CHERRY CREEK RESERVOIR

2005 ANNUAL AQUATIC BIOLOGICAL - NUTRIENT MONITORING STUDY AND AND COTTONWOOD CREEK PHOSPHORUS REDUCTION FACILITY MONITORING

MARCH 2006

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Submitted To:

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INTRODUCTION

An inter-governmental agreement was executed in 1985 by several local governmental entities within the Cherry Creek basin to form the Cherry Creek Basin Water Quality Authority (CCBWQA). This Authority was created for the purpose of coordinating and implementing the investigations necessary to maintain the quality of water resources of the Cherry Creek basin while allowing for further economic development. Based on a clean lakes water study (Denver Regional Council of Governments [DRCOG] 1984), the Colorado Water Quality Control Commission (CWQCC) set standards for phosphorus, and a TMDL for phosphorus. An in-lake phosphorus standard of 35 µg/L was adopted to maintain a seasonal mean chlorophyll *a* goal of 15 µg/L. Subsequently, a phosphorus TMDL was prepared for the reservoir allocating loads among point sources, background, and nonpoint sources within a net annual load of 14,270 lbs total phosphorus.

The Cherry Creek Basin Master Plan (DRCOG 1985), approved by the CWQCC in 1985, was adopted in part as the "Regulations for Control of Water Quality in Cherry Creek Reservoir" (Section 4.2.0, 5C.C.R.3.8.11). An annual monitoring program (In-Situ, Inc. 1986, as amended, ASI 1994 a and b) was implemented at the end of April 1987 to assist in the assessment of several aspects of the Master Plan. These monitoring studies have included long-term monitoring of 1) nutrient levels within the reservoir and from tributary streams during base flows and stormwaters, 2) nutrient levels in precipitation, and 3) chlorophyll *a* levels within the reservoir.

In September 2000, following a hearing before the CWQCC, the standard for Cherry Creek Reservoir was changed to a July - September mean value of 15 µg/L of chlorophyll *a* to be met nine out of ten years, with an underlying total phosphorus goal of 40 µg/L, also as a July - September mean. In May 2001 at the CWQCC hearing, a new control regulation was adopted for the Cherry Creek Reservoir which maintained the annual allowable total phosphorus load (TMAL) of 14,270 lbs/year as part of a "phased-TMDL" for the reservoir.

In 1994, Chadwick Ecological Consultants, Inc. (CEC) was retained by the CCBWQA to conduct annual aquatic biological and nutrient analyses on Cherry Creek Reservoir and selected tributaries. Results have been summarized in annual monitoring reports (CEC 1995 - 2005). The present study was designed to continue the characterization of the potential relationships between nutrient loading (both in-lake and external) and reservoir productivity. The specific objectives of this annual monitoring study include the following:

- Determine the concentrations of selected nutrients, primarily nitrogen and phosphorus compounds, in Cherry Creek Reservoir and various streams flowing into the reservoir, and the reservoir outflow.

- Determine the pounds of phosphorus entering Cherry Creek Reservoir from streams and precipitation and leaving the reservoir through its outlet.

- Determine biological productivity in Cherry Creek Reservoir, as measured by algal biomass (chlorophyll *a* concentration) and algal densities. In addition, determine species composition of the algal community.

- Determine potential relationships between the nutrient levels and biological productivity in Cherry Creek Reservoir through correlation of the various measurements made during the study.

- Assess the effectiveness of pollutant reduction facilities (PRF) to reduce phosphorus loads into the reservoir.

STUDY AREA

Cherry Creek was impounded in 1950 by the U.S. Army Corps of Engineers (COE) to protect the City of Denver from flash floods that may originate in the 995 km^2 drainage basin. The reservoir has maintained a surface area of approximately 350 ha (approximately 850 acres) since 1959. The reservoir and surrounding state park have also become an important recreational site, providing opportunities for activities that include fishing, boating, swimming, bicycling, bird watching, and hiking.

Sampling Sites

Sampling in 2005 was conducted at ten sites, including three sites in Cherry Creek Reservoir, six sites on tributary streams, and one site on Cherry Creek downstream of the reservoir (Fig. 1). The sampling sites are summarized below:

Cherry Creek Reservoir

CCR-1 This site is also called the Dam site, and was established in 1987. CCR-1 corresponds to the northwest trident within the lake (Knowlton and Jones 1993). Sampling was discontinued at this site in 1996 following determination that this site exhibited similar characteristics to the other two sites in this well-mixed reservoir. Sampling recommenced in July 1998 at the request of consultants for Greenwood Village.

CCR-2 This site is also called the Swim Beach site, and was established in 1987. Site CCR-2 corresponds to the northeast trident within the lake (Knowlton and Jones 1993).

CCR-3 This site is also called the Inlet site and was established in 1987, corresponding to the south trident within the lake (Knowlton and Jones 1993).

Shop Creek

SC-3 This site was established on Shop Creek in 1990 upstream of the Perimeter Road and downstream of the then new Shop Creek detention pond and most of the wetland system. This site was moved just downstream of the Perimeter Road in 1994 and again farther downstream to a location just upstream of its confluence with Cherry Creek in 1997. This site serves to monitor the water quality of Shop Creek as it joins Cherry Creek.

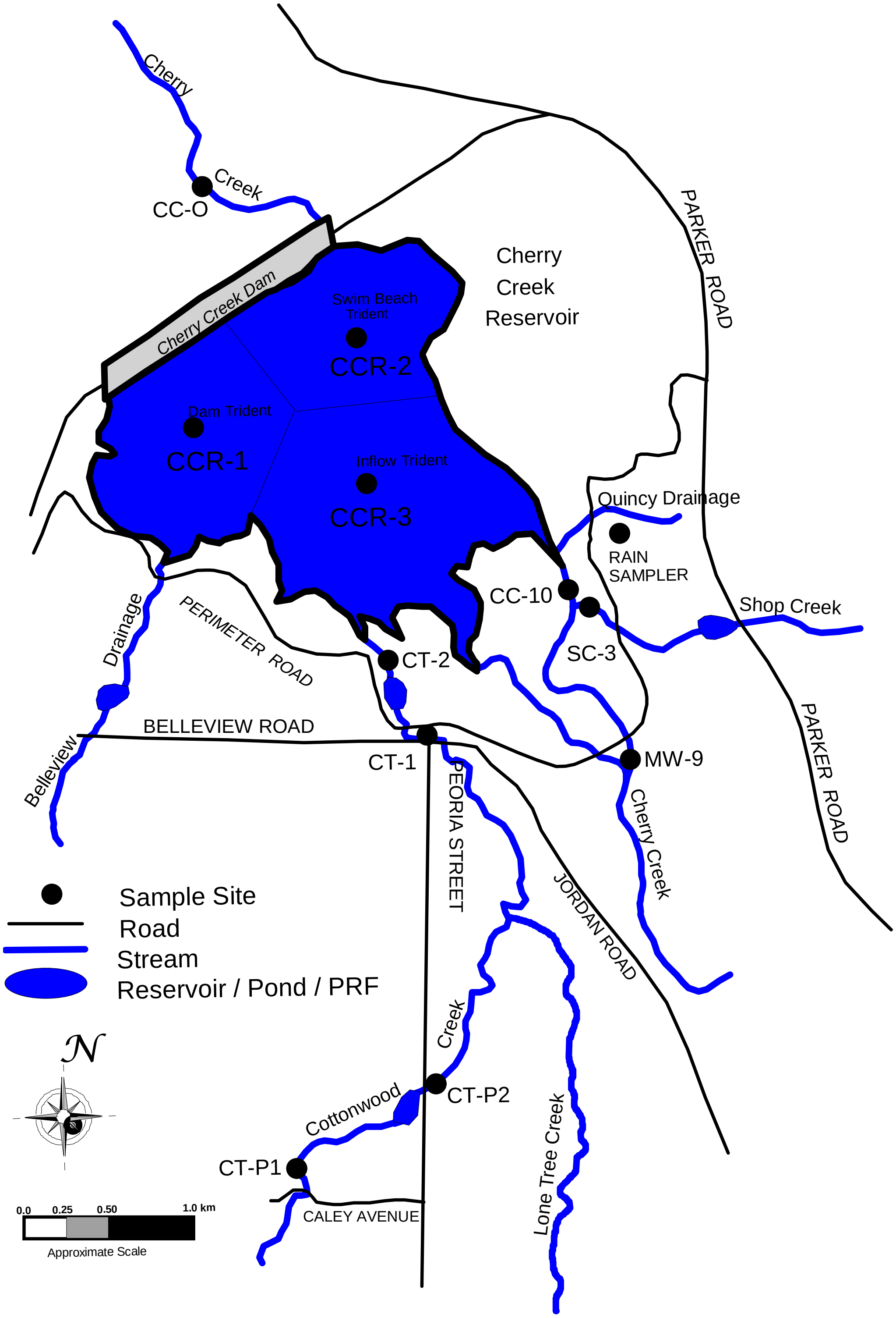

FIGURE 1: Sampling sites on Cherry Creek Reservoir and selected streams, 2005.

Cherry Creek

CC-10 This site was originally established in 1987 on Cherry Creek near the historic USGS "Melvin" gage (roughly due west of the intersection of Parker Road and Orchard Road). This location is in an area of Cherry Creek that frequently becomes dry during summer months as a result of the natural geomorphology and alluvial pumping for domestic water supply (John C. Halepaska & Associates, Inc. [JCHA] 1999, 2000).

In 1995, this site was relocated farther downstream between the Perimeter Road and the reservoir, approximately ½ km upstream of the reservoir. This site was moved still farther downstream in 1996, just upstream of the confluence with Shop Creek and closer to the reservoir. In 1999, it was moved below the confluence with Shop Creek to eliminate the effect of a stream crossing on the CC-10 hydrograph. Since 1995, Cherry Creek has been monitored in a reach with perennial flow, allowing for more accurate monitoring of water quality and surface flows in Cherry Creek before it enters the reservoir.

This site was previously called CC-I (i.e., CC-Inflow), but was renamed CC-10 to place it in context with concurrent monitoring in Cherry Creek mainstem upstream of the reservoir (JCHA 1999 - 2005). Monthly surface flow and water quality data have been collected at sites on Cherry Creek upstream of the Perimeter Road (JCHA 1999 - 2005). These sites extend from the Castlewood site in Castlewood Canyon downstream to Site CC-9 at the Perimeter Road.

CC-O This site was established in 1987 on Cherry Creek downstream of Cherry Creek Reservoir and upstream of the Hampden Avenue-Havana Street junction in the Kennedy Golf Course (near the USGS gage). Site CC-O (i.e., CC-Outflow) monitors the water quality of Cherry Creek downstream of the reservoir outlet.

Cottonwood Creek

CT-P1 This site was established in 2002 and is located just north of where Caley Avenue crosses Cottonwood Creek, west of Peoria Street. This site monitors the water quality of Cottonwood Creek before it enters a new wetland PRF, also created in 2001/2002 on the west side of Peoria Street.

CT-P2 This site was established in 2002 and is located downstream from the PRF, on the east side of Peoria Street. This site monitors the effectiveness of the PRF on water quality.

CT-1 This site on Cottonwood Creek was established in 1987 where the Cherry Creek Park Perimeter Road crosses the stream. It was chosen to monitor the water quality of Cottonwood Creek before it enters the reservoir. During the fall/winter of 1996, a PRF, consisting of a water quality/detention pond and wetland system, was constructed downstream of this site. As a result of the back-flow from this pond, this site was relocated farther upstream near Belleview Avenue in 1997.

CT-2 This site was established in 1996 and is located downstream from the PRF on Cottonwood Creek. This site monitors the effectiveness of this structure on water quality and monitors the quality of Cottonwood Creek before it enters the reservoir.

METHODS

Sampling Methodologies

Field and calculating methods for monitoring the reservoir and study sites follow the Cherry Creek Reservoir Sampling and Analysis Plan (CEC 2003) (Appendix A).

Reservoir Sampling

The general sampling schedule included regular sampling trips to the reservoir at varying frequencies over the annual sampling period, as outlined below, with increased sampling frequency during the summer growing season. Sampling was not conducted in January and December 2005 due to unsafe ice conditions on the reservoir.

Sampling Trips per Sampling Period

Sampling Period	Frequency	Trips/Period
Oct - Apr	Monthly	4
May - Sept	Bi-Monthly	11
	Total	15

During each sampling episode on the reservoir, three main tasks were conducted, including 1) determining water clarity; 2) taking depth profile measurements for temperature, dissolved oxygen, and pH conductivity; and 3) collecting water samples for chemical and biological analyses.

Water Clarity

Transparency was determined using a Secchi disk and double deck photometer. Detailed methods of both instruments can be found in the Sampling and Analysis Plan located in Appendix A.

Profile Measurements

The second task involved taking dissolved oxygen, temperature, conductivity, and pH measurements every meter from the surface to near the bottom of the reservoir to develop depth profiles for each site during each sampling episode. Readings were taken with a Yellow Springs Instrument (YSI) meter, Model #600 XL multi-probe meter. This meter was calibrated prior to each sampling event to ensure accurate measurements.

Water Sampling

Water samples for nutrient, phytoplankton, and chlorophyll *a* analyses were collected at the three lake sites. The Sampling and Analysis Plan in Appendix A outlines the detailed methods used to collect lake water samples, as well as some of the laboratory methods in sample handling and preparation.

Fish Population Data

As in the past, this monitoring study has also reviewed fish stocking and population data collected by the Colorado Division of Wildlife (CDOW). As part of their sampling schedule to reduce mortality to a walleye brood-stock population in Cherry Creek Reservoir, CDOW had been sampling fish populations every two to three years. No sampling has taken place since 2001.

Stream Sampling

Low-Flow/Ambient Sampling. Standard sampling was conducted according to the schedule below during the regular reservoir sampling trips to Cherry Creek Reservoir. This sampling was performed in order to provide information during non-storm event periods, corresponding to the low-flow ambient samples collected in past studies. Monthly samples are assumed to be representative of non-storm, low-flow events.

Sampling Trips per Sampling Period

Sampling Period	Frequency	Trips/Period
Jan - Dec	Monthly	12

Storm Sampling. Storm events were sampled at Site CC-10 on Cherry Creek, Sites CT-1, CT-2, CT-P1, and CT-P2 on Cottonwood Creek, and Site SC-3 on Shop Creek during the 2005 sampling season (Table 1). A detailed outline of storm sampling protocols can be found in Appendix A.

TABLE 1: Number of storm samples collected from tributary streams to Cherry Creek Reservoir, 2005. See Appendix C for sample dates.

	Site						
	SC-3	CC-10	CC-O	CT-1	CT-2	CT-P1	CT-P2
Number of Storm Samples	8	8	8	8	8	8	8

Surface Hydrology

Pressure transducers attached to ISCO Series 4200 or 6700 flowmeters measured and recorded water levels (stage) at six sites on three tributaries to Cherry Creek Reservoir (Fig. 1). These flow meters recorded water depth in 15-minute intervals year round. Streamflow (discharge) was estimated at these six sites using stage-discharge relationships developed for each stream site. Periodic stream discharge measurements were taken using a Marsh McBirney Model 2000 flowmeter. For a complete description of streamflow determination, see Appendix D.

Laboratory Procedures

Nutrient Laboratory Analysis

Nutrient analyses for the water collected in the study, as described above, were conducted by the laboratory of Chadwick & Associates, Inc. (C&A) in Littleton, Colorado (Table 2). Randomly selected water samples were sent to the University of Colorado Center of Limnology for chemical analyses as a quality assurance check. Detailed methodologies and laboratory QA/QC procedures are available from C&A.

TABLE 2: Parameter list, method number, and detection limits for chemical and biological analyses of water collected from Cherry Creek Reservoir and tributaries, 2005.

Parameter	Method	Detection Limit
Total Phosphorus	QC 10-115-01-1-U	2 µg/L
Total Dissolved Phosphorus	QC 10-115-01-1-U	2 µg/L
Orthophosphorus	QC 10-115-01-1-T	3 µg/L
Total Nitrogen	APHA 4500-N B (modified)	4 µg/L
Total Dissolved Nitrogen	APHA 4500-N B (modified)	4 µg/L
Ammonia	QC 10-107-06-3-D	3 µg/L
Nitrate and Nitrite	QC 10-107-04-1-B	5 µg/L
TSS	APHA 2540D	4 mg/L
TVSS	APHA 2540E	4 mg/L
Chlorophyll *a*	APHA 10200 H (modified)	1 µg/L

Biological Laboratory Analysis

Biological analyses of the samples collected in the study were conducted by the University of Colorado Center of Limnology and C&A. These analyses included species identifications and counts for phytoplankton, and analysis of chlorophyll *a*. The methods for these analyses, with appropriate QA/QC procedures, are available from C&A. These analyses provided cell counts per unit volume (cells/mL) and chlorophyll *a* concentrations in µg/L.

Quality Assurance/Quality Control

To ensure data quality, a number of quality assurance checks were used. Throughout the year, a randomly selected duplicate sample was taken at one of the reservoir sites, resulting in approximately 14% of the samples each sampling episode having a QA duplicate. All QA samples were analyzed by the University of Colorado Center for Limnology. No duplicate samples were taken from stream sites. This resulted in approximately 7% of the total samples collected having a QA duplicate, but still provided a reasonable independent assessment of lake water nutrient analyses conducted by C&A.

In addition, field sampling quality control included the use of a field blank. This field blank contained laboratory grade deionized water in a sample container identical to those used in the field collections and was carried through the entire sampling episode. The cap of this container was removed at each reservoir site and left open during the regular sampling effort at that site. Upon completion of sampling at that site, the cap was replaced. One field blank was used for every sampling trip. The field blanks and duplicate samples were analyzed for all the parameters, identical to a routine sample. Chain of custody procedures were observed during the field sampling and delivery of samples to C&A, and for samples shipped to James Saunders.

Detailed methods and results of QA/QC checks performed on the water quality data from the reservoir for 2005, with comparison between labs, are located in Appendix F. This analysis showed that results from the analytical labs were quite similar. As such, all values reported herein are based on the average of results from both laboratories, unless otherwise noted.

Calculation of Phosphorus Loading

Phosphorus loading to Cherry Creek Reservoir from streams and precipitation was estimated for the 2005 calendar year using data on streamflow and precipitation, and their respective concentrations of phosphorus. Detailed discussion of the streamflow measurements and derivation of loads can be found in Appendix D.

Calculation of Long-Term Trends in Cherry Creek Reservoir

Long-term seasonal trends were evaluated for Secchi depth, total phosphorus, and chlorophyll *a* using whole lake mean values between 1987 and 2005. Annual values were compared using linear regression analysis (described below). Additionally, annual results were analyzed using a 95% confidence interval. These analyses were used to determine if there were any significant increasing or decreasing trends in Secchi depth, total phosphorus, and chlorophyll *a* levels over time.

Statistical analyses to determine the relationship between total phosphorus concentration and flow, stage discharge relationship, QA/QC between labs, and comparisons of biological and physical parameters for each site were conducted using SPSS 1999 and NCSS 2000 statistical software (Hintze 2001). Basic descriptive statistics were used to evaluate the distributional characteristics of the data, and to determine whether a variable required transformation to meet the basic assumptions of normality. Square-root transformations were used to increase the symmetry of the data about the mean, approximating a normal distribution. If the transformation did not improve normality, the untransformed data were used in subsequent analyses. The least-squares linear regression was used to estimate slope and then an ANOVA was used to determine if the slope was significantly different than zero. A probability level of < 0.05 was used to indicate statistical significance. In the cases of the linear regressions, the R^2 value provided a measure of how well variance is explained by the regression equation. R^2 values measure the proportion of total variation that is explained or accounted for by the fitted regression line, i.e., it is a measure of the strength of the straight-line relationship.

RESULTS AND DISCUSSION

Reservoir Water Quality

Transparency

The seasonal whole-reservoir mean was 0.97 m (standard deviation of 0.28 m) between July and September 2004 (Fig. 2). The whole-reservoir mean Secchi depth varied from a low of 0.68 m observed in May, September, and October to a high of 2.38 m in early June (Fig. 3). The whole-reservoir mean maximum depth of 1% light transmittance ranged from a high of 3.23 m in late March and early August to a low of 1.33 m in late July. Deepest recorded 1% transmittance values were observed during the period between February and May, and August (mean = 2.94 m, median = 3.06 m). There was a significant negative relationship between Secchi depth and chlorophyll *a* concentration ($p < 0.05$), with chlorophyll *a* accounting for 38% of the variation in Secchi depth. There was no relationship between 1% transmittance and chlorophyll *a*.

Long-Term Secchi Transparency Trends in Cherry Creek Reservoir

In general, seasonal mean (July to September) Secchi depths increased from 1987 to 1996, then decreased in 1997 and have been relative stable since. There is not, however, a statistically significant long-term upward or downward trend ($p > 0.05$) for seasonal mean Secchi depths over the period of record (Fig. 2).

Dissolved Oxygen and Temperature

Analysis of past Cherry Creek Reservoir temperature profiles indicates that stratification occurs when there is a >2°C difference between surface and bottom temperatures (Jones 1998). Differences of approximately 1°C suggest a recent mixing event (Jones 1998). Using the above criteria, Cherry Creek Reservoir was investigated for periods of potential stratification and anoxic levels (Figs. 4 - 9).

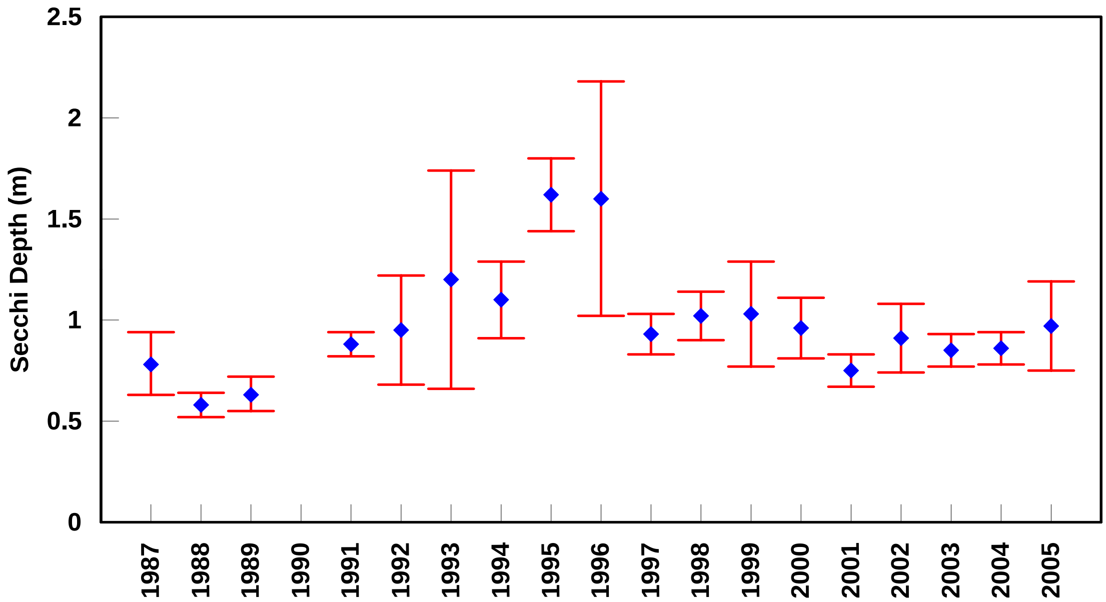

FIGURE 2: Whole-lake seasonal mean (July to September) Secchi depths (m) measured in Cherry Creek Reservoir (1987 to 2005). Error bars represent a 95% confidence interval around each mean.

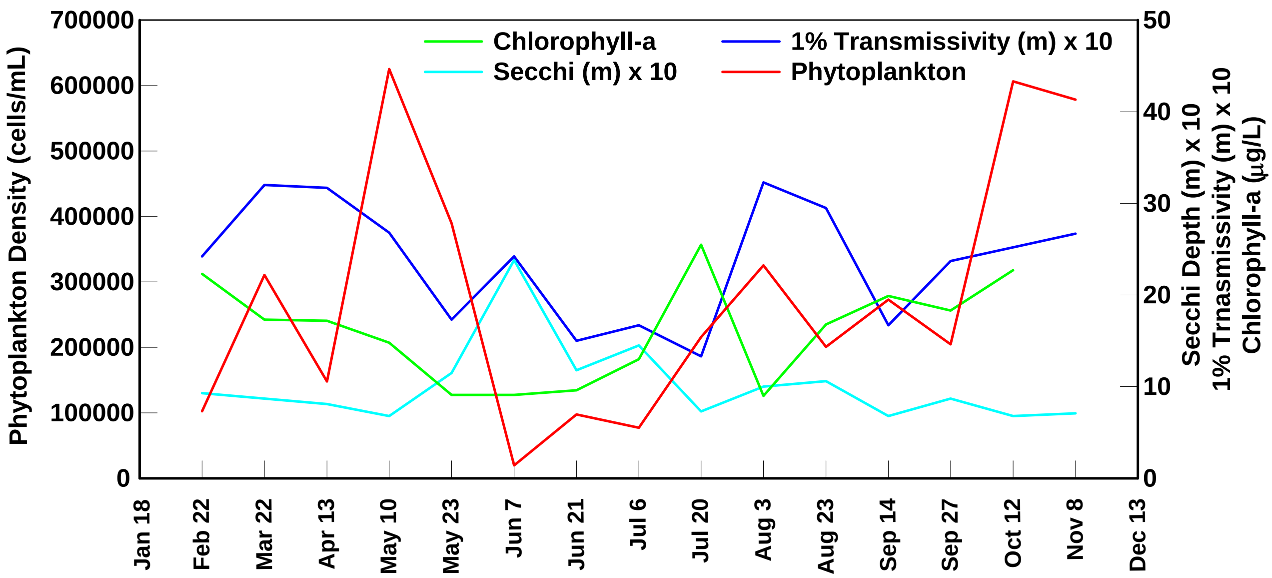

FIGURE 3: Whole-lake annual patterns in phytoplankton density, Secchi depth (× 10), 1% transmissivity (× 10), and chlorophyll *a* in Cherry Creek Reservoir, 2005.

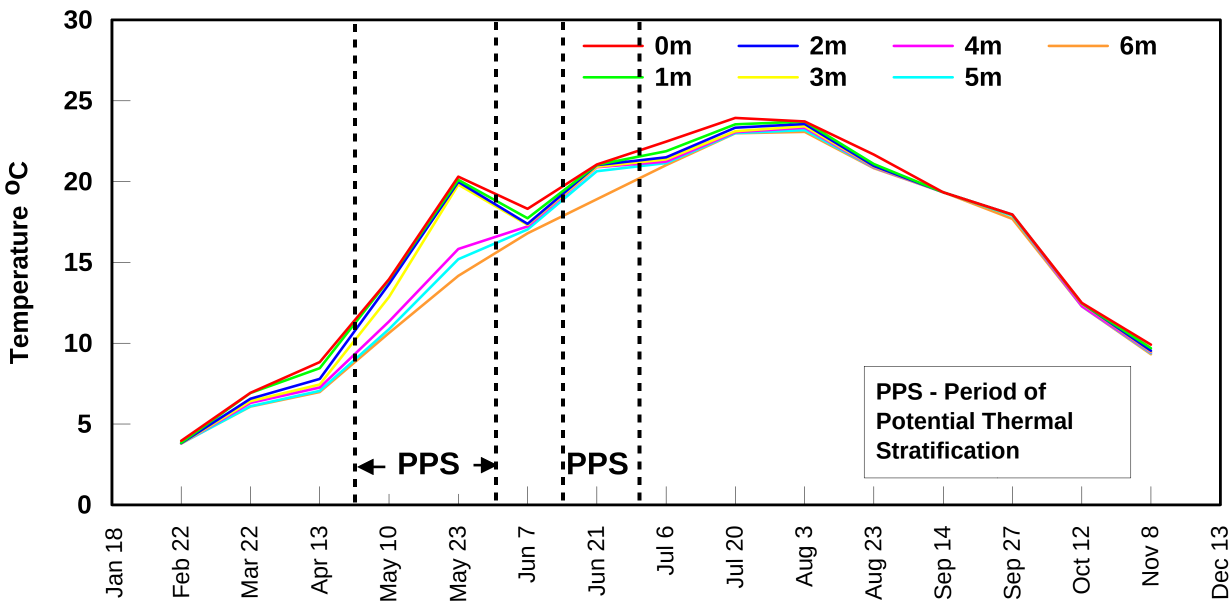

FIGURE 4: Temperature (°C) recorded at depth during routine monitoring at Site CCR-1 in 2005.

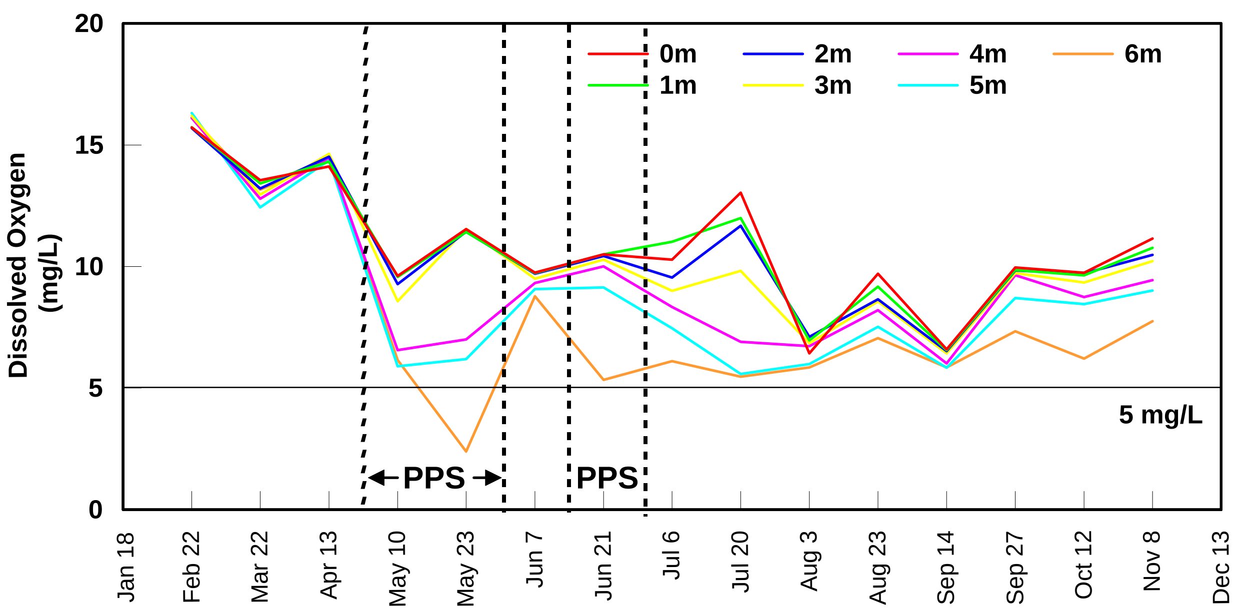

FIGURE 5: Dissolved oxygen (mg/L) recorded at depth during routing monitoring at Site CCR-1 in 2005.

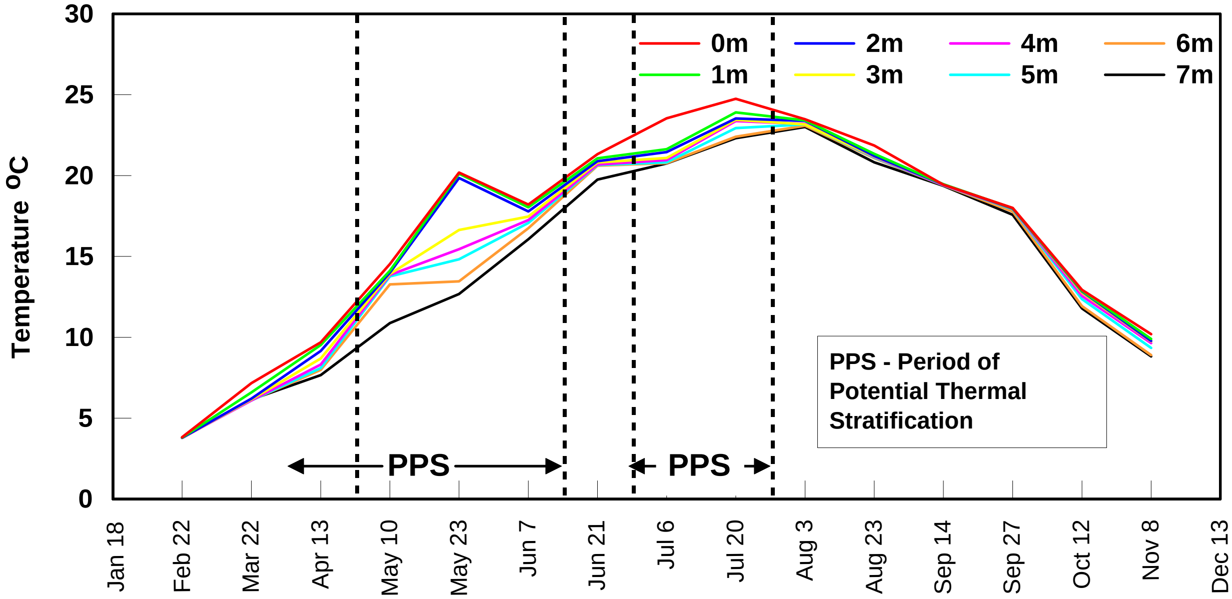

FIGURE 6: Temperature (°C) recorded at depth during routine monitoring at Site CCR-2 in 2005.

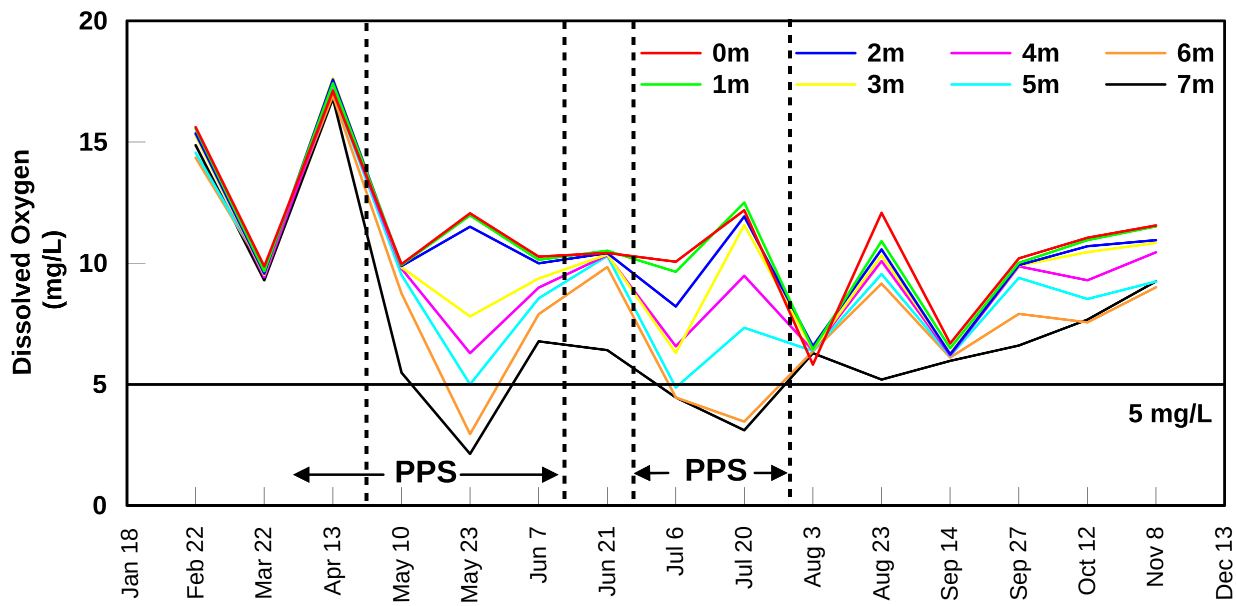

FIGURE 7: Dissolved oxygen (mg/L) recorded at depth during routine monitoring at Site CCR-2 in 2005.

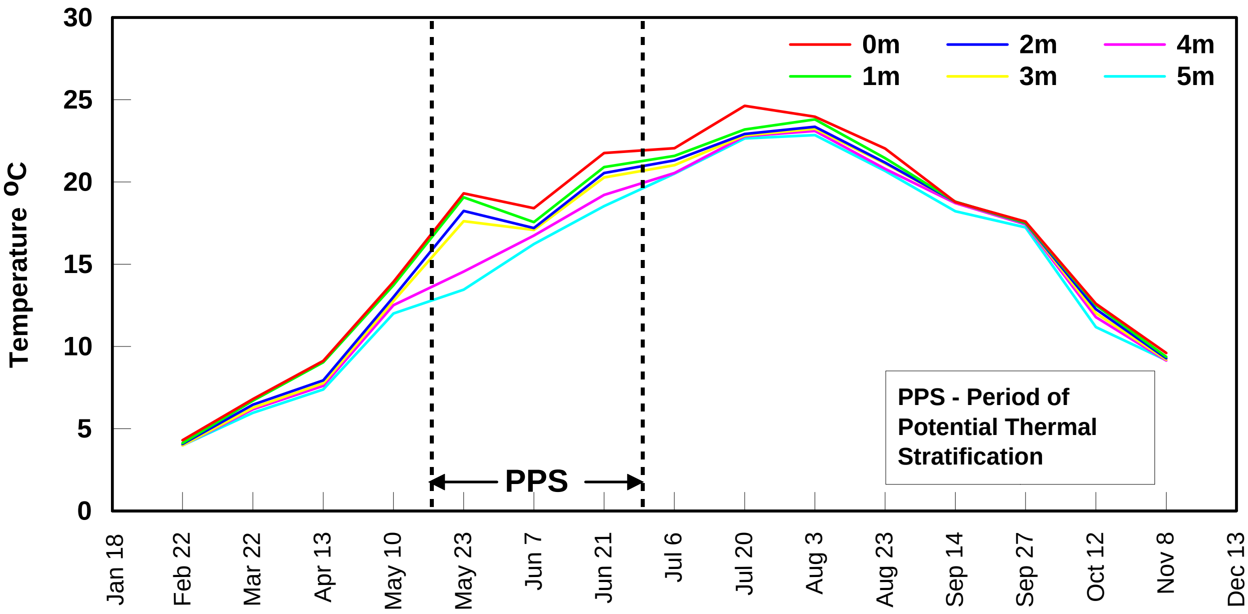

FIGURE 8: Temperature (°C) recorded at depth during routine monitoring at Site CCR-3 in 2005.

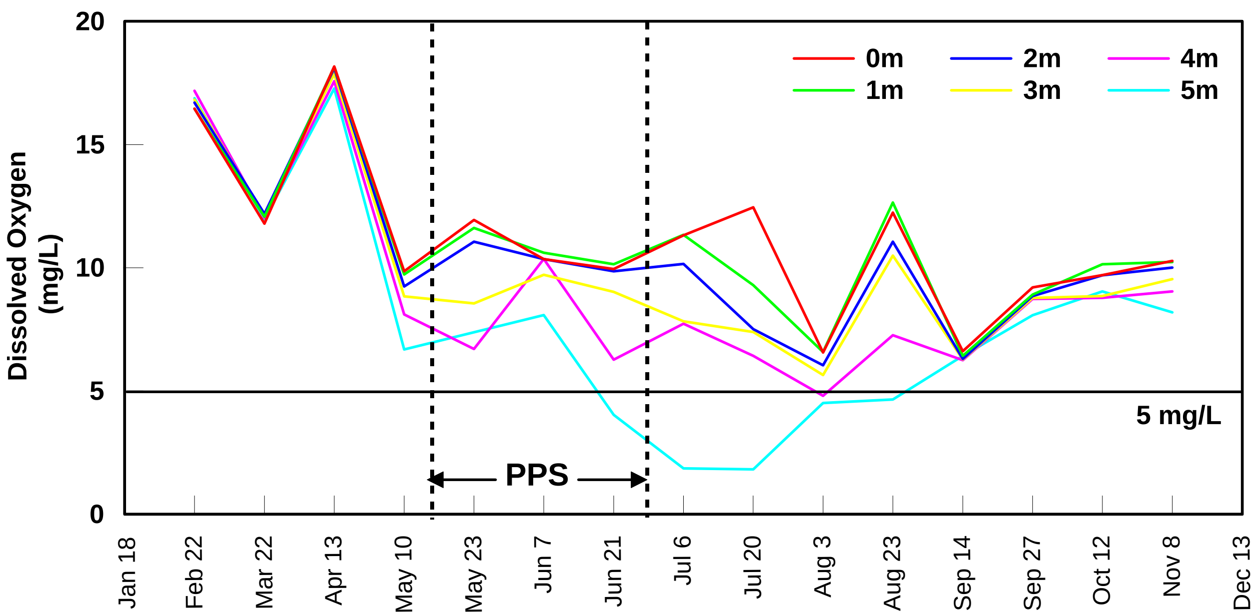

FIGURE 9: Dissolved oxygen (mg/L) recorded at depth during routine monitoring at Site CCR-3 in 2005.

The measured temperature in Cherry Creek Reservoir ranged from a high of 24.75°C in mid-July to a low of 3.79°C in mid-February As in previous years, periods of thermal stratification were observed in the reservoir. These stratification periods were observed at all lake sites (Figs. 4, 6, and 8). May 23 was the only sampling date when the entire reservoir appeared thermally stratified. During all other sampling events, only a portion of the reservoir appeared stratified. Thermal stratification was evident at Site CCR-1 on May 10 and 23, and on June 21. At Site CCR-2, stratification was evident on April13, May 10, May23, June 6. Stratification was also evident at Site CCR-3 on May 23, June 7, June 21, and July 6.

The reservoir was well mixed and oxygenated (DO > 12 mg/L) during the first three sampling events of 2005, February 22, March 22, and April 13. By mid-May, the reservoir began showing signs of thermal stratification and by late May a strong thermocline and oxycline had developed throughout the reservoir. During this period, dissolved oxygen concentrations were typically < 5 mg/L at depths greater than 4 m. While these conditions may have relatively little affect on the biological community, if persistent, microbial mediated anoxia may create favorable conditions for nutrient loading via the sediments.

On two sampling events, August 3 and September 14, the whole reservoir experienced poor dissolved oxygen conditions from the bottom waters to the surface of the reservoir. Dissolved oxygen concentrations ranged between 4.51 to 7.10 mg/L for all sites and depths sampled, which approximates 60% saturation based upon temperature and atmospheric pressure. During the remainder of the sampling events, dissolved oxygen conditions in the epilimnion ranged between 9 to 12 mg/L, and were typically above 75% saturation.

The periods of potential thermal stratification were also compared to occurrences of depressed oxygen levels, those below 5 mg/L. This value has been set by the Colorado Department of Public Health and Environment ([CDPHE] 2001) as the year round warmwater aquatic life standard. For lakes, this criteria is intended to apply to the upper levels when the lake is thermally stratified, i.e., the epilimnion and metalimnion (CDPHE 2000). As such, during those periods when the lake appears to be stratified (i.e., greater than a 2°C difference from surface to bottom), the 5 mg/L criteria would apply primarily to the middle and upper depths (perhaps 4-5 m). However, the 5 mg/L standard applies throughout the water column during mixed conditions.

The concentration and depth distribution of dissolved oxygen were similar at the two deep-water sites, CCR-1 and CCR-2 (Figs. 5 and 7). The DO concentrations at Site CCR-3 followed the same trend as was observed at the deep-water sites, but because of the lesser stratification and shallow depth at this site, the magnitude of DO change was less than that at the deep-water sites (Fig. 9). Significant whole lake mixing events appeared to occur in early July and late July (Figs. 4 - 9).

Reservoir Nutrients

Monitoring at Cherry Creek Reservoir has focused on the concentrations of phosphorus and nitrogen. Phosphorus and nitrogen are inorganic nutrients in aquatic systems and are necessary for life. Often, these nutrients are the limiting factor in the growth of algae (Cole 1979, Goldman and Horne 1983, Wetzel 2001, Cooke *et al*. 1993). Excessive amounts of these nutrients in aquatic systems may result in algal blooms which create aesthetic problems as well as potentially hazardous conditions for aquatic life.

In 2005, the whole reservoir mean concentration of total phosphorus in the photic zone ranged from 66 to 146 µg/L with an overall annual mean of 93 µg/L. Between July and September the concentration of total phosphorus in the photic zone ranged from 88 to 146 µg/L, with a mean of 116 µg/L (Fig. 10). These values are the highest observed on record (Table 3). Over the year, total phosphorus concentration in the photic zone was not significantly related to inflow ($p > 0.05$, $R^2 = 0.05$).

Patterns in nutrient concentrations collected at depth showed a well-mixed reservoir in spring and fall (Fig. 11). It appears there were brief periods of nutrient release from bottom sediments in May, July, and September, as evidenced by increasing TP concentrations with increasing depth (Fig. 11), despite little or no surface inflow to the reservoir (Fig. 10).

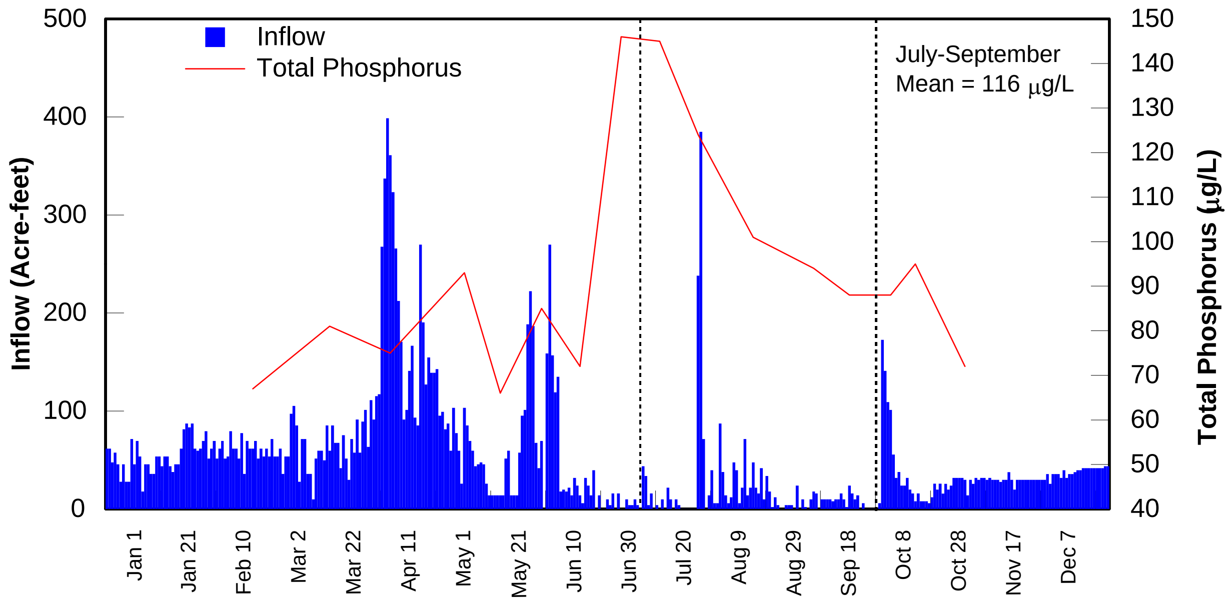

FIGURE 10: Relationship between TP (µg/L) and inflow (AF) in Cherry Creek Reservoir, 2005.

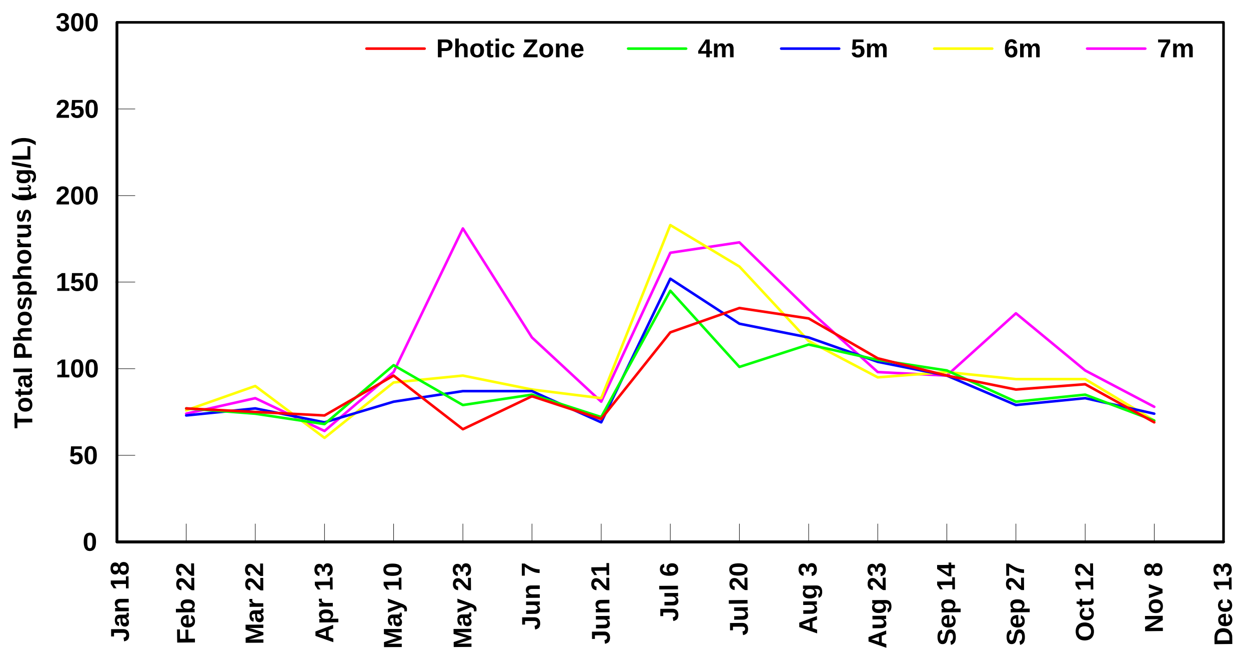

FIGURE 11: Phosphorus concentrations recorded at depth during routine monitoring in 2005.

TABLE 3: Comparison of annual mean (monitoring period) and July-September mean phosphorus, nitrogen, and chlorophyll *a* levels in Cherry Creek Reservoir, 1987 - 2005. Annual means based on January through December sampling.

Year	Source of Data	Total Nitrogen (µg/L) Annual	Total Nitrogen (µg/L) July-Sept.	Total Phosphorus (µg/L) Annual	Total Phosphorus (µg/L) July-Sept.	Mean Chlorophyll *a* (µg/L) Annual	Mean Chlorophyll *a* (µg/L) July-Sept.
1987	In-Situ 1987	1,580	741	86	93	11.1	8.3
1988	In-Situ 1988	902	1,053	52	49	21.8	31.8
1989	ASI 1990	803	828	45	39	8.5	5.6
1990	ASI 1991a	600	--	58	55	2.3	8.6
1991	ASI 1991b	1,067	1,237	86	56	9.7	9.8
1992	ASI 1993	790	970	54	66	12.1	17.0
1993	ASI 1994a	790	826	50	62	12.5	14.4
1994	CEC 1995	1,134	1,144	86	59	4.7	6.2
1995	CEC 1996	910	913	48	48	13.9	15.6
1996	CEC 1997	889	944	54	62	16.9	20.5
1997	CEC 1998	976	1,120	75	96	16.1	22.3
1998	CEC 1999	850	880	82	89	20.4	26.5
1999	CEC 2000	715	753	80	81	20.8	28.9
2000	CEC 2001	784	802	81	81	22.0	25.2
2001	CEC 2002	740	741	81	87	26.7	26.1
2002	CEC 2003	847	858	70	74	21.7	18.8
2003	CEC 2004	990	1,121	87	90	23.2	25.8
2004	CEC 2005	923	977	84	102	17.0	18.4
2005	Present Study	907	990	93	116	16.1	17.1
Long-term average		905	939	71	74	15.7	18.1
Median		889	929	80	74	16.1	18.4

The whole reservoir mean concentration of total nitrogen in the photic zone ranged from 745 to 1,256 µg/L, with a mean of 907µg/L in 2005 (Table 3). During the July to September period, the whole reservoir mean total nitrogen concentration ranged from 804 to 1,256 µg/L, with a mean concentration of 990 µg/L (Table 3).

Long-Term Phosphorus Trends in Cherry Creek Reservoir

In any long-term database, consistency in data analysis (i.e., analytical chemistry) is paramount, especially when evaluating long-term trends. Differences in methodologies or analytical laboratories may bias the data, which hinders the evaluation of potential trends. This is particularly evident in the total phosphorus and chlorophyll *a* database for Cherry Creek Reservoir. This database represents a variety of data produced by different analytical laboratories, and while the same standard method may have been utilized, subtle differences are apparent in the database. Over the long-term period, analytical method detection limits varied and the precision of the analyses appears to have increased with time. During the late 1990s, a transition from Metro Wastewater analytical services to C&A occurred, with the period between 1999 and 2005 representing the most consistent data processing methodologies. Furthermore, 1999 represents a time when a concerted effort was devoted to best management practices throughout the basin, along with PRFs being established along Shop Creek and Cottonwood Creek to control storm flow and reduce the amount of phosphorus entering the reservoir. Therefore, CEC also evaluated trends in the data between 1999 and 2005.

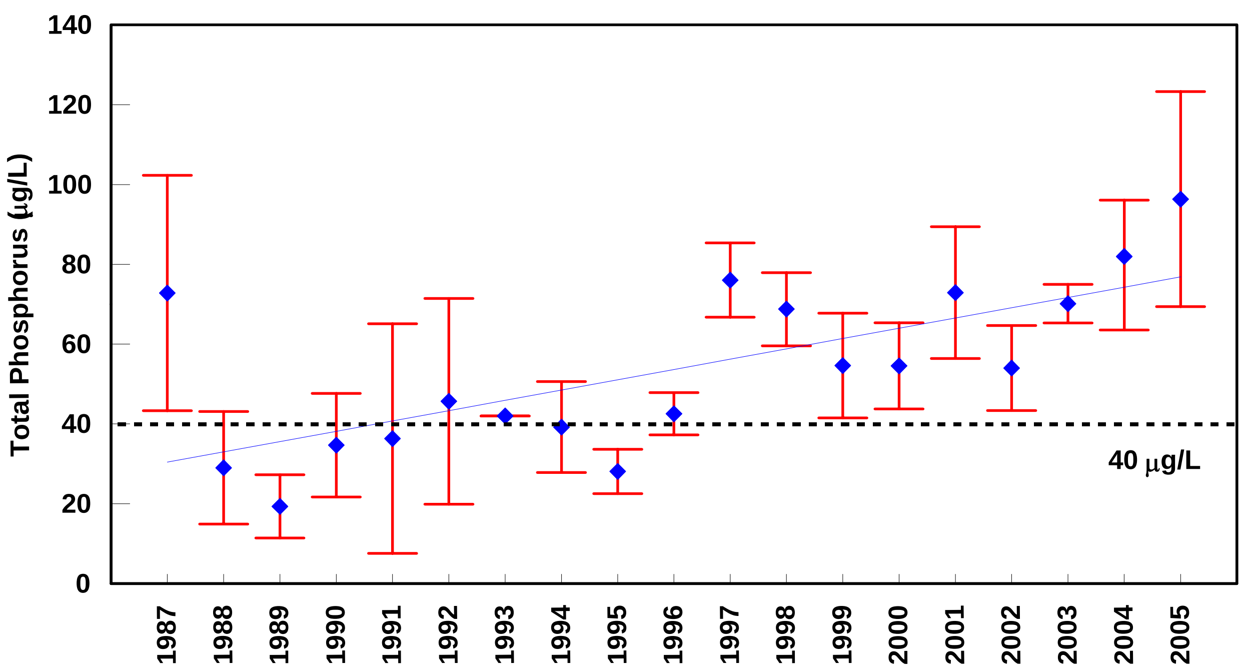

FIGURE 12: Seasonal mean (July to September) total phosphorus concentrations (µg/L) measured in Cherry Creek Reservoir, 1987 - 2005. Error bars represent a 95% confidence interval around each mean.

Routine monitoring data collected since 1987 indicates a generally increasing trend in summer mean concentration of total phosphorus (Fig. 11). In 2005, the summer mean concentration of total phosphorus was 116 µg/L. This value is higher than any values observed previously (Table 3). Regression analyses performed on 1987 - 2005 seasonal mean TP data indicates a significant ($p = <0.01$, slope = 2.6, $R^2 = 0.49$) upward trend, though this significant relationship is likely the result of changes in methodologies that occurred in 1997. With the exception of a value of 39 µg/L in 1989, seasonal mean TP values in Cherry Creek Reservoir have consistently exceeded the goal of 40 µg/L over the past 19 years of monitoring. Analysis of Variance indicates significant differences among the summer mean total phosphorus concentrations ($p < 0.001$) between 1999 and 2005, with the summer of 2005 exhibiting the highest mean total phosphorus concentrations since routine monitoring began.

Chlorophyll *a* Levels

The annual pattern of chlorophyll *a* concentrations revealed relatively low concentrations (9.0 - 9.6 µg/L) of total phosphorus in late May, June, and early August, with peak levels (22.3 - 25.5µg/L) occurring in late February, early July, and October (Fig. 13). The annual mean chlorophyll *a* concentration of 16.1 µg/L is similar to the 2004 value, and is the lowest value since 1997 (Table 3). The July - September mean chlorophyll *a* concentration is 17.1 µg/L, and still exceeded the goal of 15 µg/L for the reservoir.

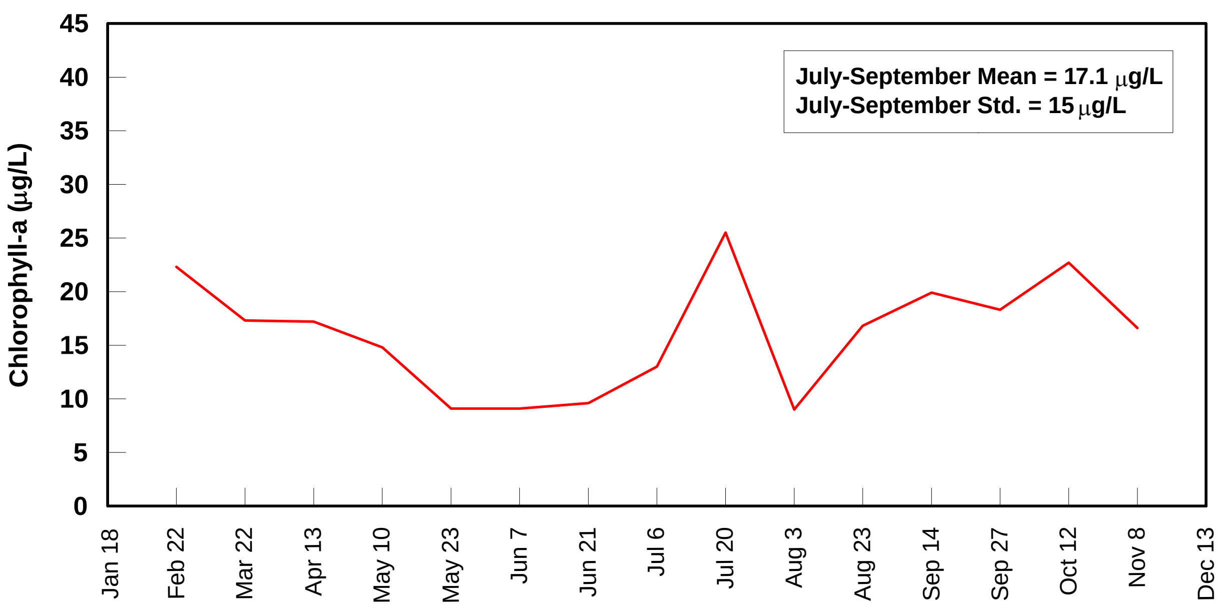

FIGURE 13: Concentration of chlorophyll *a* (µg/L) in Cherry Creek Reservoir, 2005.

Long-Term Chlorophyll *a* Trends in Cherry Creek Reservoir

July to September mean chlorophyll *a* concentrations have met the standard of 15 µg/L only five out of the past 19 years (Fig. 14), and not since 1994. Since 1987, there has been a slight, but significant ($p < 0.05$), increasing trend (slope = 0.66, $R^2 = 0.22$) in the July to September mean concentration of chlorophyll *a* in Cherry Creek Reservoir (Fig. 14).

Analysis of Variance indicates significant differences ($p < 0.05$) among the reservoir summer mean chlorophyll *a* levels from 1999 to 2005, with the 1999 summer mean chlorophyll *a* values being greater than the more recent years of 2002, 2004, and 2005. Since 1999, there has been a significant ($p < 0.01$) decreasing trend (slope = -0.19, R2 = 0.12) in summer mean chlorophyll *a* concentrations.

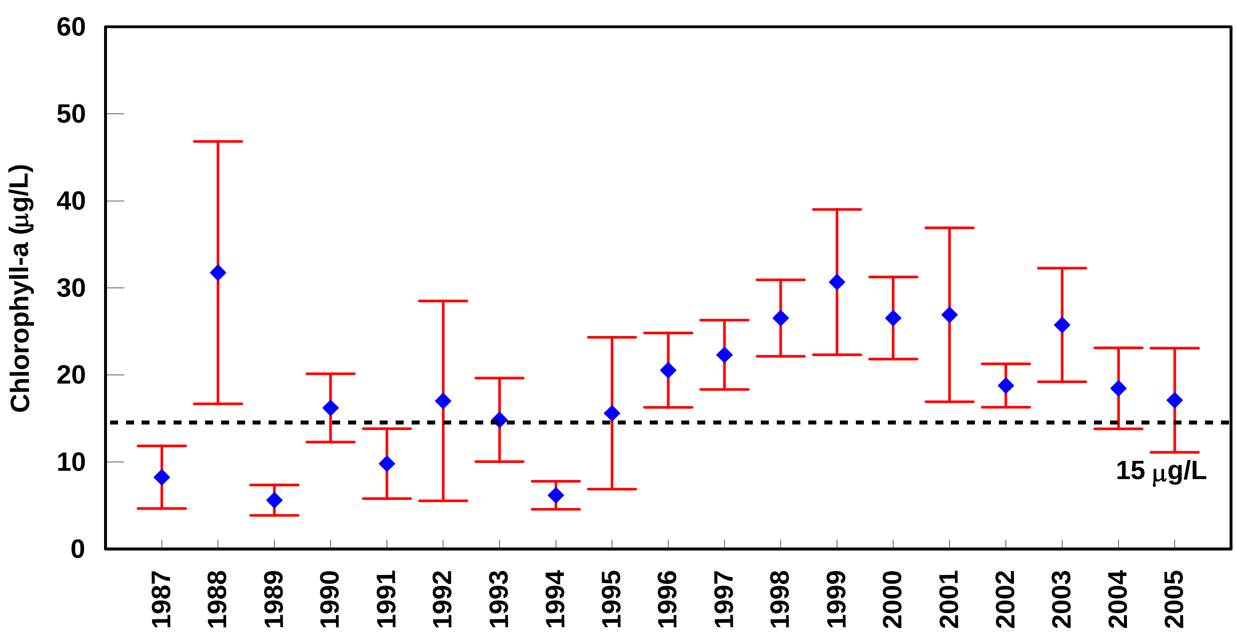

FIGURE 14: Seasonal mean (July to September) chlorophyll *a* concentrations measured in Cherry Creek Reservoir, 1987 to 2005. Error bars represent 95% confidence interval around each mean.

Reservoir Biology

Phytoplankton

Phytoplankton Populations

The photic density of phytoplankton in Cherry Creek Reservoir ranged from 19,811 cells/mL on June 7 to 625,630 cells/mL on May 10 (Table 4). The number of taxa present in the reservoir ranged from a low of 17 on June 7, and reached a high of 62 on September 27. Annually, the community was dominated by green algae. Blue-green algae was the second most prevalent group. Regression analysis found no significant correlation ($p > 0.05$) between phytoplankton density and total phosphorus concentration during 2005. Additionally, no significant relationship could be determined between phytoplankton density and chlorophyll *a* or total nitrogen concentrations.

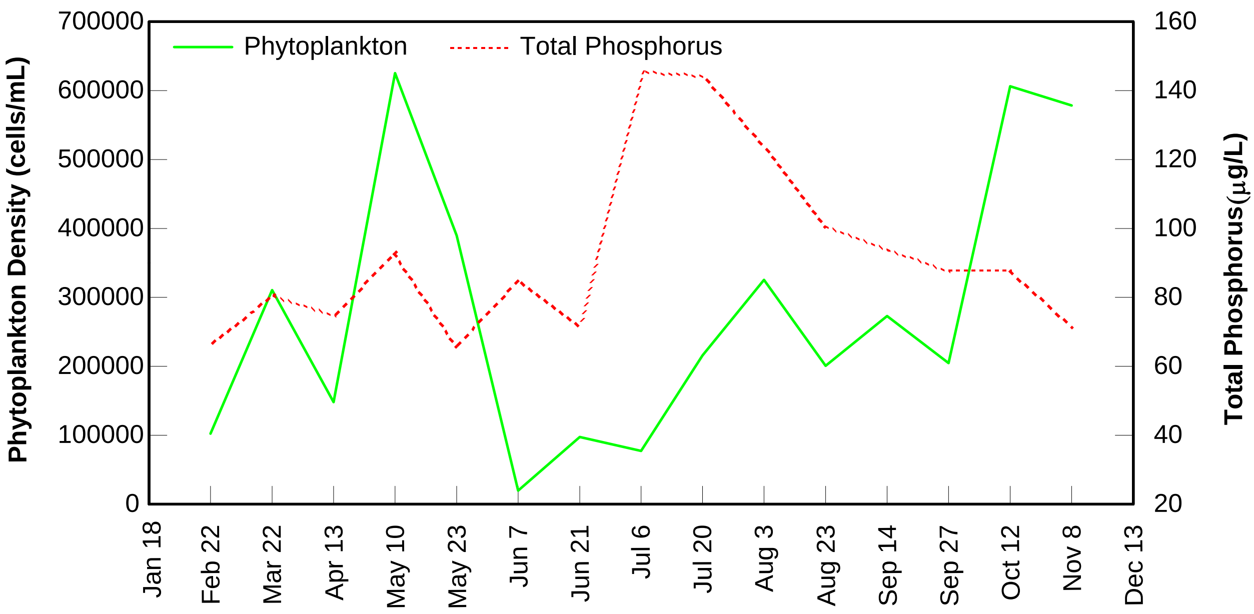

FIGURE 15: Comparison of photic phytoplankton densities from the three reservoir sampling sites to mean total phosphorus concentrations from three sites in Cherry Creek Reservoir, 2005.

TABLE 4: Density (cells/mL) of phytoplankton and total number of taxa collected from all three sites on Cherry Creek Reservoir, 2005.

Taxa	22 Feb	22 Mar	13 Apr	10 May	23 May	7 June	21 June	
Diatoms								
Centrics	60	16	4,805	9,350	1,118	50	5,280	
Pennates	1,260	7,420	970	1,290	515	90	160	
Green Algae	71,098	252,580	121,120	83,700	370,213	8,551	17,950	
Blue-Green Algae	20,040	39,200	6,810	528,820	11,042	9,895	73,720	
Golden-Brown Algae	135	130	110	110	2,730	760	0	
Yellow-Green Algae	0	0	0	0	0	0	0	
Euglenoids	0	0	0	10	4	0	0	
Dinoflagellates	30	170	0	20	1	0	0	
Cryptomonads	1,960	10,440	230	1,110	1,955	465	460	
Haptomonads	6,720	0	13,120	320	1,440	0	0	
Microflagellates	1,030	460	900	500	665	0	0	
Total Density	**102,333**	**310,416**	**148,065**	**625,230**	**389,683**	**19,811**	**97,570**	
Total Taxa	**29**	**22**	**38**	**41**	**44**	**17**	**19**	
Taxa	6 July	20 July	3 Aug	23 Aug	14 Sept	27 Sept	12 Oct	8 Nov
Diatoms								
Centrics	16	3,095	3,105	1,005	2,500	10,525	320	820
Pennates	40	6	40	40	95	90	0	80
Green Algae	7,820	194,220	223,875	14,700	224,735	138,925	567,340	549,825
Blue-Green Algae	64,580	5,940	95,500	178,335	42,640	53,040	35,812	21,940
Golden-Brown Algae	1,000	5	0	0	0	35	5	0
Yellow-Green Algae	0	0	1	5	0	0	0	0
Euglenoids	1	0	30	45	250	50	200	1
Dinoflagellates	10	555	50	35	32	1	0	0
Cryptomonads	3,770	11,760	2,600	3,155	1,310	1,850	2,550	5,780
Haptomonads	0	0	0	0	40	0	0	0
Microflagellates	30	0	20	3,480	1,360	100	20	0
Total Density	**77,267**	**215,581**	**325,221**	**200,800**	**272,962**	**204,616**	**606,247**	**578,446**
Total Taxa	**30**	**41**	**52**	**57**	**60**	**62**	**43**	**37**

Historic Phytoplankton

The phytoplankton community was dominated by green (68%) and blue-green (28%) algae in 2005 (Table 5). The dominance of green algae over blue-green algae is only the third occurrence since 1984, and furthermore, the third in the last four years. Historically, the blue-green algae have dominated the phytoplankton community. The proportions of the phytoplankton community comprised by diatoms, golden-brown algae, and dinoflagellates were similar to the long-term mean density. Additionally, the cryptomonad density was greater than the long-term mean density, while euglenoids were less than the long-term mean density.

Fish Populations

Historically, the fish community in Cherry Creek Reservoir has been composed of many species, including omnivores, insectivores, zooplanktivores, and piscivores. Fish can exert a strong influence on the structure and productivity of phytoplankton and zooplankton communities through food web pathways between different levels (phytoplankton, zooplankton, and fish) of the aquatic ecosystem (Carpenter *et al.* 1985). In addition, these trophic dynamics can affect the variability, distribution, and ratios of limiting nutrients, such as phosphorus and nitrogen (Vanni *et al*. 1996). Mechanisms that may possibly result because of fish predation include decreased herbivory by zooplankton when fish are abundant, modification of nutrient recycling rates by herbivorous zooplankton as fish abundance varies, and nutrient recycling by fish (Vanni and Layne 1996).

Stocking data from the Colorado Division of Wildlife (CDOW) shows that ten species and two hybrids have been stocked in Cherry Creek Reservoir from 1985 to 2005 (Table 6). The two stocked hybrids were the wiper, a cross between the striped bass and the white bass, and the tiger musky, a cross between a northern pike and a muskellunge. Of these 12 stocked fish taxa, rainbow trout and walleye have been stocked every year. Four fish species were stocked in 2005 (Table 6): rainbow trout, walleye, wiper, and channel catfish.

TABLE 5: Reservoir mean phytoplankton density (cells/mL) and number of taxa in Cherry Creek Reservoir, 1984 to 2005.

Density, Richness	1984	1985	1986	1987	1988	1989	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Blue-Green Algae																					
Density	71,780	66,496	99,316	168,259	155,180	273,175	307,691	77,516	15,708	10,015	18,194	16,599	19,716	44,951	15,263	164,290	148,691	941	54,114	165,677	79,154
Taxa Richness	7	7	6	18	24	24	14	16	7	3	7	9	10	11	8	19	12	3	21	27	19
Green Algae																					
Density	5,864	11,760	25,595	11,985	19,177	55,415	18,688	41,899	1,198	314	355	738	2,461	1,809	898	43,881	33,217	1,973	55,190	56,236	189,777
Taxa Richness	11	10	13	58	76	66	46	48	16	2	11	11	18	18	18	71	56	27	70	75	66
Diatoms																					
Density	1,776	3,863	5,428	10,677	12,880	9,311	4,160	1,243	946	194	2,189	2,354	1,109	628	838	12,019	5,256	978	2,026	1,720	3,610
Taxa Richness	6	4	7	34	30	31	21	11	15	2	15	13	8	18	16	34	22	24	22	26	24
Golden-Brown Algae																					
Density	--	7	125	469	56	505	821	93	158	3	63	249	227	56	--	391	1346	34	44	57	335
Taxa Richness	--	1	1	6	4	7	5	4	1	1	2	4	2	2	--	14	13	3	5	5	4
Euglenoids																					
Density	514	135	208	251	276	108	89	23	231	196	304	409	838	698	1252	126	91	22	308	24	39
Taxa Richness	2	1	1	9	9	6	3	5	2	1	2	3	3	3	1	6	4	3	9	11	8
Dinoflagellates																					
Density	--	13	19	19	83	28	23	54	--	31	5	21	--	18	45	80	157	193	20	57	60
Taxa Richness	--	1	1	2	4	3	2	2	--	1	2	4	--	2	2	8	6	5	3	5	6
Cryptomonads																					
Density	1,513	718	1,113	1,090	2,689	1,689	628	529	332	450	919	1,104	1,487	1,393	559	2,472	2,851	355	3,282	3,158	3,293
Taxa Richness	2	3	3	6	4	5	2	3	1	1	1	1	1	1	1	4	6	4	8	8	9
Miscellaneous																					
Density	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,923	5,714	15	1,294	164	2,014
Taxa Richness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	1	3	6	6
Total Density	**81,447**	**82,992**	**131,804**	**192750**	**190,341**	**340,231**	**329,773**	**121,357**	**18,573**	**11,203**	**22,029**	**21,474**	**25,838**	**49,453**	**18,855**	**225,182**	**197,323**	**4,510**	**116,278**	**227,093**	**278,282**
Total Taxa	**28**	**27**	**32**	**133**	**151**	**142**	**93**	**89**	**42**	**11**	**40**	**45**	**39**	**55**	**46**	**157**	**120**	**70**	**141**	**164**	**142**

The size of stocked fish has been variable both between species and within a given species. For example, channel catfish are stocked as fingerlings, rainbow trout as juveniles and adults, and walleye as fry (Table 6). Tiger musky are stocked as juveniles. Wipers have been stocked mostly as fry, but the CDOW did stock 10-inch long wipers in 1992. Other popular gamefish species stocked in smaller quantities and less regular intervals included largemouth bass and bluegill. The CDOW has not conducted any fish population sampling in Cherry Creek Reservoir since 2001.

Phosphorus Concentration in Streams

The mean annual concentration of total phosphorus in streams ranged from a low of 73 µg/L at CT-P1 to a high of 229 µg/L at CC-10 (Table 7). At most stream sites, the summer (July to September) mean concentration of total phosphorus was higher than the annual mean. The summer mean concentration of total phosphorus ranged from a low of 84 µg/L at Site CT-P1 to a high of 240 µg/L at Site CC-10. As expected, the concentration of total phosphorus measured in the storm flows in these streams was generally higher than that observed under base flow conditions. The mean concentration of total phosphorus in storm samples ranged from a low of 192 µg/L at Site SC-3 to a high of 351 µg/L at Site CC-10.

Long-Term Trends in Phosphorus Concentrations in Cherry Creek Reservoir Tributaries

Additional analyses were performed on data from the three main tributaries at sites directly upstream of Cherry Creek Reservoir (Sites CC-10, SC-3, and CT-2) to determine trends in phosphorus and orthophosphate concentrations from 1995 to 2005. Over this period, mean phosphorus concentration was highest at Site CC-10 (223 µg/L) and lowest at Site CT-2 (81 µg/L) (Table 8). Mean orthophosphate concentration was also highest at Site CC-10 (172 µg/L) and lowest at Site CT-2 (12 µg/L). Orthophosphate comprised 77% of the total phosphorus concentrations measured at Site CC-10 and 71% at Site SC-3. At Site CT-2, orthophosphate made up only 15% of total measured phosphorus (Fig. 16).

TABLE 6: Quantity and size of fish stocked in Cherry Creek Reservoir, 1985 to 2005.

Year	Species	Size (inches)	Number
1985	Black crappie	5	7,234
	Channel catfish	2-8	116,784
	Rainbow trout	8-12	75,753
	Walleye	0.3	2,346,000
	Yellow perch	2	90,160
1986	Bluegill	1	111,968
	Channel catfish	4	25,594
	Cutthroat trout	6	52,228
	Rainbow trout	2-18	414,136
	Tiger musky	5-6	4,723
	Walleye	0.3	1,734,000
	Wiper	0.2	80,000
1987	Bluegill	0.2	70,000
	Channel catfish	4	25,600
	Largemouth bass	5	10,000
	Rainbow trout	2-26	129,715
	Tiger musky	7	4,000
	Walleye	0.2	1,760,000
1988	Channel catfish	3	16,000
	Largemouth bass	5	10,000
	Rainbow trout	9-10	293,931
	Tiger musky	8	4,500
	Walleye	0.2	1,760,000
1989	Channel catfish	2-4	10,316
	Largemouth bass	6	8,993
	Rainbow trout	8-22	79,919
	Walleye	0.2	1,352,000
	Wiper	0.2	99,000
1990	Channel catfish	3-4	25,599
	Rainbow trout	9-15	74,986
	Tiger musky	8	2,001
	Walleye	0.2	1,400,000
	Wiper	1	8,996
1991	Channel catfish	3	13,500
	Rainbow trout	9-10	79,571
	Tiger musky	5-8	6,500
	Walleye	0.2	1,300,000
	Wiper	1	9,000
1992	Blue catfish	3	9,000
	Channel catfish	4	13,500
	Rainbow trout	9-10	101,656
	Tiger musky	7	4,940
	Walleye	0.2	2,600,000
	Wiper	10	15,520
1993	Channel catfish	4	13,500
	Rainbow trout	9-10	92,601
	Tiger musky	9	4,500
	Walleye	0.2	2,600,000
	Wiper	1	9,003

TABLE 6: Continued.

Year	Species	Size (inches)	Number
1994	Blue catfish	3	21,000
	Channel catfish	4	23,625
	Cutthroat trout	9	9,089
	Flathead catfish	1	148
	Tiger musky	8	900
	Walleye	0.2	2,600,000
	Wiper	1-4	26,177
	Rainbow trout	9-18	62,615
1995	Channel catfish	4	18,900
	Rainbow trout	9-20	139,242
	Tiger musky	8	4,500
	Walleye	0.2	2,600,000
	Wiper	1	4,500
1996	Channel catfish	3	8,100
	Cutthroat trout	9-10	85,802
	Tiger musky	7	3,500
	Rainbow trout	4-22	163,007
	Walleye	0.2	3,202,940
	Wiper	1	8,938
1997	Channel catfish	3	13,500
	Cutthroat trout	3-9	22,907
	Rainbow trout	10-24	74,525
	Tiger musky	6	4,500
	Walleye	0.2	2,600,000
	Wiper	1	9,000
1998	Channel catfish	4	7,425
	Rainbow trout	10-12	59,560
	Tiger musky	7	4,000
	Walleye	1.5	40,000
	Wiper	1.3	9,000
1999	Channel catfish	3.5	13,500
	Rainbow trout	10-19	32,729
	Tiger musky	7	3,000
	Walleye	0.2	2,400,000
	Wiper	1.3	9,000
2000	Channel catfish	4.1	13,500
	Northern pike	–	46
	Rainbow trout	4.5-20.3	180,166
	Rainbow/Cutthroat trout hybrid	–	5,600
	Tiger musky	8	4,086
	Walleye	0.23	2,400,000
2001	Channel catfish	3.5	13,500
	Rainbow trout	10-19	23,065
	Tiger musky	7	4,000
	Walleye	0.2	2,400,000
2002	Rainbow trout	10	13,900
	Tiger musky	7	4,000
	Walleye	0.2	2,519,660
2003	Rainbow trout	10-11	30,111
	Walleye	0.25	4,136,709
	Channel catfish	2-2.5	33,669

TABLE 6: Continued.

Year	Species	Size (inches)	Number
2004	Rainbow trout	10-11	43,553
	Walleye	0.25	2,874,100
	Channel catfish	2.5	13,500
2005	Rainbow trout	10.4	43,248
	Walleye	0.25	2,579,939
	Wiper	0.18	200,000
	Channel catfish	2.2	13.500

TABLE 7: Comparison of mean baseflow and mean stormflow concentrations of total phosphorus (TP) and total suspended solids (TSS) in tributaries to Cherry Creek Reservoir, 2005.

	Baseflow Samples				Storm Samples	
	Summer		Annual		June - September	
Stream, Site	TP (µg/L)	TSS (mg/L)	TP (µg/L)	TSS (mg/L)	TP (µg/L)	TSS (mg/L)
Cherry Creek						
CC-10	240	25	229	27	351	94
CCO	130	34	95	23	130	25
Cottonwood Creek						
CT-1	72	34	88	46	339	226
CT-2	111	76	99	50	221	95
CT-P1	84	24	73	20	239	93
CT-P2	98	42	77	29	251	90
Shop Creek						
SC-3	228	14	146	14	192	30

TABLE 8: Comparison of annual total phosphorus and orthophosphate concentrations for Sites CC-10, SC-3, and CT-2 from 1995 to 2005.

		Stream Site		
		CC-10	SC-3	CT-2
Total Phosphorus (µg/L)	Minimum	153	52	40
	Maximum	347	346	156
	Mean	223	146	81
Orthophosphate (µg/L)	Minimum	113	20	5
	Maximum	251	272	28
	Mean	172	105	12

Concentrations of total phosphorus have exhibited no trends over time at Site CC-10 ($p > 0.05$, Fig. 17). Concentrations of orthophosphate at Site CC-10 (Fig. 18) were also not significantly related to time ($p > 0.05$). The relationship between total phosphorus and with orthophosphate concentration with time was significant and indicated a slight upward trend at Site SC-3 (Fig. 20) with an apparent increase in variability in recent years. This may be an indication of potentially reduced effectiveness of the Shop Creek wetlands over time. Both the total phosphorus and especially orthophosphate show a decreasing trend at Site CT-2 (Figs. 21 and 22), with the trend statistically significant for orthophosphate ($p < 0.001$, $R^2 = 0.39$, slope = −0.02). The observed downward trend and strongly reduced variability in orthophosphate concentrations at Site CT-2 from 1995 - 2005 may be an indication of the increasing effectiveness of the Cottonwood Creek PRF, which was installed in 1996, and the addition of the Peoria wetland in 2002. There appears to be a seasonal pattern in phosphorus concentration at all sites, which is not specifically addressed in the trend analysis.

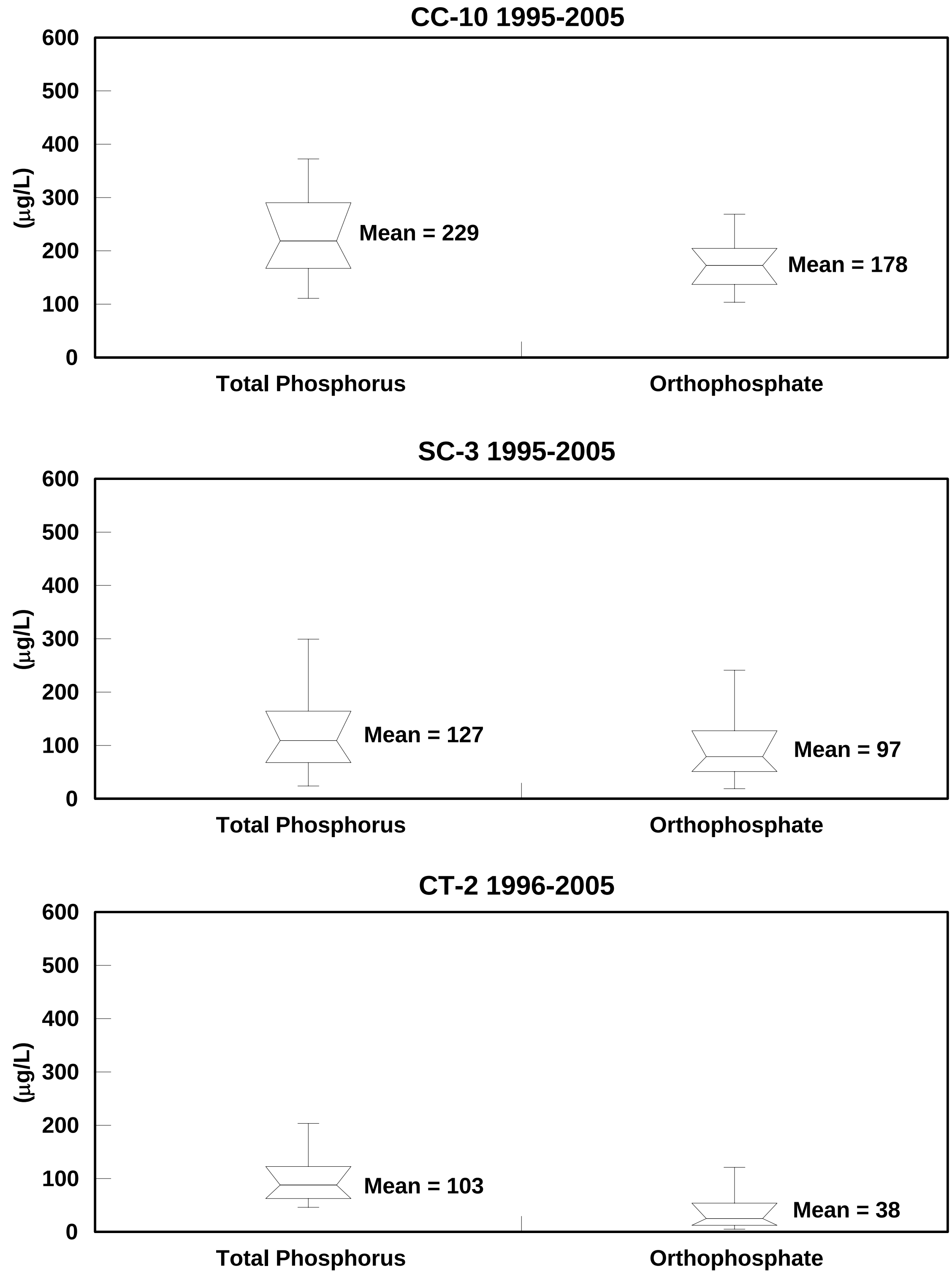

FIGURE 16: Total phosphorus and orthophosphate mean concentrations and box-plots in Cherry Creek Reservoir upstream tributaries (1995 - 2005).

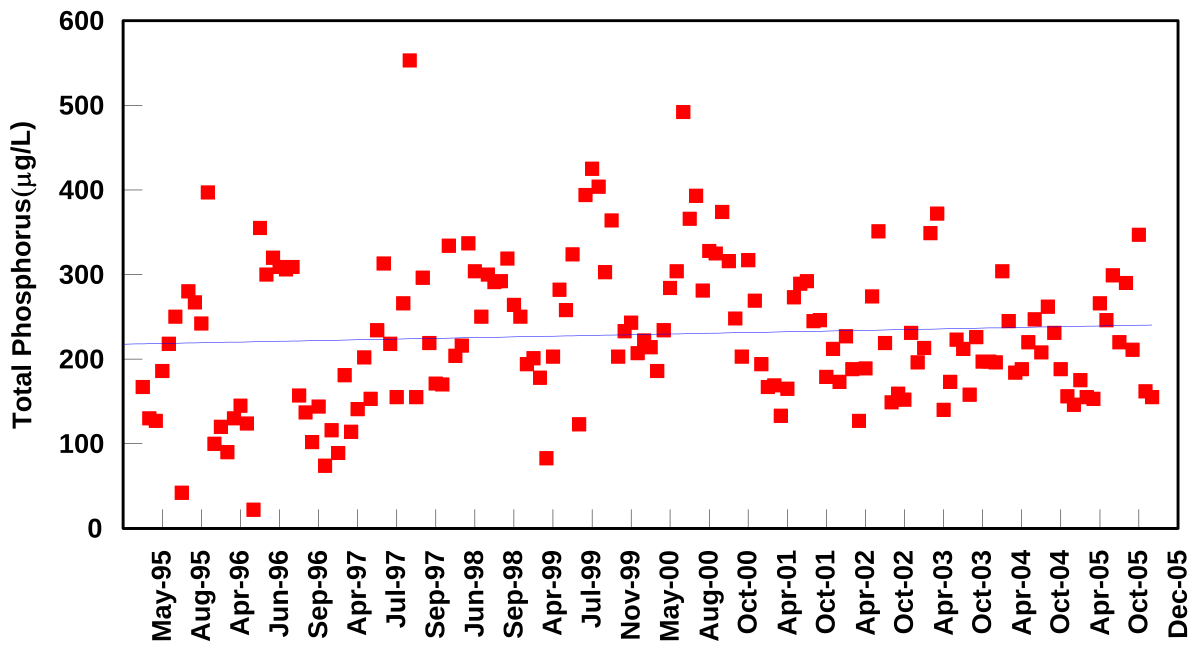

FIGURE 17: Mean total phosphorus concentrations measured in Site CC-10 (1995 - 2005).

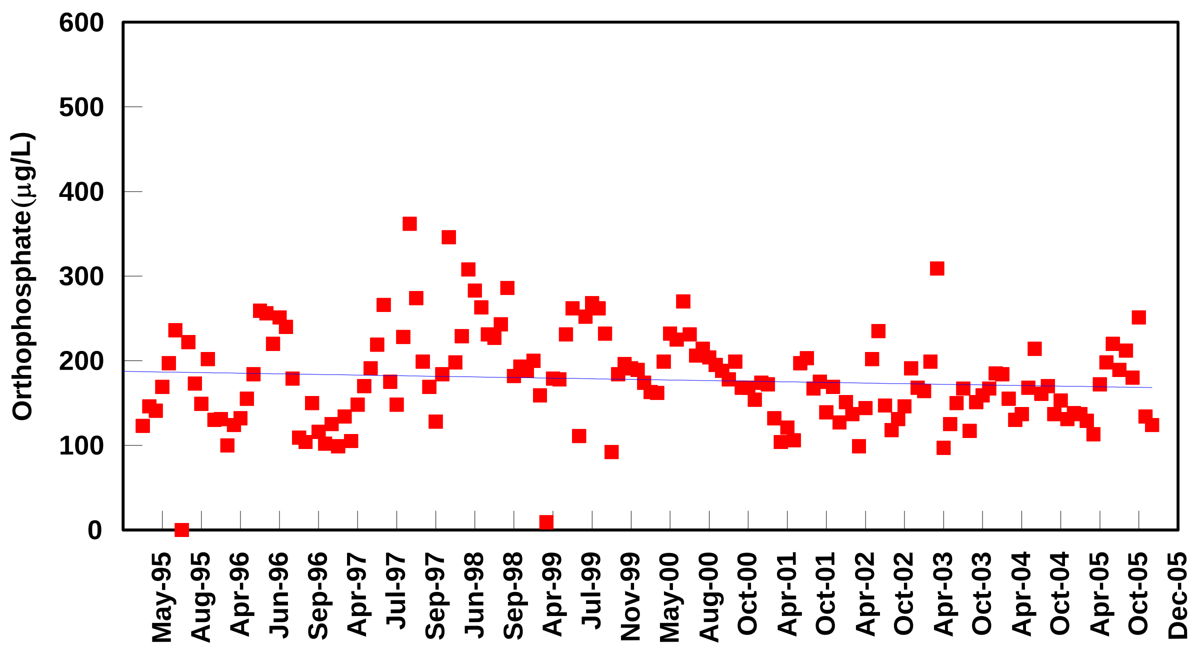

FIGURE 18: Mean orthophosphate concentrations measured in Site CC-10 (1995 - 2005).

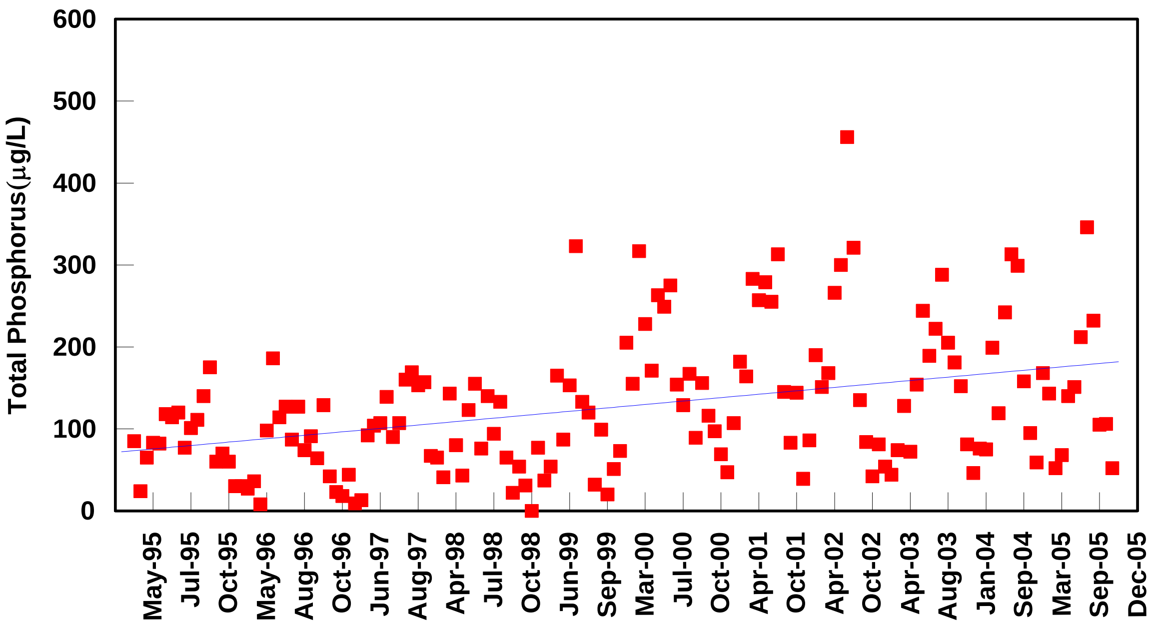

FIGURE 19: Mean total phosphorus concentrations measured in Site SC-3 (1995 - 2005).

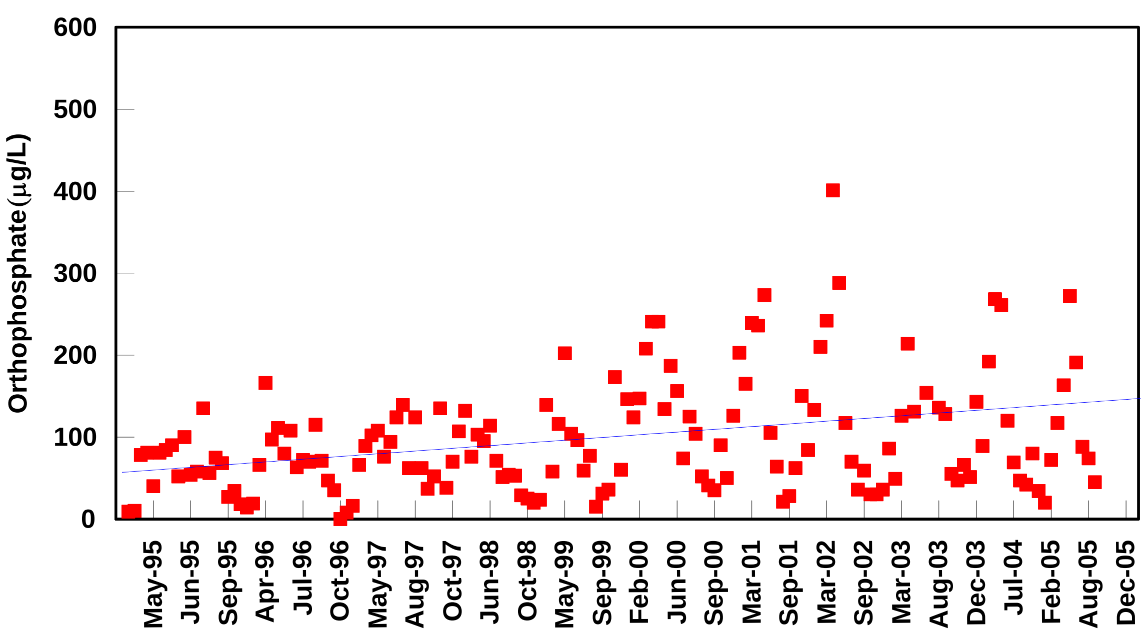

FIGURE 20: Mean orthophosphate concentrations measured in Site SC-3 (1995 - 2005).

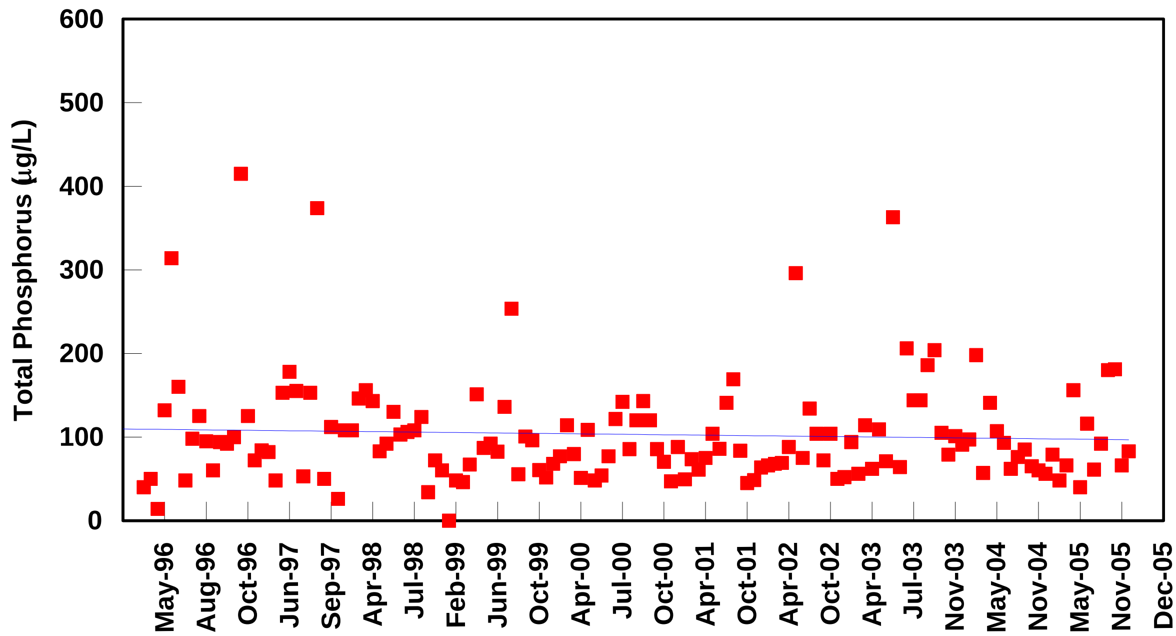

FIGURE 21: Mean total phosphorus concentrations measured in Site CT-2 (1995 - 2005).

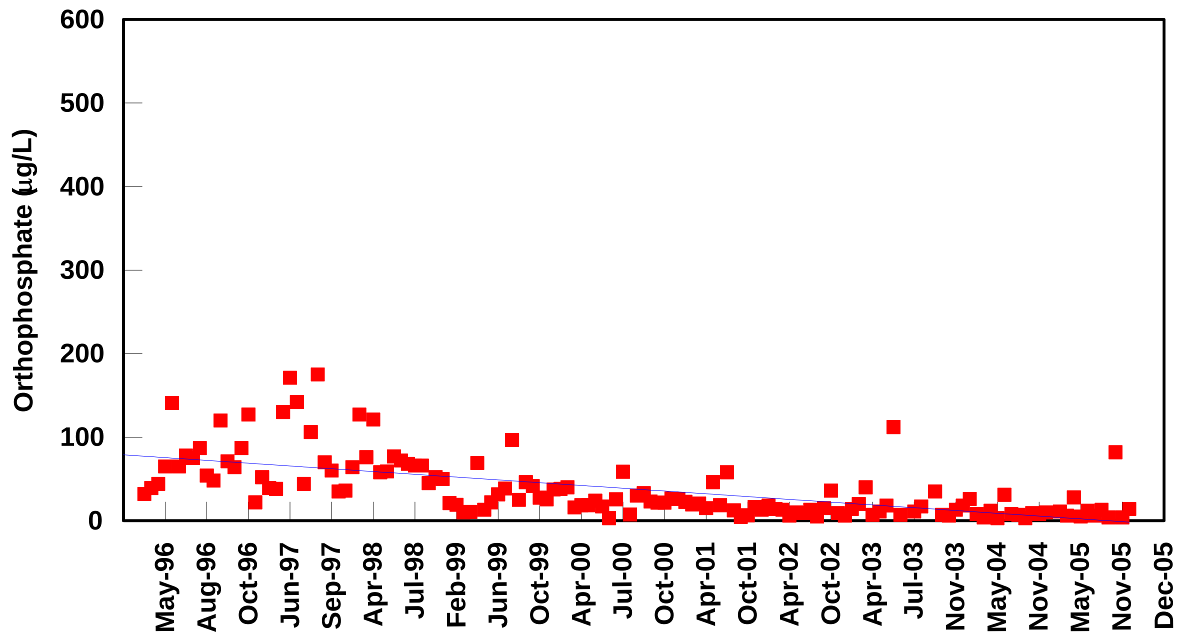

FIGURE 22: Mean orthophosphate concentrations measured in Site CT-2 (1995 - 2005).

Long-Term Trends in Phosphorus Concentrations in Cherry Creek Reservoir Alluvium

Long-term data for alluvial phosphorus concentrations from Site MW-9 were obtained from Halepaska (2005). These data were used to estimate loadings from alluvial flows to the reservoir, as summarized below. Regression analyses were also performed on data from Site MW-9 to determine trends in alluvial total dissolved phosphorus and orthophosphate concentrations from 1994 to 2005 (Figs. 23 and 24). Total dissolved phosphorus was used because total phosphorus is not measured at Site MW-9. Similar to the phosphorus trends observed at Site CC-10, alluvial concentrations of total dissolved phosphorus exhibited a significant increasing trend over time at Site MW-9, but only accounted for 22% of the variation in the data ($p < 0.001$, slope = 0.01, Fig. 23). Total dissolved phosphorus concentrations ranged from 230 µg/L to 250 µg/L, with a mean of 240 µg/L. Alluvial concentrations of orthophosphate at Site MW-9 (Fig. 24) were significantly correlated to time ($p < 0.001$, $R^2 = 0.30$, slope = 0.01), but the slope was slightly greater than zero. Orthophosphate concentrations at Site MW-9 were 1.5 - 3 times greater than the long-term median value, and appear to be outliers in the data (Fig. 16).

Historic Trends in Total Phosphorus Concentration and Discharge

Total phosphorus concentration was plotted against discharge for the three upstream tributaries (Figs. 25 - 27). Total phosphorus did not appear to track with stream discharge concentrations at Site CC-10. At Sites SC-3 and CT-2, total phosphorus concentration appears to be somewhat better matched with discharge. Statistical analyses performed on data from Site SC-3 indicate there is no significant relationship between total phosphorus concentration and discharge ($p > 0.05$). The relationship between total phosphorus concentration and discharge was significant, and indicated a positive correlation at Site CT-2, but only accounted for 6% of the variation in the data ($p < 0.01$, slope = 2.2).

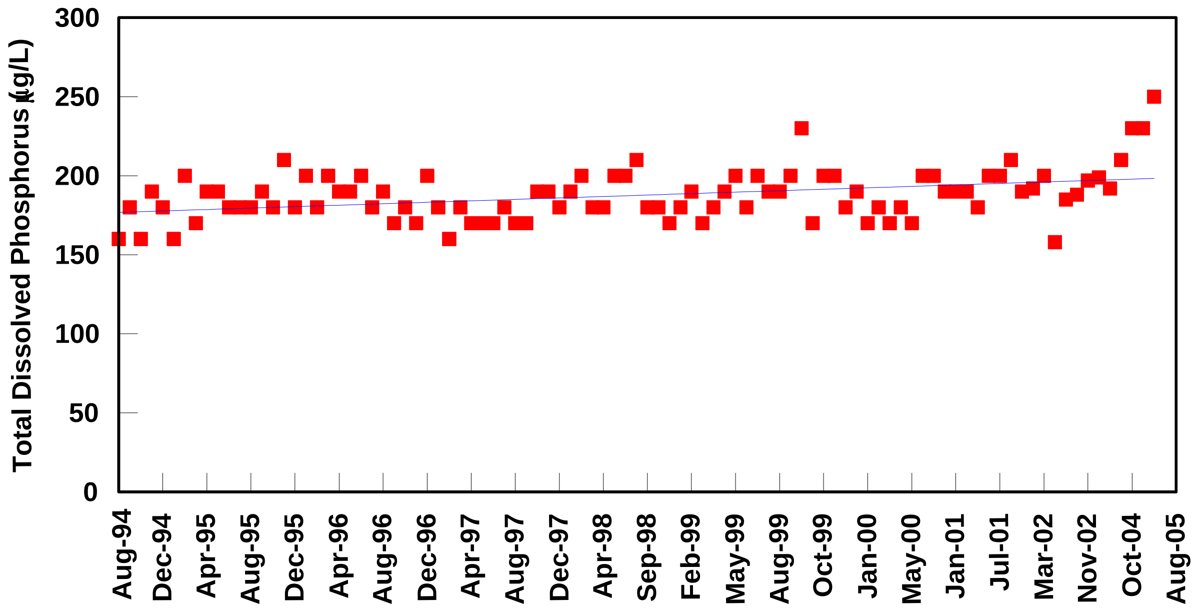

FIGURE 23: Mean total dissolved phosphorus concentrations measured at Site MW-9 (1994 - 2005).

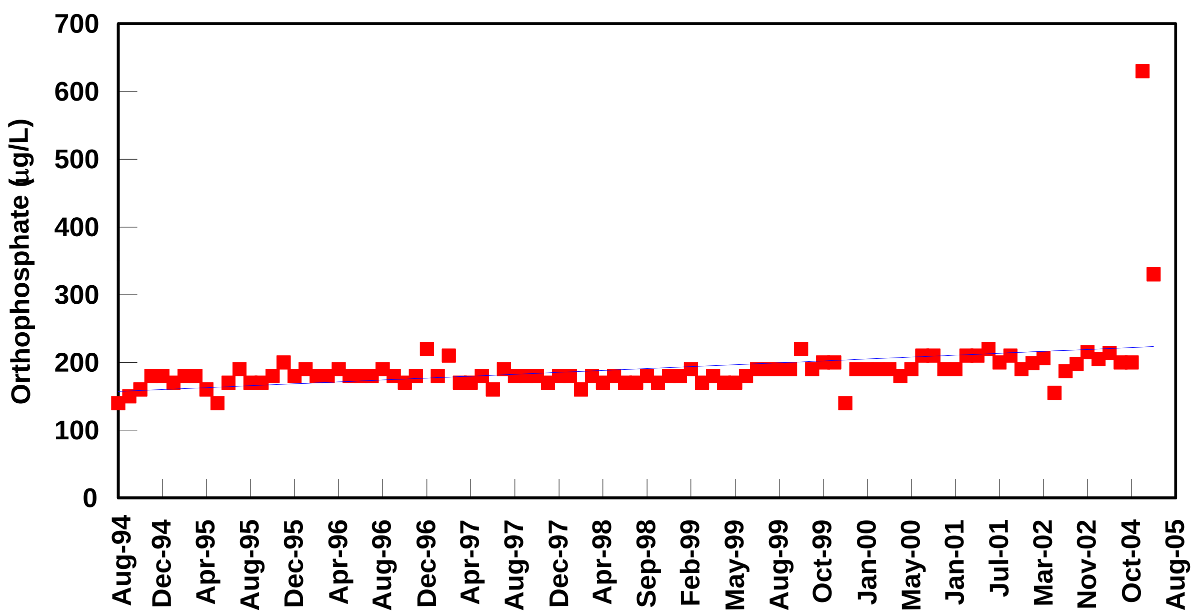

FIGURE 24: Mean orthophosphate concentrations measured at Site MW-9 (1994 - 2005).

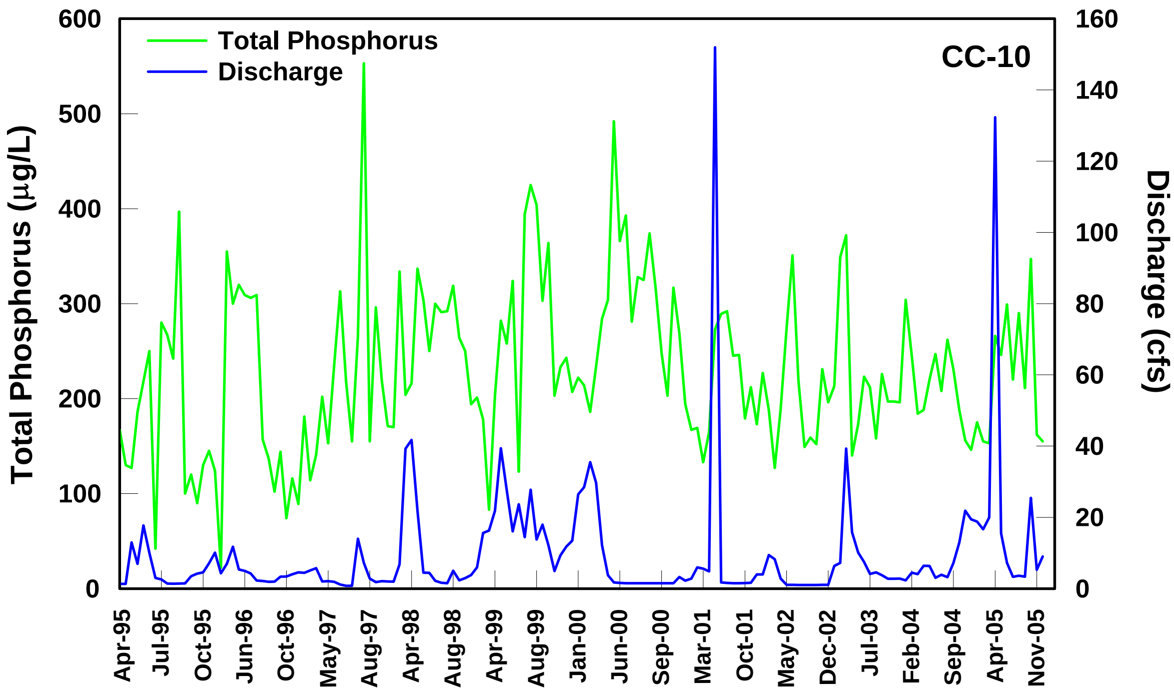

FIGURE 25: Historical patterns in total phosphorus concentrations and discharge at Site CC-10, 2005.

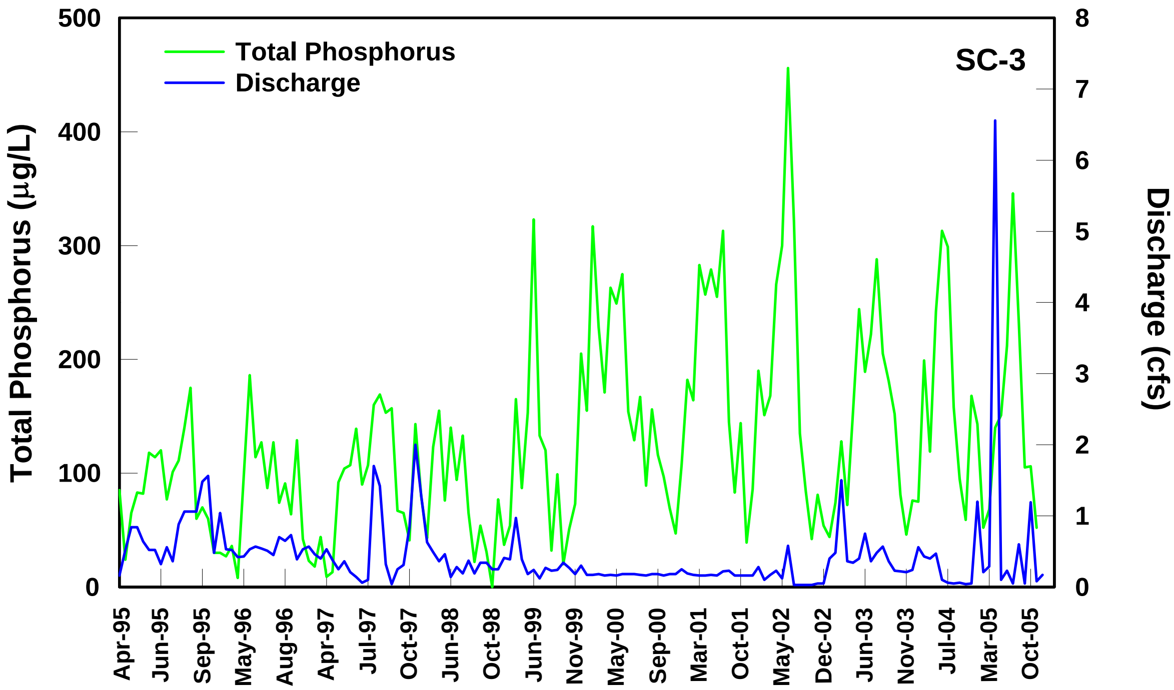

FIGURE 26: Historical pattern in total phosphorus concentrations and discharge at Site SC-3, 2005.

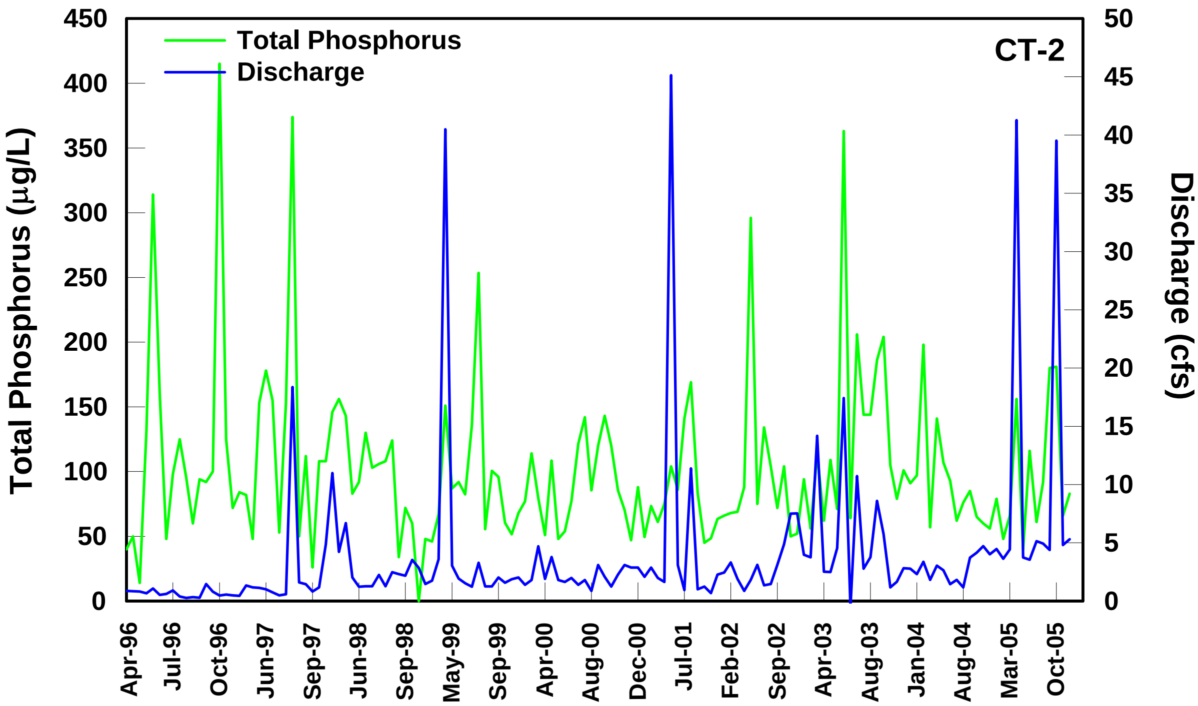

FIGURE 27: Historical pattern in total phosphorus concentrations and discharge at Site CT-2, 2005.

Phosphorus Loading to Reservoir

Nutrients which can limit or enhance algal growth in a reservoir have many sources, both within the reservoir (internal loading) or from outside the reservoir (external loading). Fish and plankton excrement, direct sediment resupply, and the decay of organic matter are all internal sources of nutrients in a reservoir (Goldman and Horne 1983). Net internal phosphorus loading to Cherry Creek Reservoir has been previously estimated to be 4,000 lbs/year (Nürnberg and LaZerte 2000). Recent studies evaluating internal loading using a variety of methodologies suggest phosphorus loading ranges between 810 lbs/yr and 1590 lbs/yr (AMEC *et al*. 2005), and alluvial phosphorus loads of approximately 1,170 lbs/yr (Lewis *et al*. 2005). Note that the phased TMAL of 14,270 lbs/year set in the May 2001 hearing does not include any internal loads, but does include alluvial loads as part of the Cherry Creek mainstem.

External source of nutrients include inflow from streams and precipitation, which carry nutrients from soil erosion, agricultural and residual runoff, treated wastewater, and airborne particulates. While both phosphorus and nitrogen are potentially important, past analyses have concluded that Cherry Creek Reservoir is generally phosphorus limited (DRCOG 1985). However, a nutrient enrichment study by Lewis *et al*. (2004) indicated that nitrogen was often the primary limiting nutrient in Cherry Creek Reservoir during the growing season.

Phosphorus (unlike nitrogen) does not have a gas phase. Thus, phosphorus concentrations cannot be reduced by interactions with the atmosphere or gases within the water column. For these reasons, efforts in past years and during the present study have concentrated on the calculation of phosphorus loading. Phosphorus loading was determined for several primary sources in 2005, including the tributary streams Cottonwood Creek, Cherry Creek, and Shop Creek, as well as from precipitation and alluvium, as summarized below.

Phosphorus Loads from Tributary Streams

The greatest proportion (66%) of the phosphorus load to the reservoir was from surface flows in the Cherry Creek mainstem (6,636 lbs). Because Cherry Creek is monitored downstream of Shop Creek, the 127 lbs contributed by Shop Creek has been subtracted from the total load calculated from the site. Additional phosphorus was contributed by Cottonwood Creek (1,697 lbs). The total phosphorus load to Cherry Creek Reservoir from tributary streams in 2005 was calculated at 8,460 lbs (Table 9).

Phosphorus Loads in Reservoir Outflow

The total outflow from Cherry Creek Reservoir as measured by the COE was 15,987 AF (Appendix D). The calculated phosphorus load leaving the reservoir in 2005 was determined to be 3,669 lbs (Table 9).

TABLE 9: Estimated net phosphorus loading (lbs/year) into Cherry Creek Reservoir, 1992 to 2005.

Source of Data	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Long-Term Mean
Shop Creek	131	83	135	115	107	117	127	96	82	103	79	103	210	127	**115**
Cherry Creek	2,894	1,727	2,142	2,795	2,347	2,041	7,666	8,745	8,306	3,412	1,105	4,637	7,379	6,636	**4,417**
Cottonwood Creek	1,081	177	321	2,184	553	646	1,143	1,822	1,087	1,292	789	1,130	2,592	1,697	**1,180**
Subtotal for Streamflows	**4,106**	**1,987**	**2,598**	**5,094**	**3,007**	**2,804**	**8,936**	**10,663**	**9,475**	**4,807**	**1,973**	**5,870**	**10,181**	**8,460**	**5,712**
Cherry Creek Alluvium	874	1,387	967	1,676	968	1,937	3,787	5,912	2,341	4,444	1,006	2,307	2,181	1,123	**2,208**
Direct Precipitation	877	736	484	1,202	740	1,020	854	896	777	586	1,267	391	150	464	**746**
Total Load	**5,857**	**4,110**	**4,049**	**7,972**	**4,715**	**5,761**	**13,577**	**17,471**	**12,593**	**9,837**	**4,246**	**8,568**	**12,512**	**10,047**	**8,665**
Cherry Creek Outflow	1,314	711	993	2,049	992	996	4,207	9,650	3,688	4,842	1,501	4,978	4,812	3,669	**3,172**
Net Load	**4,543**	**3,399**	**3,056**	**5,923**	**3,723**	**4,765**	**9,370**	**7,821**	**8,905**	**4,995**	**2,745**	**3,590**	**7,700**	**6,378**	**5,494**
Standard TP Load to Reservoir (lb/ac-ft)	**0.78**	**0.7**	**0.58**	**0.68**	**0.62**	**0.56**	**0.65**	**0.63**	**0.68**	**0.57**	**0.57**	**0.51**	**0.73**	**0.54**	**0.63**

Phosphorus Loading from Precipitation

The mean concentration of total phosphorus collected from rain samples in 2005 was 75 µg/L, which is considerably less than the long-term (1987-2005) median value of 155 µg/L used in the calculation of phosphorus loads. Outlier analysis performed on the long-term database indicated that eight values, mainly collected from 1987 to 1991 were outliers. These data were removed from the calculation of the long-term median TP value. When this value is placed in the context of total annual precipitation and areal extent of the reservoir, the total annual phosphorus load to the reservoir was 464 lbs/yr (Table 9, Appendix D). The long-term mean estimated total phosphorus loading from rain samples collected at the reservoir between 1987 and 2005 is 746 lbs (Table 10).

Phosphorus Loading from Alluvium

The water quality of alluvial flows into Cherry Creek Reservoir was monitored by JCHA. CEC estimated the total alluvial flow into Cherry Creek Reservoir to be 2,173 AF based on the analysis summarized below and in Appendix D. The total alluvial addition to the reservoir was estimated to be 1,123 lbs total phosphorus in 2005 (Table 9).

TABLE 10: Phosphorus loading into Cherry Creek Reservoir from precipitation, 1987 to 2005. Note that data from 1987-1991 are based on water years, while data for 1992 to present are based on calendar years.

Source of Data	Year	Annual Precipitation (in)	Estimated Annual Total Phosphorus from Precipitation (lbs)
In-Situ 1987	1987	18.1	870
In-Situ 1988	1988	23.3	1,119
ASI 1990	1989	13.0	625
ASI 1991a	1990	15.2	730
ASI 1991b	1991	16.5	793
ASI 1993	1992	18.5	877
ASI 1994a	1993	15.6	735
C&A 1995	1994	10.2	484
CEC 1996	1995	25.3	1,202
CEC 1997	1996	15.5	740
CEC 1998	1997	21.8	1,020
CEC 1999	1998	20.0	854
CEC 2000	1999	21.5	896
CEC 2001	2000	17.8	777
CEC 2002	2001	16.0	586
CEC 2003	2002	12.9	1,267
CEC 2004	2003	18.8	391
CEC 2005	2004	20.3	150
Present Study	2005	15.5	464
Mean		**17.5**	**767**

The COE monitors inflow to Cherry Creek Reservoir as a function of change in storage (i.e., reservoir volume) based on 1) changes in reservoir level, 2) measured outflow, 3) precipitation, and 4) evaporation, to calculate daily and monthly inflow (AF). This method for calculating reservoir volume does not specifically account for groundwater inflow via alluvium. CEC monitors surface water inflow to the reservoir using gaging stations on Cherry Creek, Cottonwood Creek, and Shop Creek (the three main surface inflows).

Given differences in the two methods for determining inflow (COE back-calculated based on change in stage vs. streamflows), combined with the potential for unmonitored multiple Cherry Creek channels in the wetlands adjacent to the reservoir and the potential for the COE calculations to underestimate dam leakage (Lewis and Saunders 2002), an exact match between COE and CEC calculated inflows should not be expected. In 2005, COE inflows were calculated at 18,534 AF, while CEC calculated inflows from streams at 15,263 AF and from precipitation at 1,098 AF (see Appendix D). Lewis and Saunders (2002) concluded that the COE method results in a systematic underestimate of inflow to the reservoir from alluvium. When estimating inflow, the COE does not specifically quantify alluvial inflows or outflows although, functionally, these alluvial flows must account for a portion of the variations in reservoir storage. Based on the Lewis and Saunders (2002) analysis, CEC believes the difference in inflow values between the COE calculations and CEC streamflows could be attributed wholly to <u>net</u> alluvial inflow. Using this approach, net alluvial inflow was estimated to be 2,173 AF in 2005. This flow and the long-term median phosphorus concentration of 190 µg/L were then used to calculate net alluvial load the reservoir of 1,123 lbs (Table 9).

<u>Mass Balance/Net Loading of Phosphorus to the Reservoir</u>

There are three principle sources of phosphorus loading to Cherry Creek Reservoir: tributary streams, alluvial flows, and precipitation (Table 9). During 2005 the three tributary streams contributing phosphorus loads to the reservoir included Cherry Creek (6,636 lbs without Shop Creek), Cottonwood Creek (1,697 lbs), and Shop Creek (127 lbs). The net load of phosphorus to the reservoir from the Cherry Creek alluvium was estimated at 1,123 lbs. The estimated phosphorus load to the reservoir from precipitation was 464 lbs. The estimated total load of phosphorus entering the reservoir in 2005 was determined to be 10,047 lbs (Fig. 28), which meets the TMAL of 14,270 lbs per year. The estimated phosphorus load leaving the reservoir in 2005 was determined to be 3,669 lbs. Consistent with the TMAL, these values do not include any estimates of internal phosphorus loads. Standardized phosphorus loads (lb/ac-ft) was 0.54 lbs/ac-ft in 2005 (Table 9).

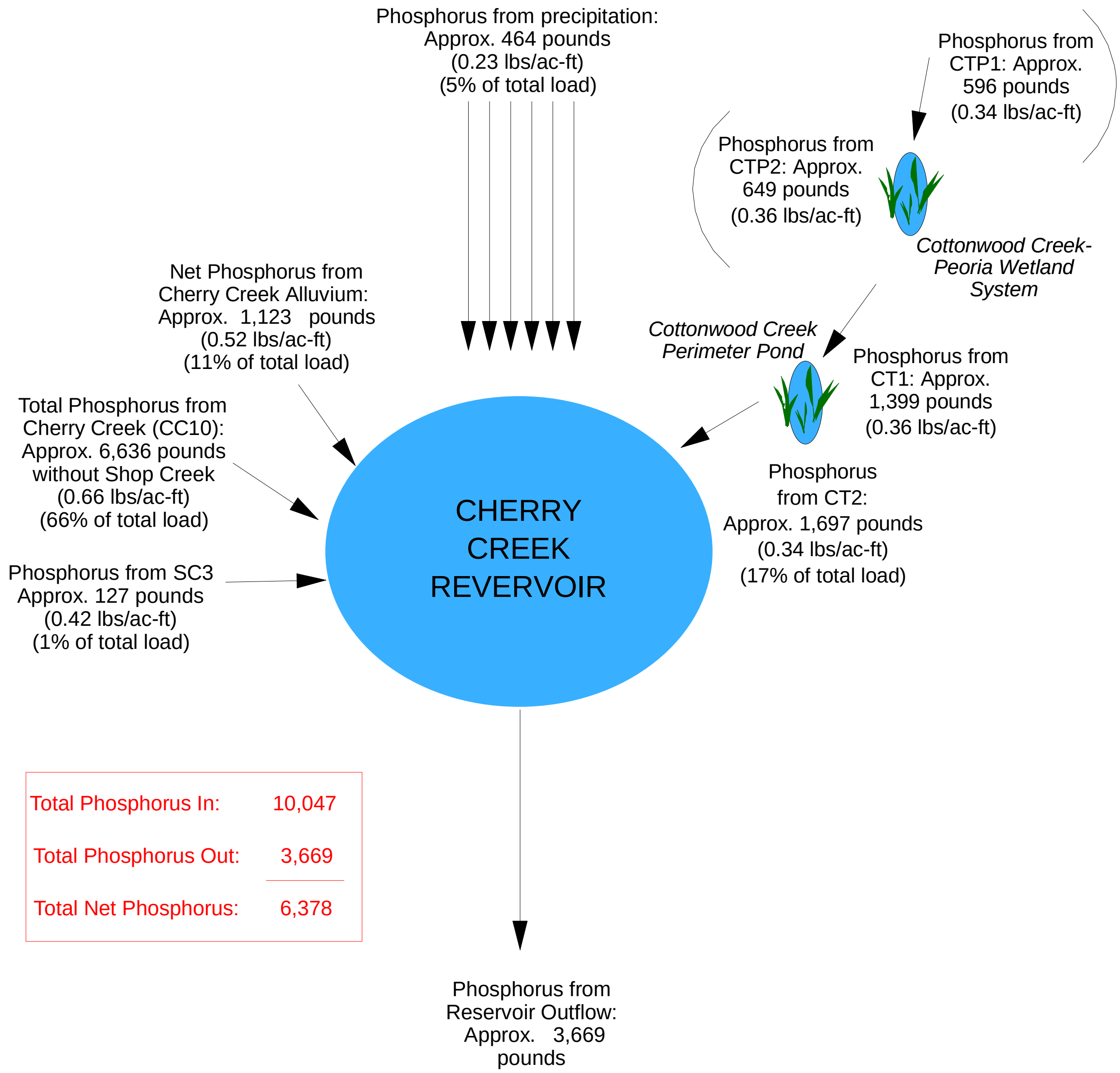

FIGURE 28: Mass balance diagram of phosphorus loading in Cherry Creek Reservoir, 2005.

Effectiveness of Cottonwood Creek Pollutant Reduction Facilities

Cottonwood Creek - Peoria Pond

The effectiveness of the Cottonwood Creek - Peoria Pond is gaged by monitoring the concentration of phosphorus and TSS and the loading of phosphorus upstream and downstream of the facility. As noted earlier, this structure came on-line during 2002. As such, the values from 2002 represent less than a full calendar year (i.e., only July - December 2002). The mean concentration of total phosphorus in 2005 increased from 92 µg/L at Site CT-P1 to 101 µg/L at Site CT-P2 (Table 11). The mean concentration of TSS increased from 47 µg/L upstream of the pond/wetland system to 51 µg/L downstream of the pond/wetland system (Table 11). The estimated load of phosphorus below the pond/wetland system increased 9%, from 596 lbs at Site CT-P1 to 649 lbs at Site CT-P2. No difference ($p > 0.05$) in mean total phosphorus or mean TSS concentrations could be determined from statistical analysis (t-test) for Sites CT-P1 and CT-P2. These data indicate that the new PRF was less effective in reducing the phosphorus loads in 2005 as compared to previous years (Table 11).

Cottonwood Creek Perimeter Pond

The effectiveness of the Cottonwood Creek stormwater "Perimeter Pond" in reducing phosphorus loads to the reservoir can be gaged by comparing concentration of total phosphorus and TSS and the loads of total phosphorus at the sites immediately upstream and downstream of the pond (Table 12). During 2005, the mean concentration of total phosphorus decreased from 180 to 142 µg/L after passing through the pond (Table 12). This represents a 21% reduction in phosphorus concentration, the third lowest percent reduction since the pond's inception (Table 12). However, the total phosphorus load increased from 1,399 lbs upstream of the pond to 1,697 lbs downstream of the pond, representing a 21% increase in total load (Table 12). This increase in load is solely due to the increased hydrological flows through CT-2. When placed in the context of standardized phosphorus loads, the pond/wetland system remains effective at reducing the total phosphorus load to Cherry Creek Reservoir. This is the first year since 1997 that the effectiveness of the pond system was greatly reduced. The concentration of TSS was decreased by 48% from 126 mg/L upstream to 66 mg/L downstream of the pond (Table 12). However, statistical analysis (t-test) determined that these differences in mean total phosphorus or TSS concentrations between Sites CT-1 and CT-2 were not statistically significant ($p > 0.05$).

TABLE 11: Historical (2002 - 2005) total phosphorus and total suspended solids concentrations through the Cottonwood Creek - Peoria wetlands system.

Parameter	Year	Sampling Sites CT-P1	Sampling Sites CT-P2	Difference	Percent Reduction
Average Total Phosphorus Concentration (µg/L) (baseflow and storm samples combined)	2002	138	152	14	(10)
	2003	101	92	-9	9
	2004	142	123	-19	13
	2005	92	101	9	(9)
	Mean	**118**	**117**	**-1.3**	**0.8**
Average Total Suspended Solids (mg/L)	2002	66	79	13	(20)
	2003	31	34	3	(10)
	2004	87	53	-34	39
	2005	47	51	4	(8)
	Mean	**58**	**54**	**-3.5**	**0.3**
Loading of Total Phosphorus (pounds)	2002	449	231	-228	64
	2003	771	574	-197	26
	2004	2590	1,499	- 1,091	42
	2005	596	649	53	(9)
	Mean	**1102**	**738**	**-363**	**31**

In past years, higher phosphorus and TSS concentrations observed at the Cottonwood Creek perimeter pond, when compared to the Cottonwood Creek - Peoria wetland system, indicate potential loading from stream channel erosion. In an effort to reduce phosphorus loading in the reservoir from the stream itself, channel reconstruction was conducted on Cottonwood Creek downstream of the Cottonwood Creek - Peoria wetland system in 2004. This reconstruction may have accounted for the increased loads observed between these two existing PRFs, e.g., 649 lbs TP at Site CT-P2 and 1,399 lbs TP at Site CT-1 (Fig. 28).

TABLE 12: Annual historical (1997 to 2005) total phosphorus and total suspended solids concentrations through the Cottonwood Creek stormwater detention pond.

Parameter	Year	Sampling Sites		Difference	Percent Reduction
		CT-1	CT-2		
Annual Average Total Phosphorus Concentration (µg/L) (baseflow, storm samples combined)	1997	200	133	-67	34
	1998	289	210	-79	27
	1999	158	157	-1	0
	2000	187	149	-38	20
	2001	165	114	-51	31
	2002	146	143	-3	2
	2003	144	129	-15	10
	2004	212	151	-61	29
	2005	180	142	-38	21
	Mean	**187**	**148**	**-39**	**19**
Annual Average Total Suspended Solids (mg/L)	1997	207	87	-120	58
	1998	311	129	-182	59
	1999	267	68	-199	74
	2000	96	64	-32	33
	2001	79	43	-36	46
	2002	130	79	-51	39
	2003	84	62	-22	26
	2004	155	77	-78	50
	2005	126	66	-60	48
	Mean	**162**	**75**	**-87**	**48**
Annual Loading of Total Phosphorus (pounds)	1997	3,351	1,103	-2,248	67
	1998	3,209	1,930	-1,279	40
	1999	6,329	3,868	-2,461	39
	2000	3,243	1,712	-1,531	47
	2001	3,356	2,205	-1,151	34
	2002	886	789	-97	11
	2003	1,777	1,130	-647	36
	2004	3,334	2,592	-742	22
	2005	1,399	1,697	298	(21)
	Mean	**2987**	**1892**	**-1095**	**31**

Shop Creek and Quincy Drainage Pond

Historical sampling of the PRFs on Shop Creek and Quincy Drainage indicate efficient phosphorus removal in these streams. Shop Creek was monitored for ten years from 1990 to 2000 at sites upstream and downstream of PRF stations (detection pond and wetlands). The Shop Creek PRF had an average phosphorus load reduction of 173 lbs, with an average of 63% reduction in load. Quincy Drainage was even more efficient with 99% reduction in loads over the period of 1996-1999. The average phosphorus load reduction was 138 lbs. CEC has not monitored the Shop Creek and Quincy Drainage PRFs since 2000.

SUMMARY AND CONCLUSIONS

Transparency

The highest transparency in Cherry Creek Reservoir was observed in the reservoir in mid-March and again in early August, and the lowest was measured in mid-July. The whole-reservoir mean Secchi depth was 0.97 m during the July to September period. This value represents the deepest mean value since 2000, and is similar to the long-term value (Table 13).

TABLE 13: Water quality and total phosphorus loads data for Cherry Creek Reservoir, July-September 1992 - 2005. **Bold** indicates value meets the respective standard, goal, or TMAL value.

Year	Chlorophyll *a* (µg/L)	Secchi Depth (m)	Total Phosphorus (µg/L)	Total Nitrogen (µg/L)	Annual Phosphorus Load (lbs/yr)*	Annual Precipitation (inches)	Annual Inflow (ac/ft)*	Standardized Phosphorus Load (lbs/ac-ft)
1992	17	0.9	66	970	**5,857**	18.5	7,474	0.78
1993	**14.4**	1.2	62	826	**4,110**	15.6	5,905	0.7
1994	**10**	1.1	59	1,144	**4,049**	10.2	7,001	0.58
1995	**9.4**	1.6	48	913	**7,972**	25.3	11,781	0.68
1996	20.5	1.6	62	944	**4,715**	15.5	7,644	0.62
1997	22.3	1	96	1,120	**5,761**	21.8	10,362	0.56
1998	26.5	1	89	880	**13,577**	20	20,903	0.65
1999	28.9	1	81	753	17,471	21.5	27,739	0.63
2000	25.2	1	81	802	**12,593**	17.8	18,610	0.68
2001	26.1	0.75	87	757	**9,837**	16	17,250	0.57
2002	18.8	0.9	74	858	**4,246**	12.9	7,498	0.57
2003	25.8	0.86	90	1,121	**8,568**	18.8	14,929	0.57
2004	18.4	0.85	102	977	**12,512**	20.3	17,177	0.73
2005	17.1	0.97	116	990	**10,047**	15.5	18,534	0.54
Long-Term Mean	18.1	1.05	74	939	8,665	17.8	13,772	0.63
Median	18.4	1	74	929	8,270	18.2	13,355	0.63

* Stream, alluvium, and precipitation.

Temperature and Dissolved Oxygen

Periods of thermal stratification were observed in the reservoir in 2005. Dissolved oxygen profiles indicated that anoxic conditions were present in lower depths of the reservoir through the summer. The temperature and oxygen profiles observed in the reservoir in 2005 were similar to those recorded in past years.

Total Phosphorus

The 2005 reservoir summer mean total phosphorus concentration of 116 µg/L was the highest observed in the period of record (Table 13), and exceeded the goal of 40 µg/L total phosphorus. Since 1987, the goal of 40 µg/L total phosphorus as a July - September mean has only been met once, in 1989.

Chlorophyll *a*

The summer mean chlorophyll *a* concentration in Cherry Creek Reservoir was 17.1 µg/L, a value in excess of the 15 µg/L standard (Table 13). The long-term summer mean chlorophyll *a* concentrations since 1996 indicate no significant difference between seasonal mean chlorophyll *a* concentrations over the past eight years. The July - September chlorophyll *a* standard of 15 µg/L has not been met since 1995 (Table 13).

Phosphorus Loading

The total precipitation at Cherry Creek Reservoir during 2005 was 15.5 inches. The mean concentration of total phosphorus collected from rain samples in 2005 was 75 µg/L, which is considerably less than the long-term (1987-2005) median value of 155 µg/L used in the calculation of phosphorus loads. The total inflow from tributary streams was 15,263 AF, which was higher than the 12,092 AF observed in 2004. The total phosphorus loads to the reservoir were estimated to be 464 lbs from precipitation, 8,460 lbs from surface flows, and 1,123 lbs from Cherry Creek alluvial flow. The total external load in 2005 of 10,047 lbs met the phased TMAL of 14,270 lbs/year. The total of 10,047 lbs in 2005 represents a 42% decrease in total load over that observed during peak flows in 1999.

PRF Effectiveness

The effectiveness of the pollution reduction facilities constructed on Cottonwood Creek appeared reduced in 2005. The standardized phosphorus load upstream of the pond/wetland system was 0.34 lbs TP/ac ft, while the standardized load downstream of the system was 0.36 lbs TP/ac ft. These data show that the Cottonwood Creek - Peoria Pond was not as effective in 2005 at removing total phosphorus from Cottonwood Creek flows when compared to the past three years of data.

The effectiveness of the Cottonwood Creek Perimeter Pond also appeared to be diminished in 2005. The total phosphorus load increased downstream of the pond, from 1,399 lbs to 1,697 lbs. However, when standardized with the hydraulic load, the phosphorus load actually decreased from 0.36 lbs/ac ft to 0.34 lbs/ac ft. In past years, higher phosphorus concentrations observed at the Cottonwood Creek perimeter pond, when compared to the Cottonwood Creek - Peoria wetland system, indicate potential loading from stream channel erosion. In an effort to reduce phosphorus loading in the reservoir from the stream itself, channel reconstruction was conducted on Cottonwood Creek downstream of the Cottonwood Creek - Peoria wetland system in 2004 and will be completed in Phase 2 in 2006. This channel reconstruction may have accounted for the increased loads observed between these two existing PRFs. Regardless, the standardized load reduction at the Cottonwood Creek Perimeter Pond indicates that this PRF continues to be effective in reducing the total phosphorus to Cherry Creek Reservoir.

LITERATURE CITED

Advanced Sciences, Inc. 1994a. *Cherry Creek Basin, Annual Water-Quality Monitoring Report, 1993 Water Year*. Project No. 8970. Prepared for the Cherry Creek Basin Water Quality Authority.

Advanced Sciences, Inc. 1994b. 1993 Cherry Creek Basin Water Quality Authority Contract: Project 8790. Exhibits A through H (amended).

AMEC, Earth and Environmental, Inc., Alex Horne Associates, and Hydrosphere Resource Consultants, Inc. 2005. *Cherry Creek Reservoir Destratification*. Feasibility report prepared for the Cherry Creek Basin Water Quality Authority.

American Public Health Association. 1998. *Standard Methods for the Examination of Water and Wastewater*, 20th Edition. Prepared and published jointly by the American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, DC.

Carpenter, S.R., J.F. Kitchell, and J.R. Hodgson. 1985. Cascading trophic interactions and lake productivity. *Bioscience* 35:634-639.

Chadwick Ecological Consultants, Inc. 1995. *Cherry Creek Reservoir Annual Aquatic Biological and Nutrient Monitoring Study, 1994*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 1996. *Cherry Creek Reservoir Annual Aquatic Biological and Nutrient Monitoring Study, 1995*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 1997. *Cherry Creek Reservoir Annual Aquatic Biological and Nutrient Monitoring Study, 1996*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 1998a. *Analysis of Phosphorus Loads to Cherry Creek Reservoir*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 1998b. *Cherry Creek Reservoir Annual Aquatic Biological and Nutrient Monitoring Study, 1997*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 1999. *Cherry Creek Reservoir 1998 Annual Aquatic Biological and Nutrient Monitoring Study*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 2000. *Cherry Creek Reservoir 1999 Annual Aquatic Biological and Nutrient Monitoring Study*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 2001. *Cherry Creek Reservoir 2000 Annual Aquatic Biological and Nutrient Monitoring Study*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 2002. *Cherry Creek Reservoir 2001 Annual Aquatic Biological and Nutrient Monitoring Study*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 2003. *Cherry Creek Reservoir 2002 Annual Aquatic Biological and Nutrient Monitoring Study and Cottonwood Creek Phosphorus Reduction Facility Monitoring*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 2004. *Cherry Creek Reservoir 2003 Annual Aquatic Biological and Nutrient Monitoring Study and Cottonwood Creek Phosphorus Reduction Facility Monitoring*. Prepared for the Cherry Creek Basin Water Quality Authority.

Chadwick Ecological Consultants, Inc. 2005. *Cherry Creek Reservoir 2004 Annual Aquatic Biological and Nutrient Monitoring Study and Cottonwood Creek Phosphorus Reduction Facility Monitoring*. Prepared for the Cherry Creek Basin Water Quality Authority.

Cole, G.A. 1979. *Textbook of Limnology*, 2nd Edition. The C.V. Mosby Company, St. Louis, MO.

Colorado Department of Public Health and Environment. 2001. *The Basic Standards and Methodologies for Surface Water* (5 CCR 1002-31). Regulation No. 31. Water Quality Control Division, Denver, CO.

Cooke, D.C., E.B. Welch, S.A. Peterson, and P.R. Newroth. 1993. *Restoration & Management of Lakes & Reservoirs*, 2nd Edition. Lewis Publishers, Boca Raton, FL.

Denver Regional Council of Governments. 1984. *Cherry Creek Reservoir Clean Lakes Study*. Denver Regional Council of Governments, Denver, CO.

Denver Regional Council of Governments. 1985. *Cherry Creek Basin Water Quality Management Master Plan*. Prepared in Cooperation with Counties, Municipalities, Water and Sanitation Districts in the Cherry Creek Basin and Colorado Department of Health.

Goldman, C.R., and A.J. Horne. 1983. *Limnology*. McGraw-Hill Company, NY.

Halepaska & Associates, Inc. 1999. *1998 Annual Report, Phase I Baseline Water Quality Data Collection Study for the Upper Cherry Creek Basin*. Prepared for the Cherry Creek Basin Water Quality Authority, Project No. 5601:6.

Halepaska & Associates, Inc. 2000. *1999 Annual Report, Phase I Baseline Water Quality Data Collection Study for the Upper Cherry Creek Basin*. Prepared for the Cherry Creek Basin Water Quality Authority.

Halepaska & Associates, Inc. 2001. *2000 Annual Report, Baseline Water Quality Data Collection Study for the Upper Cherry Creek Basin*. Prepared for the Cherry Creek Basin Water Quality Authority.

Halepaska & Associates, Inc. 2002. *2001 Annual Report, Baseline Water Quality Data Collection Study for the Upper Cherry Creek Basin*. Prepared for the Cherry Creek Basin Water Quality Authority.

Halepaska & Associates, Inc. 2003. *2002 Annual Report, Baseline Water Quality Data Collection Study for the Upper Cherry Creek Basin*. Prepared for the Cherry Creek Basin Water Quality Authority.

Halepaska & Associates, Inc. 2004. *2003 Annual Report, Baseline Water Quality Data Collection Study for the Upper Cherry Creek Basin*. Prepared for the Cherry Creek Basin Water Quality Authority.

Halepaska & Associates, Inc. 2005. *2004 Annual Report, Baseline Water Quality Data Collection Study for the Upper Cherry Creek Basin*. Prepared for the Cherry Creek Basin Water Quality Authority.

Halepaska & Associates, Inc. 2006. *2005 Annual Report, Baseline Water Quality Data Collection Study for the Upper Cherry Creek Basin*. Prepared for the Cherry Creek Basin Water Quality Authority.

Hintze, J.L. 2001. NCSS and PASS. Number Cruncher Statistical Systems, Kaysville, UT.

In-Situ, Inc. 1986 (as amended). *Cherry Creek Reservoir and Cherry Creek Basin Monitoring Program, Southeastern Denver Metropolitan Area, Colorado: Proposal No. 4405*. Prepared for the Cherry Creek Basin Authority, December 3 (with later modifications).

Jones, J.R. 1994. *Report on Cherry Creek Reservoir, Summer 1993*. Report to Cherry Creek Basin Water Quality Authority.

Jones, J.R. 1995. *Report on Cherry Creek Reservoir, Summer 1994*. Report to Cherry Creek Basin Water Quality Authority.

Jones, J.R. 1996. *Report on Cherry Creek Reservoir, 1995 Sampling Season*. Report to Cherry Creek Basin Water Quality Authority.

Jones, J.R. 1997. *Report on Cherry Creek Reservoir, 1996 Sampling Season*. Report to Cherry Creek Basin Water Quality Authority.

Jones, J.R. 1998. *Report on Cherry Creek Reservoir, 1997 Sampling Season*. Report to Cherry Creek Basin Water Quality Authority.

Jones, J.R. 1999. *Report on Cherry Creek Reservoir, 1998 Sampling Season*. Report to Cherry Creek Basin Water Quality Authority.

Jones, J.R. 2001. *Report on Cherry Creek Reservoir, 1992-2001 and Historical Data*. Report to Cherry Creek Basin Water Quality Authority.

Knowlton, M.R., and J.R. Jones. 1993. *Limnological Investigations of Cherry Creek Lake*. Final report to Cherry Creek Basin Water Quality Authority.

LaZerte, B.D., and Nürnberg, G. 2000 *Cherry Creek Reservoir Dynamic Model*. Prepared for the Cherry Creek Basin Water Quality Authority.

Lewis, W.M., and J.F. Saunders. 2002. *Review and Analysis of Hydrologic Information on cherry Creek Watershed and Cherry Creek Reservoir*. Prepared for the Cherry Creek Basin Water Quality Authority.

Lewis, W.M., J.H. McCutchan, and J.F. Saunders. 2005. *Estimation of Groundwater Flow into Cherry Creek Reservoir and its Relationship to the Phosphorous Budget of the Reservoir*. Prepared for the Cherry Creek Basin Water Quality Authority.

Nürnberg, G., and LaZerte, B. 2000. *Modeling Future Scenarios for Cherry Creek Reservoir*. Prepared for the Cherry Creek Basin Water Quality Authority.

Vanni, M.J., and C.D. Layne. 1996. Nutrient recycling and herbivory as mechanisms in the “top-down” effect of fish on algae in lakes. *Ecology* 78:21-40.

Vanni, M.J., C.D. Layne, and S.E. Arnott. 1996. “Top-down” trophic interactions in lakes: effects of fish on nutrient dynamics. *Ecology* 78:1-20.

Wetzel, R.G. 2001. *Limnology*, 3rd Edition. Academic Press, San Diego, CA.

Zellweger Analytics. 1999. *QuickChem Methods*. Milwaukee, WI.

APPENDIX A

Cherry Creek Reservoir
Sampling and Analysis Plan

CHERRY CREEK RESERVOIR

AQUATIC BIOLOGICAL AND NUTRIENT SAMPLING AND LABORATORY ANALYSES

SAMPLING, ANALYSIS, AND QUALITY ASSURANCE WORK PLAN

MAY 2003

Submitted to:

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INTRODUCTION

An inter-governmental agreement was executed in 1985 by several local governmental entities within the Cherry Creek basin to form the Cherry Creek Basin Water Quality Authority (Authority). The Authority initially created by an intergovernmental agreement, was specially authorized by legislation adopted in 1988. The Authority develops and implements the means to protect the water quality of Cherry Creek Basin and Reservoir. Following recent legislation, the Board was reconstituted in 2001 and now includes Arapahoe and Douglas Counties, seven municipalities (Aurora, Castle Rock, Centennial, Foxfield, Greenwood Village, Lone Tree, and Parker), one member representing the seven special districts (Arapahoe, Cottonwood, Inverness, Meridian, Parker, Pinery, and Stonegate Village), and seven citizens appointed by the governor. This Authority was created for the purpose of coordinating and implementing the investigations necessary to protect and to preserve the quality of water resources of the Cherry Creek basin while allowing for further economic development.

The Cherry Creek Basin Master Plan (DRCOG 1985), approved by the Colorado Water Quality Control Commission (CWQCC) in 1985, was adopted in part as the "Regulations for Control of Water Quality in Cherry Creek Reservoir" (Section 4.2.0, 5C.C.R.3.8.11). An annual monitoring program was implemented at the end of April 1987 to assist in the assessment of several aspects of the Master Plan. These monitoring studies have included long-term monitoring of 1) nutrient levels within the reservoir and from tributary streams during base flows and stormwater, 2) nutrient levels in precipitation, and 3) chlorophyll *a* levels within the reservoir. This monitoring program has been modified over the years in response to changes in the Control Regulation, various research goals, and suggestions from outside reviewers, including input from the Water Quality Control Division (WQCD).

PROJECT DESCRIPTION

The Authority has prepared this Sampling, Analysis, and Quality Assurance Work Plan (Sampling and Analysis Plan) for aquatic biological nutrient analyses to be conducted on Cherry Creek Reservoir and selected off-lake sampling sites in 2003. This Sampling and Analysis Plan sets out field and laboratory protocols necessary to achieve quality data designed to help characterize the potential relationships between nutrient loading (both in-lake and external) and reservoir productivity. The specific objectives of the Sampling and Analysis Plan study are:

1. Determine the concentrations of selected nutrients, primarily nitrogen and phosphorus species, in Cherry Creek Reservoir as well as in various streams flowing into the reservoir and measure nutrients in the reservoir outflow.

2. Determine the pounds of phosphorus entering Cherry Creek Reservoir from streams and precipitation and leaving the reservoir through the outlet.

3. Determine biological productivity in Cherry Creek Reservoir, as measured by chlorophyll *a* concentrations and algal densities.

4. Provide data on the effectiveness of pollutant removal from Pollutant Removal Facilities (PRF) constructed by the Authority.

This Sampling and Analysis Plan presents the proposed 2003 sampling and analyses requirements for Cherry Creek Reservoir and includes discussions of: 1) project organization and responsibilities; 2) quality assurance objectives for the measurement of data in terms of accuracy, representativeness, comparability, and completeness; 3) field sampling and sample preservation procedures; 4) laboratory processing and analytical procedures; and 5) guidelines for data verification and reporting, quality control checks, corrective actions, and quality assurance reporting.

PROJECT ORGANIZATION AND RESPONSIBILITIES

All personnel involved in the investigation and in the generation of data are implicitly a part of the overall project and quality assurance program. Certain individuals have specifically delegated responsibilities, as described below.

Project Manager

The Project Manager for the aquatic biological and field sampling portions of the study is responsible for fiscal oversight and technical management of the project and for ensuring that all work is conducted in accordance with Scope of Service, Sampling and Analysis Plan, and approved procedures. Tasks include:

- Maintain routine contact with the project's progress, regularly review the project schedule, and review all work products.

- Evaluate impacts on project objectives and the need for corrective actions based on quality control checks, and whenever the data quality objective of 100% completeness is not met.

- Maintain a central file, which contains or indicates the location of all documents relating to this project.

- Review and update of this Sampling and Analysis Plan, as needed.

- Coordinate with the Authority, the WQCD, and the Authority's other consultants to ensure compliance with the Cherry Creek Reservoir Control Regulation No. 72.

Quality Assurance Manager

Quality Assurance oversight will be provided by a qualified individual with specific education and experience in water quality sampling and analysis. The Quality Assurance Manager shall be responsible for evaluation and review of all data reports relevant to the project and perform data verification. The Quality Assurance Manager shall work with the Project Manager to determine the need for corrective actions and, together, will make recommendations for any needed changes to either sampling methodologies or laboratory analytical procedures.

Analytical and Biological Laboratory Managers

The Analytical Laboratory Manager shall ensure that all water quality samples are analyzed in a technically sound and timely manner. The Analytical Laboratory Manager shall be responsible for ensuring all laboratory quality assurance procedures associated with the project are followed, including proper sample entry, sample handling procedures, and quality control records for samples delivered to the laboratory. The Analytical Laboratory Manager will be responsible for all data reduction and verification and ensure that the data is provided in a format agreed upon between the Project Manager, the Analytical Laboratory Manager, and the Authority.

The Biological Laboratory Manager shall ensure that all biological samples are analyzed in a technically sound and timely manner. The Biological Laboratory Manager shall be responsible for ensuring all laboratory quality assurance procedures associated with the project are followed, including proper sample entry, sample handling procedures, and quality control records for samples delivered to the laboratory. The Biological Laboratory Manager will be responsible for all data reduction and verification, and ensure that the data is provided in a format agreed upon between the Project Manager, the Analytical Laboratory Manager, and the Authority.

Sampling Crew

The field sampling efforts shall be conducted by individuals qualified in the collection of chemical, physical, and biological surface water samples. Field tasks and sampling oversight will be provided by the Project Manager. The Sampling Crew shall be responsible for following all procedures for sample collection, including complete and accurate documentation.

AQUATIC BIOLOGICAL AND NUTRIENT SAMPLING

Reservoir Monitoring Sites

Sampling would be conducted at sites established during past sampling efforts, as modified herein (see Figure 1 for location of all sites).

Cherry Creek Reservoir

CCR-1 This site is also called the Dam site and corresponds to the northwest trident when partitioning the lake by estimations of volume.

CCR-2 This site is also called the Swim Beach site and corresponds to the northeast trident when partitioning the lake by estimations of volume.

CCR-3 This site is also called the Inlet site and corresponds to the south trident when partitioning the lake by estimations of volume.

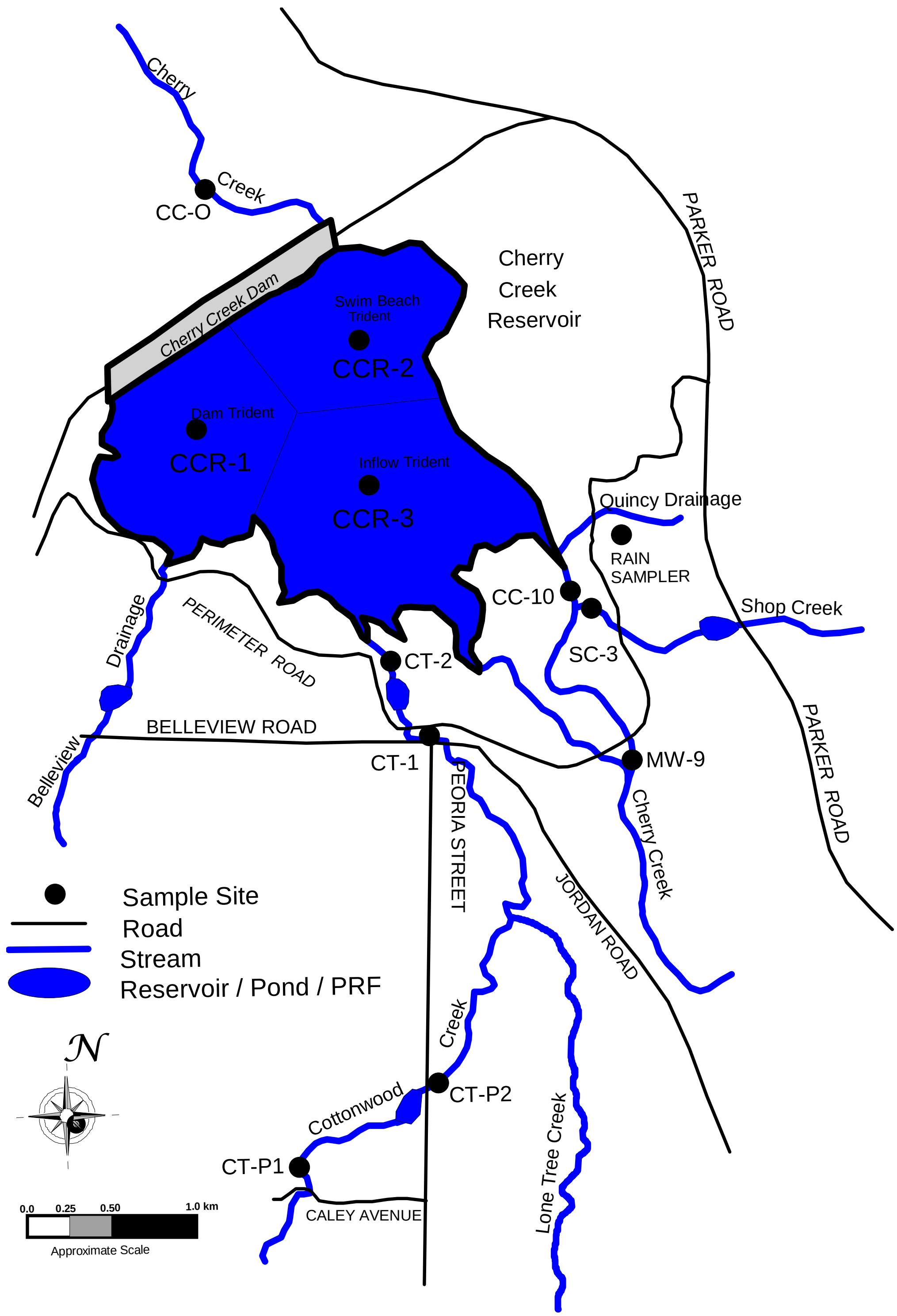


Figure 1: Sampling sites on Cherry Creek Reservoir and selected streams.

Stream Monitoring Sites

Cherry Creek

CC-10 This site is on Cherry Creek immediately downstream of the Shop Creek confluence, approximately 0.5 km upstream of Cherry Creek Reservoir. This site measures loads from Cherry Creek and Shop Creek that enter the reservoir.

CC-O This site is on Cherry Creek downstream of Cherry Creek Reservoir near the USGS gaging station within the Kennedy Golf Course.

Cottonwood Creek

CT-2 This site is immediately downstream of the phosphorus control facility (PRF), upstream of Cherry Creek Reservoir (i.e., Perimeter Road Pond). Although this site also measures the performance of the Perimeter Road Pond PRF, it is included in the reservoir portion of the effort since it is needed to measure loads to the reservoir from Cottonwood Creek.

PRF Monitoring Sites

Shop Creek

SC-3 This site is downstream of the Shop Creek detention pond and wetland complex above the confluence with Cherry Creek mainstem, and downstream of the Perimeter Road.

Cottonwood Creek

CT-P1 This site is located on Cottonwood Creek upstream of the new detention pond PRF at Peoria Street.

CT-P2 This site is located on Cottonwood Creek just downstream of Peoria Street Pond PRF and in the upper end of the streambank stabilization reach.

CT-1 This site is on Cottonwood Creek just downstream of Belleview Avenue, upstream of the Cherry Creek Park Perimeter Road. Note that Site CT-2 is included in the reservoir monitoring requirements.

Precipitation Sampling Site

This site is located near the Quincy Drainage, upstream of the Perimeter Road. The sampler consists of a clean, inverted plastic trash can lid used to funnel rain into a one-gallon container.

Analyte List

The sampling and analyses shall be conducted in accordance with the methods and detection limits provided in Table 1.

TABLE 1: Standard methods for analysis.

Analyte	Standard Methods*	Other Method Designations	Recommended Hold Times	Detection Limit
Manual Analyses				
pH		Denver Instrument pH/ATC Ag/AgCl combination electrode	24 hrs.	
Alkalinity	2320 B		24 hrs.	2 mg/$CaCO_3$/L
Hardness	2340 C (modified)	HACH Method 8266, ManVer 2 Buret Titration	24 hrs.	2 mg/$CaCO_3$/L
Total Suspended Solids	2540 D		7 days	4 mg/L
Total Volatile Suspended Solids	2540 E		7 days	4 mg/L
Chlorophyll	10200 H (modified)	Hot Ethanol Extraction	-24 hrs. before filtration	0.1 mg/m^3
Nutrient Analyses				
Orthophosphate	4500-P G	QuickChem 10-115-01-1-T	48 hrs.	3 µg/L
Total Phosphorus	4500-P G	QuickChem 10-115-01-1-U, with manual digestion	-24 hrs. before digestion	2 µg/L
Nitrate + Nitrite	4500-NO3 I	QuickChem 10-107-04-1-B	48 hrs.	5 µg/L
Total Nitrogen	4500-N B (modified)		-24 hrs. before digestion; -7 days after digestion	4 µg/L
Ammonia	none	QuickChem 10-107-06-3-D	24 hrs.	3 µg/L
Biological Analyses				
Phytoplankton	University of Colorado, Center for Limnology			

* From *Standard Methods for Examination of Water and Waste Water* (20th Edition).

Sampling Schedule

Reservoir Sampling

The general sampling schedule includes regular sampling trips to the reservoir at varying frequency over the annual sampling period, as outlined below. Sampling in our winter months (November - February) will depend on ice conditions and safety concerns.

TABLE 2: Reservoir Sampling Schedule

Sampling Period	Frequency	Trips/Period
January to April (not February)	Monthly	3
May to September	Every 2 Weeks	11
October to November (not December)	Monthly	2
	Total	16

Stream Sampling

Standard sampling is conducted monthly concurrent with the regular reservoir sampling trips when possible to generally provide information during non-storm event periods, corresponding to the low-flow ambient samples collected in earlier studies.

TABLE 3: Stream Sampling Schedule

Sampling Period	Frequency	Trips/Period
January to December	Monthly	12
	Total	12

Representative Storm Event Sampling

There are six stream sites for storm event sampling(i.e., S-3, CC-10, CT-1, CT-2, CT-P1, and CT-P2). Storm samples are not collected at Site CC-O downstream of the reservoir, unless the Army Corps of Engineers (Corps) alerts the Consultant to an outflow event that could be tied to a storm-related inflow. Up to five storm events shall be collected over the summer for Cherry Creek (Site CC-10) and on Shop Creek (Site S-3). Up to seven storm events shall be collected at the four sites on Cottonwood Creek (CT-1, CT-2, CT-P1, and CT-P2). The actual number of storm events for which samples are obtained will be subject to weather patterns.

The recommended storm sampling period is April through September to attempt to capture some of the late spring snowmelt events as well as the summer "monsoon" season..

Precipitation Sampling

Precipitation samples are to be collected after "significant" rainfall events, defined as 0.5 inches or more. The sampler shall be inspected weekly and emptied of any accumulations of insignificant precipitation and the collector (inverted trash can lid) cleaned. This procedure is required to minimize insignificant amounts of precipitation contaminating the sample by allowing "dry-fall" to be washed into the sampler between significant events.

Field Methodologies

Reservoir Sampling

Transparency

Transparency shall be determined using a Secchi disk and a combined-deck photometer. The Secchi reading would be taken from the shady side of the boat. If this is not possible, sunglasses or other shading will be used to reduce glare. The disk is lowered slowly until the white quadrants disappear, at which point the depth is recorded to the nearest tenth of a meter. The disk is then lowered roughly 1 m further and slowly brought back up until the white quadrants reappear and again the depth is recorded. The Secchi disk depth is recorded as the average of these two readings.

A second method to measure the depth of the euphotic zone is to determine the depth at which 1% of the light penetrates the water column. This is considered the point at which, on average, light no longer can sustain photosynthesis in excess of oxygen consumption from respiration (Goldman and Horne 1983). This is accomplished by using a double-deck photometer. One photocell remains on the surface, and the other is lowered into the water on the sunny side of the boat. Both photocells are attached to a data logger, which records the amount of light in micromoles per second per square meter. The underwater photocell is lowered until the value displayed on the data logger is 1% of the value of the surface photocell, and then the depth is recorded.

Depth Profile Measurements

Measurements for dissolved oxygen, temperature, conductivity, and pH shall be taken at 1 m intervals using a YSI meter, Model # 600XL multi-probe meter. This meter shall be calibrated at the C&A Laboratory prior to each sampling episode to ensure accurate readings. To determine maximum depth, a Secchi disk will be lowered until it reaches the bottom. This reading will be taken on the opposite side of the boat from where water samples are being taken to minimize chances of sample contamination from the sediment. Profile measurements are taken no deeper than 0.5 m off the bottom to minimize potential contamination of the probes.

Water Samples

A primary task is sampling of water for nutrient and biology analyses. An upper-reservoir composite sample shall be taken at each of the three reservoir sites, kept separate for each site, and analyzed individually for nutrients and chlorophyll. A composite comprised of equal contributed aliquots collected with a vertical Van Dorn water sampler (approximately 3 L) at 1 m increments beginning at the surface and continuing to the 3 m depth (the upper 3 m of the reservoir represents 71% of the lake volume).

Samples are collected using a vertical Van Dorn sampler (3 L volume) by lowering to the appropriate depth (as outlined above). A "messenger" is sent to trip the sampler, and the water is brought to the boat and transferred to a clean plastic bucket for splitting into aliquots, as described above. The sampler is rinsed thoroughly with lake water between samples and between sites. Aliquots are taken from the photic composite for chemical analyses consisting of three 4-L just (two for chlorophyll and one for nutrients).

Water sample depth profile sampling is also conducted at Site CCR-2 in the deepest area in the reservoir. At this site, additional water samples shall be obtained at the 4, 5, 6, and 7 m depths. The last sample (7 m) would be collected roughly 1 m off the bottom, to minimize disturbance of bottom sediments during sampling. With variation in reservoir elevation throughout the year, it may not be possible to actually collect a sample at the 7 m depth every sampling episode. Samples are collected using a vertical Van Dorn sampler (3 L volume). The sampler is lowered to the appropriate depth (as outlined above). A "messenger" is sent to trip the sampler, and the water is brought to the boat and transferred to a clean bucket for splitting into aliquots, as described above. The sampler is rinsed thoroughly with lake water between samples and between sites.

Based on this sampling scheme, the number of samples taken at each site is as below:

TABLE 4: Samples per Station/Sampling Episode

Location		Photic Composite	1-m Increment Depth Samples
Dam	(CCR-1)	1	0
Swim Beach	(CCR-2)	1	4
Inflow	(CCR-3)	1	0
Total Samples/Sample Episode		3	4
Grand Total		7	

Water Quality Analyses

1. Nutrients, alkalinity, hardness, and pH analyses conducted in all reservoir water samples.

2. Chlorophyll would be analyzed in the 3 m photic depth profile samples only from June - September, one set per month.

3. Phytoplankton would be sampled twice monthly from April - October, and monthly from November - March from the 0-3 m water composite samples.

See Table 1 for the list of analytes, laboratory methods, and detection limits.

Stream Sampling

One sample shall be collected from each of the stream sampling sites during the sampling period, when there is sufficient flow. Samples shall be taken as mid-stream mid-depth grab samples with a polyethylene scoop and composited in a 5-gallon plastic bucket. Aliquots shall be taken from the composite for chemical analyses consisting of two 4-L jugs for analysis of parameters, as listed in Table 5.

During these sampling episodes, water was collected from each of the seven stream sampling sites (sites on tributary streams and on Cherry Creek downstream of the reservoir) and analyzed for nutrients and suspended solids. No samples were collected at Site CC-O during January, February, October, and December due to lack of water. With the exception of Site SC-3 in July, flows were sufficient at each tributary site through the year to obtain all scheduled samples. Two samples were collected for chemical and suspended solids analysis from each of the stream sampling sites and consisted of a mid-stream, mid-column grab sample using two 1 L bottles. After collecting water samples, dissolved oxygen, temperature, conductivity, pH, and oxidation-reduction potential readings were taken at each stream site. Readings were taken with a YSI meter, model #600 XL multi-probe meter.

Automatic Sampler

Each stream sampling station upstream of the reservoir also contains an Authority-owned ISCO flow meter and sampling device, which is powered by a 12-volt battery. The flow meter is a pressure transducer that measures stream water level. Rating curves were developed for each sampling site by measuring stream discharge (ft^3/sec) with a Marsh McBirney Model # 2000 flowmeter, and recording the water level at the staff gage (ft) and ISCO flowmeter (ft). Discharge is measured using methods outlined in Harrelson *et al* 1994. To determine flow rate, the level must be translated into flow rate using a "stage-discharge" relationship. The Authority has developed such a relationship for each site over the years. Since stage-discharge relationships can change over the years, the relationship is calibrated annually using a flow meter to take stream flow measurements three to four times per year at a range of flows. These data shall be combined with previous data to validate and modify the stage-discharge relationship for that site.

Water level data are stored in the ISCO sampler and must be downloaded to calibrate the station. Downloading of the data shall occur at least monthly to minimize the risk of a bad battery or other power failure resulting in a loss of data. The flow data and stage-discharge rating curves shall be checked throughout the year by comparing calculated flow estimates to actual flow measurements taken in the field with a flowmeter. Flow at time of sampling shall be calculated using stage-discharge relationships and is used to develop the flow-to-phosphorus relationship necessary to calculate daily loads (which are totaled for monthly and annual loads). The Corps is also contacted and daily precipitation and inflows/outflows from the reservoir obtained.

Storm Event Sampling

Samples from stormwater flow events are collected with ISCO automatic samplers, which collects samples when the water reaches a pre-set level. The level is determined by analyzing annual hydrographs from each stream and determining storm levels. When the pre-set level is reached, the ISCO collects a sample every 15 minutes for approximately 2.5 hours (i.e., a timed composite) or until the water recedes below the pre-set level. This sampling procedure occurs at Sites S-3, CC-10, CT-1, CT-2, CT-P1, and CT-P2. Following the storm event, water collected by the automatic samplers shall be composited (timed composite) and transferred to water jugs for analysis. Approximately 4 L would be collected from the 24 bottles, with each bottle contributing a sample amount representative of the flow at which it was taken. During the seasons in which no storm samples are taken, the storm samplers are disabled.

Precipitation Sampling

After each significant storm, the sample bottle shall be removed and taken to a qualified laboratory for analysis of total phosphorus, total nitrogen, and nitrite-nitrate. If sufficient volume remains, samples shall be tested for alkalinity, water hardness, pH, and suspended solids. The sampler shall be inspected and cleaned of any accumulations of insignificant precipitation on a weekly basis. This will prevent extraneous “dry fall” from being washed into the sampler between significant storm events.

Field-Related Quality Assurance/Quality Control

To ensure data quality, a number of quality assurance checks will be used. During each standard sampling episode, 1-split from the reservoir and 1-split from the stream (i.e., 28 total samples) shall be shipped to CU laboratory for analysis.

Field sampling quality control will consist of the use of a field blank. This field blank shall contain laboratory-grade deionized water that will be carried through the entire sampling episode. The cap of this jug will be removed at a particular site and left open during the regular sampling effort, after which time the cap will be replaced. One field blank will be used for every sampling trip. The field blanks and trip duplicates will be analyzed for the same parameters as a routine sample and later compared to samples analyzed by a qualified laboratory to provide QA/QC checks. Chain of custody procedures will be observed during the field sampling and delivery of samples to a qualified laboratory and to the CU laboratory.

LABORATORY PROCEDURES

Chemical Laboratory Analysis

Chemical analyses for the water collected in the study (Table 1) will be conducted by a qualified laboratory. Water samples will be analyzed for the parameters listed below.

TABLE 5: List of Analytes by Sample Depth

3-m Photic Composite Samples	1-m Increment Depth Samples	Stream Samples Precipitation Samples
pH, Conductivity, and Temperature	TP, TDP, SRP	TD, TDP, SRP
Total Phosphorus (TP), Total Dissolved Phosphorus (TDP), and Soluble Reactive Phosphorus (SRP)	TN, TDN, NO_3+NO_2, Ammonia	TN, TDN, NO_3+NO_2, Ammonia
Total Nitrogen (TN, Total Dissolved Nitrogen (TDN), NO_3+NO_2, and Ammonia		Total Suspended Solids (TSS)/ Total Volatile Suspended Solids (TVSS) (not on precipitation)
Chlorophyll		
Phytoplankton (sampled on reservoir sampling dates: twice monthly from April - October, and monthly from November - March from the 0-3 m water composite samples)		

Biological Laboratory Analysis

Biological analyses for the samples collected in the study, as described above, will be conducted at a qualified laboratory and analyzed for chlorophyll *a*. The methods of these analyses, with appropriate QA/QC procedures shall be in accordance with the methods provided in Table 1. Phytoplankton samples will be sent to the Colorado University Center for Limnology to be analyzed by Dr. Jim Saunders.

DATA VERIFICATION, REDUCTION, AND REPORTING

Data verification shall be conducted to insure that raw data are not altered. All field data, such as those generated during any field measurements and observations, will be entered directly into a bound Field Book. Sampling Crew members will be responsible for proof reading all data transfers, if necessary. At least ten percent of all data transfers will be checked for accuracy.

The Quality Assurance Project Manager will conduct data verification activities to assess laboratory performance in meeting quality assurance requirements. Such reviews include a verification that: 1) the correct samples were analyzed and reported in the correct units; 2) the samples were properly preserved and not held beyond applicable holding times; 3) instruments are regularly calibrated and meeting performance criteria; and 4) laboratory QA objectives for precision and accuracy are being met.

Data reduction for laboratory analyses is conducted by Consultant's personnel in accordance with EPA procedures, as available, for each method. Analytical results and appropriate field measurements are input into a computer spreadsheet. No results will be changed in the spreadsheet unless the cause of the error is identified and documented.

A data control program will be followed to insure that all documents generated during the project are accounted for upon their completion. Accountable documents include: Field Books, Sample Chain of Custody, Sample Log, analytical reports, quality assurance reports, and interpretive reports.

Data shall be summarized and provided to the Authority's Technical Advisory Committee on a monthly basis and presented in an annual report.

REFERENCES

American Public Health Association. 1998. *Standard Methods for Examination of Water and Wastewater*, 20th Edition. American Public Health Association, Washington, DC.

Denver Regional Council of Governments. 1985. *Cherry Creek Basin Water Quality Management Master Plan*. Prepared in Cooperation with Counties, Municipalities, and Water and Sanitation Districts in the Cherry Creek Basin and Colorado Department of Health.

Goldman, C.R., and A.J. Horne. 1983. *Limnology*. McGraw-Hill Company, NY.

Hach Company. 1997. *Hach Water Analysis Handbook*, 3rd Edition. Hach Company, Loveland, CO.

Harrelson, Cheryl C., Rawlins, C.L., Potyondy, John P. 1994. *Stream channel reference sites : an illustrated guide to field technique.* Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61p.

APPENDIX B

Reservoir Water Quality Data

CCR-1 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	Average Chlorophyll *a* µg/L
	Analytical Detection Limits	2	2	3	4	4	5	3	
2/22/05	CCR-1 Photic	55	16	6	846	488	<5	9	20.5
3/22/05	CCR-1 Photic	88	25	5	857	471	<5	8	20.6
4/13/05	CCR-1 Photic	80	17	<3	970	620	<5	29	16.2
5/10/05	CCR-1 Photic	96	20	8	943	552	<5	11	14.4
5/23/05	CCR-1 Photic	65	23	9	769	565	<5	15	8.6
6/7/05	CCR-1 Photic	82	61	47	892	700	10	53	8.6
6/21/05	CCR-1 Photic	70	33	19	819	620	<5	25	9.4
7/6/05	CCR-1 Photic	153	74	50	1620	1200	<5	82	14.3
7/20/05	CCR-1 Photic	139	56	55	1030	618	<5	11	22.9
8/3/05	CCR-1 Photic	118	60	44	966	606	<5	16	9.4
8/23/05	CCR-1 Photic	98	20*	24*	837	431	<5	13	15.4
9/14/05	CCR-1 Photic	96	18	7	770	520	<5	8	19.5
9/27/05	CCR-1 Photic	83	12	8	1050	648	<5	27	19.8
10/12/05	CCR-1 Photic	90	18	9	991	566	<5	20	20.6
11/8/05	CCR-1 Photic	72	17	6	791	456	<5	40	16.5

CCR-2 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	Average Chlorophyll *a* µg/L
Analytical Detection Limits		2	2	3	4	4	5	3	
2/22/05	CCR-2 photic	77	17	6	908	447	<5	5	22.6
2/22/05	CCR-2 4m	77	17	6	1015	437	<5	4	ND
2/22/05	CCR-2 5m	73	12	5	901	461	<5	5	ND
2/22/05	CCR-2 6m	76	15	5	880	448	<5	4	ND
2/22/05	CCR-2 7m	74	18	6	831	422	<5	4	ND
3/22/05	CCR-2 photic	75	15	4	843	457	<5	6	16.7
3/22/05	CCR-2 4m	74	17	5	835	452	<5	8	ND
3/22/05	CCR-2 5m	77	15	4	797	455	<5	9	ND
3/22/05	CCR-2 6m	90	16	4	894	487	<5	14	ND
3/22/05	CCR-2 7m	83	15	5	796	472	<5	16	ND
4/13/05	CCR-2 photic	73	15	<3	923	538	<5	18	16.8
4/13/05	CCR-2 4m	68	16	<3	796	456	<5	10	ND
4/13/05	CCR-2 5m	69	17	<3	783	464	<5	14	ND
4/13/05	CCR-2 6m	60	15	<3	794	472	<5	12	ND
4/13/05	CCR-2 7m	64	15	<3	798	455	<5	12	ND
5/10/05	CCR-2 photic	96	17	8	934	549	<5	12	14.6
5/10/05	CCR-2 4m	102	18	7	808	447	<5	7	ND
5/10/05	CCR-2 5m	81	20	7	774	473	<5	8	ND
5/10/05	CCR-2 6m	92	20	7	804	495	<5	10	ND
5/10/05	CCR-2 7m	98	29	8	850	427	<5	8	ND
5/23/05	CCR-2 photic	65	23	9	723	450	<5	9	10.1
5/23/05	CCR-2 4m	79	25	13	824	467	<5	12	ND
5/23/05	CCR-2 5m	87	30	15	801	523	<5	16	ND
5/23/05	CCR-2 6m	96	36	23	806	521	<5	17	ND
5/23/05	CCR-2 7m	181	98	73	883	527	<5	21	ND
6/7/05	CCR-2 photic	84	61	46	1046	818	9	61	9.0
6/7/05	CCR-2 4m	85	60	50	619	551	12	55	ND
6/7/05	CCR-2 5m	87	64	52	659	544	16	62	ND
6/7/05	CCR-2 6m	88	67	57	704	571	20	77	ND
6/7/05	CCR-2 7m	118	93	82	761	657	36	161	ND

* "ND" denotes "No Data"

CCR-2 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	Average Chlorophyll α mg/m^3
Analytical Detection Limits		2	2	3	4	4	5	3	
6/21/05	CCR-2 Photic	71	28	16	689	477	<5	11	9.0
6/21/05	CCR-2 4m	72	33	19	752	463	<5	13	ND
6/21/05	CCR-2 5m	69	32	19	712	468	<5	15	ND
6/21/05	CCR-2 6m	83	33	20	764	482	<5	17	ND
6/21/05	CCR-2 7m	81	39	26	766	512	<5	25	ND
7/6/05	CCR-2 Photic	121	75	51	1096	786	<5	45	10.3
7/6/05	CCR-2 4m	145	107	85	922	741	<5	85	ND
7/6/05	CCR-2 5m	152	108	86	954	740	<5	202	ND
7/6/05	CCR-2 6m	183	117	96	1034	806	<5	236	ND
7/6/05	CCR-2 7m	167	125	103	1048	850	<5	264	ND
7/20/05	CCR-2 Photic	135	52	39	979	560	<5	3	25.5
7/20/05	CCR-2 4m	101	50	40	806	550	<5	11	ND
7/20/05	CCR-2 5m	126	70	60	929	644	<5	55	ND
7/20/05	CCR-2 6m	159	102	96	942	671	<5	153	ND
7/20/05	CCR-2 7m	173	113	106	1462	1114	7	214	ND
8/3/05	CCR-2 Photic	129	61	44	923	534	<5	11	8.0
8/3/05	CCR-2 4m	114	64	46	661	415	<5	3	ND
8/3/05	CCR-2 5m	118	64	51	935	544	<5	17	ND
8/3/05	CCR-2 6m	116	67	47	771	423	<5	5	ND
8/3/05	CCR-2 7m	134	69	50	793	480	<5	8	ND
8/23/05	CCR-2 Photic	106	20*	23*	859	510	<5	24	15.9
8/23/05	CCR-2 4m	105	25	23	753	439	<5	10	ND
8/23/05	CCR-2 5m	104	22*	24*	829	441	<5	9	ND
8/23/05	CCR-2 6m	95	23*	24*	723	427	<5	7	ND
8/23/05	CCR-2 7m	98	36*	38*	689	460	<5	33	ND
9/14/05	CCR-2 Photic	96	19	9	865	511	<5	12	21.8
9/14/05	CCR-2 4m	99	17	10	822	431	<5	7	ND
9/14/05	CCR-2 5m	96	18	8	738	452	<5	7	ND
9/14/05	CCR-2 6m	98	19	9	809	459	<5	6	ND
9/14/05	CCR-2 7m	96	19	9	771	440	<5	6	ND

* "ND" denotes "No Data"

CCR-2 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	Average Chlorophyll α mg/m^3
Analytical Detection Limits		2	2	3	4	4	5	3	
9/27/05	CCR-2 photic	88	11	7	942	532	<5	18	16.5
9/27/05	CCR-2 4m	81	11	7	836	433	<5	14	ND
9/27/05	CCR-2 5m	79	9	7	824	449	<5	12	ND
9/27/05	CCR-2 6m	94	10	7	831	456	<5	15	ND
9/27/05	CCR-2 7m	132	14	8	874	451	<5	17	ND
10/12/05	CCR-2 photic	91	16	7	843	484	<5	9	28.4
10/12/05	CCR-2 4m	85	15	7	810	411	<5	9	ND
10/12/05	CCR-2 5m	83	16	8	823	414	<5	11	ND
10/12/05	CCR-2 6m	94	23	14	855	421	8	10	ND
10/12/05	CCR-2 7m	99	26	18	806	439	11	18	ND
11/8/05	CCR-2 photic	69	17	6	930	508	<5	87	15.5
11/8/05	CCR-2 4m	70	14	5	759	403	<5	8	ND
11/8/05	CCR-2 5m	74	16	5	790	429	<5	11	ND
11/8/05	CCR-2 6m	70	14	5	760	417	<5	9	ND
11/8/05	CCR-2 7m	78	15	6	777	418	<5	10	ND

* "ND" denotes "No Data"

CCR-3 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	Average Chlorophyll *a* µg/L
	Analytical Detection Limits	2	2	3	4	4	5	3	
2/22/05	CCR-3 Photic	68	19	7	858	422	<5	5	23.9
3/22/05	CCR-3 Photic	79	19	4	814	462	<5	8	14.7
4/13/05	CCR-3 Photic	73	15	<3	812	445	<5	12	18.6
5/10/05	CCR-3 Photic	86	30	8	819	428	<5	6	15.5
5/23/05	CCR-3 Photic	68	22	10	744	483	<5	13	8.7
6/7/05	CCR-3 Photic	88	59	48	820	610	17	51	9.7
6/25/05	CCR-3 Photic	76	38	25	847	576	<5	22	10.3
7/6/05	CCR-3 Photic	164	72	49	1051	585	<5	19	14.4
7/20/05	CCR-3 Photic	160	63	53	1385	856	<5	17	28.0
8/3/05	CCR-3 Photic	125	65	48	876	532	<5	12	9.6
8/23/05	CCR-3 Photic	98	20*	22*	898	520	<5	13	19.2
9/14/05	CCR-3 Photic	90	19	9	777	421	<5	7	18.3
9/27/05	CCR-3 Photic	94	12	7	892	511	<5	20	18.6
10/12/05	CCR-3 Photic	84	17	8	773	419	<5	26	19.2
11/8/05	CCR-3 Photic	74	13	5	773	409	<5	9	17.9

CCR University of Colorado Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	NO3+NO2-N µg/L	NH4-N µg/L
Analytical Detection Limits		2	2	3	5	3
2/22/2005	CCR-1 photic	60.4	18.2	2.4	6.4	12.9
3/23/2005	CCR-2 5m	61.5	20.6	1.0	0.0	22.6
4/13/2005	CCR-3 photic	63.3	20.4	1.6	0.0	9.7
5/10/2005	CCR-2 6m	75.5	26.6	6.5	3.1	18.3
5/23/2005	CCR-2 5m	76.5	36.1	15.6	0.0	31.0
6/7/2005	CCR-2 photic	90.6	69.3	46.5	11.2	48.5
6/21/2005	CCR-3 photic	69.3	40.7	22.5	0.0	12.8
7/6/2005	CCR-3 photic	126.7	78.0	51.1	10.7	27.2
7/20/2005	CCR-3 photic	125.3	79.2	58.6	0.0	18.6
8/3/2005	CCR-3 photic	108.0	69.3	68.4	0.0	9.6
8/23/2005	CCR-2 photic	70.5	19.9	6.4	0.0	10.9
9/13/2005	CCR-2 4m	87.6	22.2	6.0	0.0	11.6
9/27/2005	CCR-3 photic	63.9	17.4	8.6	0.0	9.2
10/12/2005	CCR-2 photic	68.0	18.2	2.8	7.1	9.6
11/8/2005	CCR-2 photic	58.8	18.2	2.7	0.0	9.5

CCR C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	NO3+NO2-N µg/L	NH4-N µg/L
Analytical Detection Limits		2	2	3	5	3
2/22/2005	CCR-1 photic	55	16	6	<5	9
3/23/2005	CCR-2 5m	77	15	4	<5	9
4/13/2005	CCR-3 photic	73	15	<3	<5	12
5/10/2005	CCR-2 6m	92	20	7	<5	10
5/23/2005	CCR-2 5m	87	30	15	<5	16
6/7/2005	CCR-2 photic	84	61	46	9	61
6/21/2005	CCR-3 photic	76	38	25	<5	22
7/6/2005	CCR-3 photic	164	72	49	<5	19
7/20/2005	CCR-3 photic	160	63	53	<5	17
8/3/2005	CCR-3 photic	125	65	48	<5	12
8/23/2005	CCR-2 photic	106	20	23	<5	24

CCR C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	NO3+NO2-N µg/L	NH4-N µg/L
Analytical Detection Limits		2	2	3	5	3
9/13/2005	CCR-2 4m	99	17	10	<5	7
9/27/2005	CCR-3 photic	94	12	7	<5	20
10/12/2005	CCR-2 photic	91	16	7	<5	9
11/8/2005	CCR-2 photic	69	17	6	<5	87

CHERRY CREEK
D.O. DATA, 2005
Site CCR-1

Date 02/22/05
Secchi 1.05 m
1% 2.50

Depth (m)	Temp °C	Cond.	DO	pH
0	3.96	558	15.72	8.59
1	3.84	556	15.73	8.59
2	3.81	555	15.70	8.57
3	3.79	555	16.20	8.57
4	3.79	554	16.12	8.57
5	3.79	555	16.31	8.56
6	3.80	556	16.11	8.57

Date 03/22/05
Secchi 0.90 m
1% 2.50 m

Depth (m)	Temp °C	Cond.	DO	pH
0	6.93	622	13.55	5.83
1	6.91	618	13.42	8.52
2	6.56	612	13.21	8.50
3	6.41	610	12.96	8.49
4	6.31	607	12.79	8.47
5	6.10	606	12.43	8.45
6	6.07	605	13.16	8.45

Date 04/13/05
Secchi 0.76 m
1% 3.25 m

Depth (m)	Temp °C	Cond.	DO	pH
0	8.82	613	14.12	8.62
1	8.45	606	14.32	8.63
2	7.79	594	14.52	8.61
3	7.44	589	14.64	8.59
4	7.25	587	14.48	8.55
5	7.04	581	14.37	8.53
6	6.98	580	14.36	8.52

Date 05/10/05
Secchi 0.65 m
1% 2.65 m

Depth (m)	Temp °C	Cond.	DO	pH
c	13.95	691	9.61	8.61
1	13.93	691	9.57	8.61
2	13.65	685	9.27	8.60
3	12.86	672	8.57	8.51
4	11.34	650	6.56	8.30
5	10.87	639	5.89	8.19
6	10.63	638	6.15	8.15

Date 05/23/05
Secchi 1.10 m
1% 1.75 m

Depth (m)	Temp °C	Cond.	DO	pH
0	20.31	839	11.54	8.65
1	20.11	837	11.42	8.66
2	19.98	831	11.43	8.66
3	19.81	832	11.55	8.63
4	15.83	760	7.00	8.21
5	15.20	743	6.19	7.96
6	14.16	754	2.39	8.13

Date 06/07/05
Secchi 2.75 m
1% 2.50 m

Depth (m)	Temp °C	Cond.	DO	pH
0	18.31	801	9.75	8.39
1	17.74	707	9.73	8.39
2	17.39	782	9.70	8.39
3	17.33	781	9.50	8.37
4	17.23	779	9.32	8.35
5	17.04	775	9.07	8.33
6	16.80	772	8.77	8.29

Date 06/21/05
Secchi 1.30 m
1% 1.75 m

Depth (m)	Temp °C	Cond.	DO	pH
0	21.06	805	10.50	8.59
1	21.04	805	10.50	8.59
2	21.02	804	10.44	8.58
3	20.92	803	10.29	8.55
4	20.89	802	10.01	8.51
5	20.64	798	9.14	8.43
6	18.91	775	5.34	8.04

Date 07/06/05
Secchi 1.60 m
1% 1.75 m

Depth (m)	Temp °C	Cond.	DO	pH
0	22.48	840	10.28	8.54
1	21.88	826	11.02	8.59
2	21.50	822	9.54	8.50
3	21.38	818	9.00	8.46
4	21.23	819	8.33	8.41
5	21.15	819	7.46	8.35
6	21.02	818	6.10	8.24

CCR-1 DO Data Continued

Date	07/20/05			
Secchi	0.75	m		
1%	1.35	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	23.94	867	13.04	8.62
1	23.54	857	11.99	8.57
2	23.34	855	11.68	8.51
3	23.12	853	9.82	8.39
4	23.06	857	6.90	8.21
5	23.00	858	5.58	8.13
6	22.99	858	5.47	8.16

Date	08/03/05			
Secchi	1.10	m		
1%	3.40	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	23.72	885	6.43	8.31
1	23.71	885	6.96	8.30
2	23.56	882	7.10	8.26
3	23.43	881	6.84	8.15
4	23.34	880	6.72	8.11
5	23.19	878	5.99	8.02
6	23.08	877	5.85	7.98

Date	08/23/05			
Secchi	0.98	m		
1%	2.88	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	21.67	795	9.70	8.39
1	21.09	784	9.17	8.38
2	20.97	783	8.65	8.33
3	20.93	781	8.56	8.32
4	20.89	780	8.20	8.28
5	20.87	781	7.52	8.22
6	20.83	780	7.05	8.17

Date	09/14/05			
Secchi	0.75	m		
1%	2.00	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	19.33	769	6.59	8.24
1	19.34	769	6.56	8.23
2	19.34	769	6.52	8.22
3	19.34	769	6.43	8.18
4	19.34	769	6.01	8.22
5	19.35	770	5.84	8.24
6	19.35	770	5.85	8.25

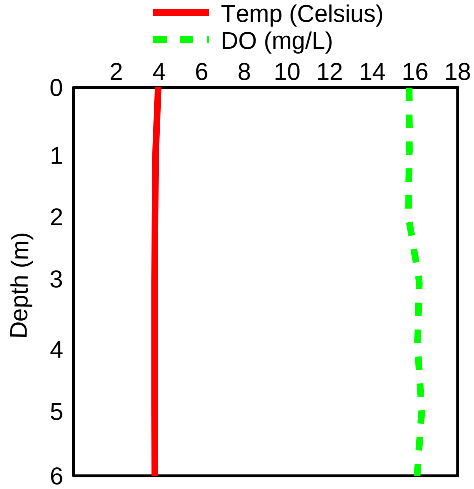
Date	09/27/05			
Secchi	1.00	m		
1%	2.50	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	17.96	806	9.96	8.35
1	17.95	807	9.85	8.34
2	17.96	806	9.83	8.34
3	17.95	806	9.73	8.32
4	17.95	807	9.64	8.28
5	17.89	806	8.70	8.17
6	17.69	804	7.33	8.15

Date	10/12/05			
Secchi	0.75	m		
1%	NA	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	12.49	682	9.74	8.25
1	12.47	682	9.63	8.24
2	12.47	681	9.71	8.24
3	12.44	680	9.34	8.23
4	12.29	677	8.74	8.19
5	12.28	675	8.45	8.16
6	12.27	675	6.21	8.15

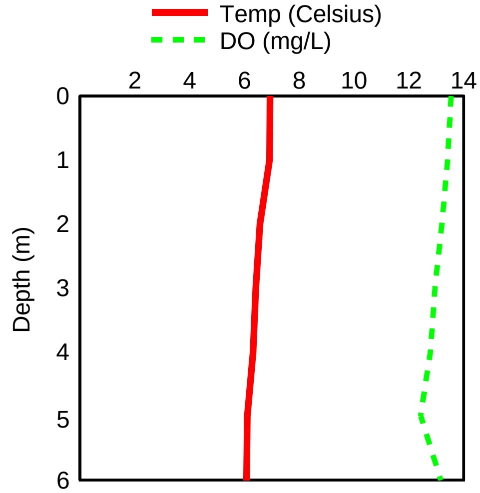
Date	11/08/05			
Secchi	0.78	m		
1%	2.75	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	9.91	640	11.15	8.56
1	9.69	637	10.77	8.52
2	9.53	634	10.48	8.45
3	9.48	634	10.23	8.37
4	9.43	633	9.44	8.25
5	9.38	633	9.01	8.18
6	9.32	634	7.75	8.16

CCR-1

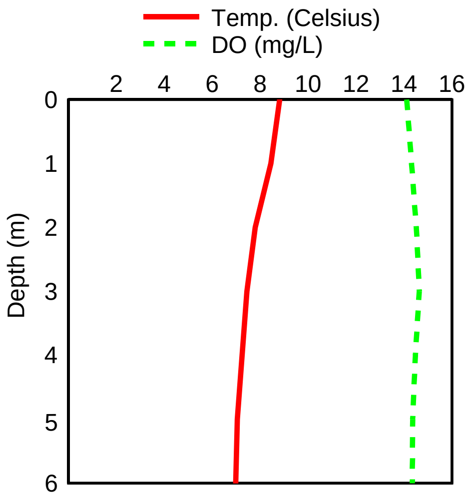
February 22, 2005



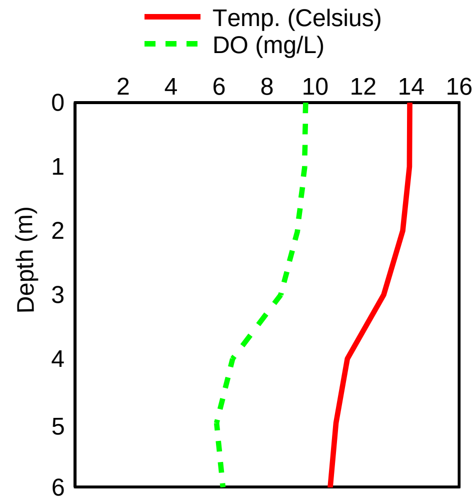
March 22, 2005



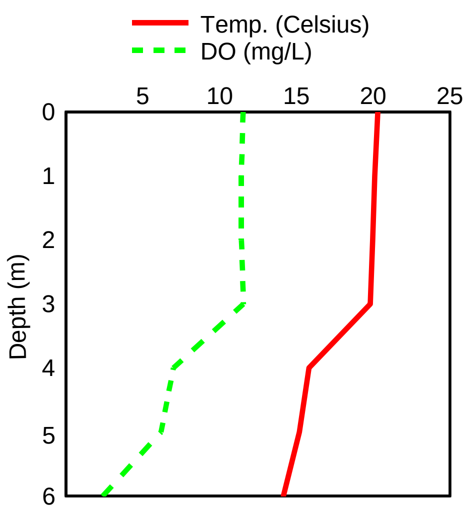
April 13, 2005



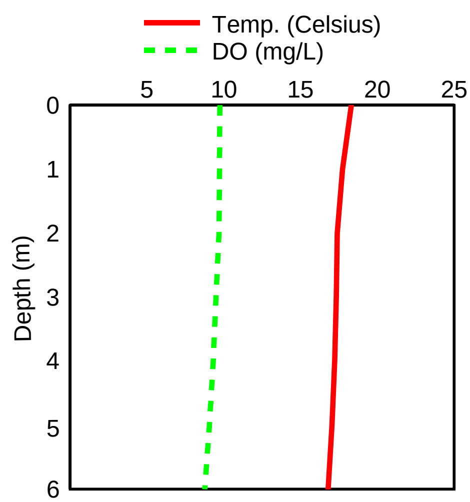
May 10, 2005



May 23, 2005

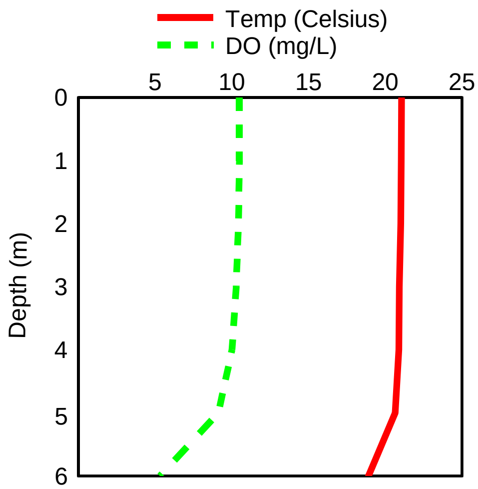


June 7, 2005

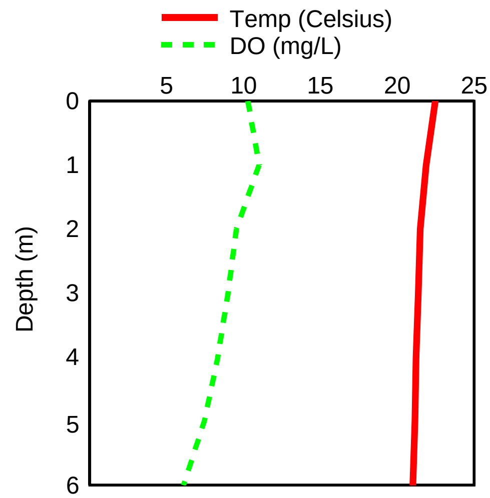


CCR-1

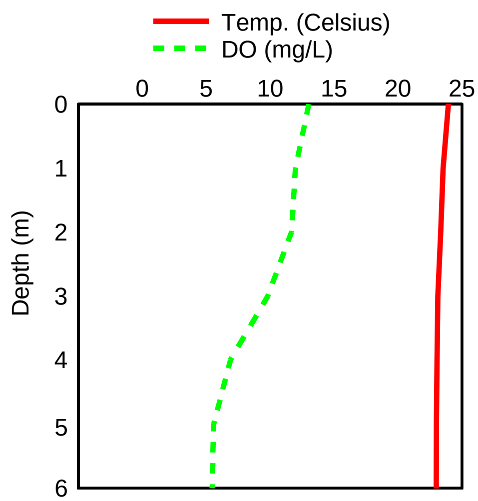
June 21, 2005



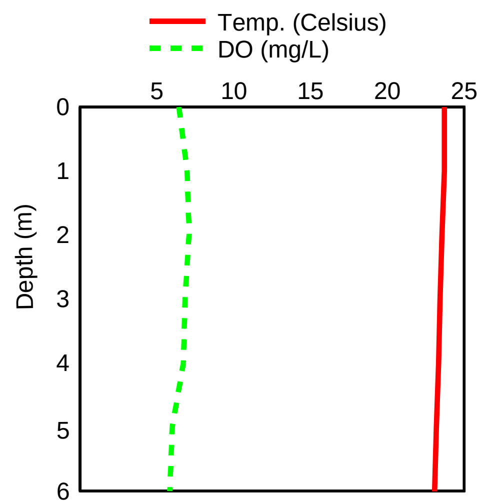
July 6, 2005



July 20, 2005



August 3, 2005



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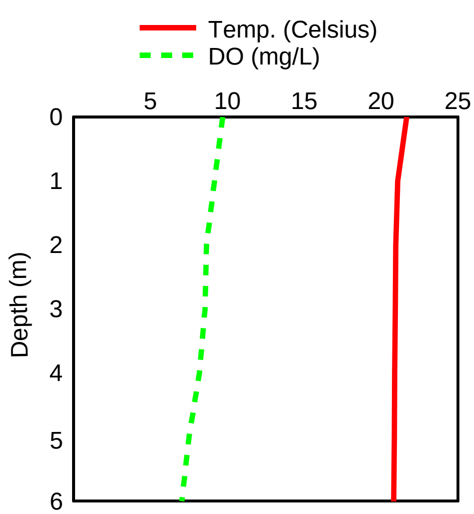
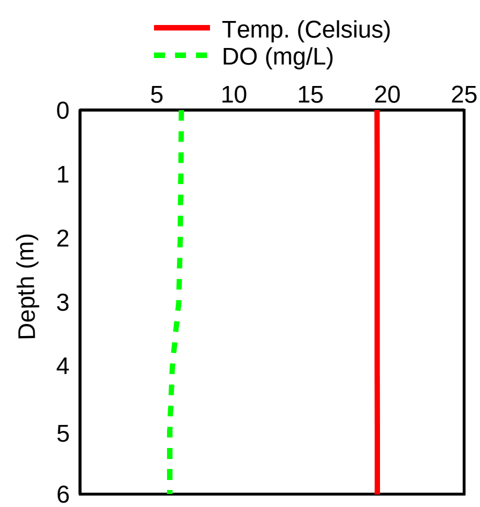
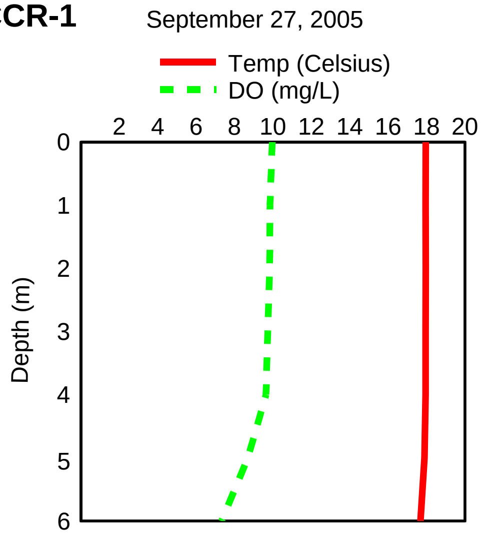


September 14, 2005



CCR-1


September 27, 2005
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DO (mg/L)
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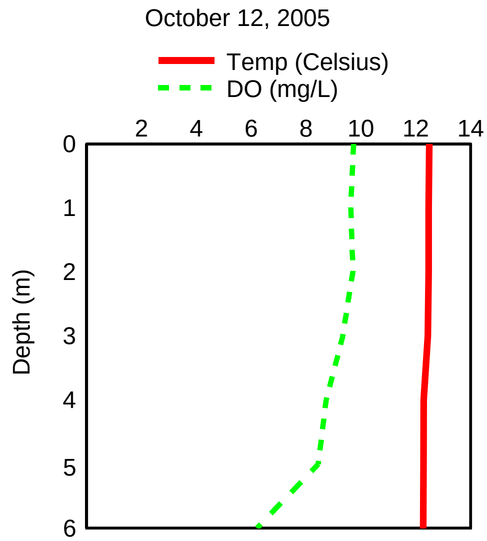
2
3
4
5
6
Depth (m)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DO (mg/L)
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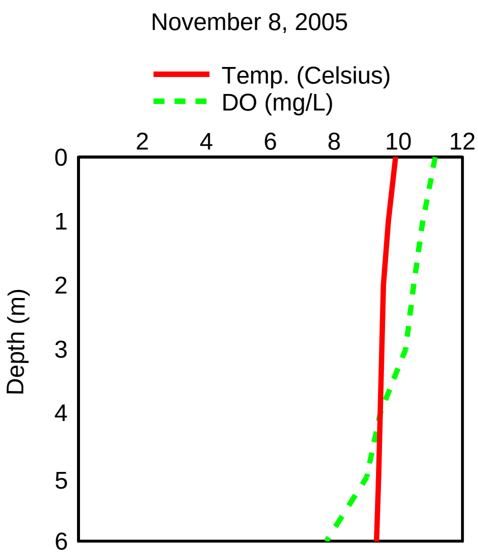
1
2
3
4
5
6
Depth (m)


November 8, 2005
Temp. (Celsius)
DO (mg/L)
2 4 6 8 10 12
0
1
2
3
4
5
6
Depth (m)

CHERRY CREEK
D.O. DATA, 2005
Site CCR-2

Date 02/22/05
Secchi 0.85 m
1% 2.25

Depth (m)	Temp °C	Cond.	DO	pH
0	3.82	555	15.62	8.53
1	3.80	554	15.55	8.53
2	3.79	554	15.36	8.52
3	3.79	554	15.25	8.51
4	3.79	554	15.31	8.49
5	3.80	554	14.56	8.48
6	3.80	554	14.35	8.48
7	3.79	557	14.87	8.46

Date 03/22/05
Secchi 0.85 m
1% 3.60 m

Depth (m)	Temp °C	Cond.	DO	pH
0	7.16	621	9.87	8.49
1	6.59	610	9.67	8.49
2	6.21	606	9.57	8.49
3	6.15	603	9.52	8.43
4	6.10	602	9.42	8.42
5	6.10	602	9.66	8.42
6	6.11	602	9.68	8.42
7	6.15	603	9.29	8.40

Date 04/13/05
Secchi 0.82 m
1% 3.60 m

Depth (m)	Temp °C	Cond.	DO	pH
0	9.69	630	17.10	8.65
1	9.52	625	17.42	8.64
2	9.16	618	17.57	8.64
3	8.69	612	17.64	8.64
4	8.31	605	17.16	8.59
5	8.09	601	17.13	8.58
6	7.99	600	16.92	8.56
7	7.66	595	16.80	8.54

Date 05/10/05
Secchi 0.70 m
1% 2.75 m

Depth (m)	Temp °C	Cond.	DO	pH
0	14.53	698	9.96	8.64
1	14.11	692	9.93	8.64
2	13.99	690	9.88	8.63
3	13.91	687	9.83	8.63
4	13.85	698	9.77	8.63
5	13.76	686	9.51	8.61
6	13.27	678	8.75	8.54
7	10.88	642	5.48	8.12

Date 05/23/05
Secchi 1.20 m
1% 1.75 m

Depth (m)	Temp °C	Cond.	DO	pH
0	20.19	834	12.06	8.64
1	20.12	834	11.98	8.68
2	19.86	831	11.51	8.65
3	16.64	774	7.80	8.34
4	15.46	769	6.29	8.19
5	14.83	731	5.00	7.38
6	13.46	716	2.95	7.86
7	12.68	702	2.13	7.81

Date 06/07/05
Secchi 2.15 m
1% 2.50 m

Depth (m)	Temp °C	Cond.	DO	pH
0	18.21	799	10.27	8.40
1	18.04	795	10.14	8.39
2	17.79	789	9.99	8.38
3	17.47	783	9.37	8.36
4	17.25	779	8.99	8.31
5	17.07	772	8.55	8.25
6	16.75	765	7.89	8.19
7	16.07	740	6.77	8.07

Date 06/21/05
Secchi 1.25 m
1% 1.75 m

Depth (m)	Temp °C	Cond.	DO	pH
0	21.33	809	10.43	8.59
1	21.07	804	10.52	8.59
2	20.89	802	10.42	8.58
3	20.81	801	10.36	8.57
4	20.69	800	10.33	8.56
5	20.66	798	10.30	8.56
6	20.62	798	9.84	8.53
7	19.75	787	6.41	8.21

Date 07/06/05
Secchi 1.50 m
1% 1.75 m

Depth (m)	Temp °C	Cond.	DO	pH
0	23.54	884	10.06	8.52
1	21.63	879	9.64	8.49
2	21.46	882	8.21	8.40
3	21.09	885	6.30	8.26
4	20.96	886	6.57	8.25
5	20.82	887	4.87	8.15
6	20.77	828	4.46	8.11
7	20.75	816	4.46	8.10

CCR-2 DO Data Continued

Date	07/20/05			
Secchi	0.85	m		
1%	1.40	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	24.75	841	12.19	8.56
1	23.91	862	12.50	8.58
2	23.53	853	11.93	8.55
3	23.45	852	11.58	8.51
4	23.38	852	9.48	8.41
5	22.94	850	7.34	8.22
6	22.40	845	3.46	7.96
7	22.32	845	3.11	7.94

Date	08/03/05			
Secchi	1.10	m		
1%	3.50	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	23.48	879	5.82	8.28
1	23.41	878	6.44	8.26
2	23.39	878	6.58	8.25
3	23.17	874	6.41	8.21
4	23.19	874	6.40	8.20
5	23.17	875	6.38	8.19
6	23.09	873	6.37	8.17
7	23.01	873	6.29	8.17

Date	08/23/05			
Secchi	1.10	m		
1%	3.10	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	21.86	795	12.08	8.48
1	21.34	785	10.91	8.47
2	21.22	784	10.57	8.46
3	21.19	783	10.32	8.44
4	21.16	783	10.09	8.41
5	21.12	782	9.55	8.34
6	21.08	783	9.15	8.33
7	20.82	782	5.20	8.12

Date	09/14/05			
Secchi	0.65	m		
1%	1.25	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	19.44	771	6.69	8.23
1	19.47	771	6.49	8.22
2	19.46	770	6.24	8.19
3	19.45	771	6.27	8.21
4	19.42	770	6.20	8.20
5	19.41	770	6.17	8.18
6	19.40	770	6.11	8.19
7	19.37	770	5.97	8.17

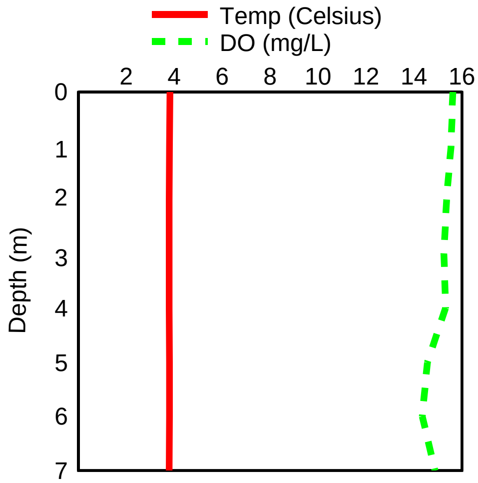
Date	09/27/05			
Secchi	0.85	m		
1%	2.25	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	18.00	806	10.20	8.40
1	17.98	806	10.02	8.39
2	17.97	806	9.92	8.39
3	17.97	806	9.90	8.38
4	17.96	807	9.87	8.37
5	17.93	806	9.39	8.28
6	17.79	805	7.91	8.26
7	17.58	802	6.60	8.24

Date	10/12/05			
Secchi	0.60	m		
1%	NA	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	12.93	688	11.05	8.42
1	12.87	687	10.95	8.41
2	12.83	687	10.70	8.38
3	12.75	684	10.46	8.36
4	12.56	681	9.29	8.26
5	12.36	676	8.52	8.19
6	11.93	661	7.56	8.17
7	11.79	656	7.67	8.19

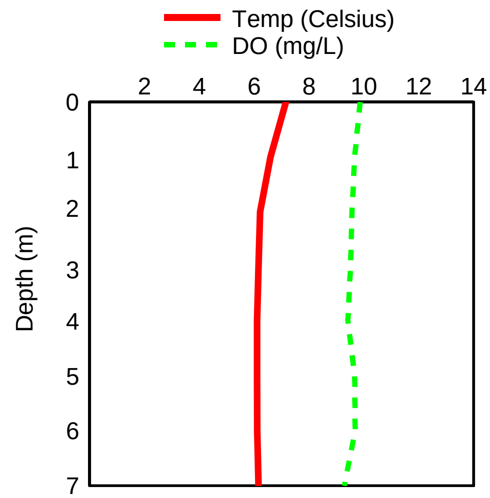
Date	11/08/05			
Secchi	0.75	m		
1%	2.75	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	10.19	644	11.56	8.67
1	9.90	639	11.52	8.66
2	9.78	637	10.95	8.61
3	9.75	636	10.84	8.60
4	9.64	636	10.45	8.57
5	9.34	631	9.24	8.49
6	8.90	626	9.00	8.47
7	8.82	625	9.25	8.48

CCR-2

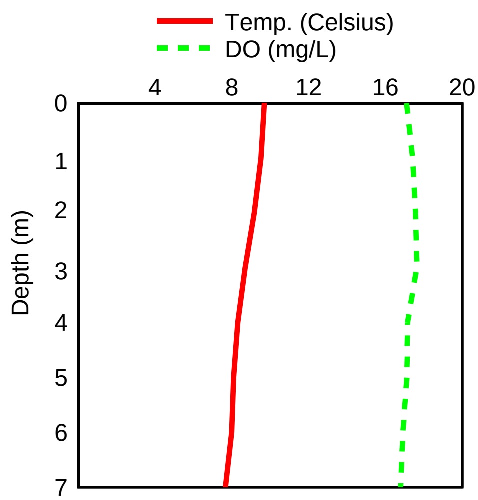
February 22, 2005



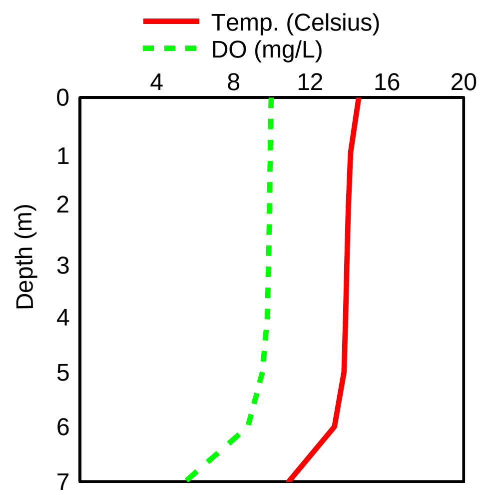
March 22, 2005



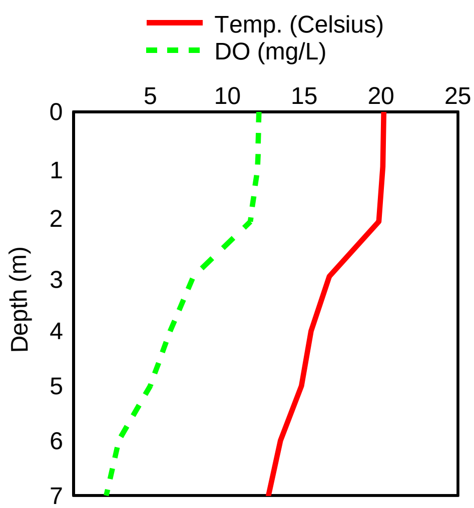
April 13, 2005



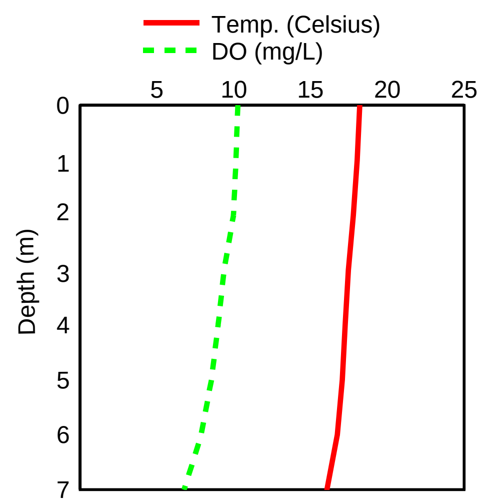
May 10, 2005



May 23, 2005

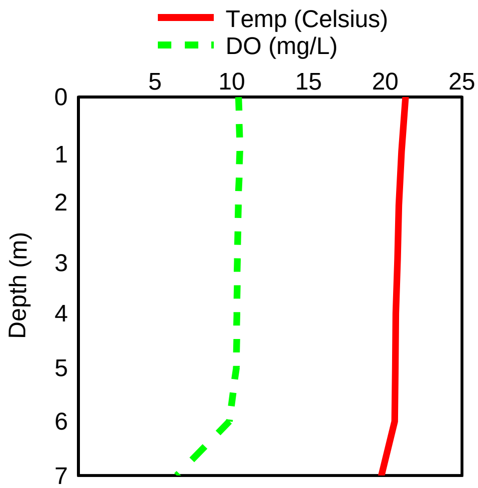


June 7, 2005

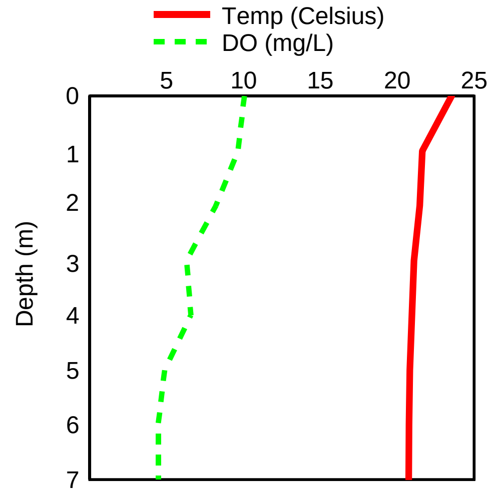


CCR-2

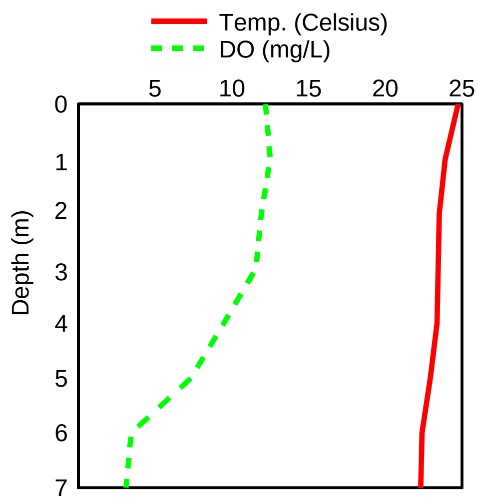
June 21, 2005



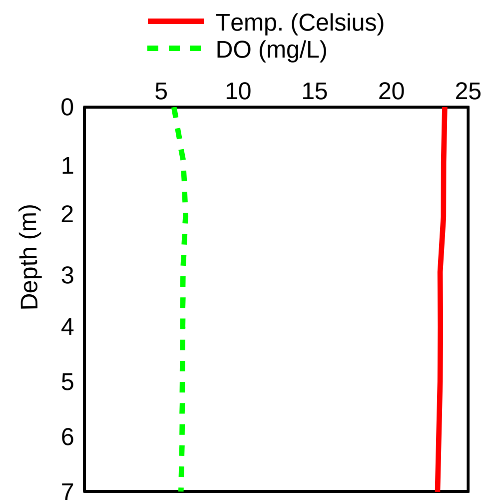
July 6, 2005



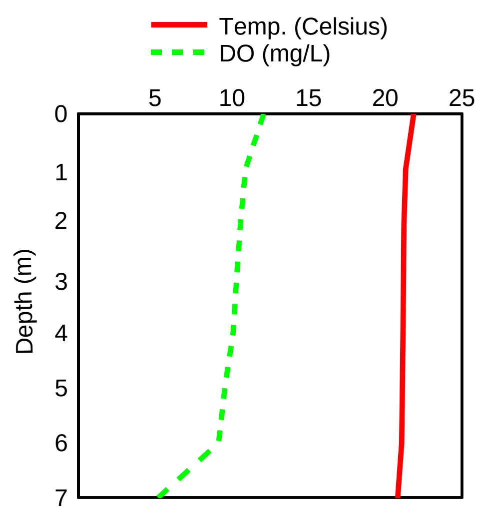
July 20, 2005



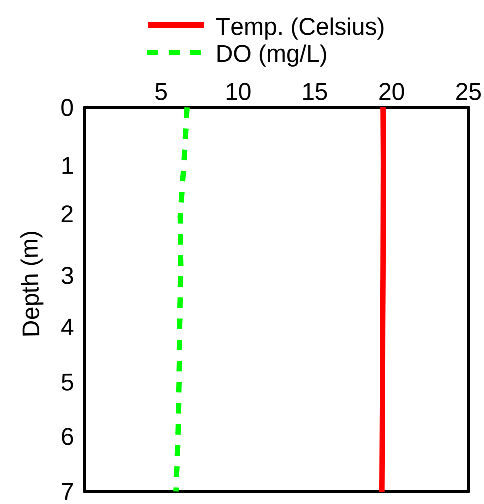
August 3, 2005



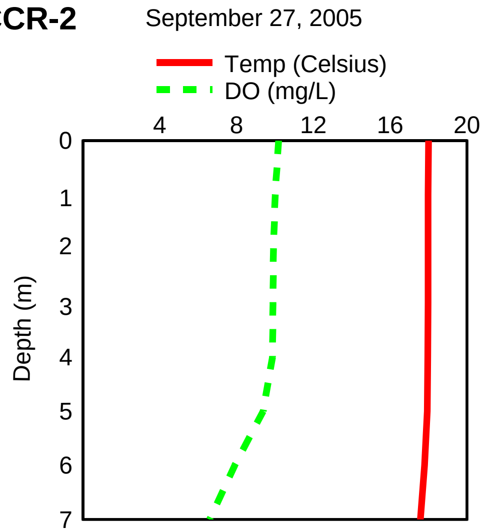
August 23, 2005

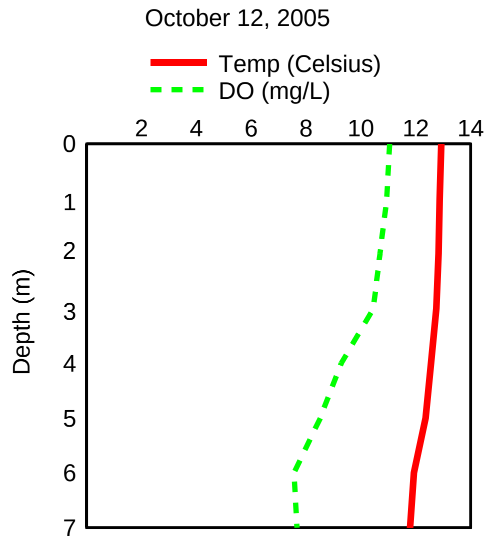


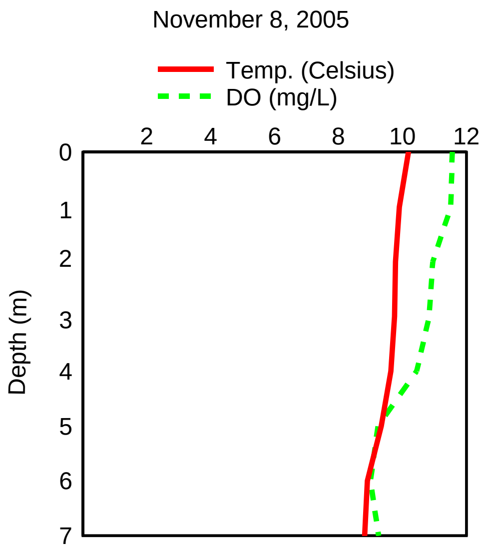
September 14, 2005



CCR-2


September 27, 2005
Temp (Celsius)
DO (mg/L)
4
8
12
16
20
Depth (m)
0
1
2
3
4
5
6
7


October 12, 2005
Temp (Celsius)
DO (mg/L)
2
4
6
8
10
12
14
Depth (m)
0
1
2
3
4
5
6
7


November 8, 2005
Temp. (Celsius)
DO (mg/L)
2
4
6
8
10
12
Depth (m)
0
1
2
3
4
5
6
7

CHERRY CREEK
D.O. DATA, 2005
Site CCR-3

Date	02/22/05			
Secchi	0.90	m		
1%	2.50			
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	4.30	561	16.46	8.58
1	4.12	559	8.58	8.57
2	4.06	558	8.57	8.57
3	3.98	558	8.57	8.57
4	3.99	557	8.56	8.56
5	3.98	557	8.57	8.57

Date	03/22/05			
Secchi	0.85	m		
1%	3.50	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	6.79	615	11.79	8.49
1	6.70	614	12.07	8.49
2	6.45	609	12.19	8.49
3	6.27	607	12.12	8.48
4	6.17	604	12.02	8.47
5	5.96	602	11.97	8.45

Date	04/13/05			
Secchi	0.84	m		
1%	2.65	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	9.12	607	18.17	8.61
1	9.04	606	18.15	8.61
2	7.94	595	18.09	8.60
3	7.76	593	17.87	8.57
4	7.60	587	17.57	8.54
5	7.38	588	17.27	8.52
6	6.85	583	16.38	8.46

Date	05/10/05			
Secchi	0.70	m		
1%	2.65	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	13.92	688	9.85	8.62
1	13.72	685	9.73	8.61
2	13.00	671	9.24	8.56
3	12.76	666	8.84	8.51
4	12.50	665	8.10	8.48
5	12.00	659	6.68	8.37

Date	05/23/05			
Secchi	1.15	m		
1%	1.70	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	19.32	830	11.94	8.64
1	19.07	827	11.62	8.63
2	18.24	799	11.06	8.58
3	17.62	801	8.55	8.47
4	14.54	760	6.70	8.15
5	13.45	ND	ND	7.16

Date	06/07/05			
Secchi	2.25	m		
1%	2.25	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	18.41	799	10.35	8.35
1	17.56	779	10.61	8.37
2	17.20	775	10.35	8.36
3	17.09	773	9.71	8.33
4	16.75	766	10.36	8.29
5	16.23	745	8.08	8.19

Date	06/21/05			
Secchi	1.00	m		
1%	1.00	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	21.76	822	9.95	8.54
1	20.91	806	10.15	8.54
2	20.55	799	9.86	8.54
3	20.28	796	9.02	8.46
4	19.21	781	6.27	8.12
5	18.53	773	4.03	8.06

Date	07/06/05			
Secchi	1.25	m		
1%	1.50	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	22.85	883	11.32	8.59
1	21.59	876	11.34	8.61
2	21.32	879	10.16	8.53
3	21.03	882	7.83	8.32
4	20.55	889	7.73	8.31
5	20.51	885	1.86	7.63

CCR-3 DO Data Continued

Date	07/20/05			
Secchi	0.60	m		
1%	1.25	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	24.64	887	12.45	8.53
1	23.19	852	9.29	8.39
2	22.92	851	7.51	8.20
3	22.84	849	7.39	8.18
4	22.78	849	6.42	8.11
5	22.65	837	1.82	7.85

Date	08/03/05			
Secchi	0.80	m		
1%	2.80	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	23.97	887	6.56	8.22
1	23.81	883	6.58	8.19
2	23.36	878	6.04	8.08
3	23.24	874	5.65	7.99
4	23.10	872	4.80	7.95
5	22.85	867	4.51	7.76

Date	08/23/05			
Secchi	1.10	m		
1%	2.87	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	22.04	797	12.24	8.46
1	21.46	787	12.65	8.51
2	21.18	782	11.06	8.46
3	21.13	782	10.50	8.45
4	20.80	779	7.26	8.27
5	20.67	777	4.65	8.12

Date	09/14/05			
Secchi	0.65	m		
1%	1.75	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	18.79	760	6.61	8.17
1	18.81	760	6.43	8.17
2	18.80	760	6.30	8.16
3	18.78	760	6.28	8.17
4	18.72	759	6.25	8.17
5	18.23	750	6.42	8.19

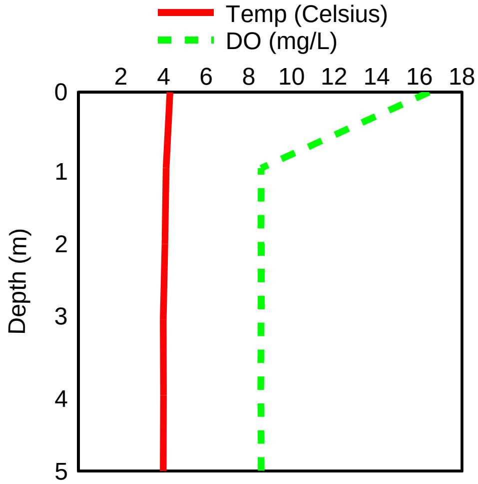
Date	09/27/05			
Secchi	0.76	m		
1%	2.37	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	17.59	799	9.20	8.34
1	17.53	799	8.91	8.34
2	17.51	798	8.85	8.33
3	17.48	798	8.77	8.32
4	17.43	797	8.73	8.32
5	17.24	794	8.07	8.23

Date	10/12/05			
Secchi	0.70	m		
1%	NA	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	12.60	681	9.70	8.15
1	12.50	680	10.14	8.28
2	12.27	676	9.69	8.29
3	12.02	669	8.85	8.27
4	11.77	659	8.78	8.25
5	11.17	647	9.04	8.25

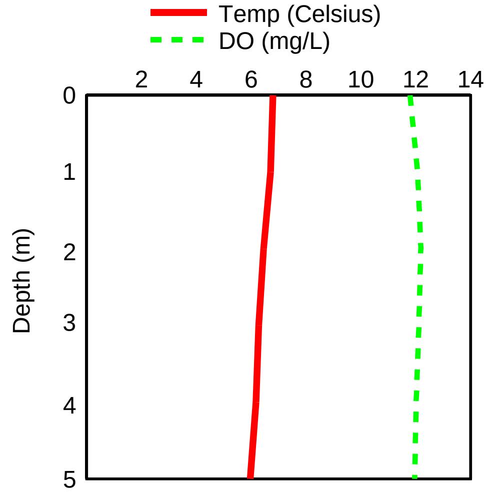
Date	11/08/05			
Secchi	0.60	m		
1%	2.50	m		
Depth (m)	**Temp °C**	**Cond.**	**DO**	**pH**
0	9.59	634	10.28	8.58
1	9.36	630	10.24	8.57
2	9.28	628	10.01	8.55
3	9.20	628	9.54	8.51
4	9.14	628	9.04	8.43
5	9.16	627	8.19	8.42

CCR-3

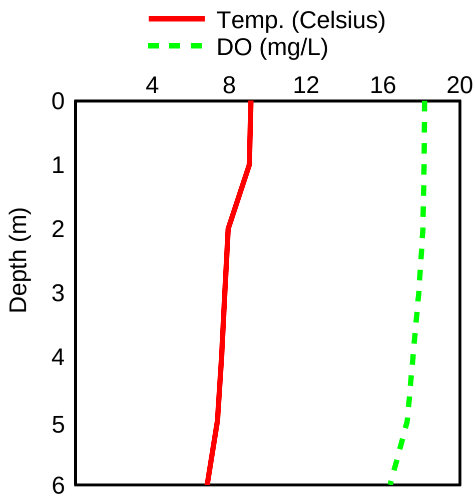
February 22, 2005



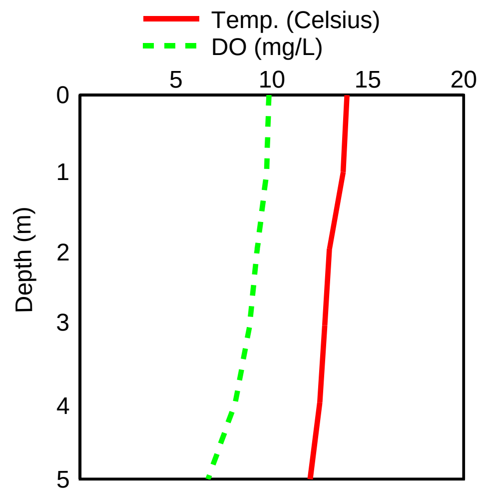
March 22, 2005



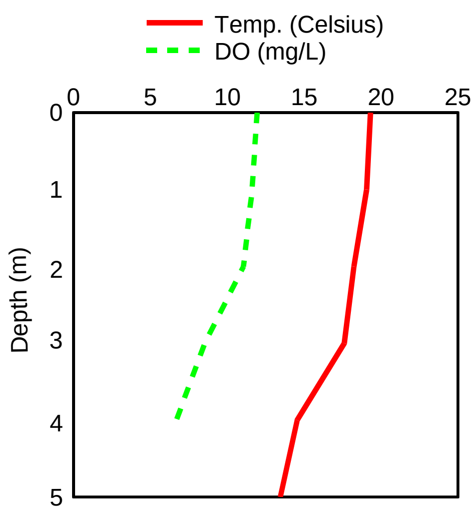
April 13, 2005



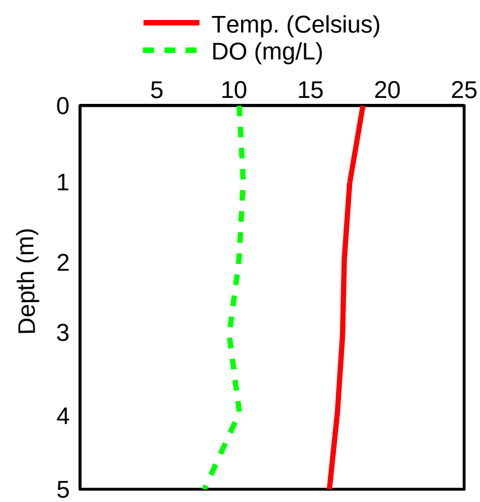
May 10, 2005



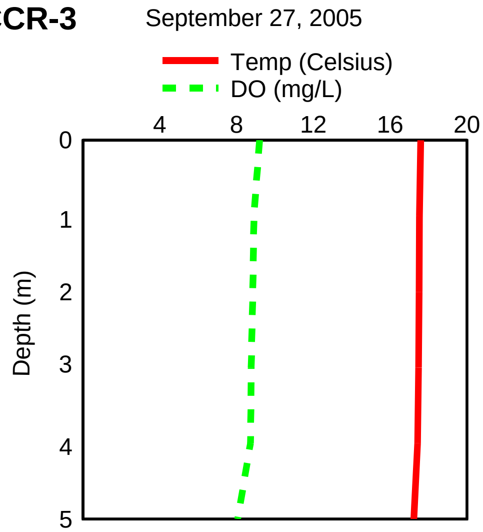
May 23, 2005

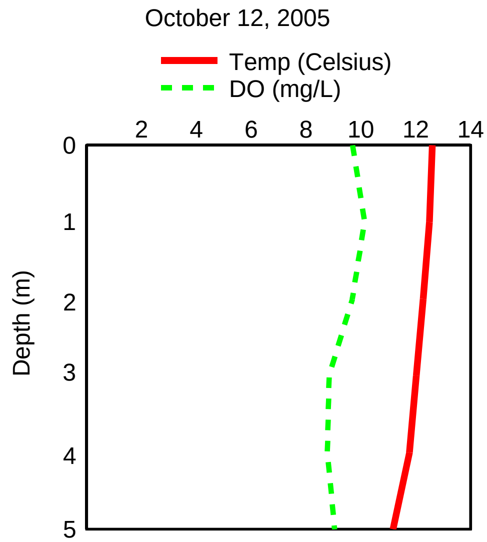


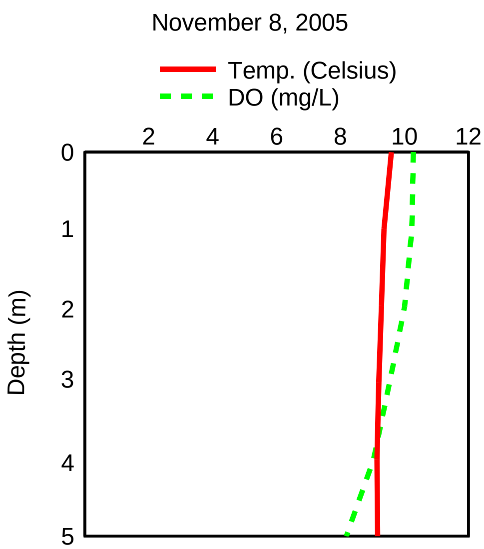
June 7, 2005



CCR-3

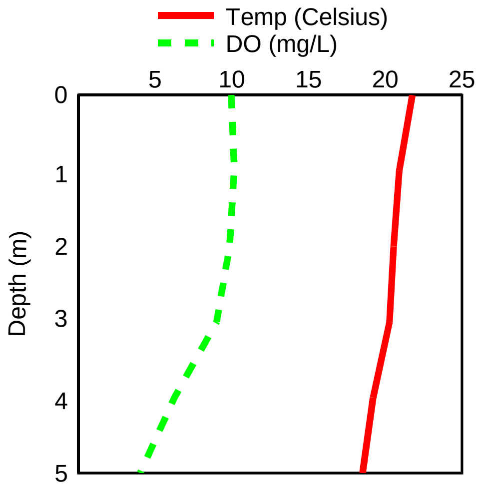

September 27, 2005
Temp (Celsius)
DO (mg/L)
4
8
12
16
20
0
1
2
3
4
5
Depth (m)


October 12, 2005
Temp (Celsius)
DO (mg/L)
2
4
6
8
10
12
14
0
1
2
3
4
5
Depth (m)

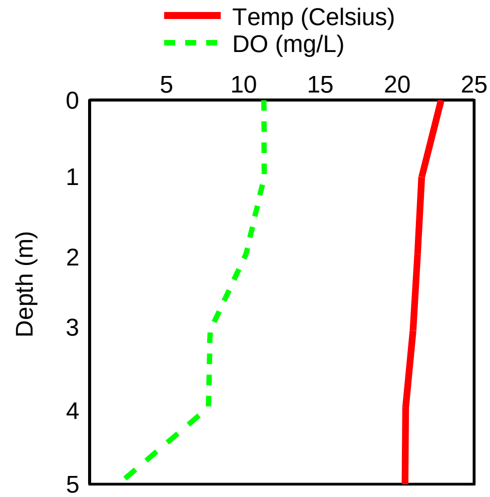

November 8, 2005
Temp. (Celsius)
DO (mg/L)
2
4
6
8
10
12
0
1
2
3
4
5
Depth (m)

CCR-3

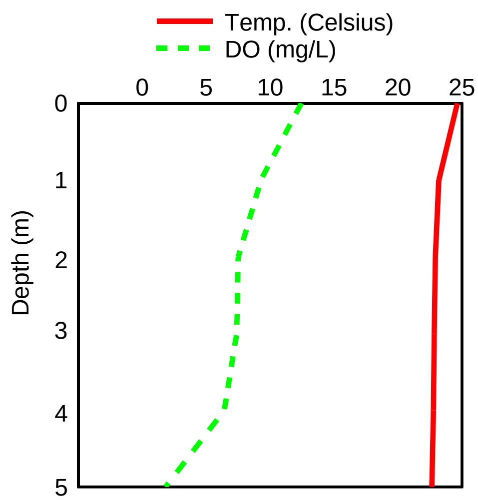
June 21, 2005



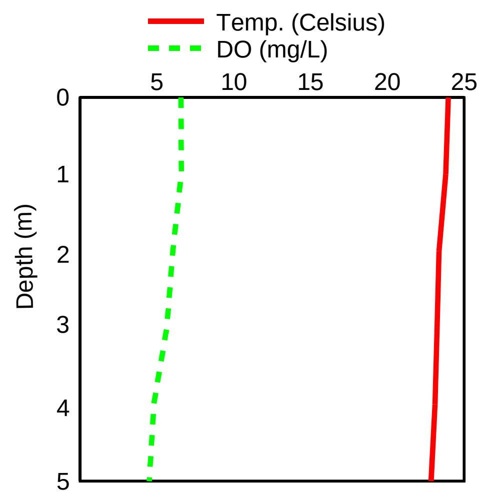
July 6, 2005



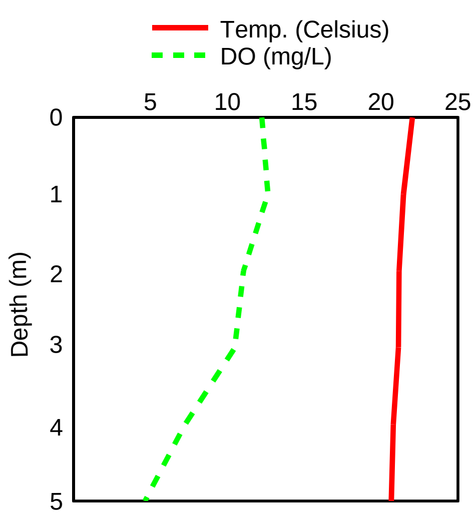
July 20, 2005



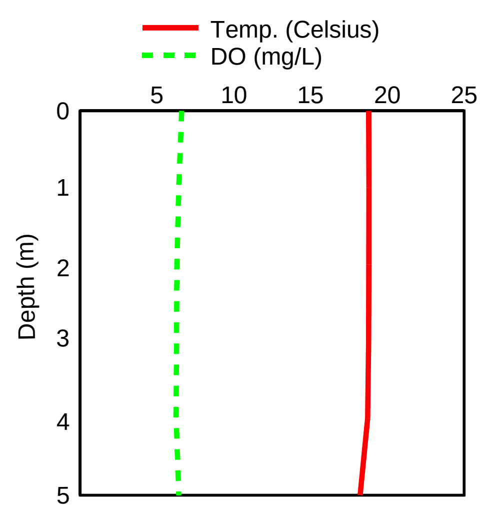
August 3, 2005



August 23, 2005



September 14, 2005



Cherry Creek Reservoir Secchi and 1% Transmissivity Depths for 2005

CCR-1				CCR-2				CCR-3			
Date	**Secchi (m)**	**1% Trans (m)**	**Ratio**	**Date**	**Secchi (m)**	**1% Trans (m)**	**Ratio**	**Date**	**Secchi (m)**	**1% Trans (m)**	**Ratio**
02/22/05	1.05	2.50	2.38	02/22/05	0.85	2.25	2.65	02/22/05	0.90	2.50	2.78
03/22/05	3.25	2.50	0.77	03/22/05	0.85	3.60	4.24	03/22/05	0.85	3.50	4.12
04/13/05	0.76	3.25	4.28	04/13/05	0.82	3.60	4.39	04/13/05	0.84	2.65	3.15
05/10/05	0.65	2.65	4.08	05/10/05	0.70	2.75	3.93	05/10/05	0.70	2.65	3.79
05/23/05	1.10	1.75	1.59	05/23/05	1.20	1.75	1.46	05/23/05	1.15	1.70	1.48
06/07/05	2.75	2.50	0.91	06/07/05	2.15	2.50	1.16	06/07/05	2.25	2.25	1.00
06/21/05	1.30	1.75	1.35	06/21/05	1.25	1.75	1.40	06/21/05	1.00	1.00	1.00
07/06/05	1.60	1.75	1.09	07/06/05	1.50	1.75	1.17	07/06/05	1.25	1.50	1.20
07/20/05	0.75	1.35	1.80	07/20/05	0.85	1.40	1.65	07/20/05	0.60	1.25	2.08
08/03/05	1.10	3.40	3.09	08/03/05	1.10	3.50	3.18	8/3/2005	0.80	2.80	3.50
08/23/05	0.98	2.88	2.94	08/23/05	1.10	3.10	2.82	08/23/05	1.10	2.87	2.61
09/14/05	0.75	2.00	2.67	09/14/05	0.65	1.25	1.92	09/14/05	0.65	1.75	2.69
09/27/05	1.00	2.50	2.50	09/27/05	0.85	2.25	2.65	09/27/05	0.76	2.37	3.12
10/12/05	0.75	ND	ND	10/12/05	0.60	ND	ND	10/12/05	0.70	ND	ND
11/08/05	0.78	2.75	3.53	11/08/05	0.75	2.75	3.67	11/08/05	0.60	2.50	4.17
Average	1.24	2.40	2.35	**Average**	1.01	2.44	2.59	**Average**	0.94	2.24	2.62
Median	1.00	2.50	2.44	**Median**	0.85	2.38	2.65	**Median**	0.84	2.44	2.74

APPENDIX C

Stream Water Quality and Precipitation Data

CC-10 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	TSS mg/L	TVSS mg/L
	Analytical Detection Limits	2	2	3	4	4	5	3	4	4
1/18/05	CC-10	175	128*	137*	1510	1370	1004	196	20.9	<4.0
2/22/05	CC-10	155	124*	129*	1064*	1079*	739	28	15.0	4.8
3/22/05	CC-10	153	122	113	673	612	359	24	16.2	4.2
4/13/05	CC-10	266	193	172	1174	990	431	38	61.6	8.4
5/10/05	CC-10	246	201	198	981	878	494	29	26.7	4.3
6/7/05	CC-10	299	221	220	824	701	381	47	30.2	5.5
7/6/05	CC-10	220	192	189	598	525	250	33	15.3	<4.0
8/3/05	CC-10	290	228	212	724	527	247	46	50.0	13.5
9/14/05	CC-10	211	173*	180*	586	515	322	16	9.7	<4.0
10/12/05	CC-10	347	266	251	984	815	351	14	44.5	7.4
11/8/05	CC-10	162	130*	134*	736	676	319	54	10.1	<4.0
12/13/05	CC-10	155	119*	124*	1620	1496	1058	53	18.8	4.0
4/25/05	CC-10 storm	324	198	187	1444	1200	684	94	82.4	10.6
6/4/05	CC-10 storm	436	ND	ND	1569	ND	ND	ND	68.0	11.8
6/12/05	CC-10 storm	403	225	215	1313	1023	525	31	117.5	13.0
6/27/05	CC-10 storm	384	249	243	1456	1194	788	14	113.7	19.7
8/4/05	CC-10 storm	319	158	152	1720	1403	766	287	134.6	15.2
8/12/05	CC-10 storm	245	171	164	1126	860	485	31	47.5	6.8

* Data within acceptable (10%) difference between parameters.
"ND" denotes "No Data"

CC-O C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus μg/L	Total Dissolved Phosphorus μg/L	Ortho-Phosphate μg/L	Total Nitrogen μg/L	Total Dissolved Nitrogen μg/L	NO3+NO2-N μg/L	NH4-N μg/L	TSS mg/L	TVSS mg/L
	Analytical Detection Limits	2	2	3	4	4	5	3	4	4
1/18/05	CC-O	53	11	9	782	569	49	91	8.8	<4.0
2/22/05	CC-O	20	13	6	781	428	<5	5	14.8	7.2
3/22/05	CC-O	75	16	4	798	457	<5	9	10.6	5.6
4/13/05	CC-O	79	17	<3	934	577	6	19	23.2	6.6
5/10/05	CC-O	107	26	14	802	438	<5	12	23.4	7.6
6/7/05	CC-O	105	79	68	676	573	27	105	14.8	4.4
7/6/05	CC-O	133	105	75	1028	833	23	123	15.1	4.7
8/3/05	CC-O	141	75	61	807	524	5	21	41.5	16.0
9/14/05	CC-O	117	22	12	797	449	15	12	43.8	11.6
10/12/05	CC-O	120	40	33	875	519	55	64	28.2	8.2
11/8/05	CC-O	94	20	8	812	408	<5	9	23.3	8.2
12/13/2005	CC-O	ND	ND	ND	ND	ND	ND	ND	ND	ND
4/27/05	CC-O Storm	93	21	10	689	457	<5	8	24.6	8.4

* Data within acceptable (10%) difference between parameters.
"ND" denotes "No Data"

CT-1 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	TSS mg/L	TVSS mg/L
	Analytical Detection Limits	2	2	3	4	4	5	3	4	4
1/18/05	CT-1	64	18*	20*	5160	4743	1950	3058	22.6	<4.0
2/22/05	CT-1	38	19	15	3427	3251	2602	322	24.2	5.8
3/22/05	CT-1	77	13	9	6189	5868	1245	4631	44.2	7.4
4/13/05	CT-1	216	34	22	1421	1051	643	68	156.2	22.0
5/10/05	CT-1	25	15	10	3741	3535	2128	1010	27.1	4.4
6/7/05	CT-1	79	32	26	1555	1348	940	50	30.6	4.4
7/6/05	CT-1	32	15	9	2529	2337	1919	18	10.8	<4.0
8/3/05	CT-1	93	29	13	5314	4735	4205	32	50.0	20.5
9/14/05	CT-1	90	25	12	3284	2951	2350	37	40.0	8.0
10/12/05	CT-1	191	84	75	1221	970	562	55	71.8	9.2
11/8/05	CT-1	68	9	4	4902	4524	3930	178	24.2	<4.0
12/13/05	CT-1	77	21	17	5592	5328	3756	680	32.8	5.6
4/25/05	CT-1 storm	299	24	15	1960	1606	848	360	195.0	17.4
6/4/05	CT-1 storm	286	ND	ND	1503	ND	ND	ND	124.5	18.8
6/12/05	CT-1 storm	275	40	29	1708	1197	730	59	96.0	15.7
8/4/05	CT-1 storm	899	62	56	1785	1023	480	182	1123.0	127.0
8/12/05	CT-1 storm	224	37	33	1911	1287	845	98	126.0	18.5
8/22/05	CT-1 storm	215	58	55	1673	1378	807	168	94.0	13.0
9/28/05	CT-1 storm	175	11	11	2891	2292	1674	98	100.8	17.7

* Data within acceptable (10%) difference between parameters.
"ND" denotes "No Data"

CT-2 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho- Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	TSS mg/L	TVSS mg/L
	Analytical Detection Limits	2	2	3	4	4	5	3	4	4
1/18/05	CT-2	79	15*	17*	5743	5202	2108	3426	35.6	5.7
2/22/05	CT-2	48	15	11	3424	3187	2550	280	23.0	7.0
3/22/05	CT-2	66	11	6	5761	5074	1116	4073	26.4	5.8
4/13/05	CT-2	156	44	28	1378	1007	643	60	68.7	10.7
5/10/05	CT-2	40	12	5	3172	2604	1541	680	32.5	6.1
6/7/05	CT-2	116	17	12	1518	1154	612	121	66.8	11.1
7/6/05	CT-2	61	13	6	2420	2228	1681	75	29.3	5.4
8/3/05	CT-2	92	27	13	3659	3178	2597	89	55.0	18.0*
9/14/05	CT-2	180	13	4	3579	2834	2442	33	143.8	23.5
10/12/05	CT-2	181	90	82	1194	911	543	24	31.3	8.3
11/8/05	CT-2	66	10	4	5237	4754	4126	238	36.2	6.7
12/13/05	CT-2	83	17	14	5546	5402	3801	657	43.6	6.8
4/25/05	CT-2 storm	155	18	13	1875	1564	790	359	65.9	13.3
6/4/05	CT-2 storm	248	ND	ND	2162	ND	ND	ND	86.8	18.3
6/12/05	CT-2 storm	174	43	33	1484	1105	619	87	73.0	18.0
8/4/05	CT-2 storm	412	30	23	2434	1585	958	152	242.0	38.5
8/12/05	CT-2 storm	175	34	28	2074	1560	893	148	61.2	11.4
8/22/05	CT-2 storm	213	62	58	1845	1338	793	222	58.3	10.3
9/28/05	CT-2 storm	167	7	7	2903	2273	1681	68	74.3	14.7

* Data within acceptable (10%) difference between parameters.
"ND" denotes "No Data"

CT-P1 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	TSS mg/L	TVSS mg/L
	Analytical Detection Limits	2	2	3	4	4	5	3	4	4
1/18/05	CT-P1	8	8	7	1196	1096	822	26	4.5	<4.0
2/22/05	CT-P1	34	15	6	1052	929	545	58	11.0	5.6
3/22/05	CT-P1	45	11	4	1042	880	485	57	12.0	5.0
4/13/05	CT-P1	146	48	33	1245	855	405	52	60.2	12.6
5/10/05	CT-P1	41	27	10	855	752	254	74	9.4	<4.0
6/7/05	CT-P1	88	32	23	1107	884	406	57	27.1	5.9
7/6/05	CT-P1	47	17	11	1330	1151	701	49	15.3	4.6
8/3/05	CT-P1	115	26	11	1271	825	296	38	35.5	10.0*
9/14/05	CT-P1	90	19	7	1157	754	317	18	20.2	8.2
10/12/05	CT-P1	165	99	90	1087	842	442	64	21.4	5.8
11/8/05	CT-P1	24	9	5	760	721	372	22	5.7	<4.0
12/13/05	CT-P1	42	9	6	1379	1190	674	17	19.4	5.6
4/25/05	CT-P1 storm	118	30	20	1390	1137	516	230	31.4	8.8
6/4/05	CT-P1 storm	186	ND	ND	1513	ND	ND	ND	44.8	9.6
6/12/05	CT-P1 storm	288	59	49	1573	1034	556	83	103.3	21.5
8/4/05	CT-P1 storm	559	89	85	1798	992	414	190	355.0	55.0
8/12/05	CT-P1 storm	194	65	60	1415	813	353	85	43.3	10.0
8/22/05	CT-P1 storm	185	77	76	1471	1081	597	117	43.3	10.3
9/28/05	CT-P1 storm	143	22	12	1565	1002	387	89	27.4	11.7

* Data within acceptable (10%) difference between parameters.
"ND" denotes "No Data"

CT-P2 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	TSS mg/L	TVSS mg/L
	Analytical Detection Limits	2	2	3	4	4	5	3	4	4
1/18/05	CT-P2	17	8	8	1436	1279	1077	20	9.5	<4.0
2/22/05	CT-P2	33	7	6	1319	1171	811	50	16.0	5.4
3/22/05	CT-P2	61	10	4	1191	982	612	40	22.6	5.8
4/13/05	CT-P2	118	46	31	1318	997	475	52	32.2	7.2
5/10/05	CT-P2	40	17	6	1091	925	477	54	42.4	7.3
6/7/05	CT-P2	82	31	18	1250	1037	629	37	34.1	6.5
7/6/05	CT-P2	68	30	20	1001	839	357	48	17.0	4.6
8/3/05	CT-P2	120	29	15	1769	1342	765	60	61.5	19.5
9/14/05	CT-P2	106	15	6	1640	1200	793	33	47.4	11.0
10/12/05	CT-P2	158	95	84	1053	794	445	12	15.0	4.6
11/8/05	CT-P2	42	9	6	1157	1054	726	15	19.3	4.0
12/13/05	CT-P2	41	9	7	1636	1494	978	50	20.2	5.0
4/25/05	CT-P2 storm	171	30	19	1739	1339	624	248	59.0	12.6
6/4/05	CT-P2 storm	175	ND	ND	1371	ND	ND	ND	41.8	8.8
6/12/05	CT-P2 storm	559	39	32	1863	749	489	11	268.5	43.8
8/4/05	CT-P2 storm	360	82	80	1662	1124	462	198	164.0	27.0
8/12/05	CT-P2 storm	169	94	91	1451	1149	709	22	33.7	8.3
8/22/05	CT-P2 storm	186	74	73	1456	1152	649	104	36.0	8.8
9/28/05	CT-P2 storm	136	22	16	1564	1055	471	46	30.3	10.8

* Data within acceptable (10%) difference between parameters.
"ND" denotes "No Data"

SC-3 C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L	TSS mg/L	TVSS mg/L
	Analytical Detection Limits	2	2	3	4	4	5	3	4	4
1/18/05	SC-3	143	91	80	2486	2214	1913	145	5.2	<4.0
2/22/05	SC-3	52	39	34	999	917	698	28	15.6	4.2
3/22/05	SC-3	68	32	20	1329	1155	891	16	6.8	4.2
4/13/05	SC-3	140	96	72	955	754	507	9	26.6	6.8
5/10/05	SC-3	151	142	117	486	451	25	28	14.5	<4.0
6/7/05	SC-3	212	171	163	613	543	205	38	8.9	<4.0
7/6/05	SC-3	346	285	272	624	437	37	24	12.6	<4.0
8/3/05	SC-3	232	209	191	490	420	12	10	15.5	3.5
9/14/05	SC-3	105	90	88	372	360	7	5	13.5	<4.0
10/12/05	SC-3	106	85	74	994	892	616	15	9.2	<4.0
11/8/05	SC-3	52	48	45	895	827	565	7	27.5	4.1
12/13/05	SC-3	ND	ND	ND	ND	ND	ND	ND	ND	ND
4/25/05	SC-3 storm	138	81	67	1469	1314	928	69	19.4	6.2
6/4/05	SC-3 storm	214	ND	ND	1622	ND	ND	ND	20.4	6.4
6/12/05	SC-3 storm	165	139	129	1035	957	648	15	13.4	6.2
6/27/05	SC-3 storm	225	199	192	883	823	413	20	15.2	6.2
8/4/05	SC-3 storm	283	166	155	1931	1625	909	331	101.5	9.0
8/12/05	SC-3 storm	127	108	105	1402	1279	975	11	9.1	<4.0

* Data within acceptable (10%) difference between parameters.
"ND" denotes "No Data"

Rain Gauge C&A Water Chemisty Data

Sample Date	Sample Name/ Location	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Ortho-Phosphate µg/L	Total Nitrogen µg/L	Total Dissolved Nitrogen µg/L	NO3+NO2-N µg/L	NH4-N µg/L
	Analytical Detection Limits	2	2	3	4	4	5	3
6/4/05	Rain Gauge	65	ND	ND	874	ND	ND	ND
6/12/05	Rain Gauge	66	9	3	974	631	338	256
6/27/05	Rain Gauge	332	98	56	4290	2798	702	1396
8/4/05	Rain Gauge	84	53*	54*	533	319	87	147
8/12/05	Rain Gauge	23	16	15	901	831	212	598
9/28/05	Rain Gauge	108	8	4	2126	1291	745	91

* Data within acceptable (10%) difference between parameters.
"ND" denotes "No Data"

APPENDIX D

Streamflow, Rainfall, Phosphorus Loading Calculations, and Normalized U.S. Army Corps of Engineers Inflow Data

Streamflow Determination

Stream discharges for Cherry Creek, Cottonwood Creek and Shop Creek were determined by developing a stage discharge relationship for each site (Table D-1). Water levels (stage) were monitored using ISCO Model 4220 and 6700 flowmeters. Rating curves were developed for each sampling site by measuring stream discharge (ft^3/sec) with a Marsh McBirney Model 2000 flowmeter, and recording the water level at the staff gage (ft) and ISCO flowmeter (ft). In 2005, nine measurements over a range of discharges were collected at Sites CC-10, CT-1, and CT-P2. Eight measurements were taken at Site CT-P1 and Site SC-3.

Flows were monitored daily on Cottonwood Creek, Shop Creek, and Cherry Creek with some dates estimated due to icing, flooding, or flowmeter malfunctions. Stage relationships were developed with nearby sites to derive flow estimates. Additionally, precipitation events and average flow of recorded data were considered in determining flow estimates.

Phosphorus Loading from Tributary Streams

For all streams, water chemistry, including concentration of total phosphorus was measured from stream samples collected at regular intervals and from storms during the months of January through December 2005 (Appendix C). Since 1999, all estimates of loading to Cherry Creek Reservoir were based upon calendar year (January to December). In previous years, loading had been estimated on a water year (October to September), but were later converted to calendar year from 1992 on.

The concentration of total phosphorus in the samples and corresponding flows, measured at sampling time, were paired in regression relationships (Table D-2). Regression analysis was used to predict total phosphorus concentrations based upon stage/discharge, only if the regression equation met the following criteria: $P < 0.05$ and $R^2 > 0.60$. Stage/discharge data from previous reports (CEC 2004, 2005) were combined with data collected in 2005, only if the stream gage or ISCO unit remained in the exact location as in 2005 (i.e., data collected prior to the movement of the gage or ISCO unit were not used). Stage discharge equations obtained from Jim Wulliman with Muller Engineering were used to calculate flows at Site CT-P2 and Site CT-2 (unpublished data, 2004). Note that for some sites, there is no significant relationship between flow values and phosphorus concentrations (e.g., the Cherry Creek mainstem inflow and Site SC-3). In those cases, including Site CC-O, the phosphorus concentrations for load calculations were based on the 2005 monthly mean value (Table D-3).

TABLE D-1: Stage (H in ft) discharge (Q in cfs) relationships for Sites CC-10, CT-1, CT-2, SC-3, CT-P1, and CT-P2.

Site	Stage Interval	Equation	R^2
CC-10	< 2.60	EXP((H+0.4844)/0.9452)	0.85
	> 2.60	EXP((H+6.45)/2.2037)-27.7427	0.94
SC-3	< 0.18	EXP((H-0.5638)/0.1545)	0.84
	> 0.18	EXP((H-0.1581)/0.5239)-1.0125	0.99
CT-P1	< 0.80	EXP((H+4.9229)/1.8597)-18.2023	0.93
	0.80 - 1.50	EXP((H+0.1596)/0.4923)-3.0508	0.94
	> 1.50	(H-0.5621)/0.0521	0.94
CT-P2	< 0.60	(3.3)*(1)*(H)^(1.5)	
	0.61 - 1.09	(0.60)*(0.50)*((2*32.2*(H_{adj}))^(0.5)	
	1.10 - 1.99	(0.60)*(0.50)*((2*32.2*(H_{adj}))^(0.5))+((3.33)*(1)*(H-1.0)^(1.5)	
	2.00 - 2.59	(0.60)*(0.50)(2*32.2*(H_{adj}))^(0.5)+((0.60)*(0.50)*((2*32.2*(H_{adj}-1.0))^(0.5))+((3.33) *(1)*(H-2.0)^(1.5)	
	2.60 - 2.99	(0.60)*(0.50)(2*32.2*(H_{adj}))^(0.5)+((0.60)*(0.50)*((2*32.2*(H_{adj}-1.0))^(0.5))+((0.60) *(0.50)*(H_{adj}-2.0)^(0.5)	
	3.00 - 3.59	(0.60)*(0.50)(2*32.2*(H_{adj}))^(0.5)+((0.60)*(0.50)*((2*32.2*(H_{adj}-1.0))^(0.5))+((0.60) *(0.50)*(H_{adj}-2.0)^(0.5))+((3.3)*(1)*(H-3.0)^(1.5)	
	3.60 - 3.99	(0.60)*(0.50)(2*32.2*(H_{adj}))^(0.5)+((0.60)*(0.50)*((2*32.2*(H_{adj}-1.0))^(0.5))+((0.60) *(0.50)*(H_{adj}-2.0)^(0.5))+((0.60)*(0.50)*(2*32.2*(H_{adj}-3.0)^(0.5)	
	4.00 - 4.49	(0.60)*(0.50)(2*32.2*(H_{adj}))^(0.5)+((0.60)*(0.50)*((2*32.2*(H_{adj}-1.0))^(0.5))+((0.60) *(0.50)*(H_{adj}-2.0)^(0.5))+((0.60)*(0.50)*(2*32.2*(H_{adj}-3.0)^(0.5))+((3.3)(1)(H-4.0))^ (1.5)	
	4.50 - 5.19	(0.60)*(0.50)(2*32.2*(H_{adj}))^(0.5)+((0.60)*(0.50)*((2*32.2*(H_{adj}-1.0))^(0.5))+((0.60) *(0.50)*(H_{adj}-2.0)^(0.5))+((0.60)*(0.50)*(2*32.2*(H_{adj}-3.0)^(0.5))+((0.60)(0.50)(2* 32.2*H_{adj}-4.0))^(0.5)	
	5.20 - 6.80	(0.60)*(0.50)(2*32.2*(H_{adj}))^(0.5)+((0.60)*(0.50)*((2*32.2*(H_{adj}-1.0))^(0.5))+((0.60) *(0.50)*(H_{adj}-2.0)^(0.5))+((0.60)*(0.50)*(2*32.2*(H_{adj}-3.0)^(0.5))+((0.60)(0.50)(2* 32.2*H_{adj}-4.0))^(0.5))+((3.3)(1)(H-5.2)^(1.5)	
CT-1	< 3.00	EXP(H/0.8715)-4.0839	0.94
	> 3.00	(H-1.5817)/0.0684	0.99
CT-2	< 0.95	((3.3)*(2)*(H)^(1.5))	
	0.95 - 1.35	((7.2)+(3.3)*(2)*(H)^(1.5))	
	> 1.35	((7.2)+(3.3)*(2)*(H)^(1.5))+((3.3)*(2)*(H-1.0)^(1.5))+((3.3)*(2)*(H-0.50)^(1.5))	

TABLE D-2: Regression equations used to estimate total phosphorus concentrations (P_{con}) given stream discharge (Q, ft^3/sec). Total phosphorus concentrations (P_{con}) were then used to estimate phosphorus loads for a given stream discharge.

Site	Discharge Interval	Equation	R^2
CT-1	Q<30	P_{con} (µg/L) = -5.5135+(83.6311*ln(Q-1.3029))	0.88
	Q>30	Cap P_{con} at 300 µg/L	--
CT-2	Q<50	P_{con} (µg/L) = 78.5536+(2.8412*Q)	0.61
	Q>50	Cap P_{con} at 250 µg/L	--
CT-P1		P_{con} (µg/L) = 182.0436*(1-0.7129^Q)	0.67
CT-P2		P_{con} (µg/L) = -37.1342+(210.7389*(1-(0.55^Q)))	0.81
Alluvium		P_{con} (µg/L) = 190*Q	--

Using these relationships, the average daily phosphorus (P_{con}) was calculated from average daily flow for each tributary stream. Daily loadings in pounds/day (L_{day}) into the reservoir were then calculated using the equation below (Eq. 1), with L_{day} then summed over 2005 to obtain total annual phosphorus loading.

EQUATION 1:

$$L_{day} = \mu g/L * Q_{in} * \frac{86400\ sec}{day} * \frac{28.3169\ L}{cf} * \frac{2.205 \times 10^{-9}\ lbs}{\mu g}$$

where:

L_{day} = pounds per day phosphorus loading,

µg/L = concentration of total phosphorus for a particular daily flow (based on the equation in Table D-2)

Q_{in} = mean daily flow in ft^3/sec.

Phosphorus Loading from Precipitation

Precipitation data collected at Denver/Centennial Airport (KAPA) was used to estimate phosphorus loading due to precipitation in 2005, based on the assumption that precipitation generally fell evenly across the reservoir (Appendix D), although rain showers in the Cherry Creek Reservoir area can be localized. Calculation of phosphorus loading into Cherry Creek Reservoir from precipitation was based on the long-term median phosphorus concentration (1987-2005) and Equation 2.

EQUATION 2:

$$L_{precip} = PR/12 * A_{res} * 43650\ ft^2/acre * \mu g/L * \frac{28.31692}{cf} * \frac{2.206 \times 10^{-9}\ lbs}{\mu g}$$

where:

L_{precip} = pounds of phosphorus from precipitation,

PR = rainfall precipitation in inches,

A_{res} = surface area of the reservoir (852 ac), and

µg/L = median concentration of phosphorus.

Cherry Creek Reservoir Outflow

Streamflow out of Cherry Creek Reservoir is monitored by a COE flow station throughout the year. Water samples were collected once a month in Cherry Creek downstream of the dam during 2005. In the relationship in Equation 1, loads leaving the reservoir were calculated based on monthly mean total phosphorus concentrations (Table D-3) and outflow data from the COE.

TABLE D-3: Monthly mean total phosphorus concentrations (P_{con}) used to estimate phosphorus loads given stream discharge.

	CC-10	SC-3	CC-O
Month	P_{con} (µg/L)	P_{con} (µg/L)	P_{con} (µg/L)
January	175	143	53
February	155	52	20
March	153	68	75
April	295	139	86
May	246	151	107
June	381	204	105
July	220	346	133
August	285	214	141
September	211	105	117
October	347	106	120
November	162	52	94
December	155	52*	94*

* Used November data due to icy conditions.

Phosphorus Loading from Alluvium

The COE monitors inflow to Cherry Creek Reservoir as a function of change in storage, based on changes in reservoir level, measured outflow, precipitation, and evaporation, to provide daily and monthly inflow (AF). CEC monitors inflow to the reservoir using gaging stations on Cherry Creek, Cottonwood Creek, and Shop Creek (the three main surface inflows). Estimates of direct precipitation were provided by the COE, and estimates of alluvial phosphorus concentrations were provided by JCHA. From these data, CEC calculates an estimated total inflow (AF) and phosphorus loading (lbs) to the reservoir.

Given differences in the two methods for determining inflow, combined with the potential for unmonitored multiple Cherry Creek channels in the wetlands adjacent to the reservoir and the potential for the COE calculations to underestimate dam leakage (Lewis and Saunders 2002), an exact match between COE and CEC calculated inflows is not expected. In 2005, COE inflows were calculated at 18,534 AF, while CEC calculated inflows at 15,263 AF from streams and 1,098 AF from precipitation (see following summary data tables). In past years, CEC adjusted (normalized) inflow values from the stream sites to account for this difference. Those normalization procedures can be found in CEC (1998b, 1999, 2000, 2001, and 2002). Beginning in 2002, CEC did not "normalize" inflow data by adding flow to the surface stream site data. Instead, we based our adjustments on conclusions reached by Lewis and Saunders (2002). They believe the COE method results in a systematic underestimate of inflow to the reservoir from the alluvium. When estimating inflow, the COE does not specifically quantify alluvial inflows or outflows although, functionally, those flows must account for a portion of the variations in reservoir storage. Based on these findings, CEC believes the difference in inflow values between the COE calculations and CEC streamflows could be attributed wholly to alluvial inflow. Using this approach, total alluvial inflow was estimated to be 2,173 AF in 2005. Calculation of alluvial phosphorus loading into Cherry Creek Reservoir was based on the long-term median (1994-2005) alluvial total dissolved phosphorus concentration of 190 µg/L and Equation 3.

EQUATION 3:

$$L_{alluvium} = \mu g/L * Q_{alluvium} * \frac{2.205 \times 10^{-9}\ lbs}{\mu g} * \frac{1{,}233{,}482\ L}{Ac\text{-}ft}$$

where:

$L_{alluvium}$ = alluvial phosphorus loading in pounds per year

µg/L = mean alluvial phosphorus concentration for the year

$Q_{alluvium}$ = total alluvial flow in Ac-ft per year

2005	Total In Af CEC	Total In Af COE
January	1467	1567
February	1208	1745
March	1362	1831
April	4058	4929
May	1144	1650
June	1336	2101
July	494	234
August	1316	1329
September	464	252
October	926	926
November	667	851
December	822	1119
Total	15263	18534

CC-10	Af CEC	P lbs CEC
January	1166	558
February	977	418
March	1111	466
April	3206	2609
May	883	594
June	730	771
July	177	99
August	393	313
September	176	102
October	341	334
November	346	155
December	509	218
Total	10015	6636

CT-2	Af CEC	P lbs CEC
January	265	66
February	210	51
March	235	59
April	766	320
May	247	64
June	575	232
July	298	76
August	880	375
September	284	71
October	567	225
November	312	80
December	302	78
Total	4942	1697

SC-3	Af CEC	P lbs CEC
January	35	14
February	20	3
March	16	3
April	85	32
May	14	6
June	31	17
July	19	18
August	42	25
September	4	1
October	18	5
November	9	1
December	11	2
Total	306	127

	Precip (af)	Outflow (af)
January	86	1676
February	9	1632
March	91	1692
April	171	4725
May	48	1432
June	99	1863
July	52	0
August	310	758
September	25	577
October	133	676
November	30	288
December	45	668
Total	1098	15987

	Precip (lbs)	Outflow (lbs)
January	36	242
February	4	89
March	38	345
April	72	1105
May	20	417
June	42	532
July	22	0
August	131	291
September	11	184
October	56	221
November	13	74
December	19	171
Total	464	3669

	Alluvium (af)	Alluvium (lbs)
2005 Total	2173	1123

CT-1

	Af CEC	P lbs CEC
January	233	45
February	173	21
March	195	31
April	538	276
May	277	74
June	421	197
July	183	20
August	531	265
September	247	56
October	517	255
November	281	75
December	303	85
Total	3898	1399

CT-P1

	Af CEC	P lbs CEC
January	69	12
February	43	8
March	100	26
April	325	139
May	111	31
June	220	86
July	50	8
August	349	150
September	80	16
October	240	94
November	82	16
December	65	11
Total	1733	596

CT-P2

	Af CEC	P lbs CEC
January	71	14
February	40	7
March	103	31
April	405	178
May	102	29
June	213	84
July	63	13
August	276	115
September	82	19
October	310	128
November	77	17
December	69	13
Total	1811	649

2005
Cherry Creek 10
Average Discharge (cfs)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.69	23.77	15.61	25.58	38.40	7.28	3.38	3.37	3.16	2.50	3.71	6.63
2	18.00	19.79	15.64	20.13	33.19	5.94	3.32	3.30	3.09	2.58	3.69	7.25
3	18.82	18.48	14.89	18.79	24.57	8.91	3.32	3.03	3.03	2.62	3.74	7.89
4	18.74	18.56	14.74	18.77	23.43	85.21	3.31	13.06	2.92	2.70	3.89	7.26
5	16.39	19.76	14.54	45.69	21.44	23.88	3.30	76.37	3.05	2.86	4.35	6.92
6	17.07	19.19	15.95	45.05	19.84	9.59	3.23	7.62	3.04	2.48	4.94	7.06
7	18.12	19.29	17.47	40.53	18.77	6.98	3.16	4.68	3.05	2.59	5.07	6.59
8	17.80	18.41	17.97	37.29	17.28	5.85	3.06	4.18	2.86	2.60	5.20	6.48
9	19.64	17.45	17.83	34.46	16.23	5.35	2.84	3.91	2.77	2.89	5.11	7.54
10	19.96	16.76	17.12	43.55	15.43	16.76	2.83	3.69	2.59	4.22	5.27	8.10
11	19.58	17.47	16.82	74.87	16.76	50.73	2.80	3.90	2.26	18.95	5.46	8.15
12	20.79	18.07	16.47	126.43	17.07	38.84	2.78	5.36	2.16	24.30	5.74	8.21
13	17.12	17.70	23.27	125.79	15.42	20.90	2.77	3.93	2.86	19.51	5.38	8.81
14	16.11	17.38	20.84	146.97	14.18	9.81	2.55	3.86	3.31	10.15	5.80	8.07
15	16.97	17.45	18.47	126.57	12.87	7.45	2.90	3.59	3.07	6.41	7.57	7.55
16	17.06	17.08	18.68	91.40	12.30	6.23	3.42	3.41	2.73	4.94	6.74	7.61
17	17.79	16.65	17.68	66.05	11.57	6.25	2.86	3.48	2.84	4.35	6.78	7.39
18	18.34	16.43	16.22	48.60	10.12	4.65	2.67	3.67	2.88	4.16	7.16	7.96
19	19.39	17.38	16.32	41.45	9.54	4.18	2.80	3.55	2.99	4.16	6.30	7.98
20	21.12	17.04	16.57	37.16	9.12	5.73	2.74	3.52	3.12	4.08	6.22	8.72
21	21.00	16.54	21.60	37.73	8.30	4.28	2.65	3.50	3.16	4.08	6.30	9.02
22	20.60	16.43	19.68	24.88	7.97	3.99	2.59	3.59	3.26	4.05	6.60	9.25
23	20.66	16.44	20.10	21.59	7.66	3.82	2.53	3.49	3.24	3.99	6.73	9.42
24	19.84	16.00	22.48	21.51	7.33	3.80	3.03	3.43	3.23	3.94	6.69	9.08
25	19.41	15.60	18.50	76.54	7.37	3.74	2.84	3.34	3.19	3.90	6.62	9.38
26	18.80	16.06	18.05	56.35	7.28	3.78	2.62	3.31	3.23	3.86	6.74	9.56
27	18.85	15.91	17.06	41.23	7.05	3.64	2.51	3.38	3.32	3.85	6.63	9.40
28	18.34	15.55	17.26	42.87	6.44	3.62	2.35	3.35	3.32	3.83	6.56	9.50
29	18.45	0.00	18.51	40.74	6.16	3.47	2.63	3.18	2.64	3.78	6.31	10.01
30	19.38	0.00	19.30	37.86	7.00	3.40	2.60	3.15	2.48	3.75	6.97	9.80
31	23.93	0.00	24.45	0.00	14.90	0.00	2.77	3.16	0.00	3.75	0.00	10.23
Total	587.76	492.64	560.09	1616.43	444.99	368.06	89.16	198.36	88.85	171.83	174.27	256.82
Max	23.93	23.77	24.45	146.97	38.40	85.21	3.42	76.37	3.32	24.30	7.57	10.23
Min	16.11	0.00	14.54	0.00	6.16	0.00	2.35	3.03	0.00	2.48	0.00	6.48
Ac-ft	1165.53	976.91	1110.66	3205.38	882.42	729.86	176.80	393.35	176.19	340.74	345.58	509.27

2005
Cherry Creek 10
Phosphorus Loading (lbs)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	18.64	20.54	12.96	41.02	51.22	15.19	3.96	5.29	3.64	4.76	3.33	5.64
2	17.14	16.84	12.98	32.20	44.15	12.35	3.89	5.18	3.56	4.92	3.31	6.16
3	17.82	15.70	12.36	30.03	32.68	20.18	3.89	4.88	3.49	5.00	3.35	6.69
4	17.74	15.74	12.24	30.00	31.16	179.33	3.88	23.06	3.36	5.16	3.50	6.17
5	15.53	16.73	12.05	73.23	28.51	50.13	3.87	119.57	3.51	5.42	3.95	5.88
6	16.17	16.26	13.21	71.96	26.38	20.14	3.80	11.81	3.51	4.71	4.45	6.00
7	17.16	16.33	14.48	64.72	25.02	14.55	3.72	7.26	3.51	4.91	4.51	5.61
8	16.98	15.58	14.89	59.56	23.02	12.09	3.58	6.49	3.30	4.95	4.59	5.51
9	18.80	14.80	14.80	55.07	21.60	11.05	3.17	6.07	3.19	5.50	4.51	6.40
10	18.99	14.23	14.20	70.17	20.53	35.76	3.16	5.74	2.99	11.23	4.64	6.87
11	18.58	14.81	13.94	122.58	22.46	106.21	3.13	6.07	2.62	37.91	4.81	6.91
12	19.73	15.29	13.65	209.28	22.85	80.49	3.10	8.69	2.51	47.04	5.12	6.96
13	16.31	14.96	19.68	205.71	20.55	43.19	3.08	6.28	3.30	37.15	4.80	7.46
14	15.35	14.68	17.47	242.01	18.88	20.23	2.84	6.11	3.80	19.20	5.17	6.84
15	16.18	14.78	15.38	204.25	17.13	15.34	2.95	5.68	3.52	12.13	6.72	6.41
16	16.20	14.56	15.53	145.81	16.35	12.86	3.11	5.45	3.14	9.37	5.99	6.46
17	16.88	14.10	14.68	105.17	15.39	12.91	3.15	5.53	3.26	8.30	6.03	6.27
18	17.52	13.91	13.46	77.39	13.47	9.61	2.77	5.66	3.31	7.96	6.36	6.75
19	18.53	14.69	13.53	66.02	12.72	8.66	3.09	5.51	3.43	8.01	5.61	6.77
20	20.07	14.40	13.73	59.22	12.19	11.97	3.04	5.46	3.58	7.82	5.54	7.39
21	19.88	13.96	18.15	60.42	11.10	8.85	2.95	5.41	3.63	7.79	5.61	7.64
22	19.50	13.86	16.38	39.80	10.67	8.26	2.87	5.60	3.74	7.74	5.87	7.83
23	19.55	13.84	16.69	34.54	10.25	7.92	2.81	5.37	3.72	7.65	5.98	7.97
24	18.78	13.55	18.86	34.51	9.82	7.89	3.39	5.29	3.71	7.60	5.95	7.69
25	18.37	13.41	15.45	123.95	9.88	7.75	3.15	5.16	3.66	7.51	5.89	7.94
26	17.80	13.53	15.00	89.99	9.75	7.88	2.69	5.11	3.71	7.43	5.99	8.09
27	17.84	13.40	14.17	65.77	9.42	8.02	2.72	5.21	3.81	7.40	5.90	7.95
28	17.36	13.10	14.32	68.53	8.61	7.47	2.58	5.18	3.82	7.35	5.83	8.04
29	17.46	0.00	15.33	65.25	8.26	7.20	2.95	4.91	3.04	7.27	5.62	8.46
30	18.37	0.00	15.97	60.56	9.60	7.05	2.90	4.86	2.85	7.25	6.19	8.29
31	22.77	0.00	20.50	0.00	20.59	0.00	3.08	4.88	0.00	7.24	0.00	8.65
Total	557.97	417.57	466.02	2608.68	594.23	770.53	99.27	312.74	102.19	333.65	155.09	217.67
Mean	18.00	13.47	15.03	84.15	19.17	24.86	3.20	10.09	3.30	10.76	5.00	7.02
Max	22.77	20.54	20.50	242.01	51.22	179.33	3.96	119.57	3.82	47.04	6.72	8.65
Min	15.35	0.00	12.05	0.00	8.26	0.00	2.58	4.86	0.00	4.71	0.00	5.51

2005
Cherry Creek Outflow
Discharge (cfs)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.00	23.00	30.00	31.00	80.00	40.00	0.00	0.00	27.00	0.00	10.00	0.00
2	24.00	25.00	30.00	31.00	56.00	40.00	0.00	0.00	31.00	0.00	10.00	0.00
3	24.00	25.00	30.00	31.00	40.00	40.00	0.00	0.00	30.00	0.00	17.00	0.00
4	25.00	30.00	30.00	31.00	40.00	40.00	0.00	0.00	30.00	0.00	18.00	0.00
5	31.00	30.00	30.00	31.00	35.00	40.00	0.00	0.00	30.00	0.00	18.00	0.00
6	31.00	30.00	30.00	35.00	29.00	40.00	0.00	0.00	30.00	0.00	18.00	0.00
7	31.00	30.00	30.00	40.00	29.00	71.00	0.00	0.00	30.00	0.00	18.00	0.00
8	31.00	30.00	30.00	49.00	29.00	80.00	0.00	0.00	16.00	0.00	18.00	0.00
9	31.00	30.00	30.00	61.00	29.00	80.00	0.00	23.00	9.00	0.00	18.00	0.00
10	31.00	30.00	30.00	61.00	29.00	53.00	0.00	31.00	9.00	0.00	0.00	0.00
11	31.00	30.00	33.00	61.00	29.00	11.00	0.00	31.00	9.00	0.00	0.00	0.00
12	31.00	30.00	34.00	61.00	29.00	11.00	0.00	31.00	9.00	0.00	0.00	0.00
13	31.00	30.00	34.00	70.00	29.00	27.00	0.00	31.00	9.00	8.00	0.00	0.00
14	31.00	30.00	34.00	80.00	29.00	148.00	0.00	31.00	9.00	13.00	0.00	2.00
15	31.00	30.00	34.00	147.00	29.00	136.00	0.00	30.00	9.00	13.00	0.00	20.00
16	31.00	30.00	34.00	207.00	26.00	63.00	0.00	16.00	4.00	13.00	0.00	20.00
17	30.00	30.00	34.00	207.00	22.00	19.00	0.00	5.00	0.00	13.00	0.00	20.00
18	30.00	30.00	29.00	206.00	22.00	0.00	0.00	5.00	0.00	13.00	0.00	20.00
19	30.00	30.00	20.00	161.00	11.00	0.00	0.00	5.00	0.00	13.00	0.00	20.00
20	30.00	30.00	20.00	94.00	5.00	0.00	0.00	5.00	0.00	19.00	0.00	19.00
21	30.00	30.00	20.00	60.00	5.00	0.00	0.00	5.00	0.00	30.00	0.00	19.00
22	30.00	30.00	20.00	55.00	5.00	0.00	0.00	5.00	0.00	30.00	0.00	19.00
23	30.00	30.00	20.00	40.00	5.00	0.00	0.00	5.00	0.00	30.00	0.00	19.00
24	26.00	30.00	20.00	40.00	5.00	0.00	0.00	5.00	0.00	30.00	0.00	19.00
25	20.00	30.00	20.00	64.00	5.00	0.00	0.00	5.00	0.00	30.00	0.00	20.00
26	20.00	30.00	20.00	80.00	25.00	0.00	0.00	14.00	0.00	30.00	0.00	20.00
27	20.00	30.00	20.00	108.00	23.00	0.00	0.00	20.00	0.00	13.00	0.00	20.00
28	20.00	30.00	20.00	80.00	0.00	0.00	0.00	20.00	0.00	11.00	0.00	20.00
29	20.00		25.00	80.00	0.00	0.00	0.00	20.00	0.00	11.00	0.00	20.00
30	20.00		31.00	80.00	0.00	0.00	0.00	20.00	0.00	11.00	0.00	20.00
31	20.00		31.00		22.00		0.00	19.00		10.00		20.00
Total	845.00	823.00	853.00	2382.00	722.00	939.00	0.00	382.00	291.00	341.00	145.00	337.00
Mean	27.26	29.39	27.52	79.40	23.29	31.30	0.00	12.32	9.70	11.00	4.83	10.87
Max	31.00	30.00	34.00	207.00	80.00	148.00	0.00	31.00	31.00	30.00	18.00	20.00
Min	20.00	23.00	20.00	31.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ac-ft	1675.64	1632.01	1691.50	4723.51	1431.73	1862.04	0.00	757.51	577.05	676.20	287.54	668.27

2005
Cherry Creek Outflow
Phosphorus Loading (lbs)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	6.86	2.48	12.14	14.38	46.18	22.66	0.00	0.00	17.04	0.00	5.07	0.00
2	6.86	2.70	12.14	14.38	32.33	22.66	0.00	0.00	19.57	0.00	5.07	0.00
3	6.86	2.70	12.14	14.38	23.09	22.66	0.00	0.00	18.94	0.00	8.62	0.00
4	7.15	3.24	12.14	14.38	23.09	22.66	0.00	0.00	18.94	0.00	9.13	0.00
5	8.86	3.24	12.14	14.38	20.20	22.66	0.00	0.00	18.94	0.00	9.13	0.00
6	8.86	3.24	12.14	16.24	16.74	22.66	0.00	0.00	18.94	0.00	9.13	0.00
7	8.86	3.24	12.14	18.56	16.74	40.22	0.00	0.00	18.94	0.00	9.13	0.00
8	8.86	3.24	12.14	22.73	16.74	45.32	0.00	0.00	10.10	0.00	9.13	0.00
9	8.86	3.24	12.14	28.30	16.74	45.32	0.00	17.50	5.68	0.00	9.13	0.00
10	8.86	3.24	12.14	28.30	16.74	30.02	0.00	23.58	5.68	0.00	0.00	0.00
11	8.86	3.24	13.35	28.30	16.74	6.23	0.00	23.58	5.68	0.00	0.00	0.00
12	8.86	3.24	13.76	28.30	16.74	6.23	0.00	23.58	5.68	0.00	0.00	0.00
13	8.86	3.24	13.76	32.48	16.74	15.29	0.00	23.58	5.68	5.18	0.00	0.00
14	8.86	3.24	13.76	37.12	16.74	83.83	0.00	23.58	5.68	8.42	0.00	1.01
15	8.86	3.24	13.76	68.20	16.74	77.04	0.00	22.82	5.68	8.42	0.00	10.14
16	8.86	3.24	13.76	96.04	15.01	35.69	0.00	12.17	2.53	8.42	0.00	10.14
17	8.58	3.24	13.76	96.04	12.70	10.76	0.00	3.80	0.00	8.42	0.00	10.14
18	8.58	3.24	11.73	95.57	12.70	0.00	0.00	3.80	0.00	8.42	0.00	10.14
19	8.58	3.24	8.09	74.70	6.35	0.00	0.00	3.80	0.00	8.42	0.00	10.14
20	8.58	3.24	8.09	43.61	2.89	0.00	0.00	3.80	0.00	12.30	0.00	9.64
21	8.58	3.24	8.09	27.84	2.89	0.00	0.00	3.80	0.00	19.42	0.00	9.64
22	8.58	3.24	8.09	25.52	2.89	0.00	0.00	3.80	0.00	19.42	0.00	9.64
23	8.58	3.24	8.09	18.56	2.89	0.00	0.00	3.80	0.00	19.42	0.00	9.64
24	7.43	3.24	8.09	18.56	2.89	0.00	0.00	3.80	0.00	19.42	0.00	9.64
25	5.72	3.24	8.09	29.69	2.89	0.00	0.00	3.80	0.00	19.42	0.00	10.14
26	5.72	3.24	8.09	37.12	14.43	0.00	0.00	10.65	0.00	19.42	0.00	10.14
27	5.72	3.24	8.09	50.11	13.28	0.00	0.00	15.21	0.00	8.42	0.00	10.14
28	5.72	3.24	8.09	37.12	0.00	0.00	0.00	15.21	0.00	7.12	0.00	10.14
29	5.72		10.12	37.12	0.00	0.00	0.00	15.21	0.00	7.12	0.00	10.14
30	5.72		12.54	37.12	0.00	0.00	0.00	15.21	0.00	7.12	0.00	10.14
31	5.72		12.54		12.70		0.00	14.45		6.47		10.14
Total	241.61	88.80	345.13	1105.12	416.76	531.89	0.00	290.57	183.68	220.75	73.53	170.89
Mean	7.79	3.17	11.13	36.84	13.44	17.73	0.00	9.37	6.12	7.12	2.45	5.51
Max	8.86	3.24	13.76	96.04	46.18	83.83	0.00	23.58	19.57	19.42	9.13	10.14
Min	5.72	2.48	8.09	14.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2005
Cottonwood Creek 1
Discharge (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.62	5.42	2.82	5.29	7.08	5.95	2.33	2.69	3.85	6.57	4.46	4.49
2	3.49	3.48	2.67	3.82	4.93	4.65	2.30	2.70	3.90	6.40	4.34	4.44
3	3.62	3.17	2.65	3.44	4.36	14.27	2.32	3.29	3.53	6.68	4.39	5.40
4	3.79	3.38	2.61	3.44	4.06	28.68	2.30	50.69	3.36	6.97	4.31	6.21
5	3.45	3.33	2.62	8.90	4.06	13.32	2.30	23.62	3.68	8.98	4.64	6.10
6	3.61	3.10	2.72	8.52	4.20	5.99	3.02	9.45	3.99	7.40	4.51	5.43
7	3.62	3.01	2.82	4.36	4.25	4.61	4.08	6.45	4.22	7.21	4.46	7.91
8	3.75	3.09	2.95	3.85	4.02	4.28	3.26	5.81	3.66	6.88	4.47	5.53
9	3.88	3.06	2.26	3.79	4.01	4.27	2.77	5.50	3.68	8.45	4.72	4.39
10	3.58	3.09	2.03	8.21	3.89	28.86	2.69	5.43	4.02	39.60	4.67	4.57
11	3.68	2.96	1.98	27.01	6.12	22.57	2.79	8.38	3.53	28.17	4.74	4.63
12	4.06	2.93	1.88	25.54	7.06	14.92	2.77	16.17	3.41	23.64	4.89	4.78
13	4.23	2.91	3.43	24.09	4.47	6.45	2.69	7.80	3.41	13.84	4.55	4.89
14	4.11	2.97	4.72	23.21	3.92	4.00	2.62	6.63	3.82	7.73	4.73	4.70
15	3.80	3.05	3.04	12.48	3.76	3.60	3.76	5.49	4.78	5.95	7.31	5.94
16	3.64	3.35	2.52	7.03	3.73	3.80	6.18	8.10	3.87	5.22	5.42	4.44
17	3.68	3.04	2.55	5.77	3.76	3.60	3.48	15.05	3.73	5.09	5.27	4.30
18	3.96	3.13	2.19	5.11	3.63	3.19	3.15	6.70	3.71	4.93	5.51	4.25
19	4.72	2.98	1.99	4.34	3.70	2.90	2.82	5.16	3.75	5.06	4.95	4.32
20	4.49	2.91	1.94	4.40	3.89	3.72	2.70	4.75	4.04	5.03	4.62	4.42
21	3.75	2.91	4.05	4.42	3.64	2.93	2.56	10.79	4.04	4.88	4.67	4.46
22	3.44	2.91	3.72	4.16	3.50	2.73	2.62	15.85	3.66	4.90	4.61	4.64
23	3.49	2.84	3.30	3.82	3.55	2.67	2.48	6.70	3.53	4.85	4.50	4.86
24	3.47	2.81	4.81	4.29	3.40	3.35	2.50	4.96	3.56	4.74	4.42	4.73
25	3.78	2.74	3.72	26.17	3.40	3.35	3.04	4.52	3.70	4.55	4.44	4.74
26	3.45	2.77	3.59	9.65	3.39	2.85	4.26	4.40	3.81	4.47	4.44	4.68
27	3.43	2.85	3.63	5.06	3.02	3.47	3.65	4.20	3.80	4.38	4.45	4.60
28	3.42	2.84	3.17	8.83	2.97	2.50	2.93	4.17	7.68	4.38	4.35	5.22
29	3.38		3.46	6.56	3.01	2.40	2.69	4.07	7.73	4.35	4.32	4.96
30	3.57		3.93	5.93	5.61	2.33	2.59	4.02	6.84	4.34	4.42	4.42
31	5.29		8.54		15.45		2.58	3.95		4.89		4.45
Total	117.25	87.03	98.31	271.49	139.84	212.21	92.23	267.49	124.29	260.53	141.58	152.90
Max	5.29	5.42	8.54	27.01	15.45	28.86	6.18	50.69	7.73	39.60	7.31	7.91
Min	3.38	2.74	1.88	3.44	2.97	2.33	2.30	2.69	3.36	4.34	4.31	4.25
Ac-ft	232.51	172.58	194.95	538.36	277.30	420.81	182.89	530.43	246.47	516.63	280.75	303.20

2005
Cottonwood Creek 1
Phosphorus Load (lbs)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	1.27	3.30	0.45	3.14	5.39	3.95	0.04	0.32	1.51	4.73	2.18	2.22
2	1.13	1.12	0.30	1.48	2.72	2.40	0.07	0.33	1.56	4.51	2.05	2.16
3	1.27	0.80	0.28	1.08	2.07	16.07	0.05	0.92	1.17	4.87	2.10	3.28
4	1.45	1.01	0.24	1.08	1.74	41.97	0.07	82.04	0.99	5.25	2.01	4.27
5	1.09	0.96	0.25	7.88	1.74	14.55	0.07	32.39	1.33	7.99	2.39	4.13
6	1.25	0.73	0.35	7.34	1.89	4.00	0.65	8.66	1.66	5.82	2.24	3.31
7	1.27	0.64	0.45	2.07	1.95	2.35	1.76	4.58	1.91	5.56	2.18	6.50
8	1.40	0.72	0.58	1.51	1.69	1.98	0.89	3.77	1.31	5.13	2.19	3.43
9	1.54	0.69	0.11	1.45	1.68	1.97	0.40	3.40	1.33	7.25	2.48	2.10
10	1.22	0.72	0.35	6.91	1.55	42.32	0.32	3.31	1.69	64.09	2.42	2.31
11	1.33	0.59	0.41	38.76	4.16	30.46	0.42	7.15	1.17	40.99	2.50	2.37
12	1.74	0.56	0.52	35.97	5.37	17.13	0.40	19.21	1.05	32.43	2.67	2.55
13	1.92	0.54	1.07	33.26	2.19	4.58	0.32	6.35	1.05	15.38	2.28	2.67
14	1.79	0.60	2.48	31.63	1.59	1.67	0.25	4.81	1.48	6.26	2.49	2.45
15	1.46	0.68	0.67	13.22	1.41	1.24	1.41	3.38	2.55	3.95	5.70	3.94
16	1.29	0.98	0.15	5.33	1.38	1.46	4.23	6.76	1.53	3.06	3.30	2.16
17	1.33	0.67	0.18	3.73	1.41	1.24	1.12	17.35	1.38	2.91	3.12	2.00
18	1.63	0.76	0.18	2.93	1.28	0.82	0.78	4.90	1.36	2.72	3.41	1.95
19	2.48	0.61	0.40	2.05	1.35	0.53	0.45	2.99	1.40	2.87	2.74	2.02
20	2.22	0.54	0.45	2.11	1.55	1.37	0.33	2.51	1.72	2.84	2.36	2.14
21	1.40	0.54	1.73	2.14	1.29	0.56	0.19	10.63	1.72	2.66	2.42	2.18
22	1.08	0.54	1.37	1.85	1.14	0.36	0.25	18.68	1.31	2.68	2.35	2.39
23	1.13	0.47	0.93	1.48	1.19	0.30	0.11	4.90	1.17	2.63	2.23	2.64
24	1.11	0.44	2.58	1.99	1.04	0.98	0.13	2.75	1.20	2.50	2.14	2.49
25	1.44	0.37	1.37	37.16	1.04	0.98	0.67	2.25	1.35	2.28	2.16	2.50
26	1.09	0.40	1.23	8.95	1.03	0.48	1.96	2.11	1.47	2.19	2.16	2.43
27	1.07	0.48	1.28	2.87	0.65	1.11	1.30	1.89	1.46	2.09	2.17	2.34
28	1.06	0.47	0.80	7.78	0.60	0.13	0.56	1.86	6.19	2.09	2.06	3.06
29	1.01		1.10	4.72	0.64	0.03	0.32	1.75	6.26	2.06	2.02	2.75
30	1.21		1.60	3.92	3.53	0.04	0.22	1.69	5.08	2.05	2.14	2.14
31	3.14		7.37		18.01		0.21	1.62		2.67		2.17
Total	44.78	20.86	31.19	275.78	74.23	197.01	19.90	265.25	56.33	254.49	74.64	85.03
Mean	1.44	0.75	1.01	9.19	2.39	6.57	0.64	8.56	1.88	8.21	2.49	2.74
Max	3.14	3.30	7.37	38.76	18.01	42.32	4.23	82.04	6.26	64.09	5.70	6.50
Min	1.01	0.37	0.11	1.08	0.60	0.03	0.04	0.32	0.99	2.05	2.01	1.95

2005
Cottonwood Creek 2
Discharge (cfs)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.19	5.51	2.90	5.42	4.30	6.08	2.49	4.79	5.50	3.05	4.85	4.85
2	4.09	4.09	2.80	4.35	3.81	3.69	2.51	4.80	5.67	2.94	4.77	4.81
3	4.20	3.84	2.77	4.06	3.66	4.32	2.58	4.93	5.54	3.06	4.96	5.50
4	4.33	4.01	2.71	4.05	3.45	43.27	2.43	38.37	5.28	3.37	4.85	6.04
5	4.06	3.97	2.73	14.87	3.35	38.25	3.46	52.92	5.52	3.95	5.09	5.97
6	4.19	3.78	2.75	14.65	3.38	14.98	5.13	34.96	5.72	3.42	4.86	5.52
7	4.20	3.72	2.76	4.75	3.39	3.55	5.49	13.75	5.72	3.20	4.97	14.30
8	4.30	3.78	2.96	4.38	3.29	3.16	4.67	5.69	5.48	3.19	4.82	5.58
9	4.39	3.75	3.09	4.33	3.44	3.17	5.02	5.78	5.52	3.77	5.06	4.78
10	4.17	3.78	2.89	14.48	3.74	14.83	4.69	5.65	5.76	37.64	4.79	4.91
11	4.24	3.68	2.85	47.05	4.23	39.63	4.73	13.57	5.50	43.35	4.84	4.95
12	4.53	3.64	2.77	44.12	5.80	33.68	4.82	30.67	5.57	39.52	5.25	5.06
13	4.66	3.63	4.05	41.28	4.21	15.91	4.60	15.21	5.04	33.56	4.85	5.31
14	4.57	3.68	5.02	32.07	3.83	3.70	4.83	4.91	4.39	16.54	5.00	4.73
15	4.34	3.74	3.73	16.72	3.64	3.12	5.20	4.23	4.78	5.62	13.48	3.59
16	4.21	3.99	3.31	13.76	3.57	4.33	13.82	4.36	4.31	5.13	5.35	4.31
17	4.24	3.74	3.34	5.75	3.54	4.18	5.63	31.91	4.23	4.95	5.45	5.18
18	4.46	3.81	3.03	5.29	3.49	3.86	4.94	16.68	4.26	4.96	5.44	5.09
19	5.02	3.69	2.86	4.74	3.41	3.62	4.68	13.39	4.28	5.24	5.36	4.28
20	4.85	3.64	2.82	4.79	3.36	4.27	4.73	6.10	4.29	5.11	4.94	4.10
21	4.30	3.63	4.52	4.80	3.22	3.65	4.54	13.59	4.22	4.97	4.98	3.85
22	4.05	3.64	4.43	4.60	3.13	3.48	4.69	45.31	4.30	4.98	4.94	4.00
23	4.10	3.58	3.85	4.35	3.10	4.04	4.65	18.64	4.14	5.08	4.85	4.47
24	4.08	3.55	4.76	4.70	3.12	3.92	4.68	13.41	4.25	4.84	4.80	4.03
25	4.32	3.50	4.23	32.87	3.07	4.10	4.94	5.99	4.28	4.75	4.82	3.06
26	4.07	3.52	4.13	26.71	3.19	3.68	5.90	5.80	4.23	4.89	4.81	4.27
27	4.05	3.58	4.10	4.35	3.14	4.24	5.17	5.81	4.17	4.79	4.82	4.20
28	4.04	3.58	3.67	4.87	3.10	3.90	4.94	5.59	4.60	4.74	4.75	4.17
29	4.01		3.74	4.28	3.16	3.84	4.68	5.57	3.45	5.04	4.73	3.69
30	4.15		4.43	3.89	3.63	3.27	4.73	5.54	3.11	4.95	4.80	3.89
31	5.42		14.67		18.01		4.82	5.72		5.00		3.95
Total	133.83	106.05	118.67	386.33	124.76	289.72	150.19	443.64	143.11	285.60	157.28	152.44
Max	5.42	5.51	14.67	47.05	18.01	43.27	13.82	52.92	5.76	43.35	13.48	14.30
Min	4.01	3.50	2.71	3.89	3.07	3.12	2.43	4.23	3.11	2.94	4.73	3.06
Ac-ft	265.38	210.30	235.32	766.09	247.40	574.51	297.83	879.74	283.79	566.34	311.89	302.29

2005
Cottonwood Creek 2
Phosphorus Loading (lbs)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	2.05	2.80	1.36	2.75	2.11	3.14	1.15	2.38	2.79	1.44	2.42	2.42
2	1.99	1.99	1.31	2.13	1.84	1.77	1.16	2.39	2.90	1.38	2.37	2.39
3	2.05	1.85	1.29	1.97	1.76	2.12	1.20	2.46	2.82	1.44	2.48	2.79
4	2.12	1.95	1.26	1.97	1.64	47.03	1.12	38.83	2.67	1.60	2.42	3.12
5	1.97	1.92	1.27	9.69	1.59	38.63	1.65	71.37	2.81	1.91	2.55	3.08
6	2.05	1.82	1.28	9.50	1.61	9.79	2.58	33.55	2.93	1.63	2.42	2.81
7	2.05	1.79	1.29	2.36	1.61	1.70	2.79	8.73	2.93	1.51	2.49	9.19
8	2.11	1.82	1.39	2.15	1.56	1.49	2.31	2.91	2.78	1.51	2.40	2.84
9	2.16	1.81	1.46	2.12	1.64	1.50	2.51	2.96	2.81	1.82	2.54	2.38
10	2.03	1.82	1.35	9.35	1.80	9.66	2.33	2.88	2.95	37.67	2.38	2.45
11	2.07	1.77	1.33	53.87	2.07	40.87	2.35	8.57	2.79	47.17	2.41	2.47
12	2.23	1.75	1.29	48.53	2.97	31.66	2.40	27.42	2.84	40.69	2.65	2.54
13	2.31	1.74	1.97	43.61	2.06	10.62	2.27	9.99	2.53	31.49	2.42	2.68
14	2.26	1.77	2.51	29.35	1.85	1.78	2.40	2.45	2.16	11.20	2.50	2.35
15	2.13	1.80	1.79	11.37	1.75	1.47	2.62	2.07	2.38	2.87	8.50	1.72
16	2.06	1.94	1.57	8.73	1.71	2.12	8.78	2.14	2.11	2.58	2.71	2.11
17	2.07	1.80	1.59	2.94	1.69	2.04	2.87	29.13	2.07	2.47	2.77	2.61
18	2.20	1.84	1.43	2.67	1.67	1.86	2.47	11.33	2.08	2.48	2.76	2.55
19	2.51	1.77	1.34	2.35	1.62	1.74	2.32	8.42	2.10	2.64	2.71	2.10
20	2.42	1.75	1.32	2.38	1.60	2.09	2.35	3.16	2.10	2.57	2.47	2.00
21	2.11	1.74	2.23	2.39	1.52	1.75	2.24	8.59	2.06	2.49	2.49	1.86
22	1.97	1.75	2.18	2.27	1.48	1.66	2.33	50.67	2.11	2.49	2.47	1.94
23	2.00	1.71	1.86	2.13	1.46	1.96	2.30	13.23	2.02	2.55	2.42	2.20
24	1.98	1.70	2.36	2.33	1.47	1.90	2.32	8.44	2.08	2.41	2.39	1.96
25	2.12	1.67	2.07	30.49	1.45	2.00	2.47	3.09	2.10	2.36	2.40	1.44
26	1.98	1.68	2.01	22.25	1.51	1.77	3.03	2.97	2.07	2.44	2.39	2.09
27	1.97	1.71	2.00	2.13	1.48	2.07	2.60	2.98	2.03	2.38	2.40	2.05
28	1.96	1.71	1.76	2.43	1.46	1.89	2.47	2.85	2.27	2.35	2.36	2.03
29	1.95		1.80	2.10	1.49	1.85	2.32	2.84	1.64	2.53	2.35	1.77
30	2.02		2.18	1.88	1.74	1.55	2.35	2.82	1.47	2.47	2.39	1.88
31	2.75		9.52		12.60		2.40	2.93		2.50		1.91
Total	65.62	51.16	59.35	320.21	63.79	231.47	76.44	374.52	71.35	225.02	80.39	77.72
Mean	2.12	1.83	1.91	10.67	2.06	7.72	2.47	12.08	2.38	7.26	2.68	2.51
Max	2.75	2.80	9.52	53.87	12.60	47.03	8.78	71.37	2.95	47.17	8.50	9.19
Min	1.95	1.67	1.26	1.88	1.45	1.47	1.12	2.07	1.47	1.38	2.35	1.44

2005
Cottonwood Creek Peoria 1
Discharge (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.81	4.52	0.74	2.04	4.13	2.45	0.44	0.60	1.01	1.84	1.36	1.11
2	0.79	2.31	0.76	1.38	2.28	1.54	0.45	0.64	1.01	1.82	1.26	1.22
3	0.82	1.07	0.74	0.97	1.81	8.27	0.59	1.41	0.86	1.88	1.21	2.76
4	0.86	0.77	0.75	0.95	1.58	18.23	0.57	51.64	0.88	2.36	1.07	2.06
5	0.83	0.73	0.75	9.19	1.58	6.03	0.56	12.07	1.10	2.95	1.53	1.42
6	0.95	0.54	0.68	3.04	1.58	2.21	0.67	4.01	1.58	2.25	1.18	1.27
7	0.96	0.47	0.73	1.58	1.50	1.46	0.78	2.45	1.25	2.03	1.22	1.13
8	1.06	0.54	1.02	1.34	1.38	1.24	0.64	2.02	0.95	1.63	1.24	1.13
9	1.16	0.51	1.10	1.33	1.26	1.35	0.57	1.76	1.04	6.11	1.43	1.05
10	1.02	0.54	0.82	5.26	1.09	22.18	0.48	2.19	1.08	26.59	1.37	1.11
11	0.97	0.43	0.73	18.25	4.65	10.41	0.51	8.52	0.86	25.53	1.32	1.27
12	1.20	0.40	0.71	18.25	2.88	8.54	0.47	10.53	0.78	13.45	1.61	1.47
13	1.36	0.39	4.50	23.36	1.85	2.92	0.42	6.99	0.64	6.22	0.88	1.41
14	1.28	0.43	4.07	14.30	1.35	2.02	0.35	6.03	1.61	3.06	1.30	1.04
15	1.14	0.50	2.09	5.55	1.15	1.82	2.42	4.44	1.55	1.90	3.55	0.79
16	1.02	0.75	1.55	2.74	1.00	2.35	2.97	11.99	0.76	1.47	1.90	0.71
17	1.02	0.49	1.45	2.06	1.04	1.79	1.40	9.62	0.73	1.38	1.77	0.59
18	1.32	0.57	0.91	1.63	0.88	1.46	0.96	2.67	0.80	1.19	1.92	0.57
19	2.24	0.44	0.81	1.58	0.84	1.17	0.50	1.82	1.22	1.46	1.30	0.51
20	1.79	0.39	0.79	1.65	0.95	1.77	0.36	1.49	1.50	1.35	1.01	0.59
21	1.19	0.39	5.67	1.54	0.95	1.16	0.35	9.55	1.55	1.24	0.91	0.70
22	1.02	0.39	2.30	1.33	0.93	0.94	0.23	8.34	1.29	1.26	1.34	0.77
23	0.94	0.33	1.41	1.27	0.94	0.83	0.17	3.02	1.24	1.24	1.30	0.97
24	0.92	0.80	2.02	2.81	1.01	2.16	0.41	2.13	1.31	1.19	1.29	0.80
25	0.91	0.77	1.70	19.56	1.07	1.73	1.41	1.73	1.45	1.23	1.28	0.75
26	0.89	0.71	1.99	4.48	1.02	1.64	2.17	1.59	1.53	1.18	1.27	0.78
27	0.89	0.73	1.47	2.97	0.77	1.29	1.81	1.60	1.85	1.16	1.24	0.84
28	0.88	0.75	1.14	5.71	0.77	0.66	1.01	1.38	4.05	1.25	1.20	1.68
29	0.77		0.89	4.33	1.06	0.62	0.57	1.29	2.61	1.27	1.16	0.87
30	0.95		1.57	3.48	5.76	0.54	0.44	1.16	2.08	1.37	1.15	0.67
31	2.72		4.64		6.96		0.50	1.08		1.95		0.65
Total	34.68	21.66	50.50	163.93	56.02	110.78	25.18	175.76	40.17	120.81	41.57	32.69
Max	2.72	4.52	5.67	23.36	6.96	22.18	2.97	51.64	4.05	26.59	3.55	2.76
Min	0.77	0.33	0.68	0.95	0.77	0.54	0.17	0.60	0.64	1.16	0.88	0.51
Ac-ft	68.77	42.95	100.14	325.07	111.09	219.68	49.93	348.53	79.66	239.57	82.43	64.82

2005
Cottonwood Creek Peoria 1
Phosphorus Load (lbs)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.19	3.48	0.16	1.00	3.05	1.36	0.06	0.11	0.29	0.84	0.49	0.34
2	0.18	1.23	0.17	0.51	1.20	0.61	0.06	0.12	0.29	0.82	0.43	0.41
3	0.20	0.32	0.16	0.27	0.81	7.63	0.10	0.53	0.21	0.87	0.40	1.65
4	0.21	0.17	0.17	0.26	0.64	17.87	0.10	50.71	0.22	1.27	0.32	1.02
5	0.20	0.16	0.17	8.62	0.64	5.15	0.09	11.65	0.34	1.83	0.61	0.53
6	0.26	0.09	0.14	1.92	0.64	1.14	0.13	2.92	0.64	1.18	0.38	0.44
7	0.26	0.07	0.16	0.64	0.59	0.56	0.18	1.36	0.42	0.99	0.41	0.35
8	0.31	0.09	0.29	0.48	0.51	0.42	0.12	0.98	0.26	0.68	0.42	0.35
9	0.37	0.08	0.34	0.47	0.43	0.49	0.10	0.78	0.30	5.24	0.54	0.31
10	0.29	0.09	0.20	4.29	0.33	21.77	0.07	1.13	0.32	26.11	0.50	0.34
11	0.27	0.06	0.16	17.89	3.62	9.92	0.08	7.90	0.21	25.07	0.47	0.44
12	0.39	0.05	0.15	17.89	1.76	7.92	0.07	10.05	0.18	13.07	0.66	0.57
13	0.49	0.05	3.46	22.93	0.85	1.80	0.05	6.22	0.12	5.36	0.22	0.53
14	0.44	0.06	2.99	13.93	0.49	0.98	0.04	5.15	0.66	1.94	0.45	0.30
15	0.36	0.08	1.04	4.62	0.36	0.82	1.33	3.39	0.62	0.88	2.44	0.18
16	0.29	0.17	0.62	1.63	0.28	1.27	1.85	11.57	0.17	0.57	0.88	0.15
17	0.29	0.07	0.55	1.02	0.30	0.80	0.52	9.08	0.16	0.51	0.78	0.10
18	0.47	0.10	0.24	0.68	0.22	0.56	0.26	1.56	0.19	0.39	0.90	0.10
19	1.17	0.06	0.19	0.64	0.20	0.38	0.08	0.82	0.41	0.56	0.45	0.08
20	0.80	0.05	0.18	0.69	0.26	0.78	0.04	0.58	0.59	0.49	0.29	0.10
21	0.39	0.05	4.75	0.61	0.26	0.37	0.04	9.01	0.62	0.42	0.24	0.14
22	0.29	0.05	1.22	0.47	0.25	0.25	0.02	7.70	0.45	0.43	0.48	0.17
23	0.25	0.03	0.53	0.44	0.25	0.20	0.01	1.90	0.42	0.42	0.45	0.27
24	0.24	0.19	0.98	1.69	0.29	1.10	0.05	1.07	0.46	0.39	0.45	0.19
25	0.24	0.17	0.73	19.18	0.32	0.75	0.53	0.75	0.55	0.41	0.44	0.17
26	0.23	0.15	0.96	3.43	0.29	0.69	1.11	0.65	0.61	0.38	0.44	0.18
27	0.23	0.16	0.57	1.85	0.17	0.45	0.81	0.66	0.85	0.37	0.42	0.20
28	0.22	0.17	0.36	4.80	0.17	0.13	0.29	0.51	2.97	0.42	0.39	0.72
29	0.17		0.23	3.27	0.31	0.12	0.10	0.45	1.50	0.44	0.37	0.22
30	0.26		0.64	2.37	4.85	0.09	0.06	0.37	1.03	0.50	0.36	0.13
31	1.61		3.61		6.19		0.08	0.32		0.93		0.13
Total	11.57	7.46	26.08	138.48	30.55	86.36	8.42	150.01	16.05	93.76	16.09	10.79
Mean	0.37	0.27	0.84	4.62	0.99	2.88	0.27	4.84	0.54	3.02	0.54	0.35
Max	1.61	3.48	4.75	22.93	6.19	21.77	1.85	50.71	2.97	26.11	2.44	1.65
Min	0.17	0.03	0.14	0.26	0.17	0.09	0.01	0.11	0.12	0.37	0.22	0.08

2005
Cottonwood Creek Peoria 2
Discharge (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.80	4.41	0.71	2.44	3.82	3.24	0.71	0.72	1.17	1.49	1.44	0.79
2	0.77	2.08	0.73	1.60	1.89	1.61	0.72	0.59	1.20	1.44	1.35	0.88
3	0.82	1.17	0.71	1.18	1.45	4.32	0.87	1.50	1.10	1.49	1.33	1.92
4	0.86	0.75	0.72	1.12	1.30	27.62	0.85	25.50	1.06	1.66	1.27	1.83
5	0.82	0.70	0.73	6.63	1.34	7.59	0.83	22.85	1.19	2.91	1.66	1.04
6	0.99	0.47	0.63	5.44	1.39	3.18	0.91	5.34	1.53	1.76	1.43	0.90
7	1.01	0.40	0.70	1.64	1.38	1.50	1.06	2.45	1.49	1.60	1.44	0.79
8	1.15	0.47	1.09	1.21	1.33	1.14	0.81	1.75	1.04	1.46	1.25	0.66
9	1.30	0.44	1.21	1.22	1.24	1.10	0.66	1.48	1.08	2.95	1.11	0.78
10	1.09	0.47	0.81	3.61	1.09	7.11	0.59	1.53	1.15	42.15	1.10	0.85
11	1.02	0.36	0.70	21.81	3.21	9.52	0.62	5.76	0.89	33.22	1.11	0.93
12	1.35	0.32	0.68	32.76	4.00	8.10	0.58	9.30	0.85	25.93	1.26	1.11
13	1.46	0.31	4.38	29.54	1.64	5.29	0.57	5.62	0.80	7.85	0.90	1.36
14	1.48	0.36	3.78	24.65	1.32	2.16	0.57	3.60	1.58	5.20	1.51	1.35
15	1.26	0.43	1.96	7.23	1.17	1.90	1.97	1.92	1.92	2.11	3.74	1.15
16	1.09	0.72	1.61	4.45	1.08	2.14	4.99	4.27	1.08	1.56	1.84	1.07
17	1.08	0.42	1.53	2.63	1.12	1.85	1.56	8.85	1.02	1.49	1.76	0.96
18	1.43	0.51	0.94	1.85	1.00	1.51	1.07	3.96	1.06	1.50	1.85	0.96
19	2.05	0.37	0.80	1.50	0.93	1.29	0.75	1.68	1.28	1.55	1.51	0.95
20	1.78	0.32	0.78	1.43	0.95	1.93	0.65	1.49	1.53	1.51	1.07	0.99
21	1.33	0.31	6.01	1.52	0.92	1.29	0.64	3.67	1.52	1.52	0.94	1.07
22	1.08	0.32	2.08	1.16	0.92	1.14	0.56	9.12	1.41	1.50	0.91	1.16
23	0.98	0.26	1.50	1.13	0.86	1.04	0.51	4.54	1.35	1.47	0.90	1.27
24	0.94	0.78	2.51	1.72	0.91	1.92	0.62	1.95	1.39	1.38	0.90	1.15
25	0.94	0.75	1.75	24.63	0.91	1.82	1.38	1.47	1.52	1.42	0.90	1.09
26	0.91	0.68	1.73	5.88	0.94	1.61	2.04	1.50	1.47	1.37	0.90	1.10
27	0.91	0.70	1.67	2.07	0.84	1.79	1.62	1.49	1.54	1.32	0.87	1.13
28	0.90	0.72	1.20	5.87	0.80	0.92	1.03	1.46	3.63	1.27	0.83	1.81
29	0.75		1.06	3.34	0.89	0.81	0.74	1.30	2.08	1.26	0.82	1.50
30	1.00		1.32	2.77	2.82	0.83	0.68	1.19	1.62	1.36	0.81	1.11
31	2.50		6.11		7.78		0.71	1.18		1.70		1.09
Total	35.85	20.00	52.14	204.03	51.24	107.27	31.87	139.03	41.55	156.40	38.71	34.75
Max	2.50	4.41	6.11	32.76	7.78	27.62	4.99	25.50	3.63	42.15	3.74	1.92
Min	0.75	0.26	0.63	1.12	0.80	0.81	0.51	0.59	0.80	1.26	0.81	0.66
Ac-ft	71.09	39.66	103.39	404.59	101.61	212.72	63.20	275.70	82.39	310.14	76.76	68.91

2005
Cottonwood Creek Peoria 2
Phosphorus Load (lbs)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.19	3.77	0.14	1.64	3.14	2.50	0.14	0.14	0.44	0.70	0.66	0.18
2	0.17	1.27	0.15	0.80	1.08	0.81	0.14	0.08	0.46	0.66	0.58	0.23
3	0.20	0.44	0.14	0.44	0.67	3.68	0.23	0.71	0.38	0.70	0.56	1.11
4	0.22	0.16	0.14	0.40	0.54	25.87	0.22	23.88	0.35	0.86	0.51	1.02
5	0.20	0.13	0.15	6.07	0.57	7.02	0.20	21.40	0.45	2.15	0.86	0.34
6	0.30	0.04	0.10	4.86	0.61	2.44	0.25	4.75	0.74	0.95	0.65	0.25
7	0.32	0.02	0.13	0.84	0.61	0.71	0.35	1.65	0.70	0.80	0.66	0.18
8	0.42	0.04	0.38	0.47	0.56	0.41	0.19	0.94	0.34	0.67	0.50	0.11
9	0.54	0.03	0.47	0.47	0.49	0.38	0.11	0.69	0.37	2.19	0.39	0.17
10	0.38	0.04	0.19	2.91	0.38	6.54	0.08	0.74	0.42	39.48	0.38	0.22
11	0.33	0.01	0.13	20.43	2.47	8.88	0.09	5.19	0.24	31.11	0.39	0.27
12	0.58	0.00	0.12	30.68	3.33	7.51	0.08	8.67	0.22	24.29	0.51	0.39
13	0.67	0.00	3.74	27.67	0.84	4.70	0.07	5.04	0.19	7.27	0.25	0.59
14	0.69	0.01	3.09	23.09	0.56	1.35	0.07	2.90	0.78	4.61	0.72	0.58
15	0.51	0.03	1.15	6.66	0.44	1.09	1.16	1.11	1.11	1.30	3.05	0.42
16	0.38	0.14	0.81	3.81	0.37	1.33	4.39	3.62	0.37	0.76	1.03	0.36
17	0.37	0.02	0.74	1.84	0.40	1.04	0.76	8.24	0.33	0.70	0.95	0.28
18	0.65	0.05	0.27	1.04	0.31	0.72	0.36	3.29	0.35	0.71	1.04	0.28
19	1.24	0.01	0.19	0.71	0.27	0.53	0.16	0.87	0.52	0.75	0.72	0.28
20	0.97	0.00	0.17	0.65	0.28	1.12	0.11	0.70	0.74	0.72	0.36	0.30
21	0.56	0.00	5.44	0.73	0.26	0.53	0.10	2.97	0.73	0.73	0.27	0.36
22	0.37	0.00	1.27	0.43	0.26	0.41	0.07	8.50	0.63	0.71	0.25	0.43
23	0.30	0.01	0.71	0.41	0.22	0.34	0.05	3.91	0.58	0.68	0.25	0.51
24	0.27	0.17	1.71	0.91	0.25	1.11	0.09	1.14	0.61	0.61	0.25	0.42
25	0.27	0.16	0.94	23.07	0.25	1.01	0.61	0.68	0.73	0.64	0.25	0.38
26	0.25	0.12	0.92	5.31	0.27	0.81	1.23	0.71	0.68	0.60	0.25	0.38
27	0.25	0.13	0.86	1.26	0.21	0.98	0.82	0.70	0.75	0.56	0.23	0.41
28	0.25	0.14	0.46	5.30	0.19	0.26	0.33	0.67	2.93	0.51	0.20	1.00
29	0.16		0.35	2.61	0.24	0.19	0.15	0.54	1.27	0.51	0.20	0.71
30	0.31		0.56	1.99	2.05	0.20	0.12	0.45	0.82	0.59	0.19	0.39
31	1.70		5.54		7.20		0.14	0.44		0.89		0.38
Total	13.99	6.93	31.14	177.46	29.27	84.44	12.87	115.31	19.19	128.37	17.06	12.91
Mean	0.45	0.25	1.00	5.92	0.94	2.81	0.42	3.72	0.64	4.14	0.57	0.42
Max	1.70	3.77	5.54	30.68	7.20	25.87	4.39	23.88	2.93	39.48	3.05	1.11
Min	0.16	0.00	0.10	0.40	0.19	0.19	0.05	0.08	0.19	0.51	0.19	0.11

2005
Shop Creek 3
Discharge (cfs)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.28	1.20	0.17	0.37	0.50	0.26	0.07	0.29	0.08	0.06	0.14	0.17
2	0.85	0.53	0.16	0.19	0.21	0.16	0.08	0.29	0.07	0.07	0.15	0.17
3	0.30	0.44	0.15	0.15	0.15	1.99	0.07	0.60	0.07	0.07	0.14	0.17
4	0.30	0.40	0.15	0.15	0.13	4.64	0.07	7.87	0.07	0.08	0.17	0.17
5	0.30	0.38	0.11	0.61	0.11	1.17	0.07	6.00	0.07	0.05	0.25	0.17
6	0.30	0.38	0.10	0.31	0.10	0.48	0.05	0.29	0.08	0.05	0.22	0.17
7	0.30	0.36	0.13	0.26	0.22	0.23	0.04	0.19	0.07	0.05	0.14	0.17
8	1.00	0.34	0.12	0.25	0.16	0.09	0.08	0.18	0.07	0.06	0.08	0.17
9	1.52	0.37	0.18	0.27	0.12	0.07	0.29	0.17	0.07	0.07	0.07	0.17
10	0.82	0.38	0.16	1.03	0.10	1.43	0.29	0.18	0.07	2.56	0.06	0.17
11	0.57	0.37	0.13	4.07	0.42	2.18	0.29	0.21	0.08	1.87	0.06	0.17
12	0.57	0.33	0.11	9.60	0.39	0.80	0.30	1.19	0.08	1.19	0.17	0.17
13	0.84	0.28	1.03	6.56	0.16	0.30	0.30	0.64	0.07	0.48	0.17	0.17
14	0.79	0.26	0.59	9.64	0.12	0.10	0.27	0.47	0.05	0.15	0.17	0.17
15	0.92	0.34	0.29	3.35	0.09	0.05	0.72	0.45	0.05	0.10	0.17	0.17
16	0.56	0.49	0.24	0.42	0.06	0.08	1.39	0.56	0.05	0.09	0.17	0.17
17	0.49	0.32	0.19	0.06	0.07	0.08	0.36	0.48	0.05	0.12	0.17	0.17
18	1.20	0.30	0.15	0.06	0.07	0.07	0.59	0.06	0.05	0.13	0.17	0.17
19	1.30	0.29	0.13	0.06	0.11	0.08	0.35	0.15	0.05	0.17	0.17	0.17
20	0.77	0.27	0.12	0.10	0.17	0.22	0.31	0.13	0.05	0.14	0.17	0.17
21	0.32	0.24	0.70	0.44	0.17	0.07	0.29	0.10	0.05	0.12	0.17	0.17
22	0.29	0.21	0.29	0.24	0.17	0.07	0.30	0.22	0.05	0.12	0.17	0.17
23	0.27	0.16	0.21	0.21	0.17	0.08	0.28	0.03	0.05	0.14	0.17	0.17
24	0.26	0.30	0.67	0.33	0.18	0.09	0.30	0.07	0.05	0.17	0.17	0.17
25	0.25	0.66	0.39	2.54	0.20	0.08	0.33	0.07	0.05	0.16	0.17	0.17
26	0.27	0.18	0.23	0.37	0.18	0.13	0.62	0.07	0.05	0.16	0.17	0.17
27	0.26	0.18	0.20	0.18	0.13	0.58	0.38	0.05	0.05	0.15	0.17	0.17
28	0.26	0.18	0.15	0.36	0.13	0.04	0.31	0.08	0.07	0.14	0.17	0.17
29	0.25		0.11	0.49	0.17	0.08	0.26	0.08	0.06	0.15	0.17	0.17
30	0.41		0.08	0.37	0.61	0.07	0.28	0.07	0.05	0.18	0.17	0.17
31	1.00		0.69		1.60		0.30	0.07		0.17		0.17
Total	17.82	10.14	8.13	43.04	7.17	15.77	9.64	21.31	1.83	9.22	4.71	5.27
Max	1.52	1.20	1.03	9.64	1.60	4.64	1.39	7.87	0.08	2.56	0.25	0.17
Min	0.25	0.16	0.08	0.06	0.06	0.04	0.04	0.03	0.05	0.05	0.06	0.17
Ac-ft	35.34	20.11	16.12	85.35	14.22	31.27	19.12	42.26	3.63	18.28	9.34	10.45

2005
Shop Creek 3
Phosphorus Loading (lbs)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.22	0.34	0.06	0.28	0.41	0.29	0.13	0.34	0.05	0.03	0.04	0.05
2	0.66	0.15	0.06	0.14	0.17	0.18	0.15	0.34	0.04	0.04	0.04	0.05
3	0.23	0.12	0.06	0.11	0.12	2.19	0.13	0.69	0.04	0.04	0.04	0.05
4	0.23	0.11	0.06	0.11	0.11	5.11	0.13	9.09	0.04	0.05	0.05	0.05
5	0.23	0.11	0.04	0.46	0.09	1.29	0.13	6.93	0.04	0.03	0.07	0.05
6	0.23	0.11	0.04	0.23	0.08	0.53	0.09	0.34	0.05	0.03	0.06	0.05
7	0.23	0.10	0.05	0.20	0.18	0.25	0.08	0.22	0.04	0.03	0.04	0.05
8	0.77	0.10	0.04	0.19	0.13	0.10	0.15	0.21	0.04	0.03	0.02	0.05
9	1.17	0.10	0.07	0.20	0.10	0.08	0.54	0.20	0.04	0.04	0.02	0.05
10	0.63	0.11	0.06	0.77	0.08	1.57	0.54	0.21	0.04	1.46	0.02	0.05
11	0.44	0.10	0.05	3.05	0.34	2.40	0.54	0.24	0.05	1.07	0.02	0.05
12	0.44	0.09	0.04	7.20	0.32	0.88	0.56	1.37	0.05	0.68	0.05	0.05
13	0.65	0.08	0.38	4.92	0.13	0.33	0.56	0.74	0.04	0.27	0.05	0.05
14	0.61	0.07	0.22	7.23	0.10	0.11	0.50	0.54	0.03	0.09	0.05	0.05
15	0.71	0.10	0.11	2.51	0.07	0.06	1.34	0.52	0.03	0.06	0.05	0.05
16	0.43	0.14	0.09	0.32	0.05	0.09	2.60	0.65	0.03	0.05	0.05	0.05
17	0.38	0.09	0.07	0.05	0.06	0.09	0.67	0.55	0.03	0.07	0.05	0.05
18	0.93	0.08	0.06	0.05	0.06	0.08	1.10	0.07	0.03	0.07	0.05	0.05
19	1.00	0.08	0.05	0.05	0.09	0.09	0.65	0.17	0.03	0.10	0.05	0.05
20	0.59	0.08	0.04	0.08	0.14	0.24	0.58	0.15	0.03	0.08	0.05	0.05
21	0.25	0.07	0.26	0.33	0.14	0.08	0.54	0.12	0.03	0.07	0.05	0.05
22	0.22	0.06	0.11	0.18	0.14	0.08	0.56	0.25	0.03	0.07	0.05	0.05
23	0.21	0.05	0.08	0.16	0.14	0.09	0.52	0.04	0.03	0.08	0.05	0.05
24	0.20	0.08	0.25	0.25	0.15	0.10	0.56	0.08	0.03	0.10	0.05	0.05
25	0.19	0.19	0.14	1.91	0.16	0.09	0.62	0.08	0.03	0.09	0.05	0.05
26	0.21	0.05	0.08	0.28	0.15	0.14	1.16	0.08	0.03	0.09	0.05	0.05
27	0.20	0.05	0.07	0.14	0.11	0.64	0.71	0.06	0.03	0.09	0.05	0.05
28	0.20	0.05	0.06	0.27	0.11	0.04	0.58	0.09	0.04	0.08	0.05	0.05
29	0.19		0.04	0.37	0.14	0.09	0.49	0.09	0.03	0.09	0.05	0.05
30	0.32		0.03	0.28	0.50	0.08	0.52	0.08	0.03	0.10	0.05	0.05
31	0.77		0.25		1.30		0.56	0.08		0.10		0.05
Total	13.75	2.84	2.98	32.27	5.84	17.35	17.99	24.60	1.03	5.27	1.33	1.49
Mean	0.44	0.10	0.10	1.08	0.19	0.58	0.58	0.79	0.03	0.17	0.04	0.05
Max	1.17	0.34	0.38	7.23	1.30	5.11	2.60	9.09	0.05	1.46	0.07	0.05
Min	0.19	0.05	0.03	0.05	0.05	0.04	0.08	0.04	0.03	0.03	0.02	0.05

2005
Cherry Creek Precipitation (in.)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.31	0.00	0.00	0.00	0.35
4	0.40	0.00	0.00	0.00	0.00	0.51	0.00	2.31	0.00	0.12	0.00	0.03
5	0.03	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.08
6	0.00	0.01	0.00	0.00	0.04	0.00	0.00	0.00	0.03	0.00	0.00	0.06
7	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03
8	0.00	0.03	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.01	0.00	0.09	0.00	0.01	0.07	0.72	0.00	0.00
10	0.00	0.00	0.00	1.19	0.00	0.09	0.00	0.07	0.00	0.84	0.00	0.00
11	0.00	0.00	0.00	0.08	0.23	0.22	0.00	0.40	0.00	0.01	0.05	0.00
12	0.23	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
14	0.01	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.20	0.00
15	0.01	0.09	0.04	0.00	0.00	0.03	0.38	0.00	0.00	0.00	0.01	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.69	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.06
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
19	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.09	0.01	0.00
20	0.00	0.00	0.05	0.07	0.00	0.04	0.00	0.00	0.00	0.01	0.00	0.00
21	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.34	0.00	0.01	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.02	0.00	0.00	0.00
23	0.00	0.00	0.13	0.00	0.00	0.19	0.00	0.00	0.01	0.00	0.00	0.00
24	0.00	0.00	0.05	0.41	0.00	0.04	0.08	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.07	0.26	0.00	0.00	0.07	0.06	0.00	0.00	0.00	0.00
26	0.00	0.00	0.05	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00
28	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00
29	0.12		0.00	0.07	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.21		0.13	0.02	0.21	0.00	0.00	0.00	0.00	0.07	0.00	0.00
31	0.20		0.04		0.00		0.00	0.00		0.00		0.00
Total	1.21	0.13	1.28	2.41	0.67	1.39	0.73	4.37	0.35	1.88	0.42	0.63
Mean	0.04	0.00	0.04	0.08	0.02	0.05	0.02	0.14	0.01	0.06	0.01	0.02
Max	0.40	0.09	0.34	1.19	0.23	0.51	0.38	2.31	0.09	0.84	0.20	0.35
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ac-ft	85.91	9.23	90.88	171.11	47.57	98.69	51.83	310.27	24.85	133.48	29.82	44.73

2005
Cherry Creek Precipitation
Phosphorus Loading (lbs)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.00	0.00	0.30	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	2.40	0.00	9.30	0.00	0.00	0.00	10.50
4	12.00	0.00	0.00	0.00	0.00	15.30	0.00	69.29	0.00	3.60	0.00	0.90
5	0.90	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.30	2.40	2.40
6	0.00	0.30	0.00	0.00	1.20	0.00	0.00	0.00	0.90	0.00	0.00	1.80
7	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.90
8	0.00	0.90	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.30	0.00	2.70	0.00	0.30	2.10	21.60	0.00	0.00
10	0.00	0.00	0.00	35.69	0.00	2.70	0.00	2.10	0.00	25.19	0.00	0.00
11	0.00	0.00	0.00	2.40	6.90	6.60	0.00	12.00	0.00	0.30	1.50	0.00
12	6.90	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	10.20	0.00	0.00	0.00	0.00	4.20	0.00	0.00	0.00	0.00
14	0.30	0.00	1.50	0.00	0.00	0.00	0.00	0.00	1.20	0.00	6.00	0.00
15	0.30	2.70	1.20	0.00	0.00	0.90	11.40	0.00	0.00	0.00	0.30	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.60	20.70	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	1.80
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60
19	0.00	0.00	0.00	0.00	0.00	2.10	0.00	0.00	0.00	2.70	0.30	0.00
20	0.00	0.00	1.50	2.10	0.00	1.20	0.00	0.00	0.00	0.30	0.00	0.00
21	0.00	0.00	6.60	0.00	0.00	0.00	0.00	10.20	0.00	0.30	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.30	0.00	1.20	0.60	0.00	0.00	0.00
23	0.00	0.00	3.90	0.00	0.00	5.70	0.00	0.00	0.30	0.00	0.00	0.00
24	0.00	0.00	1.50	12.30	0.00	1.20	2.40	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	2.10	7.80	0.00	0.00	2.10	1.80	0.00	0.00	0.00	0.00
26	0.00	0.00	1.50	0.00	0.00	0.00	5.40	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	7.20	0.00	0.00	0.00	0.00	2.70	0.00	0.00	0.00
28	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	2.70	0.00	0.00	0.00
29	3.60		0.00	2.10	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	6.30		3.90	0.60	6.30	0.00	0.00	0.00	0.00	2.10	0.00	0.00
31	6.00		1.20		0.00		0.00	0.00		0.00		0.00
Total	36.29	3.90	38.39	72.28	20.10	41.69	21.90	131.07	10.50	56.39	12.60	18.90
Mean	1.17	0.14	1.24	2.41	0.65	1.39	0.71	4.23	0.35	1.82	0.42	0.61
Max	12.00	2.70	10.20	35.69	6.90	15.30	11.40	69.29	2.70	25.19	6.00	10.50
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX E

Biological Data

2005
Cherry Creek Reservoir Phytoplankton

GENUS/SPECIES	2/22/2005	3/22/2005	4/13/2005	5/10/2005	5/23/2005	6/7/2005	6/21/2005	7/6/2005	7/20/2005	8/3/2005	8/23/2005	9/14/2005	9/27/2005	10/12/2005	11/8/2005
CYANOPHYTA															
Anabaena catenula var. *affinis*															
Anabaena circinalis															
Anabaena flos-aquae					124	5895	3050					180			
Anabaena perturbata								20							
Anabaena spiroides var. *crassa*								260				380			
Anabaenopsis elenkinii					68						465	680	240	12	
Aphanizomenon flos-aquae							420	1760	1850	140					
Aphanizomenon issatschenkoi											430		80		
Aphanocapsa delicatissima	1000													10000	
Aphanocapsa incerta											13500				
Aphanocapsa sp.															
Aphanothece minutissima															
Aphanothece clathrata														1200	
Aphanothece smithii	19000	37500		527500	10500	4000	70250	62500		74000	158000	25000	47000	22000	15000
Aphanothece sp.															
Chroococcus dispersus															
Chroococcus limneticus															
Coelosphaerium kuetzingianum										130					
Cyanobium sp.		1500	250								1500				500
Dactylococcopsis acicularis											40	80	280	160	800
Dactylococcopsis fascicularis	40	200	3680	1120	320			40		2880	480	3520	1480	1600	4800
Geitlerinema lemmermannii												1600	80	580	580
Jaaginema angustissimum												8000	1280		
Merismopedia tenuissima									4000	18000					
Microcystis sp.															
Oscillatoria sp.															
Planktolyngbya limnetica															
Planktothrix agardhii															260
Pseudanabaena limnetica			2880	200	30				90	350	3920	3200	2600	260	
Synechococcus sp.															
CHRYSOPHYTA															
Chromulina sp.	15							1000							
Dinobryon divergens				60	2650	760									
Dinobryon sociale var. *americanum*		120	10	50	80								35	5	
Mallomonas sp.	120	10	100						5						
XANTHOPHYTA															
Goniochloris fallax															
Isthmochoron lobulatum															
Pseudostaurastrum hastatum										1	5				
BACILLARIOPHYTA															
Asterionella formosa	250	80	40		55	90	160	40							
Aulacoseira granulata var. *angustissima*					18	30	3880	16	20						
Aulacoseira italica					60										
Aulacoseira italica var. *tenuissima*															
Aulacoseira sp.	20			60	20				1120						
Cyclotella glomerata			4480		960										
Cyclotella meneghiniana		5			10					10	15	10			
Cyclotella ocellata	20	10	320	9280	25							1040	960	320	20
Cyclotella sp.									1760	2720	920	1040	8000		800
Cymbella sp.					15										
Diatoma tenuis															
Fragilaria crotonensis						20	1400		195	295	50		60		
Fragilaria sp.															
Navicula cryptocephala															
Navicula sp.															
Nitzschia agnewii			10									5			
Nitzschia closterium															

2005
Cherry Creek Reservoir Phytoplankton

GENUS/SPECIES	2/22/2005	3/22/2005	4/13/2005	5/10/2005	5/23/2005	6/7/2005	6/21/2005	7/6/2005	7/20/2005	8/3/2005	8/23/2005	9/14/2005	9/27/2005	10/12/2005	11/8/2005
BACILLARIOPHYTA (cont.)															
Nitzschia draveillensis	840	7200	380	360	30				1	40	20	20			10
Nitzschia fonticola															
Nitzschia gracilis			320	200	15						5	40	40		10
Nitzschia linearis											5		10		
Nitzschia nana			10												
Nitzschia palea															
Nitzschia paleacea															60
Nitzschia tubicola											5		10		
Puncticulata bodanica															
Stephanodiscus agassizensis	20	1	5	10	5							10	5		
Stephanodiscus hantzschii										80	20	400	1500		
Stephanodiscus niagarae															
Synedra delicatissima var. *angustissima*	150	140	180	700	400							10	20		
Synedra radians				10									5		
Synedra rumpens var. *familiaris*	20		30	20							5	20	5		
Synedra rumpens var. *fragilarioides*															
Synedra rumpens															
Synedra sp.															
Synedra ulna var. *chaseana*															
Tryblionella apiculata									5						
Urosolenia eriensis					20										
HAPTOPHYTA															
Chrysochromulina parva	6720		13120	320	1440							40			
CRYPTOPHYTA															
Campylomonas marsonii	10	90	10	10	10	55	30	50	20			30	5	10	10
Campylomonas reflexa	20		70	50	185	125	40	80	15		25	70	55	20	
Chroomonas coerulea														160	1120
Chroomonas nordstedtii	40	120	60	560						880	280	320	360	80	320
Cryptomonas erosa	90	70	10	50		100	50	100	120	35	10	70	20	40	170
Cryptomonas ovata													10		
Cryptomonas rostratiformis						5	20	60	5	5		40			
Komma caudata	1040	10160	40	80	240				10000	1440	2720	720	1280	2240	4160
Plagioselmis sp.	760		40	360	1520	180	320	3480	1600	240	120	60	120		
DINOPHYTA															
Ceratium hirundinella										5	5	2	1		
Gymnodinium sp.															
Kansodinium ambiguum									5	5					
Peridiniopsis kulczynskii	30	170													
Peridiniopsis penardiforme									60	35	20	20			
Peridiniopsis polonicum					1			10	490	5	10	10			
Woloszynskia neglecta				20											
EUGLENOPHYTA															
Euglena acus					1							20	10	10	
Euglena oxyuris				10	3			1				10			
Euglena sp. 1										15	10	30	5		
Euglena sp. 2										5					
Euglena viridis											30	30	5		
Phacus caudatus															
Phacus sp.											5		5		1
Trachelomonas hispida var. *coronata*															
Trachelomonas hispida var. *crenulatocelis*															
Trachelomonas varians										5			5	170	
Trachelomonas volvocina										5		160	20	20	

2005
Cherry Creek Reservoir Phytoplankton

GENUS/SPECIES	2/22/2005	3/22/2005	4/13/2005	5/10/2005	5/23/2005	6/7/2005	6/21/2005	7/6/2005	7/20/2005	8/3/2005	8/23/2005	9/14/2005	9/27/2005	10/12/2005	11/8/2005
PRASINOPHYTA															
Monomastix sp.					160										
Nephroselmis olivacea											3200	1360	20	20	
Pedinomonas sp.					240										
Tetraselmis cordiformis	1030	460	900	500	265			30		20	280		80		
CHLOROPHYTA															
Actinastrum hantzschii															
Ankistrodesmus falcatus										25	90		60		
Ankyra judayi							280	90							
Carteria sp.													40		
Chlamydomonas globosa	10								2560			240			
Chlamydomonas ehrenbergii								50		5	40		5		
Chlamydomonas reinhardtii															
Chlamydomonas sp.											240			80	
Chlorella minutissima	71000	252500	110750	81000	368500	8250	16750	2000	185000	218500	8750	214000	125000	23000	30000
Chlorella sp.					20										
Chlorogonium sp.										5	600	40	10	400	160
Chlorogonium tetragamum												80			
Choricystis sp.														514000	491000
Closterium acutum var. *variabile*						1		5	20	5	5	5			20
Closterium sp.															
Coelastrum microporum														640	
Coelastrum sphaericum									90	30					80
Coenococcus sp.				40											
Cosmarium abbreviata															
Cosmarium bioculatum var. *depressum*										10			20		
Crucigenia fenestrata															
Crucigenia quadrata									1280		80		640	140	
Crucigenia tetrapedia	4		160											1280	
Crucigeniella apiculata												1920			
Dictyosphaerium ehrenbergianum													1280		
Dictyosphaerium pulchellum									360						
Dimorphococcus sp.											240		480		
Diplochloris lunata			5120		800						880	480			
Elakatothrix viridis			20						20	10	5	10			40
Kirchneriella dianae															
Kirchneriella irregularis			160												
Kirchneriella lunaris			160												
Kirchneriella obesa			480											80	1280
Lagerheimia genevensis															1440
Micractinium pusillum												960			
Monoraphidium contortum			10						20				40		
Monoraphidium griffithii															
Monoraphidium minutum	20	20	80	560	40					80	80	80	80	80	80
Monoraphidium mirabile					15										
Monoraphidium sp.			20	10											
Mougeotia sp.															
Nephrocytium agardhianum				40			50			30	640	240	80	40	
Oocystis apiculata										20					
Oocystis borgei		40		60		40		40	800	160	320		160	30	
Oocystis lacustris						20	160	20				40			20
Oocystis parva															
Oocystis solitaria							30	10							
Oocystis sp.					40			40							
Pandorina smithii							520	4160							
Pediastrum boryanum				160				80			80				
Pediastrum duplex var. *duplex*					40	180	120	360	40						
Pediastrum duplex var. *gracillimum*	4								410						
Pediastrum simplex									40				10		
Pediastrum tetras											50	160	80	40	80
Pseudodictyosphaerium sp.			3680	480					1440	2880	640	3280	6400	3000	8000

2005
Cherry Creek Reservoir Phytoplankton

GENUS/SPECIES	2/22/2005	3/22/2005	4/13/2005	5/10/2005	5/23/2005	6/7/2005	6/21/2005	7/6/2005	7/20/2005	8/3/2005	8/23/2005	9/14/2005	9/27/2005	10/12/2005	11/8/2005
CHLOROPHYTA (cont.)															
Phacotus lenticularis															
Pteromonas aculeata				80							80	80	40		
Quadricoccus sp.									320	320					
Quadrigula sp.															
Raphidocelis contorta				160											
Raphidocelis microscopica			160	160	160				500	250	640	480	4000	19000	11500
Scenedesmus acuminatus	40										40	80	160	1920	800
Scenedesmus arcuatus var. *gracilis*															
Scenedesmus armatus															
Scenedesmus bicaudatus									20	10	160				
Scenedesmus communis		10	80	320		60	40	80	120	30	160	1040	90	480	640
Scenedesmus ecornis					160									160	
Scenedesmus ellipticus					18			880	700	20	20	320	40	160	
Scenedesmus intermedius			80	320	320				40	160		320		960	
Scenedesmus obliquus															
Scenedesmus subspicatus			160	160						80					1280
Schroederia setigera										40		40	5	880	
Spermatozopsis exsultans	10										520	640	80		
Spondylosium planum															
Staurastrum chaetoceras													5		
Staurastrum sp.										5					5
Tetraedron caudatum				20				5			20	40	40		40
Tetraedron minimum	10	10		80	80				80	80	160	160		10	800
Tetraedron sp.															
Tetrastrum elegans					20				320	320				640	2560
Tetrastrum heterocanthum															
Tetrastrum staurogeniaeforme				40					40	640	160		80	320	
Treubaria triappendiculata				10						160					
TOTAL DENSITY (cells/mL)	102333	310416	148065	625230	389683	19811	97570	77267	215581	325221	200800	272962	204616	606247	578446

APPENDIX F

Quality Assurance/Quality Control

QA/QC Analysis

A number of steps are taken to assure the quality of water chemistry and chlorophyll *a* data being collected. First, field blanks are taken into the field during water quality sampling. Secondly, Chadwick & Associates, Inc. (C&A) laboratory performs internal QA/QC for each set of samples for each sampling period, including duplicate analysis of all samples, frequent checks against known standards, and frequent calibration of equipment. Lastly, duplicate aliquots are sent to an independent laboratory (University of Colorado [CU]) for analysis. Chlorophyll *a* analysis is conducted by C&A aquatic biological laboratory.

Data quality for total phosphorus (TP), total dissolved phosphorus (TDP), soluble reactive phosphorus (SRP, measured as orthophosphate), nitrate-nitrite, and ammonia for C&A and CU laboratories were compared using a simple, least squares regression analysis. To determine if the laboratories are in agreement on the data, the regression must meet the following criteria:

1. The linear regression must represent a significant relationship ($p \leq 0.05$),
2. The regressions should have a slope at or near 1, and
3. The regression should explain the majority of the observed variance (i.e., $R^2 \geq 0.50$).

In cases when one or more of the criteria are not met, the data do not meet the independent QA/QC and only the CU data would be used.

<u>2005</u>

Comparison of data collected during the 2005 field season shows good agreement between C&A and CU for TP, TDP, SRP, nitrate-nitrite, and ammonia (Table F-1). Regression slopes were all significantly different ($p \leq 0.05$) from zero, with slope values ranging from 0.89 to 1.29. Values for R^2 ranged from 0.55 to 0.99. Because of the close correlation between the results from the two labs, values from both labs were averaged. C&A and CU found most values for nitrate-nitrite to be below the analytical detection limit (5 µg/L). This demonstrates good agreement between labs, but prevented the development of a statistical regression. Data from C&A and CU laboratories were compared to detect outliers (Hintze 2001). Outliers were detected (RStudent >2) for SSR on August 3 and 23, TDP on July 20, total phosphorus on June 7, and ammonia on November 8 were omitted from least regression analysis.

TABLE F-1: Summary statistics from comparison between Chadwick & Associates, Inc. laboratories and University of Colorado laboratories for phosphorus and nitrogen species for 2005. ND = no difference; all values were below analytical detection limits.

	p	Slope	R^2	QA/QC Criteria Met
Total Phosphorus	<0.001	1.29	0.90	Yes
Total Dissolved Phosphorus	<0.001	0.95	0.99	Yes
Soluble Reactive Phosphorus (Orthophosphate)	<0.001	0.89	0.99	Yes
Nitrate-Nitrite	n/a	n/a	n/a	n/a
Ammonia	<0.01	0.89	0.55	Yes

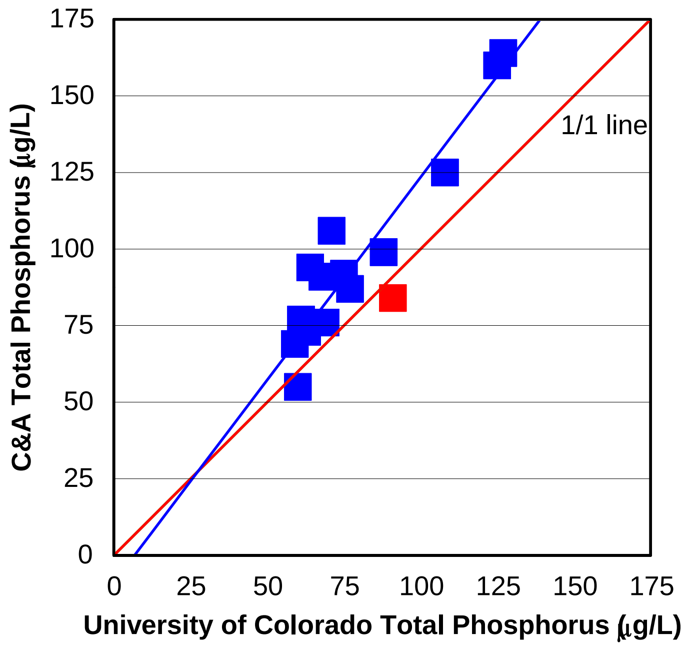


FIGURE F-1: Relationship between Chadwick & Associates, Inc. laboratory total phosphorus and University of Colorado total phosphorus for 2005. Red = outlier omitted for regression analysis.

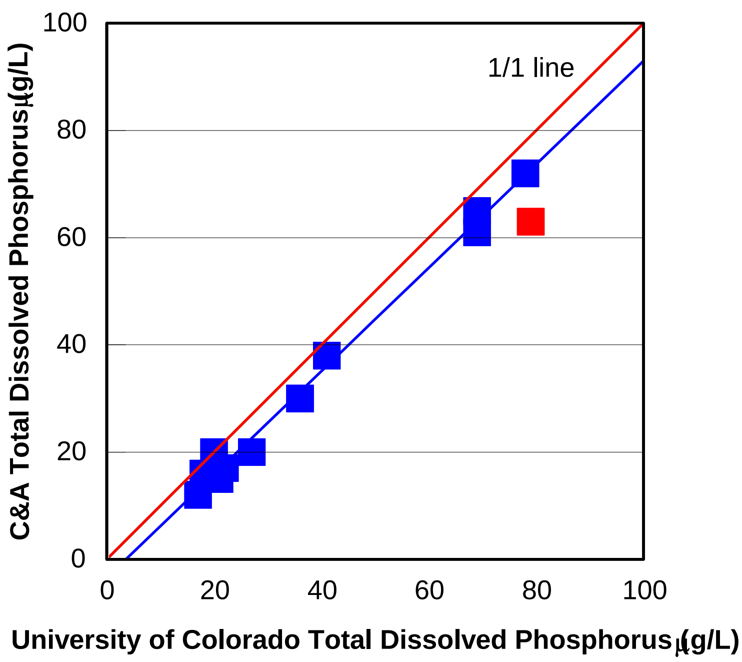


FIGURE F-2: Relationship between Chadwick & Associates, Inc. laboratory total dissolved phosphorus and University of Colorado total dissolved phosphorus for 2005. Red = outlier omitted for regression analysis.

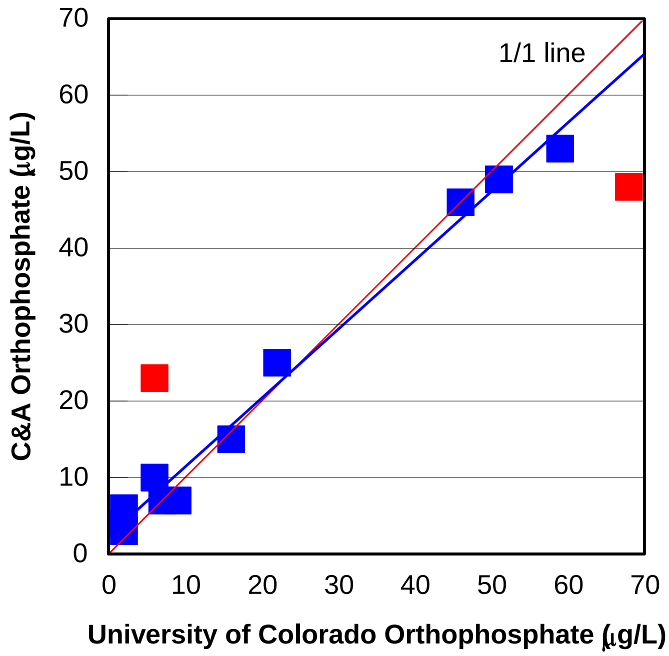


FIGURE F-3: Relationship between Chadwick & Associates, Inc. laboratory orthophosphate and University of Colorado orthophosphate for 2005. Red = outlier omitted for regression analysis.

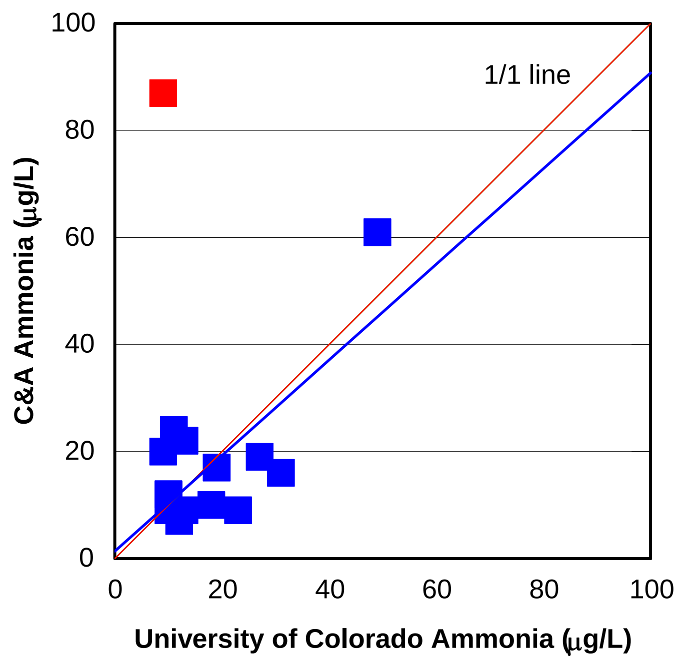


FIGURE F-4: Relationship between Chadwick & Associates, Inc. laboratory ammonia and University of Colorado ammonia for 2005. Red = outlier omitted for regression analysis.