg/L micrograms per liter

mg/L milligrams per liter

2.6 CLARK FORK RIVER PERIPHYTON MONITORING

Periphyton samples were collected at seven Clark Fork River stations during 2010 from the Clark Fork River at Deer Lodge to the Clark Fork River above the Flathead River. Collection of periphyton standing crop occurred twice at each station, once in August and once in September during the Clark Fork River nutrient compliance period. The monitoring stations include those identified in Table 1-3 with a sampling frequency of "P10." Periphyton sampling activities included sample collection, analysis, and data quality review and were conducted by University of Montana Watershed Health Clinic personnel under the direction of Dr. Vicki Watson. Roughly twenty samples were collected at prescribed stratified locations at each station, and were analyzed for:

- Chlorophyll-a in milligrams per square meter (mg/m^2)
- Ash-free Dry Weight (AFDW) in grams per square meter (g/m^2)

The samples provide a measure of the chlorophyll-a and AFDW concentrations from individual specific locations collected within the Clark Fork River at a monitoring station. The samples were averaged to characterize algal concentrations of the river at that station at the time of sampling. Average values computed for each sampling event (August and September mean) were further averaged to arrive at the "summer mean" chlorophyll-a and AFDW concentrations for each station.

2.6.1 PERIPHYTON TEMPORAL COMPARISON

Results of Clark Fork River 2010 periphyton monitoring are summarized in Table 2-3 and; Appendix G, Table G-1 and Figures G-1 and G-2. As shown in Figure G-1, chlorophyll-a concentrations were greater in September than in August at each station except at station 15.5, Clark Fork River above Missoula. This station had the highest measured algal concentration in August, but decreased nearly 50 mg/m^2 in September. This can be attributed to an algal bloom in August that died off before the September sampling (V. Watson, personal communication, 25 March, 2011). Station 25, Clark Fork River above Flathead, had the lowest measured and near constant algal concentrations in August and September. The greatest algal concentration increase was measured at station 9, Clark Fork River at Deer Lodge, where concentrations increased from 50 mg/m^2 in August to 156 mg/m^2 in September. Algal concentration increases of 60 mg/m^2 or more from August to September were measured at station 10, Clark Fork River above Little Blackfoot River; station 12, Clark Fork River at Bonita and; station 18, Clark Fork River below Missoula.

AFDW concentrations are summarized in Appendix G, Table G-2 and Figure G-3. AFDW concentrations generally follow the temporal pattern of chlorophyll-a concentrations described above, except at station 10, Clark Fork River above Little Blackfoot River. Here the August and September AFDW concentrations were nearly equal.

2.6.2 PERIPHYTON SPATIAL COMPARISON

As shown in Table 2-3 and Figure G-2 in Appendix G, the summer mean chlorophyll-a concentrations, spatially, were nearly constant (ranging from 89 to 103 mg/m^2) at the five upstream stations and decreased downstream at station 22, Clark Fork River at Huson (79 mg/m^2), and station 25, Clark Fork River above Flathead (38 mg/m^2). The lowest concentration for any one month and summer mean occurred furthest downstream at station 25, the Clark Fork River above Flathead. Figure G-2 in Appendix G compares 2010 summer mean chlorophyll-a concentrations between stations.

As shown in Table G-2 and Figure G-3 in Appendix G, summer mean AFDW concentration in the Clark Fork River in 2010 was greatest at station 12, Clark Fork River at Bonita, at 74 g/m^2 and decreased at each downstream station to station 25, Clark Fork River above Flathead River, at 20 g/m^2.

2.6.3 BENTHIC ALGAL CHLOROPHYLL-A STANDARDS ATTAINMENT

The August and September chlorophyll-a concentrations at each station are compared to the Clark Fork River summer maximum benthic algal chlorophyll-a standard of 150 mg/m^2. The summer mean chlorophyll-a concentration at each station is compared to the Clark Fork River summer mean benthic algal chlorophyll-a standard of 100 mg/m^2. Clark Fork River standards for benthic algal chlorophyll-a are provided in Table 1-1. Clark Fork River 2010 chlorophyll-a results and attainment summary are provided in Table 2-3 below, and in Table G-1 and Figures G-1 and G-2 in Appendix G.

As shown in Table 2-3, the summer maximum chlorophyll-a standard of 150 mg/m^2 was attained at all stations in August and exceeded at only station 9, Clark Fork River at Deer Lodge, in September (156 mg/m^2). The summer mean chlorophyll-a standard of 100 mg/m^2 was exceeded at two of the seven monitoring stations in 2010: station 9 Clark Fork River at Deer Lodge and station 18 Clark Fork River below Missoula, each with summer mean chlorophyll-a concentration of 103 mg/m^2. All other monitoring stations attained the summer mean standard.

Table 2-3. Clark Fork River 2010 Chlorophyll-a Standards Attainment Summary

Station	August [1] (mg/m^2)	September [1] (mg/m^2)	Summer Mean [2] (mg/m^2)
Clark Fork at Deer Lodge	50	*156*	*103*
Clark Fork above Little Blackfoot	59	120	89
Clark Fork at Bonita	60	138	99
Clark Fork above Missoula	121	72	96
Clark Fork below Missoula	66	139	*103*
Clark Fork at Huson	64	93	79
Clark Fork above Flathead	38	37	38
Standard (mg/m^2)	**150**	**150**	**100**
# Sites Above Standard	**0**	**1**	**2**
Percent Exceeding Standard	**0%**	**14%**	**29%**

Notes:

1. Chlorophyll-a Maximum Standard Value for any one site at one given time is 150 mg/m^2
2. Chlorophyll-a Mean Standard Value for any one site over the summer season is 100 mg/m^2

Concentrations exceeding respective standard values are highlighted

mg/m^2-milligrams per square meter, Clark Fork-Clark Fork River

Standards established by Administrative Rules of Montana (ARM) 17.30.631 for benthic algal chlorophyll-a, Clark Fork River Warm Springs Creek to Flathead River, from June 21 to September 21

2.7 LAKE PEND OREILLE WATER QUALITY

IDEQ completed one Lake Pend Oreille water quality monitoring event in 2010. Water quality monitoring was completed June 15-16, at six nearshore monitoring locations and two open water locations and included nutrient sample collection, field parameters, and Secchi depth measurements. Due to lack of available funding by IDEQ, the following 2010 monitoring program components were not completed: 1) monitoring at one open water location (monitoring was completed at only two of three open water locations during the June monitoring event), 2) laboratory analysis of chlorophyll-a samples, 3) periphyton monitoring, and 4) monthly monitoring July through September. The following sections review Lake Pend Oreille water quality data provided by IDEQ for the June 2010 monitoring event.

2.7.1 LAKE PEND OREILLE FIELD PARAMETERS

Field parameter measurements including water temperature, DO (percent saturation and mg/L) were collected at six nearshore and two open water locations in June 2010 by IDEQ. Water temperature and DO were measured incrementally to establish profile information to evaluate lake stratification. If stratification was present, composite sampling methods were used to collect nutrient samples. Based on water temperature and DO measurements, lake stratification was observed at three monitoring locations including Bayview Nearshore, Bayview Open water, and

Pend Oreille North. Lake Pend Oreille 2010 water temperature and DO profile data are presented Tables M-1 to M-8 in Appendix M.

2.7.2 LAKE PEND OREILLE SECCHI DEPTH

Secchi depth measurements were recorded at four nearshore and two open water locations in June 2010 by IDEQ. Secchi depth measurements varied from 3.25 meters at Pend Oreille North to 5.5 meters at Bayview Open water. Secchi depth measurements could not be collected at Oden Bay and Sunnyside monitoring locations due to depth to bottom limitation (less than 3 meters). Lake Pend Oreille 2010 Secchi Depth measurements are presented Table M-9 and Figure M-1 in Appendix M.

2.7.3 LAKE PEND OREILLE NUTRIENT MONITORING

Nutrient samples including TP and TN were collected at six nearshore and two open water locations in June 2010 by IDEQ. Water temperature and DO were measured incrementally to establish profile data which are used to evaluate lake stratification at each station sampled. If the station was stratified, then two samples were taken. One sample represented the epilimnion and was a depth-integrated sample from the surface to 1% light extinction depth (roughly 2.5x Secchi Depth), or above the thermocline whichever was less. The second sample represented the hypolimnion and was collected approximately halfway between the hypolimnion “knee” and the bottom, or as deep as sampling equipment allowed (R. Steed, personal communication, June 23, 2011). Stratified samples were collected at Bayview Nearshore, Bayview Open Water, and at Pend Oreille (PDO) North monitoring stations. The average June nutrient concentrations in the epilimnion were 7.9 µg/L TP and 86 µg/L TN. The average June nutrient concentrations in the hypolimnion were 5.6 µg/L TP and 134 µg/L TN. The analytical detection limit for June 2010 Lake Pend Oreille TN results is 90 µg/L. The project required quanitation limit as specified in the Lake Pend Oreille water quality Quality Assurance Project Plan (TSWQC, 2009) is 100 µg/L. As presented by IDEQ, concentrations below analytical detection limits are evaluated using one half the project required quanitation limit (50 µg/L). Lake Pend Oreille 2010 TN and TP June 2010 sample results are presented Table M-10 in Appendix M.

2.8 LAKE PEND OREILLE NUTRIENT LOADING

Nutrient loading into Lake Pend Oreille was evaluated using the U.S. Army Corps of Engineers (USACE) FLUX model. The FLUX model is one of three USACE models that comprise the BATHTUB Eutrophication model (Walker 1999). The model uses grab-sample nutrient concentrations, corresponding discharge measurements and complete discharge records to calculate annual nutrient loading. The FLUX model provides six methods to synthesize the discharge-nutrient concentration relationship from individual sample records and impute them onto the entire flow record. Method 6, *Regression Applied to Individual Flows,* has been used by the Council in previous nutrient loading evaluations and is used in this evaluation to maintain a consistent method. Method 6 is generally preferred over the other regression-based methods when the discharge-nutrient concentration relationship is well defined. Method 6, *Regression Applied to Individual Flows*, is defined in the following equation (Walker 1999):

$$\mathbf{W_6 = \Sigma_j \exp [a + (b+1) \ln (Q_j) + SE^2/2],}$$

Where,

W_6 = estimated mean flux over N days, method 6 (kg/year)
c = measured concentration in sample in milligrams per cubic meter (mg/m^3)
a= intercept of ln(c) versus ln(q) regression
b= slope of ln(c) versus ln(q) regression (q is the measured flow during sample)
Q_j = mean flow on day j in cubic hectometers per year (hm^3/year)
Σ_j = sum over N dates in daily flow record
SE= Standard error of estimate for ln(c) versus ln(q) regression

For the loading analysis, nutrient concentrations were converted from µg/L to milligrams per cubic meter (mg/m^3), and discharge values were converted from cfs to cubic hectometers per year (hm^3/year).

To be consistent with previous nutrient loading analysis completed by the Council, nutrient loads were estimated using the record of daily discharge from USGS station 12392000, Clark Fork River at Whitehorse Rapids. This station is located downstream of Cabinet Gorge Dam and includes an assumed 600 cfs groundwater inflow derived from seepage around the dam.

The FLUX model stratified discharge data to develop separate regression equations and improve estimates of loading. These stratifications were developed by the model to lower the coefficient of variation for the loading calculations. For each stratum, the regression equation is applied individually to each daily flow value. The sum of daily loads provides the annual estimate. Nutrient concentrations reported at less than the laboratory reporting limit were evaluated using a value of one half the laboratory reporting limit. FLUX model flow and load summary output files for TP and TN are provided in Appendix N.

Nutrient loading to Lake Pend Oreille from the Clark Fork River was calculated using the FLUX model applying nutrient concentration-flow regressions to daily flow values (Method 6). Nutrient loading estimates to Lake Pend Oreille from the Clark Fork River in 2010 are provided below:

- Clark Fork River inflow 16,072 hm^3 or 13,029,731 acre-feet
- Total phosphorus loading 139,054 kilograms or 306,562 pounds
- Total nitrogen loading 2,234,235 kilograms or 4,925,645 pounds

The estimated TP load to Lake Pend Oreille from the Clark Fork River in 2010 is less than the Clark Fork River allocated target load of 259,500 kilograms per year. Three consecutive years of TP loads are needed to evaluate short-term exceedance of the target. Short-term exceedance of the target will be evaluated following 2011 Clark Fork—Pend Oreille water quality monitoring. Although no targets were established for TN loading to Lake Pend Oreille, they are reported above.

Other Lake Pend Oreille nutrient targets were not evaluated in 2010 including the area-weighted average in-lake TP concentration and the TN to TP ratio, due to the limited Lake Pend Oreille monitoring data available.

3.0 DATA QUALITY ASSURANCE REVIEW

A data quality assurance (QA) review has been completed on all data included in this report. HydroSolutions completed a QA review on all Clark Fork River monthly monitoring data, Clark Fork River peak flow monitoring data, and portions of the Clark Fork River summer nutrient monitoring data. QA reviews have been completed by monitoring program sponsoring organizations identified in Table 1-2.

The QA review in the following sections applies to monthly monitoring conducted in the Clark Fork River, Clark Fork River peak flow monitoring, and portions of the Clark Fork River summer nutrient monitoring (including data quality objectives field precision, field sensitivity, and completeness; and data logic check).

The QA review was completed using guidance outlined in the latest Clark Fork River Watershed Monitoring Program QAPP and follows the MDEQ QA/QC Checklist. The DEQ QA/QC checklist is provided in Appendix L and includes descriptions of data qualifiers used in this section. The QA review also includes:

- Review of chain-of-custody forms and laboratory data sheets to verify that appropriate analyses were run and that the samples were analyzed within specified holding times;
- A comprehensive review of the sample delivery group to evaluate the overall quality of the data including potential transcription errors, detection or reporting limit discrepancies, data omissions, and suspect or anomalous values;
- Review of field data noting and explaining anomalous or suspect values; and
- Sample logic checks noting instances where dissolved sample fractions exceeded total concentrations.

3.1 SAMPLE HANDLING

3.1.1 CONDITION OF SAMPLES UPON RECEIPT

Sample handling followed guidance outlined in the QAPP. After the sample was collected, it was immediately placed on ice in a cooler for delivery to the laboratories. All samples were collected in containers provided by the respective laboratories and were delivered intact. The State Laboratory did not report any sample handling discrepancies for sample preservation. The Missoula Laboratory noted that in February, the soluble ammonia nitrogen as N and soluble nitrate and nitrite as N sample for sample-ID CFR-30-021810-QC-FD was acidified, and that the TP sample was not. The laboratory was able to analyze and provide results for both samples. As a corrective measure, the Missoula Laboratory verifies the pH of each of TP samples during the sample drop off procedure.

3.1.2 ALL FIELD DOCUMENTATION COMPLETE

Site visit forms and chain-of-custody forms were completed for each of the monthly sampling events completed by HydroSolutions. Avista personnel also completed site visit forms and chain-of-custody forms during Clark Fork River peak flow monitoring. These forms were reviewed following completion of each event by the HydroSolutions project manager. Field notes were also recorded in a log book for each of the monthly sampling events. Site visit forms, chain-of-custody forms, and field notes are maintained in paper and digital format by HydroSolutions in their Helena office.

3.1.3 HOLDING TIMES MET

Analytical holding times were reviewed for Clark Fork River monthly, peak flow, and summer nutrients monitoring. Analytical holding times for all samples were met for monthly monitoring. During Clark Fork River peak flow monitoring, there were seven samples that exceeded EPA analytical holding times including four for TN and one each for TP, soluble nitrate and nitrite as N, and soluble ammonia nitrogen as N. These peak flow monitoring samples are collected by Avista and analyzed by the Missoula Lab. During Clark Fork River summer nutrient monitoring there were ten samples that exceeded EPA analytical holding times for TN. The sampling and analysis of these summer nutrient samples is completed by the Missoula Lab. A summary of the samples exceeding EPA analytical holding times is provided in Table I-1 in Appendix I. These results have been qualified with an “H” flag in the MT-eWQX database.

3.1.4 FIELD QUALITY CONTROL SAMPLE COLLECTION FREQUENCY

During Clark Fork River monthly monitoring, one field duplicate sample and one field blank sample were collected during each month to meet the frequency specified in the QAPP. During the Clark Fork River peak flow monitoring, one field duplicate sample and one field blank sample were collected during the monitoring period.

During the Clark Fork summer nutrient monitoring, one field duplicate sample and at least one field blank sample were collected at each of nine stations during the monitoring period. A summary of the number and frequency of field duplicate and field blank samples collected during the Clark Fork River monthly, peak flow, and summer nutrient monitoring is provided in Appendix I, Tables I-2 and I-3 respectively.

3.1.5 SAMPLE IDENTIFICATION

Sample identification matched those specified in Table 1-3 and in the QAPP. In order to conform to the MT-eWQX system, the sampling date and activity code were added to each of the sample identification names (example: CFR-30-121709-S). The “S” is an activity code that indicates the sample is a routine sample. Other activity codes include: QC-FD and QC-FB, indicating field duplicate and field blank quality control samples respectively. The activity code PF indicates the sample was collected during peak flow monitoring.

3.2 METHODOLOGY

3.2.1 LABORATORY AND FIELD METHODS

Laboratory and field methods were completed as described in the QAPP.

3.2.2 LABORATORY REPORTING LIMIT

In general the laboratory reporting limits for all analytes met the project-required reporting limit specified in the QAPP. There were 41 nutrient results in which the laboratory reporting limit was raised due to sample matrix interference. These results are qualified as “D” (sample dilution) and include 11 soluble nitrate and nitrite as N results, 11 TP results, 10 TN results, and 9 SRP results. All of the diluted samples are from samples collected at station 2.5, Silver Bow Creek at Opportunity and included four field duplicate quality control sample results. A summary of analytes, the laboratory reporting limit, and their project required reporting limit is provided in Table 1-5. The qualified results are summarized in Appendix E and provided in Appendix K.

3.2.3 LABORATORY QUALITY CONTROL FREQUENCY

Laboratory quality control samples including laboratory duplicate, blank, matrix spike, and laboratory control samples were analyzed at a frequency following criteria specified in the analytical method or as described in each laboratories respective Laboratory’s Quality Assurance Plan (LQAP). Copies of the LQAP are included in the QAPP. Laboratory analytical quality assurance reports for 2010 Clark Fork River monthly, peak flow, and summer nutrient monitoring are included in Appendix J.

The State Laboratory completed one quality control sample for every analyte each month. In total, 92 quality control samples were completed. Including the field duplicate and field blank sample results, the State Laboratory completed 410 total analytical results (excluding calculations for total hardness) for an overall quality control sample frequency of 22 percent.

Quality control sample analysis frequency completed in 2010 for the State Laboratory is summarized in Appendix I, Table I-4a.

Missoula Laboratory quality control samples were reviewed as part of this report for the Clark Fork River monthly, peak flow, and summer nutrient monitoring activities. Laboratory quality control samples completed by the Missoula Laboratory included: continuing calibration blanks, instrument and procedure duplicates, laboratory control standards (low and mid range), external control standards, and matrix spikes. The Missoula Laboratory analyzes quality control samples at the following frequency (S. Kenyon, personal communication, 21 February 2011):

- External control standard, Mid-range control standard, and continuing calibration blanks are analyzed once for every 10 samples (instrument duplicates and spike sets are not considered samples)
- Low range control standard is analyzed once per sampling event
- Matrix spike sets and instrument duplicate samples are analyzed once for every 15 samples
- Calibration curves are run at a minimum once per analysis; however, they may be rerun if there are any failures.

The quality control sample analysis frequency completed in 2010 for the Missoula Laboratory is summarized in Appendix I, Table I-4b. The summary is based on review of the Missoula Laboratory 2010 analytical quality assurance reports for typical months provided in Appendix J.

3.3 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) for the monitoring program are described in the QAPP (TSWQC, 2010a). DQOs for measurement data also referred to as data quality indicators, include precision, accuracy, measurement range (sensitivity), representativeness, completeness, and comparability. DQOs for the monitoring program are addressed below.

3.3.1 PRECISION

Precision refers to the degree of variability in repeat measurements of the same property. Precision for laboratory analyses of samples are evaluated through laboratory reporting of relative percent differences (RPDs) in duplicate sample analyses. Precision for constituents measured in the field are evaluated by conducting repeat measurements. RPD is calculated as follows:

$$RPD = (O-D) / ((O+D)/2) \times 100$$

Where:
O = original, and
D = duplicate

LABORATORY PRECISION

Laboratory precision is measured by assessing results of laboratory duplicate samples. As described in the QAPP, the criteria used to assess analytical method precision are:

Water Chemistry 20 % RPD for duplicate results > 5 times the reporting limit

The laboratory duplicate sample results from the State Laboratory were reviewed for each analyte each month. None of the laboratory duplicate sample results exceeded laboratory precision criteria.

Missoula Laboratory instrument duplicate and procedure duplicate sample results were reviewed for each analyte each month. None of the instrument duplicate or procedure duplicate sample results exceeded laboratory precision criteria.

All of the duplicate sample results from the State Laboratory and the Missoula Laboratory are shown in the laboratory analytical quality assurance reports in Appendix J. A summary of the results of the laboratory quality assurance report review is included in Table I-5 in Appendix I.

FIELD (OVERALL) PRECISION

Overall precision is measured by assessing results of co-located field duplicate samples. As described in the QAPP, the criteria used to assess overall precision are:

Water Chemistry 25 % RPD for duplicate results > 5 times the reporting limit

Of the 214 co-located field duplicate pairs reviewed, there was one that exceeded the above data quality objective criteria. The August 16, 2010 co-located field duplicate samples for soluble nitrate and nitrite as N had a relative percent difference of 27 percent and results (28.1 and 37.0 µg/L respectively) were greater than five times the reporting limit (2.0 µg/L). Data associated with this sample has been qualified as “J” (estimated value). Data are associated by the day or event that they are collected. A summary table of field duplicate sample results and their relative percent difference is provided in Table I-6 in Appendix I.

3.3.2 LABORATORY ACCURACY

Accuracy is the combination of high precision and low bias. It is measured by assessing how close an analytical measurement is to its "true" value. The tool for assessing accuracy of measurements is the recovery of known concentrations through matrix spikes of field samples and in standard concentration solutions of Laboratory Control Samples (LCS) to establish method accuracy. Accuracy is determined by percent recovery as follows:

$$\textbf{\% Recovery for matrix spikes} = ((SSR - SR)/SA) \times 100$$

Where:
SSR = spiked sample result,
SR = sample result, and
SA = spike amount added

$$\textbf{\% Recovery for control standards} = (FC/TC) \times 100$$

Where:
FC = found concentration, and
TC = true concentration

There are two levels of assessing accuracy in the quality control process:

1) the method or laboratory controls represented by laboratory control samples; and

2) the sample represented by matrix spikes and matrix spike duplicate samples.

The QAPP established an accuracy goal of plus or minus 10 percent for water chemistry analyses.

Of the 92 matrix spike and laboratory control samples reported samples analyzed, from the State Laboratory, no result exceeded the accuracy goal.

The Missoula Laboratory quality control samples were reviewed for accuracy for monthly, peak flow, and summer nutrient monitoring. The Missoula Laboratory analyzed low and mid range control standards, external control standards, and matrix spike samples. The Missoula Laboratory's accepted control standard recovery limit ranged from plus or minus 10 to 15 percent. The accepted recovery limit for matrix spike samples was 85 to 115 percent. There were no samples that exceeded the accepted recovery limits.

No results have been qualified due to accuracy. A summary of matrix spike and quality control sample results is presented in Appendix I, Table I-5. All of the matrix spike and laboratory control sample results for the State Laboratory and the Missoula Laboratory are shown in the laboratory analytical quality assurance reports in Appendix J.

3.3.3 MEASUREMENT RANGE OR SENSITIVITY

Measurement Range or Sensitivity refers to the limit of a measurement to reliably detect a characteristic of a sample. For analytical methods, sensitivity is expressed as MDL. Laboratories determine their MDLs annually and routinely check each method's ability to achieve this level of sensitivity using negative controls through method blanks, continuing calibration blanks, and laboratory reagent blanks. For field data, sensitivity is assessed through the preparation and analysis of field blanks.

LABORATORY SENSITIVITY

Sensitivity quality controls for all laboratory methods follow the frequency and criteria specified in the analytical method or as described in the LQAP. In reviewing the State Laboratory's 2010 quality control reports, there were no laboratory blank samples that exceeded the LQAP standard and all sample results were less than analytical reporting limits or not detected. A summary of laboratory sensitivity results is presented in Appendix I, Table I-5.

The Missoula Laboratory analyzed continuous calibration blank samples during monthly and summer nutrient monitoring for July 2010 to December 2010 samples. All continuous calibration blank sample results were less than analytical reporting limits or not detected. Blank samples are also analyzed in developing their methods standards curve. There were no anomalies reported by the Missoula Laboratory in terms of laboratory sensitivity. No results have been qualified due to laboratory sensitivity.

All of the laboratory blank and continuous calibration blank sample results for the State Laboratory and the Missoula Laboratory are shown in the laboratory analytical quality assurance reports in Appendix J.

FIELD SENSITIVITY

The sensitivity of field meters used in the monitoring of field constituents during monthly and summer nutrient monitoring are specified in the respective manuals for the YSI 556 water quality probe and Hach 2100P turbidimeter, provided in the QAPP (2010). Project measurement limits for chemical analyses are provided in Table 1-5. The criteria used to assess field method sensitivity for water samples is:

Field method controls (Field Blank) < Project Required Quantitation Limit

For field blanks that exceed this criteria, all associated project data less than ten times the detected value are qualified as "B", indicating analytical detection of the field blank. Of the 286 field blank and trip blank samples analyzed by the State and Missoula Laboratories, there was one field blank sample result that exceeded the above data quality objectives. The monthly monitoring TN field blank collected on March 15, 2010 had a result of 65 µg/L. The associated TN results have been qualified. Data are associated by the day or event that they are collected. Field blanks exceeding method detection limits are summarized in Appendix I, Table I-7.

During the Clark Fork River summer nutrient monitoring, trip blanks were collected for each day that samples were collected. Results of the 76 trip blank samples were reviewed and none exceeded sensitivity criteria.

3.3.4 SAMPLE REPRESENTATIVENESS

Representativeness is the extent to which the measurements actually represent the true environmental conditions in time and space. The study design directs measurements of field parameters and chemical analyses to be collected at benchmarked locations by wading from the bank. The sampling locations were chosen to best represent the reach of interest and to minimize any potential site-specific bias. Given the high volume and flow of water and large cross sectional area of the river, heterogeneous distribution of water and sediment do exist. This is especially true of Clark Fork River during peak flow conditions when suspended sediment concentrations are elevated and not evenly distributed throughout the water column, primarily affecting sediment associated parameters such as phosphorus and metals.

For 2010 monitoring, sample representativeness was first achieved through the study design, and secondly through the sampler's consistency in executing the study design. During 2010 monitoring, samplers followed guidance outlined in the QAPP and collected all samples from designated locations.

3.3.5 SAMPLE COMPLETENESS

Completeness is the comparison between the amounts of data that has been planned to be collected versus how much usable data were actually collected, expressed as a percentage. Data may be determined to be unusable (Rejected) in the validation process or lost due to sampler or laboratory error. Loss of more than 10 percent of the data points in a calendar year would have a significant effect on the annual trendline; therefore, the QAPP established project completeness at 90 percent. Sample completeness for each activity of the 2010 monitoring program is summarized in Appendix I, Tables I-8a to I-13.

During Clark Fork River monthly monitoring the established sample completeness goal was met for all constituents and is summarized in Appendix I, Table I-8a and 8b.

Preliminary 2010 Pend Oreille River monitoring data were available at the time of this report from the WDOE and is subject to revision until the data are finalized in their annual report. The established sample completeness goal was met for most constituents during Pend Oreille River monthly monitoring. Temperature and SC results were not reported for every month and have completeness less than 90 percent for this monitoring activity. Additionally, Station 55, Pend Oreille River at Metaline Falls, was not able to be sampled in December due to ice. Project completeness is summarized in Appendix I, Table I-9.

Lake Pend Oreille nutrient, field parameter, and Secchi depth monitoring results were provided from IDEQ for June 2010 at six nearshore and two open water lake locations. Lake Pend Oreille nutrient, field parameter and Secchi depth monitoring typically occurs at six nearshore and three open water lake locations collected monthly June through September. Due to lack of available funding monitoring was completed in only one of four months at six of six nearshore lake locations and two of three open water lake locations. Analysis of chlorophyll-a samples did not occur during 2010 monitoring. Lake Pend Oreille periphyton monitoring, which typically occurs once in September each year, was not completed in 2010. The completeness goals for this monitoring activity were not met. The completeness goals for Lake Pend Oreille monitoring are summarized in Appendix I, Table I-10.

During Clark Fork River peak flow monitoring, project completeness was met for all constituents. Project completeness is summarized in Appendix I, Table I-11.

During Clark Fork River summer nutrient monitoring completeness was met for all constituents and is summarized in Appendix I, Table I-12.

The established sample completeness goal was met for chlorophyll-a and AFDW for Clark Fork River periphyton monitoring and is summarized in Appendix I, Table I-13.

3.3.6 SAMPLE COMPARABILITY

Sample comparability was achieved for this project through consistent sampling locations, procedures, and analyses as outlined in the QAPP (TSWQC, 2010).

3.4 LOGIC CHECKS

Logic checks were performed to further validate the 2010 monitoring data. If logic checks were violated, then associated data values are flagged and in some cases rejected. The following logic checks were reviewed:

- TP greater than SRP
- TN greater than TSIN
- Total recoverable greater than dissolved for metals constituents

PHOSPHORUS: TOTAL AND SOLUBLE REACTIVE

Associated TP and SRP concentrations were reviewed for all 2010 monitoring data. There were four sample pairs in which the soluble concentration exceeded the total concentration. Two of the sample pairs were within the range of analytical error (± 10%) as discussed with the Missoula Laboratory. The SRP samples collected during 1) Clark Fork River monthly monitoring at station 27.5, Thompson River near mouth, on March 15, 2010, and 2) Clark Fork River summer nutrient monitoring at station 2.5, Silver Bow Creek at Opportunity, on September 1, 2010, are outside the range of analytical error. Instrument duplicate and matrix spike samples were completed and passed laboratory quality control standards. These results have been flagged with data qualifier “R, rejected,” as discussed with MDEQ and the Council’s Monitoring Committee. TP-SRP logic check is summarized in Table I-14 in Appendix I.

NITROGEN: TOTAL AND SOLUBLE INORGANIC

Associated TN and total soluble inorganic nitrogen (TSIN) concentrations were reviewed for all 2010 monitoring data. There are no sample pairs in which the soluble concentration exceeds the total concentration and all pass the TN-TSIN logic check.

METALS: TOTAL RECOVERABLE AND DISSOLVED COPPER AND ZINC

Associated total recoverable and dissolved copper and zinc concentrations were reviewed for all 2010 monitoring data. There were 12 total recoverable-dissolved pairs in which the dissolved copper concentration exceeded the total recoverable copper concentration. Each result is at or near the detection limit and within the expected analytical error. None of these results have been qualified. All total recoverable zinc and dissolved zinc results were below method detection limits and therefore pass the logic test.

3.5 DATA QUALITY REVIEW SUMMARY

The QA review presented above applies to Clark Fork River monthly monitoring, Clark Fork River peak flow monitoring, and portions of the Clark Fork River summer nutrient monitoring (including data quality objectives field precision, field sensitivity, and completeness; and data logic check) in 2010. A summary of that data quality review is provided below.

SAMPLE HANDLING

1) The Missoula Laboratory noted that in February, the soluble ammonia nitrogen as N and soluble nitrate and nitrite as N sample for sample-ID CFR-30-021810-QC-FD was acidified, and that the TP sample was not. The laboratory was able to analyze and provide results for both samples.
2) During Clark Fork River peak flow monitoring there were seven samples analyzed by the Missoula Laboratory that exceeded EPA analytical holding times including four for TN; and one each for TP, soluble nitrate and nitrite as N, and soluble ammonia nitrogen as N. During Clark Fork River summer nutrient monitoring there were ten samples analyzed by the Missoula Laboratory that exceeded EPA analytical holding times for TN. These results have been qualified with an “H” flag in the Montana Equis Water Quality Exchange (MT-eWQX) database.

METHODOLOGY

3) All field and analytical methods were carried out as prescribed in the QAPP (TSWQC, 2010).
4) Analytical reporting limits were met for all analytes.
5) The number and frequency of laboratory quality control samples met standards specified for the analytical method or for the LQAP.

DATA QUALITY OBJECTIVES

6) Laboratory precision criteria for analytes were achieved at both the State and Missoula laboratories. A complete list of laboratory duplicate sample analytical results for the State Laboratory and Missoula Laboratory are shown in the laboratory analytical quality assurance reports in Appendix J.
7) Field precision was assessed by reviewing field duplicate samples. Of the 214 original-duplicate pairs reviewed, there was one 2010 field duplicate sample that exceeded field precision criteria. The data associated with this duplicate has been qualified with a “J” estimated flag. A complete list of field duplicate results and the associated RPDs can be found in Appendix I, Table I-6.
8) Laboratory accuracy was assessed by reviewing laboratory quality control reports for results of control samples and matrix spike samples. For the State Laboratory, no laboratory control or matrix spike samples were outside of established limits. For the Missoula Laboratory, 74 laboratory control standard and matrix spike samples exceeded the QAPP’s ±10 percent recovery goal, but none exceeded that laboratory’s quality control recovery limit. No results were qualified due to accuracy.

9) Laboratory sensitivity was assessed by reviewing results of laboratory quality control reports. All laboratory blanks from the State Laboratory and Missoula Laboratory were reported less than the laboratory reporting limit.
10) Field sensitivity was assessed by reviewing field blank samples. Of the 286 field blank and trip blank samples analyzed by the State and Missoula Laboratories, there was one field blank sample result that exceeded the DQO criteria for sensativity. The monthly monitoring TN field blank collected on March 15, 2010 had a result of 65 µg/L. The associated TN results have been qualified.
11) The program completeness goal of 90 percent was met for all program activities except for Lake Pend Oreille monitoring.
12) Sample representativeness and sample comparability were achieved through consistent sampling locations, procedures, and analyses as outlined in the QAPP.

LOGIC CHECKS

13) Logic checks for total and dissolved (or soluble) fractions were performed on phosphorus, nitrogen, copper, and zinc to further validate the 2010 monitoring data. Data failing logic tests were qualified appropriately, and are summarized in Table I-14 in Appendix I. In total, two sample pairs for TP-SRP were rejected because the soluble fraction exceeded the total concentration. All associated results were flagged in the MT-eWQX database.

4.0 DATA VALIDATION RESPONSE ACTIONS AND RECOMMENDATIONS

DATA REVIEW PROCESS

Data collected during the 2010 monitoring program were reviewed to check for calculation and transformation errors, measurements within calibration range, and data entry errors. Data were reviewed according to the MDEQ Quality Control Checklist to ensure project DQOs are met and data are validated, flagged, or rejected accordingly. Results from the data review process are detailed in the data quality assurance review section above.

DATA VERIFICATION

Data verification was completed through routine monthly checks ensuring that the QAPP and analytical quality control procedures were followed. Sampling documentation, representativeness, compliance with sample holding times, instrument calibration and tuning, field and lab blank sample analyses, method QC sample results, field duplicates and the presence of any elevated laboratory reporting limits were reviewed. This review occurred monthly with data from the State Laboratory. Water quality data from the Missoula Laboratory were transmitted incrementally in July 2010, December 2010, and January 2011. Due to the delay in receiving water quality results from the Missoula Laboratory, routine data validation was not accomplished for this data; data validation was completed only after incremental receipt of the data.

DATA VALIDATION

Data validation was completed for the 2010 Tri-State Water Quality Council Monitoring Program data. Data review, verification, and validation was completed by monitoring program activity contacts listed in Table 1-2 for the respective data sets, except for Clark Fork River peak flow monitoring which is reviewed by HydroSolutions. The final Monitoring Program 2010 data validation was conducted by the MDEQ Quality Assurance Officer. All 2010 data incorporated in the MT-eWQX and Council's database has been validated.

RESPONSE ACTIONS AND RECOMMENDATIONS

Based on review and validation 2010 Monitoring Program data, the following response actions and recommendations are made:

- Missoula and State Laboratories will continue to verify the pH of incoming samples during the sample drop off process.
- Continue to review and update the peak flow sampling and analysis plan yearly.
- Continue to provide Clark Fork River peak flow monitoring site visit forms for Avista sampling personnel to complete in the field during each of the six sampling events and for the quality control samples to document sample collection.
- Continue conducting field training with Avista sampling personnel to ensure consistency with peak flow sampling protocols and methods.
- Communicate frequently with Missoula Laboratory during Clark Fork River summer nutrient monitoring to ensure all samples have been collected and analyzed within holding times and meet program requirements.
- Request timely receipt of all monthly analytical data including the data reports, quality assurance report, and electronic data deliverable (EDD) from the State and Missoula laboratories to meet contractual reporting schedules. Receiving this information in a timely fashion is necessary to perform routine data verification, for regular monitoring program assessments, and to provide feedback and corrective actions, if necessary.
- Request the University of Montana Watershed Health Clinic Laboratory to provide MT-eWQX compatible EDD when reporting data results including AFDW.
- Verify that dissolved cadmium samples are analyzed with a laboratory reporting limit of 0.08 µg/L rather than at the project required quantitation limit of 1 µg/L, so that results can be compared with the chronic toxicity standard. Propose revising the project required quantitation limit to 0.08 µg/L in the QAPP.
- Missoula Laboratory will develop methods to review associated total and dissolved fractions prior to data (MT-eWQX EDD) submittal.
- The Council to work with the IDEQ to secure adequate funding to complete regular annual water quality monitoring in Lake Pend Oreille as specified in Border Agreement Technical Guidance. A water quality monitoring program that includes annual evaluation of in-lake TP concentrations is essential to determine if the goal of maintaining open lake water quality is being met (TSWQC, 2001). Monitoring will also provide means to detect long-term trends in trophic status of the lake, since it is critical to detect real trends early

enough so that appropriate and effective actions can be taken to protect Lake Pend Oreille water quality (TSWQC, 2001).

DATA UPLOAD

Following the data review and validation process, data from Clark Fork River monthly monitoring, Clark Fork River peak flow monitoring, Clark Fork River summer nutrient monitoring, and Clark Fork River periphyton monitoring are compiled into a single database for inclusion into the MT-eWQX. Following data validation and acceptance by Montana DEQ and the Council's Monitoring Committee, the 2010 Clark Fork—Pend Oreille water quality data were submitted to the National Water Quality Exchange (WQX) Warehouse on May 3, 2010, with WQX Transaction ID: _8a85ba1c-7e6f-48db-a50f-59742a8479e0.

Lake Pend Oreille monitoring data are maintained by the IDEQ and Pend Oreille River monitoring data are maintained by the WDOE.

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