Clear Creek / Standley Lake Watershed Agreement

2016 Annual Report

September 1, 2017

Clear Creek Watershed Annual Report – 2016

September 1, 2017

Submitted to the Water Quality Control Commission by:

Black Hawk/Central City Sanitation District
Central Clear Creek Sanitation District
Church Ditch Water Authority
City of Arvada
City of Black Hawk
City of Golden
City of Idaho Springs
City of Northglenn
City of Thornton
City of Westminster
Clear Creek County
Clear Creek Skiing Corporation
Clear Creek Watershed Foundation
Climax Molybdenum Company/Henderson Operations
Colorado Department of Transportation
Farmers' High Line Canal and Reservoir Company
Farmers' Reservoir and Irrigation Company
Molson Coors Brewing Company
Gilpin County
Jefferson County
St. Mary's Glacier Water and Sanitation District
Town of Empire
Town of Georgetown
Town of Silver Plume
Upper Clear Creek Watershed Association

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List of Acronyms and Abbreviations

AF – Acre Feet

ANS – Aquatic Nuisance Species

AS – Autosampler

BHCCSD – Black Hawk / Central City Sanitation District

BMP – Best Management Practice

BNR – Biological Nutrient Removal

CC05 – Clear Creek Sampling Station: Clear Creek at Bakerville

CC26 – Clear Creek Sampling Station: Clear Creek at Lawson Gage

CC40 – Clear Creek Sampling Station: Clear Creek near the junction of US-6 and I-70

CC60 – Clear Creek Sampling Station: Clear Creek at Church Ditch Headgate

CCAS26 – Clear Creek Autosampler Station: Clear Creek at Lawson Gage

CC59 – Clear Creek Autosampler Station: Clear Creek 2 Miles West of Highway 58/US6 in Golden. Stormwater-Only Location Operated by City of Golden

CCAS59 – Clear Creek Autosampler Station: Clear Creek 2 Miles West of Highway 58/US6 in Golden

CCWF – Clear Creek Watershed Foundation

CDOT – Colorado Department of Transportation

CDPHE – Colorado Department of Public Health and Environment

CDWA – Church Ditch Water Authority

CFS –Cubic Feet per Second

Church – Church Ditch

Croke – Croke Canal

CY –Cubic Yard

DO – Dissolved Oxygen

EWM – Eurasian watermilfoil

fDOM – Fluorescent Dissolved Organic Matter

FHL – Farmers' High Line Canal

FRICO – Farmers' Reservoir and Irrigation Company

FT – Feet

IGA –Intergovernmental Agreement

I-70 – U.S. Interstate 70

KDPL – Kinnear Ditch Pipeline

LBS – Pounds

MGD – Millions of Gallons per Day

MS4 – Municipal Separate Storm Sewer System

N/A – Not Available

ORP – Oxidation/Reduction Potential

OWTS – Onsite Wastewater Treatment System

Reg. – Regulation

SL10 – Standley Lake Sampling Location Near Water Treatment Plant Intake

TIN – Total Inorganic Nitrogen

TN – Total Nitrogen

TP – Total Phosphorus

TSS – Total Suspended Solids

UCC – Upper Clear Creek

UCCWA – Upper Clear Creek Watershed Association

USGS – United States Geological Survey

UV – Ultraviolet

WQCC – Water Quality Control Commission

WWTF – Wastewater Treatment Facility

Executive Summary

ES-1. Introduction

Standley Lake is an off-channel, municipal and agricultural reservoir located in Jefferson County. This 43,000 acre-foot reservoir is a direct-use drinking water supply for over 300,000 consumers in the downstream cities of Northglenn, Thornton, and Westminster. The reservoir also provides water to farms located in Adams and Weld counties, as well as recreational opportunities. The Standley Lake watershed consists of nearly 400 square miles of the upper Clear Creek watershed (the Upper Basin), small direct drainage areas to delivery canals (the Canal Zone), and the lake's relatively small direct watershed. Figure ES-1 shows Standley Lake, the Upper Basin, and the Canal Zone.

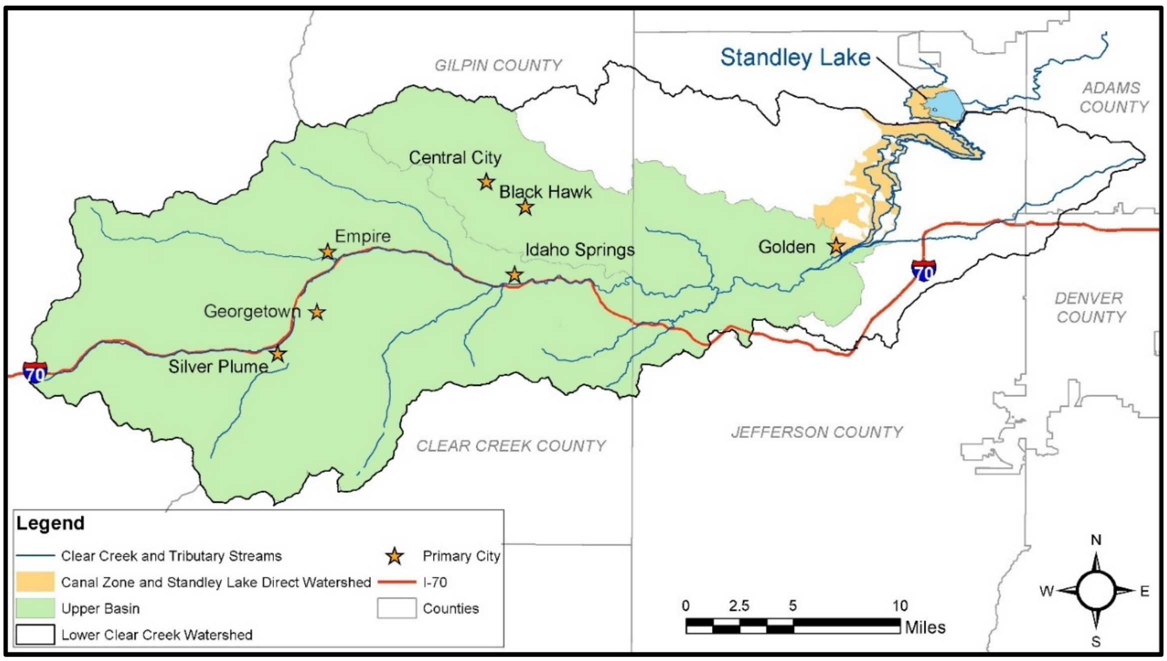

Figure ES-1. Standley Lake and Its Watershed

Water quality in the Upper Basin is affected by a variety of sources. The region contains seven domestic wastewater treatment facilities (WWTFs) which serve the local population and resorts and two non-domestic WWTFs. Additionally, the Upper Basin contains operating and abandoned mines and receives water from trans-basin diversions. Water quality in the Upper Basin may also be impacted by nonpoint sources of pollution, including numerous onsite wastewater treatment systems (septic systems, OWTS), application of roadway deicers and traction sands, and residential and commercial stormwater runoff.

In 1993, the Clear Creek/Standley Lake Watershed Agreement (1993 Agreement) was signed to address certain water-quality issues and concerns within the Clear Creek watershed. The focus of the 1993 Agreement is water quality as it affects Standley Lake. In accordance with the annual reporting obligations set forth in the 1993 Agreement, this report presents an overview of activities protective of water quality. This includes monitoring, maintenance, management, education and other activities. This information is supported by a summary of observed 2016 water quality in: WWTF effluent, Clear Creek, the Canal Zone, and Standley Lake. This water-quality data is evaluated in the context of the previous five years of record.

ES-2. Monitoring Activities

Water-quality samples are collected in Standley Lake and at numerous stations throughout the watershed to monitor the concentrations of nutrients, select metals, and other key constituents. Gaging stations are located across the watershed and provide measurements of flows. The combination of these measurements allows the estimation of loading of in Clear Creek and to (and from) Standley Lake.

Water quality monitoring in the Upper Basin and Canal Zone includes the collection of grab samples and the use of autosamplers for the collection of composite samples. The monitoring program has a strong emphasis on the collection of composite samples instead of grab samples. Relative to grab samples, composite samples provide a more complete picture of water quality over the course of the sampling period. These composite samples are of two types: ambient and event. Ambient samples are collected on a periodic basis over a 24-hour period. Events samples are typically storm events. However, in the Canal Zone they also include first-flush samples; which are collected during the initiation of water delivery to Standley Lake. In 2016, an additional sampling station was installed at the CC59 location. This new station (CCAS59) will allow for the continued collection of ambient samples at this location, and allow the City of Golden to collect storm-driven event samples at the original station (CC59). Table ES-1 summarizes sample counts in 2016 by sample type and sub-region of the watershed.

Table ES-1. Summary of 2016 Water-Quality Sample Collection

Sub-Region	Type of Sample	Number of Locations	Total Number of Samples Collected
Upper Basin	Grab Samples	17	47
	Ambient Composites	4	23
	Storm-triggered Composites	1	4
Canal Zone	Grab Samples	10	60
	Ambient Composites	2	14
	Storm-triggered Composites	0	0
	First Flush Composites	4	4
Standley Lake	Grab Samples	1 (3 depths)	60
	Vertical Profiles	1	Four Times Daily When Ice-Free, Every Meter

Standley Lake is monitored throughout the year when ice is off the lake. Daily lake profiles are taken, and bi-monthly grab samples are also collected at three depths (at the surface, in the photic zone, and in the hypolimnion). Table ES-1 provides a summary of water-quality sampling in Standley Lake in 2016.

ES-3. Activities and Accomplishments

This section provides highlights of the efforts to manage, enhance, and protect water quality in both the Clear Creek watershed and in Standley Lake. These activities were completed by a variety of interested groups and entities. The following groups of activities are described:

- Canal Maintenance,
- Wastewater Treatment Facilities,
- Illicit Discharges and Emergency Response,
- Nonpoint Source Control and Stormwater Management,
- Public Education, Outreach, and Partnerships, and
- Other Activities.

This section provides a selection of these efforts in 2016. This is not a complete list; additional activities and greater detail are presented in the main report.

Canal Maintenance

- The Church Ditch Water Authority completed the construction of a new headworks structure with improved operational capabilities.
- Maintenance activities were performed on all canals to improve flow and protect water quality. These included vegetation removal, bank repair and shaping, and sediment removal.
- The City of Arvada continued to collaborate with partners to repair and replace diversion control structures and erosion control systems affected by the 2013 flooding. These partners included Jefferson County, the Colorado Department of Transportation, Urban Drainage, and ditch operation companies.

Wastewater Treatment Facilities

- WWTFs continued to sample for, and report, nutrient concentrations in effluent to comply with the requirements of the Colorado Department of Public Health and Environment (CDPHE) Regulation 85.
- The City of Idaho Springs completed installation of an ultraviolet (UV) disinfection system at the city's WWTF.

Illicit Discharges and Emergency Response

- The City of Golden responded to 54 reports of illicit discharges or potential discharges to the storm sewer system in 2016. This resulted in eight written warnings and 16 verbal warnings being issued. In three cases, clean-up costs were levied.
- The Illicit Discharge Detection and Elimination Program of the City of Arvada issued eight written Notices of Violation. The city's vacuum trucks were often used to conduct clean-ups.
- Jefferson County inspected nine reports of illicit discharges, each of which resulted in enforcement actions.
- The Clear Creek Office of Emergency Management continued to maintain and update the Code Red Emergency Call-Down System to promptly and effectively notify downstream users of Clear Creek water of any potential contamination from an upstream source.
- In 2016, the dispatch centers of Clear Creek County, the City of Golden, and Jefferson County launched nine calls for incidents within their respective jurisdictions that impacted Clear Creek.

Nonpoint Source Control and Stormwater Management

- The City of Golden administered 33 stormwater-quality construction permits and conducted 542 erosion and sediment control inspections.
- The Stormwater Maintenance Program of the City of Golden performed 288 inspections resulting in 194 letters sent to land owners requesting maintenance.
- In addition, the City's Stormwater Division inspects and cleans municipal inlets twice per year. Sediment control structures in the stormwater conveyance system captured a total of 403 cubic yards of debris.
- The MS4 permit program of Jefferson County includes construction site runoff control, post-construction site runoff control, and pollution prevention/good housekeeping. Each control program is supplemented by a corresponding inspection program.
- The City of Arvada completed 1,473 erosion and sediment control inspections on 146 active construction sites.
- The Stormwater Program of the City of Arvada inspected 58 permanent BMPs. In addition, 13 new BMPs were added to the 194 previously installed.
- The Wastewater Division of the City of Arvada inspected 3,036 inlets and manholes and performed maintenance and cleaning on 818. In addition, 8,064 feet of storm sewer pipe were cleaned, removing 230,580 pounds of debris.
- Clear Creek County issued six permits for floodplain development and finalized four. In addition, 13 permits were issued for BMPs and five finalized. These actions are part of the County's efforts to control the release of sediment to Clear Creek.
- Clear Creek County implemented the final phase of new regulations for onsite water treatment systems (septic systems). Under the new regulations, operating permits are required for systems that are designed to provide a higher level of treatment. In 2016, seven

operating permits, 19 standard treatment permits, 10 repair or alteration permits, and 115 use permits were issued.

- The Colorado Department of Transportation (CDOT) continued work on projects in the watershed. A major focus of CDOT projects is the control and capture of sediment from highway maintenance activities. Projects included substantial completion of the eastbound Peak Period Shoulder Lane Project on I-70 and completion of the US 6 Acceleration Lane Project.
- The Clear Creek Watershed Foundation (CCWF) completed the Middle North Empire Creek Restoration Project in 2016. This was the second of three phases to address sources of contamination to North Empire Creek. North Empire Creek drains into the West Fork of Clear Creek near the Town of Empire.

Public Education, Outreach, and Partnerships

- The Clear Creek Watershed Foundation organized and hosted the eighth annual Clear Creek Watershed Festival in September at a creek-side venue in Idaho Springs. The Festival provides the opportunity for watershed stakeholders to share their message and educate participants.
- The City of Golden, Jefferson County, and the City of Arvada all continued efforts to engage and educate the public. An important aspect of this is attending or hosting public events and festivals.
- The Rooney Road Recycling Center was supported by both Jefferson County and the City of Golden.
- The Clear Creek County Transfer Station and Recycling Center continues to support efforts to protect the watershed. These activities include household hazardous waste collection, participation in the Paint Care Program, and providing trash disposal and recycling opportunities.
- The City of Arvada and the Arvada Police Department collected 2,875 pounds of medications during a drug take-back event on April 7^{th}.
- The City of Idaho Springs Police Department, in cooperation with the Clear Creek Sheriff's Department, held its first ever drug collection event.

Other Activities

- Idaho Springs and Black Hawk worked to develop Source Water Protection Plans. The purpose of these plans is to prevent contamination of their drinking water supply.
- The monitoring and management of aquatic invasive species in Standley Lake continued. The densities of Eurasian Watermilfoil remained low in 2016. Sampling demonstrated that Standley Lake continues to be free of zebra and quagga mussels.

ES-4. Observed Flow and Water Quality

To assess water-quality conditions in 2016 in Clear Creek and Standley Lake, records of flow and water quality were reviewed and compared to the previous five years of record (2011-2015). For Clear Creek and the canals, the water-quality analyses focused on total suspended solids (TSS), total nitrogen (TN), and total phosphorus (TP). For Standley Lake the assessment also included chlorophyll *a*, Secchi depth, and dissolved oxygen. In the Upper Clear Creek Basin, data analyses focused on results from two locations: an upstream location at Lawson (stations CCAS26/CC26); and a downstream location near the canal diversion points to Standley Lake at stations CCAS59/CC60. Water-quality analyses of Standley Lake focused on results from sampling location SL10, near the deepest part of the lake. Highlights of findings from these analyses are presented below.

Discharge

Annual hydrographs for Upper Basin location (CC26) exhibited twin peaks in flows in 2016 (Figure ES-2); with higher peak in early June followed by a secondary peak in late June. The mid-June decrease appears to have been driven by a period of low temperature in the upper portion of the basin; the low temperatures would have decreased the rate of snow melt. The overall pattern—an initial rise in April followed by rapidly increasing flows in late-May, coinciding with snowmelt runoff, was consistent with past years. The annual hydrograph at the lower location (CC60) followed the same basic pattern. Total annual flows at the upper station (CC26) were slightly (-14%) below the 2011-2015 average. Annual flows at the lower station (CC60) of 146,029 AF were also lower (-9%) than the 2011-2015 average of 160,691 AF. Compared to the longer-term average however, flows at CC60 were slightly (5%) above the average (1975-2015, 139,334 AF). This reflects a pattern of higher than normal flows in recent years.

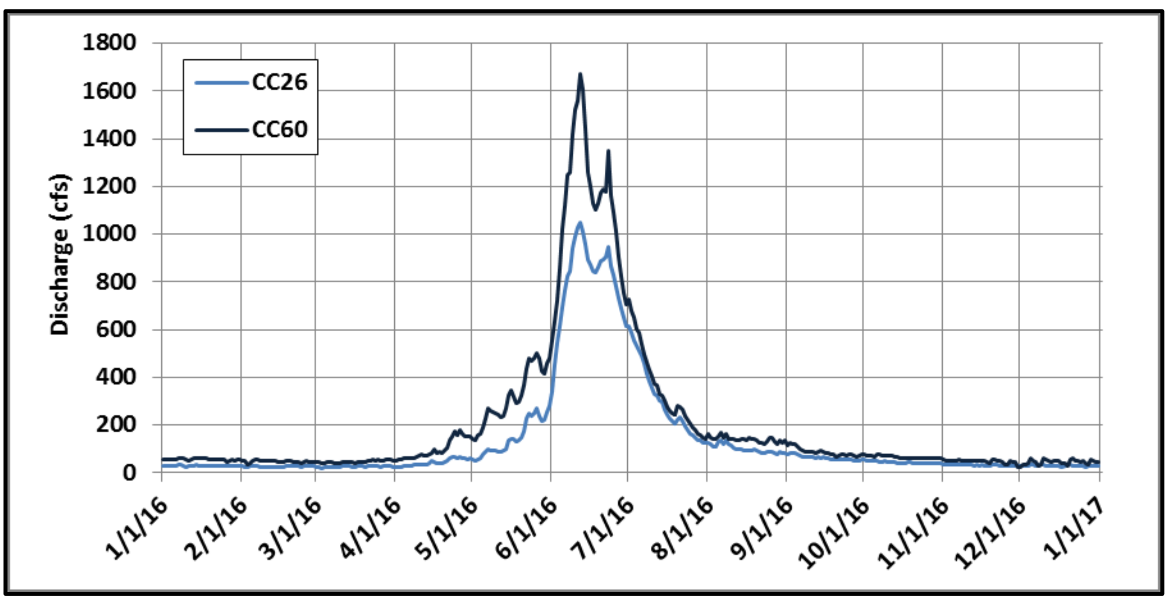

Figure ES-2. 2016 Clear Creek Hydrographs (CC26, CC60)

WWTF Effluent Concentrations

The WWTFs in the Clear Creek watershed continued efforts in 2016 to reduce nutrient discharges. In 2012, the Water Quality Control Commission (WQCC) adopted Regulation 85, the Nutrients Management Control Regulation, which established numeric standards for nutrient concentrations in WWTF effluent. WWTFs with a design capacity of less than or equal to 1.0 MGD, or WWTFs owned by a disadvantaged community are not required to meet the discharge limits set in the regulation. Of the nine WWTFs in the watershed, only Black Hawk / Central City (with a design hydraulic capacity of 2.0 MGD) is subject to effluent limits under Regulation 85. However, all seven of the domestic WWTF are subject to monitoring requirements under this regulation. A summary of 2016 TP and TN effluent data for these WWTFs is presented in Table ES-2.

Table ES-2. Summary of Total Phosphorus and Total Nitrogen Concentrations in Wastewater Treatment Facility Effluent in 2016 (Grab Samples)

Location	WWTF	Flow (MGD)	Total Phosphorus (mg/L)			Total Nitrogen (mg/L)		
			Min	Max	Average	Min	Max	Average
Upstream ↓ Downstream	**Loveland Ski Area**	0.009	0.19	7.37	2.10	1.26	84.0	31.1
	Georgetown	0.40	0.01	0.56	0.16	1.90	16.1	7.72
	Empire	0.03	1.95	2.56	2.16	5.44	10.5	8.04
	Central Clear Creek	0.041	1.09	4.65	1.88	20.6	45.2	31.2
	St. Mary's	0.009	0.15	1.89	0.73	2.82	19.2	12.1
	Idaho Springs	0.299	0.24	1.36	0.67	1.32	4.86	2.83
	Black Hawk / Central City	0.357	0.04	0.15	0.07	4.10	12.0	6.71

Total Suspended Solids and Nutrients in Clear Creek

Concentrations of TSS were higher in the lower part of the basin relative to the upper portion (Figure ES-3). This is consistent with observations from previous years and reflects expected patterns in loading as a result of changes in land use over the watershed. The range of TSS concentrations at both CCAS59/60 and CC26 were consistent with those observed in previous years. However, peak springtime TSS concentrations and average concentrations of TSS were lower in 2016 at both stations. As a result, TSS loads in 2016 were lower than all but 2012 for the five-year comparison period. Both the upstream and downstream stations demonstrated these decreases in TSS loads. It is possible that the decrease in loads (driven by lower concentrations) is a result of the timing of sample collection. The late-June samples were collected between the peaks observed in the hydrograph (Figure ES-2). This decrease in flows may have been related to a decrease in sediment transport.

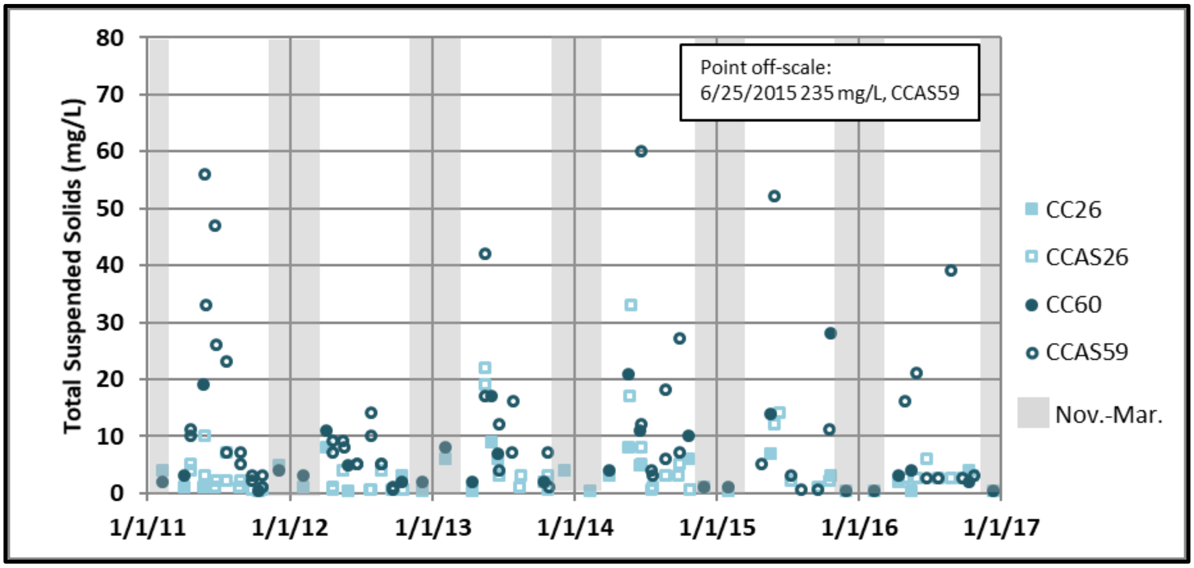

Figure ES-3. Total Suspended Solids Concentrations (Non-Event) in the Upper Basin, 2011-2016

Typically TP concentrations at both stations show a substantial increase during the snowmelt period. However in 2016, as can be seen in Figure ES-4, this pattern was not as strong as observed in past years. As discussed for TSS, this may be explained by the timing of sample collection. Conceptually, TP concentrations are closely linked with TSS due to particle-associated transport. The similarity in concentration patterns for TSS and TP in 2016 are consistent with this understanding. The loads of TP in 2016 were below the 2011-2016 average; the only year in the 2011-2016 period with lower estimated loading was 2012.

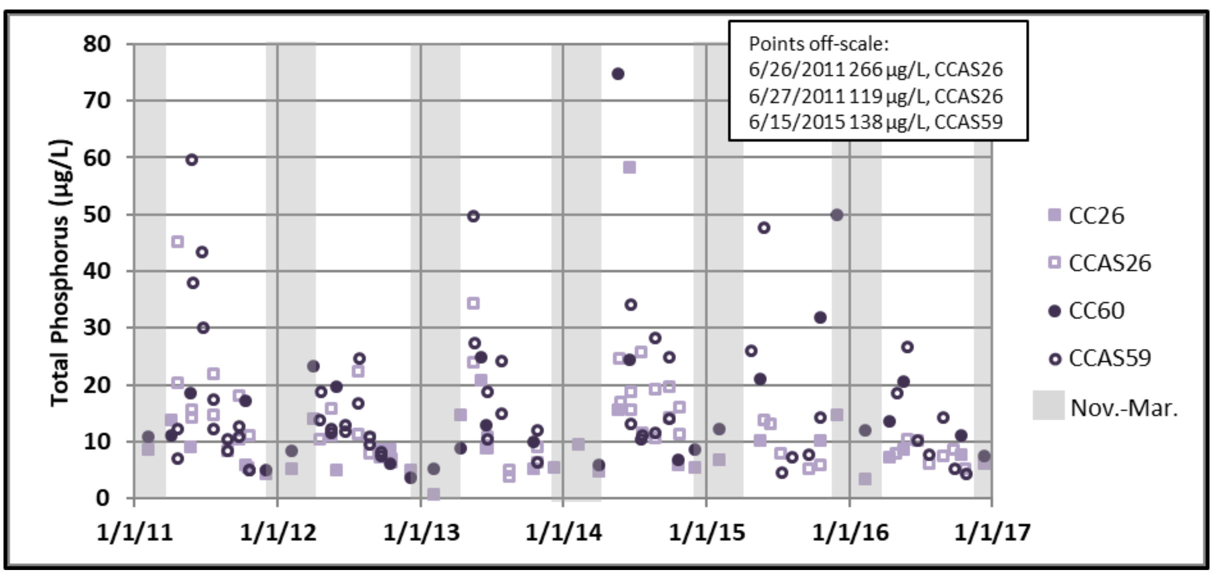

Figure ES-4. Total Phosphorus Concentrations (Non-Event) in the Upper Basin, 2011-2016

A seasonal pattern of lower TN concentrations in summer and higher concentrations during the winter low-flow period (typically November to March) was observed in the 2016. This pattern in ambient TN concentration data is consistent with previous years (Figure ES-5). This pattern is driven by the dilution of sources during periods of higher flow. The range of TN concentrations was generally consistent with those observed in past years. Monthly averages were somewhat lower (-3 to -26% lower) than recent years. In the Upper Basin (CC26) there appears to be a pattern of sustained lower TN concentrations for the post-2011 period when compared to the 2005-2011 period. It is likely that this decrease is the integrated result of facility upgrades at the Georgetown WWTF, process improvements at other facilities, and the range of other watershed activities undertaken to improve water quality in the Clear Creek basin. Loading of TN was lower in 2016 relative to recent years. This was driven by the combination of slightly lower flows and slightly lower concentrations.

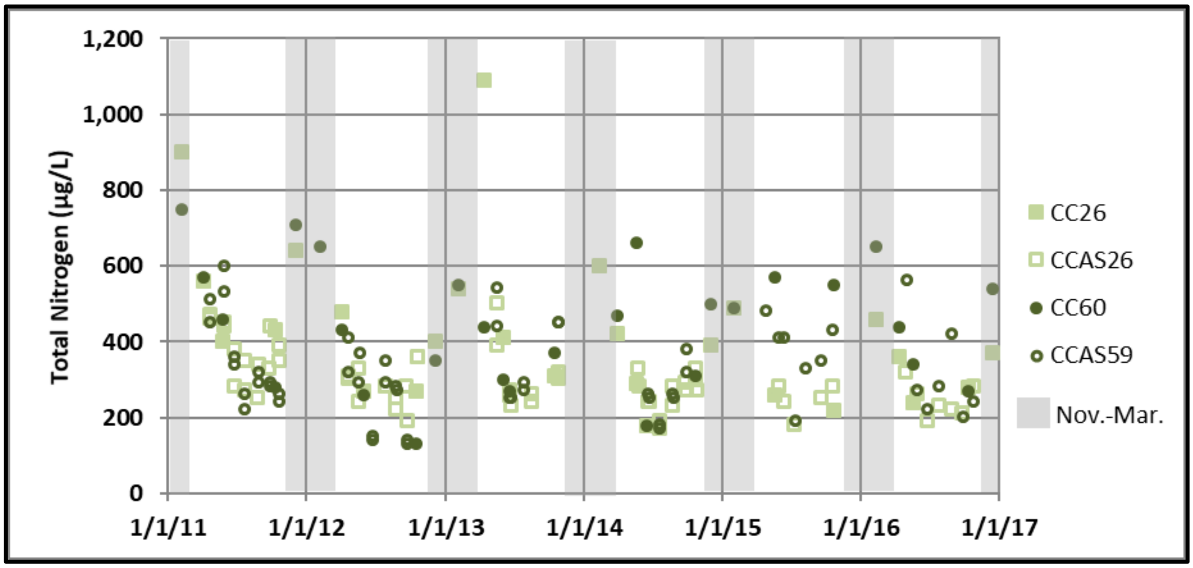

Figure ES-5. Total Nitrogen Concentrations (Non-Event) in the Upper Basin, 2011-2016

Inflow and Loading into Standley Lake

The total volumes of outflow from Standley Lake in 2016 were very close to the 2011-2015 average. In contrast, inflow to Standley Lake was below average in 2016. Inflows and outflows from Standley lake are shown for the 2011-2016 period in Figure ES-6.

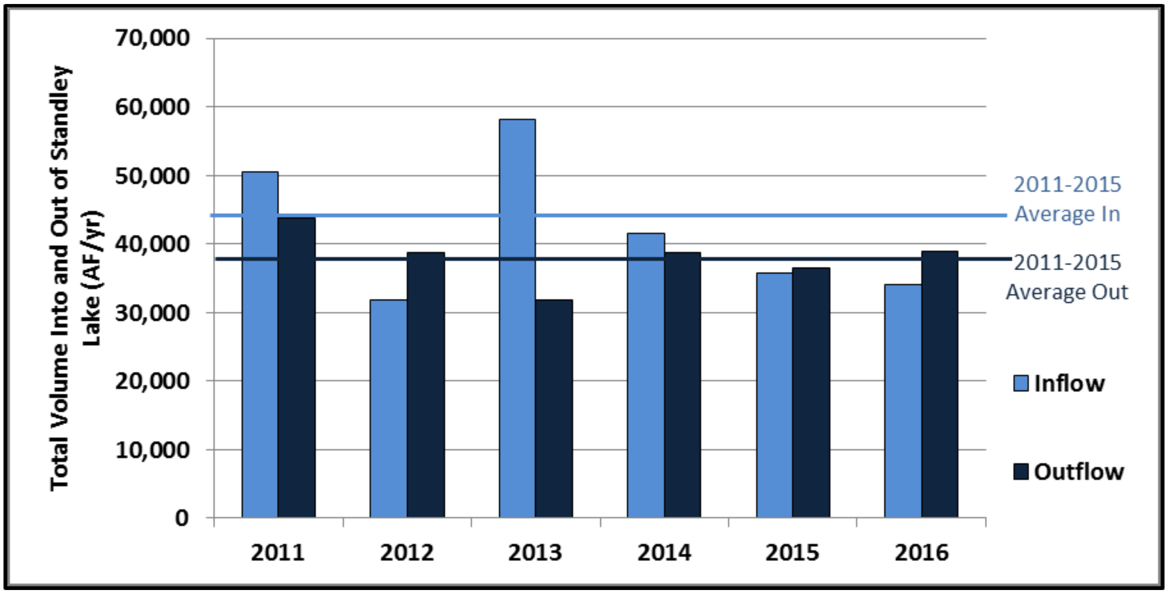

Figure ES-6. Total Annual Inflow and Outflow for Standley Lake, 2011-2016

A net decrease in contents in Standley Lake was observed in 2016. Daily contents for Standley Lake are presented in Figure ES-7 for the 2011-2016 period. At the beginning of 2016, lake contents were nearly as high as the two previous years. In the spring, the lake filled to near capacity where it remained for May, June, and much of July. Following this, lake contents decreased to levels not seen since 2012.

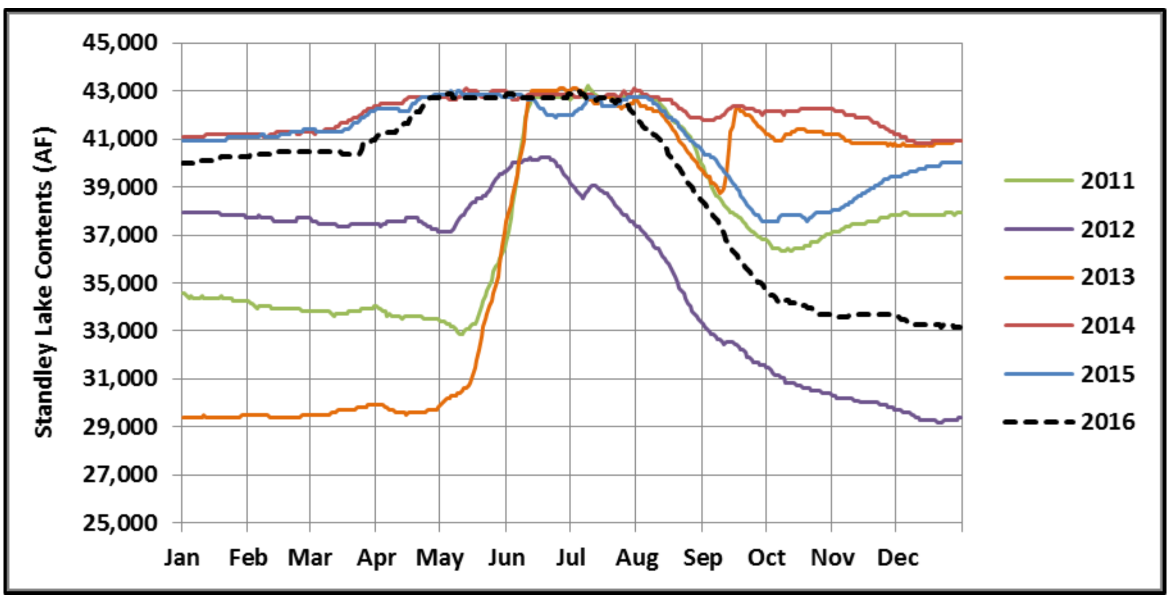

Figure ES-7. Standley Lake Contents, 2011-2016

TP loading estimates into and out of Standley Lake based on all ambient (non-storm-event) samples are displayed in Figure ES-8. Non-storm event loading of TP in 2016 was below (-27%) the average of the past five years. This is primarily driven by a decrease in loading from the Farmers' Highline Canal.

As with previous years, loadings of TP into the lake were greater than outflow, indicating some level of phosphorus retention.

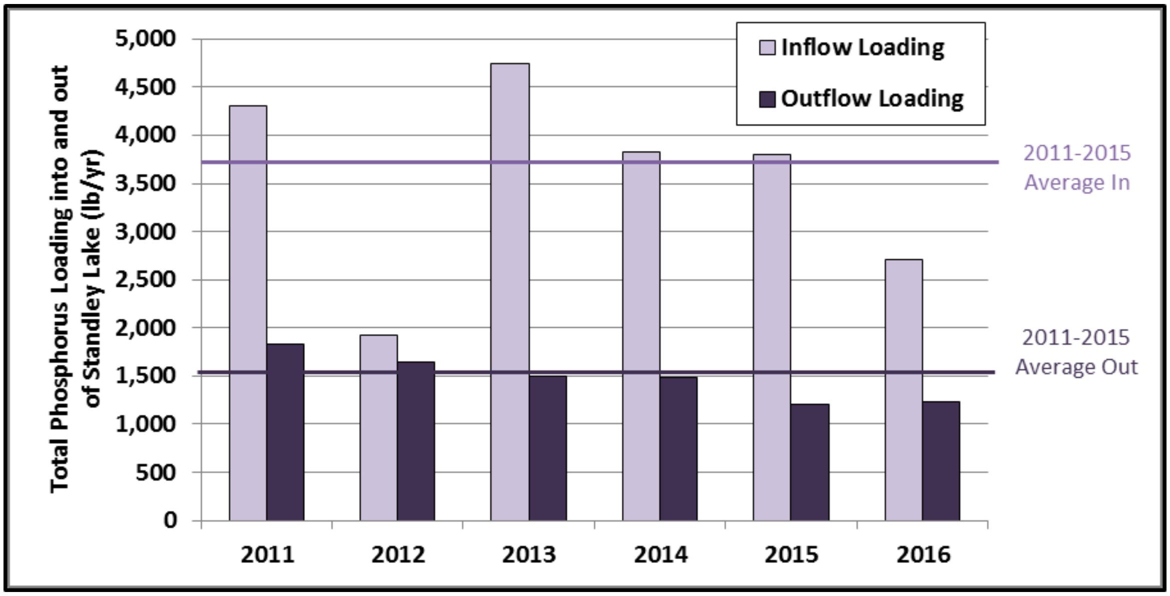

Figure ES-8. Total Phosphorus Loading into and out of Standley Lake, 2011-2016

TN loading, based on ambient samples, into and out of Standley Lake for 2011-2016 is presented in Figure ES-9. The mass of TN entering Standley Lake in 2016 was 15% lower than the average of the previous five years. Outflow of TN in 2016 was similar (4% higher) to the 2011-2015 average. As with previous years, loading into the lake was higher than outflow from the lake. As with TP, this indicates a degree of nutrient retention in the lake.

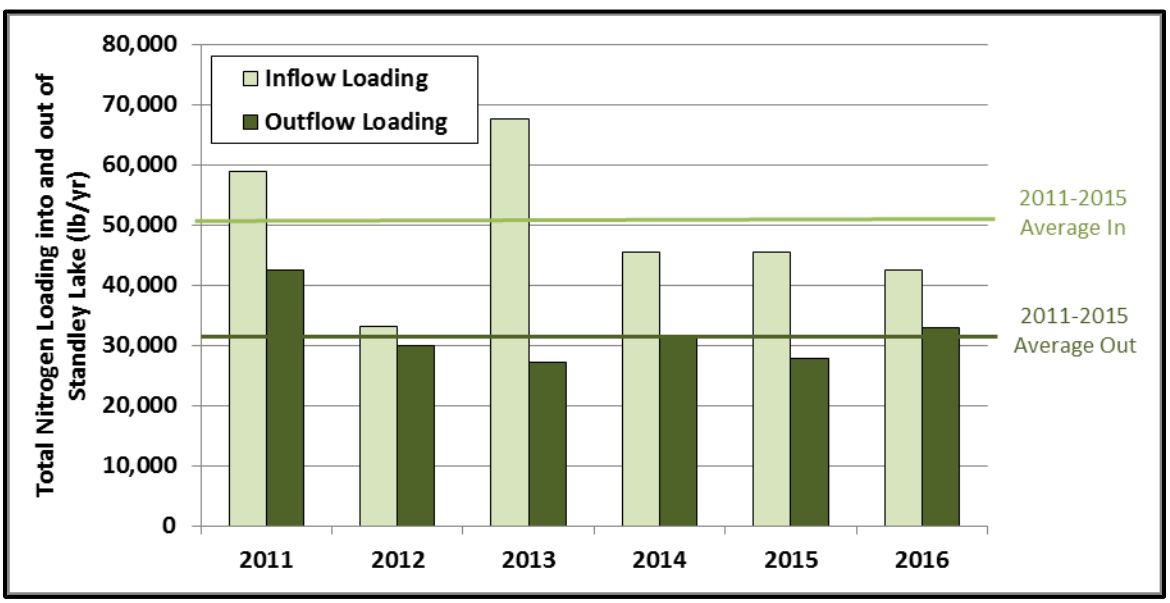

Figure ES-9. Total Nitrogen Loading into and out of Standley Lake, 2011-2016

Water Quality in Standley Lake

Overall, the monitored water-quality parameters indicated that high water quality was maintained in 2016. This observation is consistent with recent years, and a testament to the diverse efforts of stakeholders to maintain high water quality throughout the basin.

Each year, Standley Lake experiences hypoxia (dissolved oxygen concentrations ≤ 2.0 mg/L) in the hypolimnion. This is common for stratified reservoirs in Colorado. Standley Lake had a period of hypoxia of 87 days in 2016. This period was shorter than the 2011-2015 average of 103 days (Figure ES-10).

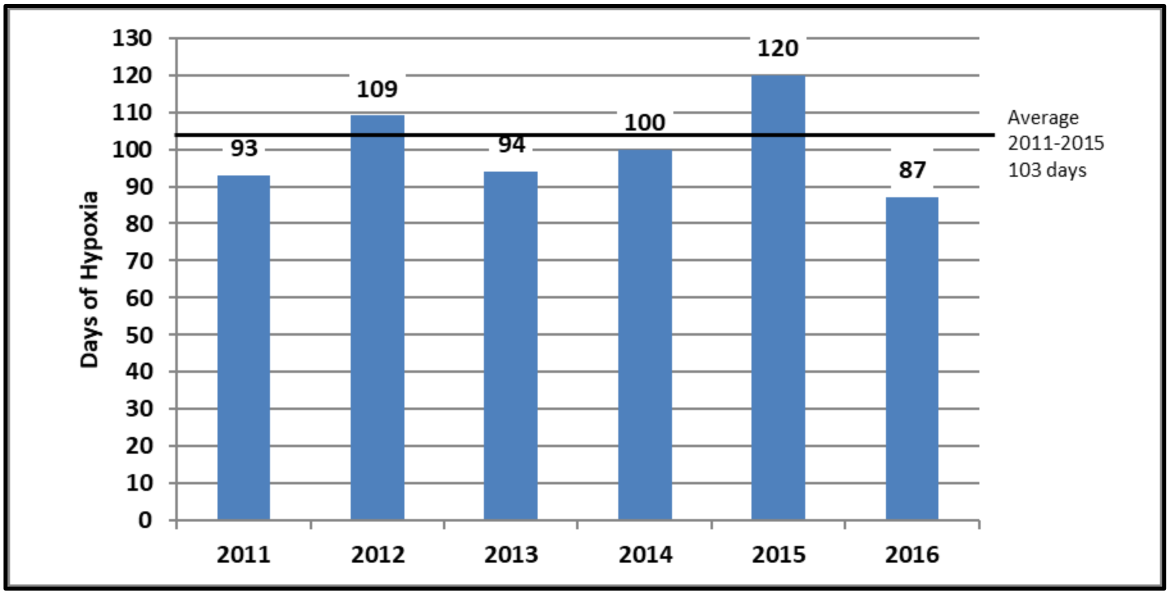

Figure ES-10. Days of Hypoxia (DO < 2.0 mg/L), 2011-2016

The concentrations of TP in the photic zone and the hypolimnion were comparable and relatively consistent for much of the year. This is in contrast to past years, which have shown increases in TP concentrations at the bottom of the reservoir due to internal loading (Figure ES-11). In 2016, higher nitrate concentrations at the bottom of the reservoir later in the summer likely affected redox conditions. Contour plots of oxidation-reduction potential (ORP, Figure ES-12) show that reducing conditions (low ORP) conditions were less prevalent in 2016 when compared to a typical year. Thus, nitrate may have served to inhibit phosphorus releases in 2016, even though oxygen concentrations were very low.

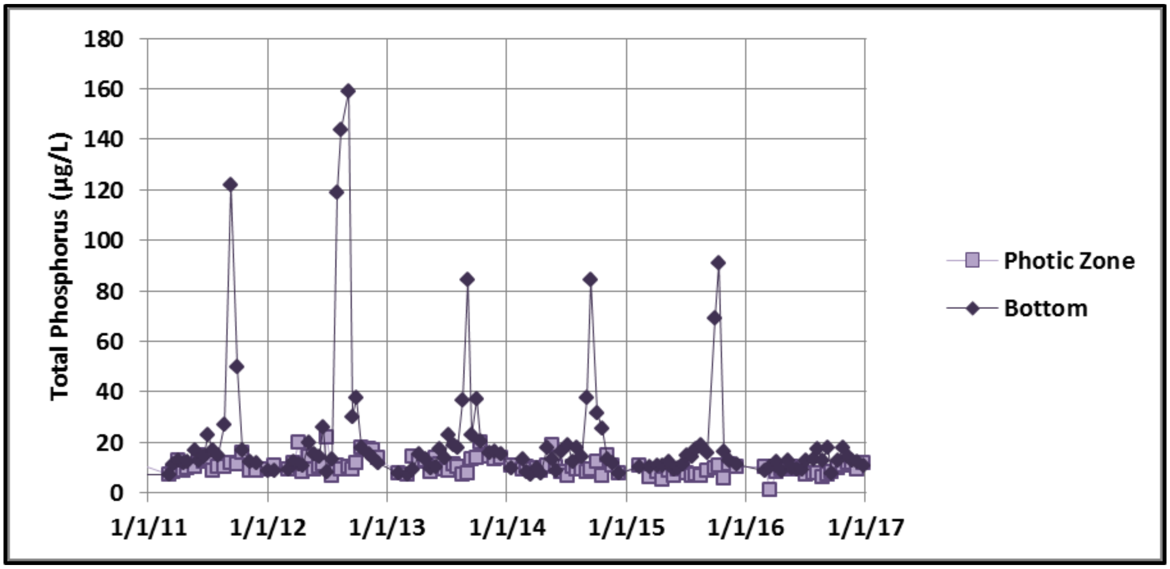

Figure ES-11. Total Phosphorus Concentrations in the Photic Zone and Bottom of Standley Lake, 2011-2016 (Site SL10)

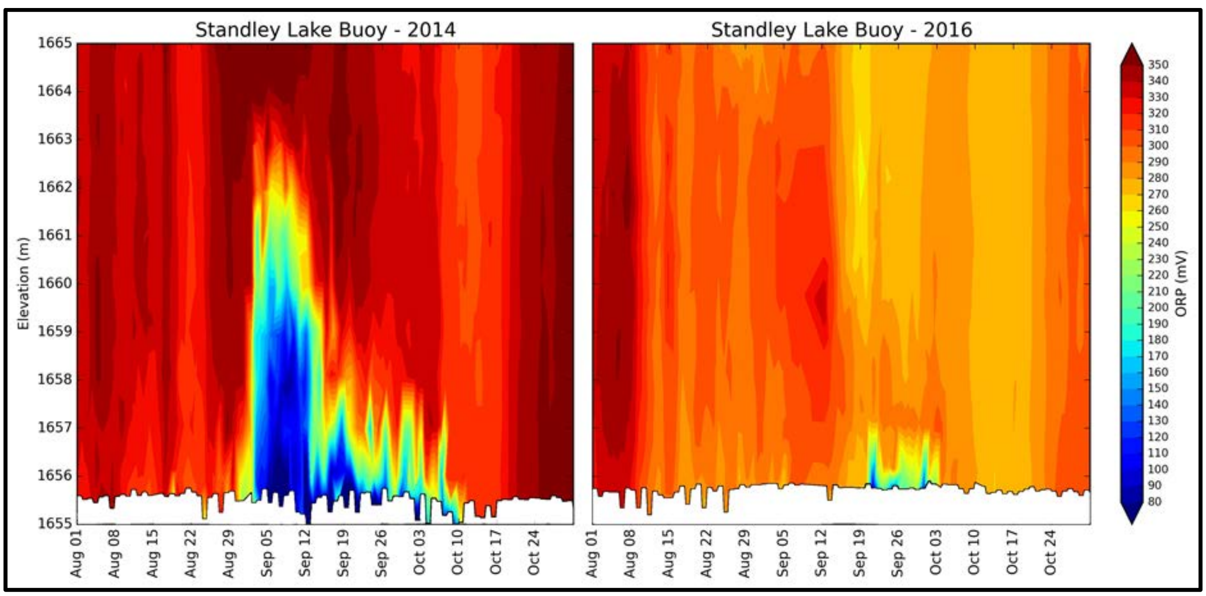

Figure ES-12. Comparison of ORP in the Bottom 10 Meters of Standley Lake; Typical Year (2014) and 2016

Concentrations of TN in the lake for 2011-2016 are shown in Figure ES-13. In contrast to TP, observed concentrations followed patterns consistent with past years. Overall, TN concentration ranges observed in 2016 at the bottom and in the photic zone were comparable to previous years. The 2016 average TN concentrations (341 µg/L hypolimnion, 250 µg/L photic zone) were 13% lower in the hypolimnion and 7% lower in the photic zone when compared with the 2011-2015 annual average concentrations.

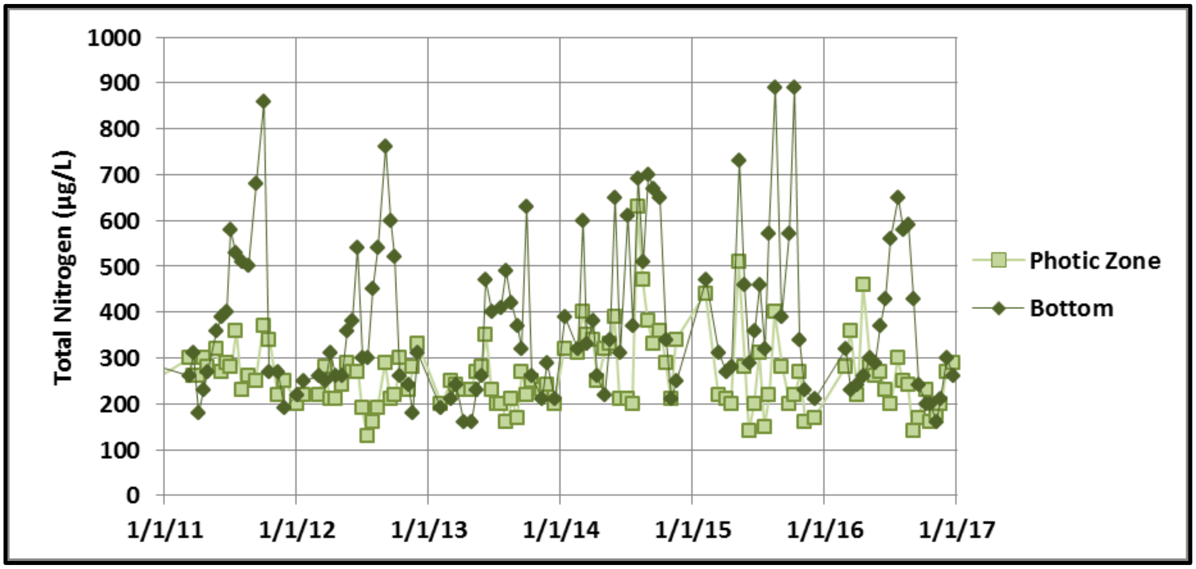

Figure ES-13. Total Nitrogen Concentrations in the Photic Zone and Bottom of Standley Lake, 2011-2016 (Site SL10)

As seen in previous years, chlorophyll *a* concentrations in Standley Lake were low during the summer months, with the peak concentration of 6.6 µg/L observed in October, and a spring peak of 5.8 µg/L observed in late May. The site-specific March through November chlorophyll *a* standard of 4 µg/L was met in 2016 with an average value of 3.2 µg/L. To account for the natural variability in chlorophyll *a* concentrations, the standard is assessed using a concentration of 4.4 µg/L. The 2016 average complies with both the 4.0 µg/L standard and 4.4 µg/L assessment threshold. For the five-year period (2012-2016), each year had a March to November average concentration below 4.0 µg/L (Figure ES-14).

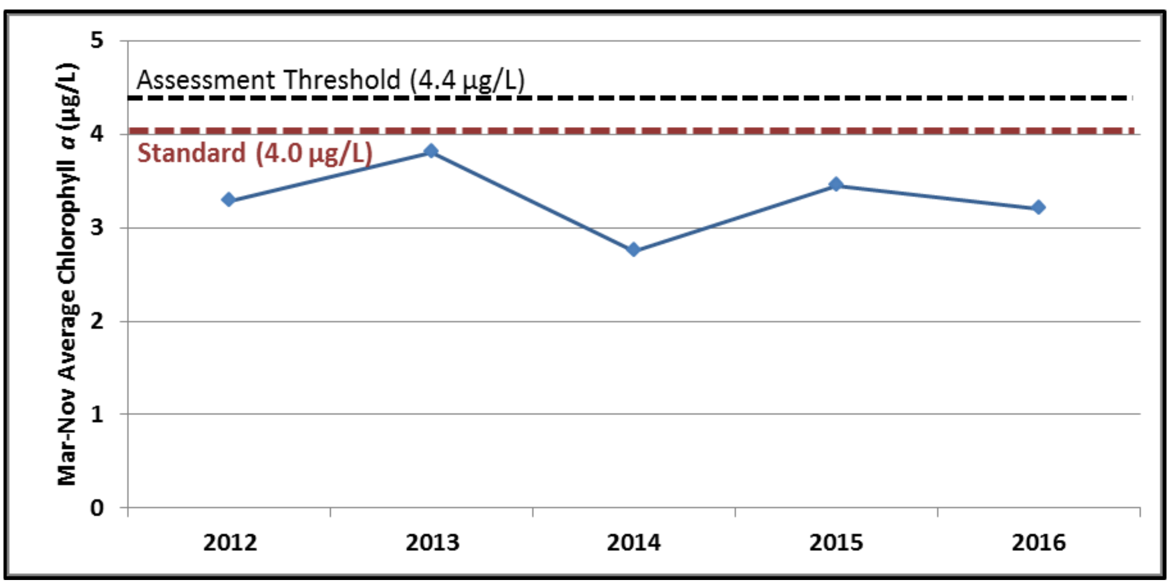

Figure ES-14. Observed Average Chlorophyll *a* Concentrations (Mar-Nov) Compared with the Standard and the Assessment Threshold, 2012-2016 (Photic Zone at Site SL10)

The average clarity in 2016, measured using a Secchi disk, was 3.8 meters (Figure ES-15). The individual Secchi-depth measurements observed in 2016 were consistent with previous years.

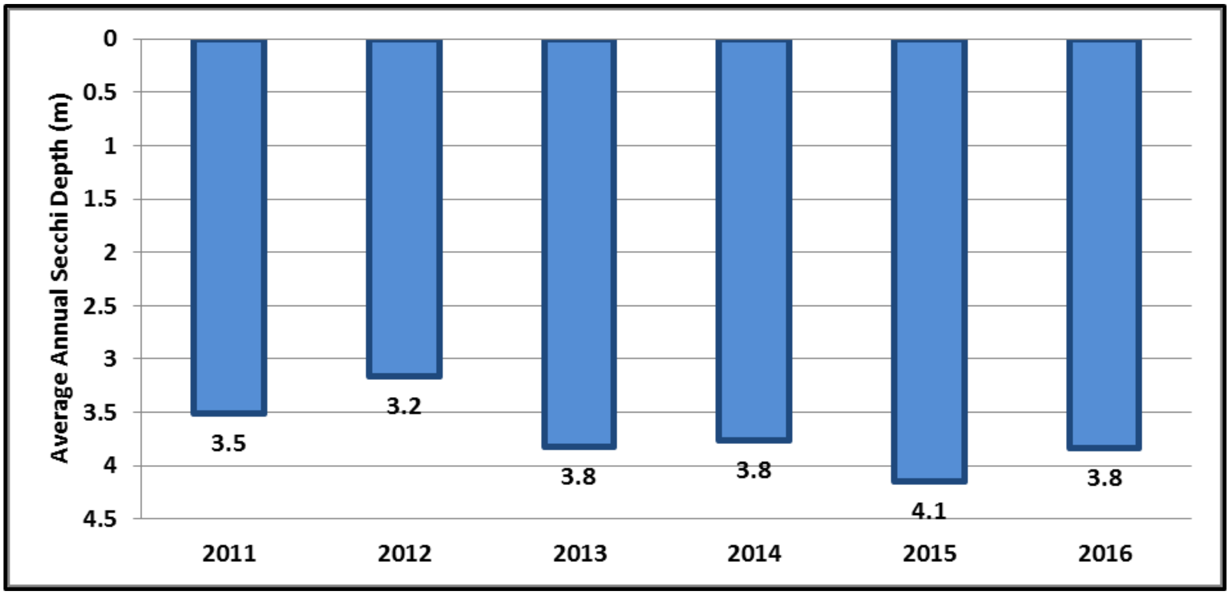

Figure ES-15. Average Annual Secchi Depth in Standley Lake, 2011-2016

These observations demonstrate that good water quality is being maintained in Standley Lake. This, in turn, provides strong evidence of the effectiveness of the efforts to manage, enhance, and protect water quality throughout the Clear Creek and Standley Lake watersheds.

I. Introduction

A. Purpose and Scope of Report

This annual report provides a review of 2016 water-quality efforts in the Clear Creek watershed. In 1993, the Clear Creek/Standley Lake Watershed Agreement (1993 Agreement, Appendix A) was signed by a contingent of governmental agencies and private corporations to address water-quality issues and concerns within the Clear Creek watershed – specifically as they affect the water quality of Standley Lake. This report fulfills the annual reporting obligations set forth in the 1993 Agreement. Water-quality data for 2016 are presented and compared to the recent conditions as represented by the previous five years of data (2011-2015).

B. Organization of the Report

Following this introductory section, this report is organized as follows:

- **Section II. Description of Standley Lake, Its Watershed, and Routine Monitoring** – An overview of the reservoir and its watershed, including maps and monitoring practices.
- **Section III. Activities and Accomplishments** – A summary of 2016 activities related to water-quality management and improvement in the Clear Creek Basin, canals, and Standley Lake.
- **Section IV. Upper Basin Water Flows and Water Quality** – A presentation of data collected from two key locations in the Upper Basin, with a focus on nutrient concentrations and annual loading of total nitrogen, total phosphorus, and total suspended solids.
- **Section V. Canal Zone Flows and Water Quality**—A presentation of flows in the canals that flow into Standley Lake. This section also includes an analysis of changes in total nitrogen, total phosphorus, and total suspended solids concentrations observed across the length of the Farmers' Highline and Croke canals.
- **Section VI. Standley Lake Flows, Contents, and Loading –** A summary of 2016 inflow to Standley Lake, outflow from the lake, and lake storage. This section also includes an analysis of nutrient loading into and out of the lake, with consideration of total nitrogen and total phosphorus loads from each canal.
- **Section VII. Standley Lake Water Quality** - An analysis of lake water quality with a focus on total nitrogen, total phosphorus, chlorophyll *a,* dissolved oxygen, and clarity.
- **Section VIII. Conclusions** – A summary of findings from the report.

In addition, four appendices are included to provide additional background and detailed information:

- Appendix A. Clear Creek / Standley Lake Watershed Agreement;
- Appendix B. Upper Clear Creek / Standley Lake Watershed Water Quality Monitoring Plan;
- Appendix C. Clear Creek, Canal, and Standley Lake Water-Quality Monitoring Data for 2016; and
- Appendix D. Regulation 85 Water-Quality Monitoring Data--2016

II. Description of Standley Lake, Its Watershed, and Routine Monitoring

A broad description of Standley Lake and its watershed is provided in this section. The watershed is comprised of the Upper Basin and the Canal Zone. The Upper Basin is a portion of the larger Clear Creek watershed. The Canal Zone refers to the lands draining either directly to the lake or to the canals which flow into the reservoir. Routine monitoring activities for each area are also summarized.

A. Standley Lake

Standley Lake is an off-channel, municipal and agricultural reservoir located in Jefferson County, Colorado (Figure 1). This reservoir covers approximately 1,200 acres and has a storage capacity of 43,000 acre-feet (AF). It serves as a direct-use drinking water supply for over 300,000 consumers in the cities of Northglenn, Westminster, and Thornton. In addition, the reservoir supports recreational activities and provides water to farms located in Adams and Weld counties. It is owned and operated by the Farmers' Reservoir and Irrigation Company (FRICO).

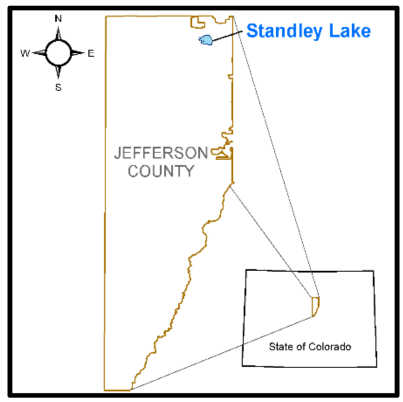

Figure 1. Location of Standley Lake

Through the Standley Lake Monitoring Program, the lake is monitored regularly during the ice-free period. Although the lake is sampled at multiple locations, the focus for this report is the deepest sampling location, SL10 (Figure 2). This location is approximately one-quarter mile south of the municipal supply intakes. Routine monitoring practices for Standley Lake are described in detail in the Upper Clear Creek/Standley Lake Watershed Water Quality Monitoring Program (Appendix B). Lake monitoring efforts at SL10 are summarized below:

- **Daily Profiles –**Standley Lake water quality is measured four times per day using an automated profiler (Figure 3). Measurements are taken every meter, from the surface to within 2 meters of the bottom. The profiler is equipped with a multi-probe sonde which provides readings of water temperature, dissolved oxygen, pH, conductivity, turbidity, oxidation/reduction potential (ORP), and chlorophyll *a* concentrations.

- **Water-Quality Sampling** – Grab samples are collected in the lake at three depths: the surface, the bottom of the photic zone (at two times the measured Secchi depth), and one meter from the bottom. Sampling occurs twice each month if the lake is not frozen. A wide range of constituents is measured, including nutrients, metals, algae, suspended solids, and field parameters.

- **Zooplankton Tows** – Zooplankton tows are conducted during each lake sampling event.

- **Invasive Species Monitoring** – Monitoring for zebra and quagga mussels is conducted during each lake sampling event. Monitoring for Eurasian watermilfoil is performed once per year.

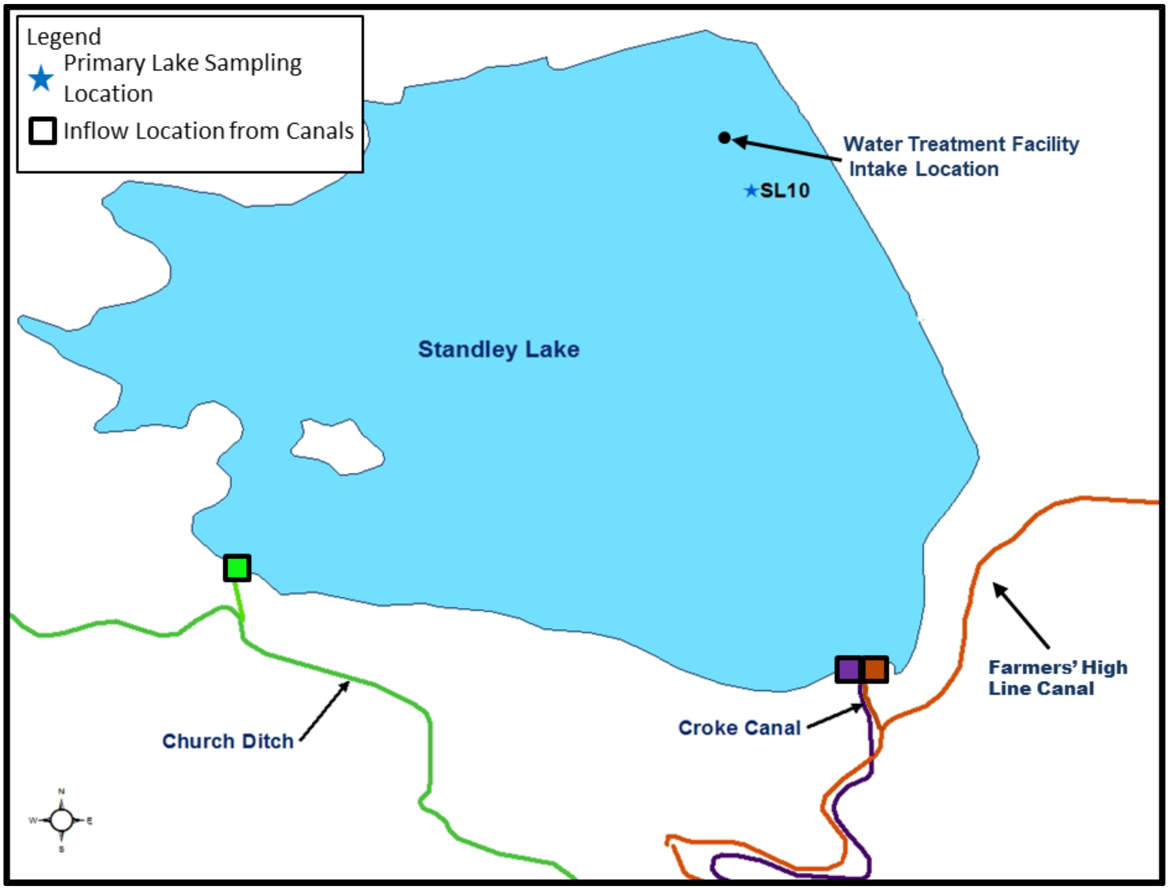

Figure 2. Standley Lake, Sampling Location SL10, and the Locations of Canal Inflows

Figure 3. Water-Quality Profiler at SL10

B. Description of the Watershed

The Clear Creek watershed covers 575 square miles and is located west of Denver, Colorado, with headwaters at the Continental Divide (Figure 4). The Upper Basin of the Clear Creek watershed is that portion of the watershed above the headgates for the canals feeding Standley Lake. It extends from the headwaters downstream to near Golden. The Standley Lake watershed includes the Upper Basin of the Clear Creek watershed, the canals used to transport water from Clear Creek to the lake and their drainage areas (the Canal Zone), and a direct lake watershed. The following subsections describe the Upper Basin and the Canal Zone. In addition to supplying drinking water to 350,000 residents in the watershed, Clear Creek provides water for recreational, agricultural, and industrial purposes

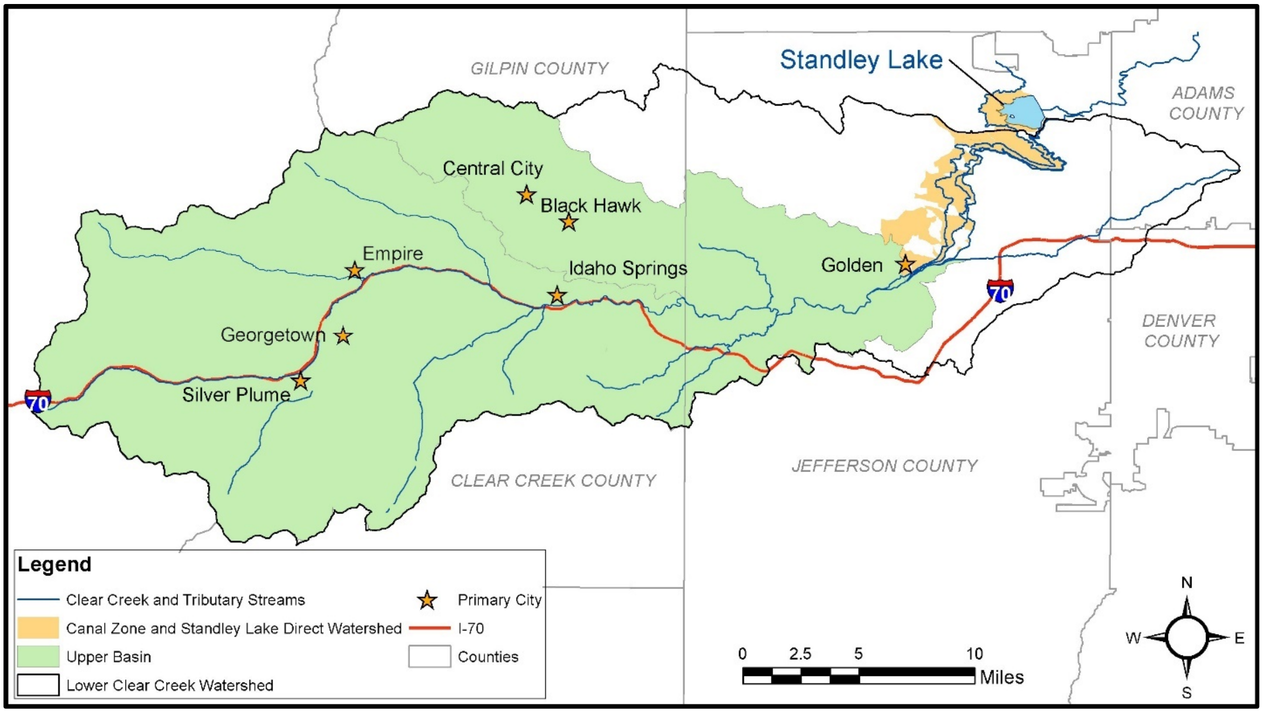

Figure 4. The Standley Lake Watershed, Upper Basin, Canal Zone, and Direct Watershed

1. Upper Basin

The Upper Basin region of the Clear Creek watershed (Figure 4) is comprised of nearly 400 square miles upstream of the Croke Canal headgate. This region includes the upper portion of Clear Creek and its tributaries -- the most prominent of these being the West Fork of Clear Creek, Leavenworth Creek, the South Fork of Clear Creek, Fall River, Chicago Creek, the North Fork of Clear Creek, Beaver Brook, Soda Creek, Tucker Gulch, and Elk Creek. Numerous cities and towns are scattered throughout this mountainous area including Idaho Springs, Black Hawk, Central City, Empire, Georgetown, and Silver Plume. Additionally, U.S. Interstate 70 (I-70) runs through the watershed. This highly-utilized transportation corridor averages approximately 40,000 vehicles per day near Idaho Springs (CDOT 2015).

Water quality in the Upper Basin is affected by a variety of sources. Prominent amongst these are the nine wastewater treatment facilities (WWTFs) in the region which serve the local population and resorts (Figure 5). Additionally, the Upper Basin contains operating and abandoned mines and receives water from trans-basin diversions. Water quality in the Upper Basin may also be impacted by nonpoint sources of pollution, including numerous on-site wastewater treatment systems (OWTS), application of roadway deicers and traction sands, and residential and commercial stormwater runoff.

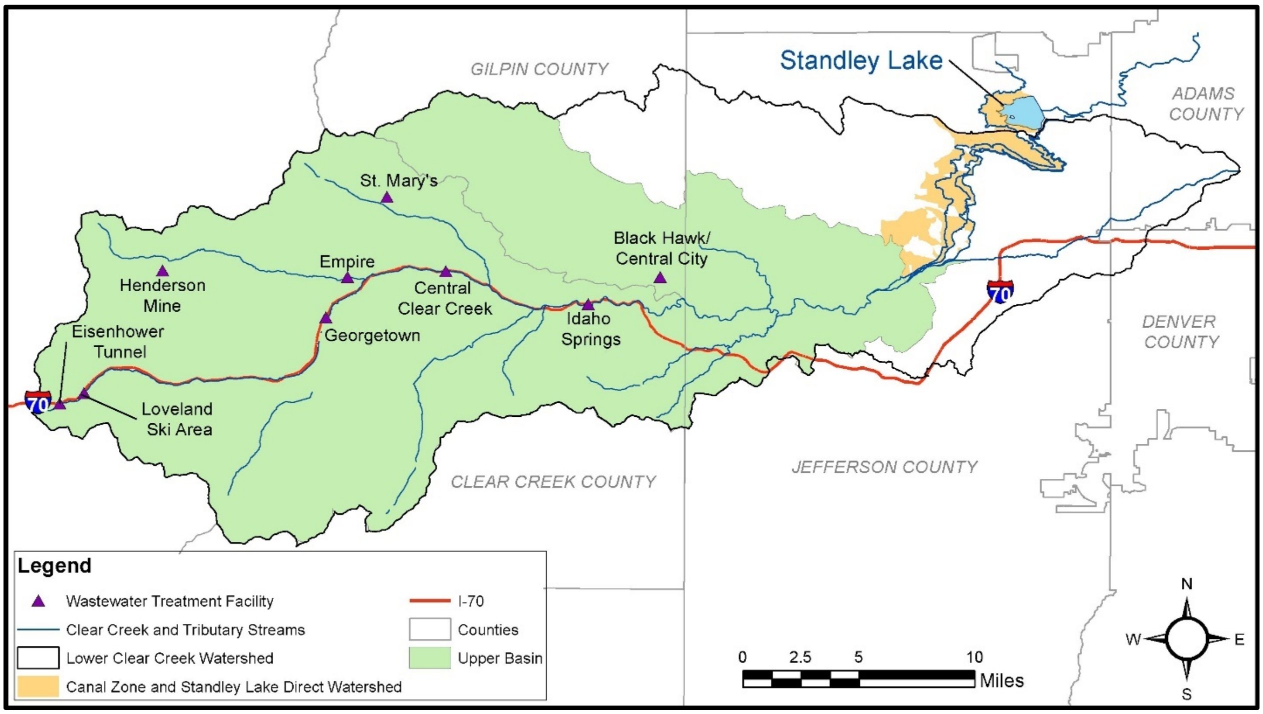

Figure 5. Wastewater Treatment Facilities in the Upper Basin

Flow measurements and water-quality samples are collected at numerous stations throughout the watershed to monitor the concentrations of nutrients, select metals, and other key constituents (Figure 6).

Upper Basin monitoring activities have been designed to evaluate the relative contributions of various nutrient sources, the effectiveness of best management practices (BMPs), WWTF operational changes, and nutrient reductions from WWTF upgrades. The monitoring program has a strong emphasis on composite samples versus grab sampling. Composite samples are comprised of multiple sub-samples collected regularly over a pre-determined time period. Relative to grab samples, composite samples provide a more complete picture of water quality over the course of the sampling period. These composite samples are of two types: ambient and event. Ambient samples are collected on a periodic basis and are collected over a 24-hour period. Event samples are storm-triggered. All sampling for the Upper Basin is described in detail in the Upper Clear Creek/Standley Lake Watershed Water Quality Monitoring Plan (Appendix B).

The analyses described in the Upper Basin portion of this report are based on data from two key sampling areas (described in Table 1 and circled on Figure 6), selected based on their location and higher frequency of sampling. For this report, three important constituents are analyzed: total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS).

Table 1. Key Watershed Locations in the Upper Basin

General Area	Purpose	Station Name and Location	Station Type
Clear Creek main stem, downstream of the confluence with the West Fork, at the location of USGS* Lawson flow gage	Characterize water quality in the upper portion of the Upper Basin	CC26 – Clear Creek at Lawson Gage	Grab Sample Station
		CCAS26 -- Clear Creek at Lawson Gage	24-Hr Composite Autosampler
Clear Creek main stem, near the canal headgates, near Golden	Characterize water quality near the Clear Creek canal diversions to Standley Lake	CC60 – Clear Creek at Church Ditch Headgate	Grab Sample Station
		CCAS59 – Clear Creek 2 miles west of Highway 58/US6	24-Hr Composite Autosampler

*United States Geological Survey

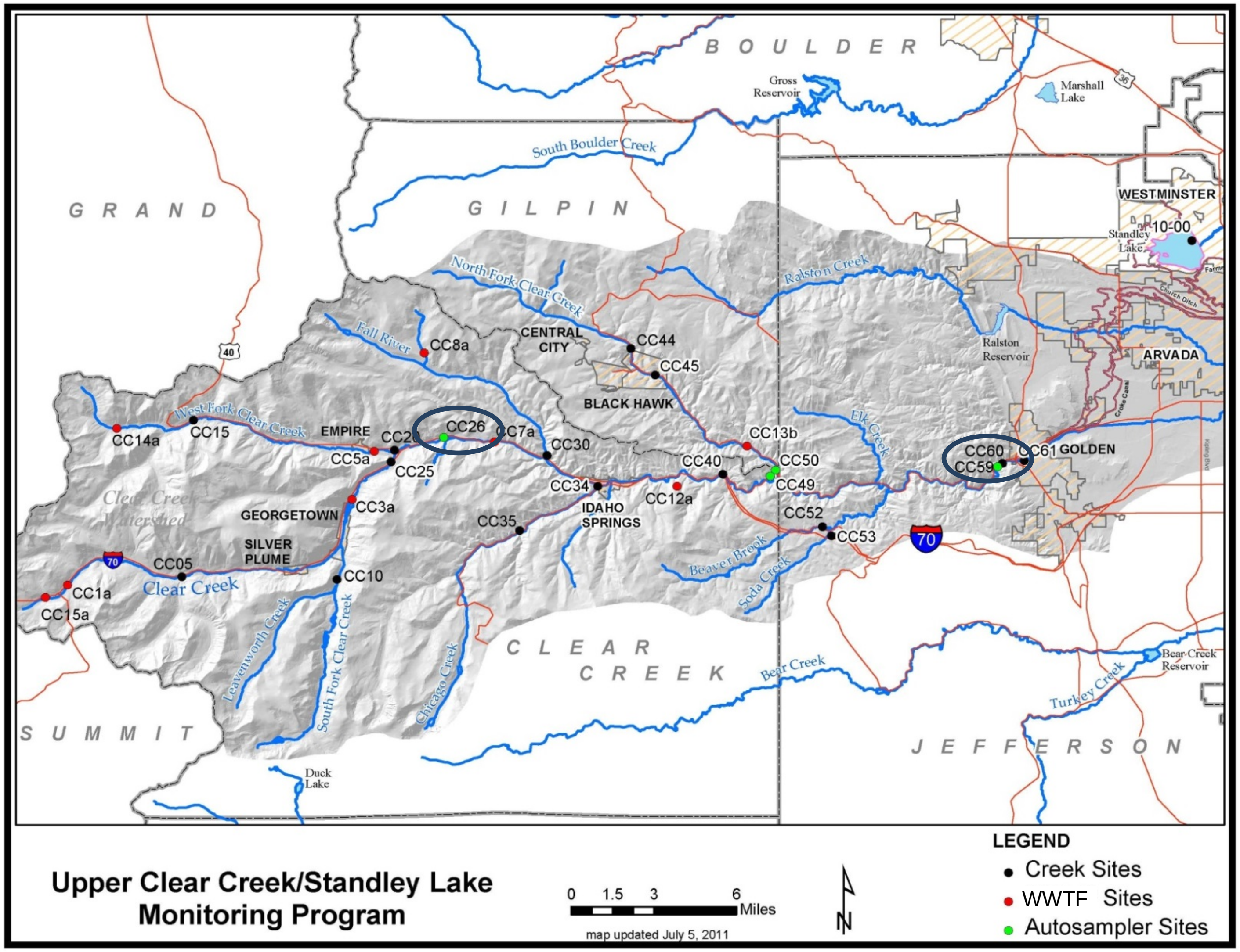

Figure 6. Upper Clear Creek Sampling Stations (Key locations for this report are circled)

2. Canal Zone

The Canal Zone contains the canals (and surrounding drainage areas) that divert water from Clear Creek into Standley Lake: Church Ditch (Church), Farmers' High Line Canal (FHL), and the Croke Canal (Croke) (Figure 7). The Kinnear Ditch Pipeline (KDPL) also contributes water to Standley Lake sourced from the Coal Creek, South Boulder Creek, and Fraser River basins. The canals are slow-flowing (low gradient), open and largely unlined ditches. In addition, they are subject to nonpoint-source loading from adjacent horse and cattle operations, agricultural operations, and residential properties (some with OWTSs). To protect Standley Lake water quality, a substantial percentage (~80%) of the stormwater inputs/runoff into the Clear Creek canals has been hydrologically disconnected from the canals since the 1990s.

To provide information for evaluation of the nutrient loadings from nonpoint sources in the Canal Zone, the Church, Croke, and FHL canals are sampled at the headgates where water is diverted and again at the inlets into the lake. The KDPL is sampled near the inlet into the lake. Figure 7 shows the inlet monitoring location for each canal (CCT4, CCT11, CCT27, and CCT22d). Routine monitoring for the Canal Zone is described in detail in Appendix B.

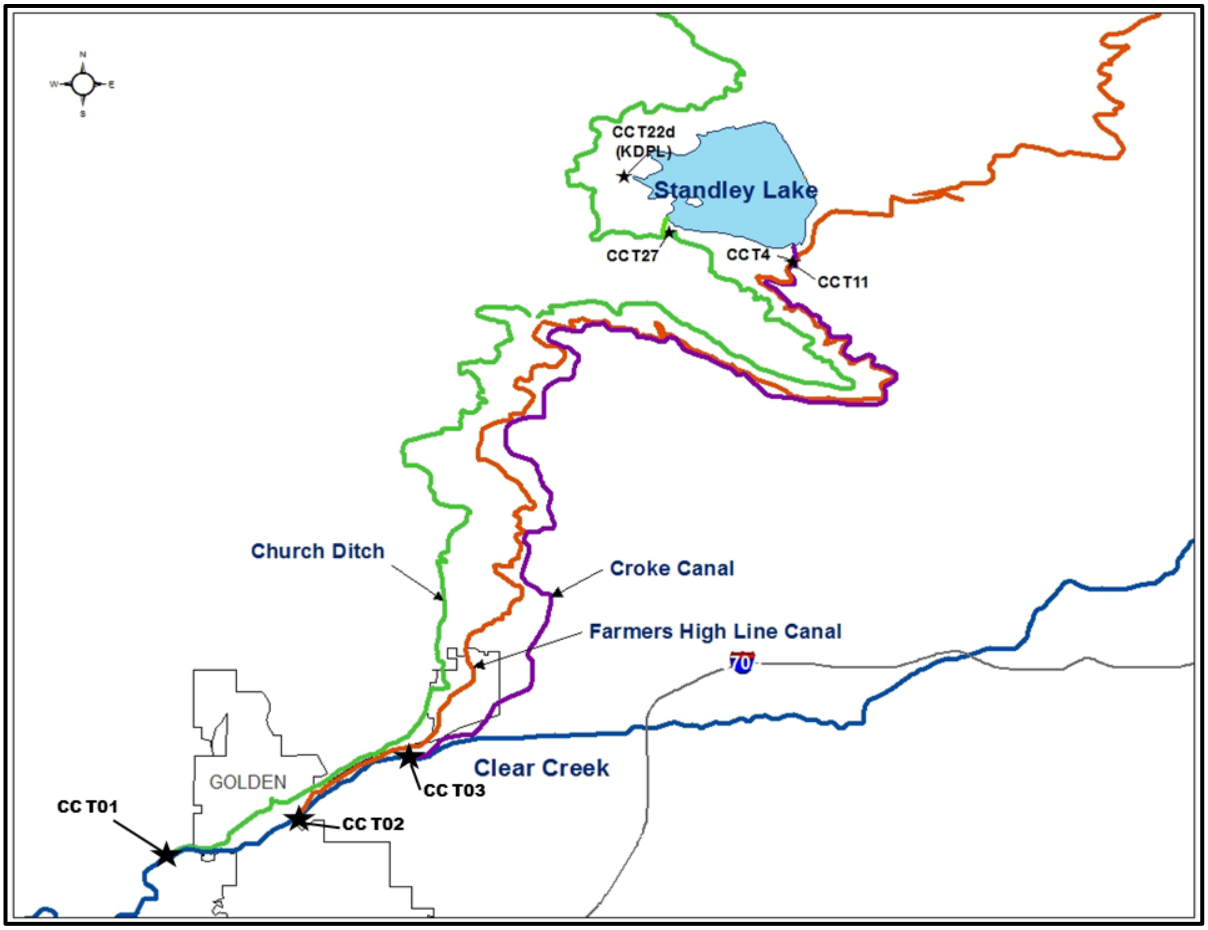

Figure 7. The Three Canals that Divert Water from Clear Creek to Standley Lake and Sampling Stations at the Lake Inflow Locations (Including KDPL)

III. Activities and Accomplishments

This section provides highlights of the 2016 efforts to manage, enhance, and protect water quality in both the Clear Creek watershed and in Standley Lake. These activities were completed by a variety of interested groups and entities. The following groups of activities are described:

- Monitoring Activities;
- Canal Maintenance;
- Wastewater Treatment Facilities;
- Illicit Discharges and Emergency Response;
- Nonpoint Source Control, Stormwater Management and Remediation;
- General Public Education, Outreach, and Partnerships; and
- Other Activities.

A. Monitoring Activities

The routine collection of flow measurements and water-quality samples throughout the Upper Basin, the Canal Zone, and in Standley Lake is guided by the Upper Clear Creek / Standley Lake Watershed Water Quality Monitoring Program. Water-quality sample collection in 2016 is summarized in Table 2. Samples were analyzed for a range of constituents, as described in the monitoring plan (Appendix B). Some of the funding used for flow and water-quality monitoring are listed in Table 3.

Table 2. Summary of 2016 Water-Quality Sample Collection

Sub-Region	Type of Sample	Number of Locations	Total Number of Samples Collected
Upper Basin	Grab Samples	17	47
	Ambient Composites	4	23
	Storm-triggered Composites	1	4
Canal Zone	Grab Samples	10	60
	Ambient Composites	2	14
	Storm-triggered Composites	0	0
	First Flush Composites	4	4
Standley Lake	Grab Samples	1 (3 depths)	60
	Vertical Profiles	1	Four Times Daily When Ice-Free, Every Meter

Table 3. Funding Resources for Flow and Water Quality Monitoring in 2016

Entity	Activity Funded	2016 Amount
Standley Lake Cities	Water-Quality Sampling and Analysis	$200,000+
	Flow Gage Support at: 1) Bakerville (CC05), 2) Lawson (CC26), 3) Fall River, and 4) Berthoud Falls on the West Fork of Clear Creek	
Clear Creek County	Support Flow Gage at Leavenworth Creek	$7,500
City of Golden	Water-Quality Sampling and Analysis	n/a
	Support USGS G age on the W. Fork of Clear Creek	$10,790
Upper Clear Creek Watershed Association (UCCWA)	Flow Gage Support at CC40	$4,005

In 2016, a new second sampling station was installed at the CC59 location. The original CC59 monitoring site is located on Clear Creek in Golden, approximately 300 yards upstream of the Church Ditch headgate in Golden. The new CCAS59 sampling station is located approximately 100 ft upstream of the original monitoring station. The City of Golden operates the original CC59 station, primarily for the collection of stormwater samples. The collection of ambient samples at this station was interfering with stormwater sampling. These ambient samples are considered a critical part of the Standley Lake watershed model. The new station was installed to allow for the continued collection of composite ambient samples.

The new SLIGA CCAS59 Sampling Station

The monthly collection of ambient 24-hour composites using the SLIGA autosampler began in April 2016. In the spring of 2017, a sonde was installed and connected to a datalogger. The sonde, a YSI EXO2, measures depth, temperature, pH, ORP, turbidity, and fluorescent dissolved organic matter (fDOM). These *in-situ* data will be collected on a seasonal basis. During the late summer, this site becomes very shallow, and the sonde will be removed during these periods.

B. Canal Maintenance

In 2016, maintenance and upgrades to the delivery canals were performed to ensure that the efficient delivery of high-quality water to Standley Lake continued.

1. Church Ditch Water Authority

Prior to the 2017 irrigation season, the Church Ditch Water Authority (CDWA) completed the construction of a new headworks structure with improved operational capabilities. This structure provides Church Ditch staff with better control of flows diverted from Clear Creek. It also provides the ability for remote access to gate controls. This capability simplifies flow adjustments and allows immediate shutdowns in the event of contamination in Clear Creek. The structure also allows for the removal of sediment from the diversion channel upstream of the headworks. This will reduce sedimentation from Clear Creek and help minimize ditch maintenance.

New Church ditch headworks structure.

CDWA continues to focus on maintenance of the ditch and associated easement. This maintenance includes vegetation removal, ditch shaping, and bank repair. Vegetation removal reduces the risk of blockages, increases ditch capacity, and decreases sedimentation from erosion. In 2016, vegetation was removed along both sides of the ditch. The removal was performed at several locations for a total of approximately 16,000 linear feet along the ditch. Ditch shaping and bank repair were performed to increase ditch capacity, improve flow, and protect water quality by reducing erosion. The ditch was reshaped and cleaned in 2016 at several locations, covering approximately 2,500 ft of ditch.

CDWA actively oversees any projects within the ditch easement or channel to ensure proper care is taken to maintain water quality by minimizing or eliminating erosion and stopping potential contaminants from entering the ditch. In 2016, such projects included the placement of two pedestrian bridges, one culvert ditch crossing, and multiple utility bores. Finally, CDWA also replaced a number of user headgates—providing new headwalls, gates, and check pads where needed. These projects were completed by mixing native soil with bentonite and adding rip rap to provide bank stability.

Installation of new pedestrian bridge over Church ditch

2. [Farmers' Highline Canal and Reservoir Company]

Farmer's Highline Canal and Reservoir Company staff continued activities that support protection of or improvements to water quality. An example includes the installation of handrails at the Farmers' Highline Canal (FHL) headgate on Clear Creek to improve the safety of water-quality staff during sample collection. Other activities to enhance and maintain water quality include ditch maintenance, mowing, removal of sediment, and flushing.

3. [Croke Canal]

Activities on the Croke in 2016 performed by FRICO and the Standley Lake Operating Committee continued to support the protection of water quality. An example of one of these activities is a continuing process to address land uses with the potential to impact ditch water quality. In 2016, land uses identified as potentially impacting water quality included horse boarding operations and equestrian access to the ditch road. In early 2017 a pedestrian bridge is expected to be installed to allow access across the Croke Canal.

4. [City of Arvada]

In 2016, the City of Arvada continued restoring and improving waterways that were impacted by the historic flooding of September 2013. A significant amount of funding and man-hours were dedicated to assisting Jefferson County, CDOT, Urban Drainage, and ditch operation companies. This assistance supported the repair and replacement of diversion control structures and erosion control systems along Leyden Creek, Ralston Creek, Church Ditch, Farmers' Highline Canal and the Croke Canal.

C. Wastewater Treatment Facilities

As described in Section II, nine wastewater treatment facilities are located in the Upper Basin (Figure 5). The following sub-sections provide a brief discussion of key activities at the three largest WWTFs in the basin. At the end of this section, effluent nutrient concentrations from 2011 to 2016 are presented for each of the WWTFs that are subject to Regulation 85 monitoring requirements.

1. Black Hawk / Central City Sanitation District WWTF

The Black Hawk / Central City Sanitation District (BHCCSD) continues to achieve excellent nutrient removal at their WWTF. Effluent total phosphorus is controlled through the concerted action of enhanced biological nutrient removal (BNR), tertiary filtration with mechanical disk filters, and an additional chemical coagulation / flocculation process. Total nitrogen concentrations are controlled by nitrification / denitrification reactions in the BNR process. The final treatment step prior to discharge is ultraviolet (UV) disinfection.

The treatment methods continue to result in very low levels of nutrients in the effluent. Effluent concentrations of TP and total inorganic nitrogen (TIN, Table 4) are substantially lower than the Regulation 85 values[1].

Table 4. BHCCSD WWTF 2016 Effluent Concentrations Compared to Regulation 85 Limitations

	Total Phosphorus (mg/L)		Total Inorganic Nitrogen (mg/L)	
Percentile	BHCCSD WWTF	Reg 85 Value	BHCCSD WWTF	Reg 85 Value
50th	0.06	1.0	5.9	15
95th	0.11	2.5	10.1	20

The average daily flow volume in 2016 was 0.414 million gallons per day (MGD). This is consistent with the range of volumes observed since 2012 (0.392 to 0.416 MGD).

BHCCSD monitors and calculates seasonal TP and TIN loadings to North Clear Creek pursuant to a 2000 intergovernmental agreement (IGA) among Central City, Black Hawk, Gilpin County, and the District. In Figure 8 and Figure 9 total phosphorus and total inorganic nitrogen loadings for 2016 are compared to the loading goals specified in a 2000 Water Court Stipulation. BHCCSD was not party to the Stipulation, but agreed under the IGA to use its best efforts to operate and maintain the WWTF, which was designed to meet these loading goals. The loading goals are based on an average effluent TP concentration of 0.3 mg/L and an average effluent TIN concentration of 10 mg/L. BHCCSD continues to successfully meet the loading goals (Figure 8 and Figure 9).

[1]While actual flows are less than 1.0 MGD, the design capacity of the plant is 2.0 MGD. Regulation 85 is further described in the following section.

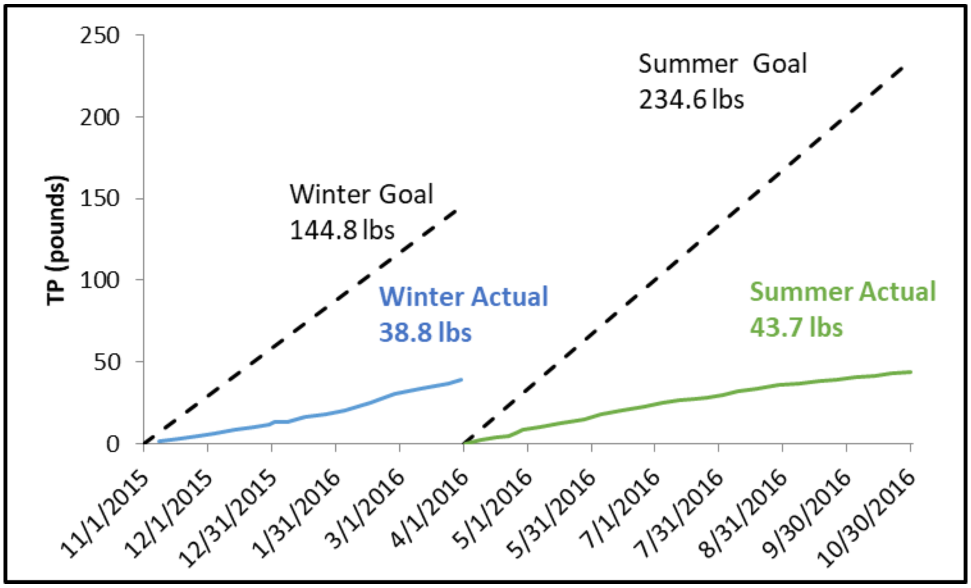

Figure 8. Seasonal TP Loadings to the North Fork of Clear Creek from BHCCSD WWTF

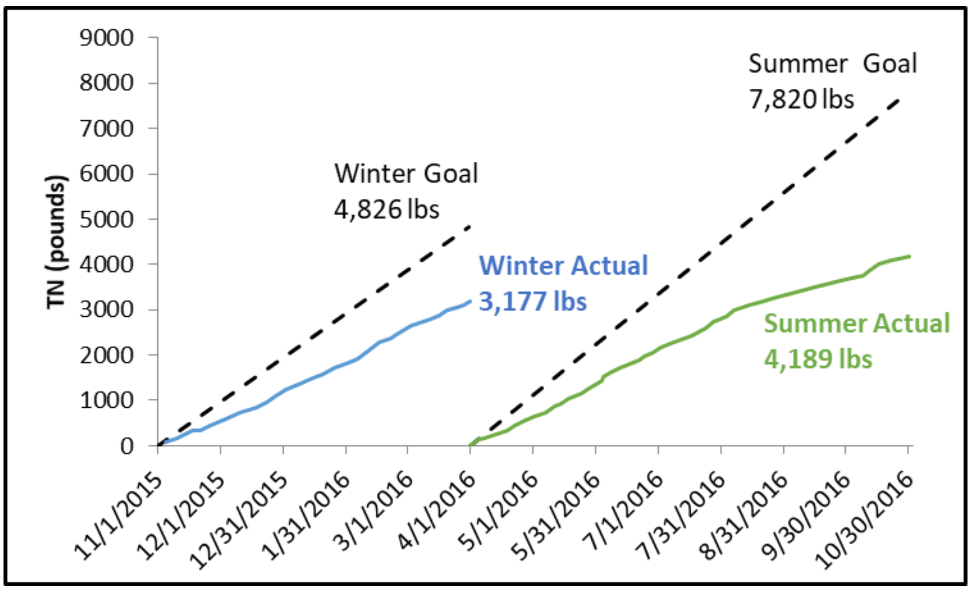

Figure 9. Seasonal TIN Loadings to the North Fork of Clear Creek from BHCCSD WWTF

2. Georgetown WWTF

Under a longstanding agreement, wastewater from the town of Silver Plume is treated at the Georgetown WWTF. In 2016, both towns continued work to locate and resolve infiltration and inflow issues.

3. Idaho Springs WWTF

The City of Idaho Springs completed installation of a UV disinfection system in 2016 at the city's WWTF. The city no longer uses gaseous chlorine and sulfur dioxide for disinfection; however, liquid chlorine and sodium bisulfite are onsite for emergency backup. Facility upgrades continued with the commencement of the engineering phase to install an on-site dewatering facility for sludge produced by the aerobic digester. The project is tentatively scheduled for completion in late 2017.

4. Observed WWTF Effluent Concentrations

In 2012, the Water Quality Control Commission (WQCC) adopted Regulation 85 (CDPHE 2012), the Nutrients Management Control Regulation, which establishes numeric standards for nutrient concentrations in WWTF effluent (Table 5). WWTFs are not required to meet the discharge limits set in the regulation if they have a design capacity of less than or equal to 1.0 MGD or if they are owned by a disadvantaged community. Of the nine WWTFs in the watershed, only the Black Hawk / Central City Sanitation District facility (with a design hydraulic capacity of 2.0 MGD) is subject to Regulation 85 effluent limits.

Table 5. Regulation 85 Limitations, Existing Facilities, for TP and TIN

Constituent	Units	Median (50^{th} Percentile)	95^{th} Percentile
Total Phosphorus	mg/L as P	1.0	2.5
Total Inorganic Nitrogen	mg/L as N	15	20

The WQCC, through Regulation 85, also requires all domestic WWTFs to sample and report effluent nutrient concentrations. Major WWTFs (greater than 1 MGD) are required to sample monthly; this requirement only applies to the Black Hawk / Central City Sanitation District. Minor dischargers (less than 1 MGD) are required to sample once every two months at a minimum. This applies to the six remaining domestic WWTFs in the watershed. Sampling under Regulation 85 began in April of 2013. Prior to this, periodic effluent sampling for nutrients was conducted as part of the Upper Clear Creek (UCC) Monitoring Program. Nutrient analysis of samples from the WWTFs was discontinued with the implementation of Regulation 85. Data from the UCC Monitoring Program and data collected to meet Regulation 85 requirements represent end-of-pipe concentrations and are generated by different laboratories, and in some cases, using different methods. As a result, some caution should be used when comparing the results of each sampling program.

TP and TN concentrations measured for each WWTF subject to monitoring requirements for Regulation 85[2] in 2011-2016 are presented in Figure 10 through Figure 15. These figures show observations from both the UCC Monitoring Program (through early 2013) and Regulation 85

[2] In previous reports, this section included figures for the Eisenhower Tunnel and Henderson Mine WWTFs. These facilities are not subject to Regulation 85 monitoring requirements and no additional data has been provided for this report since 2013. Readers with interest in these facilities are referred to previous reports (e.g. Hydros [2016]).

sampling (2013 to present). Note that the sampling frequency varied by WWTF and over the course of the year. Data collected as part of the UCC Monitoring Program are depicted with filled data points, and data collected as part of Regulation 85 are depicted with hollow data points. For context, the average daily flow for each facility is provided on the figure.

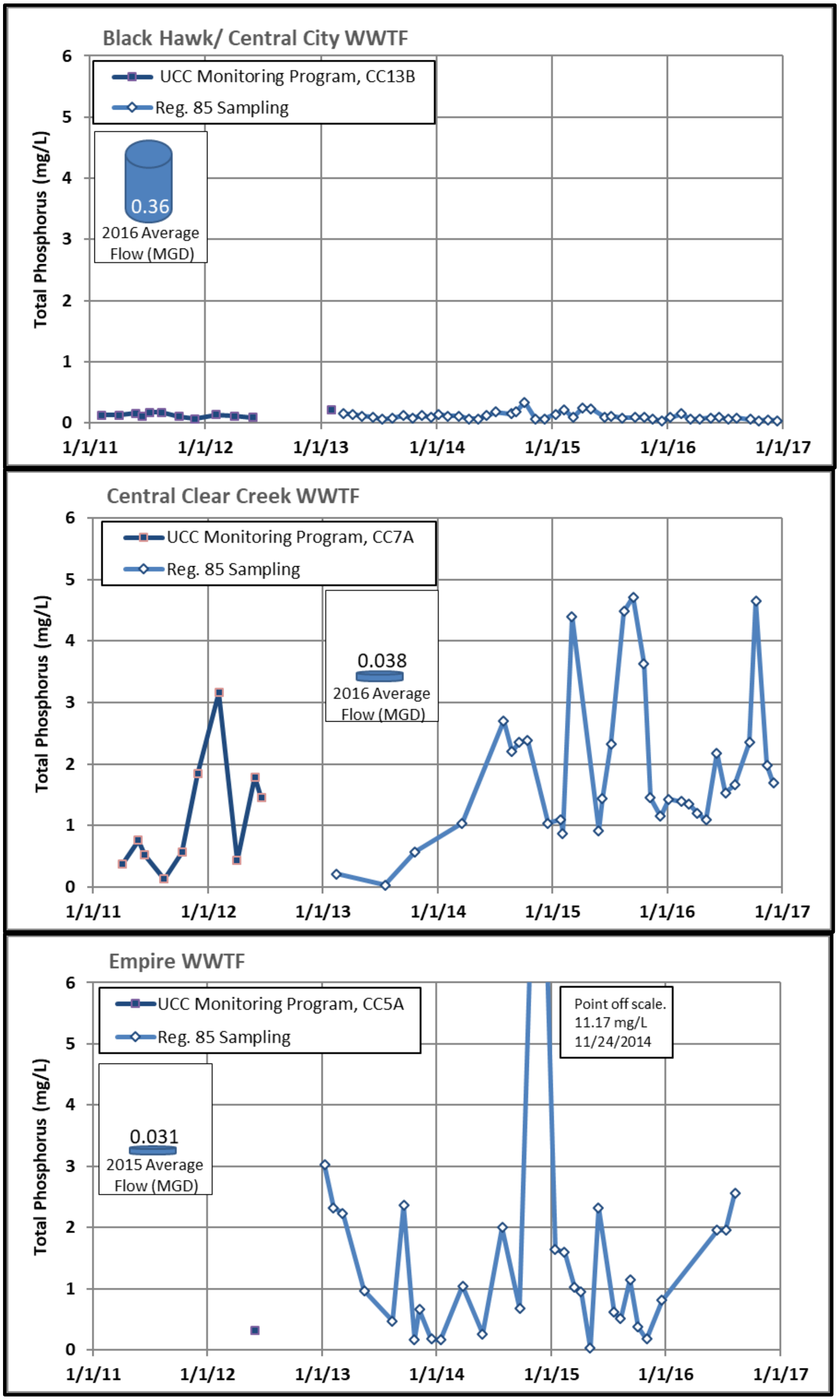

Figure 10. Effluent TP Concentrations (2011-2016) for Black Hawk/Central City, Central Clear Creek, and Empire WWTFs

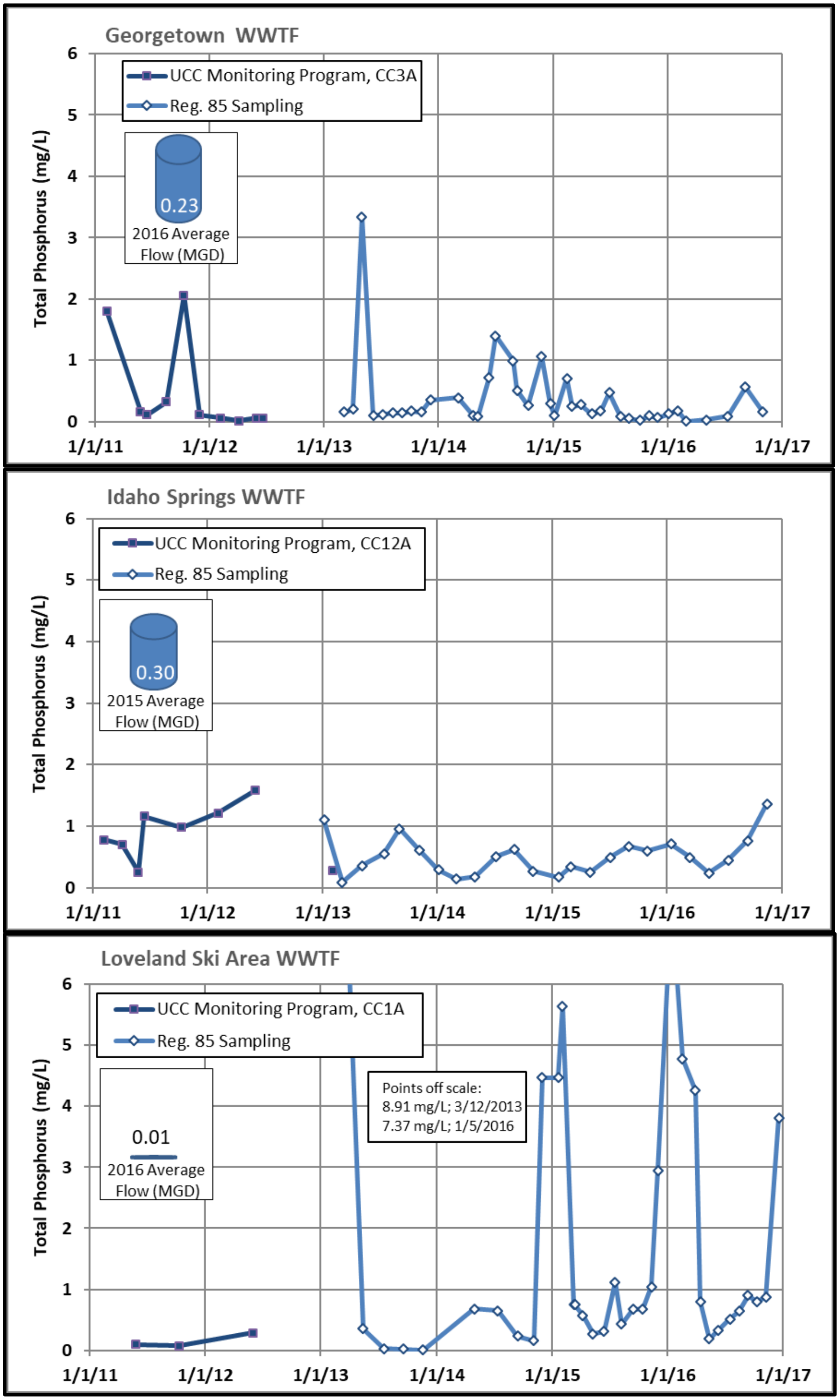

Figure 11. Effluent TP Concentrations (2011-2016) for Georgetown, Idaho Springs and Loveland Ski Area WWTFs

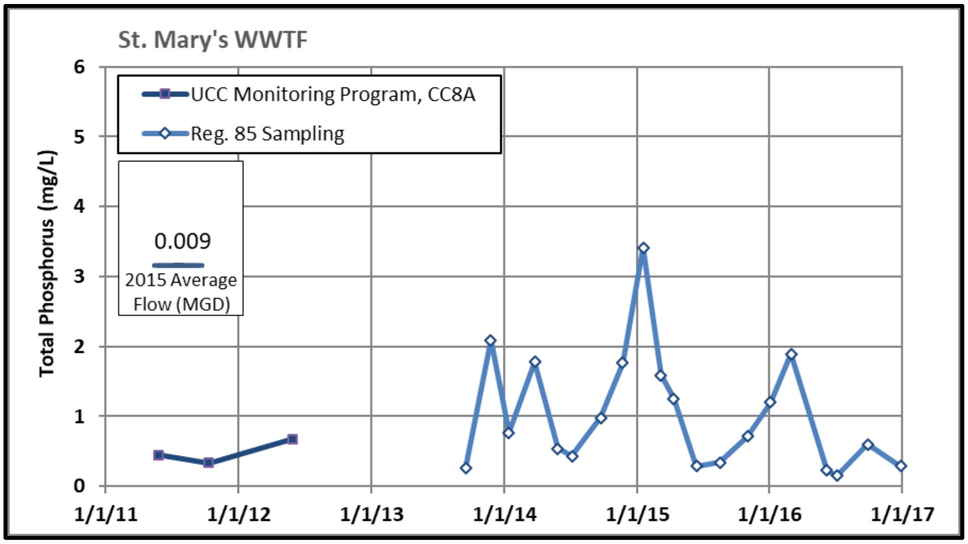

Figure 12. Effluent TP Concentrations (2011-2016) for St. Mary's WWTF

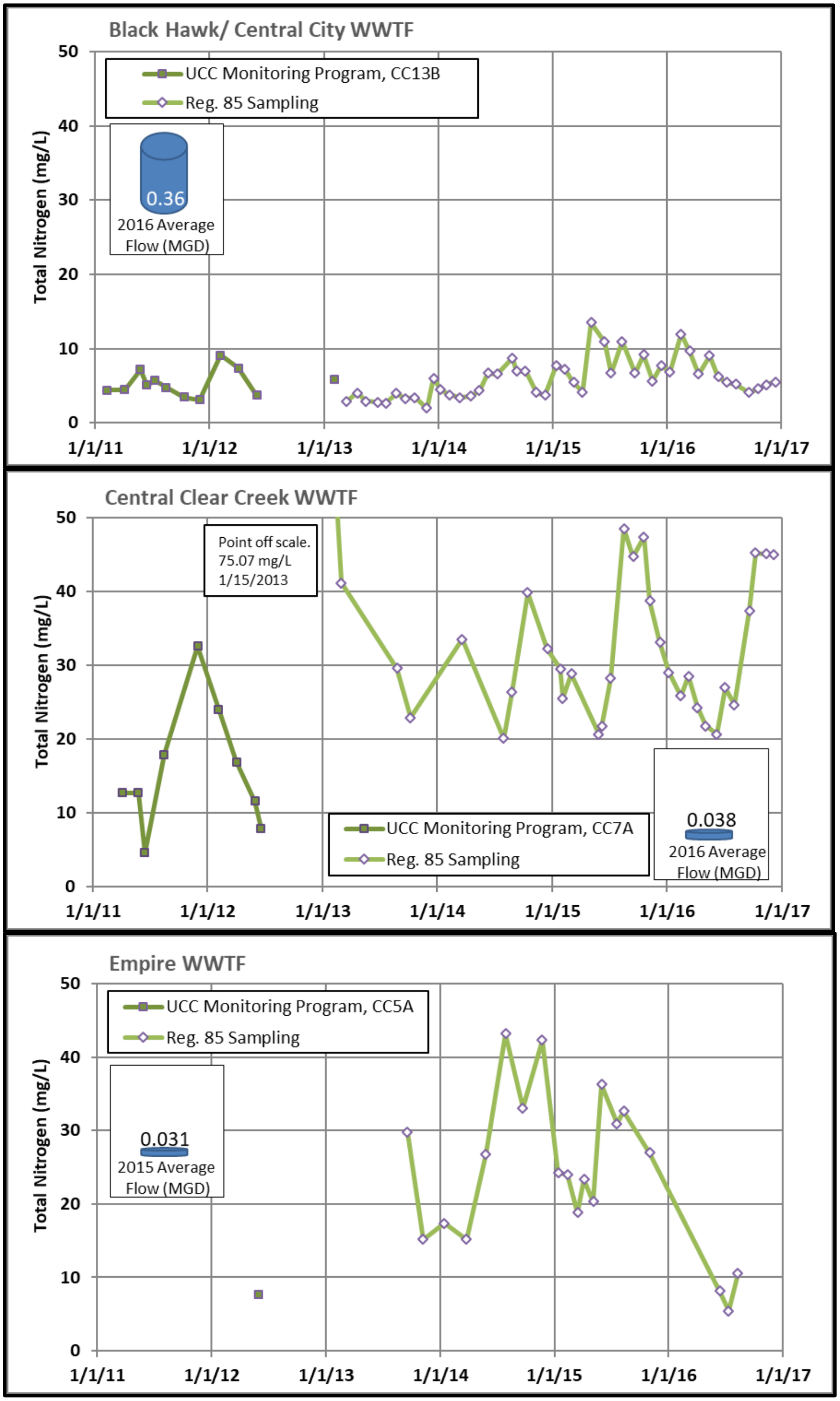

Figure 13. Effluent TN Concentrations (2011-2016) for Black Hawk/Central City, Central Clear Creek, and Empire WWTFs

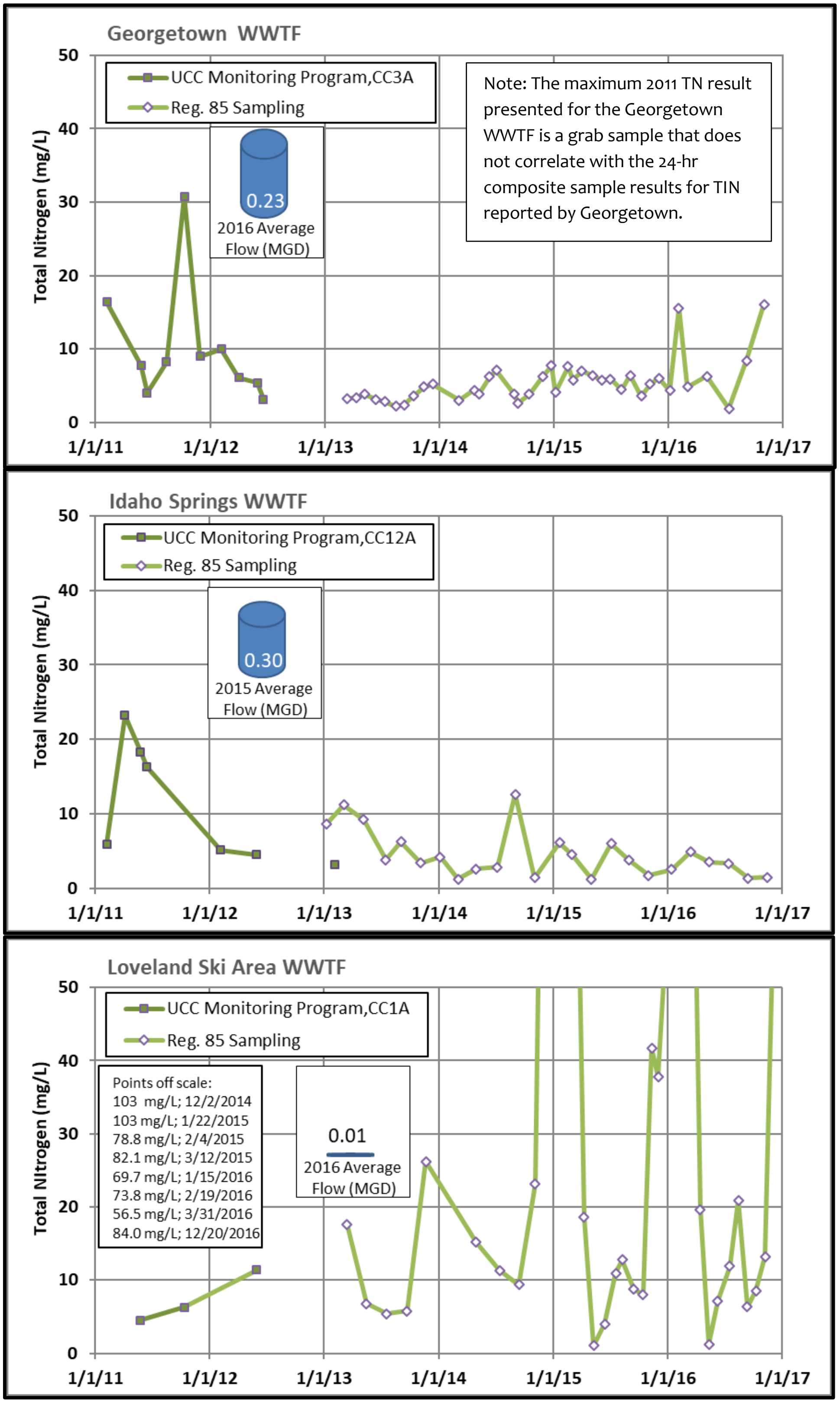

Figure 14. Effluent TN Concentrations (2011-2016) for Georgetown, Idaho Springs and Loveland Ski Area WWTFs

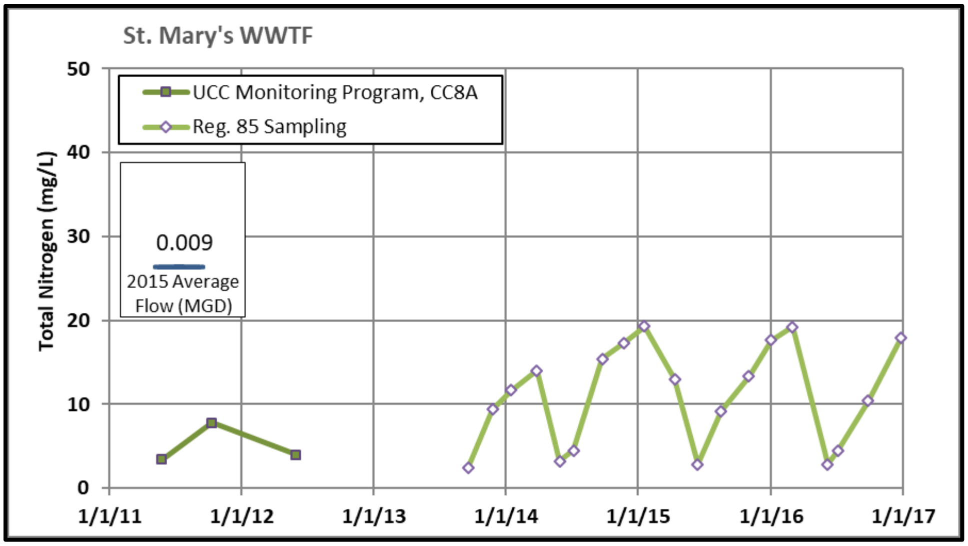

Figure 15. Effluent TN Concentrations (2011-2016) for St. Mary's WWTF

D. Illicit Discharges and Emergency Response

Limitation and control of illicit discharges and the timely response to unexpected upstream releases are key to controlling the potential effects of these incidents on in-stream and reservoir water quality. Programs to address these issues continue to be effective and are a focus of stakeholders.

1. Illicit Discharges

The City of Golden responded to 54 reports of illicit discharges or potential discharges to the storm sewer system in 2016. This resulted in the issuance of eight written and 16 verbal warnings. In three cases, clean-up costs were levied. Jefferson County inspected nine reports of illicit discharges, each of which resulted in enforcement actions. The county maintains a comprehensive storm sewer outfall map. This map is maintained to enable the tracing and investigation of illicit discharges and illegal dumping. The Illicit Discharge Detection and Elimination Program of the City of Arvada issued eight written Notices of Violation. The city's vacuum trucks were often used to conduct clean-ups. This was necessary where the responsible party was not identified or was unable to clean up the spill. In addition, Arvada conducted dry-weather screenings of outfalls. These outfall inspections help identify and eliminate potential sources of illicit discharges. Further, these are used to evaluate the condition of outfalls and identify those in need of repair. Outfalls found to be in need of repair are listed on a maintenance schedule.

2. Emergency Response

Clear Creek County uses the Code Red Emergency Call-Down System. This system is used to promptly and effectively notify downstream users of Clear Creek water of any potential contamination from an upstream source. The Clear Creek Office of Emergency Management continues to maintain and update the call lists database. The system applies to incidents / spills into Clear Creek and its tributaries that occur in Clear Creek County.

In 2016, the dispatch centers of Clear Creek County, the City of Golden, and Jefferson County launched nine calls for incidents within their respective jurisdictions that impacted Clear Creek. Clear Creek County launched a total of three calls; one in response to a raw sewage leak and two related to traffic accidents.

E. Nonpoint Source Control, Stormwater Management, and Remediation

Additional efforts to reduce pollutant and nutrient loading to Clear Creek are discussed in this section. The sources in the previous two sections, WWTFs and illicit discharges, are types of point sources. The sources in this section are primarily non-point sources, including stormwater and erosion. It also includes OWTS monitoring and regulation and the remediation of abandoned mines. The following subsections provide selected highlights of such activities in 2016.

1. Erosion and Sediment Control

City of Golden: The City of Golden operates under a Municipal Separate Storm Sewer System (MS4) permit and is designated a Qualifying Local Program by the Water Quality Control Division. Under this permit and designation, the City ensures that erosion and sediment controls are implemented on construction sites. In 2016, the City of Golden administered 33 stormwater-quality construction permits and conducted 542 erosion and sediment control inspections. These inspections resulted in 112 written and 85 verbal notifications of violations. Two stop-work orders were issued and at two sites, performance security for corrections was used.

The Stormwater Maintenance Program of the City of Golden performs yearly inspections on all private systems requiring routine cleaning and maintenance. In 2016, 288 inspections were conducted resulting in 194 maintenance request letters sent to land owners. In addition, municipal inlets are inspected and cleaned twice each year by the city's Stormwater Division. This aggressive schedule helps increase the efficiency of system operation and improves the quality of stormwater released to the creek. Stormwater conveyance system improvements have included sumped manholes and sediment traps. The sumped manholes allow for the settling of solids in stormwater. These sumps are cleaned twice each year, yielding an average of one cubic yard (CY) per cleaning. In addition to the reconfigured channel and sediment trap in Tucker Gulch, the City has also installed sediment traps in ponds and at outfalls. In 2016, sediment traps removed and captured 403 CY of debris that would have otherwise been released to Clear Creek.

Jefferson County: The MS4 permit program of Jefferson County includes construction site runoff control, post-construction site runoff control, and pollution prevention/good housekeeping. Each control program is supplemented by a corresponding inspection program. The county maintains a small-site erosion control manual that explains the basic principles of erosion control and illustrates techniques to control sediment from small development sites.

City of Arvada: The City of Arvada's MS4 Program includes a concentrated effort to ensure that erosion and sediment controls are implemented on construction sites. In 2016, 1,473 erosion and sediment control inspections were conducted on 146 active construction sites. These inspections resulted in 32 notices of violation. For two builders building inspections were made contingent on the demonstration of compliance.

A second key component of Arvada's stormwater program is the inspection and enforcement of permanent stormwater BMPs. Examples of these include detention and retention ponds, swales, and underground proprietary devices. In 2016, 13 new permanent BMPs were added to the 194 BMPs previously implemented since the program began. The city inspected 58 permanent BMPs in 2016. Inspections are followed by reports identifying areas of non-compliance to be addressed. These reports are sent to owners of the stormwater conveyance.

Arvada's Wastewater Division is responsible for storm sewer maintenance under the MS4 permit. In 2016, the Wastewater Division inspected 3,036 inlets and manholes, of which 818 required maintenance and cleaning. Crews also cleaned 8,064 ft of storm sewer pipe resulting in the removal of 230,580 pounds (lbs) of debris from the system. Projects to improve stormwater drainage were completed at nine locations.

Pollution prevention is an ongoing component of the City of Arvada's stormwater protection efforts. All City of Arvada facilities with runoff control plans are inspected twice annually. Employee training on pollution prevention for municipal operations is conducted routinely. The training focus is two-fold: 1) preventing and mitigating any potential contamination sources from city facilities, and 2) spill response procedures specific to work in the field. Arvada's spill response hotline is answered after-hours by personnel at the water treatment plant, who then dispatch on-call staff to respond to the spill.

Clear Creek County: As part of the county's efforts to control the releases of sediment to Clear Creek, permits are required for BMPs and floodplain development. The purpose of these permits is to monitor BMP performance and ensure environmental and public safety. In 2016, the county issued six permits for floodplain development and finalized four. In addition, 13 BMP permits were issued and five finalized.

Colorado Department of Transportation: A major focus of CDOT projects is the control and capture of sediment from highway maintenance activities. During construction of these projects, attention is paid to control of erosion and sediment.

In 2016, the eastbound Peak Period Shoulder Lane Project on I-70 was substantially completed. The project includes permanent sediment control facilities (BMPs) that represent a significant improvement relative to pre-project conditions. Also, the US 6 Acceleration Lane Project was completed in 2016. This project created a formal chain-down station at the eastbound on-ramp from US 6 to I-70 near the headwaters of Clear Creek. Water-quality BMPs were included at the ramp and chain station areas to address the high rates of sand usage at this location.

2. Onsite Wastewater Treatment Systems

In 2016, Clear Creek County implemented the final phase of new regulations for OWTS (also known as septic systems). Under the new regulations, operating permits are required for any OWTS that that is designed to provide higher level treatment. The permit verifies that the mechanical and/or electrical components of the system are operating as designed. In 2016, seven operating permits, 19 standard treatment permits, 10 repair or alteration permits, and 115 use permits were issued.

3. Remediation

The Clear Creek Watershed Foundation (CCWF) completed the Middle North Empire Creek Restoration Project in 2016. This was the second of three phases to address sources of contamination to North Empire Creek. North Empire Creek drains into the West Fork of Clear Creek near the Town of Empire

The project included four components. In the first, the large (0.5 acre) waste pile at the Gold Dirt mine was reshaped and revegetated. Second, the waste pile at the Equator mine was removed to a repository. Third, a fluvial fan containing highly mineralized material was removed to a repository. The completion of these three were necessary to allow the final component to be completed—the restoration of the channel of North Empire Creek.

Gold Dirt Mine Waste Pile (left). Restored Channel of North Empire Creek (right)

F. General Public Education, Outreach and Partnerships

Outreach activities, primarily through festivals, seminars, and public meetings, are a key component of educating the public about the protection of water quality.

1. General Public Education and Outreach

Clear Creek Watershed Foundation: The CCWF organized and hosted the eighth annual Clear Creek Watershed Festival in September 2016. This popular event is held at Courtney Riley Cooper Park located along the banks of Clear Creek in central Idaho Springs. The event and creek-side venue provide the opportunity for watershed stakeholders to share their message and educate participants.

City of Golden: The Stormwater Program of the City of Golden continues its public education campaign by distributing educational materials and attending or hosting public events. Events in 2016 included the Water-Wise Seminar and Greener Golden. At these events, Golden distributes Garden-in-a-Box kits to encourage the planting of water-conserving landscapes.

Jefferson County: Jefferson County residents, and visitors to the watershed, had opportunities to learn about and be involved in programs that promote water quality and environmental stewardship. These opportunities were made available as part of the county's Public Education and Outreach and

Public Participation and Involvement programs. The Jefferson County MS4 and floodplain programs continue to participate in a number of public events to reach diverse audiences.

Hydroscape at City of Arvada's Stormwater Division Booth at Trails Day

City of Arvada: Public education and outreach continues to be a major component of Arvada's Stormwater Program. Education for contractors, city personnel, citizens, and students is provided by the city on an on-going basis. This ensures that the public is aware that city storm drains flow directly to waterways and that certain activities can contaminate those waterways. The city provides the public with various resources to increase their awareness, such as the adopt-a-street or trail program, storm drain marking, household hazardous chemical disposal and recycling, and brochures and demonstrations that are focused on preventing stormwater pollution. In 2016, city stormwater and environmental education staff had a booth at two festivals and spoke one-on-one to attendees about issues concerning water quality.

2. Recycling and Disposal of Household Chemicals and Hazardous Waste

Rooney Road Recycling Center: This facility provides critical recycling and disposal services for household hazardous waste and electronics. In 2016, the facility collected more than 604,000 lbs of household hazardous waste. Support and participation with the Rooney Road facility are provided by both Jefferson County and the City of Golden.

Clear Creek County: The Clear Creek County Transfer Station and Recycling Center continues to support efforts to protect the watershed. In 2016, three one-day household hazardous waste collection days were held. The year-round collection of household paint, through the PaintCare Program, filled a total of 25 Gaylord boxes (4'x4'x4'). Approximately 685 CY of screened compost from the transfer station were put to beneficial use in the county. Compost is offered for sale to the public and at a low or no cost for reclamation projects in the county. In 2016, the transfer station received 3,690,980 lbs of household trash, construction material, furniture, tires, appliances, and rubble. Residents recycled 871,520 lbs of metals, glass, plastic, cardboard, paper, and electronics.

3. Pharmaceutical Disposal

Prescription drug take-back events are an important way of ensuring that unused prescription drugs are not disposed of in landfills or sanitary sewers, thus preventing them from reaching Colorado's waterways. The City of Arvada and Arvada Police Department hosted a prescription drug take-back event at City Hall on April 7th, 2016 and recovered 2,875 lbs of prescription drugs. Also in 2016, the

Idaho Springs Police Department held its first ever drug collection event in cooperation with the Clear Creek Sheriff's Department.

G. Other Activities

The following section provides a description of various water quality-related activities that occurred in the watershed in 2016.

1. Standley Lake Infrastructure and Standley Lake Park

The Standley Lake Operating Committee, working with FRICO, continued to address water resources and water-quality issues along the Croke ditch and in Standley Lake itself. To that end, the following accomplishments were completed.

The inlet conduits and associated piping of the Standley Lake facilities were shut down and inspected in the fall of 2016. This was done to help ensure the continued reliable delivery of water from the lake to the water treatment facility. A second shut down was necessary to inspect the 102-inch lines on the upper and lower intakes. These shutdowns required the City of Westminster to use the Standley Lake Bypass Line. This line bypasses the lake, routing water directly from the canals feeding Standley Lake to the water treatment facilities. During this time, water was delivered to the City of Northglenn by diverting water from the Semper pipeline into the FHL canal. As part of these inspections), all boats and equipment were sprayed for aquatic nuisance species (ANS) prior to launching and diving.

The popularity of Standley Lake as a regional amenity was demonstrated by a 15-20% increase in visitation in 2016. Improvements to Standley Lake Park include the ongoing trail work for the Refuge-to-Refuge trail. Maintenance to the park included control measures for noxious species; both terrestrial and aquatic. Goats were used to mitigate noxious weeds in various areas of the park. Additionally, approximately 1,600 inspections were conducted on watercraft to control the spread of ANS.

2. City of Arvada Water Discharge Permit Management

As part of efforts to maintain and improve water quality, Arvada is committed to responsibly managing water discharges so as to not degrade downstream water quality. Two examples of this commitment are described in the following.

Arvada makes routine annual discharges of residual treated drinking water from the Arvada Water Treatment Plant to Ralston Creek. These occur after the plant is shut down in the fall. Water is discharged under a general discharge permit and is analyzed prior to discharge to ensure it meets all stream standards.

The City also obtained a new subterranean dewatering permit. This permit allows the operation of a system to dewater the foundation of the newly constructed Transit Hub. A sampling well and pump system have been installed on site to allow Arvada to conduct monitoring necessary for permit compliance.

3. Clear Creek County Wildfire Protection Plan and Wildfire Mitigation Grant Program

The Clear Creek County Office of Emergency Management continued work on community wildfire mitigation. The Echo Hills Wildfire Mitigation Project is ongoing. Work completed in 2016, or slated for completion in 2017, includes wildfire reduction measures on over 30 acres of County Right-of-Way and the creation of defensible space and hazardous fuels reduction around homes on approximately 23 properties covering 57 acres.

4. Source Water Protection Plans

Both Idaho Springs and Black Hawk worked on developing Source Water Protection Plans. The plan for Idaho Springs was successfully adopted. It is anticipated that Black Hawk's plan will be adopted in 2017.

5. Aquatic Invasive Species Management

Eurasian Watermilfoil - Eurasian watermilfoil (EWM; *Myriophyllum spicatum L)* is a non-native, noxious aquatic weed that grows rapidly at depths of up to 35 ft. EWM can grow into dense mats that severely interfere with recreation and can provide a substrate for blue-green algae growth. Blue-green algae blooms can ultimately cause taste and odor events in drinking water supplies. EWM was first observed in Standley Lake in 1998 and positively identified in 2000. EWM weevils, an herbivorous insect specialized to EWM, have been stocked on the west side of the lake on five occasions since 2002. When an adequate weevil population is sustained, the weevils may be able to control the spread of the milfoil. A substantial decrease in milfoil densities has been observed since the weevil stocking program. Additional contributors to EMW density declines include other insects, reservoir drawdown, and competition from native plants.

Eurasian watermilfoil near Control Site (Location M1, see Figure 14) in 2002

The 2016 EWM survey was performed on August 22, 2016. This marked the third consecutive year that the survey was performed[3] by City of Westminster personnel. Each of the ten sample sites

[3] As discussed in previous reports (e.g. Hydros [2016]), the plant survey underwent a change in methodologies in 2014. Prior to that time, sampling was performed by divers and focused on EWM weevils. Beginning in 2014, the survey method began using a rake for sample collection. The effect of the change in sampling

(Figure 16) was surveyed using an electronic depth finder to identify the densest part of the weed bed. A one-square meter (m^2) sample was collected at each location using a 1-meter wide rake. The vegetation samples were then returned to the lab for identification and enumeration. A subsample of 25 randomly chosen milfoil stems were selected for examination. A dissecting scope (40x magnification) was used to evaluate insect populations, insect damage to plants, and disease.

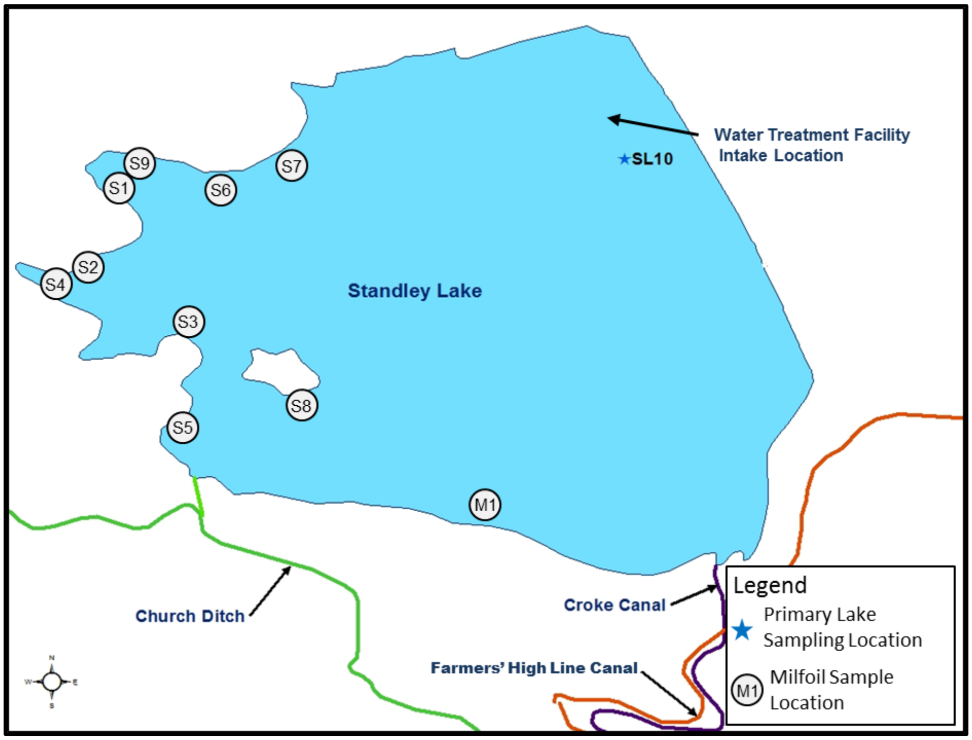

Figure 16. Milfoil Sample Locations

In 2016, average milfoil densities were 72.4 stems/m^2 (Figure 17). These densities are higher than the 2011 to 2015 average of 49.6 stems/m^2. The period from 2011 through 2016 has shown variability in milfoil density, however, it appears that densities have reached a semi-stable condition with an average density around a level of approximately 50 stems/m^2. The 2016 densities are on the higher end of conditions observed in the post-2011 period. The highest densities of EWM in 2016 were recorded at locations S8 and S9 (Figure 18), with densities greater than 100 stems/m^2. The remaining sites all had lower densities of EWM, ranging from 20 to 80 stems/m^2.

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methodologies on milfoil densities is uncertain, given the lack of a direct comparison. However, the milfoil densities measured in the 2014-2016 period (rake method) are consistent with milfoil densities measured in the preceding years (diver method).

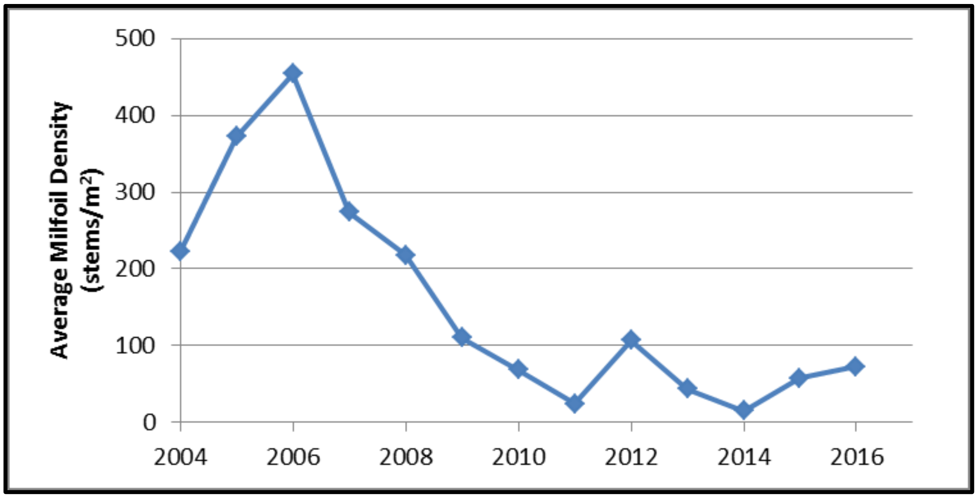

Figure 17. Average Milfoil Densities in Standley Lake (2004-2016) [pre-2014 data from Enviroscience (2013)]

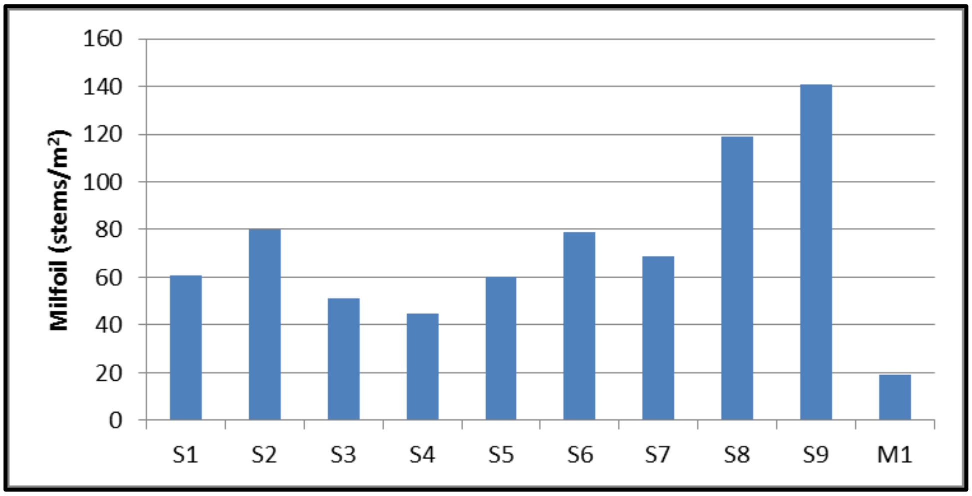

Figure 18. Milfoil Densities by Site, 2016

Weevil stocking appears to have played a significant role in the long-term decrease in EWM based on the observed relationship between weevil populations, EMW density, and plant damage. Many of the sites had strong evidence of weevil damage to EWM. Sites S2, S4, and S7 each had more than 70% of the EWM with weevil damage (Figure 19). However, other factors are likely contributing to the long-term decrease in EWM. Competition from other aquatic vegetation for the limited pool of available nutrients, minerals, and light provides an additional control on milfoil populations. This is shown in Figure 20 which provides a comparison of the abundance, expressed as a percentage of the total plant population, of milfoil at each sample site. The 2016 sampling showed an increased abundance of milfoil (average of 87% for all sites), relative to the 2015 (64%) and 2014 (51%) sampling events. The past three years have been a period of high water storage with minimal drawdown (discussed further in Section VI A). This may be a factor in the increasing abundance of EMW.

In summary, average EWM densities in Standley have decreased nearly 90% from peak densities in 2006. Since 2011, EMW densities have remained far lower than the peaks. From 2011 to 2016, the average EMW density has been around 50 stems/m^2. The maintenance of these lower EWM densities results from multiple controlling factors including EWM weevils, other herbivorous insects, and competition from other aquatic vegetation.

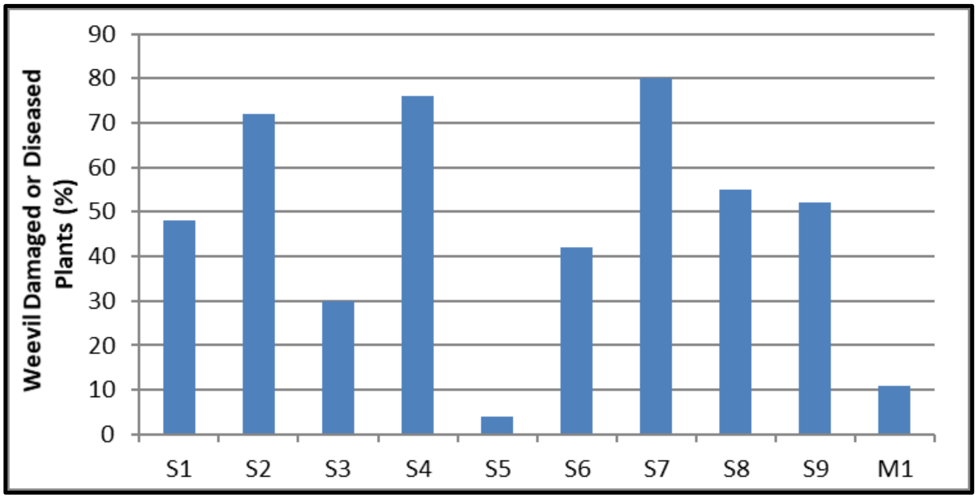

Figure 19. Weevil Damaged or Diseased Plants by Site, 2016

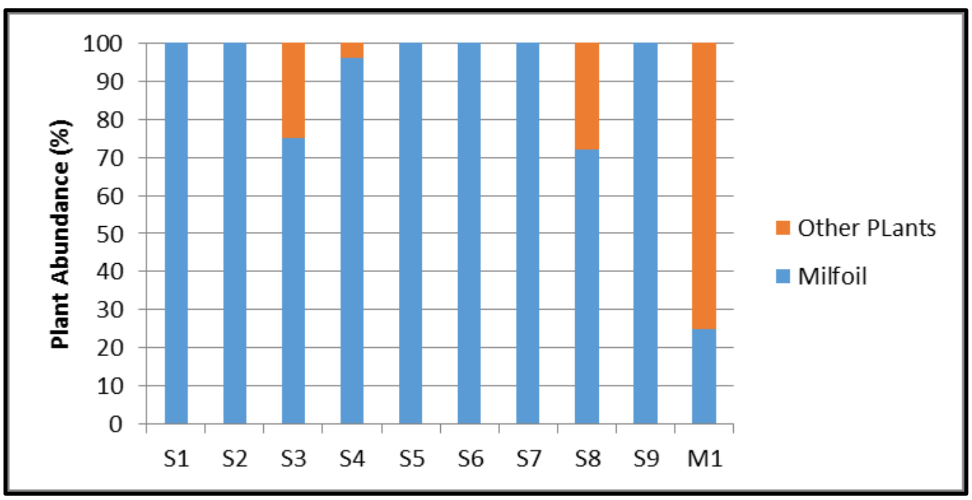

Figure 20. Relative Milfoil Abundance in Standley Lake in 2016

Zebra and Quagga Mussels - Zebra and quagga mussels are non-native, aquatic invasive species. They can be introduced to new water bodies by the unintentional transfer of organisms from an infested water body, often via boats or fishing bait. These mussels cause serious damage to the ecosystem and require costly control procedures for drinking water treatment facilities. Both zebra and quagga veligers (zebra or quagga mussel larvae) were discovered in a few of Colorado's lakes in 2008. Prevention is key to protecting Standley Lake from aquatic mussel infestation. An intensive boat inspection and decontamination program was initiated in 2008 to protect the lake from new invasive species. Additionally, no live aquatic baits are allowed in the reservoir.

Monitoring for these mussels in Standley Lake includes three methods: zooplankton tows, substrate samplers, and shoreline surveys. Standley Lake is monitored for aquatic mussels every two weeks using the zooplankton tow procedure. The tows are performed at the lake inlets, SL-10 (Figure 2), and the boat ramp/outlet area. Several invasive species have a planktonic life stage, and sampling with the plankton nets can provide early warning of infestation. In addition, substrate samplers, constructed and monitored by Colorado Parks and Wildlife, are placed throughout the lake. Substrate samplers are made up of a float, rope, plastic plates, and an anchor weight. A plate is located every 10 ft from the surface to the bottom of the lake. The plates and ropes are checked periodically for aquatic mussel growth. A plate or rope that feels like sand paper will be scraped and examined under the microscope for veligers. Shoreline surveys are performed when the water level is at the lowest for the year. A shoreline survey consists of walking the shoreline in teams looking for adult mussels attached to any hard substrate. Sampling tows, substrate samplers, and shoreline surveys from 2016 show that Standley Lake continues to be free of zebra and quagga mussels.

IV. Upper Basin Flows and Water Quality

The previous section provided highlights of the activities and accomplishments undertaken by interested entities to manage, enhance, and protect the water quality of the Clear Creek watershed. This section describes an analysis of water-quality data in the Upper Basin in 2016. Constituents included in this analysis are discharge (flow), total suspended solids, total phosphorus, and total nitrogen. The analysis is based on data from two sampling locations CC26 (Clear Creek at Lawson Gage) and CCAS59/60 (Clear Creek upstream of the Church Ditch headgate) (Figure 6). The data from each location include both grab samples and composite samples. Grab samples represent the conditions at a single point of time. Composite samples, comprised of multiple samples collected over 24 hours represent the conditions occurring over the entire collection period. The data presentation and discussion in this section focus on ambient (non-event) samples. However, loading estimates are presented both including and excluding the event samples (e.g. storm event samples).

Water quality in the upper portion of the Upper Basin is represented by location CC26. This station is located on the main stem of Clear Creek (Figure 6) between Georgetown and Idaho Springs. This location includes samples from stations CC26 (grab) and CCAS26 (autosampler). Water quality in the lower portion of the Upper Basin is represented by location CCAS59/60. This combined station includes samples from CCAS59 (autosampler and grab) and CC60 (grab). The two stations are located upstream of the Church Ditch headgate in Golden.

A. Discharge

The annual hydrographs for Upper Basin location (CC26) exhibited twin peaks in flows—one higher peak in early June followed by a secondary peak in late June (Figure 21). The mid-June decrease in flows appears to have been driven by a period of low temperature in the upper portion of the basin; the low temperatures would have decreased the rate of snow melt. The overall pattern--rising in early April and steeply increasing mid-May, coinciding with snowmelt runoff, was consistent with past years. The annual hydrograph at the lower location (CC60) demonstrated patterns consistent with both the twin-peak in flows and the overall patterns. At both locations, peak annual flow rates occurred in early June and the falling limb of the snowmelt hydrograph extended through the summer punctuated by a few increases in stream flow associated with precipitation events.

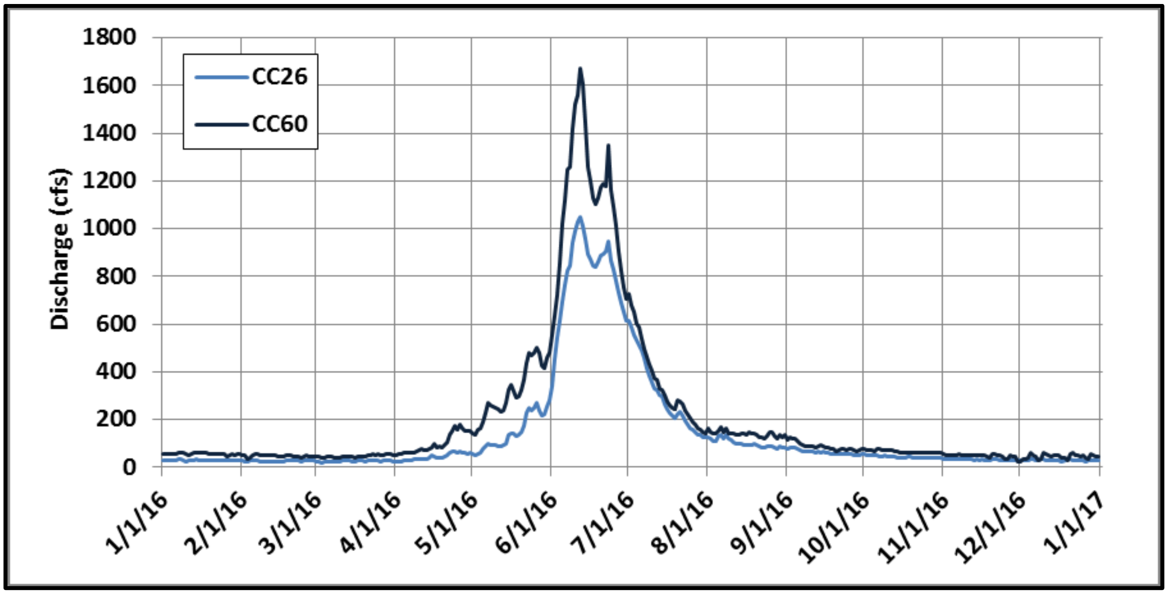

Figure 21. 2016 Clear Creek Hydrographs (CC26, CC60)

Total annual flows at the upper station (CC26) of 98,860 AF were below (-14%) the 2011-2015 average of 114,634 AF. Annual flows at the lower station (CC60) of 146,029 AF were also lower (-9%) than the 2011-2015 average of 160,691 AF. Compared to the longer-term average however, flows at CC60 were slightly (5%) above the average (1975-2015, 139,334 AF). This reflects the higher than normal flows in recent years. Total annual flow volumes (in AF per year) for 2011-2016 are presented in Figure 22, which also includes the 2011-2015 average flow volume at each location for reference.

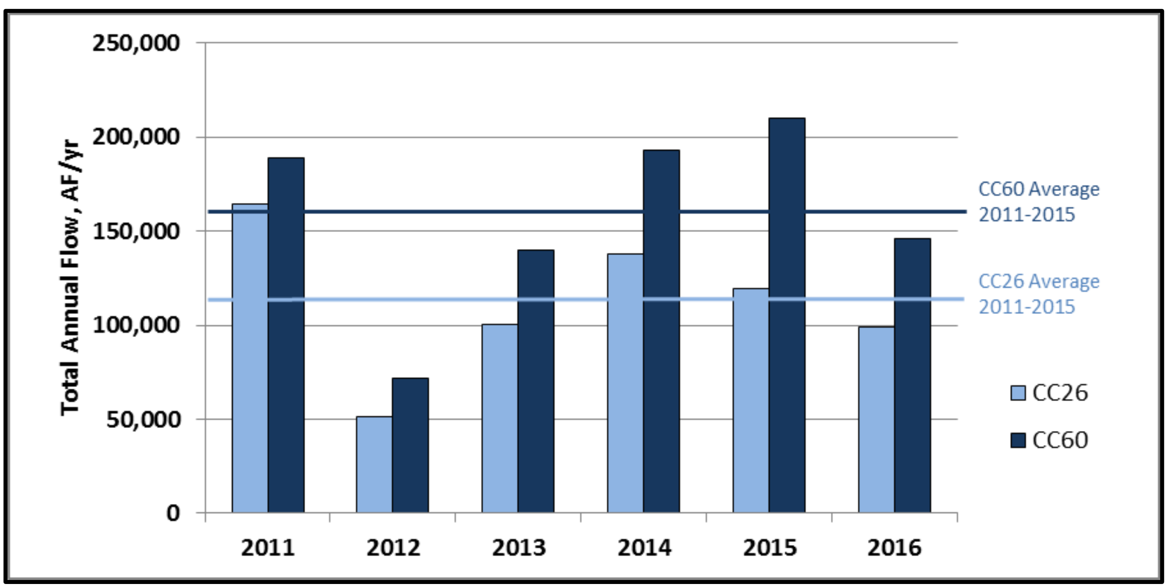

Figure 22. Total Annual Flow in Clear Creek at CC26 and CC60, 2011-2016

Hydrographs from CC60 for 2011-2016 are shown in Figure 23. The timing, patterns, and magnitude of flows in 2016 are generally consistent with those of previous years.

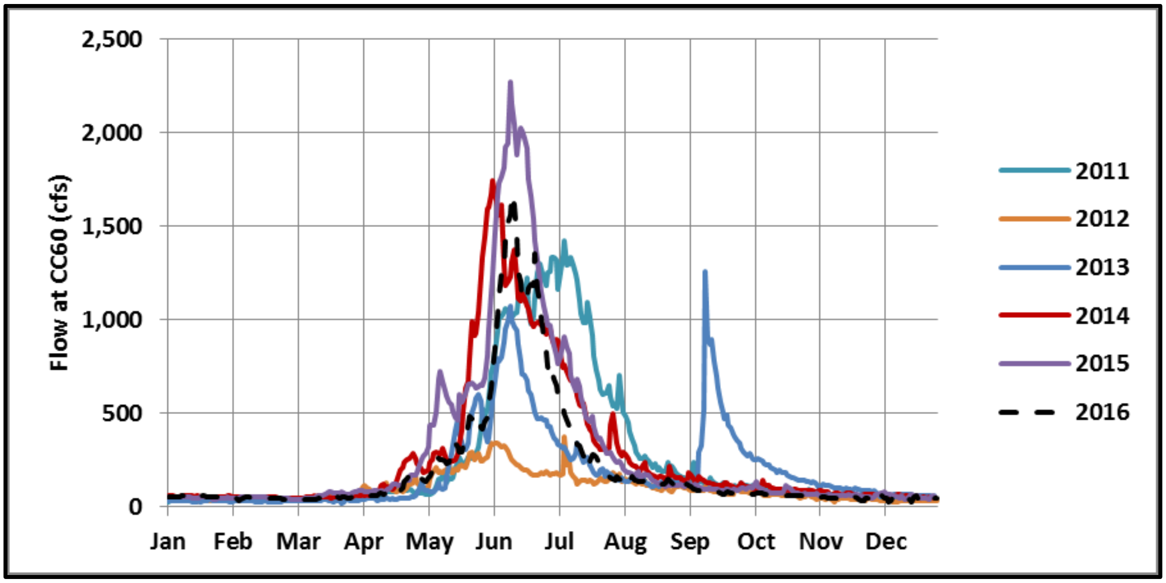

Figure 23. Annual Clear Creek Hydrographs for 2011-2016 (CC60)

B. Total Suspended Solids

Total suspended solids concentrations in 2016 from grab samples and ambient composites from at CCAS59/60 and CC26 are displayed in Figure 24. The highest TSS concentration (39 mg/L) was measured at the lower station (CCAS59) on August 30, 2016. The maximum observed TSS (6 mg/L) for the upper portion of the basin (CCAS26) was observed on June 27, 2016. Changes in land use, increased anthropogenic disturbance, and decreases in forest cover all contribute to increased TSS concentrations at the lower station.

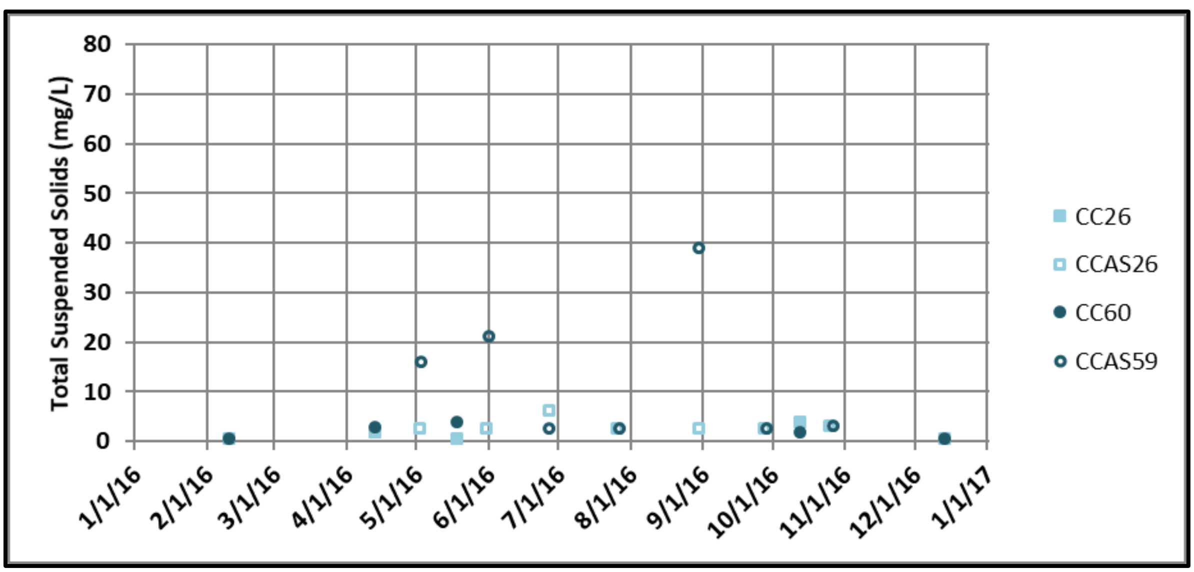

Figure 24. Total Suspended Solids Concentrations (Non-Event) in the Upper Basin, 2016

Non-storm-event TSS sample results in the Upper Basin over the last six years are presented in Figure 25. In this figure, and subsequent related figures for TP and TN, the November to March period is highlighted in grey. This is done to emphasize the seasonality of the observed water quality patterns. A general pattern of higher concentrations at the lower location (CCAS59/60) is apparent. Peak springtime TSS concentrations at both CCAS59/60 and CC26 were lower than the peak concentrations observed in previous years.

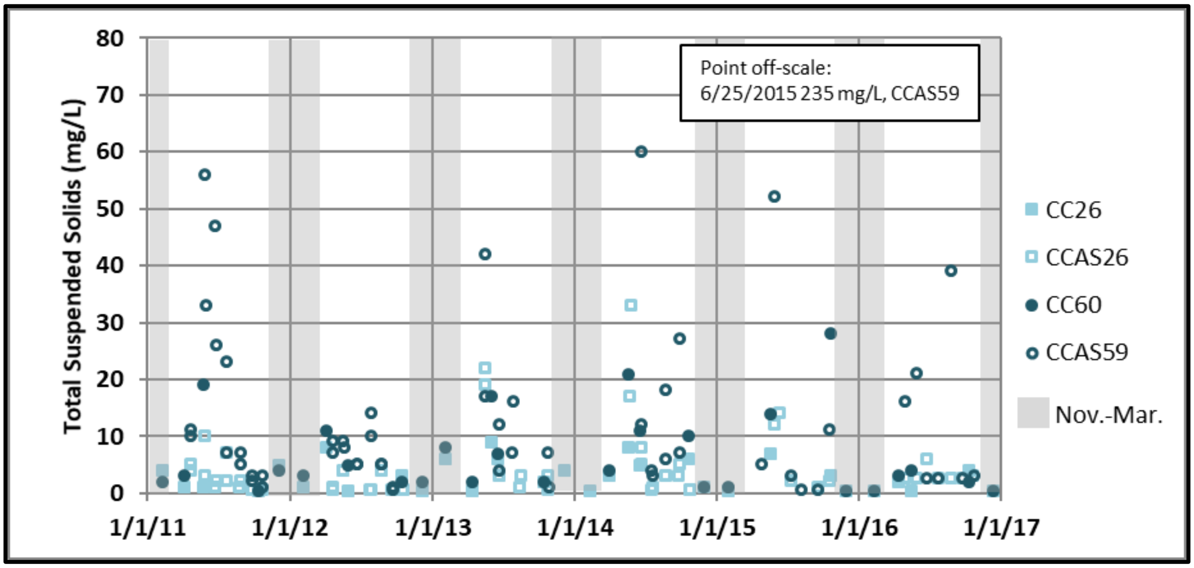

Figure 25. Total Suspended Solids Concentrations (Non-Event) in the Upper Basin, 2011-2016

Average monthly TSS concentrations in the lower portion of the basin in 2016 are compared to the average and range of previous years (2011-2015) in Table 6. Monthly concentrations in 2016 were generally lower than averages of the previous five years; May and June showed the largest magnitude differences (May 11.1 mg/L and June 25.8 mg/L below respective five-year averages).

Table 6. Monthly Average Total Suspended Solids Concentrations (Non-Event) in the Upper Basin at CCAS59/60

Month	2016 TSS Concentrations (mg/L)	2011-2015 Average and Range of TSS (mg/L)	% Difference -- 2016 Versus 2011-2015 Average
February	0.5*	3.5 (1.0-8)	-86%
April	3.0*	6.9 (2.0-11)	-56%
May	10.0	21.2 (5.0-56)	-53%
June	11.8	37.6 (4.0-235)	-69%
July	2.5*	9.7 (3.0-23)	-74%
October	2.5	6.6 (0.5-2.8)	-62%

* "Average" based on only one observed value.

One possible explanation for these decreases in concentration in May and June is that the sampling dates may have missed the higher concentrations that typically occur during the period of snowmelt. The samples collected in May and early June occurred on the rising shoulder of the flow peak (Figure 26). The samples collected in late June occurred between the peaks of flow. If patterns observed in previous years were followed, it is likely that higher TSS concentrations may have occurred in early- to mid-June during the period of sharply rising flows.

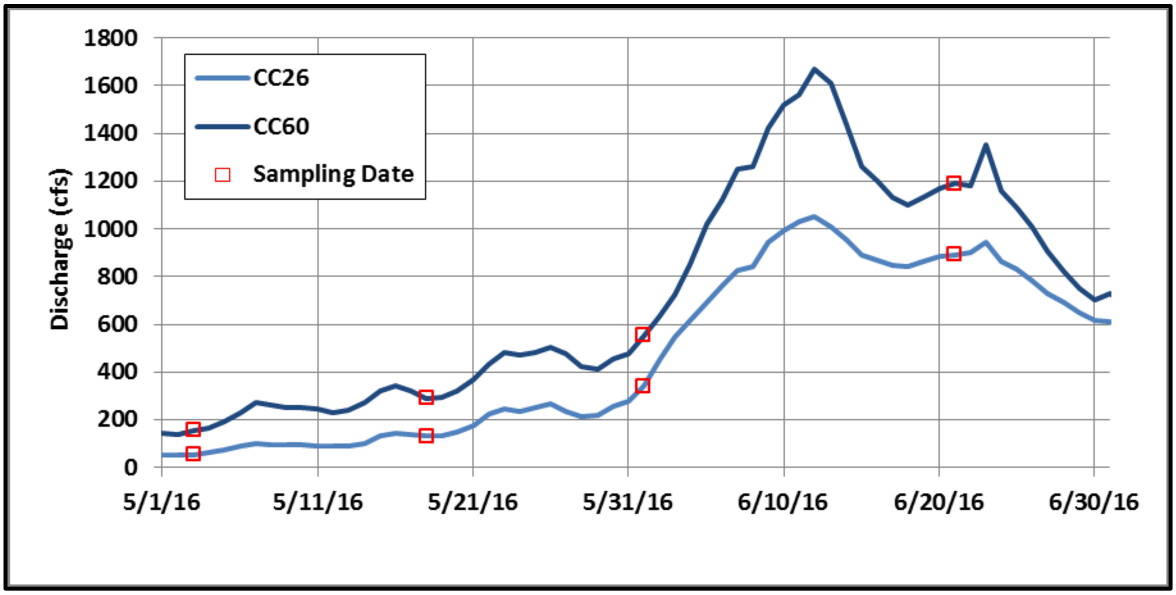

Figure 26. Sampling Dates for CC26 and CC60 in 2016 and Daily Streamflow Values

An analysis was performed of the longer-term record (2005-2016) of TSS concentrations in the Upper Basin. This analysis did not show evident patterns in TSS concentrations in the Upper Basin at either the CC26 or the CCAS59/60 locations.

Loads were calculated using daily flows, from USGS gage measurements, and concentration data, from samples collected as part of the Upper Clear Creek/Standley Lake Watershed Water Quality Monitoring Program. A mid-point step function was used to fill in daily concentrations between available sample data. Annual loads are then calculated as the sum of individual daily loads. Non-storm-event TSS loading at CC26 and CCAS59/60 was calculated for 2016 and compared to estimates from 2011-2015 (Figure 27). At both locations, loads were lower than all other years except for 2012.

Volume-weighted concentrations were computed at the two key locations for the past six years (Figure 28). They were calculated by summing the annual load and dividing by the annual flow volume. Volume-weighted concentrations were lower than concentrations calculated for the past five years. This result is expected given that loadings were low but flows volumes were only slightly below average.

In summary, the TSS concentrations and loads in 2016 were lower than those typically observed. It appears possible that sampling in 2016 missed peak TSS concentrations during snowmelt. Both the upstream and downstream station showed similar seasonal patterns in TSS loading and concentrations.

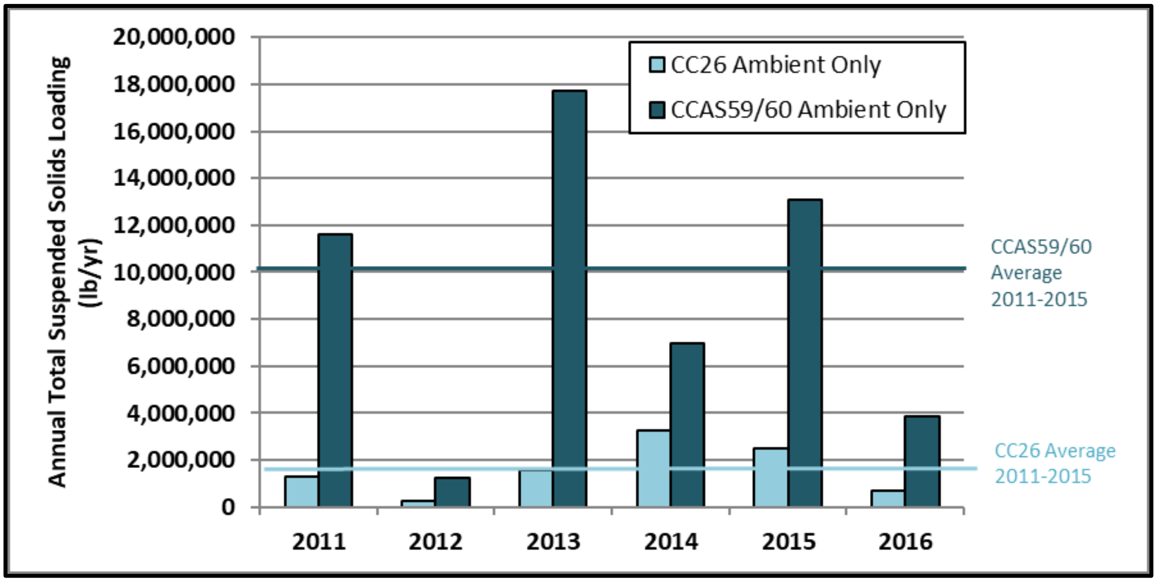

Figure 27. Total Suspended Solids Loading Estimates in the Upper Basin, 2011-2016

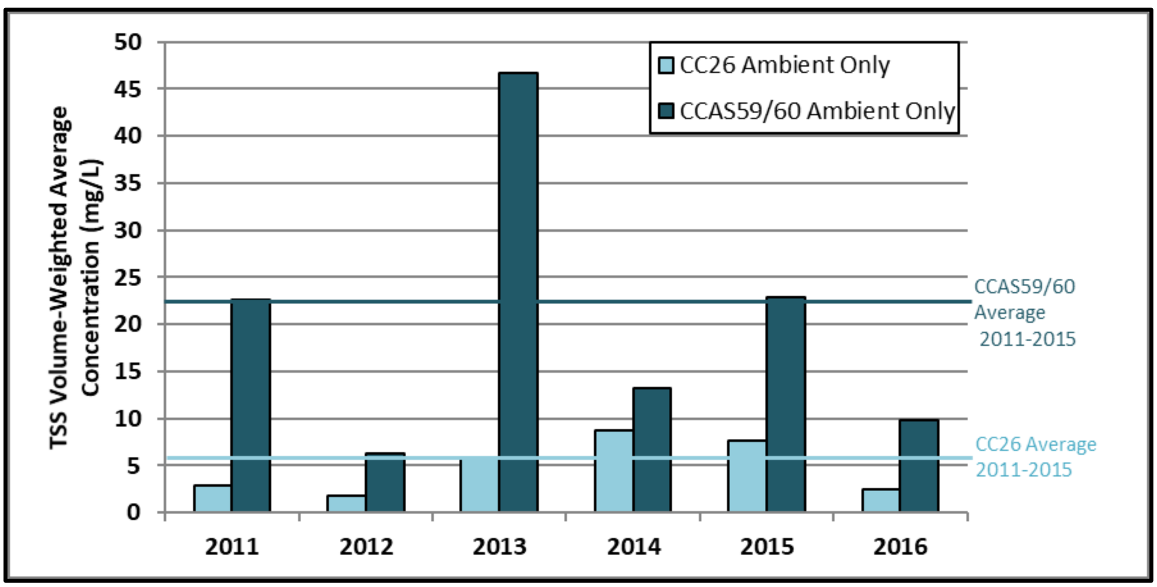

Figure 28. Total Suspended Solids Volume-Weighted Concentration Estimates in the Upper Basin, 2011-2016

C. Total Phosphorus

Total phosphorus concentrations from grab samples and ambient composites in the Upper Basin are displayed in Figure 29. At CC60 concentrations show a slight increase in May relative to the remainder of the year. At CC26, and for most of the year at CC60, TP concentrations show little variation and are typically around 10 µg/L. The maximum measured concentration of 26.6 µg/L occurred on June 1, 2016 at CC60.

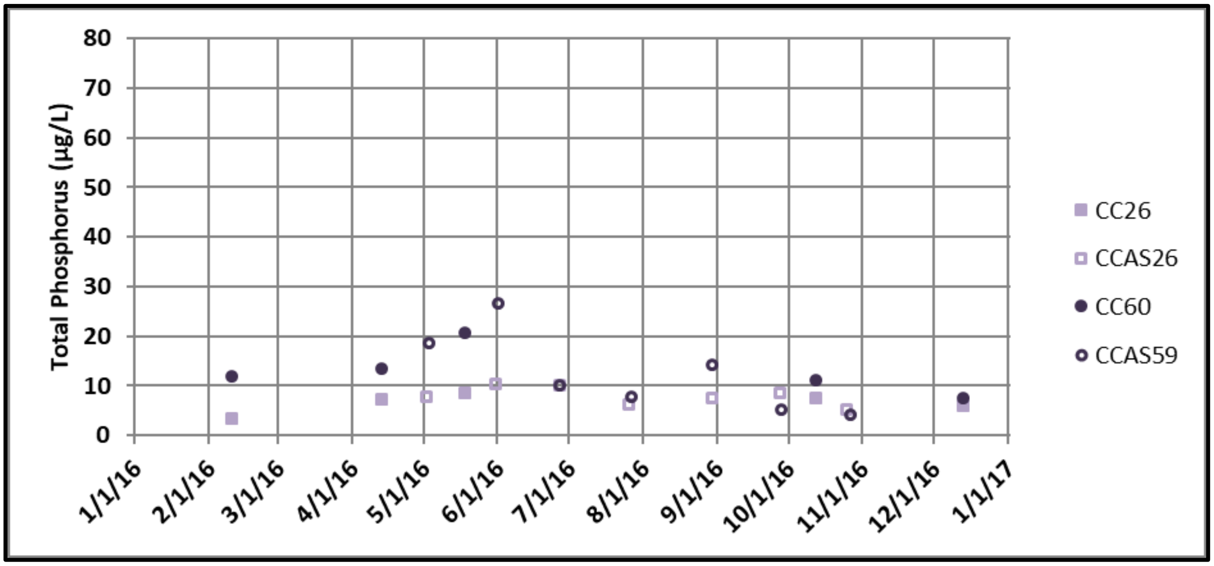

Figure 29. Total Phosphorus Concentrations (Non-Event) in the Upper Basin, 2016

Typically TP concentrations at both stations show a substantial increase during the snowmelt period. However in 2016, as can be seen in Figure 30, this pattern was not as strong as observed in past years. As discussed for TSS, this may be explained by the timing of sample collection 2016. Conceptually, TP concentrations are closely linked with TSS due to particle-associated transport. The similarity in concentration patterns for TSS and TP in 2016 is consistent with this understanding.

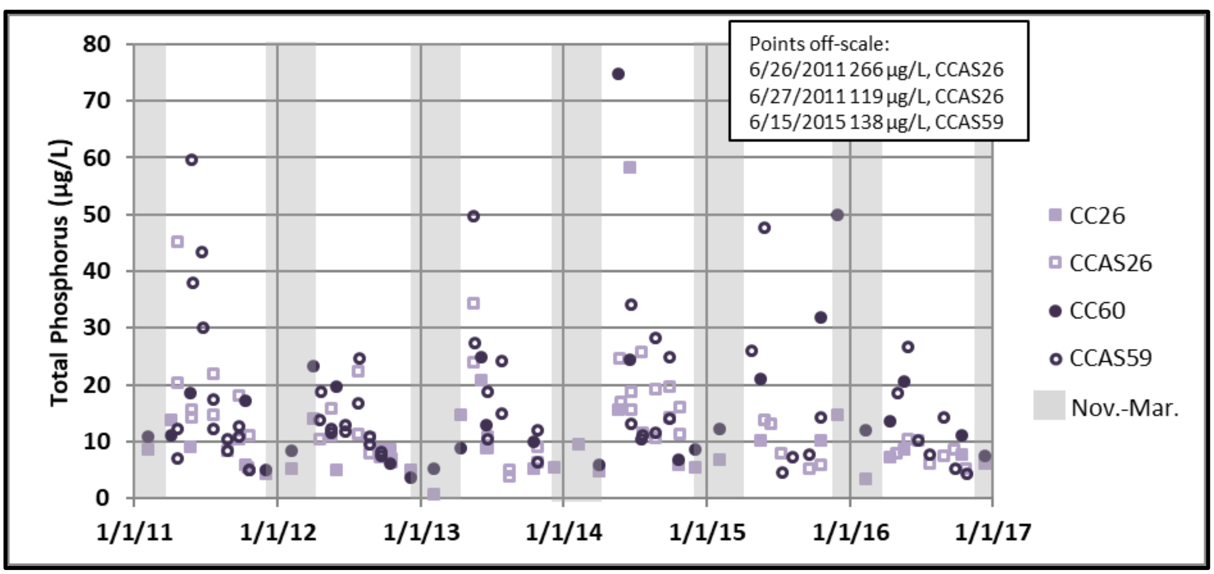

Figure 30. Total Phosphorus Concentrations (Non-Event) in the Upper Basin, 2011-2016

Monthly average TP concentrations for 2016 and the 2011-2015 average and range are shown in Table 7. In general, 2016 monthly TP concentrations are relatively consistent throughout the year. These concentrations are generally lower than the average 2011 to 2015 concentrations.

Table 7. Monthly Average Total Phosphorus Concentrations (Non-Event) in the Upper Basin at CCAS59/60

Month	2016 Average TP (μg/L)	2011-2015 Average and Range of TP (μg/L)	% Difference -- 2016 Versus 2011-2015 Average
February	12.0*	9.2 (5.3-12.3)	31%
April	13.5*	14.0 (5.9-25.8)	-3%
May	19.5	32.7 (11.5-74.7)	-40%
June	18.4	32.8 (10.3-138)	-44%
July	7.7*	15 (4.5-24.5)	-49%
October	7.7	11.6 (4.8-31.9)	-34%

*"Average" based on only one observed value

An analysis was performed of the longer-term record (2005-2016) of TP concentrations in the Upper Basin. This analysis did not show evident patterns in TP concentrations in the Upper Basin at either the CC26 or the CCAS59/60 locations.

Non-storm-event TP loading at CC26 and CCAS59/60 was calculated for 2016 and compared to estimates from 2011-2015 (Figure 31). Loads in 2016 were lower than the 2011-2015 average. This decrease in loading is expected given the decrease in concentrations observed relative to previous years.

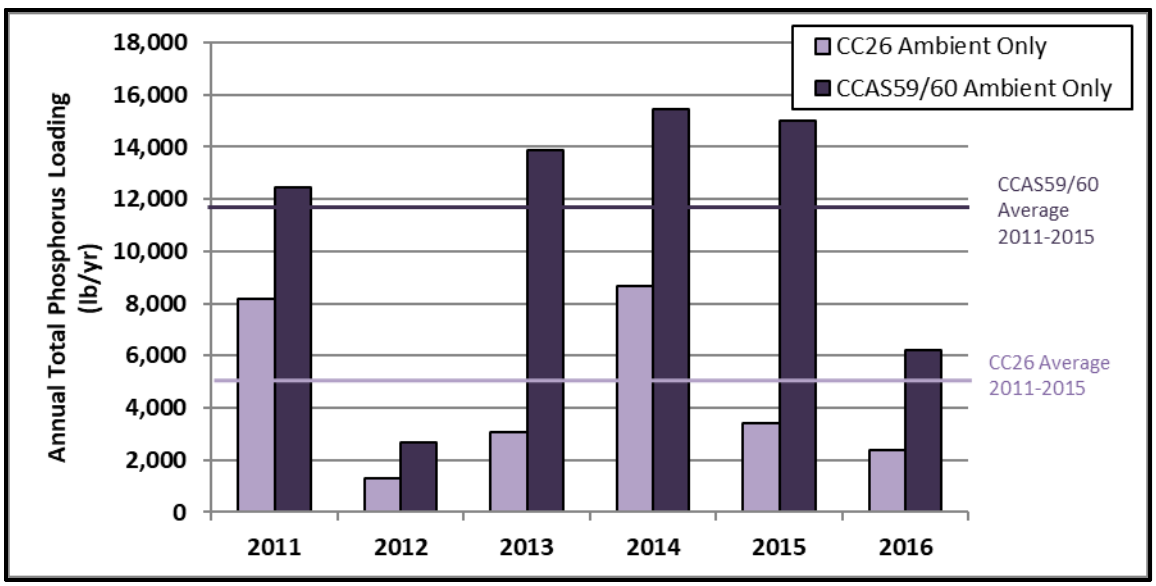

Figure 31. Annual Total Phosphorus Loading Estimates in the Upper Basin, 2011-2016

Volume-weighted concentrations (annual load divided by annual volume) of TP at CC26 and CCAS59/60 are presented in Figure 32 for 2011-2016. In 2016, volume-weighted concentrations at CCAS59/60 were lower than the average of the previous five years.

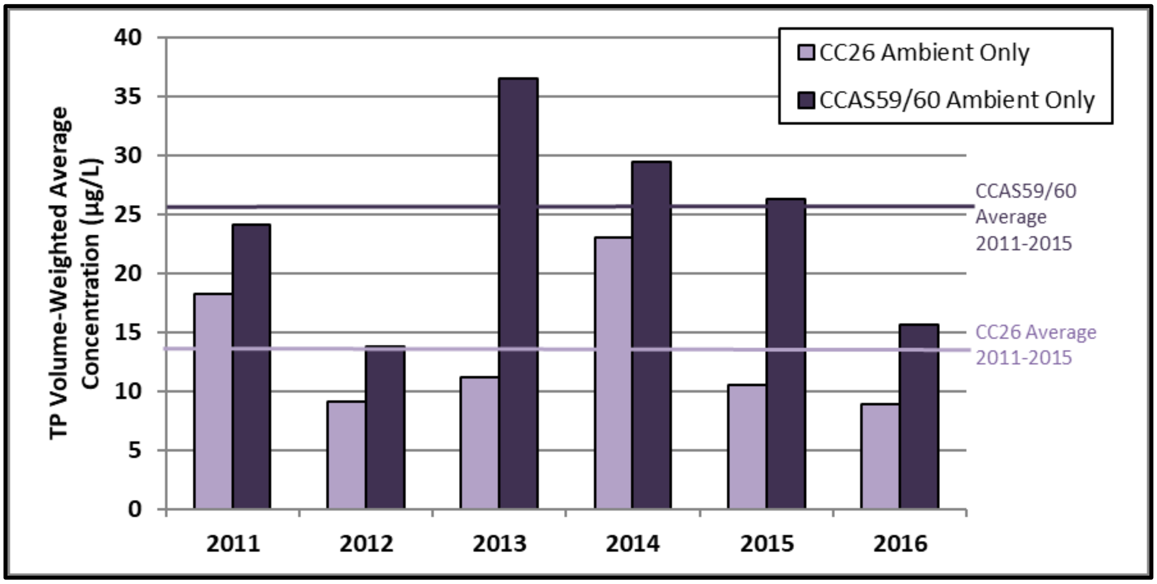

Figure 32. Volume-Weighted Total Phosphorus Concentration Estimates in the Upper Basin, 2011-2016

In summary, TP concentrations in 2016 were lower than average. These lower concentrations are reflected in the loading and volume-weighted average concentrations. As discussed for TSS, it appears that these low TP concentrations may be the result of sample timing rather than a reflection of an actual large decrease in TP concentrations. Concentrations of TP in Clear Creek at both the upstream and downstream stations are typically below the relevant water-quality standard.

D. Total Nitrogen

Ambient total nitrogen concentrations observed in the Upper Basin for 2016 based on grab and composite sample data are presented in Figure 33. Data from both stations follow the same general seasonal pattern, with lower concentrations during the summer months, and higher concentrations during the winter and early spring. This pattern is the inverse of the pattern for TSS and TP; indicating that the mechanisms of nitrogen loading are different. The maximum non-storm-event concentration observed at CC26 of 460 µg/L was observed on February 10, 2016. The maximum concentration of 650 µg/L at CC60 was observed on February 10, 2016.

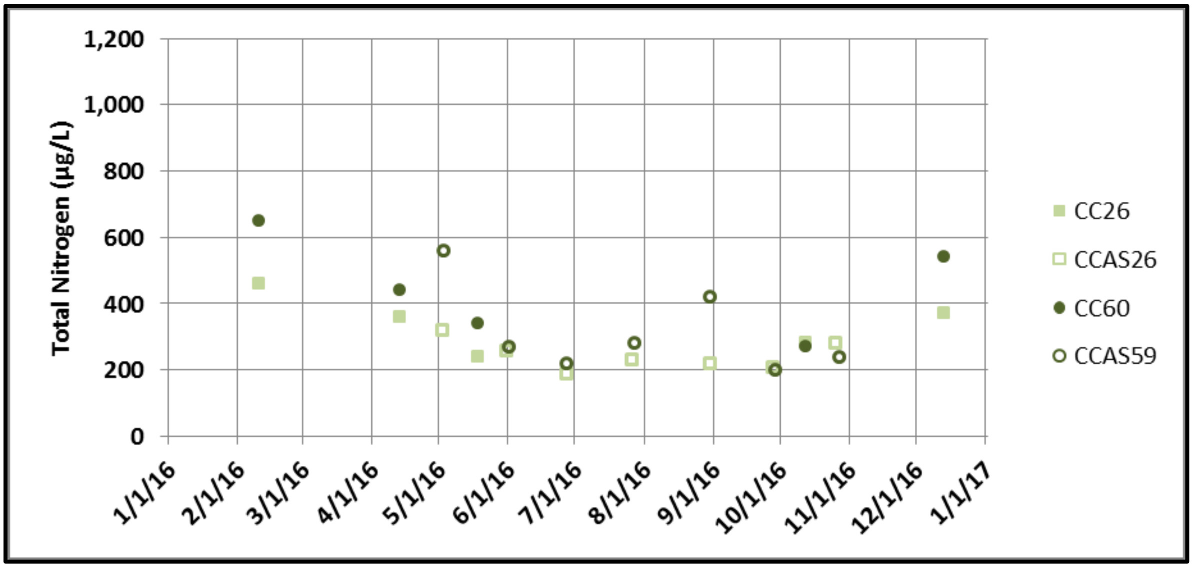

Figure 33. Total Nitrogen Concentrations (Non-Event) in the Upper Basin, 2016

A temporal pattern of lower TN concentrations in summer and higher concentrations during the winter low-flow period (typically November to March) winter was observed in the 2016. This pattern in ambient TN concentration data is consistent with previous years (Figure 34). This pattern is driven by the dilution of sources during periods of higher flow.

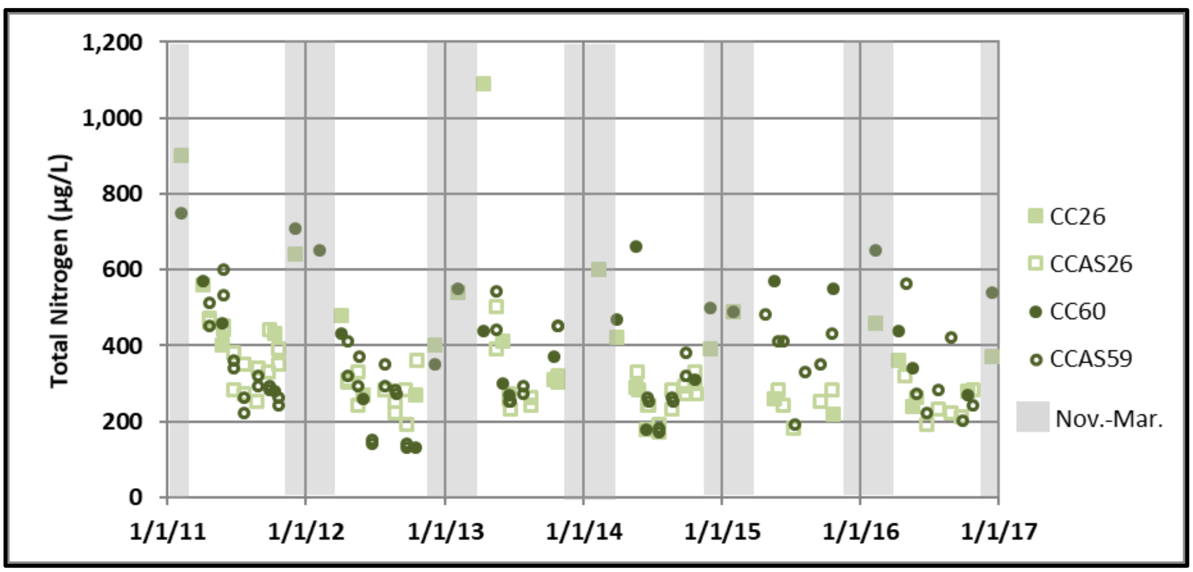

Figure 34. Total Nitrogen Concentrations (Non-Event) in the Upper Basin, 2011-2016

A comparison of monthly average TN concentrations at CCAS59/60 for 2016 and the 2011-2015 average is provided in Table 8. These non-storm-event results for TN from 2016 are all within observed ranges from the previous five years. Further, monthly 2016 concentrations are generally similar to the monthly averages from 2011 to 2015.

Table 8. Monthly Average Total Nitrogen Concentrations (Non-Event) in the Upper Basin at CCAS59/60

Month	2016 TN (µg/L)	2011-2015 Average and Range of TN (µg/L)	% Difference -- 2016 Versus 2011-2015 Average
February	650*	610 (490-750)	7%
April	440*	453 (320-570)	-3%
May	450	466 (260-660)	-3%
June	245	293 (140-530)	-16%
July	280*	247 (170-350)	14%
October	255	345 (130-550)	-26%

*Average based on one observed value

Analysis of the long-term record (2005-2016) did not result in any evident patterns in TN concentrations in the Lower Basin at CCAS59/60. However, in the Upper Basin (CC26) there appears to be a continued pattern of sustained lower TN concentrations for the period of 2012-2016 when compared to the 2005-2011 period (Figure 35). As discussed in the 2015 Standley Lake Report (Hydros 2016), it is likely that this decrease is the integrated result of facility upgrades at the Georgetown WWTF, process improvements at other facilities, and the diverse range of other watershed activities undertaken to improve water quality in the Clear Creek basin.

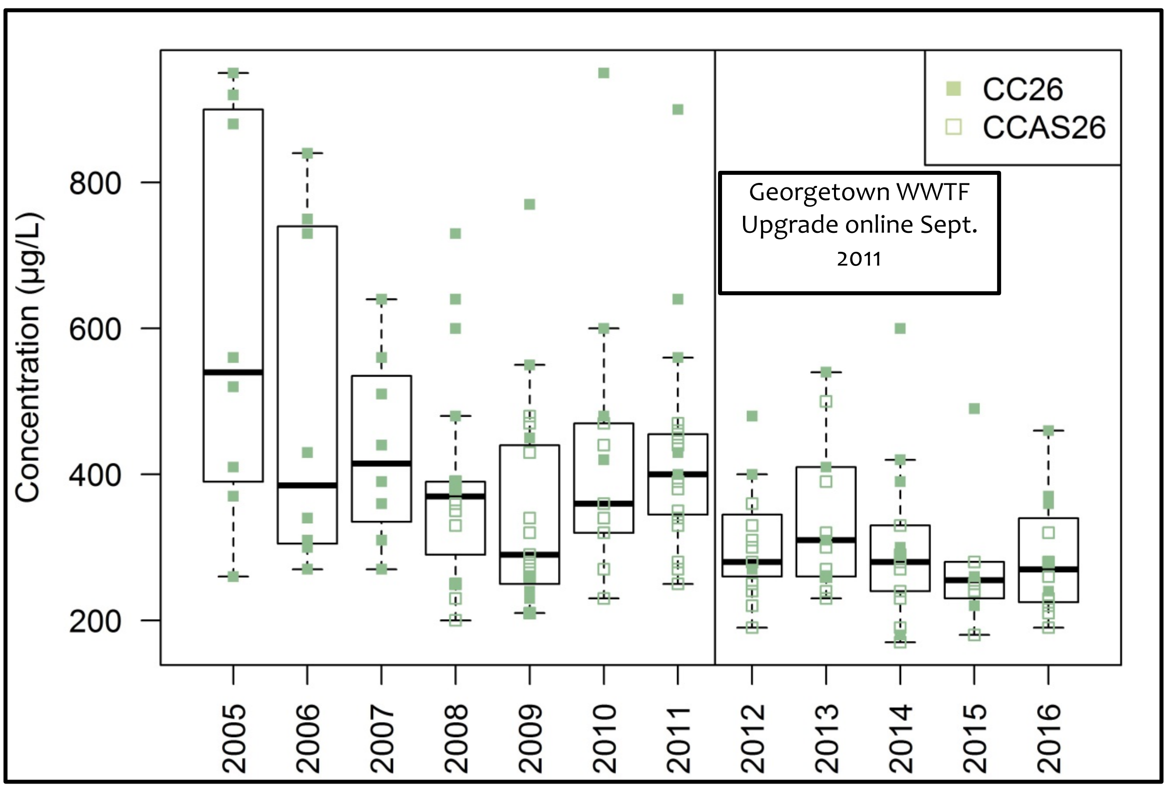

Figure 35. Total Nitrogen Concentrations at CC26 for the period of 2005-2016

Loading at both CCAS59/60 and CC26 are lower than the average of the past five years (Figure 36). This decrease in loads is driven by the combined effect of slightly lower flows and lower concentrations.

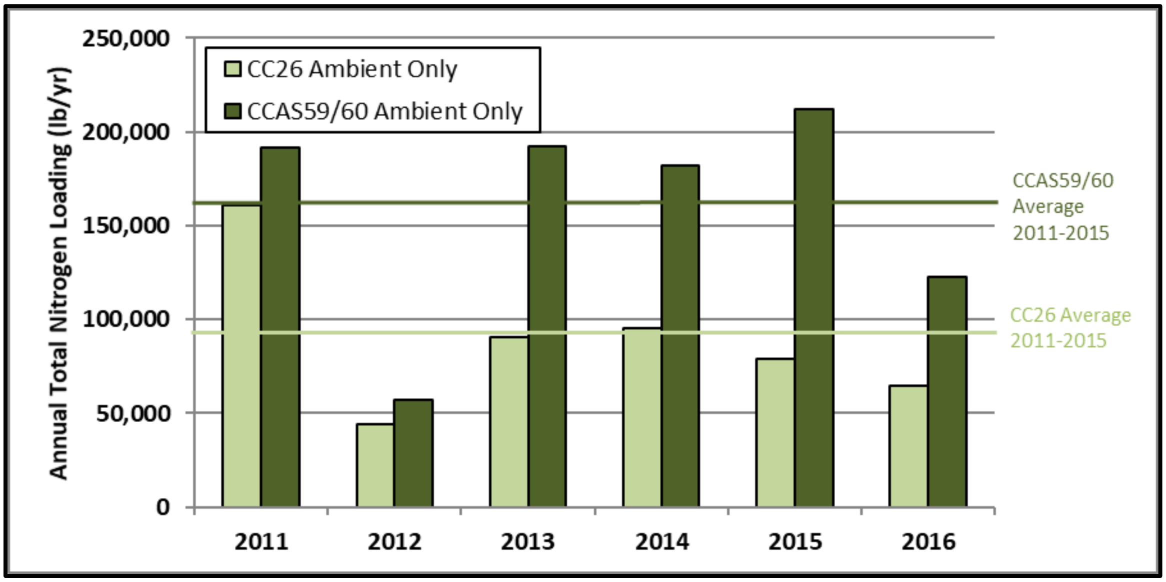

Figure 36. Total Nitrogen Loading Estimates in the Upper Basin, 2011-2016

Volume-weighted concentrations (annual load divided by annual volume) of TN at CC26 and CCAS59/60 are presented in Figure 37 for 2011-2016. Volume weighted concentrations of TN at both stations are slightly below the averages of the previous five years.

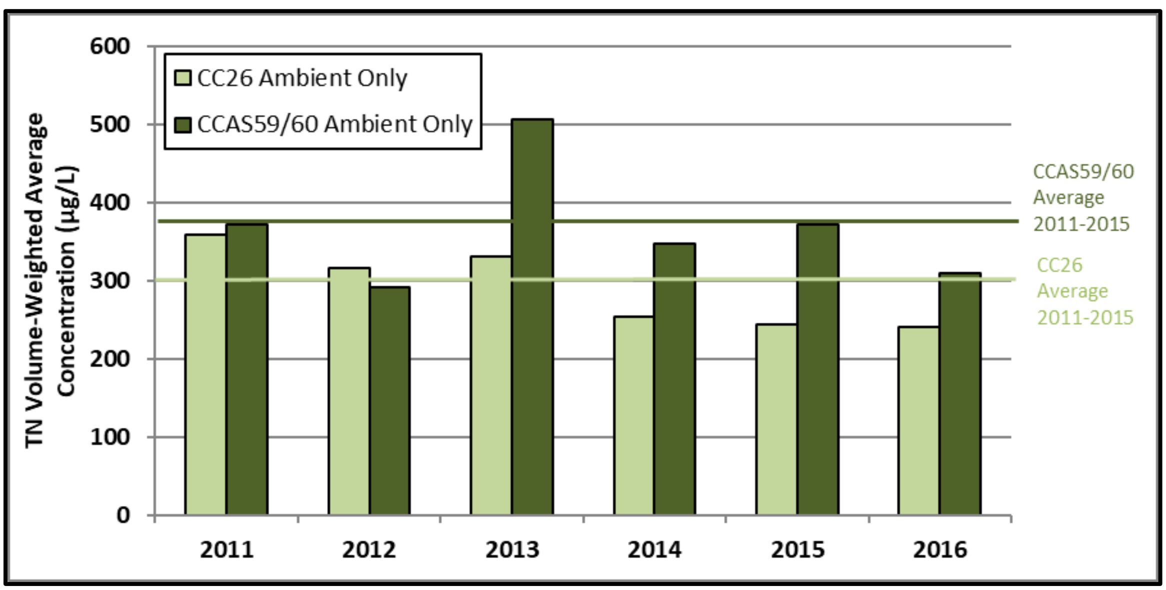

Figure 37. Volume-Weighted Total Nitrogen Concentration Estimates in the Upper Basin, 2011-2016

In summary, TN concentration patterns in 2016 were similar for the upstream (CC26) and downstream (CC60) locations; this is in contrast to the observations for TSS and TP. Concentrations of TN in the Upper Basin were generally consistent with those observed in the previous five years. However, the loading estimates for 2016 were lower than most of the previous years. This decrease in loading is consistent with the decrease in volume-weighted concentrations of TN in 2016. All observed concentrations of TN in Clear Creek from ambient samples were below the relevant water-quality standard for both the upstream and downstream stations.

E. Effects of Storm Events on Loading

The loading calculation results described earlier in this section include grab samples and ambient composite data. These types of samples, which are taken at regular intervals, are not intended to capture the water-quality response to storm events. It is widely recognized, however, that precipitation events can result in substantial changes to water quality. As such, since 2006 event-triggered sampling has been conducted and this was continued in 2016 at station CC59. For the event-triggered samples, the storm-event concentrations were assumed to represent concentrations for the full day of the composite sample, though runoff events can cover longer or shorter periods. The storm event data were collected at station CC59 and the ambient data were collected at CCAS59/60.

In July and August 2016, four event-triggered samples were collected at CC59. The effects of these storms on loading estimates are presented in Table 9 and Figure 38. Incorporating these event samples into the loading calculations increases the annual loads of TN (8%), TP (30%), and TSS (45%). The effects are even more apparent loading estimates for the individual months (Table 9).

The effects of a single storm event are exemplified by the August 30, 2016 event. This single-day event is estimated to have contributed 6,952 lbs of TN, 921 lbs of TP and 816,218 lbs of TSS of loading. These amounts represent a substantial fraction of the annual loading (TN: 6%, TP: 15%, TSS: 21%); and represents a substantial fraction of the loading differences seen in Figure 38. The large loading estimates for August 30, 2016 are the result of the high concentrations measured on this date (TN: 10,650 µg/L; TP 1,370 µg/L and TSS: 1,240 mg/L). While not all storm events have such high concentrations, and correspondingly large impact on annual totals, this event demonstrates the importance of understanding the effects of storm events on water quality. The comparison of the effects of storm events on a year-to-year basis is not straight forward. The effects of storm events on loading estimates are highly dependent on the number of storm events captured by sampling and by the concentrations observed during each individual event.

Table 9. Effect of Storm Events on Annual and Monthly Loading at CCAS59/60

Time Period	Increase in TN Loading with Storm Events	Increase in TP Loading with Storm Events	Increase in TSS Loading with Storm Events
2016 (Annual Load)	8%	30%	45%
July 2016 (Monthly Load)	16%	159%	592%
August 2016 (Monthly Load)	85%	377%	167%

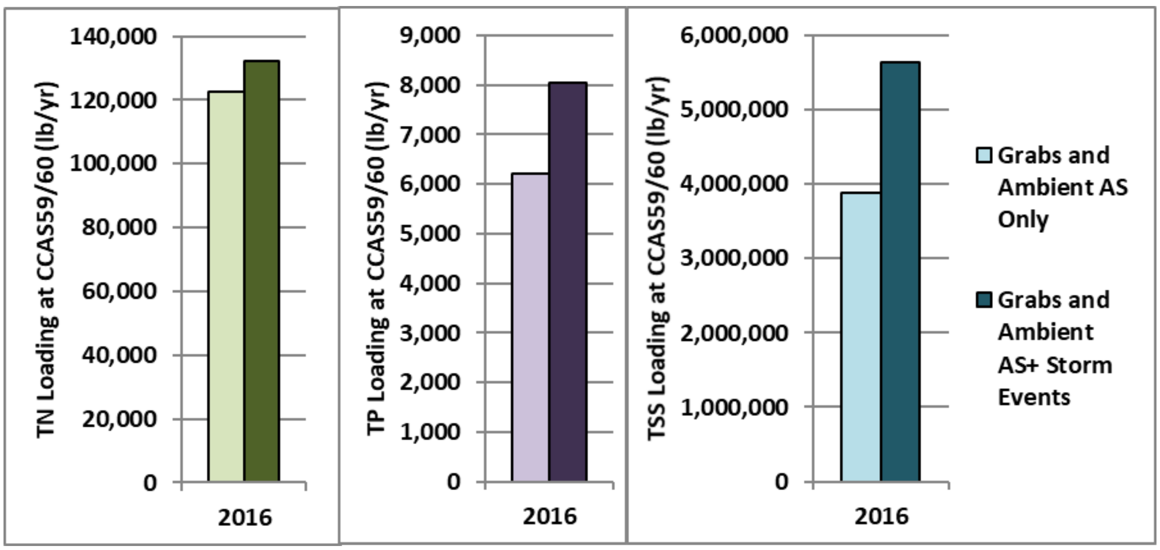

Figure 38. Total Nitrogen, Total Phosphorus, and Total Suspended Solids Loading in 2016 With and Without Storm Events (Ambient Samples Collected at CCAS59/CC60, Storm Event Samples Collected at CC59)

F. Upper Basin Summary

In summary, annual flows at CC26 and CC60 were slightly below the 5-year averages. However, at CC60 the flows were slightly above the longer-term average. The pattern and timing of peak flows was generally consistent with past years. However, in 2016 a period of cold weather in the upper extent of the Clear Creek watershed resulted in a period of decreased flows and a two-peaked pattern. The annual loads of TSS and TP, as measured at both CC26 and CC60 were below average. This appears to be primarily driven by decreases in concentrations in May and June. It appears that the timing of the sampling in 2016 may have bracketed the period of likely highest concentrations (associated with peak snowmelt flows). The loads and concentrations of TN were consistent in pattern and magnitude with past years. At the CC26 station, the pattern of lower TN concentrations in the post-2011 period, appears to continue when compared to the pre-2011 data. This pattern is likely to be primarily the result of WWTF upgrades and process improvements with contributions from other watershed activities intended to improve water quality in the Clear Creek watershed.

V. Canal Zone Flows and Water Quality

The Upper Basin is the source for the water diverted into the inflow canals to feed Standley Lake. This section presents the timing and volume of flows for the inflow canals. In addition, this section provides a description of water-quality changes along the FHL and Croke canals from their points of diversion on Clear Creek to the reservoir.

A. Flows

Water enters Standley Lake via four conveyances (Figure 7): Church Ditch, Croke Canal, Farmers' High Line Canal (FHL), and Kinnear Ditch Pipeline (KDPL). Inflows for 2016 from each of these sources are shown in Figure 39. During the irrigation season (April to October), the FHL Canal was the dominant source of inflows. Later in the irrigation season, additional water was delivered by the Church Ditch and the KDPL. The Croke Canal has the most senior rights in the Clear Creek Basin during the non-irrigation season (November – March). As is typical, following the curtailment of flows from FHL in early November the Croke Canal provided the only inflow to Standley Lake until early April.

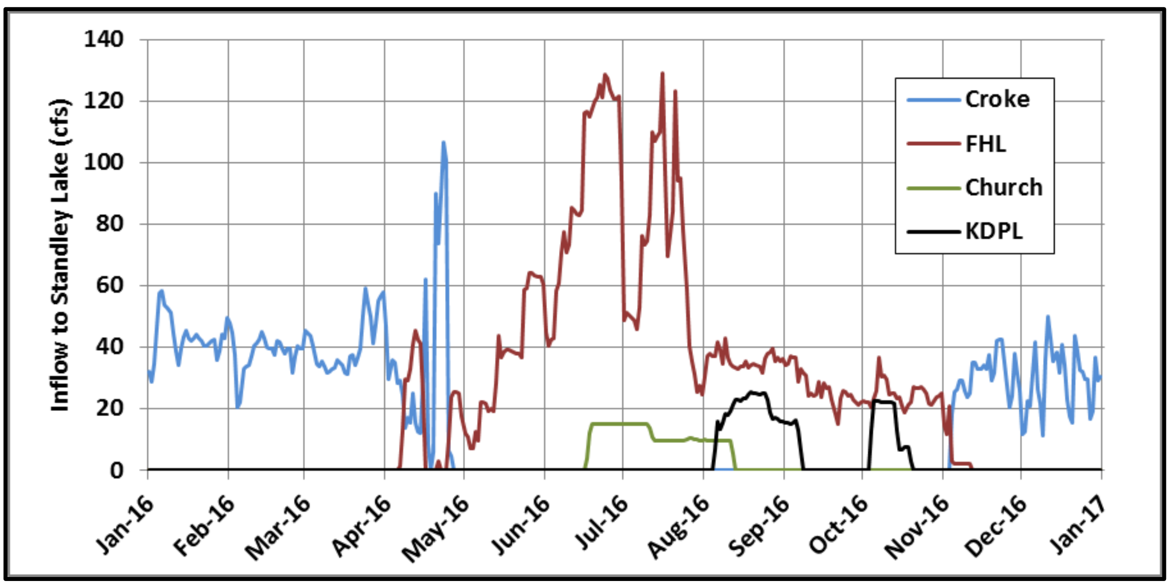

Figure 39. Inflow to Standley Lake, 2016

B. Water Quality

The Croke Canal and the FHL Canal are the dominant sources of water to Standley Lake. These canals follow parallel paths for approximately 15 miles between their headgates at Clear Creek and their turnouts to Standley Lake. Over this distance the canals pass through a diverse range of land uses. When a canal is in use, water-quality samples are collected at both the headgate and at the release point to Standley Lake. To better understand the effects of the Canal Zone on water quality, an analysis of concentration differences observed between the canal headgates and turnouts was performed. As with the Upper Basin and Standley Lake water quality discussions, this analysis focused on TSS, TP, and TN.

Average annual concentrations were calculated for TSS, TP, and TN. These averages were calculated for the canal headgate and at the turnout locations for the Croke and FHL. For the Croke Canal, there is substantial increase in TSS concentrations between the headgate and the turnout (Figure 40, right). The increase in TSS is associated with a corresponding increase in TP (Figure 41, right). However, there is little difference between locations for TN (Figure 42, right). In contrast, typically little difference is observed in the FHL between headgate and turnout for TSS, TP, or TN (Figures 38-40, left). The specific sources of TSS and associated TP along the Croke Canal are unknown at this time. However, the activities described to address land use issues by the Croke Canal (Section III.B.3) have the potential to limit or control sources of TSS and TP.

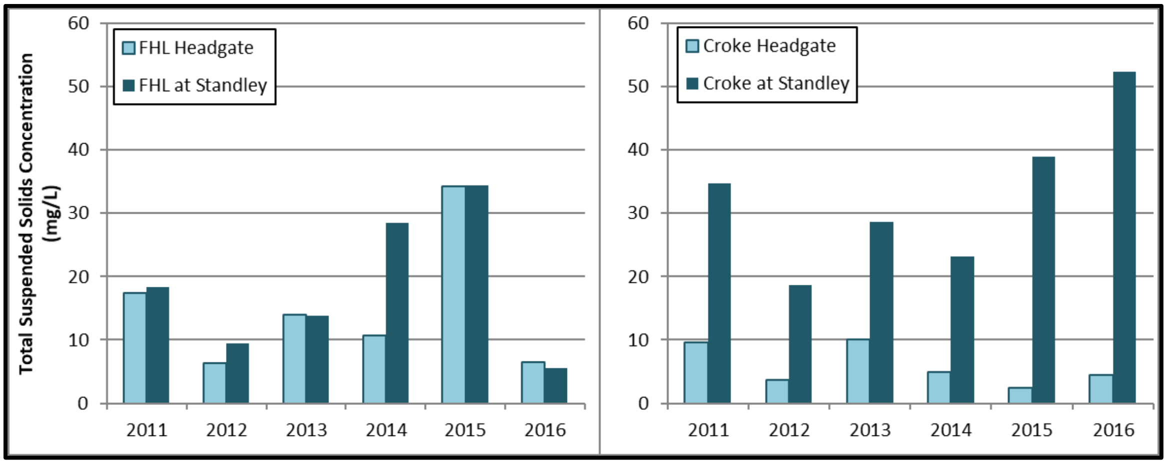

Figure 40. Total Suspended Solids in FHL (left) and Croke (right) Canals

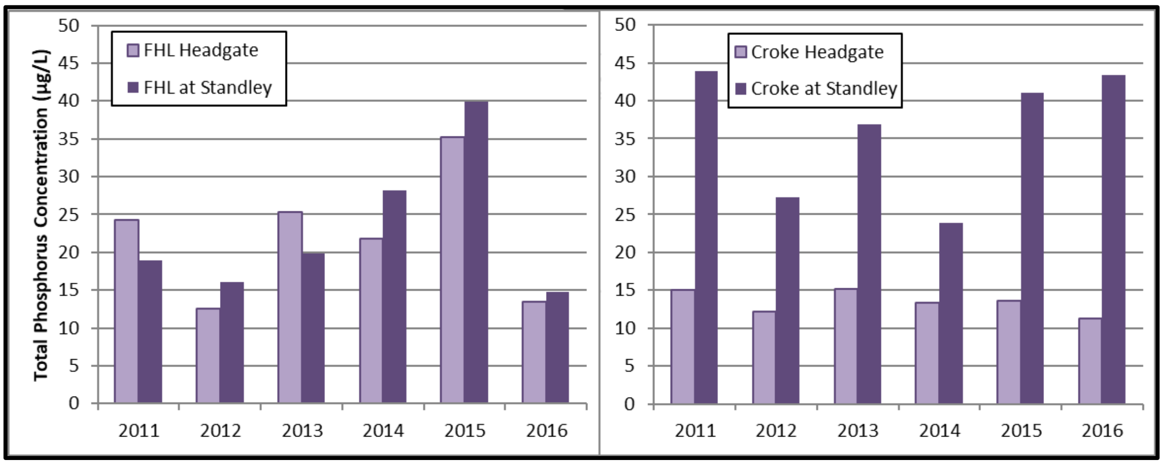

Figure 41. Total Phosphorus Concentrations in FHL (left) and Croke (right) Canals

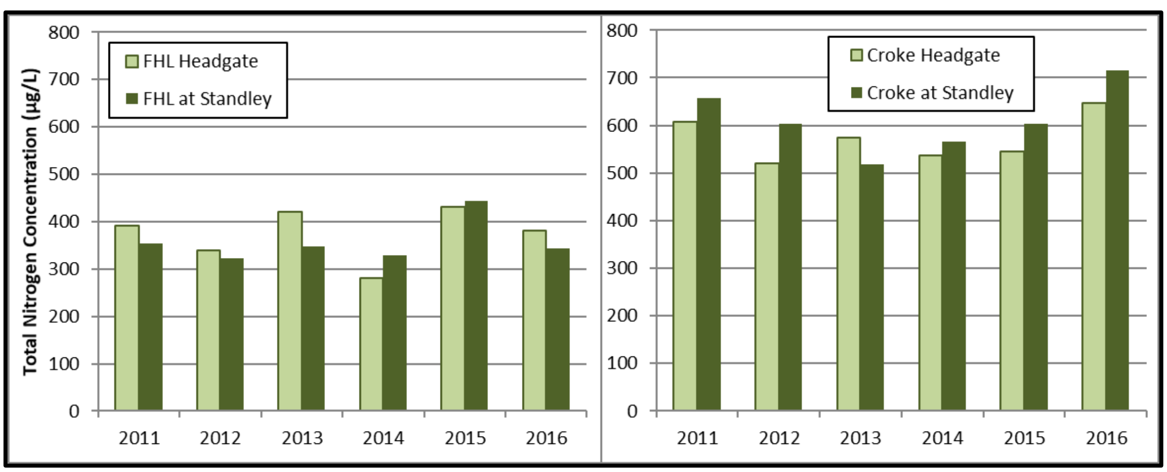

Figure 42. Total Nitrogen Concentrations in FHL (left) and Croke (right) Canals

VI. Standley Lake Flows, Contents, and Loadings

This section provides a discussion of the quantity and quality of the inflows to and outflows from Standley Lake. In addition, the loadings of TSS, TN and TP are described along with the lake contents.

A. Flows and Contents

The daily flow rates, and associated season patterns, for each of the four conveyances to Standley Lake were presented previously (Figure 39). Annual inflow volume from each source is shown in Figure 43 for the period of 2011 through 2016. The largest sources of water to Standley Lake are the FHL and Croke Canals. They provide, respectively, 54% and 37% of total inflows. Church Ditch and KDPL inflows are smaller sources, combining to provide the remaining 9% of total inflows.

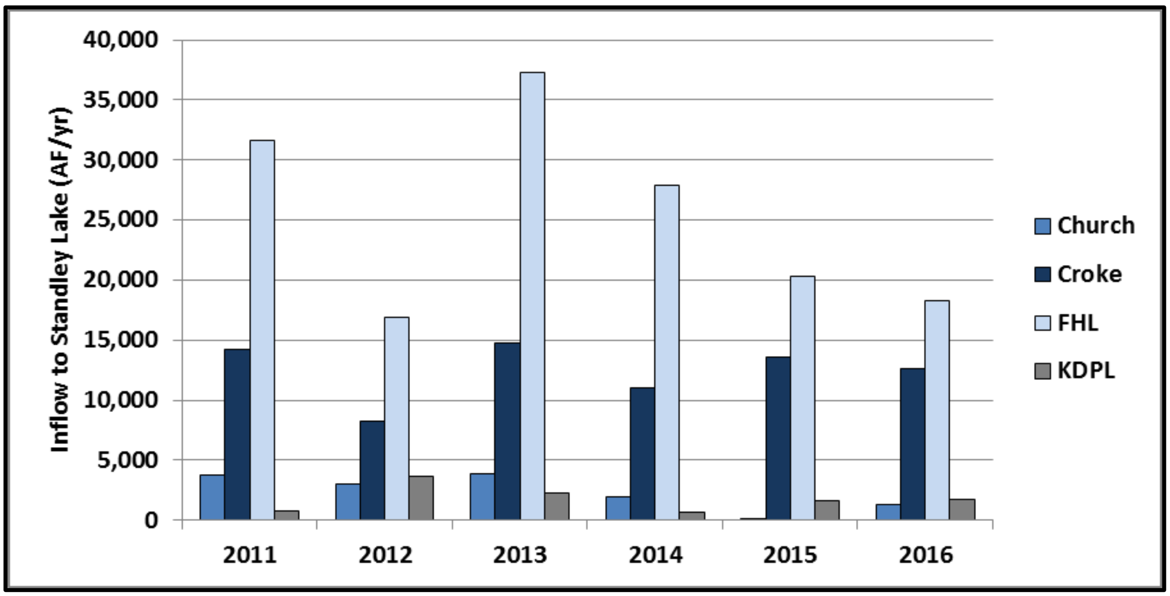

Figure 43. Annual Inflow to Standley Lake by Source, 2011-2016

Inflow and outflow rates from the lake in 2016 are presented in Figure 44. Inflows outpace outflows during the March through May period. During the later summer and early fall (August through September) outflows outpace inflows. Overall, the most rapid outflows occurred during the summer and fall. Total measured annual inflow (the sum of all four sources) and outflow for 2011-2016 are presented in Figure 45. In 2016, total inflows were 22% lower than the 2011-2015 average. Outflows were only 3% higher than the average of the previous five years.

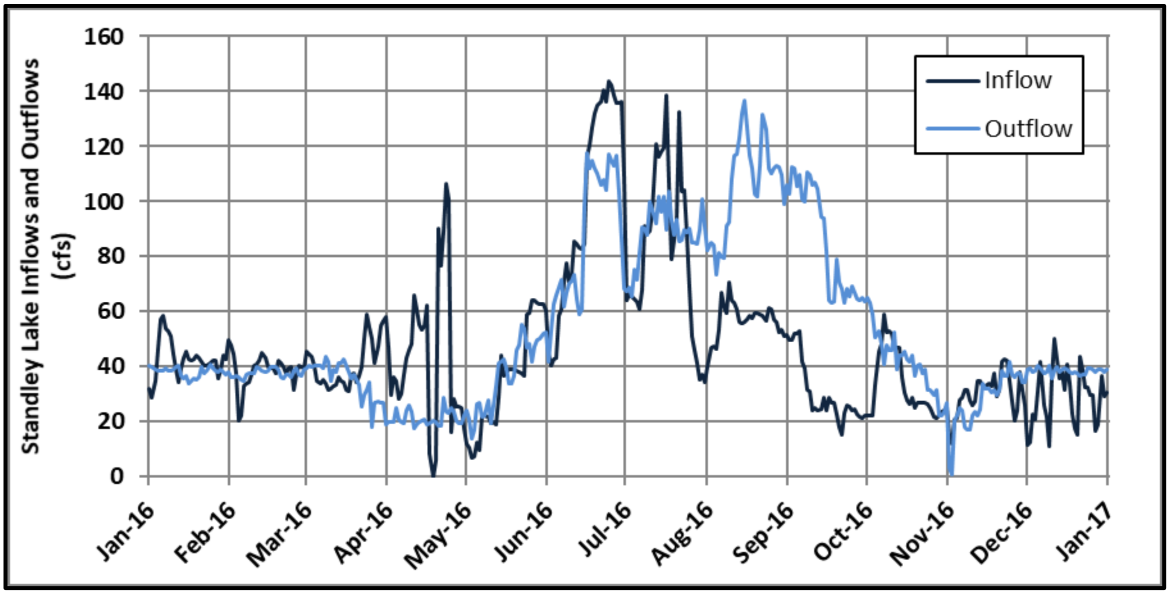

Figure 44. Inflows to and Outflows from Standley Lake, 2016

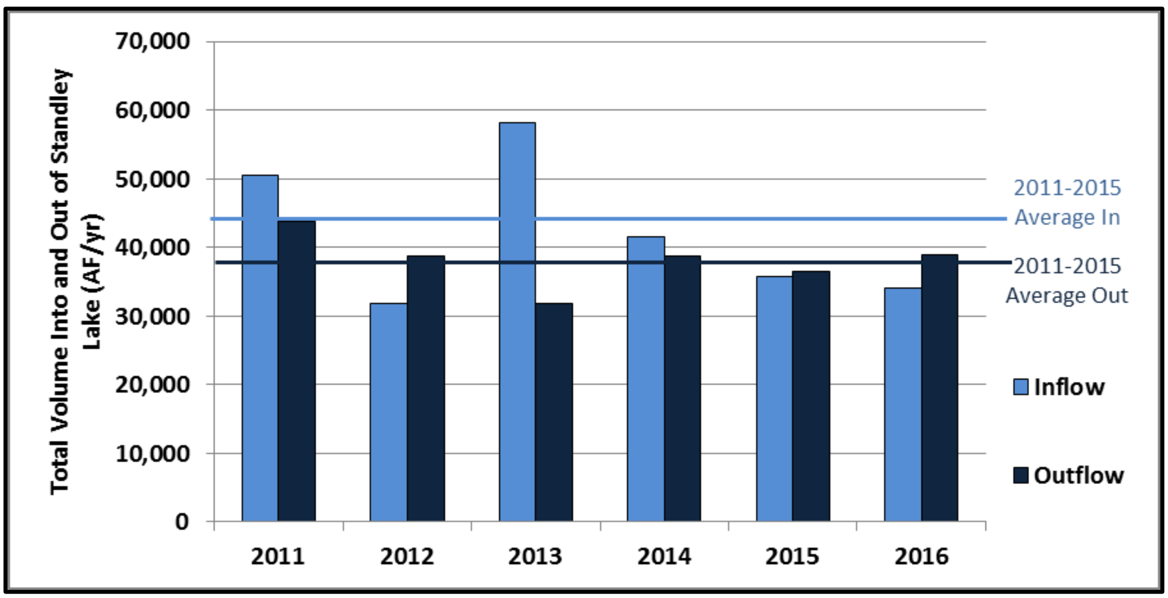

Figure 45. Total Measured Annual Standley Lake Inflow and Outflow, 2011-2016

Daily contents for Standley Lake for each of the past six years are presented in Figure 46. Contents were calculated from gage-height measurements using the elevation-area-volume relationship for the lake. At the beginning of 2016, lake contents were nearly as high as the two previous years. In the spring, the lake filled to near capacity where it remained for May, June and much of July. Following this, lake contents decreased to levels not seen since 2012. Nonetheless, in 2016, the annual average lake content was nearly identical (2% greater) to the average of the previous five years.

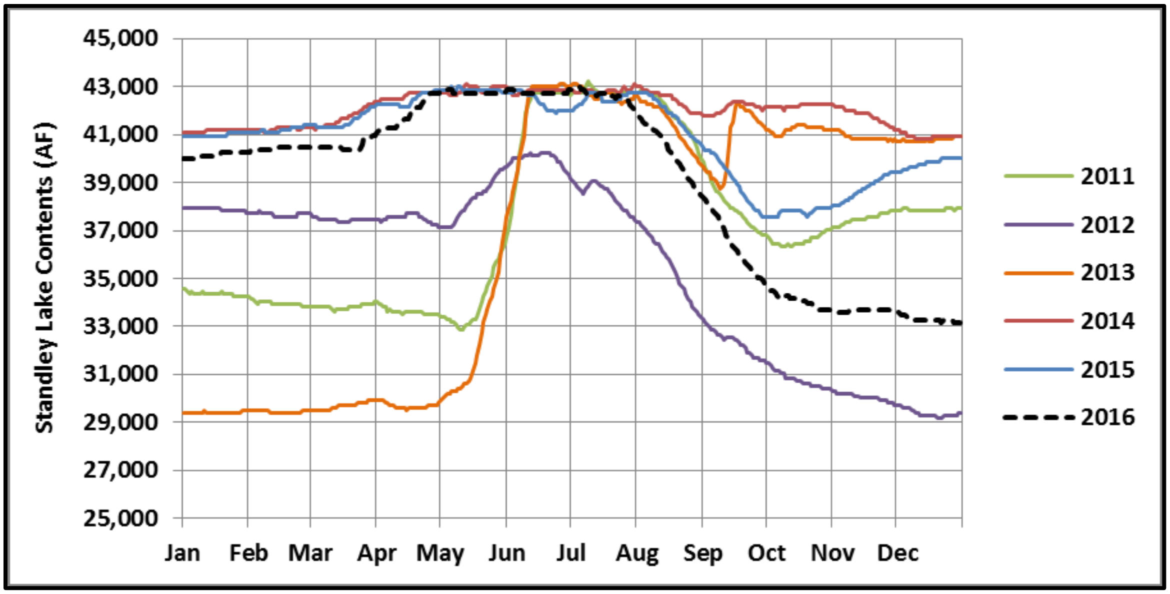

Figure 46. Standley Lake Contents, 2011-2016

B. Loading Into and Out of Standley Lake and Inflow Water Quality

Estimates of nutrient loading into and out of the lake are described in this sub-section. The concentration data are from samples collected as part of the Upper Clear Creek/Standley Lake Watershed Water Quality Monitoring Program. The sampling data used for inflows includes ambient grab samples and 24-hour ambient composites. Loads are calculated using daily flows and concentration data. To compute the loads, a mid-point function was used to fill daily concentrations between the available sample data. Event samples collected on the canals have included storm event samples and first flush samples. These types of samples provide an indication of the effects of different events on loading to the reservoir.

1. Total Phosphorus

Total phosphorus loading into Standley Lake is presented by source for the 2011-2016 period in Figure 47. The canals which contributed the greatest volumes of water to Standley Lake, the Croke and FHL Canals (Figure 43), delivered the largest TP loads (Figure 47). However, in 2016 the Croke Canal contributed more TP relative to the FHL even as it provided a lower volume of water. This pattern is in contrast to past years. The observed change in pattern appears to be primarily driven by a decrease in loading from and concentrations in the FHL (Figure 41). Loading from the Croke Canal in 2016 is generally consistent with the magnitude of past years.

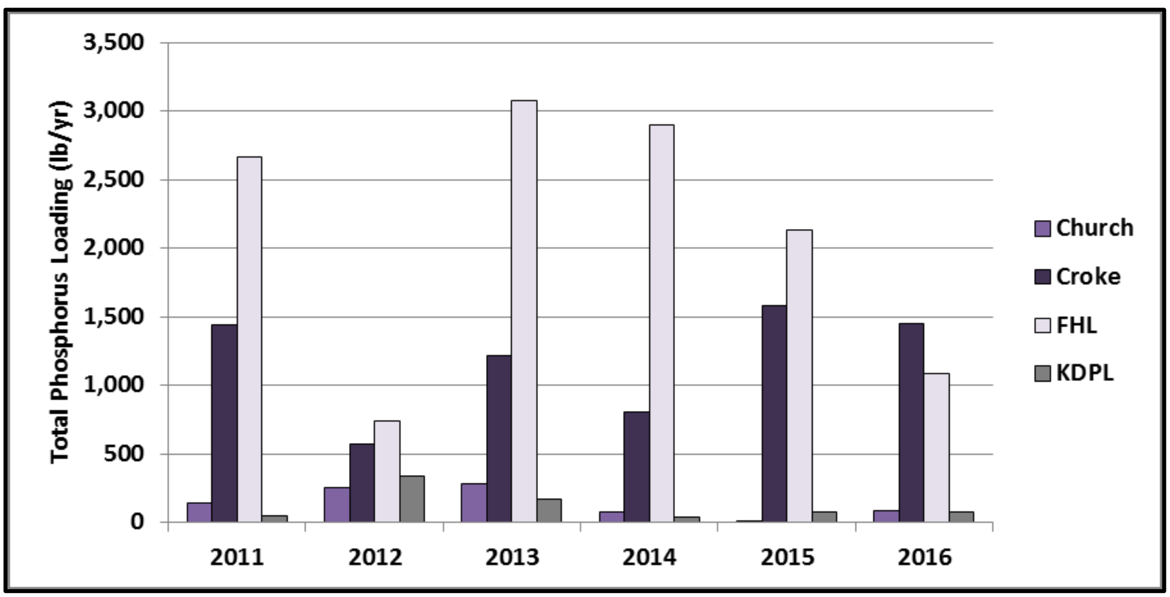

Figure 47. Total Phosphorus Loading into Standley Lake by Source, 2011-2016

Estimated annual TP loadings into and out of Standley Lake for 2011-2016 are shown in Figure 48. Non-storm event loading of total phosphorus in 2016 was below (-27%) the average of the past five years. This decrease is primarily driven by the decrease in loading from the FHL. As with previous years, loadings of total phosphorus into the lake were greater than outflow, indicating some level of phosphorus retention.

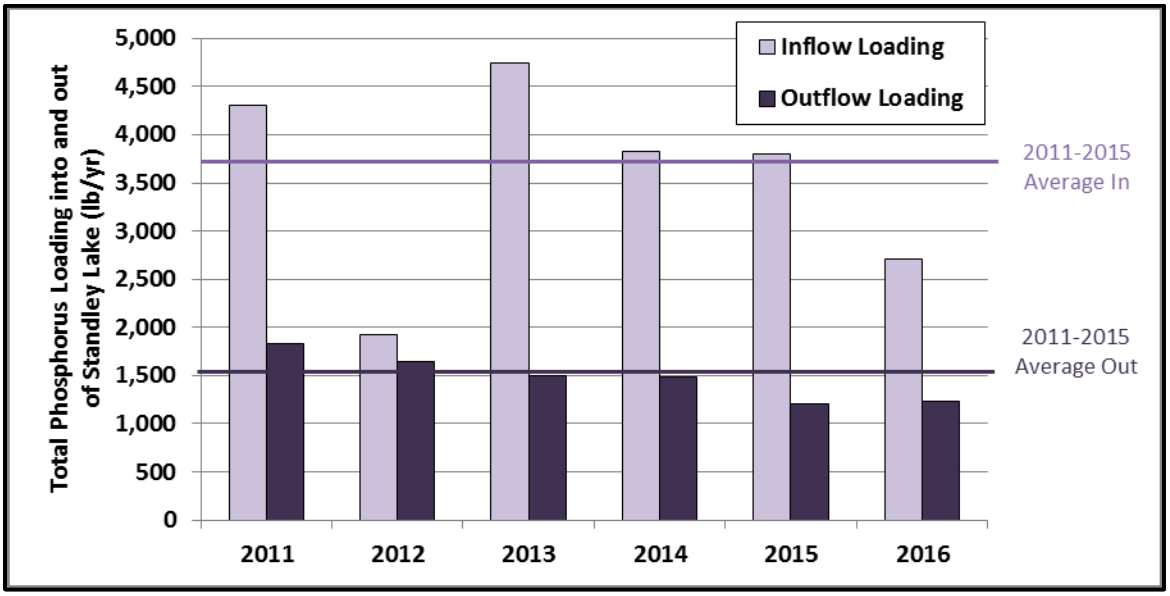

Figure 48. Total Phosphorus Loading into and Out of Standley Lake, 2011-2016

The volume-weighted TP concentrations into Standley Lake are presented in Figure 49 by source. The Croke had the highest volume-weighted concentration and KDPL the lowest. The combined average of the canals (29 µg/L) in 2016 was 7% lower than the 2011-2015 average.

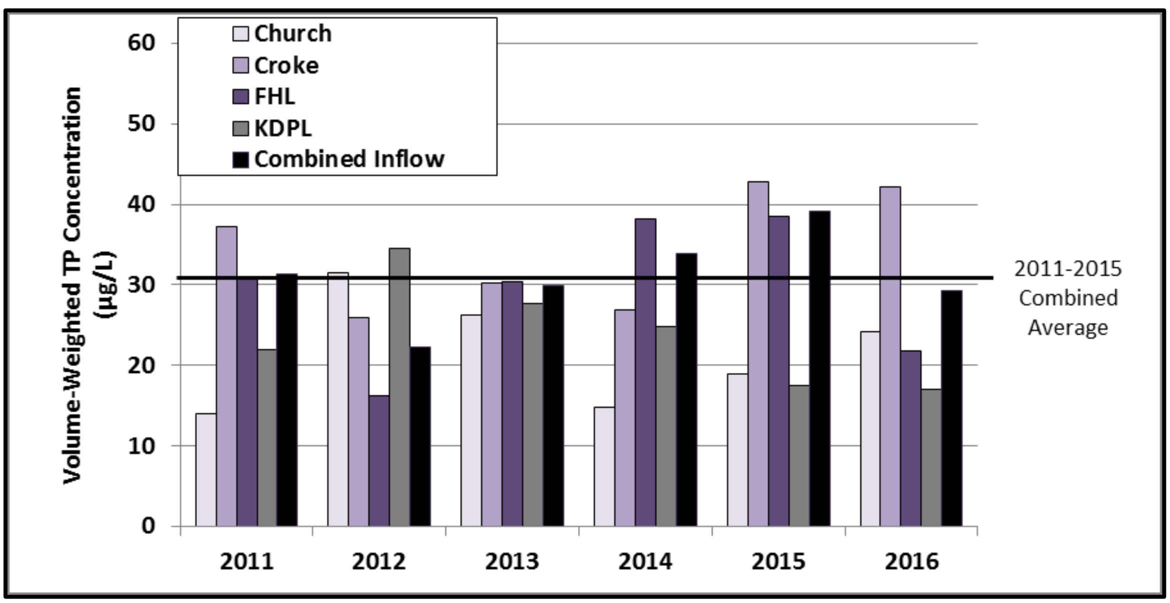

Figure 49. Volume-Weighted Total Phosphorus Concentrations into Standley Lake by Source, 2011-2016

2. Total Nitrogen

Total nitrogen loading into Standley Lake, grouped by source and based on data from ambient grab and ambient composite samples, is displayed in Figure 50. Combined TN loading into and out of the lake is presented in Figure 51. As with TP, loads were the highest in the Croke Canal and for the FHL loads in 2016 were lower than all but one year from the 2011-2015 period. The mass of TN entering Standley Lake in 2016 was 15% lower than the average of the previous five years. Outflow of total nitrogen in 2016 was similar (4% higher) than the 2011-2015 average. As with previous years, loading into the lake was higher than outflow from the lake, indicating some level of nitrogen retention. Nitrogen can be retained in a reservoir through biological uptake and deposition of particulate organic carbon to the bottom sediment.

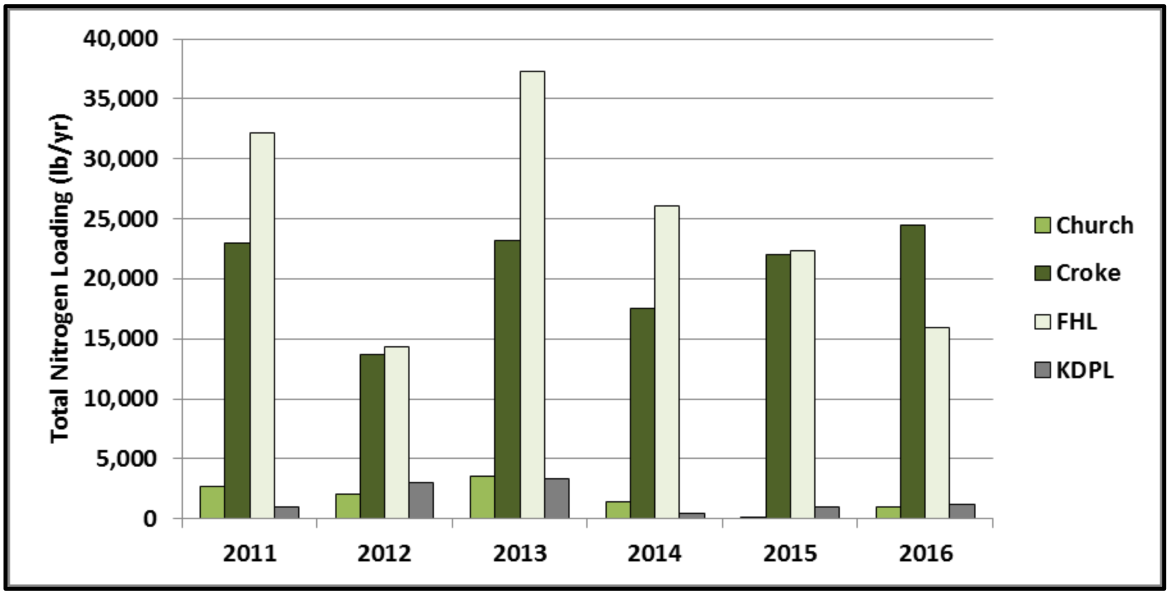

Figure 50. Total Nitrogen Loading into Standley Lake by Source, 2011-2016

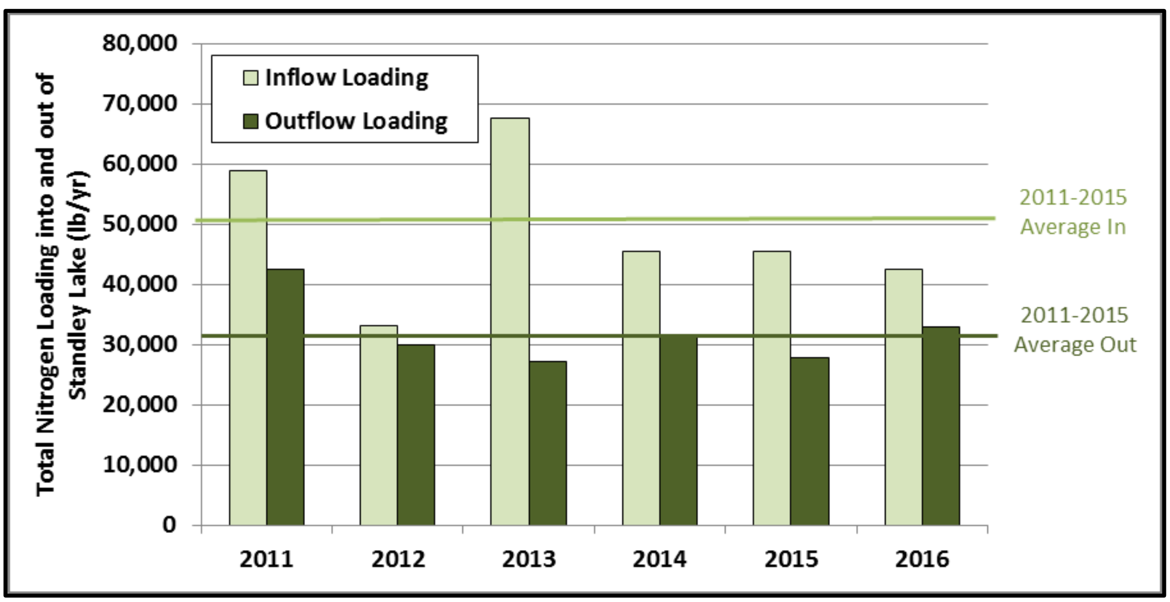

Figure 51. Total Nitrogen Loading into and Out of Standley Lake, 2011-2016

Volume-weighted total nitrogen concentrations into the lake are presented in Figure 52. The combined average from all sources in 2016 (460 µg/L) was slightly higher than the 2011-2015 average of (422 µg/L). The increased volume weighted concentrations in the Croke Canal are a reflection of the higher estimated loads and associated higher observed concentrations observed in this source in 2016.

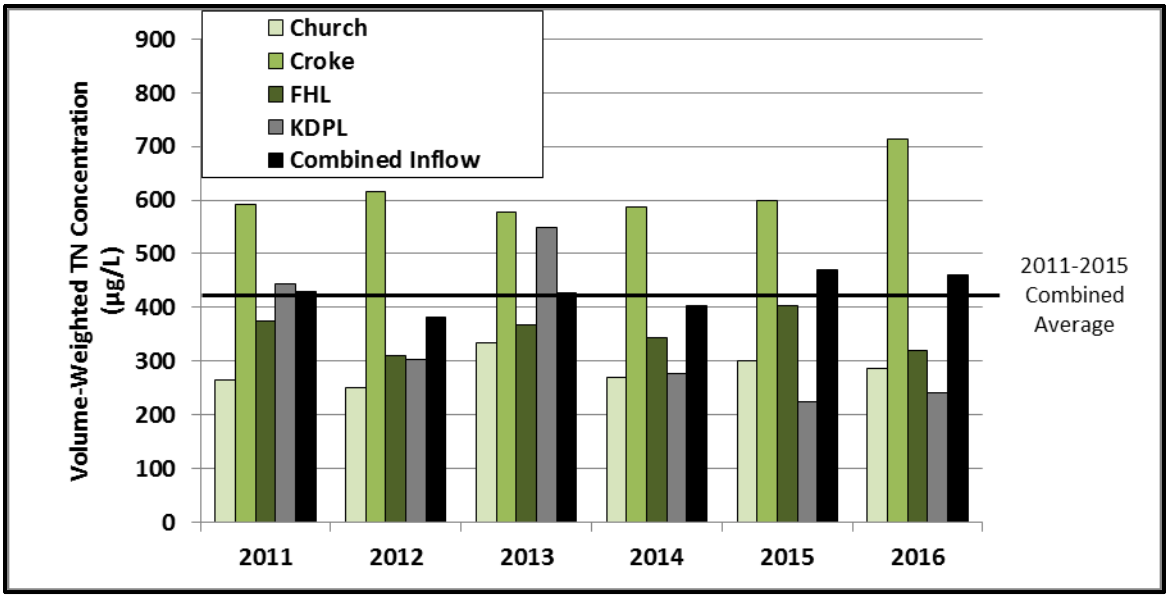

Figure 52. Volume-Weighted Total Nitrogen Concentrations into Standley Lake by Source, 2011-2016

3. Effect of Storm Events on Nutrient Loading

In 2016, no storm event data were collected on the canals feeding Standley Lake. However, first flush samples were collected. The effects of first flush are included in the load estimates in the previous section.

C. Standley Lake Loading Summary

Standley Lake began 2016 with relatively high levels with the lake filling to near capacity in May. This level was maintained until near the end of the summer, when drawdown began. Overall, the average contents in 2016 were very close to the five-year average of 2011- 2016. The loading of nutrients, TN and TP, to the Lake in 2016 were below average. This decrease in loading was primarily driven by concentration decreases seen in FHL and supplemented by a decrease in overall inflow volumes. As is typical, the outflow of nutrients from the lake was lower than the inflow indicating the retention of nutrients in the lake.

VII. Standley Lake Water Quality

In this section, the in-reservoir water-quality responses to the hydrology and nutrient loads are discussed. The data considered here were measured at sampling location SL-10 (Figure 2). This sampling location was selected as it has an extensive sampling history, is directly relevant to water treatment plant operations, and is the location of the automatic lake profiler station. The water-quality measurements discussed include: dissolved oxygen (DO), TP, TN, chlorophyll *a*, and clarity.

A. Dissolved Oxygen

Dissolved oxygen is an important water-quality constituent because of its effect on aquatic life and drinking water treatment. Dissolved oxygen at the sediment-water interface (i.e. the bottom of the lake) is of particular relevance. Low DO at this location can result in the loading of nutrients and certain metals from the sediment to the water column. These releases can lead to increases in water treatment costs and the potential for taste and odor events in drinking water.

Each year, Standley Lake experiences hypoxia (DO concentrations ≤ 2.0 mg/L) in the hypolimnion. This is common for stratified reservoirs in Colorado. In 2016, DO concentrations started dropping at the bottom in mid-May and hypoxic conditions were well developed by the beginning of August. These hypoxic conditions were maintained until turnover in early October. A contour plot of dissolved oxygen concentrations in Standley Lake for March through early December 2016 is provided in Figure 53.

Dissolved oxygen concentrations measured at the top and bottom of Standley Lake through 2016 are provided in Figure 54. At the surface, the cyclical patterns in DO concentrations are driven by the decrease in oxygen solubility with increasing temperatures. The onset of stratification is observed to occur in mid-May, as indicated by the divergence of lake-bottom DO concentrations from surface concentrations. This divergence increases in magnitude as dissolved oxygen is depleted in the hypolimnion, and is maintained by continued stratification. Consistent with the contour plot (Figure 53), the divergence between surface and bottom DO concentrations is rapidly extinguished with turnover in early October.

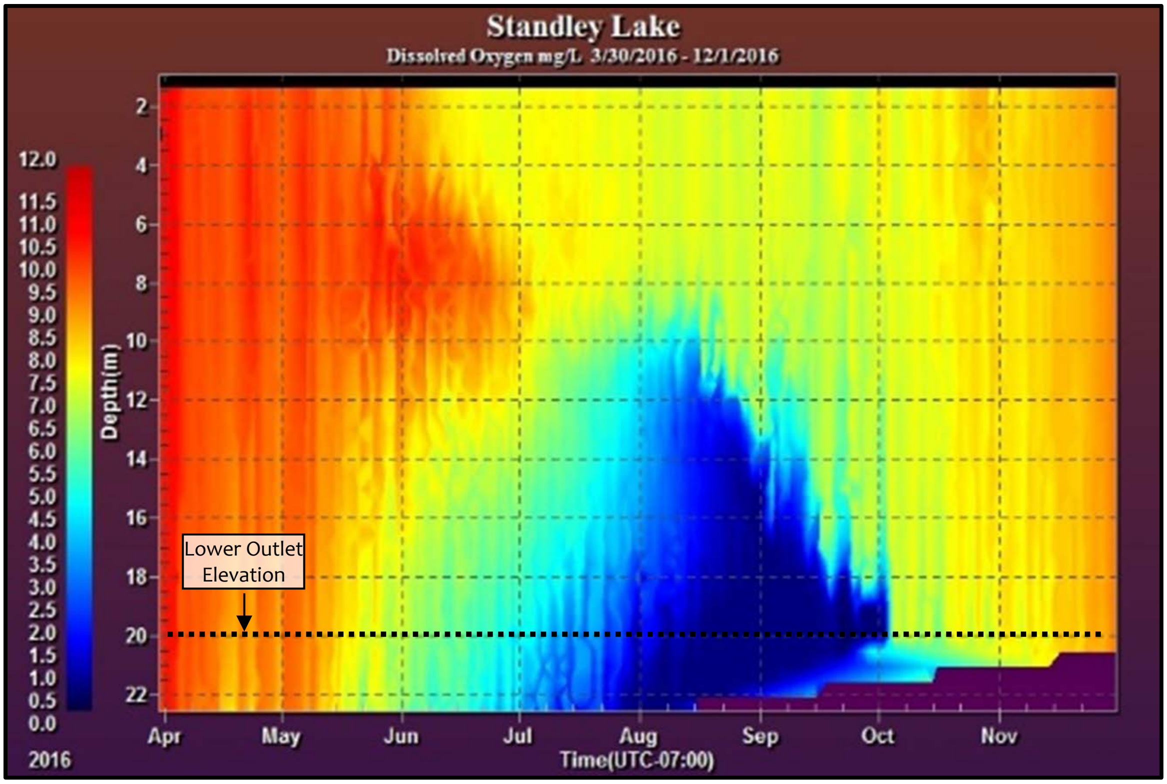

Figure 53. Contour Plot of Dissolved Oxygen in Standley Lake, March-December 2016

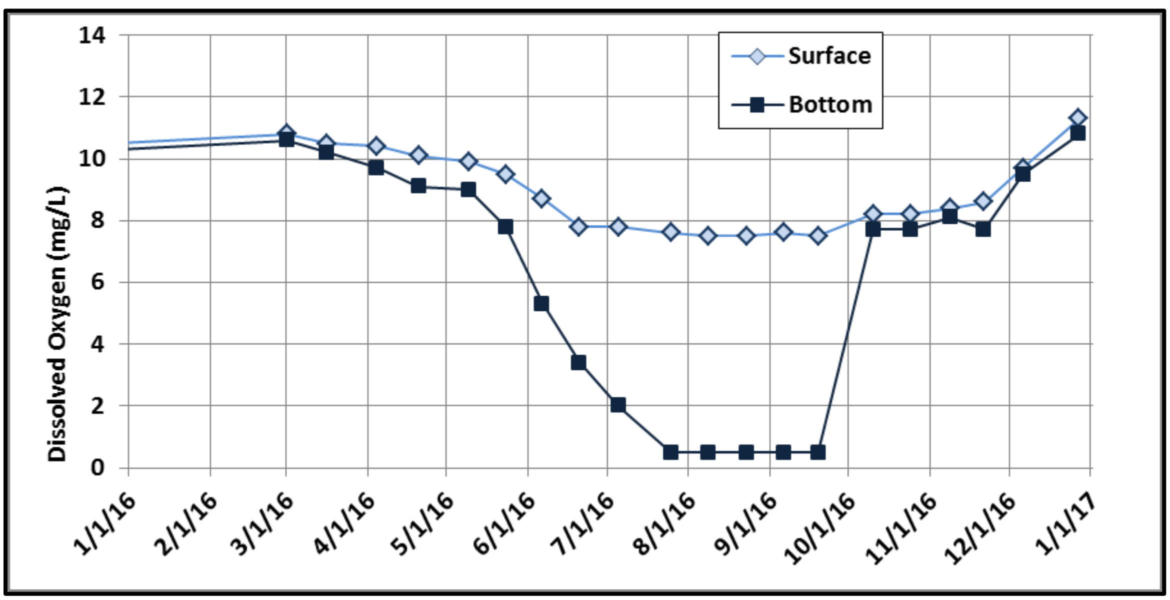

Figure 54. Dissolved Oxygen Concentrations in Standley Lake, 2016

The 2016 seasonal dissolved oxygen patterns generally match those observed in previous years in Standley Lake, as shown in Figure 55. In comparison to recent years however, the development of hypoxic conditions occurred later and turnover was earlier.

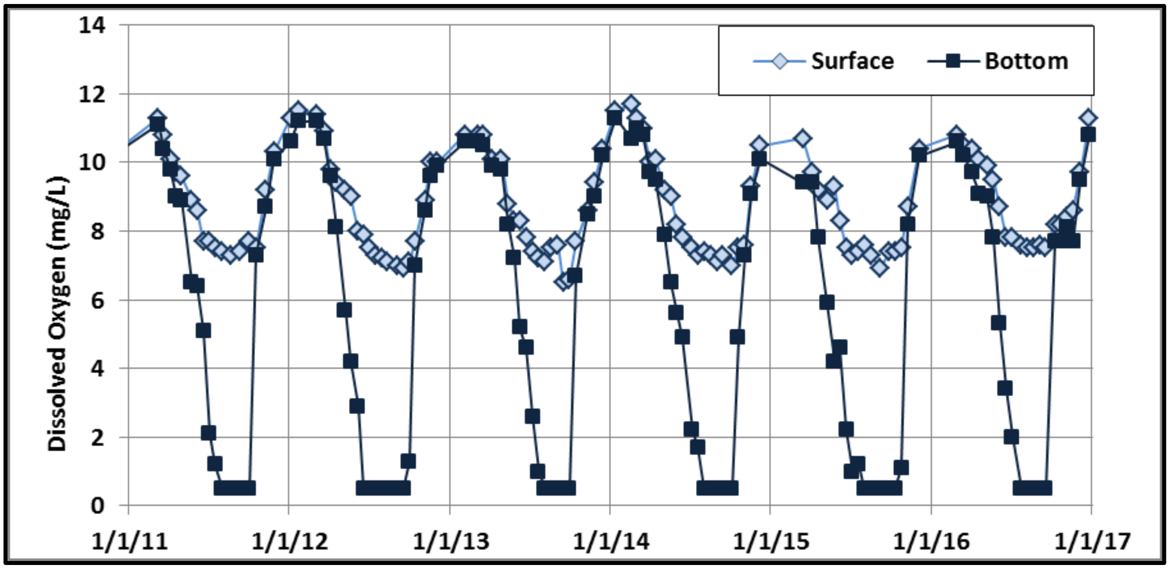

Figure 55. Dissolved Oxygen Concentrations in Standley Lake, 2011-2016

Hypoxia occurs each year in the hypolimnion of Standley Lake, but the start date, end date, and duration vary from year to year. In 2016, the hypoxic period started July 10th and lasted until turnover on October 4th. The period of hypoxia was lower than the 2011-2015 average of 103 days (Figure 56). After a longer than usual period of hypoxia in 2015, the number of days of hypoxia in 2016 was similar to the longer-term average (2005-2015, 93 days) and lower than the five-year (2011-2015) average of 103 days.

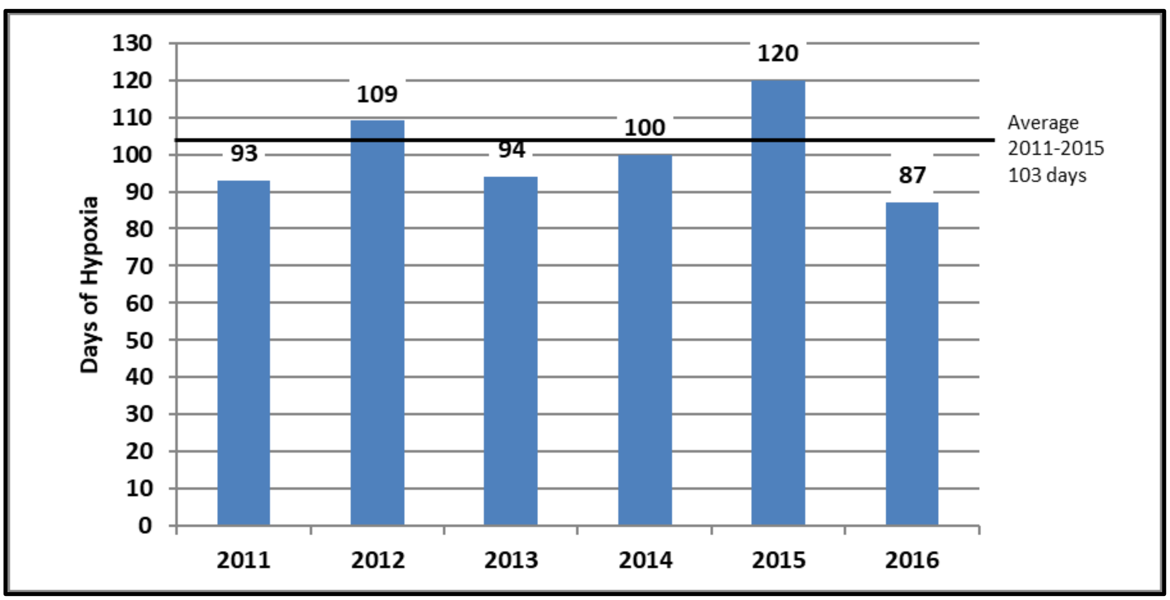

Figure 56. Days of Hypoxia (DO < 2.0 mg/L), 2011-2016

B. Total Phosphorus

Total phosphorus concentrations observed in Standley Lake in 2016 are displayed in Figure 57. Measurements are made at the bottom of the photic zone, defined as twice the Secchi depth, and at the bottom of Standley Lake. Concentrations in the photic zone and the hypolimnion were comparable and relatively consistent for much of the year. Concentrations at the bottom of Standley Lake increases slightly in the July to September period relative to the photic zone.

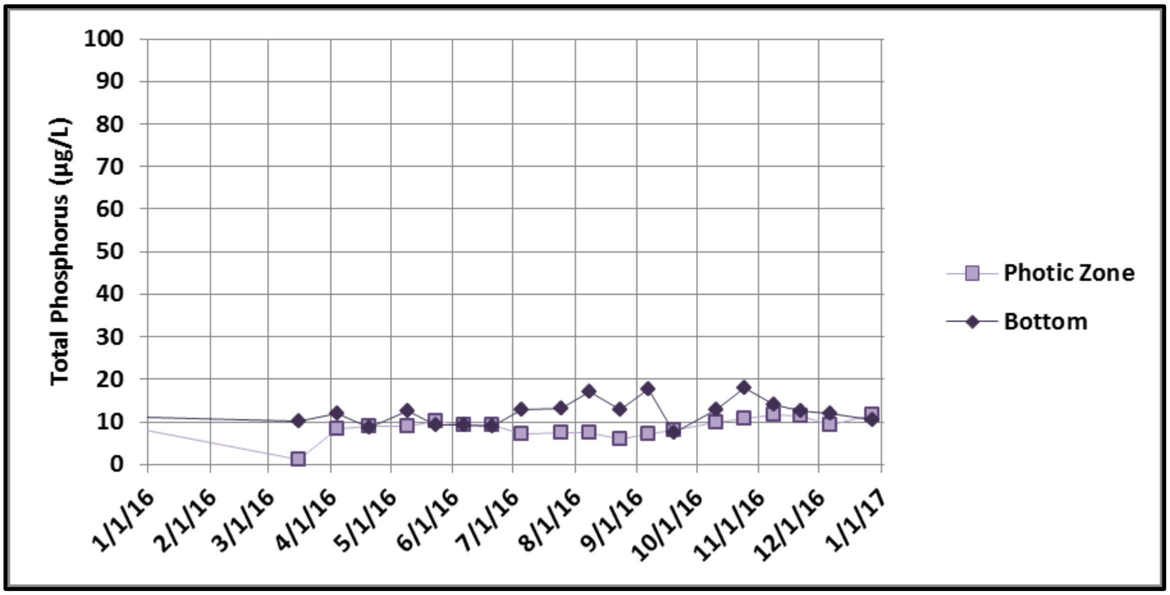

Figure 57. Total Phosphorus Concentrations in Standley Lake, 2016

The observed pattern of TP concentrations at the bottom location was sharply different from previous years, as shown in Figure 58. In 2016, sudden summer increase in TP concentrations was observed in the bottom of the reservoir. This increase is typically seen in the hypolimnion towards the end of the period of hypoxia and is due to internal loading from the sediments.

Nitrate can inhibit sediment phosphorus release under anoxic conditions by maintaining an oxidized surficial sediment layer that retains phosphorus (Beutel, et al, 2008). In Standley Lake, peak nitrate concentrations at the bottom (Site 10-70) typically occur in June or July and are often less than 225 µg/L (Figure 59). In 2016, nitrate concentrations reached 270 µg/L at the bottom location in August, which is later than usual and may have affected redox conditions. This is demonstrated by a comparison of oxidation-reduction potential (ORP) between a typical year (2014) and 2016. Contour plots of ORP (Figure 60) show that reducing (low ORP) conditions were less prevalent in 2016 when compared to a typical year. A hypothesis is that the high, late nitrate concentrations resulted from unusually high ammonia concentrations observed on July 5, 2016 (Figure 61). The source of ammonia at that time may have been a high, short-term external loading event, although the sampling data (taken every two weeks) do not show increased concentrations.

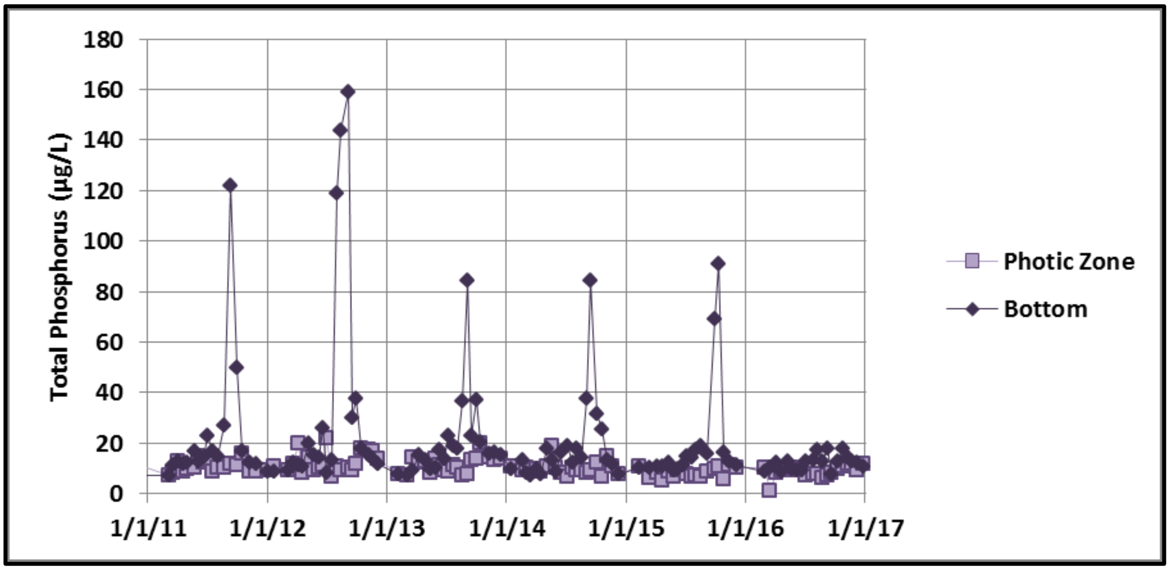

Figure 58. Total Phosphorus Concentrations in Standley Lake, 2011-2016

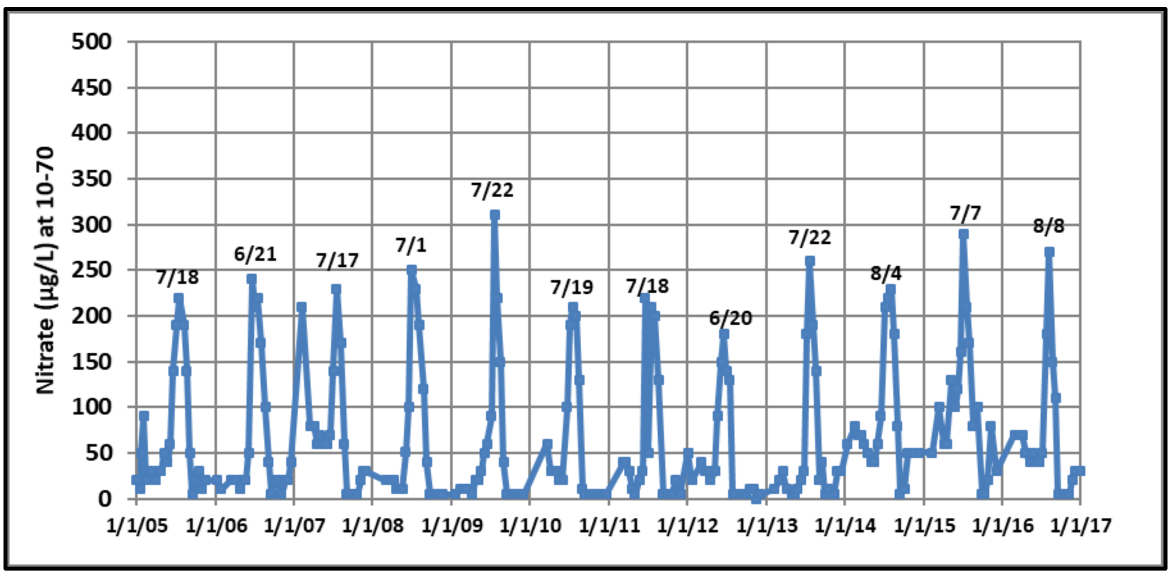

Figure 59. Nitrate Concentrations at the Bottom of Standley Lake (Site-10-70). Dates of peak observations displayed.

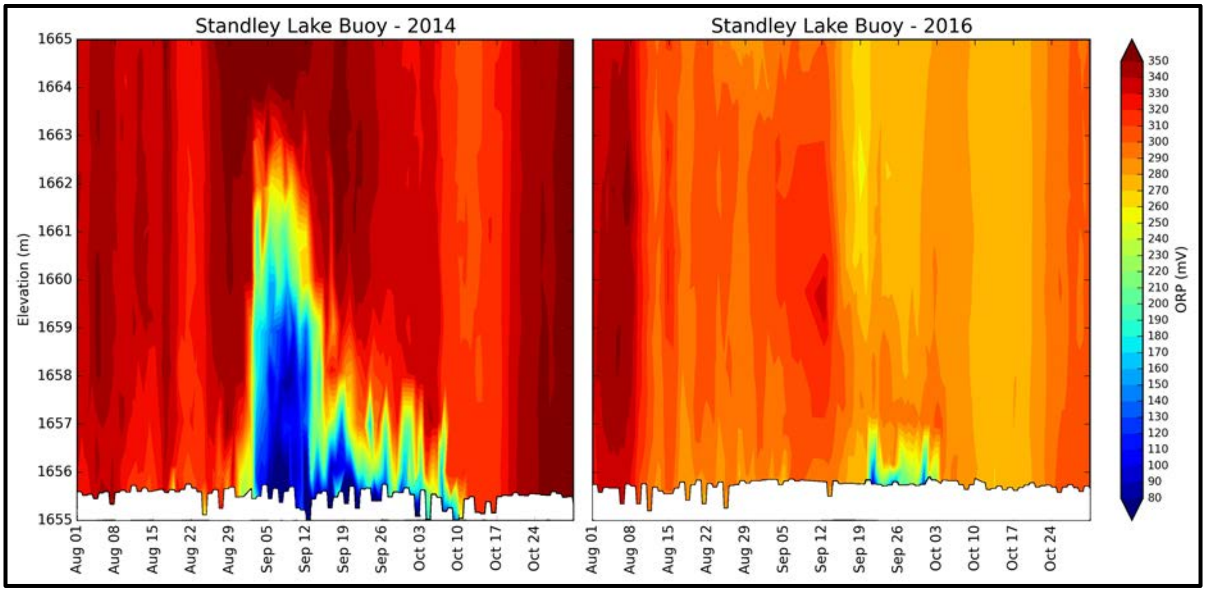

Figure 60. Comparison of ORP in the Bottom 10 Meters of Standley Lake; Typical Year (2014) and 2016

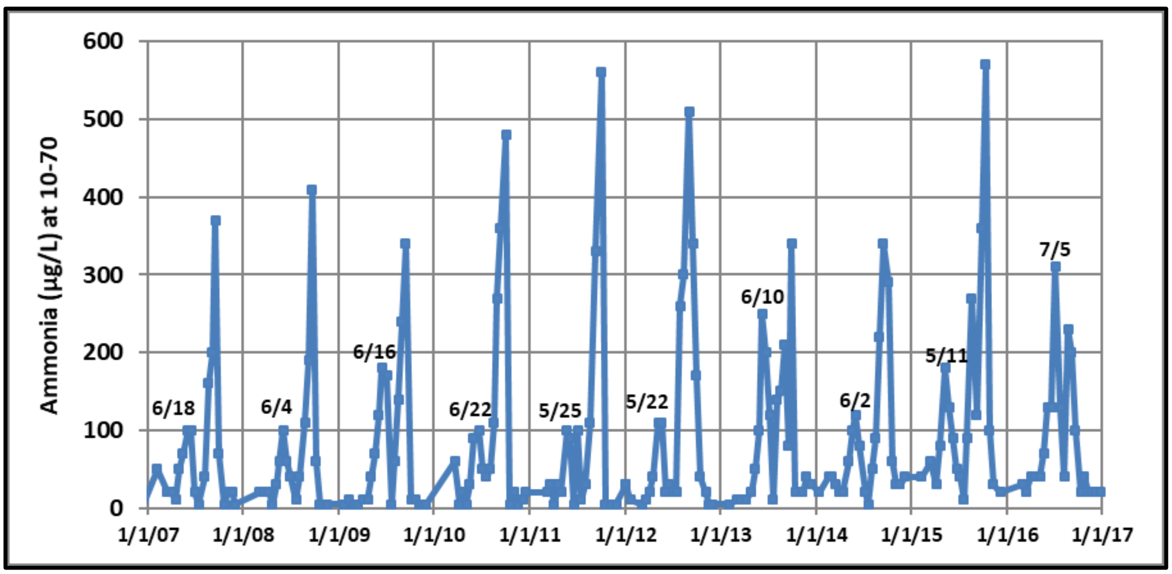

Figure 61. Ammonia at the Bottom of Standley Lake (Site 10-70). Dates displayed for peak spring concentrations. Note July peak in 2016.

C. Total Nitrogen

Concentrations of TN observed in Standley Lake in 2016 in the photic zone and hypolimnion are shown in Figure 62. The pattern in the hypolimnion is similar to that seen in other years and is a reflection of external loading during runoff and internal loading in late summer. The maximum 2016 concentration observed in the hypolimnion (650 µg/L), was observed on July 25, 2016. As in past years, concentrations in the photic zone had smaller fluctuations relative to the hypolimnion.

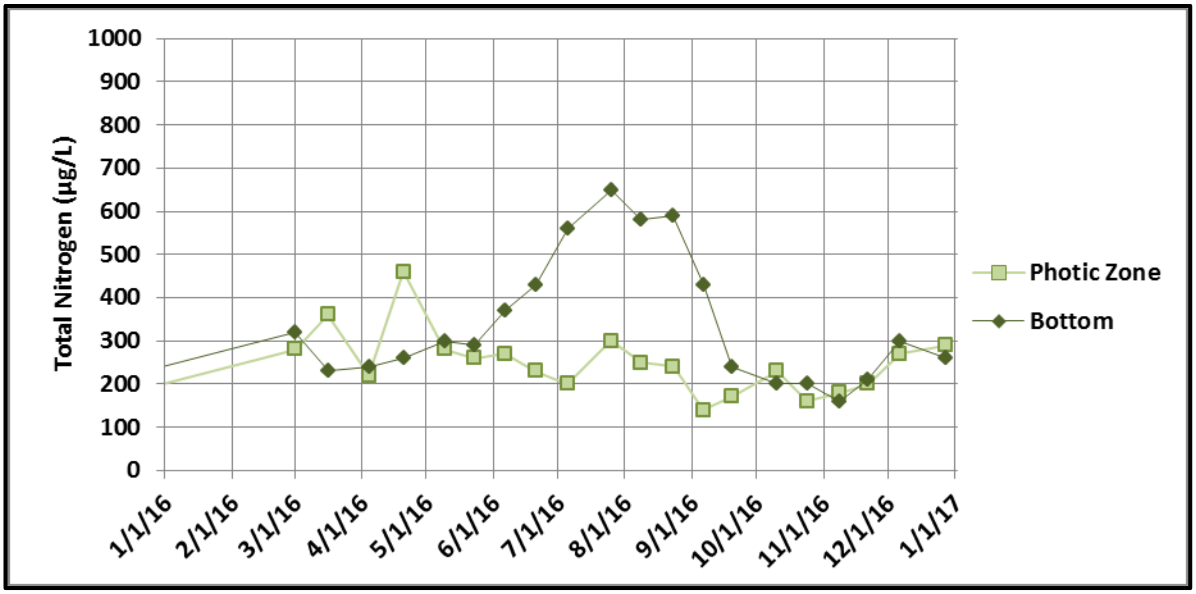

Figure 62. Total Nitrogen Concentrations in Standley Lake, 2016

Concentrations of TN in the lake for 2011-2016 are shown in Figure 63. Overall, TN concentration ranges observed in 2016 at the bottom and in the photic zone were comparable to previous years. The 2016 average TN concentrations (341 µg/L hypolimnion, 250 µg/L photic zone) were 13% lower in the hypolimnion and 7% lower in the photic zone when compared with the 2011-2015 annual average concentrations.

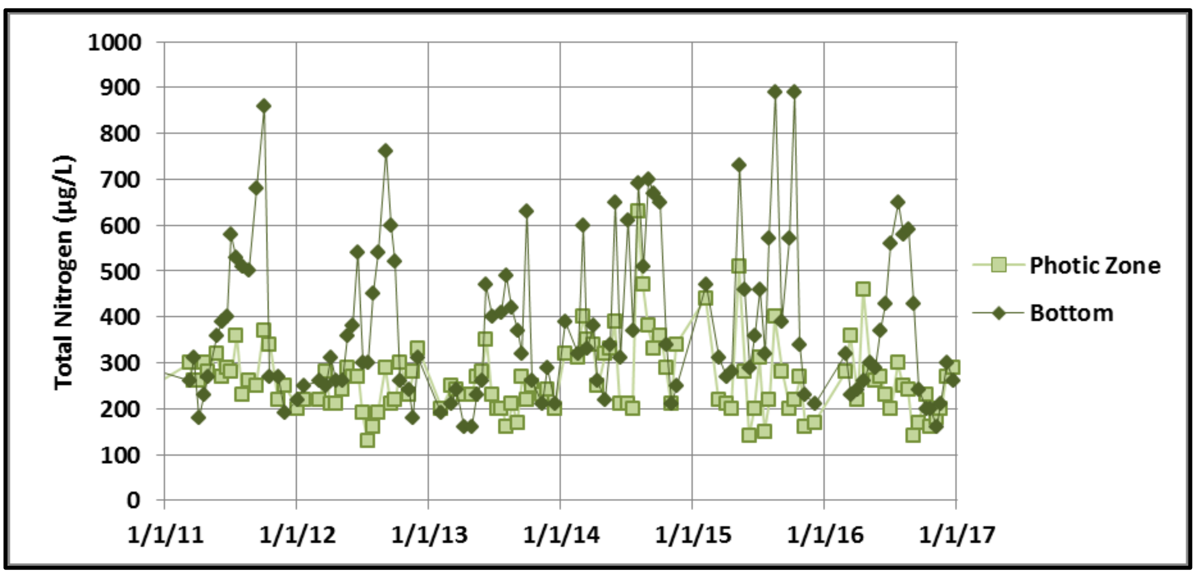

Figure 63. Total Nitrogen Concentrations in Standley Lake, 2011-2016

D. Chlorophyll *a*

Chlorophyll *a* concentrations observed in Standley Lake in 2016 are presented in Figure 64. March through November is the relevant period for standards assessment, these observations are outlined in green. The maximum concentration measured in 2016 was 6.6 µg/L and occurred on October 24, 2016. In 2016, there was a secondary peak (5.8 µg/L) on May 9, 2016.

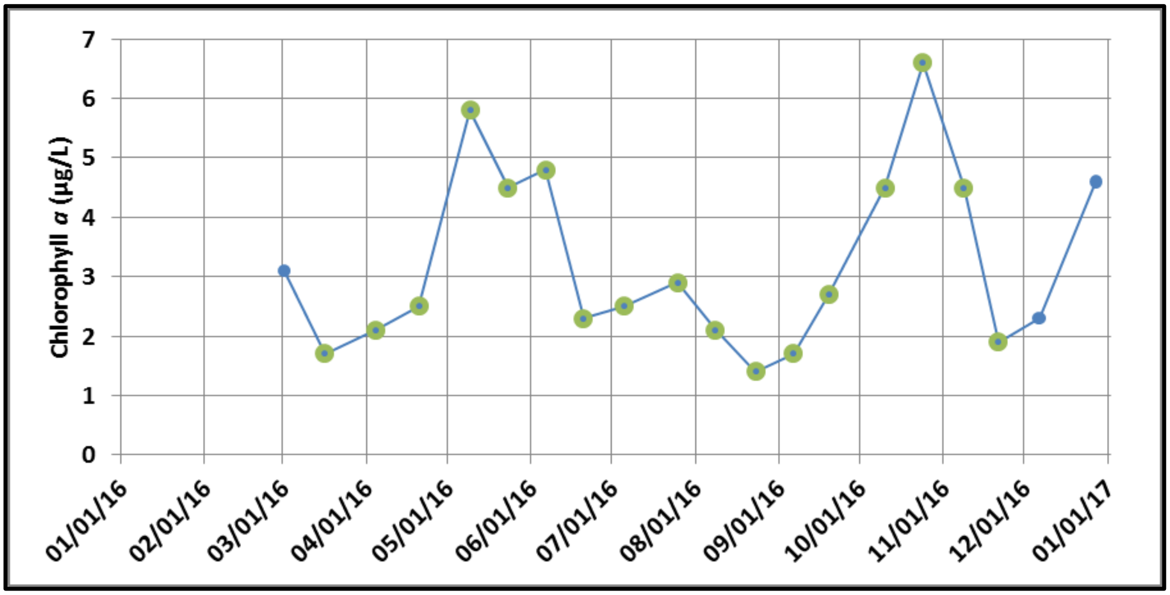

Figure 64. Chlorophyll *a* Concentrations in Standley Lake, 2016 (March-November observations highlighted in green)

Chlorophyll *a* concentrations observed from 2011 through 2016 are shown in Figure 65. Consistent with the previous figure, the green-outlined markers indicate March-November. The temporal patterns and the concentrations observed in 2016 were generally consistent with those seen during the 2011-2016 period. A seasonal pattern with chlorophyll *a* concentrations peaking after fall turnover is typical for Standley Lake. This fall peak in chlorophyll *a* is the result of turnover and an increase in concentrations of nutrients at the surface. The spring peak is slightly smaller relative to the fall peak, a pattern consistent with past years. Increasing temperatures in the spring, combined with a well-mixed water column and adequate nutrients provide conditions amenable to phytoplankton growth.

A contour plot of chlorophyll *a* concentrations in Standley Lake for March-December 2016 is shown in Figure 66. The spring time bloom is apparent in May and early June concentrated in the mid-depths of the reservoir. During this period, an analysis of in-reservoir water temperature found that depths of approximately 6 to 8 m are approximately isothermal with the temperature of water entering the reservoir from the FHL canal. This depth is consistent with the upper portion of the zone of high chlorophyll *a* observed in the spring. This suggests that interflow in spring acts to deliver nutrients to these mid-depths, helping to fuel the chlorophyll *a* concentrations. In contrast, the fall bloom is distributed evenly through the entire reservoir as a result of the fall turnover. Concentrations of chlorophyll *a* remained low for the June through September period.

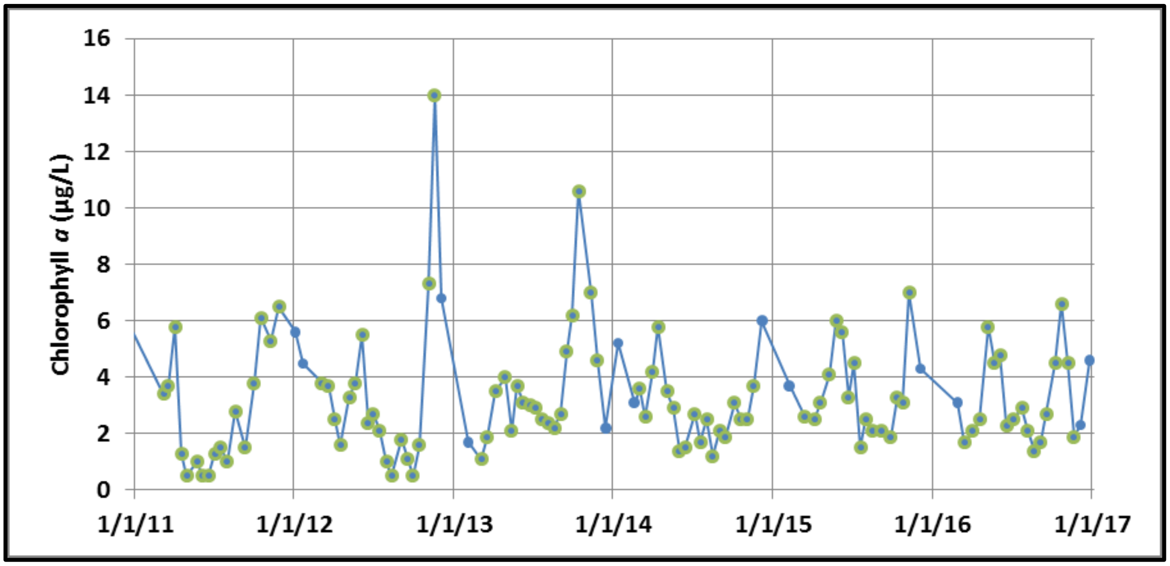

Figure 65. Chlorophyll *a* Concentrations in Standley Lake, 2011-2016 (with March-November observations highlighted in green)

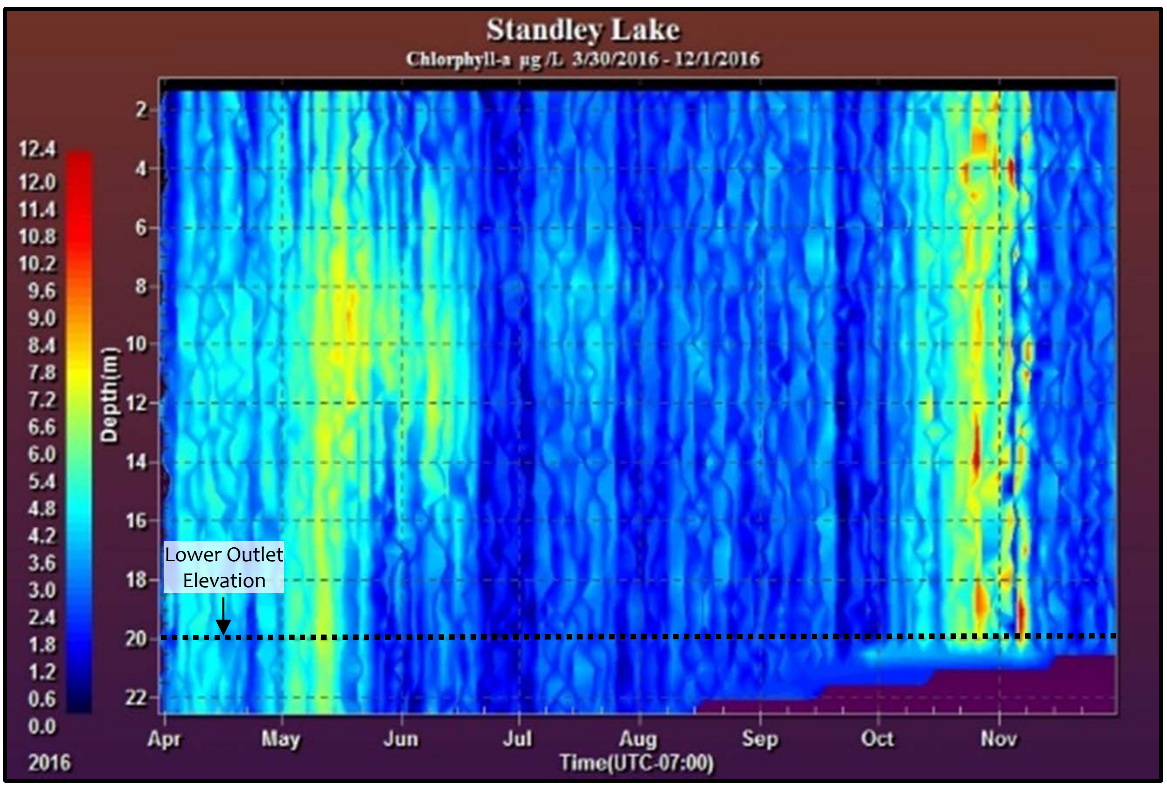

Figure 66. Contour Plot of Chlorophyll *a* Concentrations in Standley Lake, March-December 2016

A chlorophyll *a* standard of 4.0 µg/L was established in 2009 for Standley Lake. This standard is evaluated on an annual basis using the average of observed data for the nine-month period from March through November. To account for the natural variability in chlorophyll *a* concentrations, the standard is assessed using a concentration of 4.4 µg/L. In 2016, the average concentration was 3.2 µg/L (Figure 67). This average is calculated as the average of all measurements from the photic zone for the period of March through November.

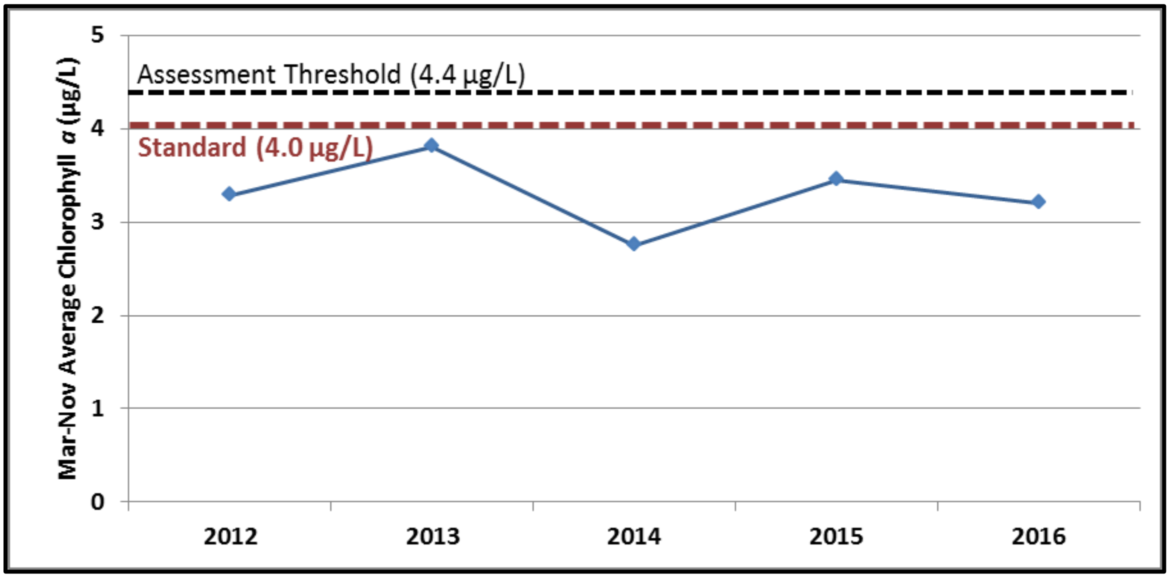

Figure 67. March - November Average Chlorophyll *a* Concentrations, 2012-2016

The chlorophyll *a* standard for Standley Lake was met once again in 2016. The 2016 average complies with both the 4.0 µg/L standard and 4.4 µg/L assessment threshold. The standard is met when four out of the five most recent years have a March-though-November average concentration below 4.4 µg/L. Every year in the five-year period from 2012 to 2016 has had a March-November average concentration below 4.0 µg/L. Of the last ten years, only one year (2007, at 4.8 µg/L) had a March-November average concentration above 4.0 µg/L. This occurred prior to the implementation of the relevant standard in 2009.

E. Secchi Depth

Clarity in Standley Lake is measured using a Secchi disk. When taking this measurement, a black-and-white disk is lowered vertically into the lake until the disk is no longer visible. The resulting depth, termed the Secchi depth, provides a measure of the scattering and absorption of light in the upper portion of the water column. This includes the effects of algae, non-algal organic particulate matter, inorganic suspended solids, dissolved organic matter, and the water molecules themselves. Secchi-depth measurements for Standley Lake in 2016 are shown in Figure 68. The measure of clarity with the greatest depth (5.8 m) occurred on July 25, 2016. Through the year clarity is variable, reflecting a combination of effects such as inflowing suspended solids, algal growth, particle settling, and stratification.

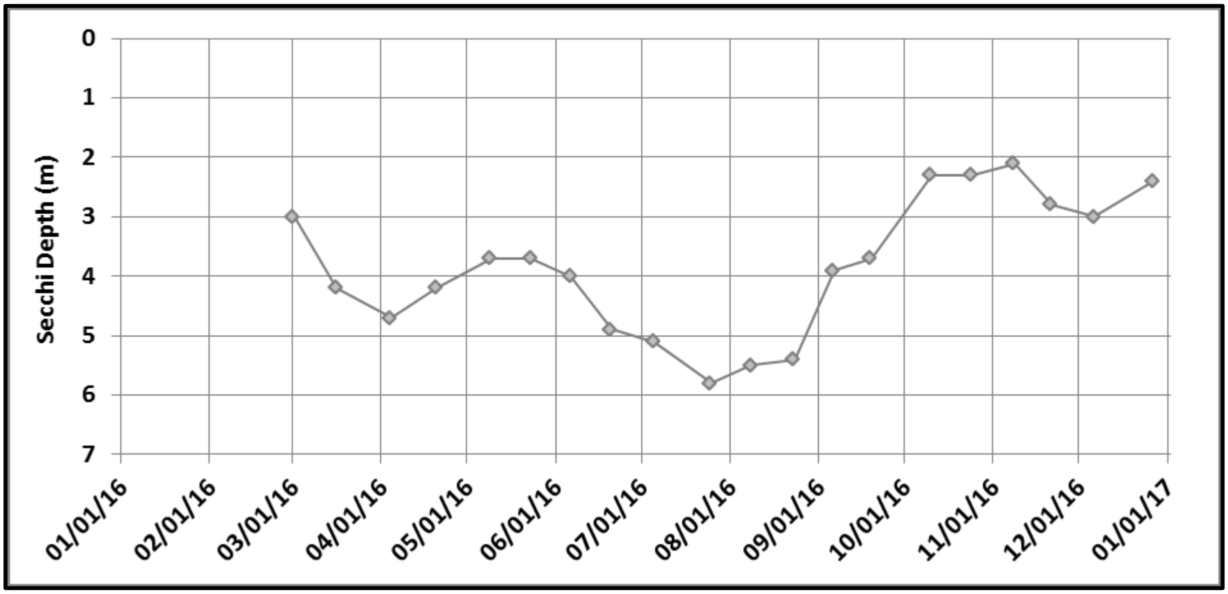

Figure 68. Clarity as Measured by Secchi Depth in Standley Lake, 2016

Individual Secchi-depth measurements for the past six years are shown in Figure 69. Average annual Secchi depths for the same period can be found in Figure 70. The annual average (3.8 m) and range of Secchi depths observed in 2016 were consistent with the range of those observed in recent years.

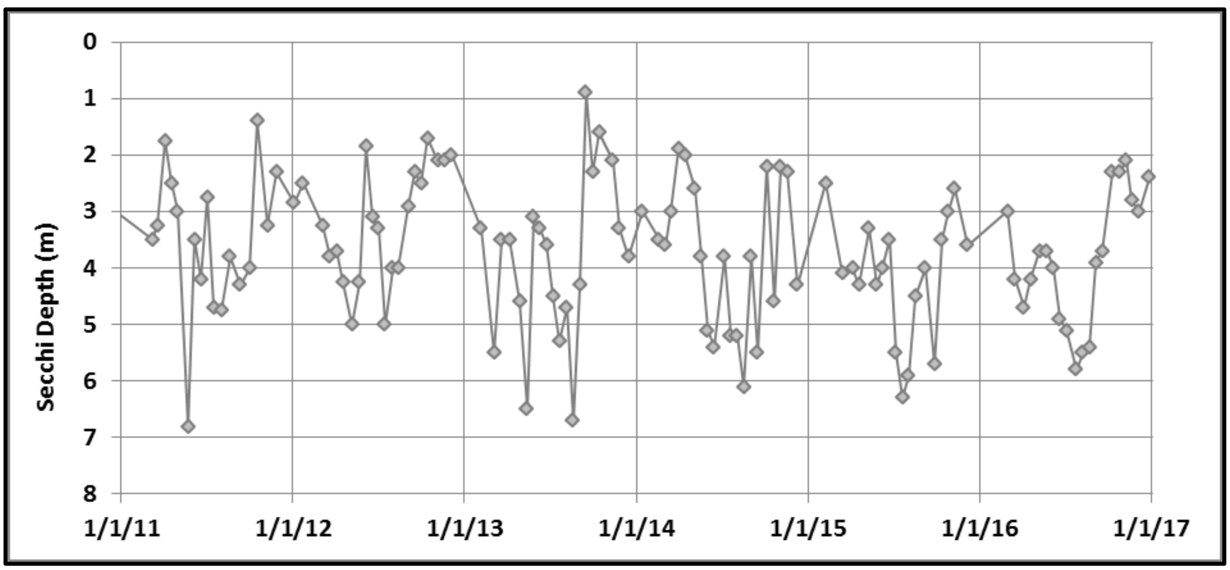

Figure 69. Clarity as Measured by Secchi Depth in Standley Lake, 2011-2016

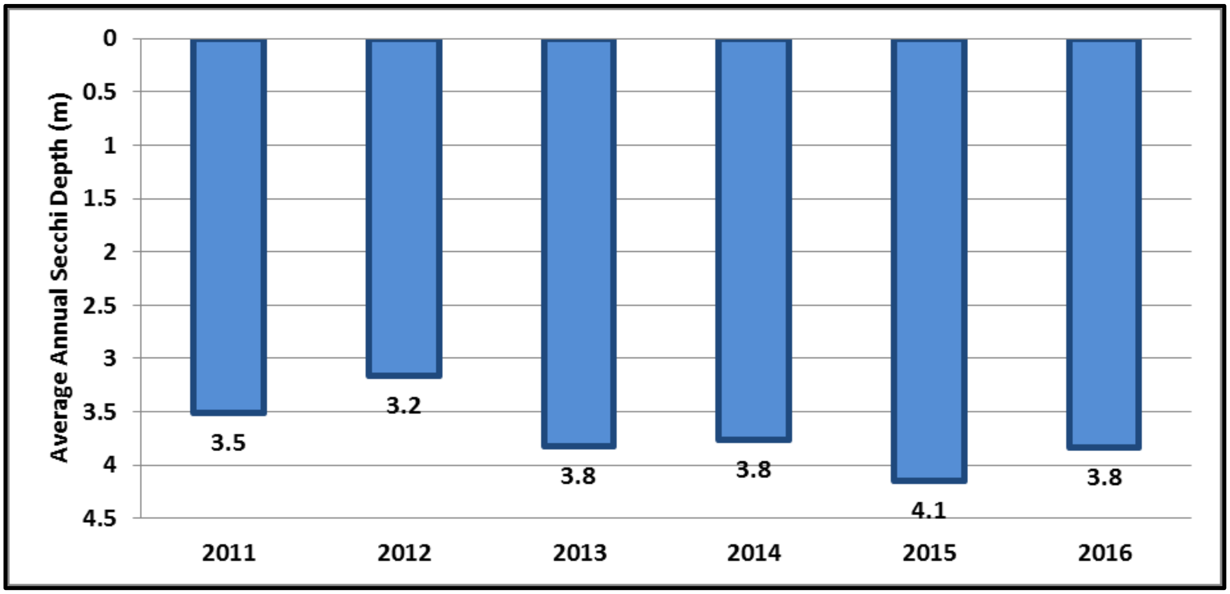

Figure 70. Average Annual Secchi Depth in Standley Lake, 2011-2016

F. Standley Lake Water Quality Summary

Water quality in Standley Lake, as indicated by the water-quality constituents discussed in this section, was good in 2016. As is typical, Standley demonstrated a period of summer stratification and associated hypolimnetic hypoxia. In contrast to past years, this period of hypoxia was not associated with an increase in TP concentrations in the hypolimnion. The patterns and magnitudes of TN concentrations were consistent with past years. Clarity, as measured using a Secchi disk, and chlorophyll *a* are broad measures of water quality that provide a reflection of the overall water quality conditions in the lake. In 2016, chlorophyll *a* concentrations and Secchi depths were consistent with past years. Further, in 2016 chlorophyll *a* concentrations were in compliance with relevant standards.

VIII. Conclusions

Members of the UCCWA, the Standley Lake Cities, and other parties to the 1993 Agreement continued efforts in 2016 to monitor, preserve, and improve water quality in Clear Creek and Standley Lake. Across the watershed, a diverse set of activities occurred; these included: monitoring and improvement of WWTF operations, control of sediment and nonpoint sources of pollution, and remedial activities. These direct actions were supplemented by numerous public outreach and educational activities, extensive water-quality monitoring, and planning efforts to support the management of streams and lakes in the watershed.

In Clear Creek, the observed annual flows at CC26 and CC60 were slightly below the average of the previous five years. At the downstream station (CC60), annual flows were slightly above the thirty-year (1975-2015) average. The pattern and timing of peak flows was generally consistent with past years. However, in 2016 a period of cold weather in the upper extent of the Clear Creek watershed resulted in a period of decreased flows and a hydrograph with two distinct peaks. The annual loads of TSS and TP, as measured at both CC26 and CC60 were below average. This appears to be primarily driven by decreases in the concentrations observed in May and June. It appears likely that the timing of the sampling in 2016 may have bracketed the typical period of highest concentrations (associated with peak snowmelt flows). The loads and concentrations of TN were consistent in pattern and magnitude with past years. At the upstream station (CC26), the pattern of decreased TN concentrations in the post-2011 period has continued. This pattern is likely to be primarily the result of WWTF upgrades and process improvements with contributions from other watershed activities. This observation is a testament to the effectiveness of the efforts undertaken to preserve and improve water quality in Clear Creek.

Standley Lake began 2016 with relatively high storage levels, and the lake filled to near capacity in May. This level was maintained until near the end of the summer, when drawdown began. Overall, the average contents in 2016 were very close to the average of the previous five years. In 2016 the loading of nutrients, TN and TP, to the lake was below average. This decrease in loading was primarily driven by concentration decreases seen in the FHL canal. As is typical, the outflow of nutrients from the lake was lower than the inflow, indicating the net retention of nutrients.

Standley demonstrated a period of summer stratification and associated hypolimnetic hypoxia; this pattern is normal in Standley and other Colorado reservoirs. In contrast to past years, this period of hypoxia was not associated with an increase in TP concentrations in the hypolimnion. Higher nitrate concentrations at the bottom of the reservoir later in the summer likely affected redox conditions, serving to inhibit phosphorus releases in spite of very low oxygen concentrations. The patterns and magnitudes of TN concentrations were consistent with past years. The maintenance of lower nutrient concentrations is manifested in the broader measures of water quality such as clarity and chlorophyll *a.* In 2016, chlorophyll *a* concentrations and Secchi depths were consistent with past years. Further, the chlorophyll *a* concentrations were in compliance with the standard. These observations demonstrate that good water quality is being maintained in Standley Lake. This, in turn, provides strong evidence of the effectiveness of the efforts to manage, enhance, and protect water quality throughout the Clear Creek and Standley Lake watersheds.

IX. References

Beutel, M.W., A. J. Horne, W.D. Taylor, R.F. Losee, and R.D. Whitney. 2008. Effects of Oxygen and Nitrate on Nutrient Release from Profundal Sediments of a Large, Oligo-mesotrophic Reservoir, Lake Mathews, California. Lake and Reservoir Management. 24:18-29.

CDOT 2015. http://dtdapps.coloradodot.info/otis/trafficdata.

Colorado Department of Public Health and Environment (CDPHE). 2012. Nutrients Management Control Regulation. 5 CCR 1002-85 (Regulation 85). Water Quality Control Commission. Adopted June 11, 2012; Effective September 30, 2012.

Enviroscience. 2013. 2013 Milfoil Weevil Survey at Standley Lake, Westminster, Colorado. Enviroscience, Stowe, Ohio.

Hydros Consulting 2016. Clear Creek/ Standley Lake Watershed Agreement. 2015 Annual Report. September 9, 2016.

Appendix A – Clear Creek/Standley Lake Watershed Agreement

Appendix A

Clear Creek / Standley Lake

Watershed Agreement

AGREEMENT

The undersigned parties hereto agree as follows:

I. Preamble.

This Agreement seeks to address certain water quality issues and concerns within the Clear Creek Basin of Colorado, and specifically, such issues as they affect the water quality of Standley Reservoir, an agricultural and municipal water supply reservoir located in Jefferson County Colorado, which is supplied with water primarily from Clear Creek. For purposes of this Agreement, the Clear Creek Basin is divided into three (3) areas of segments: the Upper Clear Creek Basin ("Upper Basin"), consisting of Clear Creek and its tributaries from its source to and including the headgate of the Croke Canal in Golden, Colorado; the Standley Lake Tributary Basin ("Tributary Basin"), consisting of the lands directly tributary to Standley Lake, the Church Ditch, the Farmers High Line Canal, the Croke Canal, and lands directly tributary to these Canals; and Standley Lake ("Standley Lake"), consisting of the Lake itself.

The parties to this Agreement are governmental agencies and private corporations having land use, water supply, and/or wastewater treatment responsibilities within the Clear Creek Basin. The parties are: (1) UCCBA; (2) City of Golden; (3) City of Arvada; (4) Jefferson County; (5) Jefferson Center Metropolitan District; (6) City of Westminster; (7) City of Northglenn; (8) City of Thornton; (9) City of Idaho Springs; (10) Clear Creek County; (11) Gilpin County; (12) Black Hawk/Central City Sanitation District; (13) Town of Empire; (14) City of Black Hawk; (15) City of Central; (16) Town of Georgetown; (17) Town of Silverplume; (18) Central Clear Creek Sanitation District; (19) Alice/St. Mary's Metropolitan District; (20) Clear Creek Skiing Corporation; (21) Henderson Mine; (22) Coors Brewing Company; (23) Church Ditch Company; (24) Farmers High Line Canal and Reservoir Company; and (25) Farmers Reservoir and Irrigation Company. For purposes of this Agreement, the parties can be divided into four (4) functional groups, as follows: The Upper Basin Entities ("Upper Basin Users" or "UCCBA"), consisting of the members of the Upper Clear Creek Basin Association (generally representing entities with jurisdiction over land use and wastewater treatment activities in the Upper Basin that can affect water quality in the Upper Basin); the Tributary Basin Entities ("Tributary Basin Entities"), consisting of the Cities of Golden, Arvada, and Westminster, and the County of Jefferson and the Jefferson Center Metropolitan District (generally representing entities with jurisdiction over land use activities that can affect water quality in the Tributary Basin); the Standley Lake Cities ("Standley Lake Cities"), consisting of the Cities of Westminster, Northglenn, and Thornton, (representing the municipal water users from Standley Lake); and the three canal companies (the "Canal Companies"), consisting of the Church Ditch Company, the Farmers High Line Canal and Reservoir Company, and the Farmers Reservoir and Irrigation Company (representing the entities that own and operate canals through which water is conveyed to Standley Lake for municipal and agricultural use).

In accordance with the geographical and functional divisions, this Agreement generally sets out rights and obligations with respect to certain water quality matters within the Clear Creek Basin (as above defined) by area or segment and by functional group.

II. Agreement.

1. The parties will submit a joint alternative proposal to the Water Quality Control Commission ("WQCC") in the matter captioned "For Consideration of Revisions to the Water Quality Classifications and Standards, Including Adoption of a Narrative Standard, for Segment 2, Standley Lake, of Big Dry Creek, in the South Platte Basin, and Adoption of a Standley Lake Control Regulation" on or before December 23, 1993. Said alternative proposal shall contain the following points:

a. Request the WQCC to adopt a narrative standard only for Standley Lake at this time, with further consideration of any control regulation or numeric criteria for implementation of the standard at or after the triennial review of the South Platte River to be held in 1997. The narrative standard shall require maintenance of Standley Lake in a mesotrophic state, as measured by a combination of relevant indicators, as recommended by the parties' consultants prior to December 23, 1993.

b. Request language in the Rule and in the Statement of Basis and Purpose for the regulation explaining that during the next triennium ending in 1997 ("triennium") the parties hereto will be conducting additional testing and monitoring, as well as implementing certain best management practices and controls on a voluntary basis, the results of which will be reported to the WQCC on an annual basis, and that point-source discharge permits written during the triennium shall not include any new or more stringent nutrient effluent limitations or wasteload allocations to meet the narrative standard. The proposed language will also refer to the intention of the parties and the Commission that should the narrative standard not be met at the end of the triennium, and substantial progress has not been made in reducing the nutrient loads to Standley Lake, additional measures may be required, including numeric standards or effluent limitations for phosphorous and/or nitrogen in the Upper Basin, and for additional best management controls in Standley Lake to be considered.

2. Should the WQCC fail to approve and adopt the substance of the proposed alternative described in paragraphs 1.a. and 1.b. above, this agreement shall automatically terminate and the parties shall be released from all other obligations and rights hereunder.

3. At or after the triennial review in 1997, the UCCBA and Standley Lake Cities agree that if substantial progress has not been made by the UCCBA in reducing its portion of nutrient loading and in developing controls to maintain appropriate reductions in nutrient loads to Standley Lake sufficient to maintain the narrative standard, they

will jointly petition the Commission to adopt a control regulation for Standley Lake containing the following points:

a. Total Phosphorous effluent limitation of 1.0 mg/l as P as a thirty (30) day average at the Upper Clear Creek Wastewater Treatment Plants, or such other numeric standard(s) or effluent limitations (s) for phosphorous or nitrogen, or in combination, with opportunity for point to point source and nonpoint source to point source trading among the entities that operate the UCCBA treatment plants, as has been determined will be effective in achieving and maintaining the narrative standard for Standley lake. Such numeric standard(s) or effluent limitation(s) shall be implemented over a three year period to allow time for the affected entities to fund, design and construct improvements necessary to meet the standards.

b. In-lake treatment to reduce internal phosphorous loading by 50% from the 1989-90 measured loadings in the 1993 USGS report by Mueller and Ruddy, or such other standards for reduction of internal phosphorous and nitrogen loading as has been determined will be effective in achieving and maintaining the narrative standard for Standley Lake, within three (3) years.

4. The UCCBA, in consultation with the Standley Lake Cities and Tributary Basin Entities will prepare a Best Management Practices Manual by December 31, 1994 for nonpoint sources that will cover disturbed areas of 1 acre or more and use its best efforts to have it approved and adopted for implementation by all jurisdictions within the Upper Basin by July 1, 1995. This Manual will be prepared to deal with the geologic, topographic and weather conditions existing within the Upper Basin to facilitate the reduction of nutrient loading from the various activities of the Upper Basin. This Manual will be coordinated with the Standley Lake Cities and Tributary Basin entities. The plan will include a program for monitoring representative results, to be included in the overall basin monitoring plan. For purposes of development of BMPs, Jeffco will not be considered to be part of the UCCBA.

5. The UCCBA, in consultation with the Standley Lake Cities and the Tributary Basin Entities, will examine the costs and effects of nutrient removal at UCCBA wastewater treatment plants, including operational controls or modifications which would decrease nutrient loads. Recommendations of such review shall be furnished to all the parties hereto by June 30, 1994. The UCCBA will use its best efforts to have its members implement operational modifications which can be implemented without significant capital improvements as quickly as reasonably practical.

6. The Standley Lake Cities, in consultation with the other parties, will develop a Standley Lake Management Plan by December 31, 1994 which will address in-lake nutrient loading and potential nutrient loading from lake activities, water supply operations, recreational activities, and activities in the watershed. The Standley Lake Cities will use their best efforts to implement the Lake Management Plan by

June, 1995. It is understood that the water rights implications of the plan must be considered.

7. The parties will jointly design, implement, and fund in such allocations as they shall agree a monitoring program to evaluate (1) nutrient loadings from point sources; (2) nutrient loadings from non-point sources in the Upper Basin; (3) nutrient loadings from non-point sources in the Tributary Basin; (4) internal Lake loading; and (5) the effect of nutrient reduction measures implemented by the various parties on the trophic status of Standley Lake. The results of the monitoring program will be provided to the Water Quality Control Commission for informational purposes annually. A description of the monitoring program will be included with the Annual Reports.

8. The Tributary Basin Entities and the Standley Lake Cities, in consultation with the other parties, will develop Best Management Practices (BMPs) for each of their jurisdictions by December 31, 1994, and shall use their best efforts to have them adopted as regulations by July, 1995. The BMPs will be designed to remove pollutants to the maximum extent practical considering the costs and benefits of possible measures; provided, however that no retro-fitting of existing construction or development will be required.

9. The Tributary Basin Entities, the Standley Lake Cities and the Canal Companies will develop a Management Plan for the Tributary Basin, addressing stormwater quality and quantity, hazardous substance spills, canal flushing, crossing permits, the Canal Companies' stormwater concerns, and the water rights implications of the above by December, 1994, and use their best efforts to achieve adoption of the portions of the Plan under the control of each entity by July, 1995. If not all affected parties adopt the agreed measures, then the parties that have adopted such measures will determine whether or not to implement the Plan despite such non-adoption by one or more parties.

10. Each functional group (The UCCBA, The Tributary Entities, The Standley Lake Cities, and the Canal Companies) shall provide each other group with semi-annual reports detailing the progress made on the implementation of its responsibilities herein, including development of any BMPs, nutrient reduction programs or controls, or other items required by this agreement, beginning in June, 1994. The parties shall also meet periodically after each report is completed to discuss progress by the parties. It is anticipated that the various functional groups may assign or appoint task groups or committees to address specific tasks or areas of concern (e.g. BMPs; ISDS; Wastewater Plant operational changes; monitoring, etc). If so, then the task groups shall provide the appropriate reports and participate in follow-up meetings.

11. This agreement may be enforced as a contract according to the laws of the State of Colorado; however, this agreement shall not create any right to claim or recover monetary damages for a breach thereof.

12. It is anticipated that other regional agencies with land use and/or water quality responsibilities or impacts within the Clear Creek Basin (as above defined) may join in the parties' monitoring and other efforts pursuant to this Agreement.

13. This Agreement may be executed in counterparts.

Appendix B – Upper Clear Creek/Standley Lake Watershed Water-Quality Monitoring Plan

Upper Clear Creek/Standley Lake Watershed

Water Quality Monitoring Plan

Standley Lake

December 2013

TABLE OF CONTENTS

APPENDICES

Abbreviations and Acronyms

BH/CC	Blackhawk/Central City
C	Centigrade
CC	Clear Creek
cfs	cubic feet per second
COC	chain of custody
CWQCC	Colorado Water Quality Control Commission
DI	Deionized Water
DO	Dissolved Oxygen
DRP	Dissolved Reactive Phosphorus (ortho-Phosphate-P)
EPA	U.S. Environmental Protection Agency
FHL	Farmers Highline Canal
FRICO	Farmers Reservoir and Irrigation Company
HCl	Hydrochloric acid
ISDS	Individual Sewage Disposal System
KDPL	Kinnear Ditch Pipe Line
LDMS	Laboratory Data Management System
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
m	meter
mgd	million gallons per day
mg/L	milligrams per liter
MSCC	Mainstem Clear Creek
mv	millivolt
N	Nitrogen
NFCC	North Fork Clear Creek
NG	City of Northglenn
NPS	Nonpoint Source
NTU	Nephelometric Turbidity Units
ORP	Oxidation Reduction Potential
OWTS	Onsite Wastewater Treatment System
pCi/L	picocuries per liter
P	Phosphorus
QC	Quality Control
SDWA	Safe Drinking Water Act
SFCC	South Fork Clear Creek
SLC	Standley Lake Cities
SLWQIGA	Standley Lake Water Quality Intergovernmental Agreement
SM	Standard Methods for the Examination of Water and Wastewater
TH	City of Thornton
TOC	Total Organic Carbon
TSS	Total Suspended Solids
TVSS	Total Volatile Suspended Solids
UCC	Upper Clear Creek
USGS	United States Geological Survey
Westy	City of Westminster
WFCC	West Fork Clear Creek
WMA	Upper Clear Creek Watershed Management Agreement
WQIGA	Water Quality Intergovernmental Agreement (Standley Lake)
WQS	Colorado Water Quality Standards (Regs #31 and #38)
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

MONITORING PROGRAMS OVERVIEW

Introduction

The quality of the water in Standley Lake has been monitored for more than two decades. Efforts to protect Standley Lake through state water quality regulations culminated in adoption of the numeric chlorophyll *a* standard for the lake in 2009. The Colorado Water Quality Control Commission ("CWQCC") established the chlorophyll *a* standard at 4.0 µg/L with a statistically derived assessment threshold of 4.4 µg/L. The standard is based on the arithmetic average of the individual monthly average chlorophyll *a* data for samples collected during March through November in each year. Exceedance of the standard would occur if the yearly 9-month average of the monthly chlorophyll *a* average results is greater than 4.4 µg/L more frequently than once in five years. In addition, a version of the narrative standard adopted in 1993 was also retained stating that the trophic status of Standley Lake shall be maintained as mesotrophic as measured by a combination of common indicator parameters such as total phosphorus, chlorophyll *a*, secchi depth and dissolved oxygen. The voluntary implementation of best management practices clause included in the 1993 version of the standard was eliminated from the 2009 narrative standard.

The Standley Lake Cities ("SLC") of Northglenn, Thornton and Westminster remain committed to effective and efficient water quality monitoring in the watershed as originally agreed to in the 1993 Watershed Management Agreement. The Standley Lake Water Quality Intergovernmental Agreement ("SLWQIGA" or "WQIGA"), entered into between the SLC, details the provisions for costs sharing related to cooperative efforts regarding water quality issues in the Clear Creek Basin and Standley Lake. The WQIGA monitoring program is subdivided into three inter-related programs for which the SLC provide field sampling, laboratory analyses and data management support: the Upper Clear Creek Monitoring Program, the Tributary Basin Monitoring Program and the Standley Lake Monitoring Program.

The Monitoring Committee was formed to periodically evaluate the monitoring programs and propose appropriate modifications as necessary. The proposals are evaluated by the SLWQIGA committee prior to implementation. Representatives from the SLC, Upper Clear Creek Basin and the Tributary Basin are actively involved in committee activities as appropriate. This document details the specific requirements and responsibilities of the SLC and outlines the commitments of additional entities involved in the Standley Lake watershed monitoring programs.

Standley Lake serves as the sole drinking water source for the cities of Northglenn and Westminster and is one of several drinking water sources for the City of Thornton. The monitoring program is designed to collect samples from a variety of locations in the watershed with varying anthropogenic and natural sources of pollutants. The data is used for trend analysis, modeling and for numerous other applications. Interpretation of the results allows the upstream and downstream communities to work cooperatively to minimize impacts to water quality.

Safety Considerations

The personal safety of the sampling team members is paramount in the decision making process for collection of water quality samples. At no time should personal safety be jeopardized in order to collect a sample. Environmental conditions may change suddenly and are variable throughout the watershed.

The following safety measures should be observed during all sampling activities:

- Sample collection should be performed by a two person team whenever possible.
- Weather conditions at the sampling sites should be evaluated prior to leaving the laboratory.
- Personal flotation devices should be worn if the creek water level is greater than twelve inches deep. Hydrostatically triggered, self-inflating personal flotation devices are recommended for non-lake sampling, as the device will automatically inflate if the sensor is submerged below six inches of water.
- Personal flotation devices are mandatory on Standley Lake. Lake sampling team members should be experienced swimmers.
- Wear waterproof gloves and sock liners, as appropriate.
- Exercise caution on slippery rocks, river banks and boat docks.
- Cell phones must be available during sampling, but be aware that cell phone signals are not reliable in all areas of Clear Creek Canyon.
- First aid kits must be available in all sampling vehicles, including boats. It is recommended that sampling team members be trained in basic first aid techniques.
- Supervisors are notified of the sampling team's itinerary and the expected return time to the lab. Sampling teams will notify supervisors of any delay in the expected return time.

UPPER CLEAR CREEK MONITORING PROGRAM

The Upper Clear Creek ("UCC") Monitoring Program is designed to provide water quality information in order to evaluate nutrient loadings from both point sources (discrete) and non-point sources (dispersed) within the Upper Clear Creek Basin.

The Upper Clear Creek Monitoring Program includes three distinct sub-programs, each designed to obtain water quality data during specified conditions:

- ambient grab samples;
- continuous stream monitoring and the automated collection of 48-hour ambient samples, and
- the automated collection of event samples.

UCC – AMBIENT GRAB SAMPLES

Program Coordination: Thornton
Program Participants: Thornton, Westminster, Arvada, Golden, Upper Basin WWTPs

Grab samples are single, point-in-time samples collected in-stream throughout the Upper Clear Creek Basin. Grab sample locations were selected to correspond with established USGS gage stations and additional sites have been included over the years as the monitoring program has evolved. Refer to the table below for sample site locations. The rationale for selection of the specific sampling sites is included in Appendix A. A map of the watershed is included in Appendix B.

Grab samples are collected five times during the year to correspond with seasonally varying flow conditions in Clear Creek. The *Short Schedule* is collected three times per year (February, April and December) and includes four stream locations. The *Long Schedule* is collected twice per year (May and October) and includes 16 stream locations. Laboratory analytical protocols limit sample collection to Monday through Thursday. Sampling is performed each year on approximately the same schedule. The specific sampling dates for the year are predetermined at the beginning of the year.

Starting in 2013, Wastewater Treatment Plant (WWTP) effluent samples are collected by treatment plant staff and are analyzed for nutrients (nitrogen and phosphorus) by commercial laboratories in accordance with Colorado Regulation 85. Sampling and analysis plans were developed by each WWTP outlining the monitoring locations, frequency and analytical parameters for testing. The analytical data reported by the WWTPs to the Colorado Water Quality Control Division will be included in the watershed annual reports.

WWTP Effluent Sample ID	Sample Location
CC1A	Loveland WWTP
CC3A	Georgetown WWTP
CC5A	Empire WWTP
CC7A	Central Clear Creek WWTP
CC8A	St Mary's WWTP
CC12A	Idaho Springs WWTP
CC13B	Black Hawk/Central City WWTP
CC14A	Henderson Mine WWTP
CC15A	Eisenhower Tunnel WWTP

UCC – AMBIENT GRAB SAMPLES
Locations and Sample Schedule

Clear Creek Sample ID	Flow Gage	Sample Location *	Early Feb	Early Apr	Late May	Mid Oct	Early Dec
CC05	Staff gage	MSCC at Bakerville			X	X	
CC10	Recording gage	SFCC upstream of the lake			X	X	
CC15	Staff gage	WFCC below Berthoud			X	X	
CC20	Recording gage	WFCC below Empire			X	X	
CC25	Recording gage	MSCC above WFCC			X	X	
CC26	Recording gage	MSCC at Lawson Gage	X	X	X	X	X
CC30	Staff gage	Fall River above MSCC			X	X	
CC34	----	MSCC above Chicago Creek			X	X	
CC35	Recording gage	Chicago Creek above Idaho Springs WTP			X	X	
CC40	Recording gage	MSCC below Idaho Springs WWTP (US 6 and I-70))	X	X	X	X	X
CC44	Staff gage	NFCC above BH/CC WTP intake			X	X	
CC45	----	NFCC above original BH/CC WWTP			X	X	
CC50	Recording gage	NFCC at the mouth	X	X	X	X	X
CC52	----	Beaver Brook at the mouth			X	X	
CC53	----	Soda Creek at the mouth			X	X	
CC60	----	MSCC at Church Ditch Headgate	X	X	X	X	X

* MSCC = Mainstem Clear Creek WFCC = West Fork Clear Creek WTP = Water Treatment Plant
SFCC = South Fork Clear Creek NFCC = North Fork Clear Creek WWTP = Wastewater Treatment Plan

UCC – AMBIENT GRAB SAMPLES
Analytical Parameters for Creek samples – includes parameters for both Short and Long Schedules

Analyte	Analytical Method Reference	Reporting Limit Goal	Responsible Laboratory
Total Nitrogen	SM 4500-NO3 I	0.02 mg/L	Westminster
Nitrate/Nitrite as N	SM 4500-NO3 I	0.01 mg/L	Westminster
Ammonia as N	SM 4500-NH3 H	0.01 mg/L	Westminster
Total Phosphorus	SM 4500-P E	0.0025 mg/L	Northglenn
Ortho-phosphate as P (dissolved) or DRP	SM 4500-P E	0.0025 mg/L	Northglenn
Total Organic Carbon (TOC)	SM 5310 B	0.5 mg/L	Thornton
Total Suspended Solids	SM 2540 D	1 mg/L	Thornton
Temperature	SM 2550 B	1.0 °C	Field Teams/Golden
pH	SM 4500-H+ B	1.0 Std Units	Field Teams/Golden
Conductivity	SM 2510 B	10 µS/cm	Field Teams/Golden
Turbidity	SM 2130 B	1.0 NTU	Field Teams/Golden
Dissolved Oxygen	SM 4500-O G	1.0 mg/L	Field Teams/Golden
Stream Depth	Staff gage reading	0.1 ft	Field Teams

Table Notes:
1) SM refers to the 22nd Edition of Standard Methods for the Examination of Water and Wastewater.
2) Reporting limit goals are matrix dependent and may be increased for complex matrices and may be lower depending on laboratory capability.
3) TOC is analyzed on samples from sites CC05, CC20, CC26, CC35, CC40, CC45, CC50, CC52, CC53, and CC60 during the Long Schedule events. TOC is analyzed on all four creek grab samples during the Short Schedule events.

UCC – AMBIENT GRAB SAMPLES

Flow Monitoring

Various mechanisms are employed throughout the watershed for monitoring the hydrologic conditions at strategic locations. USGS real-time recording gages are installed at CC10, CC20, CC25, CC26, CC35, CC50 and CC61 (Clear Creek at Golden). USGS staff gages are in place at CC05, CC15, CC30 and CC44. The staff gage readings are recorded to the nearest 0.1 foot and may be converted to stream flow using the USGS calibration rating curve established for the location.

The recording gage at CC40 (Clear Creek at US 6 and I-70) is operated and maintained by Clear Creek Consultants on behalf of UCCWA. The SLC provide financial support for the USGS gages at CC05 at Bakerville (staff gage) and CC26 at Lawson (recording gage). The City of Golden provides financial support for the USGS gage on the West Fork of Clear Creek at Empire.

UCC – AMBIENT GRAB SAMPLES

Program Coordination - Short Schedule (Thornton)

Two weeks before the scheduled Clear Creek sampling date:

- Contact Westminster and Northglenn to request adequate supply of sample bottles from each lab.
- Prepare four sample kits as directed below. Each sample bottle kit includes the containers for sampling at one location.

Sample Bottle Kit Prep- Short Schedule

Destination	Quantity	Volume	Bottle Type	Parameter	Laboratory	Additional Documentation
Clear Creek Team – Feb, April and Dec **ONLY** (Collect samples at CC26, CC40, CC50 and CC60)	4	1L	Rectangular plastic	Phosphorus series	Northglenn	Instructions, COCs and one field data sheet
	4	500 mL	Plastic jug	TSS	Thornton	
	4	250 mL	Rectangular plastic	Nitrogen series	Westminster	
	4	40 mL	Glass vial	TOC	Thornton	

Table Notes:
1) Phosphorus series includes total P and dissolved ortho-phosphate-P (also referred to as DRP).
2) Nitrogen series includes total N, ammonia-N and nitrate/nitrite-N.
3) The additional documentation forms are included in Appendix C.

On Clear Creek sampling day (Short Schedule):

- Calibrate turbidity, pH, conductivity, and DO meters in the lab. Ensure all probes and meters are working properly before leaving the lab. Take aliquots of the standards into the field to check instrument calibration if necessary.

- At each sample location, collect samples and analyze for pH, temperature, DO, conductivity, and turbidity. Complete the COC and record all results on the Field Data Sheet (refer to Appendix C).

- The field samples are returned to the Thornton Lab and refrigerated until pickup by Westminster and Northglenn personnel. The samples are relinquished to Westminster (nitrogen) and Northglenn (phosphorus) and the COCs are signed appropriately. The original copies of the COCs are retained by Westminster and Northglenn. Original field data sheets and copies of the COCs are retained by the City of Thornton for permanent archive.

UCC – AMBIENT GRAB SAMPLES

Sampling Locations Directions and Narrative Descriptions - Short Schedule

Sampling Frequency: Feb, April, Dec

POINT	DIRECTIONS AND DESCRIPTION OF LOCATION
CC26	Travel westbound I-70 and exit at Dumont/Downieville. Travel frontage road west towards Lawson. Immediately after the I-70 overpass turn left and park in area just beyond the end of the guardrail. Sample creek at USGS gage and sampling station by bridge. [RECORDING GAGE] **Sample TOC**
CC40	Travel eastbound on I-70 and take US 6 exit. Pull off in parking area just east of the off ramp. (The Tributary at 244 Restaurant is across the road) Sample just below the USGS recording gage. **Sample TOC**
CC50	Travel US 6 eastbound to the intersection of US 6 and CO 119. Turn left up Highway 119 towards Blackhawk/Central City. Approximately 0.2 miles upstream from the intersection is a pullout area on the left with a small red building and cellular antenna pole near a boarded-up tunnel entrance. Sample at the USGS recording gage. [RECORDING GAGE] **Sample TOC**
CC60	Approximately 1 mile west of intersection of Hwy 58 and US 6. Park in the pullout on the south side of highway and walk (or drive) downhill to the Church Ditch diversion structure. Go across the mesh bridge and sample from the main stem of Clear Creek. Do not sample from Church Ditch. **Sample TOC**

Photographs of the sampling locations and GPS coordinates are included in Appendix D.

UCC – AMBIENT GRAB SAMPLES
Program Coordination - Long Schedule (Thornton)

Two weeks before the scheduled Clear Creek sampling date:

- Contact Westminster and Northglenn to request adequate supply of sample bottles from each lab.
- Contact and coordinate the sampling teams. Make sure that there are two samplers available and one set of field meters (turbidity, pH, conductivity and DO) for two Creek Teams. Refer to the Program Participants Contact Information list in Appendix F for sampling personnel who may assist with sampling.
- Prepare sample kits as directed below. Each sample bottle kit includes the containers for sampling at one location.

Prepare sample bottle kits as directed below. Each sample bottle kit contains the prepared sample bottles to collect samples at one location. Prepare 16 bottle kits: 8 kits each for Creek Teams A and B.

Sample Bottle Kit Prep- Long Schedule

Destination	**Quantity**	**Volume**	**Bottle Type**	**Parameter**	**Laboratory**	**Additional Documentation**
Clear Creek Team A (Collects samples at CC25, CC05, CC10, CC26, CC34, CC35, CC52 and CC53)	8	1L	Rectangular plastic	Phosphorus series	Northglenn	One set of: Instructions, COCs and one field data sheet
	8	500 mL	Plastic jug	TSS	Thornton	
	8	250 mL	Rectangular plastic	Nitrogen series	Westminster	
	5	40 mL	Glass vial	TOC	Thornton	
Clear Creek Team B (Collects samples at CC15, CC20, CC30, CC40, CC44, CC45, CC50 and CC60)	8	1L	Rectangular plastic	Phosphorus series	Northglenn	One set of: Instructions, COCs and one field data sheet
	8	500 mL	Plastic jug	TSS	Thornton	
	8	250 mL	Rectangular plastic	Nitrogen series	Westminster	
	5	40 mL	Glass vial	TOC	Thornton	
QC	4	2 L	1:1 HCl rinsed Rectangular plastic	QC spikes and dups for Golden	Golden	QC sampling completed by Team A in May and Team B in October.
	1 (blank)	1 L	Rectangular plastic	Phosphorus series	Northglenn	
	1 (blank)	250 mL	Rectangular plastic	Nitrogen series	Westminster	

Table Notes:
1) Phosphorus series includes total P and dissolved ortho-phosphate-P (also referred to as DRP).
2) Nitrogen series includes total N, ammonia-N and nitrate/nitrite-N.
3) The additional documentation forms are included in Appendix C.

<u>On Clear Creek sampling day (Long Schedule):</u>

- Calibrate turbidity, pH, conductivity, and DO meters in the lab. Ensure all probes and meters are working properly before leaving the lab. Take aliquots of the standards into the field to check instrument calibration if necessary.

- Prepare coolers with ice and sample bottle kits. The Creek Team chosen for QC sampling must also include in the field sample bottle kit: field blank bottles (nitrogen and phosphorus), one field duplicate cubitainer, and at least 4 two-liter bottles for QC samples. Thornton prepares both sample kits for Clear Creek Teams A and B and will provide the extra materials needed for the QC sampling in the appropriate sample kit.

- Meet your sampling team partner at the designated location (usually City of Golden Public Works).

- At each sample location, collect samples and analyze for pH, temperature, DO, conductivity, and turbidity. Complete the COC and record all results on the Field Data Sheet (refer to Appendix C). Samples will be collected at all creek sites for nitrogen series, phosphorus series and TSS. TOC samples are collected only at designated creek sites: CC05, CC20, CC26, CC35, CC40, CC45, CC50, CC52, CC53, and CC60.

- The Clear Creek Team selected for QC sampling will randomly select four creek sites. Collect one sample (2-liter HCl rinsed bottle) at four randomly selected creek sites for preparation of the spike and duplicate nutrient QC samples by Golden Laboratory staff.

- Complete the COC for the QC samples.

- Return to the Golden Lab when sampling is completed. Relinquish the QC samples to the Golden Lab staff.

- Golden Lab staff prepares one duplicate and one spike sample for total nitrogen and total phosphorus from the four QC samples.

- Analyze and complete any missed field parameters as allowable.

- Make two copies of each team's field data sheet: one of each for Golden and one of each for Westminster to use for logging in the samples to the electronic spreadsheet.

- The field samples and prepared QC samples are returned to the Thornton Lab and refrigerated. The samples are relinquished to Westminster (nitrogen) and Northglenn (phosphorus) and the COCs are signed appropriately. The original copies of the COCs are retained by Westminster and Northglenn. Original field data sheets and copies of the COCs are retained by the City of Thornton for permanent archive.

UCC – AMBIENT GRAB SAMPLES
Sampling Locations Directions and Narrative Descriptions - Long Schedule

Clear Creek Team A

Sampling frequency: late May, mid Oct

Sample bottles: Creek sites: One 1 liter rectangular (phosphorus series), one 500 mL (TSS), one 250 mL (nitrogen series) and one 40 mL amber glass vial (TOC) as required.

POINT	DIRECTIONS AND DESCRIPTION OF LOCATION
CC25	Travel west on I-70 approximately 0.8 miles west of mile marker 232. Pull off the highway on the right side immediately beyond the guardrail for the bridge structure. Walk down the hill to the creek. Sample immediately downstream of the box culvert across from the recording gage located downstream. [RECORDING GAGE]
CC05	1-70 westbound to Exit 221 (Bakerville) Exit; go south back over Interstate (left). Park at call box. Take sample upstream of parking area, read gage located downstream. [Read the STAFF GAGE and record on the field data sheet]. **Sample TOC**
CC10	I-70 eastbound to Georgetown. Begin at intersection of 6th and Rose in Georgetown. Go 2.2 miles up Guanella Pass Road (go to the first lake). U-turn by the lake inlet and park on the right side of road. Sample from stream above lake inlet point. [RECORDING GAGE]
CC26	Travel eastbound on I-70 and exit at Lawson. Travel frontage road through Lawson. Immediately before the road curves left under I-70 is a parking area straight ahead through an opening at the end of a guardrail. Sample creek at gage and USGS sampling station by the bridge over the creek. [RECORDING GAGE] **Sample TOC**
CC34	From I-70 (either direction) Exit 240 (Chicago Creek), pull off in the small parking area on the other side of the bridge. Sample the main stem of Clear Creek upstream of Chicago Creek across from the Forest Service Building.
CC35	Continue approx. 3.7 miles on Hwy 103. Pull off on the right shoulder just past the green roofed house that looks like a barn (on the left). Cross road and sample creek at recording gage. [RECORDING GAGE] **Sample TOC**
CC52	Exit I-70 eastbound at Beaver Brook/Floyd Hill (Exit #247). Turn left onto the north frontage road (US Hwy 40). Travel east approximately 2.4 miles. Pull off to the side of road and sample Beaver Brook at this point. **Sample TOC**

CC53 Continue travelling east bound 0.3 miles and cross the second white bridge. Exit immediately on the right to Soda Creek Drive. Park on the right. Sample Soda Creek upstream of the bridge. **Sample TOC**

Photographs of the sampling locations and GPS coordinates are included in Appendix D.

UCC – AMBIENT GRAB SAMPLES
Sampling Locations Directions and Narrative Descriptions - Long Schedule

Clear Creek Team B

Sampling frequency: late May, mid Oct

Sample bottles: Creek sites: One 1 liter rectangular (phosphorus series), one 500 mL (TSS), one 250 mL (nitrogen series) and one 40 mL amber glass vial (TOC) as required.

POINT	DIRECTIONS AND DESCRIPTION OF LOCATION
CC40	Traveling westbound on I-70 take the US 6 exit (#244) at the bottom of Floyd Hill. Turn right at the bottom of the ramp, and pull off to the right in the parking area 150 feet east of the off-ramp. (The Tributary at 244 Restaurant is across the road). Sample below recording gage. [RECORDING/STAFF GAGE] **Sample TOC**
CC30	Drive west on 1-70 to Exit 238 (Fall River Road/St. Mary's Glacier). At the junction of the on/off ramp and Fall River Road is a parking area on the left across from a railing and stairway with USGS equipment. Descend the stairs and sample the creek above the staff gage attached to the bridge. [Read the STAFF GAGE and record on the field data sheet]
CC15	Travel west on I-70 and take US 40 west through Empire. Approximately 6 miles west of Empire there is a large pullout on the creek (left) side of the highway with a large tree in the middle of the pullout. Sample directly below the tree at the creek. Staff gage is along the north bank of stream next to a tree at the stream's edge. [Read the STAFF GAGE and record on the field data sheet]
CC20	Returning back through Empire eastbound, travel along the road/ramp from US 40 towards Westbound I-70. Immediately after turning onto road/ramp, there is a large open space on the right and a Colorado Dept. of Transportation (CDOT) maintenance area on the left. If the gate is open, turn left into the CDOT maintenance yard and sample approx. 150 feet downstream of the bridge at recording gage/staff gage. If the gate is closed, park across the street from the gate and walk into the CDOT maintenance area. [RECORDING/STAFF GAGE] **Sample TOC**
CC44	Return east on I-70 to the Central City Parkway and take the Parkway to Central City. Central Parkway turns into Nevada Street. Nevada Street turns into Spring Street when it crosses over Main Street. Take Spring Street to Gregory Street and turn right. Travel down through Central City into Blackhawk, past Blackhawk's Main Street and turn left on Hwy 119. Travel westbound on 119 approx. 0.9 miles.

There is a small wooden building and parking area on the left side of the road at the Black Hawk water intake. Sample the creek behind the building.

CC45 Turn around and drive east on 119 approx. 1.5 miles and turn right on Mill Street. Take the first left onto Main Street and drive to the east end of the casino and parking garage on the left. At the east end of the building is an alley between the parking garage and a small brown building. Sample the creek at the end of the alley upstream of the old Black Hawk WWTP site. **Sample TOC**

CC50 Continue down Hwy 119 eastbound toward US 6. Approximately 1.4 miles downstream of the new Black Hawk/Central City WWTP and approximately 0.2 miles upstream from the intersection of Hwy 119 and US 6 is a pullout area on the right just past a small red building and cellular antenna pole near a boarded-up tunnel entrance. Sample at the recording gage. [RECORDING GAGE] **Sample TOC**

CC60 Drive east down US 6/Hwy 119. Approximately 0.6 miles east of Tunnel 1 (0.45 miles west of the intersection of Hwy. 58 and US 6) is a pullout/dirt road on the south side of highway. Walk or drive down the hill to the Church Ditch diversion structure. Go across the mesh bridge and sample from the main stem of Clear Creek. Do not sample from Church Ditch. **Sample TOC**

Photographs of the sampling locations and GPS coordinates are included in Appendix D.

UCC – AMBIENT GRAB SAMPLES

QA/QC Program - Long Schedule Only

Duplicate and spike quality control samples are prepared from creek samples collected during the Clear Creek Long Schedule sampling events for selected nutrients and are analyzed by Westminster (total nitrogen) and Northglenn (total phosphorus). The QC samples are prepared by the City of Golden at their laboratory on the day of sampling. Four creek locations are randomly selected for preparation of the QC samples. One duplicate and one spike are submitted to each laboratory. The analytical procedure for QC preparation is detailed below:

SOP - QC Preparation for Clear Creek Studies

Night before:

- Soak 2 1-Liter Class A volumetric flasks with 1:1 HCl. One flask will be used to make up fresh Nitrate standard and the other will be used for spiking the selected Clear Creek sample (with both nitrate and phosphorus spikes).

The Morning of Sampling Day:

- Remove 5 mg/L Phosphorus standard from fridge to warm to room temperature. This standard is prepared by the City of Northglenn and is stable for 3 months. It is usually in a 125 ml brown glass bottle.
- Remove 100 mg/L Nitrate-N standard from fridge. It is stored in a 125 ml brown Nalgene bottle. This standard is prepared fresh by the City of Golden each time. The method to prepare a 100 mg/L NO3-N standard is in Standard Methods, 21st Ed., page 4-120 and described below.

- **To Prepare Fresh Nitrate-N Standard**
  - Thoroughly rinse out one of the HCl acid soaked 1-Liter flasks to prepare the fresh standard in.
  - Fill flask with 200-300 mL DI water.
  - Weigh out 0.7218 grams of KNO3 and add to flask. (KNO3 is stored in the desiccator).
  - Dilute to 1-Liter volume with DI and mix thoroughly.
  - Discard old standard and refill bottle with fresh standard. Rinse bottle out with fresh standard 2-3 times before filling. Record new prep date on bottle.

- Prepare 4 sample bottles for spike and duplicate samples. Bottles used for spike and duplicate prep are provided by the City of Thornton and are the square plastic 16 ounce "milk type" bottle. They are pre HCl washed and stored in the cabinet above the wastewater sink.

  Two labs receive spike and duplicate samples from this program:
  - Northglenn for low level total phosphorus analysis.
  - Westminster for total nitrogen analysis.

  The bottles are marked with consecutive numbers from month to month, year after year. Refer to the last sample set numbers in the brown Clear Creek Quality Control Log Book (above Vicki's desk) and mark new bottles with the next consecutive number set (##). Mark the 4 bottles with the following information:

  - City of Northglenn - P(##) - Spike for Phosphorus, Date of sampling.
  - City of Northglenn - D(##) - Duplicate for Phosphorus, Date of sampling.

  - City of Westminster - N(##) - Spike for Nitrogen, Date of Sampling.
  - City of Westminster - D(##) - Duplicate for Nitrogen, Date of sampling.

When Samples Arrive in Golden's Lab:

Certain 2 Liter samples from Clear Creek sites will have been randomly selected by the sampling team as "QC" samples.

- Select ONE of these as the QC sample (**spike and duplicate)** and set aside. Record which site was chosen in the QC log book.

This sample will be spiked with both Nitrogen and Phosphorus at concentrations within the analytical ranges of Northglenn's and Westminster's labs.

The "**spiked sample"** will be made in the remaining HCl rinsed volumetric flask and will use up 1 liter from the 2 liter bottle.
The remaining 1 liter volume will be split into the "**duplicate sample**" bottles for both labs.

- **To Prepare Spiked Sample**

  - Rinse out the remaining 1-Liter volumetric flask with DI.
  - Then rinse flask with a small portion of the selected QC Creek sample - 2 times.
  - Refer to the last sampling to determine new spike volumes.

  **Spike amounts for Phosphorus are usually within the 1.75 to 3.0 ml volume range for a total spiked concentration of 0.00875 mg/L to 0.015 mg/L, i.e.,*

  1.75 mL of 5 mg/L phosphorus standard in 1 liter = 0.00875 mg/L concentration spiked

  **Spike amounts for Nitrogen are usually within a 1.5 to 3.0 ml volume range for a total spiked concentration of 0.15 mg/L to 0.3 mg/L, i.e.,*

  1.5 mL of 100 mg/L nitrogen-N standard in 1 liter = 0.15 mg/L concentration spiked

- Mix the Clear Creek sample well and pour approximately 500 mL into pre-rinsed flask.
- Add determined spike volumes of both standards to flask. Mix well.
- Dilute to volume with additional Creek sample finalizing volume with a pipet. (It is too hard to bring it to volume by pouring from the 2 liter container!)
- Mix well and pour into 2 bottles labeled for spike samples (“N” and “P”).

To Prepare Duplicate Sample

- Thoroughly mix remaining Clear Creek sample.
- Pour into 2 bottles labeled for duplicates (“D”).

Record the following information in the brown "Clear Creek QC" book:

1. the time the samples arrived at Golden
2. the new consecutive sample numbers
3. the Clear Creek sample site number that was selected for preparation of the QC samples
4. the volumes spiked for phosphorus and nitrogen

Generate new chain of custody forms for the 4 new samples. One form can be filled out for both Westminster and Northglenn labs. Sampling teams will deliver samples to respective labs. Copies of previous chain of custody forms are in the lower file drawer in drinking water cabinet.

UCC AUTOSAMPLER 48-HOUR AMBIENT SAMPLES

Program Coordination: Westminster and Golden
Field Sampling Teams: Westminster, Thornton, Golden, Arvada

Autosampler sites were selected at strategic locations in the watershed in order to assess diurnal variations in water quality in Clear Creek. The 48-hour ambient composites are collected with programmable automatic sampling devices. Each of the 24 sample bottles represents a two hour time period, resulting from collecting equal volumes of sample in each of two consecutive hours; therefore, 48 hours of samples are collected in 24 bottles. The 24 discrete samples are composited into two 24-hour samples on a time weighted basis (i.e. equal sample volumes are taken from 12 discrete autosampler bottles and combined into a single composite sample). Additional discrete or composite samples may be submitted for analysis based on anomalies noted in field observations for the individual autosampler bottles.

Ambient samples are collected approximately seven times per year on a monthly schedule starting in April and ending in October. The schedule for the ambient sampling is based on clear weather predictions and is staggered at different times during the week, including weekends.

Analytical probes and data logging equipment are active at the autosampler sites year-round to continuously monitor in-stream conditions for temperature and conductivity. From April through October, or as weather conditions permit, additional probes are deployed for pressure (depth), turbidity and pH. YSI multi-probe sondes are deployed at each autosampler location. The sample locations are equipped with data loggers for remote monitoring of water quality conditions in the watershed and to remotely control activation of the autosamplers.

UCC AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Sample Locations

CC AS 26	Mainstem of CC at USGS Lawson gage
CC AS 49	Mainstem of CC above the confluence of the North Fork
CC AS 50	North Fork of CC above confluence of Mainstem of CC at USGS gage
CC AS 59	Mainstem of CC above Golden and Church Ditch diversions

UCC AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Flow Monitoring

USGS gages provide the average daily flow associated with each of the two 24-hour composite samples for the ambient autosamplers. Flow data is obtained directly from the gage stations at CC26 and CC50 to correlate with CC AS 26 and CC AS 50, respectively. Flow data from the gage at CC40 is used to correlate to CC AS 49 because there are no significant inflows to or diversions from Clear Creek between CC40 and CC AS 49.

The flow data associated with CC AS 59 is considered to be an estimated flow. The flows diverted to the City of Golden water treatment plant and the Church Ditch will be added to the gage flows recorded at the USGS gage at CC61 (Clear Creek at Golden) to estimate the flow at CC AS 59.

UCC AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Analytical Parameters

Analyte	Analytical Method Reference	Reporting Limit Goal	Responsible Laboratory
Total Nitrogen	SM 4500-NO3 I	0.02 mg/L	Westminster
Nitrate/Nitrite-N	SM 4500-NO3 I	0.01 mg/L	Westminster
Ammonia-N	SM 4500-NH3 H	0.01 mg/L	Westminster
Total Phosphorus	SM 4500-P E	0.0025 mg/L	Northglenn
Ortho-phosphate-P (dissolved) or DRP	SM 4500-P E	0.0025 mg/L	Northglenn
Total Suspended Solids (TSS)	SM 2540 D	1 mg/L	Thornton
Total Organic Carbon (TOC)	SM 5310 B	0.5 mg/L	Thornton
pH	SM 4500-H+ B	1.0 Std Units	Field Teams
Temperature	SM 2550 B	1.0 °C	Field Teams
Conductivity	SM 2510 B	10 µS/cm	Field Teams
Turbidity	SM 2130 B	1.0 NTU	Field Teams
Total and Dissolved Arsenic	EPA 200.7	0.001 mg/L	Golden
Total and Dissolved Cadmium	EPA 200.7	0.0005 mg/L	Golden
Total and Dissolved Copper	EPA 200.7	0.002 mg/L	Golden
Total and Dissolved Iron	EPA 200.7	0.02 mg/L	Golden
Total and Dissolved Lead	EPA 200.7	0.0005 mg/L	Golden
Total and Dissolved Manganese	EPA 200.7	0.002 mg/L	Golden
Total and Dissolved Molybdenum	EPA 200.7	0.002 mg/L	Golden
Total and Dissolved Zinc	EPA 200.7	0.02 mg/L	Golden

Table Notes:
1) SM refers to the 22nd Edition of Standard Methods for the Examination of Water and Wastewater.
2) Reporting limit goals are matrix dependent and may be increased for complex matrices and may be lower depending on laboratory capability.
3) EPA recommended holding times less than 72 hours may not be met due to the extended sampling routine.
4) Samples collected for nutrients (nitrogen and phosphorus) with a turbidity reading of greater than 100 NTU are analyzed by commercial laboratories that have demonstrated proficiency in analyzing complex matrices for nutrients.

UCC AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Program Coordination (Westminster and Golden)

Field Equipment

Equipment Installed At Autosampler Locations

- Permanent and tamper-proof enclosure box with lock
- American Sigma 900, 900 Max or other automated sampler
- Power supply – solar panel, rechargeable battery or direct power
- Sample tubing long enough to reach from the autosampler to the streambed. Probes must be contained in protective piping secured in the creek bed
- Dedicated field probes for turbidity, temperature, conductivity and pH
- Depth/velocity flow sensor
- Recording gage at CC26 – Operated and maintained by USGS
- Staff gage at CC50
- Rain gage at CC59
- 24 discrete HCl rinsed autosampler bottles with caps. Bottles must be numbered and inserted in the designated position in autosampler (positions numbered 1 through 24)
- Continuous recording datalogger
- Cellular modem and antenna at CC26, CC50 and CC59

UCC AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Autosampler Operation

On a monthly basis between April and October, autosamplers are set to collect time-weighted discrete samples for a 48-hour period. The autosamplers are strategically located in order to correlate stream flow with the chemical water quality data collected on the samples. In order to associate the relative impacts of the point and nonpoint pollutant sources located between the sample stations, it is advisable to observe the same “slug” of water at both the upstream and downstream locations. Using the “time of travel” study conducted by USGS in 1999, the downstream autosamplers on Clear Creek are delayed for a predetermined time based on in-stream flow at the Lawson stream gage.

The time of travel estimates tables are included in Appendix E.

Autosampler Setup:

Equipment required:

- 24 discrete HCl rinsed autosampler bottles with caps
- Keys and/or tools to access autosampler enclosure
- Field data collection/station audit sheets

Setup Procedure:

1. Unlock sample enclosure and remove sampler head. Set aside without disturbing or bumping the distributor arm.
2. Load uncapped bottles in the correct positions in the bottom of the sampler.
3. Secure bottles in place with the retaining ring. Store caps in a ziplock bag inside the autosampler until sample collection.
4. Program the sampler according to manufacturer's instructions to collect two 450 mL storm samples per bottle, one sample per pulse.
5. After starting the autosampler, ensure that the distributer arm is positioned above bottle #1.
6. Replace sampler head and lock in place.
7. Record station/equipment information on field sheet.
8. Make sure the autosampler program is ***RUNNING*** before locking the enclosure.
9. The autosampler may be set up ahead of a scheduled start time.

Sample Collection

Additional equipment required:

- Keys and/or tools to access autosampler enclosures
- Large cooler with ice to collect sample bottles
- 24 pre-cleaned, HCl rinsed, discrete sample replacement bottles
- Field data sheets/station audit sheets
- Chain of custody forms
- Laptop with Loggernet software and data cable (9 pin serial cable with SC32B adapter) if retrieving data directly from datalogger
- Two 3-liter or larger Nalgene bottles (clean and rinsed with 1:1 hydrochloric acid) for compositing samples
- 250 mL graduated cylinder (clean and rinsed with 1:1 hydrochloric acid) for compositing samples

- Prepared sample bottles provided by participating Cities for nutrients, solids and metals analyses
  - 1 L square plastic – phosphorus series (Northglenn)
  - 250 mL plastic – nitrogen series (Westminster)
  - 500 mL plastic bottle – TSS (Thornton)
  - 45 mL amber glass vial with septa cap – TOC (Thornton)
  - 250 ml round plastic – total and dissolved metals (Golden - for Clear Creek sites)
- Chain of Custody forms – Refer to Appendix C
- Field Sampling form - Refer to Appendix C

Sample Collection Procedure:

1. Unlock enclosure and remove sampler head.
2. Retrieve date/time information from autosampler if required. To collect sample history on American Sigma samplers, press <Change/ Halt> button, press <time/read> button for 5 seconds. The sample collection time for the first sample will appear. Record data on the field sheet. Press <yes> for next sample time to appear. Continue until all data is recorded.
3. Date and time information for samples is also automatically stored in a data file by the dataloggers at all sites except CC59.
4. Record station/equipment information on field sheet.
5. Make note of any samples with high turbidity determined by visual observance or data obtained from the datalogger.
6. Cap bottles and place in a cooler with ice for transport to Golden lab for compositing.

   Optional compositing of samples in the field is performed by pouring off equal volumes into 3-liter (or larger) pre-cleaned bottles. Refer to the Sample Compositing Procedure Step 1. Save remaining volume of any high turbidity samples to take back to the lab. Discard remaining sample.
7. Clean out autosampler base and reload with a new set of pre-cleaned bottles.
8. Reset the autosampler by pressing the START button (Sigma 900 autosampler). Ensure that the distributor arm is parked over bottle #1 and the display reads “Program Running” before closing the autosampler and placing it back in the enclosure. .
9. Take all samples to the Golden Water Quality Laboratory for compositing, splitting, distribution and wet chemistry analysis of pH, turbidity and conductivity.

UCC AUTOSAMPLER 48-HOUR AMBIENT SAMPLES

Sample Compositing

1. Composite samples in the laboratory if compositing was not performed in field. Shake sample bottles and pour equal volumes of sample from the first 12 bottles into a composite bottle marked "A". Shake sample bottles and pour equal volumes of sample from the remaining 12 bottles into a composite bottle marked "B".
2. Perform turbidity, temperature, pH and conductivity measurements on composited samples. Enter data on the Sampling Form.
3. Use the well mixed composites (A and B) to fill the appropriate bottles for the Northglenn, Thornton, Westminster and Golden labs.
4. If any discrete bottle(s) appears to have an unusually high turbidity and enough sample is available, analyze for turbidity and conductivity. Record on Sampling Form. If there is enough sample, pour the high turbidity discreet samples into separate nutrient and solids bottles for individual analysis.
5. Complete the COCs.
6. Deliver and relinquish to each city their respective samples (Westminster-nitrogen series, Thornton-TSS and TOC, Northglenn-phosphorus series) and sign COCs as appropriate.
7. Original field data sheets and COCs are retained by the Cities of Westminster and Golden for permanent archive.
8. Samples are created in the web-accessible Excel spreadsheet by Westminster for data entry and results archive.

UCC AUTOSAMPLERS – EVENT SAMPLES
Sample Locations

CC AS 49 Event	Mainstem of CC above the confluence of the North Fork
CC AS 50 Event	North Fork of CC above confluence of Mainstem of CC at USGS gage
CC AS 59 Event	Mainstem of CC above Golden and Church Ditch diversions

UCC AUTOSAMPLERS – EVENT SAMPLES
Flow Monitoring

Westminster and Golden will obtain the 15 minute interval flow data from the USGS gage at CC61 (Clear Creek at Golden) to correlate to CC AS 59. The average event flow will be calculated to correspond to the specific time-event composited samples. If the 15 minute interval flow data is not available, the average daily flow will be associated with the event. The average daily flow at UCCWA gage CC40 will be used to correlate with CC AS 49. Flow at CC50 is measured by a USGS gage at that site.

UCC AUTOSAMPLERS – EVENT SAMPLES
Analytical Parameters

Storm event samples are analyzed for the same suite of analytical parameters listed in the previous section for the 48-hour ambient samples. Samples may not be analyzed within the EPA recommended holding time for some parameters based on the random nature of the storm event triggering.

UCC AUTOSAMPLERS – EVENT SAMPLES
Program Coordination (Westminster and Golden)

Field Sampling Teams: Westminster, Thornton, Golden, Arvada

The event autosampler program was initiated in 2006 to assess the pollutant concentrations mobilized during significant snow melt (runoff) or rain events at 48-hour ambient locations CC AS 49, CC AS 50 and CC AS 59. Automated sample collection of stormwater is triggered based on changes in ambient turbidity, conductivity, stage height, or rain gage readings, depending on the autosampler location. The autosamplers are currently set to trigger when the 30 minute running average exceeds a predetermined turbidity level (for example, 100 NTU). The autosampler at CC AS 50 triggers based on a combination of change in stream depth, precipitation and turbidity in order to eliminate triggering autosampler event sampling that might be associated with localized human disturbances in the creek (e.g. sluice mining). Autosamplers trigger independently depending on the localized conditions in the watershed. The autosampler collects discrete samples every 15 minutes until the parameter that triggered the event returns to the ambient condition or until the maximum number of samples is collected. The discrete samples may be analyzed individually or multiple discrete samples may be composited based on the field observations. As necessary, refer to the previous section for instructions on compositing samples from autosamplers. Event sampling can also be started remotely in the event of a spill or other event that might not cause the triggering parameters to be met.

Storm event samples are analyzed for the same suite of analytical parameters listed in the previous section for the 48-hour ambient samples. Samples may not be analyzed within the EPA recommended holding time for some parameters based on the random nature of the storm event triggering.

UCC AUTOSAMPLERS - EVENT SAMPLES

Field Equipment

Storm event sampling utilizes the same equipment listed in the previous section for the 48-hr ambient samples.

Autosampler Operation

Field equipment used for storm event sampling is operated using the same techniques as described in the previous section for 48-hr ambient sampling.

Sample Compositing

Sample compositing is performed similarly to the procedure described in the previous section for 48-hr ambient sampling; however, fewer samples are typically composited based on the severity and duration of a storm event.

TRIBUTARY BASIN MONITORING PROGRAM

The Standley Lake Tributary Basin Monitoring Program is designed to provide water quality information for evaluation of the nutrient loadings from non-point sources in the Standley Lake Tributary Basin. The only point source discharge between CC60 on the main stem of Clear Creek and the canal diversions to Standley Lake is the Coors cooling basin return flow.

Three tributaries (the terms trib and canal are interchangeable) divert Clear Creek water to Standley Lake: the Church Ditch, the Farmers Highline ("FHL") Canal and the Croke Canal. The trib monitoring locations were selected to assess the relative loadings to the canals from areas within unincorporated Jefferson County and the city limits of Golden and Arvada. Denver Water supplies Westminster with a small quantity of water via the Kinnear Ditch Pipeline ("KDPL") which enters Standley Lake after passing through a wetlands area located west of 96th Ave and Alkire Street. The upstream and downstream locations near the wetlands are monitored when there is flow through the pipeline. The Denver Water raw water sources include Gross Reservoir and Coal Creek.

Trib samples are collected year-round on a monthly basis. All tributaries flowing at a rate that allows collection of a representative sample are monitored.

The Church Ditch delivery structure at Standley Lake was relocated in 2008 from the west side of the lake to the south side of the lake in order to avoid the potential for significant stormwater impacts to the lake. The former Church Ditch monitoring location at Standley Lake (T-09) was abandoned in 2009 when the new delivery structure (T-27) became operational.

The raw water pipeline at Semper (T-24) is monitored monthly. The raw water pipeline at NWWTP (T-25) is monitored only when the Semper facility is offline.

TRIB SAMPLES

Locations and Sample Schedule

Sample ID	Sample Location *	Every month of the year when flowing**
T-01	Church Ditch at Headgate on MSCC	X
T-02	FHL at Headgate on MSCC	X
T-03	Croke Canal at Headgate on MSCC	X
T-04	Croke Canal at Standley Lake	X
T-11	FHL at Standley Lake	X
T-22A	Kinnear Ditch Pipeline (KDPL) – at Coal Creek entry point into pipeline	X
T-22D	Kinnear Ditch Pipeline (KDPL) downstream of wetlands	X
T-24	Raw Water Pipeline at Semper	X
T-25	Raw Water Pipeline at NWWTP	X
T-27	Church Ditch delivery structure at SL (est. 2009)	X

*MSCC = Mainstem Clear Creek

** Exceptions noted in paragraph above the table.

TRIB SAMPLES

Analytical Parameters and Analytical Scheme

Analyte	Analytical Method Reference	Reporting Limit Goal	Responsible Laboratory	Monitoring Frequency
Temperature	SM 2550 B	1.0 °C	Field Team	Monthly
pH	SM 4500-H+ B	1.0 Std Units	Field Team	Monthly
Conductivity	SM 2510 B	10 µS/cm	Field Team	Monthly
Turbidity	SM 2130B	1.0 NTU	Field Team	Monthly
Dissolved Oxygen	SM 4500-O G	1.0 mg/L	Field Team	Monthly
Total Phosphorus	SM 4500-P E	0.0025 mg/L	Northglenn	Monthly
Ortho-phosphate as P (dissolved) or DRP	SM 4500-P E	0.0025 mg/L	Northglenn	Monthly
Total Suspended Solids (TSS)	SM 2540 D	1 mg/L	Thornton	Monthly
Total Organic Carbon	SM 5310	0.5 mg/L	Thornton	Monthly
E. coli	SM 9221 D	1 cfu/100mL	Thornton	Monthly
Total and Dissolved Iron	EPA 200.7	0.05 mg/L	Thornton	Monthly
Total and Dissolved Manganese	EPA 200.8	0.002 mg/L	Thornton	Monthly
Total and Dissolved Zinc	EPA 200.8	0.020 mg/L	Thornton	Monthly
Total Nitrogen	SM 4500-NO3 I	0.02 mg/L	Westminster	Monthly
Nitrate/Nitrite as N	SM 4500-NO3 I	0.01 mg/L	Westminster	Monthly
Ammonia as N	SM 4500-NH3 H	0.01 mg/L	Westminster	Monthly
Gross Alpha and Gross Beta	EPA 901.1	0.1 pCi/L	Westminster	Quarterly
Total and Dissolved Arsenic	EPA 200.8	0.001 mg/L	Thornton	Quarterly
Total and Dissolved Barium	EPA 200.8	0.002 mg/L	Thornton	Quarterly
Total and Dissolved Cadmium	EPA 200.8	0.0005 mg/L	Thornton	Quarterly
Total and Dissolved Chromium	EPA 200.8	0.001 mg/L	Thornton	Quarterly
Total and Dissolved Copper	EPA 200.8	0.002 mg/L	Thornton	Quarterly
Total and Dissolved Iron	EPA 200.7	0.05 mg/L	Thornton	Quarterly
Total and Dissolved Lead	EPA 200.8	0.0005 mg/L	Thornton	Quarterly
Total and Dissolved Manganese	EPA 200.8	0.002 mg/L	Thornton	Quarterly
Total and Dissolved Molybdenum	EPA 200.8	0.002 mg/L	Thornton	Quarterly
Total and Dissolved Selenium	EPA 200.8	0.005 mg/L	Thornton	Quarterly
Total and Dissolved Zinc	EPA 200.8	0.020 mg/L	Thornton	Quarterly
Bromide	SM 4110 A	0.1 mg/L	Thornton	Monthly
Chloride	SM 4110 A	5 mg/L	Thornton	Quarterly
Sulfate	SM 4110 A	10 mg/L	Thornton	Quarterly
Total Hardness (as $CaCO_3$)	EPA 130.2	5 mg/L	Thornton	Quarterly

Table Notes:
1) SM refers to the 22nd Edition of Standard Methods for the Examination of Water and Wastewater.
2) Reporting limit goals are matrix dependent and may be increased for complex matrices and may be lower depending on laboratory capability.
3) Quarterly parameters are analyzed in March, June, September and December at all sampled locations.
4) Samples collected for nutrients (nitrogen and phosphorus) with a turbidity reading of greater than 100 NTU are analyzed by commercial laboratories that have demonstrated proficiency in analyzing complex matrices for nutrients.

TRIB SAMPLES

Program Coordination (Northglenn)

Before the scheduled Tributary sampling date:

- Ensure an adequate supply of sample containers is available from Thornton. Westminster's bottles will be picked up at Westminster on sampling day before the start of sampling at T-24.
- Label the Trip blank bottle and fill with laboratory DI water.
- Calibrate the multimeter for conductivity, pH and DO.
- Analyze the Trip Blank for conductivity, pH and DO.
- Pack Trip Blank in cooler to monitor field activities for phosphorus contamination.

Sample Bottle Kit – Tribs Monthly and Quarterly

Quantity	Volume	Bottle Type	Parameter	Laboratory
9	500 mL	Rectangular plastic	Phosphorus series	Northglenn
1 (Trip blank)	500 mL	Rectangular plastic	Phosphorus series	Northglenn
9	500 mL	Plastic	TSS, Total Hardness, Chloride, Sulfate	Thornton
9	40 mL	Glass vial	TOC	Thornton
9	250 mL	Glass	E. coli	Thornton
9	250 mL	Plastic	Total Metals	Thornton
9	125 mL	Plastic	Dissolved Metals	Thornton
9	250 mL	Plastic	Quarterly Total Metals	Thornton
9	125 mL	Plastic	Quarterly Dissolved Metals	Thornton
9	250 mL	Plastic	Nitrogen series, UV-254	Westminster
9	1 L	Plastic	Rads	Westminster

Sample Collection

Equipment required:

- Key to access T-2
- Key to access T-27
- Gate Code for access at T-22A
- Field data book
- Cooler with blue ice or ice
- Trip blank filled with DI
- Sample bottles as detailed above

- Bucket for sample collection
- pH and DO meters and probes
- Ballpoint pen
- Waterproof marker
- Chain of custody forms
- NOTE – Four wheel drive vehicle recommended for sampling due to steep inclines at some locations and potentially rugged or muddy conditions.

Sample collection procedure:

1. Meet with Westminster staff at Semper. Drop off bottles for Westminster staff to collect sample at T-25.
2. Starting with T-24, collect field samples in the order detailed below for each location where water is flowing.
3. Rinse the sample bucket with the field sample water repeatedly at each location before collecting the sample.
4. Collect enough volume of the field sample in the bucket to fill all sample bottles for the location.
5. Fill the appropriate sample bottles from the bucket.
6. Label the sample bottles with location, date and time of collection.
7. Analyze the sample in the field for conductivity, pH, DO and temperature. Record data in the field notebook.
8. Repeat the process at each location.
9. Return to Westminster’s Semper WTP to receive T-25 sample from Westminster staff. Sign COC and keep the original copy of the COC.
10. Leave an unsigned copy of the Thornton COC at Westminster so the samples can be logged into the Tribal database by Westminster staff.
11. Complete the COCs and relinquish custody of the samples to Westminster staff. Sign COC and keep a copy of the COC. Leave the original COC with the samples.
12. Return to Northglenn Lab and analyze samples for turbidity on a calibrated meter. Record data in the field notebook.
13. Contact Thornton to pick up collected field samples. Request replenishment of bottles for the next sampling event as needed.
14. Relinquish samples to Thornton and sign COCs. Retain a copy of the COC. Thornton takes possession of the original COC.
15. Northglenn retains a copy of all COCs and field documentation for permanent archive.

TRIB SAMPLES

Sampling Locations Directions and Narrative Descriptions

Tributary sampling occurs generally in an upstream to downstream fashion. Samples are collected at designated locations when water is flowing.

Trib 24
T-24 is located at Westminster's Semper Water Treatment Plant at 8900 Pierce Street. The sample is collected from the RAW water tap in the Operator's Laboratory. Do **NOT** increase the flow at the tap at this location. First tap on the left labeled 24.

Trib 22A
T-22A is the upstream sample point on the Kinnear Ditch pipeline. It is accessed through a gate located at Hwy. 72 and Plainview Rd. A key is required to access the location. The sample point is approximately 0.2 miles from Plainview Rd. Sample is taken at the flume where Coal Creek enters the pipeline.

Trib 1
T-1 is located at the Church Ditch headgate on Clear Creek. This site is accessed via Hwy 6 approximately 0.5 miles west of Hwy 93. There is a diversion from Clear Creek above this location which diverts water from Clear Creek and runs it parallel to the Creek. There are two gates at this location one sends water back into Clear Creek and the other is the Church Ditch headgate. Sample is taken from the bridge just above both gates.

Trib 2
T-2 is located at the Farmers Highline headgate on Clear Creek.
The site is accessed behind the Coors office building at the end of Archer St. Sample is taken from the bridge just inside the gate. Sample the downstream side of the headgate if it is open or on the upstream side if the headgate is closed (Clear Creek side).

Trib 3
T-3 is located at the Croke Canal headgate on Clear Creek.
This site is on Coors property. It is along the frontage road through Coors, on the east side of a small "pond". Sample the downstream side of the headgate if it is open or on the upstream side if the headgate is closed (Clear Creek side).

Trib 22D
T-22D is on the Kinnear Ditch Pipeline between 96th Ave and 88th Ave on Alkire St.
The sample is taken just downstream of the culvert on the east side of Alkire St.

Trib 04 and Trib 11
The Croke Canal (T-04) passes UNDER the Farmers Highline (T-11) in the area just west of 86th and Kipling prior to entering Standley Lake. The Farmers Highline passes OVER the Croke in a concrete structure. Sample the Croke on the south side of the Farmers Highline concrete structure. Sample the Farmers next to the white autosampler housing box.

Trib 25
Located at Westminster's Northwest Water Treatment Plant located at 104th & Wadsworth. The sample is collected by Westminster from the raw water tap on the west wall in the membrane filter gallery. Sample only if T-24 is not running.

Trib 27
Located on the south side of Standley Lake at the Church Ditch delivery structure. This sampling location was activated in 2009.

Photographs of the sampling locations and GPS coordinates are included in Appendix D.

TRIB CONTINUOUS MONITORING
Program Coordination (Westminster)

Field sampling team: Westminster

A YSI multi-parameter sonde and data logging equipment are deployed year-round at the trib location where the Farmers Highline Canal (T-11) crosses over the Croke Canal (T-04), provided there is sufficient flow in one of the canals. A sonde was also installed at the new Church Ditch inlet (T-27) in 2009 and operates under similar conditions. The probes provide continuous in-stream monitoring of pH, ORP, temperature, depth (pressure transducer), conductivity and turbidity. Remote access to the data logger data facilitates monitoring of water quality at these inflow locations to Standley Lake. The FHL/Croke station is also equipped with a tipping-bucket rain gauge.

TRIB CONTINUOUS MONITORING
Sample Locations

CC AS T04	Croke Canal approximately 0.5 mile from Standley Lake inlet
CC AS T11	Farmers Highline Canal approximately 0.5 mile from Standley Lake inlet
CC AS T27	Church Ditch at Standley Lake inlet

Table Note: Historical data from these locations are available as part of the Clear Creek Canal Program that was eliminated in 2008. The sample location identifications associated with the Clear Creek Canal Program have been retained.

TRIB AUTOSAMPLER 48-HOUR AMBIENT SAMPLES

Program Coordination: Westminster
Field Sampling Teams: Westminster

Autosampler sites in the Tributary Basin are located at the canal inlets to Standley Lake. The 48-hour ambient composites are collected with programmable automatic sampling devices as described in the UCC autosampler 48-hr ambient program section of this plan in order to assess any water quality impacts introduced by the canals.

Ambient samples are collected approximately seven times per year on a monthly schedule starting in April and ending in October to coincide with the UCC autosampler 48-hr ambient sample program.

TRIB AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Sample Locations

CC AS T04	Croke Canal approximately 0.5 mile from Standley Lake inlet
CC AS T11	Farmers Highline Canal approximately 0.5 mile from Standley Lake inlet
CC AS T27	Church Ditch at Standley Lake inlet

TRIB AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Flow Monitoring

Flow in the canals is tracked by the ditch operators and water accountants.

TRIB AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Analytical Parameters

Analyte	Analytical Method Reference	Reporting Limit Goal	Responsible Laboratory
Total Nitrogen	SM 4500-NO3 I	0.02 mg/L	Westminster
Nitrate/Nitrite-N	SM 4500-NO3 I	0.01 mg/L	Westminster
Ammonia-N	SM 4500-NH3 H	0.01 mg/L	Westminster
Total Phosphorus	SM 4500-P E	0.0025 mg/L	Northglenn
Ortho-phosphate-P (dissolved) or DRP	SM 4500-P E	0.0025 mg/L	Northglenn
Total Suspended Solids (TSS)	SM 2540 D	1 mg/L	Thornton
Total Organic Carbon (TOC)	SM 5310 B	0.5 mg/L	Thornton
Total and Dissolved Arsenic	EPA 200.8	0.001 mg/L	Thornton
Total and Dissolved Barium	EPA 200.8	0.002 mg/L	Thornton
Total and Dissolved Cadmium	EPA 200.8	0.0005 mg/L	Thornton
Total and Dissolved Chromium	EPA 200.8	0.001 mg/L	Thornton
Total and Dissolved Copper	EPA 200.8	0.002 mg/L	Thornton
Total and Dissolved Iron	EPA 200.7	0.05 mg/L	Thornton
Total and Dissolved Lead	EPA 200.8	0.0005 mg/L	Thornton
Total and Dissolved Manganese	EPA 200.8	0.002 mg/L	Thornton
Total and Dissolved Molybdenum	EPA 200.8	0.002 mg/L	Thornton
Total and Dissolved Selenium	EPA 200.8	0.005 mg/L	Thornton
Total and Dissolved Zinc	EPA 200.8	0.020 mg/L	Thornton
pH	SM 4500-H+ B	1.0 Std Units	Field Teams
Temperature	SM 2550 B	1.0 °C	Field Teams
Conductivity	SM 2510 B	10 µS/cm	Field Teams
Turbidity	SM 2130 B	1.0 NTU	Field Teams

Table Notes:
1) SM refers to the 22nd Edition of Standard Methods for the Examination of Water and Wastewater.
2) Reporting limit goals are matrix dependent and may be increased for complex matrices and may be lower depending on laboratory capability.
3) EPA recommended holding times less than 72 hours may not be met due to the extended sampling routine.
4) Samples collected for nutrients (nitrogen and phosphorus) with a turbidity reading of greater than 100 NTU are analyzed by commercial laboratories that have demonstrated proficiency in analyzing complex matrices for nutrients.

TRIB AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Program Coordination (Westminster)

Field Equipment

Equipment Installed At Autosampler Locations

- Permanent and tamper-proof enclosure box with lock
- American Sigma 900, 900 Max or other automated sampler
- Power supply – solar panel, rechargeable battery or direct power
- Sample tubing long enough to reach from the autosampler to the streambed. Probes must be contained in protective piping secured in the creek bed
- Dedicated field probes for turbidity, temperature, conductivity and pH
- Depth/velocity flow sensor
- Rain gage at T4/T11
- 24 discrete HCl rinsed autosampler bottles with caps. Bottles must be numbered and inserted in the designated position in autosampler (positions numbered 1 through 24)
- Continuous recording datalogger
- Cellular modem and antenna at T4/T11 and T27

TRIB AUTOSAMPLER 48-HOUR AMBIENT SAMPLES
Autosampler Operation

On a monthly basis between April and October, autosamplers are set to collect time-weighted discrete samples for a 48 hour period. The autosamplers are located at the canal inlets to Standley Lake. In order to associate the relative impacts of the point and nonpoint pollutant sources located between the last autosampler location on Clear Creek (CC AS 59), it is advisable to observe the same "slug" of water at the canal inlets to Standley Lake. The time of travel in the Farmer's Highline canal is calculated from the inflows to the canal at the headgate on Clear Creek.

The time of travel estimates table for the Farmer's Highline Canal is included in Appendix E.

Autosampler Setup:

Equipment required:

- 24 discrete HCl rinsed autosampler bottles with caps
- Keys and/or tools to access autosampler enclosure.
- Field data collection/station audit sheets.

Setup Procedure:

1. Unlock sample enclosure and remove sampler head. Set aside without disturbing or bumping the distributor arm.
2. Load uncapped bottles in the correct positions in the bottom of the sampler.
3. Secure bottles in place with the retaining ring. Store caps in a ziplock bag inside the autosampler until sample collection.
4. Program the sampler according to manufacturer's instructions to collect two 450 ml storm samples per bottle, one sample per pulse.
5. After starting the autosampler, ensure that the distributer arm is positioned above bottle #1.
6. Replace sampler head and lock in place.
7. Record station/equipment information on field sheet.
8. Make sure the autosampler program is ***RUNNING*** before locking the enclosure.
9. The autosampler may be set up ahead of a scheduled start time.

Sample Collection

Additional equipment required:

- Keys and/or tools to access autosampler enclosures
- Large cooler with ice to collect sample bottles
- 24 pre-cleaned, HCl rinsed, discrete sample replacement bottles
- Field data sheets/station audit sheets
- Chain of custody forms
- Laptop with Loggernet software and data cable (9 pin serial cable with SC32B adapter) if retrieving data directly from datalogger
- Two 3-liter Nalgene bottles (clean and rinsed with 1:1 hydrochloric acid) for compositing samples
- 250 mL graduated cylinder (clean and rinsed with 1:1 hydrochloric acid) for compositing samples
- Prepared sample bottles provided by participating Cities for nutrients, solids and metals analyses
    - 1 L square plastic – phosphorus series (Northglenn)
    - 250 mL plastic – nitrogen series (Westminster)
    - 500 mL plastic bottle – TSS (Thornton)
    - 45 mL amber glass vial with septa cap – TOC (Thornton)
    - 500 ml non-preserved metals bottle and 500 ml preserved metals bottle (Thornton)
- Chain of Custody forms – Refer to Appendix C
- Field Sampling form - Refer to Appendix C

Sample Collection Procedure:

1. Unlock enclosure and remove sampler head.
2. Retrieve date/time information from autosampler if required. To collect sample history on American Sigma samplers, press <Change/ Halt> button, press <time/read> button for 5 seconds. The sample collection time for the first sample will appear. Record data on the field sheet. Press <yes> for next sample time to appear. Continue until all data is recorded.
3. Date and time information for samples is also automatically stored in a data file by the dataloggers at all sites except CC59.
4. Record station/equipment information on field sheet.
5. Make note of any samples with high turbidity determined by visual observance or data obtained from the datalogger.
6. Optional compositing of samples in the field is performed by pouring off equal volumes into three-liter (or larger) pre-cleaned bottles. The 24 sample bottles may also be brought back to a laboratory for compositing. Refer to the Sample Compositing Procedure Step 1. Save remaining volume of any high turbidity samples to take back to the lab. Discard remaining sample.
7. Clean out autosampler base and reload with a new set of pre-cleaned bottles.
8. Reset the autosampler by pressing the START button (Sigma 900 autosampler). Ensure that the distributor arm is parked over bottle #1 and the display reads “Program Running” before closing the autosampler and placing it back in the enclosure.
9. Return to the Westminster Water Quality Laboratory for compositing, splitting, distribution and wet chemistry analysis of pH, turbidity and conductivity.

TRIB AUTOSAMPLER 48-HOUR AMBIENT SAMPLES

Sample Compositing

1. Composite samples in the laboratory if compositing was not performed in field. Shake sample bottles and pour equal volumes of sample from the first 12 bottles into a composite bottle marked "A". Shake sample bottles and pour equal volumes of sample from the remaining 12 bottles into a composite bottle marked "B".
2. Perform turbidity, temperature, pH and conductivity measurements on composited samples. Enter data on the Sampling Form.
3. Use the well mixed composites (A and B) to fill the appropriate bottles for the Northglenn, Thornton and Westminster labs.
4. If any discreet bottle(s) appears to have an unusually high turbidity and enough sample is available, analyze for turbidity and conductivity. Record on Sampling Form. If there is enough sample, pour the high turbidity discreet samples into separate nutrient and solids bottles for individual analysis.
5. Complete the COCs.
6. Relinquish to each city their respective samples (Westminster-nitrogen series, Thornton-TSS, metals and TOC, Northglenn-phosphorus series) and sign COCs as appropriate.
7. Original field data sheets and COCs are retained by the Cities of Westminster for permanent archive.
8. Samples are created in the web-accessible Excel spreadsheet by Westminster for data entry and results archive.

TRIB AUTOSAMPLER EVENT SAMPLES
Program Coordination (Westminster)

Field Sampling Team: Westminster

The event autosampler program was initiated on the Tributaries in 2009 at CC AS T11 to assess the pollutant concentrations mobilized during significant snow melt (runoff) or rain events at the location closest to Standley Lake. Automated sample collection of stormwater is triggered based on a turbidity reading of 100 NTU. The autosampler may also be activated remotely to begin sampling immediately or programmed to start sampling at a designated time in an attempt to capture the downstream effects of a storm in the upper watershed based on time of travel. The autosampler collects discrete samples every 15 minutes until the ambient condition drops below the trigger level or until the maximum number of samples is collected. The discrete samples may be analyzed individually or multiple discrete samples may be composited based on the field observations.

TRIB AUTOSAMPLERS EVENT MONITORING
Sample Locations

Trib Autosampler Event Samples are only collected at CC AS T11. First flush samples may be collected at all three Trib Autosampler Continuous Monitoring locations.

CC AS T11 Event	Farmers Highline Canal approximately 0.5 mile from Standley Lake inlet

Table Note: Historical data from this location is available as part of the Clear Creek Canal Program which was eliminated in 2008. The sample location identifications associated with the Clear Creek Canal Program have been retained.

TRIB AUTOSAMPLER EVENT SAMPLES
Flow Monitoring

Flow in the canals is tracked by the ditch operators and water accountants. The average daily flow data corresponding with the time-event composited samples will be used for loadings calculations for storm events.

Refer to Appendix E for the time of travel data for the Farmers Highline Canal. Time of travel studies have not been performed from the canal headgates on Clear Creek to Standley Lake for the Croke Canal or the relocated Church Ditch inlet structure.

TRIB AUTOSAMPLER EVENT SAMPLES
Analytical Parameters

Storm event samples are analyzed for the same suite of analytical parameters listed in the previous section for the 48-hour ambient samples. Samples may not be analyzed within the EPA recommended holding time for some parameters based on the random nature of the storm event triggering.

TRIB AUTOSAMPLER EVENT SAMPLES

Field Equipment

Storm event sampling utilizes the same equipment listed in the previous section for the 48-hr ambient samples.

Autosampler Operation

Field equipment used for storm event sampling is operated using the same techniques as described in the previous section for 48-hr ambient sampling.

Sample Compositing

Sample compositing is performed similarly to the procedure described in the previous section for 48-hr ambient sampling; however, fewer samples are typically composited based on the severity and/or duration of a storm event.

STANDLEY LAKE MONITORING PROGRAM

Standley Lake is a storage reservoir that serves as the raw drinking water source for the SLC. Over 250,000 consumers rely on Standley Lake for their drinking water. The Standley Lake ("SL") Monitoring Program is designed to provide water quality information in order to evaluate internal loadings in Standley Lake and the effects of nutrient reduction measures and best management practices on the trophic status of Standley Lake. Regularly spaced and frequent sampling is necessary to provide sufficient data for monitoring trends for the analytes used to evaluate trophic status including dissolved oxygen, chlorophyll and nutrients.

The main water quality monitoring efforts on Standley Lake include:

- Daily top to bottom lake profiles
- Bimonthly grab samples
- Zooplankton tows
- Invasive species monitoring and control

SL – DAILY LAKE PROFILES

Program Coordination (Westminster)

The sampling location in Standley Lake (Site 10-00) is situated near the outlet structure. The lake site was selected based on the lengthy historical record of water quality monitoring data and because the water is drawn from the lake at this location via pipelines to the SLC's water treatment plants. Sampling at varying depths in the lake provides extensive information for use in drinking water treatment process decisions and evaluating water resource management options.

Standley Lake is monitored at Site 10-00 using an automated profiler equipped with a multi-probe sonde four times each day from early spring to late fall for the analytes listed in the following table. The profiler is removed from the lake prior to freezing of the lake surface. Refer to the watershed map in Appendix B for the location of the SL monitoring location. The solar powered unit collects data from the surface of the lake to within five feet off the bottom and every meter in between. The profiler data is accessible via the internet and provides a depth-integrated profile of the lake water quality.

SL – DAILY LAKE PROFILES

Analytical Parameters

Analyte	**Analytical Method Reference**	**Reporting Limit Goal**
Temperature	SM 2560 A	1.0 °C
pH	SM 4500-H+ B	1.0 Std Units
Conductivity	SM 2510 B	10 µS/cm
Turbidity	SM 2130 B	1.0 NTU
Dissolved Oxygen	YSI (optical probe)	1.0 mg/L
Chlorophyll	YSI (electrode)	1.0 µg/L
ORP	SM 2580 A	1.0 mv

Table Notes: 1) SM refers to the 22nd Edition of Standard Methods for the Examination of Water and Wastewater.
2) Reporting limits are matrix dependent and may be increased for complex matrices.

SL – BIMONTHLY GRAB SAMPLES

Program Coordination: Westminster

The same sampling location in Standley Lake (Site 10-00) is used for both the daily lake profiles and the bimonthly grab samples. Sampling at varying depths in the lake provides extensive information for use in drinking water treatment process decisions and evaluating water resource management options. Refer to the watershed map in Appendix B for the location of the SL monitoring location.

SL – BIMONTHLY GRAB SAMPLES

Locations

Grab samples are collected twice each month from March through November, but the sampling may be extended during the winter if the lake is not frozen. The raw water pipeline at Semper (T-24) may be sampled for a subset of the routine analytical parameters when the lake is frozen or when safety of the sampling team is a concern (i.e. high winds, frozen boat dock ramp, etc.).

Sample Identification	**Sample Location**
SL 10-00	SL surface
SL 10-PZ	SL at two times the Secchi depth
SL 10-70	SL at five feet off the bottom. (Approximate depth of 60 ft when lake is full at gage height 96)
SL 69-00	SL surface at the boat dock
T-24	Semper raw water pipeline. T-24 is approximately 10 ft higher than SL 10-70

SL – BIMONTHLY GRAB SAMPLES

Analytical Parameters

Analyte	Analytical Method Reference	Reporting Limit Goal	Responsible Laboratory
Temperature	SM 2550 B	1.0 °C	Field Team
pH	SM 4500-H+ B	1.0 Std Units	Field Team
Conductivity	SM 2510 B	10 µS/cm	Field Team
Turbidity	SM 2130 B	1.0 NTU	Field Team
Dissolved Oxygen	YSI (optical probe)	1.0 mg/L	Field Team
ORP	YSI (electrode)	1 mv	Field Team
Chlorophyll	YSI (electrode)	1.0 µg/L	Field Team
Secchi Depth	Secchi disk	0.1 meter	Field Team
Total Nitrogen	SM 4500-NO3 I	0.02 mg/L	Westminster
Nitrate/Nitrite as N	SM 4500-NO3 I	0.01 mg/L	Westminster
Ammonia as N	SM 4500-NH3 H	0.01 mg/L	Westminster
Gross Alpha and Gross Beta	EPA 900.0	0.1 pCi/L	Westminster
Zooplankton	SM 10900	1 per L	Westminster
Algae	SM 10900	1 per mL	Westminster
Chlorophyll *a*	SM 10200-H	1.0 µg/L	Westminster
UV-254	SM 5910 B	0.001 cm^{-1}	Westminster
Total Phosphorus	SM 4500-P E	0.0025 mg/L	Northglenn
Ortho-phosphate as P (dissolved) or DRP	SM 4500-P E	0.0025 mg/L	Northglenn
Total Organic Carbon	SM 5310 B	0.5 mg/L	Thornton
Total Suspended Solids	SM 2540 D	1 mg/L	Thornton
Total and Dissolved Arsenic	EPA 200.8	0.001 mg/L	Thornton
Total and Dissolved Barium	EPA 200.8	0.002 mg/L	Thornton
Total and Dissolved Cadmium	EPA 200.8	0.0005 mg/L	Thornton
Total and Dissolved Chromium	EPA 200.8	0.001 mg/L	Thornton
Total and Dissolved Copper	EPA 200.8	0.002 mg/L	Thornton
Total and Dissolved Iron	EPA 200.7	0.05 mg/L	Thornton
Total and Dissolved Lead	EPA 200.8	0.0005 mg/L	Thornton
Total and Dissolved Manganese	EPA 200.8	0.002 mg/L	Thornton
Total and Dissolved Molybdenum	EPA 200.8	0.002 mg/L	Thornton
Total and Dissolved Selenium	EPA 200.8	0.005 mg/L	Thornton
Dissolved Silicon	EPA 200.7	0.02 mg/L	Westminster
Total and Dissolved Zinc	EPA 200.8	0.020 mg/L	Thornton
Total Mercury	EPA 245.1	0.0002 mg/L	Thornton
Total Hardness (as $CaCO_3$)	EPA 130.2	5 mg/L	Thornton
E. coli	SM 9221 D	1 cfu/100mL	Thornton
BTEX	EPA 524.2	0.0005 mg/L	Thornton

Table Notes: 1) SM refers to the 22nd Edition of Standard Methods for the Examination of Water and Wastewater.
2) Reporting limit goals are matrix dependent and may be increased for complex matrices and may be lower depending on laboratory capability.

SL – BIMONTHLY GRAB SAMPLES

Analytical Scheme

The analytical scheme for Standley Lake was designed to capture the biological, physical and chemical changes occurring in the lake ecosystem throughout the year. Seasonality plays an important role in lake dynamics and subsequently, on the water treatment processes. The table below details the variable analytical scheme, with the caveat that weather patterns may require modification to the plan. Rads (Gross Alpha and Gross Beta) and metals are collected before and after run-off, and before and after lake turnover, which are both subject to annual fluctuation.

Month	Lake Sample Location	Analytes														
		Hand Profile	Secchi depth	Rads	E coli	Zooplankton	Nutrients	Metals	Algae	Chlorophyll *a*	TOC	TSS	Total Hardness	BTEX	UV-254	Dissolved Silicon
January 1st week	10-00	X	X	X	X	X										
	10-PZ			X			X	X	X	X	X	X	X		X	X
	10-70	X		X	X		X	X			X	X	X		X	X
	T-24								X						X	
January 3rd week	10-00	X	X			X										
	10-PZ						X		X	X					X	X
	10-70	X					X								X	X
	T-24								X						X	
February 1st week	10-00	X	X		X	X										
	10-PZ						X		X	X	X	X	X		X	X
	10-70	X			X		X				X	X	X		X	X
	T-24								X						X	
February 3rd week	10-00	X	X			X										
	10-PZ						X		X	X					X	X
	10-70	X					X								X	X
	T-24								X						X	
March 1st week	10-00	X	X	X	X	X										
	10-PZ			X			X		X	X	X	X	X		X	X
	10-70	X		X	X		X				X	X	X		X	X
	T-24								X						X	
March 3rd week	10-00	X	X			X										
	10-PZ						X		X	X					X	X
	10-70	X					X								X	X
	T-24								X						X	
April 1st week	10-00	X	X		X	X										
	10-PZ						X		X	X	X	X	X		X	X
	10-70	X			X		X				X	X	X		X	X
	69-00													X		
	T-24								X						X	
April 3rd week	10-00	X	X			X										
	10-PZ						X		X	X					X	X
	10-70	X					X								X	X
	T-24								X						X	

Month	Lake Sample Location	Analytes														
		Hand Profile	Secchi depth	Rads	E coli	Zooplankton	Nutrients	Metals	Algae	Chlorophyll *a*	TOC	TSS	Total Hardness	BTEX	UV-254	Dissolved Silicon
May 1st week	10-00	X	X		X	X										
	10-PZ						X		X	X	X	X	X		X	X
	10-70	X			X		X				X	X	X		X	X
	T-24								X						X	
May 3rd week	10-00	X	X			X										
	10-PZ						X		X	X					X	X
	10-70	X					X								X	X
	69-00													X		
	T-24								X						X	
June 1st week	10-00	X	X	X	X	X										
	10-PZ			X			X	X	X	X	X	X	X		X	X
	10-70	X		X	X		X	X			X	X	X		X	X
	T-24								X						X	
June 3rd week	10-00	X	X			X										
	10-PZ						X		X	X					X	X
	10-70	X					X								X	X
	69-00													X		
	T-24								X						X	
July 1st week	10-00	X	X		X	X										
	10-PZ						X		X	X	X	X	X		X	X
	10-70	X			X		X				X	X	X		X	X
	T-24								X						X	
July 3rd week	10-00	X	X			X										
	10-PZ						X	**X**	X	X			X		X	X
	10-70	X					X	**X**					X		X	X
	69-00													X		
	T-24								X						X	
August 1st week	10-00	X	X		X	X										
	10-PZ						X		X	X	X	X			X	X
	10-70	X			X		X				X	X			X	X
	T-24								X						X	
August 3rd week	10-00	X	X	X		X										
	10-PZ			X			X	X	X	X			X		X	X
	10-70	X		X			X	X					X		X	X
	69-00													X		
	T-24								X						X	
September 1st week	10-00	X	X		X	X										
	10-PZ						X		X	X	X	X			X	X
	10-70	X			X		X				X	X			X	X
	T-24								X						X	

Month	**Lake Sample Location**	**Analytes**														
		Hand Profile	Secchi depth	Rads	E coli	Zooplankton	Nutrients	Metals	Algae	Chlorophyll *a*	TOC	TSS	Total Hardness	BTEX	UV-254	Dissolved Silicon
September 3rd week	10-00	X	X	X		X										
	10-PZ			X			X	X	X	X			X		X	X
	10-70	X		X			X	X					X		X	X
	69-00													X		
	T-24								X						X	
October 1st week	10-00	X	X		X	X										
	10-PZ						X	**X**	X	X	X	X	X		X	X
	10-70	X			X		X	**X**			X	X	X		X	X
	T-24								X						X	
October 3rd week	10-00	X	X	X		X										
	10-PZ			X			X	X	X	X			X		X	X
	10-70	X		X			X	X					X		X	X
	69-00													X		
	T-24								X						X	
November 1st week	10-00	X	X		X	X										
	10-PZ						X		X	X	X	X	X		X	X
	10-70	X			X		X				X	X	X		X	X
	T-24								X						X	
November 3rd week	10-00	X	X			X										
	10-PZ						X		X	X					X	X
	10-70	X					X								X	X
	T-24								X						X	
December 1st week	10-00	X	X	X	X	X										
	10-PZ			X			X		X	X	X	X	X		X	X
	10-70	X		X	X		X				X	X	X		X	X
	T-24								X						X	
December 3rd week	10-00	X	X			X										
	10-PZ						X		X	X					X	X
	10-70	X					X								X	X
	T-24								X						X	

Table notes:
1) Hand Profile includes analysis of temperature, pH, conductivity, turbidity, DO, chlorophyll and ORP at the surface of the lake and at the bottom of the lake using the sonde.
2) Rads includes Gross Alpha and Gross Beta.
3) Metals includes the total and dissolved forms of As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Mo, Se and Zn, dissolved Si and total Hg. **Metals for the 3rd week of July and the 1st week of October consist of ONLY total and dissolved arsenic.**
4) Nutrients include the phosphorus series and the nitrogen series analytes. Phosphorus series includes total P and dissolved ortho-phosphate-P (also referred to as DRP). Nitrogen series includes total N, ammonia-N and nitrate/nitrite-N.
5) Total Hardness is reported as $CaCO_3$.

SL – BIMONTHLY GRAB SAMPLES
Program Coordination (Westminster)

SL Sample bottle kit

The sample containers required for each monitoring event varies depending on the parameters to be analyzed. Westminster will assemble sample bottle kits for each event. The following table details the sample containers for various parameters.

Parameter	**Volume**	**Bottle Type**	**Laboratory**
Phosphorus series	1L	Rectangular plastic	Northglenn
Nitrogen series, UV-254	250 mL	Rectangular plastic	Westminster
Rads	1 L	Plastic	Westminster
Zooplankton	250 mL	Plastic	Westminster
Algae	1 L	Plastic	Westminster
Chlorophyll *a*	1 L	Brown plastic	Westminster
Dissolved Silica	250 mL	Rectangular Plastic	Westminster
Total metals, Total Hg	500 mL	Plastic	Thornton
Dissolved metals	500 mL	Plastic	Thornton
TOC	40 mL	Glass vial	Thornton
TSS, Total Hardness	500 mL	Plastic jug	Thornton
E. coli	250 mL	Glass	Thornton
BTEX	40 mL	Glass vial	Thornton
BTEX trip blank	40 mL	Glass vial	Thornton

Table Notes:
1) A trip blank is required to be prepared when field samples are collected for BTEX. The trip blank is comprised of a pre-cleaned glass vial filled with DI and is used to monitor for volatile organic contamination during transport and lab storage prior to analysis. Analysis of the trip blank is only required when any of the BTEX analytes are detectable in the field samples.
2) Phosphorus series includes total P and dissolved ortho-phosphate-P (also referred to as DRP).
3) Nitrogen series includes total N, ammonia-N and nitrate/nitrite-N.
4) Rads includes: Gross Alpha and Gross Beta
5) BTEX includes: benzene, toluene, ethyl benzene and total xylenes

SL – BIMONTHLY GRAB SAMPLES
Sample Collection

Equipment

Pontoon Boat
Marking Pen – Waterproof
Depth Finder
Secchi Disk
Log book and pen
Van Dorn bottle
Labeled sample bottles (refer to individual monitoring plans)
Churn sample splitter
PZ tube sampler
Ice packs
Coolers
Chain of custody forms
YSI 6600 Sonde - calibrated
YSI 650 Meter and cable
Handheld anemometer/%Relative humidity meter
Cellular phone
GPS unit
Digital camera
Boat Tool Kit
Laptop computer – fully charged with communication cable and "console" application installed
Water pitcher and wide bristle brush for cleaning sonde cage
Jackets, hats, gloves or other protective clothing as appropriate for the weather conditions
First aid kit
Personal flotation devices (one per person)
Survival Suits – yellow (1 hr protection) and orange (1/2 hr protection) -as appropriate
Profiler enclosure key
Boat Anchor(s)
Key for boat ramp during off-season
Zooplankton tow net – 63 µm

Sample collection procedure

At Laboratory

- Prepare and label all required sampling containers.
- Complete basic information on the chain of custody (COC) forms.
- Update the YSI 6600 file names using the format XXMMDDYY, where XX denotes the field sampling program identification (e.g. SL, CC, RC, etc.), MM denotes the month, DD denotes the day and YY denotes the year.
- Notify laboratories about the sampling event and schedule sample pickup.
- Assemble the sampling equipment and load into the truck.
- Calibrate the sonde.

Sampling on Standley Lake

Van Dorn Bottle

- The Van Dorn bottle provides a means of collecting water samples at selected depths below the surface. It is made of an open-ended plastic cylinder that is attached to a rope, and lowered to any desired depth.
- Each end of the cylinder is fitted with a rubber cover. The Van Dorn bottle is attached to the length of rope, marked in 0.1 m increments, with the covers pulled out and attached to the trigger device.
- The depth of the lake is determined using the sonde. The bottle is lowered to a depth one meter above the bottom of the lake.
- A metal weight called a "messenger" is attached to the rope above the bottle. The water sample is taken by dropping a weighted “messenger" down the rope. When the weight hits the triggering device on the upper Van Dorn bottle, the catch releases the rubber end covers. The two covers are pulled together and seal off the ends.
- When the bottle has been closed, it is pulled to the surface.
- Water samples from the Van Dorn bottle are transferred to the appropriate sample containers.
- The Van Dorn sampler has a four liter capacity. If the volume of sample required is greater than the Van Dorn sampler can hold, multiple sample volumes can be collected and combined in the churn. The churn and churn spigot should be rinsed out with new sample water prior to sample collection in order to prevent cross-contamination from prior samples. Once the churn contains enough sample, it is thoroughly mixed and the sample is dispensed into the required sample containers.
- Sample containers are labeled with sample location, date and time of sample collection and the sampler’s initials. The label should indicate any preservative in the sample container.
- Full sample containers are placed in coolers with ice packs until they are returned to the laboratory.

PZ Tube Sampler

- The PZ (photic zone) sampler is used to sample a column of water from the surface of the lake to the depth of the photic zone. Photic zone is defined as twice the secchi depth. The PZ sampler is comprised of a churn sample splitter connected to a polypropylene tube equipped with a quick release connector on one end and a check valve on the other end.
- Measure the secchi depth through the floor port on the pontoon boat. Do not wear sunglasses. Record data in the logbook.
- Hook up the quick release connector end of the tube to the churn.
- The tube is marked in 0.5 meter lengths. Lower the end of the tube with the check valve into the water until it is at the depth of the photic zone.
- Pull the tube up out of the water and hold the end with the check valve upside-down at a height over your head, until the tube drains down to floor level, then quickly drop the check-valve end of the tube back into the water vertically to the depth of the photic zone. The water entering the end of the tube will push the air bubble and prior sample into the churn as the tube is lowered into the water. Use the first collected volume of sample to rinse the tube and churn. Waste the sample back to

the lake. Start collecting the second volume of sample. Repeat this step until sufficient quantity of sample has been collected in the churn. The capacity of the churn is 12 liters.

- Once the churn contains enough sample, it is thoroughly mixed and the sample is dispensed into the required sample containers.
- Sample containers are labeled with sample location, date and time of sample location and the sampler's initials. The label should indicate any preservative in the sample container.
- Sample containers are placed in a cooler with ice packs until they are returned to the laboratory.

Surface Sampling

- Surface sampling is accomplished through the floor port of the pontoon boat. Sample containers are dipped into the water until full to collect samples.
- Sample containers are labeled with sample location, date and time of sample collection and the sampler's initials. The label should indicate any preservative in the sample container.
- Sample containers are placed in a cooler with ice packs until they are returned to the laboratory.

Zooplankton Tows

- Zooplankton samples are collected at SL-10 using a 63 µm tow net.
- A vertical tow sampling methodology involves lowering the tow net to the bottom of the lake and retrieving it at a slow speed of approximately one foot per second up to the surface.
- The zooplankton collected in the net are washed into a 250 mL sample bottle using multiple DI water rinses to ensure all organisms in the net are transferred to the sample container. The final volume in the bottle is not required to be consistent.
- The sample depth is recorded on the sample bottle along with date and location.

SL – AQUATIC INVASIVE SPECIES MANAGEMENT

Eurasian Watermilfoil

Eurasian Watermilfoil ("EWM"), *Myriophyllum spicatum L*, is a non-native, aquatic, noxious weed that grows rapidly and to a depth of 35 feet. EWM grows in dense mats that severely interfere with recreation and has been known to provide a substrate for blue-green algae growth. Blue-green algae blooms can ultimately cause taste and odor events in drinking water supplies. EWM was first observed in Standley Lake in 1998. It was positively identified in 2000. In 2012, it was confirmed that the Eurasian watermilfoil hybridized with a native Colorado species Northern watermilfoil (Myriophillum sibiricum). The hybrid species is more robust and grows even quicker than the Eurasian watermilfoil.

Eurasian milfoil weevils have been stocked in the lake (on the west side) on four occasions from 2004 through 2011. The weevil larva bore into the stem of the milfoil which damages the plant. When an adequate weevil population is sustained, the weevils may be able to control the spread of the milfoil. Annual surveys of weevil populations in the lake are performed by contractors. Standley Lake experienced a steady milfoil density decline from 2006, of 500 stems/m^2 to 26 stems/m^2 in 2011. Unfortunately with the appearance of the hybrid milfoil, the density again increased in 2012 to 106 stems/m^2.

In 2007 the SLC initiated a pilot study on Standley Lake using two solar pond aerators to investigate the theory that continuous aeration will oxidize the sediment and deprive the milfoil of nutrients. Samples were collected and analyzed for nutrients to assess nutrient reduction at the aerator sites compared to other sites in the lake. The solar aerators were removed in the fall of 2009. The results of the study were inconclusive as there was an overall reduction in milfoil growth throughout the lake in 2009.

As lake conditions permit, bathymetric studies are performed on Standley Lake during the early summer for mapping the submerged aquatic vegetation in order to assess milfoil growth and the effectiveness of the remedies.

Zebra and Quagga Mussels

Zebra and quagga mussels are non-native, aquatic invasive species that are introduced to new water bodies by the unintentional transfer of organisms from an infested water body via boats or fishing bait. Aquatic mussels cause serious damage to the ecosystem and result in costly control procedures for drinking water treatment facilities. Both zebra and quagga mussels were discovered in 2008 in a few of Colorado's lakes. Prevention of aquatic mussel infestation is key to protecting Standley Lake. An intensive boat inspection and decontamination program was initiated in 2008 to protect the lake from new invasive species. No live aquatic baits are allowed at Standley Lake.

Standley Lake is monitored for aquatic mussels every two weeks using the zooplankton tow procedure described previously. The tows are performed at the lake inlets, SL-10, and the boat ramp/outlet area. Several invasive species have a planktonic life stage and sampling with the plankton nets will provide early warning of infestation. In addition, substrate samplers, constructed and monitored by Colorado Parks and Wildlife are placed throughout the lake. Substrate samplers are made up of a float, rope, plastic plates and an anchor weight. A plate is located at every 10 feet of depth from the surface to the bottom of the lake at various locations. The plates and ropes are checked periodically for aquatic mussel growth. A plate or rope that feels like sand paper will be scraped and examined under the microscope for veligers (zebra or quagga mussel larvae).

Shoreline surveys are performed when the water level is at the lowest for the year. A shoreline survey consists of walking the shoreline in teams looking for adult mussels attached to any hard substrate.

DATA MANAGEMENT AND REPORTING

The City of Westminster is responsible for management of the data collected in support of the monitoring efforts. A Microsoft Excel spreadsheet is used for archival of monitoring data collected for all programs detailed in this document except the lake profile data. The IGA partners have access to the system via an internet host site which also provides backup protection for the data.

The City of Westminster logs in all samples collected by the various sampling teams. The coordinated sample creation effort reduces interpretation errors and subsequent reporting inconsistencies. Each IGA partner is responsible for analytical results entry for their assigned analyses into the spreadsheet. On a quarterly basis, a peer review team, comprised of at least one representative from each of the SLC, evaluates the data and identifies possible errors or data anomalies. Each city makes corrections to the spreadsheet and submits a final version of the data. The spreadsheet is current to within six months.

Data results from this program, along with other reporting requirements as stated in the Joint Agreement, will be reported to the Colorado Water Quality Control Commission on an annual basis. Only data collected during the normal sampling schedule is included in the annual report. The data is reported in tabular and graphic formats.

Each laboratory must retain all records (i.e. field notebooks and logs, instrument logs, bench sheets, instrument printouts, electronic data files, chain of custody forms, etc.) pertaining to the monitoring programs until the SLC IGA representatives jointly, in writing, authorize disposal of the records.

The periods of record for monitoring data are summarized in the following table:

Program	Period of Record	Available Format
Clear Creek Grabs	1994 – 2001	MS Access/Excel
	2002 – current	MS Excel
Clear Creek Grabs - EPA Metals Data	1994 – current	MS Excel
Clear Creek Autosamplers Ambient	2006 – current	MS Excel
Clear Creek Autosamplers Event	2006 – current	MS Excel
Standley Lake Tributaries – grabs and autosamplers (includes data for the program formerly called Clear Creek Canals)	1988 – 2001	MS Access/Excel
	2002 - current	MS Excel
Standley Lake	1988 – 2001	MS Access/Excel
	2002 - current	MS Excel

Table Notes: The data archive includes phosphorus data from 1999-current, all Thornton data from 2001-current and all Westminster data from 2002-current.

Appendix C – Clear Creek, Canal, and Standley Lake Water-Quality Monitoring Data – 2016

APPENDIX C1 CLEAR CREEK GRAB SAMPLES

APPENDIX C2 TRIBUTARY GRAB SAMPLES

APPENDIX C3 AMBIENT AUTOSAMPLERS

APPENDIX C4 EVENT AUTOSAMPLERS

APPENDIX C5 CLEAR CREEK EVENT AUTOSAMPLERS—METALS (GOLDEN)

APPENDIX C6 STANDLEY LAKE SAMPLES

Appendix C – Clear Creek, Canal, and Standley Lake Water-Quality Monitoring Data – 2016

APPENDIX C1 CLEAR CREEK GRAB SAMPLES

APPENDIX C2 TRIBUTARY GRAB SAMPLES

APPENDIX C3 AMBIENT AUTOSAMPLERS

APPENDIX C4 EVENT AUTOSAMPLERS

APPENDIX C5 CLEAR CREEK EVENT AUTOSAMPLERS—METALS (GOLDEN)

APPENDIX C6 STANDLEY LAKE SAMPLES

Clear Creek Grabs

Method				SM2550B	SM4500H+B	SM2510B	SM4500OG	SM2130B	SM5310B	SM2540D	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM4500PE	SM4500PE				
DL				1.0	1.0	10	1.0	1	0.5	1	0.01	0.01	0.02	0.0025	0.0025				
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3				
Max decimals				1	1	0	1	1	1	0	2	2	2	4	4				
Reporting Units				°C	s.u.	µS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Sample Date	Sample Time	Sample Type	Location ID	Temp	pH	Conductivity, Specific	Oxygen, Dissolved	Turbidity	Carbon, Total Organic	Solids, Total Suspended	Nitrogen, Ammonia (Salicylate)	Nitrogen, Nitrate+Nitrite	Nitrogen, Total Nitrogen	Phosphorus, Dissolved (DRP)	Phosphorus, Total	Notes	Conclusion	Field Notes	Lab Notes
02/10/16	9:11	G	CC 26	1.6	7	395	10.5	1.2	0.92	<1	0.05	0.32	0.46	< 0.0025	0.0034				
02/10/16	9:32	G	CC 40	<1	7.5	415	10.5	1	0.92	1	0.03	0.39	0.49	0.0038	0.0072			Staff gage = 4.8; ice	
02/10/16	9:44	G	CC 50	2.2	7.3	801	10.4	34.5	1.6	10	0.02	0.71	0.87	< 0.0025	0.0108				
02/10/16	10:11	G	CC 60	1.3	7.7	469	11	4.2	1.13	<1	0.06	0.48	0.65	< 0.0025	0.012				
04/13/16	10:07	G	CC 26	6.3	7.8	473	11	<1	0.97	2	0.05	0.27	0.36	0.0026	0.0072				
04/13/16	10:31	G	CC 40	7.5	7.1	412	11.2	2.6	1.14	5	0.01	0.29	0.38	< 0.0025	0.0199				
04/13/16	10:43	G	CC 50	8.2	7	408	9.8	26.4	1.99	21	< 0.01	0.15	0.25	< 0.0025	0.0188				
04/13/16	11:04	G	CC 60	9.2	7	447	9.6	4.9	1.42	3	0.02	0.34	0.44	< 0.0025	0.0135				
05/18/16	10:15	G	CC 05	2.9	8.4	324	9.7	2.7	4.5	<1	< 0.01	0.08	0.28	0.0037	0.006			Staff gage = 4.1 ft	
05/18/16	10:55	G	CC 10	4.3	8.3	120	9.5	1.1		<1	< 0.01	0.05	0.17	< 0.0025	0.0046				
05/18/16	10:51	G	CC 15	4.4	7.7	437	9.4	3		<1	0.04	0.13	0.29	0.0093	0.0165				
05/18/16	11:08	G	CC 20	5.1	7.5	318	9.4	3.8	2.7	3	0.01	0.1	0.23	0.0039	0.0162				
05/18/16	11:27	G	CC 25	8.2	8	260	9	3.3		<1	0.02	0.11	0.25	0.0026	0.0089				
05/18/16	11:57	G	CC 26	7.2	8	303	9.2	3.2	2.7	<1	0.01	0.11	0.24	0.0035	0.0087				
05/18/16	10:29	G	CC 30	3.8	8.6	99	10	2.3		3	0.01	0.03	0.22	0.0204	0.0275			Staff gage = 4.0 ft	
05/18/16	12:24	G	CC 34	7.9	7.9	284	9.3	3.5		2	< 0.01	0.11	0.27	< 0.0025	0.0106				
05/18/16	13:13	G	CC 35	5.5	8.3	92	9.1	5.1	3.8	3	< 0.01	0.06	0.24	0.0052	0.0198				
05/18/16	10:13	G	CC 40	6.2	8.8	320	9.3	5.3	3.6	4	0.01	0.13	0.52	0.0683	0.0898	Rising hydrograph; rain 3 days prior; 50% increase in org-N; no sign of nitrates from waste water.		Staff gage = 3.8 ft	
05/18/16	11:52	G	CC 44	4.7	8	89	9.5	6.1		2	0.06	0.03	0.2	0.01	0.0201				
NS	NS	G	CC 45													Site eliminated July 2015			
05/18/16	12:10	G	CC 50	8.8	7.7	210	8.7	13.9	3.8	7	< 0.01	0.16	0.36	0.0063	0.022				
05/18/16	13:49	G	CC 52	9.8	8	232	8.8	13.1	4.6	9	< 0.01	0.16	0.37	0.0072	0.0225				
05/18/16	14:27	G	CC 53	8.8	7.9	312	9	13.9	5.1	3	< 0.01	0.51	0.78	0.0087	0.0273				
05/18/16	12:33	G	CC 60	9	7.7	270	8.8	8.1	3.1	4	< 0.01	0.16	0.34	0.0037	0.0206				
05/18/16		QC	CCP108												0.0269	Blind QC sample			
05/18/16		QC	CCD108										0.31		0.0164	Blind QC sample			
05/18/16		QC	CCN108										0.56			Blind QC sample			
10/12/16	9:36	G	CC 05	2.2	6.7	201	10.6	1	2.6	3	< 0.01	0.21	0.27	0.005	0.0066			Staff gage = 3.6 ft	
10/12/16	10:00	G	CC 10	5	7.4	137	10.5	1		<1	< 0.01	0.11	0.14	0.0033	0.0051				
10/12/16	10:22	G	CC 15	4.4	7.4	747	9.3	1.7		3	0.07	0.17	0.34	< 0.0025	0.0039				
10/12/16	10:05	G	CC 20	5.6	7.4	410	9	1.9	1.2	5	0.02	0.17	0.27	< 0.0025	0.0089				
10/12/16	10:20	G	CC 25	6	7.4	196	10.7	1.6		6	0.03	0.17	0.29	< 0.0025	0.0081				
10/12/16	10:33	G	CC 26	5.5	7.4	278	10.9	2.5	2.5	4	0.03	0.18	0.28	< 0.0025	0.0076				
10/12/16	9:38	G	CC 30	4.8	7.8	57	10	1.3		<1	< 0.01	0.04	0.57	< 0.0025	0.0079			Staff gage = 1.2 ft	
10/12/16	10:52	G	CC 34	6.6	7.6	232	10.9	1.5		<1	0.02	0.17	0.25	< 0.0025	0.0085				
10/12/16	11:07	G	CC 35	4.1	7.7	80	11.4	5.4	3.7	2	< 0.01	0.05	0.11	0.0027	0.0077				
10/12/16	9:17	G	CC 40	7.2	7.4	265	9.6	1.1	1.3	<1	< 0.01	0.14	0.23	0.0025	0.0097			Staff gage = 3.8 ft	
10/12/16	11:07	G	CC 44	6.6	7.8	142	9.2	1.5		<1	< 0.01	< 0.01	0.07	0.0026	0.0066				
10/12/16		G	CC 45													Site eliminated July 2015			
10/12/16	11:40	G	CC 50	10.6	7.4	716	8.5	35.4	1.9	6	0.73	0.11	0.92	< 0.0025	0.0087				
10/12/16	11:32	G	CC 52	7.2	7.4	888	10.5	32.4	5.4	1	0.04	0.51	0.64	< 0.0025	0.0084				
10/12/16	11:50	G	CC 53	7.9	7.7	784	10	1.9	5.7	2	< 0.01	0.72	0.91	0.0044	0.0189				
10/12/16	12:12	G	CC 60	8.4	7.7	310	9.4	1.4	1.4	2	0.04	0.13	0.27	< 0.0025	0.0112				
10/12/16		QC	CCP109												0.0224	Blind QC sample			
10/12/16		QC	CCD109										0.14		0.0081	Blind QC sample			
10/12/16		QC	CCN109										0.4			Blind QC sample			
12/13/16	9:20	G	CC 26	< 1	7	359	10.2	< 1	0.8	<1	0.02	0.27	0.37	0.0028	0.0061				
12/13/16	9:51	G	CC 40	< 1	7.2	370	9.1	< 1	0.9	<1	0.01	0.38	0.51	< 0.0025	0.006				
12/13/16	10:10	G	CC50	1.6	7.3	868	8.6	20.2	1.5	7	0.02	0.47	0.7	< 0.0025	0.0072				
12/13/16	10:40	G	CC 60	< 1	7.6	453	10	< 1	1	<1	< 0.01	0.42	0.54	< 0.0025	0.0075				

Tribs

Sample Date	Sample Time	Sample Type	Location ID	Conductivity, Specific	Oxygen, Dissolved	pH	Temp	Turbidity	Phosphorus, Dissolved (DRP)	Phosphorus, Total	Nitrogen, Ammonia (Salicylate)	Nitrogen, Nitrate+Nitrite	Nitrogen, Total Nitrogen	Gross Alpha	Gross Alpha, Uncertainty	Gross Beta	Gross Beta, Uncertainty	Carbon, Total Organic	Solids, Total Suspended	E. coli,
Method				SM2510B	SM4500OG	SM4500H+B	SM2550B	SM2130B	SM4500PE	SM4500PE	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM7110B	SM7110B	SM7110B	SM7110B	SM5310B	SM2540D	SM9221D
Reporting Limit Goal				10	1.0	1.0	1.0	1	0.0025	0.0025	0.01	0.01	0.02	variable	variable	variable	variable	0.5	1	1
Max Sig figs				3	3	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
Max decimals				0	1	1	1	1	4	4	2	2	2	1	1	1	1	1	0	0
Reporting Units				µS/cm	mg/L	s.u.	°C	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	pCi/L	pCi/L	mg/L	mg/L	cfu/100mL
01/06/16		G	Trib 01	433	10.9	7.4	0.3	1.2	< 0.0025	0.006	0.01	0.48	0.45-S					1.3	<1	1
01/06/16		G	Trib 02	486	11.9	7.8	0.4	2.2	< 0.0025	0.0066	0.01	0.99	1.1					1.4	3	9
01/06/16		G	Trib 03	443	9.8	7.9	7.1	2	< 0.0025	0.0086	< 0.01	0.52	0.52-S					1	4	40
01/06/16		G	Trib 04	477	9.8	7.7	4.7	24.7	0.0041	0.0401	< 0.01	0.5	0.6					1.2	50	40
NS	NS	G	Trib 11																	
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
01/06/16		G	Trib 24	351	9	7.9	8.5	1.5	0.0038	0.0108	< 0.01	0.04	0.14					1.8	3	5
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	
NS	NS	G	Trib 01																	
NS	NS	G	Trib 02																	
02/03/16	9:45	G	Trib 03	578	9.2	7.7	6	3	0.0026	0.0144	0.03	0.56	0.75					1.2	3	86
02/03/16	10:25	G	Trib 04	628	9.1	7.7	2.8	53.6	0.0046	0.0775	0.06	0.55	1					1.3	109	57
NS	NS	G	Trib 11																	
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
02/03/16	8:30	G	Trib 24	387	9.3	7.5	8.4	0.9	< 0.0025	0.0072	0.01	0.11	0.36					1.9	4	1
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	
03/02/16	9:05	G	Trib 01	472	10.5	7.6	4.9	2.5	< 0.0025	0.006	< 0.01	0.45	0.52					1.4	5	<1
03/02/16	9:25	G	Trib 02	480	7.4	7.7	12	2.7	0.0034	0.0092	< 0.01	0.49	0.57					1.3	7	3
03/02/16	9:40	G	Trib 03	512	7.2	7.7	12.2	2.7	0.0043	0.0103	< 0.01	0.5	0.6					1.6	8	173
03/02/16	10:15	G	Trib 04	513	7.3	7.3	10.4	16.2	0.005	0.0328	0.01	0.47	0.61					1.4	31	29
NS	NS	G	Trib 11																	
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
03/02/16	8:25	G	Trib 24	344	8.6	7.7	9.5	1.4	< 0.0025	0.0087	< 0.01	0.08	0.27					6	<1	2
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	
04/06/16	9:15	G	Trib 01	380	10.2	7	8	3.8	< 0.0025	0.0085	0.02	0.5	0.58	1.6	1.9	2.1	2.4	1.3	3	<1
04/06/16	9:30	G	Trib 02	395	8.7	7.2	8.6	3.4	< 0.0025	0.008	0.01	0.54	0.65	1.8	2.1	1.1	2.3	2	3	11
04/06/16	9:45	G	Trib 03	444	8	7.3	11.2	3	0.0039	0.0129	0.01	0.64	0.71	2.7	2.3	1.9	2.2	1.8	2	23
04/06/16	10:20	G	Trib 04	446	8.4	7.1	10.9	9.8	0.0055	0.0203	< 0.01	0.52	0.62	1.7	0.6	2.8	2.4	2	17	15
04/06/16	10:25	G	Trib 11	428	8	7.5	10.1	2.9	< 0.0025	0.0118	< 0.01	0.46	0.55	3.7	2.5	0.8	2.3	2.2	2	82
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
04/06/16	8:30	G	Trib 24	307	8.5	7.1	10.6	1.9	< 0.0025	0.01	0.01	0.09	0.23	1.1	1.7	0	2.1	1.6	2	1
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	

Tribs

Method				SM2510B	SM4500OG	SM4500H+B	SM2550B	SM2130B	SM4500PE	SM4500PE	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM7110B	SM7110B	SM7110B	SM7110B	SM5310B	SM2540D	SM9221D
Reporting Limit Goal				10	1.0	1.0	1.0	1	0.0025	0.0025	0.01	0.01	0.02	variable	variable	variable	variable	0.5	1	1
Max Sig figs				3	3	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
Max decimals				0	1	1	1	1	4	4	2	2	2	1	1	1	1	1	0	0
Reporting Units				µS/cm	mg/L	s.u.	°C	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	pCi/L	pCi/L	mg/L	mg/L	cfu/100mL
Sample Date	Sample Time	Sample Type	Location ID	Conductivity, Specific	Oxygen, Dissolved	pH	Temp	Turbidity	Phosphorus, Dissolved (DRP)	Phosphorus, Total	Nitrogen, Ammonia (Salicylate)	Nitrogen, Nitrate+Nitrite	Nitrogen, Total Nitrogen	Gross Alpha	Gross Alpha, Uncertainty	Gross Beta	Gross Beta, Uncertainty	Carbon, Total Organic	Solids, Total Suspended	E. coli,
05/04/16	9:00	G	Trib 01	395	9.7	7.1	10.2	9	0.0049	0.0182	0.01	0.36	0.63					3.4	14	5
05/04/16	9:15	G	Trib 02	413	9.7	7.2	8.8	11.4	0.0054	0.0253	0.01	0.48	0.71					3.4	17	47
05/04/16	9:30	G	Trib 03	423	8	7.2	11.3	8.4	0.0047	0.0237	< 0.01	0.42	0.65					3.4	21	23
NS	NS	G	Trib 04																	
05/04/16	10:05	G	Trib 11	510	8.4	7.4	14.6	4.9	0.0029	0.0166	< 0.01	0.22	0.53					3.8	5	40
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
05/04/16	8:20	G	Trib 24	391	8.5	7.1	12.4	2.7	< 0.0025	0.0131	0.02	0.08	0.34					1.7	6	1
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	
06/01/16	9:20	G	Trib 01	177	8.5	7.6	12.8	11.4	< 0.0005	0.0249	0.01	0.1	0.34	1.1	1.3	3.2	2.3	3.1	21	14
06/01/16	9:30	G	Trib 02	201	8.3	7.8	11.4	11	0.004	0.0295	< 0.01	0.13	0.39	2.4	1.7	0.6	2.1	3	20	22
06/01/16	9:45	G	Trib 03	186	7.5	7.7	12.2	11.7	0.0051	0.0297	< 0.01	0.12	0.38	1.7	1.5	0	2.1	3.4	22	45
NS	NS	G	Trib 04																	
06/01/16	10:25	G	Trib 11	226	6.9	7.7	14.6	8.3	0.0066	0.0263	0.02	0.16	0.41	1.7	1.5	0	2	3.3	9	518
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
06/01/16	8:25	G	Trib 24	389	5.8	7.5	13.2	4.2	< 0.0025	0.0103	0.05	0.14	0.36	1.6	1.8	0	2	1.7	<1	<1
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	
07/06/16	9:10	G	Trib 01	127	7.9	7.2	15.2	2	< 0.0025	0.0091	< 0.01	0.1	0.28					1.9	4	14
07/06/16	9:35	G	Trib 02	130	7.7	7.4	14.6	2	< 0.0025	0.0101	0.01	0.11	0.29					1.7	5	31
07/06/16	9:50	G	Trib 03	129	6.9	7.4	16.2	1.9	< 0.0025	0.0096	< 0.01	0.11	0.27					2.2	2	17
NS	NS	G	Trib 04																	
07/06/16	10:45	G	Trib 11	148	6.2	7.4	18.8	4.9	0.0031	0.0171	< 0.01	0.11	0.28					1.9	5	388
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
07/06/16	8:35	G	Trib 24	391	3.3	7.4	14.8	3.4	< 0.0025	0.0117	0.03	0.18	0.38					1.7	2	<1
NS	NS	G	Trib 25																	
07/06/16	10:30	G	Trib 27 (New Church Ditch Inlet)	139	5.6	7.5	18.8	5.9	0.0081	0.0262	0.01	0.1	0.3					2	7	921
08/03/16	9:10	G	Trib 01	209	6.6	7.2	16.9	2.4	< 0.0025	0.011	0.01	0.15	0.27					1.4	2	52
08/03/16	9:25	G	Trib 02	206	6.6	7.2	18.3	4.9	0.0031	0.0166	< 0.01	0.19	0.31					1.9	3	326
08/03/16	9:40	G	Trib 03	225	5.2	7.4	21.2	1	< 0.0025	0.01	0.01	0.17	0.26					1.4	<1	326
NS	NS	G	Trib 04																	
08/03/16	10:25	G	Trib 11	215	5.8	7.6	20.1	3.6	< 0.0025	0.0142	< 0.01	0.11	0.25					1.5	4	231
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
08/03/16	8:35	G	Trib 24	390	1.9	7.1	14.1	6.9	< 0.0025	0.0124	< 0.01	0.22	0.4					1.8	4	14
NS	NS	G	Trib 25																	
08/03/16	10:10	G	Trib 27 (New Church Ditch Inlet)	204	5.6	7.6	19.7	3.4	0.0048	0.0199	0.01	0.08	0.26					1.7	1	261

Tribs

Method				SM2510B	SM4500OG	SM4500H+B	SM2550B	SM2130B	SM4500PE	SM4500PE	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM7110B	SM7110B	SM7110B	SM7110B	SM5310B	SM2540D	SM9221D
Reporting Limit Goal				10	1.0	1.0	1.0	1	0.0025	0.0025	0.01	0.01	0.02	variable	variable	variable	variable	0.5	1	1
Max Sig figs				3	3	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
Max decimals				0	1	1	1	1	4	4	2	2	2	1	1	1	1	1	0	0
Reporting Units				µS/cm	mg/L	s.u.	°C	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	pCi/L	pCi/L	mg/L	mg/L	cfu/100mL
Sample Date	Sample Time	Sample Type	Location ID	Conductivity, Specific	Oxygen, Dissolved	pH	Temp	Turbidity	Phosphorus, Dissolved (DRP)	Phosphorus, Total	Nitrogen, Ammonia (Salicylate)	Nitrogen, Nitrate+Nitrite	Nitrogen, Total Nitrogen	Gross Alpha	Gross Alpha, Uncertainty	Gross Beta	Gross Beta, Uncertainty	Carbon, Total Organic	Solids, Total Suspended	E. coli,
09/14/16	9:20	G	Trib 01	281	7.1	8	14.3	1.9	0.0042	0.0047	< 0.01	0.15	0.19	1.4	1.6	0.7	2.2	1.3	1	18
09/14/16	9:40	G	Trib 02	285	6	7.8	16.2	2.2	< 0.0025	0.0059	0.01	0.18	0.25	1.2	1.5	2.8	2.2	1.4	3	33
09/14/16	9:50	G	Trib 03	312	6	8	15.7	2.1	< 0.0025	0.0064	0.01	0.19	0.28	2.1	1.7	0.2	2.1	1.8	2	276
NS	NS	G	Trib 04																	
09/14/16	10:35	G	Trib 11	299	6.2	7.8	16	4.5	0.0033	0.0132	0.01	0.18	0.28	1.5	1.5	0.7	2.2	1.6	9	366
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
09/14/16	8:40	G	Trib 24	325	1	7.3	18.4	9.9	0.0042	0.0152	0.02	0.12	0.31	0.6	0.7	0.9	2.2	1.9	13	50
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	
10/05/16	9:05	G	Trib 01	308	8.8	7.2	7.8	0.9	0.0033	0.0058	0.01	0.1	0.15					1.3	<1	7
10/05/16	9:20	G	Trib 02	285	6.9	7.4	13	0.8	< 0.0025	0.0049	0.01	0.1	0.15					1.3	<1	9
10/05/16	9:35	G	Trib 03	343	6.2	7.2	12.7	0.8	< 0.0025	0.0066	0.02	0.16	0.22					1.5	<1	140
NS	NS	G	Trib 04																	
10/05/16	10:10	G	Trib 11	299	7	7.1	12.4	1.9	< 0.0025	0.0092	< 0.01	0.06	0.15					1.6	4	130
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
10/05/16	8:25	G	Trib 24	316	5.1	7.7	17.2	4	< 0.0025	0.013	0.01	0.03	0.14					2	8	10
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	
11/02/16	9:25	G	Trib 01	357	8	7.6	8.8	1.2	< 0.0025	0.006	< 0.01	0.21	0.32					1.3	<1	1
11/02/16	9:45	G	Trib 02	348	7	7.4	12.6	1.1	< 0.0025	0.0072	< 0.01	0.23	0.3					1.3	1	5
11/02/16	10:00	G	Trib 03	387	7.3	7.4	11	1.8	0.0044	0.0099	0.02	0.25	0.37					1.4	5	91
NS	NS	G	Trib 04																	
11/02/16	10:35	G	Trib 11	359	6.9	7.6	12.3	2	< 0.0025	0.0094	< 0.01	0.17	0.29					1.6	7	78
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
11/02/16	8:40	G	Trib 24	320	5.3	7.4	16.6	4.3	< 0.0025	0.0132	< 0.01	0.09	0.24					1.7	9	61
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	
12/07/16	9:25	G	Trib 01	401	9.8	7.3	0.7	0.7	< 0.0025	0.0043	0.02	0.42	0.61	1.8	1.9	0.2	2.3	1.1	1	<1
NS	NS	G	Trib 02																	
12/07/16	9:45	G	Trib 03	428	8.6	7.5	3.5	2.1	0.003	0.0101	0.01	0.43	0.66	1.6	1.8	0	2.2	1.2	5	38
12/07/16	10:25	G	Trib 04	450	9	7.2	0.02	34.9	0.0054	0.046	0.01	0.41	0.75	1.2	2.4	3.4	2.5	1.4	55	136
NS	NS	G	Trib 11																	
NS	NS	G	Trib 22a																	
NS	NS	G	Trib 22d																	
12/07/16	8:40	G	Trib 24	341	7.3	7.7	10	1.9	0.003	0.0096	0.01	0.04	0.21	1.5	1.6	0.9	2.1	1.8	<1	24
NS	NS	G	Trib 25																	
NS	NS	G	Trib 27 (New Church Ditch Inlet)																	

Tribs

Sample Date	Sample Time	Sample Type	Location ID	Iron, Dissolved	Iron, Total	Manganese, Dissolved	Manganese, Total	Zinc, Dissolved	Zinc, Total	Hardness, Total	Chloride	Sulfate	Bromide	Arsenic, Dissolved	Arsenic, Total	Barium, Dissolved	Barium, Total	Beryllium, Dissolved	Beryllium, Total	Cadmium, Dissolved	Cadmium, Total	Chromium, Dissolved	Chromium, Total	Copper, Dissolved
Method				**EPA200.7**	**EPA200.7**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA130.2**	**SM4110A**	**SM4110A**	**SM4110A**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**
Reporting Limit Goal				**0.01**	**0.01**	**0.00025**	**0.00025**	**0.0025**	**0.0025**	**5**	**5**	**10**	**0.1**	**0.00015**	**0.00015**	**0.0001**	**0.0001**	**0.001**	**0.001**	**0.00010**	**0.00010**	**0.00050**	**0.00050**	**0.00025**
Max Sig figs				**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Max decimals				**3**	**3**	**5**	**5**	**4**	**4**	**0**	**0**	**0**	**1**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Reporting Units				**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L as CaCO3**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
01/06/16		G	**Trib 01**	0.015	0.13	0.2	0.23	0.21	0.24															
01/06/16		G	**Trib 02**	0.014	0.14	0.22	0.19	0.22	0.21															
01/06/16		G	**Trib 03**	0.017	0.16	0.14	0.18	0.16	0.21															
01/06/16		G	**Trib 04**	0.014	1.2	0.032	0.2	0.084	0.22															
NS	NS	G	**Trib 11**																					
NS	NS	G	**Trib 22a**																					
NS	NS	G	**Trib 22d**																					
01/06/16		G	**Trib 24**	0.0036	0.064	0.00059	0.024	0.01	0.014															
NS	NS	G	**Trib 25**																					
NS	NS	G	**Trib 27 (New Church Ditch Inlet)**																					
NS	NS	G	**Trib 01**																					
NS	NS	G	**Trib 02**																					
02/03/16	9:45	G	**Trib 03**	0.024	0.47	0.17	0.26	0.11	0.21															
02/03/16	10:25	G	**Trib 04**	0.026	4	0.19	0.47	0.056	0.39															
NS	NS	G	**Trib 11**																					
NS	NS	G	**Trib 22a**																					
NS	NS	G	**Trib 22d**																					
02/03/16	8:30	G	**Trib 24**	<0.0026	0.042	0.0053	0.019	0.015	0.018															
NS	NS	G	**Trib 25**																					
NS	NS	G	**Trib 27 (New Church Ditch Inlet)**																					
03/02/16	9:05	G	**Trib 01**	0.014	0.32	0.27	0.26	0.22	0.2	180	51	109	<0.1	0.00019	<0.00006	0.049	0.05	<0.000054	<0.000054	0.00072	0.00074	<0.000088	0.00014	0.0097
03/02/16	9:25	G	**Trib 02**	0.011	0.27	0.18	0.19	0.13	0.17	176	49	112	<0.1	0.00028	<0.00006	0.048	0.053	<0.000054	<0.000054	0.00054	0.00068	0.00016	0.00026	0.0041
03/02/16	9:40	G	**Trib 03**	0.0097	0.29	0.14	0.17	0.1	0.14	186	53	114	<0.1	0.00026	0.00026	0.048	0.052	<0.000054	<0.000054	0.00045	0.00059	0.00017	0.00012	0.0037
03/02/16	10:15	G	**Trib 04**	0.022	1.2	0.064	0.2	0.046	0.15	198	49	113	<0.1	0.00093	0.0019	0.052	0.066	<0.000054	0.000093	0.00009	0.00059	0.00016	0.00096	0.0021
NS	NS	G	**Trib 11**																					
NS	NS	G	**Trib 22a**																					
NS	NS	G	**Trib 22d**																					
03/02/16	8:25	G	**Trib 24**	<0.0026	0.1	0.00047	0.051	0.0073	0.023	132	32	68	<0.1	0.00042	0.00018	0.045	0.051	<0.000054	<0.000054	0.000014	0.000083	0.00014	<0.000088	0.0029
NS	NS	G	**Trib 25**																					
NS	NS	G	**Trib 27 (New Church Ditch Inlet)**																					
04/06/16	9:15	G	**Trib 01**	0.02	0.44	0.23	0.28	0.16	0.19															
04/06/16	9:30	G	**Trib 02**	0.022	0.41	0.18	0.22	0.14	0.16															
04/06/16	9:45	G	**Trib 03**	0.024	0.34	0.11	0.16	0.086	0.12															
04/06/16	10:20	G	**Trib 04**	0.028	0.76	0.07	0.17	0.018	0.062															
04/06/16	10:25	G	**Trib 11**	0.02	0.18	0.0014	0.027	0.044	0.05															
NS	NS	G	**Trib 22a**																					
NS	NS	G	**Trib 22d**																					
04/06/16	8:30	G	**Trib 24**	0.0041	0.098	0.00032	0.022	0.0089	0.012															
NS	NS	G	**Trib 25**																					
NS	NS	G	**Trib 27 (New Church Ditch Inlet)**																					

Tribs

Sample Date	Sample Time	Sample Type	Location ID	Iron, Dissolved	Iron, Total	Manganese, Dissolved	Manganese, Total	Zinc, Dissolved	Zinc, Total	Hardness, Total	Chloride	Sulfate	Bromide	Arsenic, Dissolved	Arsenic, Total	Barium, Dissolved	Barium, Total	Beryllium, Dissolved	Beryllium, Total	Cadmium, Dissolved	Cadmium, Total	Chromium, Dissolved	Chromium, Total	Copper, Dissolved
Method				EPA200.7	EPA200.7	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA130.2	SM4110A	SM4110A	SM4110A	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8
Reporting Limit Goal				0.01	0.01	0.00025	0.00025	0.0025	0.0025	5	5	10	0.1	0.00015	0.00015	0.0001	0.0001	0.001	0.001	0.00010	0.00010	0.00050	0.00050	0.00025
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Max decimals				3	3	5	5	4	4	0	0	0	1	5	5	5	5	5	5	5	5	5	5	5
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
05/04/16	9:00	G	Trib 01	0.12	1.3	0.39	0.52	0.14	0.44															
05/04/16	9:15	G	Trib 02	0.097	1.2	0.25	0.38	0.076	0.28															
05/04/16	9:30	G	Trib 03	0.12	1.2	0.28	0.42	0.085	0.33															
NS	NS	G	Trib 04																					
05/04/16	10:05	G	Trib 11	0.041	0.36	0.0012	0.074	0.016	0.065															
NS	NS	G	Trib 22a																					
NS	NS	G	Trib 22d																					
05/04/16	8:20	G	Trib 24	0.0076	0.11	0.00011	0.034	0.0051	0.011															
NS	NS	G	Trib 25																					
NS	NS	G	Trib 27 (New Church Ditch Inlet)																					
06/01/16	9:20	G	Trib 01	0.12	1.3	0.39	0.52	0.14	0.44	76	14	27		0.00018	0.00077	0.026	0.036	<0.000054	0.00014	0.00041	0.00095	<0.000088	0.00098	0.0076
06/01/16	9:30	G	Trib 02	0.097	1.2	0.25	0.38	0.076	0.28	76	16	29		0.0002	0.00054	0.028	0.036	<0.000054	<0.000054	0.00038	0.00082	<0.000088	0.00087	0.0096
06/01/16	9:45	G	Trib 03	0.12	1.2	0.28	0.42	0.085	0.33	76	15	28		0.00019	0.00059	0.025	0.035	<0.000054	<0.000054	0.00041	0.00096	<0.000088	0.00097	0.0072
NS	NS	G	Trib 04																					
06/01/16	10:25	G	Trib 11	0.041	0.36	0.0012	0.074	0.016	0.065	88	18	32		0.00028	0.00037	0.029	0.033	<0.000054	<0.000054	0.00017	0.00038	<0.000088	0.00045	0.0063
NS	NS	G	Trib 22a																					
NS	NS	G	Trib 22d																					
06/01/16	8:25	G	Trib 24	0.0076	0.11	0.00011	0.034	0.0051	0.011	136	34	66		0.00045	0.0005	0.058	0.057	<0.000054	<0.000054	0.00003	0.000034	<0.000088	<0.000088	0.0039
NS	NS	G	Trib 25																					
NS	NS	G	Trib 27 (New Church Ditch Inlet)																					
07/06/16	9:10	G	Trib 01	0.051	0.3	0.036	0.076	0.051	0.072															
07/06/16	9:35	G	Trib 02	0.053	0.27	0.032	0.072	0.051	0.068															
07/06/16	9:50	G	Trib 03	0.049	0.27	0.028	0.073	0.047	0.068															
NS	NS	G	Trib 04																					
07/06/16	10:45	G	Trib 11	0.033	0.43	0.0014	0.06	0.027	0.048															
NS	NS	G	Trib 22a																					
NS	NS	G	Trib 22d																					
07/06/16	8:35	G	Trib 24	0.0088	0.18	0.0027	0.086	0.01	0.014															
NS	NS	G	Trib 25																					
07/06/16	10:30	G	Trib 27 (New Church Ditch Inlet)	0.072	0.49	0.0013	0.05	0.02	0.038															
08/03/16	9:10	G	Trib 01	0.027	0.34	0.035	0.11	0.045	0.09					0.00021	0.00028	0.026	0.032	<0.000054	<0.000054	0.00024	0.00031	0.0002	0.00022	0.0028
08/03/16	9:25	G	Trib 02	0.028	0.43	0.017	0.087	0.04	0.082					0.00017	0.00027	0.025	0.033	<0.000054	<0.000054	0.00018	0.00033	0.00015	0.00033	0.0028
08/03/16	9:40	G	Trib 03	0.019	0.12	0.0088	0.062	0.03	0.058					0.00016	0.00019	0.027	0.03	<0.000054	<0.000054	0.00013	0.00023	<0.000088	<0.000088	0.0022
NS	NS	G	Trib 04																					
08/03/16	10:25	G	Trib 11	0.016	0.36	0.00055	0.056	0.012	0.037					0.00025	0.00024	0.027	0.032	<0.000054	<0.000054	0.000051	0.00017	<0.000088	0.00022	0.002
NS	NS	G	Trib 22a																					
NS	NS	G	Trib 22d																					
08/03/16	8:35	G	Trib 24	<0.0026	0.47	0.00032	0.19	0.0054	0.017					0.00025	0.00062	0.05	0.062	<0.000054	<0.000054	0.000036	<0.000012	0.00016	0.00042	0.0038
NS	NS	G	Trib 25																					
08/03/16	10:10	G	Trib 27 (New Church Ditch Inlet)	0.024	0.26	0.00036	0.031	0.0094	0.022					0.00023	0.00035	0.024	0.032	<0.000054	<0.000054	0.000041	0.000051	<0.000088	0.00015	0.0016

Tribs

Method				EPA200.7	EPA200.7	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA130.2	SM4110A	SM4110A	SM4110A	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8
Reporting Limit Goal				0.01	0.01	0.00025	0.00025	0.0025	0.0025	5	5	10	0.1	0.00015	0.00015	0.0001	0.0001	0.001	0.001	0.00010	0.00010	0.00050	0.00050	0.00025
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Max decimals				3	3	5	5	4	4	0	0	0	1	5	5	5	5	5	5	5	5	5	5	5
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample Date	Sample Time	Sample Type	Location ID	Iron, Dissolved	Iron, Total	Manganese, Dissolved	Manganese, Total	Zinc, Dissolved	Zinc, Total	Hardness, Total	Chloride	Sulfate	Bromide	Arsenic, Dissolved	Arsenic, Total	Barium, Dissolved	Barium, Total	Beryllium, Dissolved	Beryllium, Total	Cadmium, Dissolved	Cadmium, Total	Chromium, Dissolved	Chromium, Total	Copper, Dissolved
09/14/16	9:20	G	Trib 01	0.04	0.25	0.077	0.09	0.074	0.09	118	17	63		0.00014	0.00017	0.036	0.036	<0.000054	<0.000054	0.00031	0.0004	<0.000088	0.00018	0.003
09/14/16	9:40	G	Trib 02	0.038	0.23	0.059	0.082	0.061	0.08	128	18	61		0.00018	0.00019	0.037	0.04	<0.000054	<0.000054	0.00024	0.00035	<0.000088	0.00018	0.0032
09/14/16	9:50	G	Trib 03	0.037	0.2	0.048	0.064	0.048	0.077	128	22	63		0.00022	0.00025	0.038	0.039	<0.000054	<0.000054	0.00034	0.00045	<0.000088	0.00016	0.0031
NS	NS	G	Trib 04																					
09/14/16	10:35	G	Trib 11	0.024	0.3	0.014	0.049	0.018	0.032	122	19	62		0.00029	0.000099	0.039	0.036	<0.000054	<0.000054	0.00007	0.00021	<0.000088	0.00044	0.002
NS	NS	G	Trib 22a																					
NS	NS	G	Trib 22d																					
09/14/16	8:40	G	Trib 24	0.005	0.4	0.0014	0.12	0.005	0.0099	120	27	52		0.0004	0.0004	0.048	0.041	<0.000054	<0.000054	0.000014	0.000034	<0.000088	0.00038	0.0037
NS	NS	G	Trib 25																					
NS	NS	G	Trib 27 (New Church Ditch Inlet)																					
10/05/16	9:05	G	Trib 01	0.12	0.11	0.088	0.094	0.1	0.11															
10/05/16	9:20	G	Trib 02	0.11	0.1	0.068	0.071	0.083	0.088															
10/05/16	9:35	G	Trib 03	0.09	0.084	0.083	0.084	0.065	0.067															
NS	NS	G	Trib 04																					
10/05/16	10:10	G	Trib 11	0.097	0.093	0.042	0.045	0.032	0.035															
NS	NS	G	Trib 22a																					
NS	NS	G	Trib 22d																					
10/05/16	8:25	G	Trib 24	0.061	0.15	0.042	0.048	0.0087	0.0066															
NS	NS	G	Trib 25																					
NS	NS	G	Trib 27 (New Church Ditch Inlet)																					
11/02/16	9:25	G	Trib 01	0.018	0.14	0.087	0.098	0.081	0.098															
11/02/16	9:45	G	Trib 02	0.018	0.11	0.06	0.074	0.094	0.11															
11/02/16	10:00	G	Trib 03	0.031	0.15	0.13	0.22	0.047	0.069															
NS	NS	G	Trib 04																					
11/02/16	10:35	G	Trib 11	0.017	0.095	0.011	0.049	0.033	0.045															
NS	NS	G	Trib 22a																					
NS	NS	G	Trib 22d																					
11/02/16	8:40	G	Trib 24	0.0055	0.21	0.0016	0.1	0.0094	0.016															
NS	NS	G	Trib 25																					
NS	NS	G	Trib 27 (New Church Ditch Inlet)																					
12/07/16	9:25	G	Trib 01	0.016	0.085	0.088	0.098	0.14	0.16	164	31	93		0.00018	0.00017	0.045	0.044	<0.000054	<0.000054	0.00044	0.00047	<0.000088	<0.000088	0.0031
NS	NS	G	Trib 02																					
12/07/16	9:45	G	Trib 03	0.019	0.17	0.047	0.11	0.091	0.14	176	38	91		0.00022	0.0003	0.044	0.044	<0.000054	<0.000054	0.00034	0.00043	0.00011	<0.000088	0.0023
12/07/16	10:25	G	Trib 04	0.015	2.3	0.0064	0.25	0.049	0.21	188	35	101		0.00081	0.0024	0.048	0.069	<0.000054	<0.000054	0.00013	0.00084	<0.000088	0.002	0.002
NS	NS	G	Trib 11																					
NS	NS	G	Trib 22a																					
NS	NS	G	Trib 22d																					
12/07/16	8:40	G	Trib 24	0.0043	0.087	0.00029	0.018	0.0057	0.0074	140	29	62		0.00038	0.0007	0.045	0.051	<0.000054	<0.000054	0.000019	ND	<0.000088	0.00022	0.004
NS	NS	G	Trib 25																					
NS	NS	G	Trib 27 (New Church Ditch Inlet)																					

Tribs

Method				EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.7	EPA200.7	EPA200.8	EPA200.8				
Reporting Limit Goal				0.00025	0.00020	0.00020	0.00050	0.00050	0.005	0.005	0.00050	0.00050	0.0005	0.0005	0.0020	0.0020	0.00003	0.00003				
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3				
Max decimals				5	5	5	5	5	4	4	5	5	5	5	5	5	5	5				
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Sample Date	Sample Time	Sample Type	Location ID	Copper, Total	Lead, Dissolved	Lead, Total	Molybdenum, Dissolved	Molybdenum, Total	Nickel, Dissolved	Nickel, Total	Selenium, Dissolved	Selenium, Total	Silver, Dissolved	Silver, Total	Strontium Dissolved ICAP	Strontium Total	Vanadium Dissolved ICAP/MS	Vanadium Total ICAP/MS	Notes	Conclusion	Field Notes	Lab Notes
01/06/16		G	Trib 01	[redacted]																		
01/06/16		G	Trib 02	[redacted]																		
01/06/16		G	Trib 03	[redacted]																		
01/06/16		G	Trib 04	[redacted]																		
NS	NS	G	Trib 11	[redacted]																		
NS	NS	G	Trib 22a	[redacted]																		
NS	NS	G	Trib 22d	[redacted]																		
01/06/16		G	Trib 24	[redacted]																		
NS	NS	G	Trib 25																			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																			
NS	NS	G	Trib 01																Not sampled			
NS	NS	G	Trib 02																Not sampled			
02/03/16	9:45	G	Trib 03																			
02/03/16	10:25	G	Trib 04																			
NS	NS	G	Trib 11																Not sampled			
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
02/03/16	8:30	G	Trib 24																			
NS	NS	G	Trib 25																Not sampled			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																Not sampled			
03/02/16	9:05	G	Trib 01	0.0098	0.00064	0.00063	0.0019	0.0018	0.0038	0.0031	0.00033	0.00085	<0.000014	<0.000014	0.26	0.26	0.000061	0.00012				
03/02/16	9:25	G	Trib 02	0.0085	0.000077	0.00064	0.0021	0.002	0.0035	0.0025	0.00048	<0.00015	<0.000014	<0.000014	0.27	0.28	0.000092	0.00025				
03/02/16	9:40	G	Trib 03	0.0086	0.000085	0.00085	0.0021	0.0018	0.0033	0.0025	0.00044	0.00053	0.00016	<0.000014	0.28	0.3	0.000086	0.00023				
03/02/16	10:15	G	Trib 04	0.018	0.00038	0.013	0.0024	0.0021	0.0028	0.003	0.00048	<0.00015	<0.000014	0.00014	0.3	0.29	0.0004	0.0016				
NS	NS	G	Trib 11																Not sampled			
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
03/02/16	8:25	G	Trib 24	0.0054	0.000055	0.00073	0.0025	0.0026	0.0016	0.0013	0.00037	<0.00015	<0.000014	0.000019	0.22	0.22	0.0002	0.00021				
NS	NS	G	Trib 25																Not sampled			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																Not sampled			
04/06/16	9:15	G	Trib 01																			
04/06/16	9:30	G	Trib 02																			
04/06/16	9:45	G	Trib 03																			
04/06/16	10:20	G	Trib 04																			
04/06/16	10:25	G	Trib 11																			
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
04/06/16	8:30	G	Trib 24																			
NS	NS	G	Trib 25																Not sampled			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																Not sampled			

Tribs

Method				EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.7	EPA200.7	EPA200.8	EPA200.8				
Reporting Limit Goal				0.00025	0.00020	0.00020	0.00050	0.00050	0.005	0.005	0.00050	0.00050	0.0005	0.0005	0.0020	0.0020	0.00003	0.00003				
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3				
Max decimals				5	5	5	5	5	4	4	5	5	5	5	5	5	5	5				
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Sample Date	Sample Time	Sample Type	Location ID	Copper, Total	Lead, Dissolved	Lead, Total	Molybdenum, Dissolved	Molybdenum, Total	Nickel, Dissolved	Nickel, Total	Selenium, Dissolved	Selenium, Total	Silver, Dissolved	Silver, Total	Strontium Dissolved ICAP	Strontium Total	Vanadium Dissolved ICAP/MS	Vanadium Total ICAP/MS	Notes	Conclusion	Field Notes	Lab Notes
05/04/16	9:00	G	Trib 01																			
05/04/16	9:15	G	Trib 02																			
05/04/16	9:30	G	Trib 03																			
NS	NS	G	Trib 04																Not sampled			
05/04/16	10:05	G	Trib 11																			
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
05/04/16	8:20	G	Trib 24																			
NS	NS	G	Trib 25																Not sampled			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																Not sampled			
06/01/16	9:20	G	Trib 01	0.028	0.00089	0.0087	0.002	0.0024	0.0015	0.0027	0.00026	<0.00015	0.000028	0.00012	0.099	0.1	< 0.000034	0.00082				
06/01/16	9:30	G	Trib 02	0.025	0.00093	0.0066	0.0021	0.0025	0.0016	0.0022	0.00024	0.00038	<0.000014	0.000074	0.12	0.12	< 0.000034	0.0011				
06/01/16	9:45	G	Trib 03	0.028	0.00067	0.0073	0.002	0.0024	0.0016	0.0024	0.00023	0.00063	<0.000014	0.000092	0.11	0.11	< 0.000034	0.0013				
NS	NS	G	Trib 04																Not sampled			
06/01/16	10:25	G	Trib 11	0.012	0.00049	0.0023	0.0023	0.0024	0.0015	0.0015	0.00034	0.00027	0.000014	0.000042	0.13	0.13	0.00011	0.00089				
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
06/01/16	8:25	G	Trib 24	0.007	0.00012	0.00093	0.0026	0.0026	0.0025	0.0013	0.00054	<0.00015	<0.000014	0.00003	0.23	0.24	0.00013	0.00046				
NS	NS	G	Trib 25																Not sampled			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																Not sampled			
07/06/16	9:10	G	Trib 01																			
07/06/16	9:35	G	Trib 02																			
07/06/16	9:50	G	Trib 03																			
NS	NS	G	Trib 04																Not sampled			
07/06/16	10:45	G	Trib 11																			
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
07/06/16	8:35	G	Trib 24																			
NS	NS	G	Trib 25																Not sampled			
07/06/16	10:30	G	Trib 27 (New Church Ditch Inlet)																			
08/03/16	9:10	G	Trib 01	0.0072	0.00016	0.0016	0.0021	0.0021	0.00079	0.001	0.00069	0.00019	<0.000014	<0.000014	0.12	0.12	0.00023	0.00024				
08/03/16	9:25	G	Trib 02	0.007	0.00012	0.0021	0.0017	0.0021	0.00065	0.0011	<0.00015	0.0002	<0.000014	<0.000014	0.13	0.13	0.0001	0.00026				
08/03/16	9:40	G	Trib 03	0.0039	0.000072	0.0006	0.0019	0.0021	0.00056	0.0012	0.00066	0.00026	<0.000014	<0.000014	0.14	0.14	0.00012	<0.000034				
NS	NS	G	Trib 04																Not sampled			
08/03/16	10:25	G	Trib 11	0.0056	0.000095	0.0015	0.0021	0.0023	<0.00032	0.00058	0.00046	0.00022	<0.000014	0.000038	0.13	0.14	0.00018	0.00043				
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
08/03/16	8:35	G	Trib 24	0.014	<0.000038	0.0024	0.0026	0.0028	0.0006	0.0014	0.00051	0.00052	<0.000014	0.000054	0.22	0.24	0.00029	0.00096				
NS	NS	G	Trib 25																Not sampled			
08/03/16	10:10	G	Trib 27 (New Church Ditch Inlet)	0.0035	0.000085	0.001	0.0018	0.0021	<0.00032	0.00045	0.00092	<0.00015	<0.000014	<0.000014	0.13	0.13	0.00018	0.00034				

Tribs

Method				EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.7	EPA200.7	EPA200.8	EPA200.8				
Reporting Limit Goal				0.00025	0.00020	0.00020	0.00050	0.00050	0.005	0.005	0.00050	0.00050	0.0005	0.0005	0.0020	0.0020	0.00003	0.00003				
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3				
Max decimals				5	5	5	5	5	4	4	5	5	5	5	5	5	5	5				
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Sample Date	Sample Time	Sample Type	Location ID	Copper, Total	Lead, Dissolved	Lead, Total	Molybdenum, Dissolved	Molybdenum, Total	Nickel, Dissolved	Nickel, Total	Selenium, Dissolved	Selenium, Total	Silver, Dissolved	Silver, Total	Strontium Dissolved ICAP	Strontium Total	Vanadium Dissolved ICAP/MS	Vanadium Total ICAP/MS	Notes	Conclusion	Field Notes	Lab Notes
09/14/16	9:20	G	Trib 01	0.0051	0.00018	0.00055	0.0024	0.0028	0.002	0.0012	0.00017	0.00024	<0.000014	<0.000014	0.15	0.18	0.0001	0.00019				
09/14/16	9:40	G	Trib 02	0.0056	0.00018	0.0006	0.0024	0.0022	0.002	0.0012	0.00034	0.00058	<0.000014	<0.000014	0.16	0.18	0.00014	0.00022				
09/14/16	9:50	G	Trib 03	0.0052	0.0002	0.00058	0.0024	0.0022	0.002	0.001	0.00029	0.00059	<0.000014	<0.000014	0.18	0.2	0.00024	0.00027				
NS	NS	G	Trib 04																Not sampled			
09/14/16	10:35	G	Trib 11	0.0041	0.00022	0.0012	0.0025	0.0026	0.0015	0.00086	0.00026	<0.00015	<0.000014	0.00005	0.17	0.19	0.00028	0.00054				
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
09/14/16	8:40	G	Trib 24	0.0076	0.00011	0.0017	0.0022	0.0017	0.0017	0.00089	0.00042	<0.00015	<0.000014	0.000028	0.17	0.2	0.00035	0.00087				
NS	NS	G	Trib 25																Not sampled			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																Not sampled			
10/05/16	9:05	G	Trib 01																			
10/05/16	9:20	G	Trib 02																			
10/05/16	9:35	G	Trib 03																			
NS	NS	G	Trib 04																Not sampled			
10/05/16	10:10	G	Trib 11																			
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
10/05/16	8:25	G	Trib 24																			
NS	NS	G	Trib 25																Not sampled			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																Not sampled			
11/02/16	9:25	G	Trib 01																			
11/02/16	9:45	G	Trib 02																			
11/02/16	10:00	G	Trib 03																			
NS	NS	G	Trib 04																Not sampled			
11/02/16	10:35	G	Trib 11																			
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
11/02/16	8:40	G	Trib 24																			
NS	NS	G	Trib 25																Not sampled			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																Not sampled			
12/07/16	9:25	G	Trib 01	0.0036	0.00012	0.00031	0.0021	0.0017	0.0027	0.003	0.00036	0.00035	<0.000014	0.00002	0.25	0.26	0.000057	0.00016				
NS	NS	G	Trib 02																Not sampled			
12/07/16	9:45	G	Trib 03	0.0051	0.00014	0.00099	0.0021	0.0026	0.0024	0.0032	0.00046	0.00051	<0.000014	0.000041	0.25	0.27	0.00011	0.00038				
12/07/16	10:25	G	Trib 04	0.025	0.00028	0.024	0.0022	0.0022	0.0019	0.0038	0.00063	0.00065	0.000022	0.00033	0.28	0.28	0.00039	0.0032				
NS	NS	G	Trib 11																Not sampled			
NS	NS	G	Trib 22a																Not sampled			
NS	NS	G	Trib 22d																Not sampled			
12/07/16	8:40	G	Trib 24	0.0062	0.000059	0.00056	0.0026	0.0028	0.0011	0.00091	0.00051	0.00078	<0.000014	<0.000014	0.2	0.19	0.00024	0.00028				
NS	NS	G	Trib 25																Not sampled			
NS	NS	G	Trib 27 (New Church Ditch Inlet)																Not sampled			

Ambient Autosamplers (with TH metals)

Method				SM2550B	SM4500H+B	SM2510B	SM2130B	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM4500PE	SM4500PE	SM5310B	SM2540D	EPA200.8	EPA200.8
Reporting Limit Goal				1.0	1.0	10	1.0	0.01	0.01	0.02	0.0025	0.0025	0.5	1	0.00015	0.00015
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3	3
Max decimals				1	1	0	1	2	2	2	4	4	1	0	5	5
Reporting Units				°C	s.u.	µS/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample Date	Sample Time	Sample Type	Location ID	Temp	pH	Conductivity, Specific	Turbidity	Nitrogen, Ammonia (Salicylate)	Nitrogen, Nitrate+Nitrite	Nitrogen, Total Nitrogen	Phosphorus, Dissolved (DRP)	Phosphorus, Total	Carbon, Total Organic	Solids, Total Suspended	Arsenic, Dissolved	Arsenic, Total
05/02/16	0:00	24C	CC AS 26	7.1	7.6	445	1.5	0.03	0.22	0.32	< 0.0025	0.0078	NT	< 5		
05/02/16	8:45	24C	CC AS 49	7.4	7	436	14.3	0.03	0.23	0.35	0.0033	0.0117	NT	< 5		
05/02/16	8:45	24C	CC AS 50	6.3	7.2	420	2.5	0.02	0.38	0.61	0.0039	0.0206	NT	6		
05/03/16	10:40	G	CC AS 59	6.4	6.7	385	11.3	< 0.01	0.35	0.56	0.0039	0.0184	NT	16		
05/02/16	22:15	24C	CC AS T2	13.7	7.8	442	25.8	< 0.01	0.5	0.71	0.0029	0.0389	NT	37		
05/03/16	10:00	24C	CC AS T11	11.1	8.2	542	2.6	0.01	0.28	0.51	0.0172	0.0258	NT	< 5		
05/31/16	8:00	24C	CC AS 26	12.4	7.3	199	4.2	0.03	0.09	0.26	0.0042	0.0103	NT	< 5		
05/31/16	12:00	24C	CC AS 49	13.3	7.4	178	5.4	< 0.01	0.08	0.23	0.003	0.0164	NT	7		
05/31/16	12:00	24C	CC AS 50	12.6	7.2	163	8.7	< 0.01	0.12	0.28	< 0.0025	0.0197	NT	9		
06/01/16	11:15	G	CC AS 59	9.8	7.1	171	14	< 0.01	0.09	0.27	0.0037	0.0266	NT	21		
05/31/16	3:36	24C	CC AS T2	18.6	7.7	207	7.5	< 0.01	0.12	0.28	< 0.0025	0.0165	NT	11		
06/01/16	3:30	24C	CC AS T11	16.5	7.7	222	12.2	0.01	0.13	0.36	0.0039	0.0282	NT	23		
06/27/16	8:00	24C	CC AS 26	19.1	7.2	104	2.7	< 0.01	0.1	0.19	< 0.0025	0.0101	NT	6		
06/27/16	10:45	24C	CC AS 49	19.4	7.2	102	5.9	< 0.01	0.09	0.2	< 0.0025	0.0162	NT	9		
06/27/16	10:45	24C	CC AS 50	19.6	7.2	181	6.4	< 0.01	0.17	0.3	< 0.0025	0.014	NT	6		
06/27/16	14:00	24C	CC AS 59	25.4	7.5	110	3.6	< 0.01	0.1	0.22	< 0.0025	0.0101	NT	<5		
06/27/16	15:00	24C	CC AS T2	27.6	7.6	117	4.8	< 0.01	0.1	0.21	0.0041	0.0129	NT	11		
06/27/16	22:20	24C	CC AS T11	23.4	7.5	124	17.7	< 0.01	0.11	0.28	0.0046	0.0307	NT	43		
07/26/16	8:00	24C	CC AS 26	13.8	7.8	154	2.4	0.01	0.1	0.23	< 0.0025	0.006	1.3	< 5		
07/26/16	14:15	24C	CC AS 49	20.8	7.5	166	4.8	< 0.01	0.11	0.3	< 0.0025	0.0149	1.8	9		
07/26/16	14:15	24C	CC AS 50	20.7	7.6	406	22.5	0.01	0.55	0.85	< 0.0025	0.0192	2.6	11		
07/27/16	11:25	G	CC AS 59	14.9	7.4	181	2.1	0.01	0.11	0.28	< 0.0025	0.0077	1.3	< 5		
07/27/16	23:50	24C	CC AS T2	26.9	7.8	192	1.6	< 0.01	0.14	0.34	< 0.0025	0.0082	1.6	< 5		
07/27/16	8:00	24C	CC AS T11	23.4	7.4	200	7.8	0.01	0.14	0.31	< 0.0025	0.0189	1.5	18		
08/30/16	11:50	G	CC AS 26	11.3	7.5	226	1	0.02	0.1	0.22	< 0.0025	0.0073	1.3	< 5		
08/30/16	12:15	24C	CC AS 49	16.3	7.8	211	2.5	< 0.01	0.11	0.26	< 0.0025	0.0101	1.9	< 5		
08/30/16	12:15	24C	CC AS 50	16.7	7.7	584	35.8	0.03	0.39	0.78	< 0.0025	0.0135	2.4	11		
08/30/16	22:00	24C	CC AS 59	21.6	7.7	231	2.3	0.12	0.13	0.42	< 0.0025	0.0142	3.7	39		
08/31/16	1:00	24C	CC AS T2	21.8	7.6	240	278	0.02	0.21	2.27	0.0103	0.218	2.9	480		
08/31/16	10:45	24C	CC AS T11	21	7.5	250	5.9	0.01	0.11	0.32	< 0.0025	0.0218	2	31		
09/27/16	23:00	24C	CC AS 26	11.6	7.9	285	1.3	0.02	0.14	0.21	0.0033	0.0084	1.5	<5		
09/28/16	9:30	24C	CC AS 49	16.4	8	276	2	< 0.01	0.13	0.21	0.0029	0.0074	2.6	<5		
09/28/16	9:30	24C	CC AS 50	14.9	7.6	739	23.4	0.02	0.47	0.62	< 0.0025	0.0091	2.3	7		
09/28/16	22:00	24C	CC AS 59	18.2	8.1	297	1.2	0.01	0.14	0.2	0.0027	0.0051	2.3	<5		
09/28/16	1:45	24C	CC AS T2	22	8	310	1.8	< 0.01	0.15	0.22	< 0.0025	0.0074	1.5	8		
09/29/16	12:30	24C	CC AS T11	18.9	8	322	9.1	0.01	0.13	0.27	0.0027	0.0204	1.5	22		
10/25/16	23:00	24C	CC AS 26	9.1	7.3	319	1	0.03	0.18	0.28	< 0.0025	0.0051	1.3	3		
10/26/16	10:40	24C	CC AS 49	11.1	7.4	314	1.1	0.01	0.14	0.24	< 0.0025	0.0073	1.8	3		
10/26/16	10:40	24C	CC AS 50	9.2	7	838	112	< 0.01	0.36	0.54	< 0.0025	0.0149	2.9	47		
10/27/16	10:45	G	CC AS 59	4.5	7.6	366	2	0.01	0.17	0.24	< 0.0025	0.0041	1.2	3		
10/27/16	5:00	24C	CC AS T2	14.4	7.6	376	1.9	0.01	0.17	0.25	< 0.0025	0.0048	1.4	<1		
10/27/16	15:30	24C	CC AS T11	18.3	8.1	384	7.6	0.01	0.13	0.25	< 0.0025	0.023	1.7	21		

Ambient Autosamplers (with TH r

Method				EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.7	EPA200.7	EPA200.8	EPA200.8
Reporting Limit Goal				0.00010	0.00010	0.00005	0.00005	0.00010	0.00010	0.00050	0.00050	0.00025	0.00025	0.01	0.01	0.00020	0.00020
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3	3	3
Max decimals				5	5	5	5	5	5	5	5	5	5	3	3	5	5
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample Date	Sample Time	Sample Type	Location ID	Barium, Dissolved	Barium, Total	Beryllium dissolved	Beryllium Total	Cadmium, Dissolved	Cadmium, Total	Chromium, Dissolved	Chromium, Total	Copper, Dissolved	Copper, Total	Iron, Dissolved	Iron, Total	Lead, Dissolved	Lead, Total
05/02/16	0:00	24C	CC AS 26					0.00028	0.00031			0.0022	0.0046	0.032	0.28	0.00027	0.0014
05/02/16	8:45	24C	CC AS 49					0.002	0.0022			0.012	0.034	0.0096	0.42	0.00011	0.0024
05/02/16	8:45	24C	CC AS 50					0.0026	0.0038			0.015	0.097	0.14	4	0.00013	0.0048
05/03/16	10:40	G	CC AS 59					0.0014	0.002			0.0097	0.037	0.095	1.6	0.00021	0.0035
05/02/16	22:15	24C	CC AS T2					0.00062	0.0013			0.0066	0.027	0.045	2.9	0.00012	0.0034
05/03/16	10:00	24C	CC AS T11					0.00026	0.00046			0.0066	0.012	0.031	0.29	0.000084	0.0007
05/31/16	8:00	24C	CC AS 26					0.00019	0.00027			0.0026	0.0039	0.081	0.33	0.0005	0.0017
05/31/16	12:00	24C	CC AS 49					0.00046	0.00061			0.0083	0.017	0.093	0.61	0.00052	0.0026
05/31/16	12:00	24C	CC AS 50					0.0011	0.0014			0.021	0.036	0.92	2.1	0.0011	0.0031
06/01/16	11:15	G	CC AS 59					0.00043	0.001			0.008	0.028	0.19	2.1	0.00079	0.0073
05/31/16	3:36	24C	CC AS T2					0.00042	0.00069			0.0082	0.018	0.18	0.83	0.00061	0.0028
06/01/16	3:30	24C	CC AS T11					0.00016	0.00064			0.006	0.017	0.15	1.4	0.0005	0.0041
06/27/16	8:00	24C	CC AS 26														
06/27/16	10:45	24C	CC AS 49														
06/27/16	10:45	24C	CC AS 50														
06/27/16	14:00	24C	CC AS 59														
06/27/16	15:00	24C	CC AS T2														
06/27/16	22:20	24C	CC AS T11														
07/26/16	8:00	24C	CC AS 26					0.000095	0.00012			0.00092	0.00059	0.052	0.096	0.00036	0.00081
07/26/16	14:15	24C	CC AS 49					0.00013	0.00041			0.0024	0.0055	0.03	0.7	0.00019	0.0013
07/26/16	14:15	24C	CC AS 50					0.00074	0.0016			0.0048	0.044	0.021	5.6	0.000052	0.0034
07/27/16	11:25	G	CC AS 59					0.00021	0.00022			0.0026	0.0032	0.031	0.12	0.00017	0.00054
07/27/16	23:50	24C	CC AS T2					0.00012	0.00024			0.0024	0.0055	0.024	0.26	0.00016	0.00088
07/27/16	8:00	24C	CC AS T11					0.000089	0.00031			0.0024	0.0069	0.024	0.91	0.00015	0.0025
08/30/16	11:50	G	CC AS 26														
08/30/16	12:15	24C	CC AS 49														
08/30/16	12:15	24C	CC AS 50														
08/30/16	22:00	24C	CC AS 59														
08/31/16	1:00	24C	CC AS T2														
08/31/16	10:45	24C	CC AS T11														
09/27/16	23:00	24C	CC AS 26														
09/28/16	9:30	24C	CC AS 49														
09/28/16	9:30	24C	CC AS 50														
09/28/16	22:00	24C	CC AS 59														
09/28/16	1:45	24C	CC AS T2														
09/29/16	12:30	24C	CC AS T11														
10/25/16	23:00	24C	CC AS 26					0.00014	0.0002			0.0012	0.0014	0.054	0.16	0.00026	0.00069
10/26/16	10:40	24C	CC AS 49					0.00037	0.00044			0.0037	0.0062	0.027	0.092	0.00017	0.00052
10/26/16	10:40	24C	CC AS 50					0.0024	0.0043			0.0058	0.12	0.021	19	0.000053	0.0091
10/27/16	10:45	G	CC AS 59					0.00034	0.0004			0.0029	0.005	0.046	0.2	0.00011	0.00036
10/27/16	5:00	24C	CC AS T2					0.00032	0.00052			0.0028	0.011	0.017	1.3	0.000074	0.0047
10/27/16	15:30	24C	CC AS T11					0.00011	0.00039			0.0022	0.0062	0.029	0.19	0.0001	0.00036

Ambient Autosamplers (with TH r

Method				EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.7	EPA200.7	EPA200.8	EPA200.8
Reporting Limit Goal				0.00025	0.00025	0.00050	0.00050	0.00032	0.00032	0.00050	0.00050	0.00001	0.00001	0.00200	0.00200	0.00003	0.00003
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3	3	3
Max decimals				5	5	5	5	5	5	5	5	5	5	5	5	5	5
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample Date	Sample Time	Sample Type	Location ID	Manganese, Dissolved	Manganese, Total	Molybdenum, Dissolved	Molybdenum, Total	Nickel dissolved	Nickel Total	Selenium, Dissolved	Selenium, Total	Silver dissolved	Silver Total	Strontium Dissolved ICAP	Strontium ICAP	Vanadium Dissolved	Vanadium Total
05/02/16	0:00	24C	CC AS 26	0.18	0.24												
05/02/16	8:45	24C	CC AS 49	0.61	0.71												
05/02/16	8:45	24C	CC AS 50	0.94	0.96												
05/03/16	10:40	G	CC AS 59	0.38	0.55												
05/02/16	22:15	24C	CC AS T2	0.16	0.48												
05/03/16	10:00	24C	CC AS T11	0.011	0.11												
05/31/16	8:00	24C	CC AS 26	0.04	0.15												
05/31/16	12:00	24C	CC AS 49	0.11	0.23												
05/31/16	12:00	24C	CC AS 50	0.35	0.42												
06/01/16	11:15	G	CC AS 59	0.084	0.39												
05/31/16	3:36	24C	CC AS T2	0.089	0.22												
06/01/16	3:30	24C	CC AS T11	0.0026	0.2												
06/27/16	8:00	24C	CC AS 26														
06/27/16	10:45	24C	CC AS 49														
06/27/16	10:45	24C	CC AS 50														
06/27/16	14:00	24C	CC AS 59														
06/27/16	15:00	24C	CC AS T2														
06/27/16	22:20	24C	CC AS T11														
07/26/16	8:00	24C	CC AS 26	0.015	0.04												
07/26/16	14:15	24C	CC AS 49	0.00083	0.076												
07/26/16	14:15	24C	CC AS 50	1.3	1.5												
07/27/16	11:25	G	CC AS 59	0.047	0.067												
07/27/16	23:50	24C	CC AS T2	0.00078	0.076												
07/27/16	8:00	24C	CC AS T11	0.00085	0.075												
08/30/16	11:50	G	CC AS 26														
08/30/16	12:15	24C	CC AS 49														
08/30/16	12:15	24C	CC AS 50														
08/30/16	22:00	24C	CC AS 59														
08/31/16	1:00	24C	CC AS T2														
08/31/16	10:45	24C	CC AS T11														
09/27/16	23:00	24C	CC AS 26														
09/28/16	9:30	24C	CC AS 49														
09/28/16	9:30	24C	CC AS 50														
09/28/16	22:00	24C	CC AS 59														
09/28/16	1:45	24C	CC AS T2														
09/29/16	12:30	24C	CC AS T11														
10/25/16	23:00	24C	CC AS 26	0.086	0.1												
10/26/16	10:40	24C	CC AS 49	0.093	0.11												
10/26/16	10:40	24C	CC AS 50	3.9	4.1												
10/27/16	10:45	G	CC AS 59	0.12	0.13												
10/27/16	5:00	24C	CC AS T2	0.088	0.16												
10/27/16	15:30	24C	CC AS T11	0.0071	0.11												

Ambient Autosamplers (with TH r

Method				EPA200.8	EPA200.8				
Reporting Limit Goal				0.0025	0.0025				
Max Sig figs				3	3				
Max decimals				4	4				
Reporting Units				mg/L	mg/L				
Sample Date	Sample Time	Sample Type	Location ID	Zinc, Dissolved	Zinc, Total	Notes	Conclusion	Field Notes	Lab Notes
05/02/16	0:00	24C	CC AS 26	0.086	0.12	Start time 0100 on 05/01/16, end time 0000 on 05/02/16.			
05/02/16	8:45	24C	CC AS 49	0.39	0.47	Start time 0945 on 05/01/16, end time 0845 on 05/02/16.			
05/02/16	8:45	24C	CC AS 50	0.54	0.87	Start time 0945 on 05/01/16, end time 0845 on 05/02/16.			
05/03/16	10:40	G	CC AS 59	0.23	0.42	Grab sample			
05/02/16	22:15	24C	CC AS T2	0.1	0.3	Start time 2315 on 05/01/16, end time 2215 on 05/02/16.			
05/03/16	10:00	24C	CC AS T11	0.028	0.083	Start time 1100 on 05/02/16, end time 1000 on 05/03/15.			
05/31/16	8:00	24C	CC AS 26	0.058	0.094	Start time 0900 on 05/30/16, end time 0800 on 05/31/16.			
05/31/16	12:00	24C	CC AS 49	0.1	0.16	Start time 1300 on 05/30/16, end time 1200 on 05/31/16.			
05/31/16	12:00	24C	CC AS 50	0.29	0.34	Start time 1300 on 05/30/16, end time 1200 on 05/31/16.			
06/01/16	11:15	G	CC AS 59	0.088	0.26	Grab sample			
05/31/16	3:36	24C	CC AS T2	0.085	0.16	Start time 1915 on 05/30/16, end time 1815 on 05/31/16.			
06/01/16	3:30	24C	CC AS T11	0.054	0.14	Start time 0430 on 05/31/16, end time 0330 on 06/01/16.			
06/27/16	8:00	24C	CC AS 26	[redacted]	[redacted]	Start time 0900 on 06/26/16, end time 0800 on 06/27/16.			
06/27/16	10:45	24C	CC AS 49	[redacted]	[redacted]	Start time 1145 on 06/26/16, end time 1045 on 06/27/16.			
06/27/16	10:45	24C	CC AS 50	[redacted]	[redacted]	Start time 1145 on 06/26/16, end time 1045 on 06/27/16.			
06/27/16	14:00	24C	CC AS 59	[redacted]	[redacted]	Start time 1500 on 06/26/16, end time 1400 on 06/27/16.			
06/27/16	15:00	24C	CC AS T2	[redacted]	[redacted]	Start time 1600 on 06/26/16, end time 1500 on 06/27/16.			
06/27/16	22:20	24C	CC AS T11	[redacted]	[redacted]	Start time 2320 on 06/26/16, end time 2220 on 06/27/16.			
07/26/16	8:00	24C	CC AS 26	0.029	0.038	Start time 0900 on 7/25/16, end time 0800 on 7/26/16.			
07/26/16	14:15	24C	CC AS 49	0.036	0.09	Start time 15:15 on 7/25/16, end time 14:15 on 7/26/16.			
07/26/16	14:15	24C	CC AS 50	0.3	0.58	Start time 15:15 on 7/25/16, end time 14:15 on 7/26/16.			
07/27/16	11:25	G	CC AS 59	0.057	0.068	Grab sample			
07/27/16	23:50	24C	CC AS T2	0.044	0.065	Start time 0:50 on 7/26/16, end time 23:50 on 7/27/16.			
07/27/16	8:00	24C	CC AS T11	0.05	0.063	Start time 09:00 on 7/26/16, end time 08:00 on 7/27/16.			
08/30/16	11:50	G	CC AS 26	[redacted]	[redacted]			Sample line was out of the water. Grab sample collected.	
08/30/16	12:15	24C	CC AS 49	[redacted]	[redacted]	Start time 1315 on 8/29/16, end time 1215 on 8/30/16.			
08/30/16	12:15	24C	CC AS 50	[redacted]	[redacted]	Start time 1315 on 8/29/16, end time 1215 on 8/30/16.			
08/30/16	22:00	24C	CC AS 59	[redacted]	[redacted]	Start time 2300 on 8/29/16, end time 2200 on 8/30/16.			
08/31/16	1:00	24C	CC AS T2	[redacted]	[redacted]	Start time 0200 on 8/30/16, end time 0100 on 8/31/16.			
08/31/16	10:45	24C	CC AS T11	[redacted]	[redacted]	Start time 1145 on 8/30/16, end time 1045 on 8/31/16.			Large solids storm event at cc as T2; we missed it by about 8 hours with the ccast11 sample.
09/27/16	23:00	24C	CC AS 26	[redacted]	[redacted]	Start time 0000 on 9/27/16, end time 2300 on 9/27/16			
09/28/16	9:30	24C	CC AS 49	[redacted]	[redacted]	Start time 1030 on 9/27/16, end time 0930 on 9/28/16.			
09/28/16	9:30	24C	CC AS 50	[redacted]	[redacted]	Start time 1030 on 9/27/16, end time 0930 on 9/28/16.			
09/28/16	22:00	24C	CC AS 59	[redacted]	[redacted]	Start time 2300 on 9/27/16, end time 2200 on 09/27/16			
09/28/16	1:45	24C	CC AS T2	[redacted]	[redacted]	Start time 0245 on 9/28/16, end time 0145 on 9/29/16.			
09/29/16	12:30	24C	CC AS T11	[redacted]	[redacted]	Start time 1330 on 9/28/16, end time 1230 on 9/29/16			
10/25/16	23:00	24C	CC AS 26	0.042	0.054	Start time 0000 on 10/25/16, end time 2300 on 10/25/16			
10/26/16	10:40	24C	CC AS 49	0.085	0.1	Start time 1140 on 10/25/16, end time 1040 on 10/26/16.			
10/26/16	10:40	24C	CC AS 50	1.1	1.7	Start time 1140 on 10/25/16, end time 1040 on 10/26/16.			
10/27/16	10:45	G	CC AS 59	0.096	0.11	Grab sample collected			
10/27/16	5:00	24C	CC AS T2	0.075	0.11	Start time 0600 on 10/26/16, end time 0500 on 10/27/16.			
10/27/16	15:30	24C	CC AS T11	0.03	0.095	Start time 1630 on 10/26/16, end time 1530 on 10/27/16			

Event Autosamplers

Method				SM2550B	SM4500H+B	SM2510B	SM2130B	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM4500PE	SM4500PE	SM4500NH3H	EPA 300.0	SM4500NorgB	Calc	SM4500PE	SM4500PE	SM5310B	SM2540D	EPA200.8
DL				1.0	1.0	10	1.0	0.01	0.01	0.02	0.0025	0.0025	0.05	0.02	0.01	0.10	0.01	0.01	0.5	1	0.00015
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Max decimals				1	1	0	1	2	2	2	4	4	2	2	2	2	2	2	1	0	5
Reporting Units				°C	s.u.	µS/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample Date	Sample Time	Sample Type	Location ID	Temp	pH	Conductivity, Specific	Turbidity	Nitrogen, Ammonia (Salicylate)	Nitrogen, Nitrate+Nitrite	Nitrogen, Total Nitrogen	Phosphorus, Dissolved (DRP)	Phosphorus, Total	Nitrogen, Ammonia	Nitrogen, Nitrate+Nitrite	Nitrogen, Total Kjeldahl	Nitrogen, Total Nitrogen	Phosphorous, Dissolved (SRP)	Phosphorous, Total	Carbon, Total Organic	Solids, Total Suspended	Arsenic, Dissolved
04/11/16	0:00	CE	CC AS T2	11.9	7.6	460	10.4				< 0.0025	0.0121	NT	NT	NT	NT	NA	NA	NT	12	0.00011
04/11/16	0:00	CE	CC AS T11	11.3	7.8	480	7				< 0.0025	0.023	NT	NT	NT	NT	NA	NA	NT	8	0.00054
11/04/16	19:30	CE	CC AS T3	16.2	7.9	389	1.6	0.01	0.27	0.37	< 0.0025	0.0074							1.5	8	0.00032
11/05/16	7:30	CE	CC AS T4	12.7	7.9	358	15.4	0.01	0.13	0.37	0.0075	0.0512							LE	34	0.0013

Event Autosamplers

Method				**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.7**	**EPA200.7**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**
DL				**0.00015**	**0.00010**	**0.00010**	**0.00010**	**0.00010**	**0.00010**	**0.00010**	**0.00050**	**0.00050**	**0.00025**	**0.00025**	**0.01**	**0.01**	**0.00020**	**0.00020**	**0.00025**	**0.00025**	**0.00050**	**0.00050**	**0.00050**	**0.00050**
Max Sig figs				**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Max decimals				**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**3**	**3**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Reporting Units				**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Sample Date	**Sample Time**	**Sample Type**	**Location ID**	**Arsenic, Total**	**Barium, Dissolved**	**Barium, Total**	**Beryllium, Dissolved**	**Beryllium, Total**	**Cadmium, Dissolved**	**Cadmium, Total**	**Chromium, Dissolved**	**Chromium, Total**	**Copper, Dissolved**	**Copper, Total**	**Iron, Dissolved**	**Iron, Total**	**Lead, Dissolved**	**Lead, Total**	**Manganese, Dissolved**	**Manganese, Total**	**Molybdenum, Dissolved**	**Molybdenum, Total**	**Nickel, Dissolved**	**Nickel, Total**
04/11/16	0:00	**CE**	**CC AS T2**	0.00014	0.049	0.059	<0.000054	0.000079	0.00034	0.00079	<0.000088	0.0012	0.0035	0.02	0.018	1.2	0.000058	0.0027	0.11	0.26	0.0025	0.0025	0.0017	0.0031
04/11/16	0:00	**CE**	**CC AS T11**	0.00034	0.044	0.051	<0.000054	<0.000054	0.00018	0.00029	<0.000088	0.00044	0.0029	0.0071	0.014	0.44	0.000062	0.0017	0.0018	0.057	0.0025	0.0026	0.001	0.0015
11/04/16	19:30	**CE**	**CC AS T3**	0.00036	0.046	0.043	<0.000054	<0.000054	0.0002	0.00035	0.0001	0.000099	0.0023	0.0052	0.012	0.16	0.000083	0.00078	0.011	0.082	0.0021	0.002	0.0028	0.003
11/05/16	7:30	**CE**	**CC AS T4**	0.0017	0.056	0.07	<0.000054	<0.000054	0.000073	0.00043	0.0007	0.005	0.0023	0.016	0.015	1.4	0.00023	0.012	0.00063	0.18	0.003	0.003	0.0057	0.007

Event Autosamplers

Method				EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.7	EPA200.7	EPA200.8	EPA200.8	EPA200.8	EPA200.8	SM9221D				
DL				0.00050	0.00050							0.0025	0.0025	1				
Max Sig figs				3	3							3	3	3				
Max decimals				5	5							4	4	0				
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	cfu/100mL				
Sample Date	Sample Time	Sample Type	Location ID	Selenium, Dissolved	Selenium, Total	Silver, Dissolved	Silver, Total	Strontium, Dissolved	Strontium, Total	Vanadium, Dissolved	Vanadium, Total	Zinc, Dissolved	Zinc, Total	E. coli,	Notes	Conclusion	Field Notes	Lab Notes
04/11/16	0:00	CE	CC AS T2	0.00076	<0.00015	<0.000014	0.000029	0.26	0.28	0.00015	0.00081	0.079	0.2	NT	Bottles 1-12. Start time 0100 on 04/10/16, end time 0000 on 04/11/16.			SGS. Hardness = 160 mg/L
04/11/16	0:00	CE	CC AS T11	0.0018	<0.00015	<0.000014	0.000015	0.31	0.29	0.00015	0.00053	0.036	0.062	NT	Bottles 1-12. Start time 0100 on 04/10/16, end time 0000 on 04/11/16.	Westy didn't recieve nitrogen sample so labeled NT		SGS. Hardness = 170 mg/L
11/04/16	19:30	CE	CC AS T3	0.00042	0.00046	0.00002	0.000042	0.23	0.25	0.00027	0.00034	0.052	0.083	NT	First Flush. Bottles 1-12 collected 24 hourly samples. Start time 2030 on 11/03/16, end time 1930 on 11/04/16			
11/05/16	7:30	CE	CC AS T4	0.0006	<0.00015	0.000019	0.00015	0.32	0.34	0.00078	0.0023	0.024	0.1	NT	First Flush. Bottles 1-12 collected 24 hourly samples. Start time 0830 on 11/04/16, end time 0730 on 11/05/16			TOC Broken no results

Clear Creek Event Autosamplers - Metals (Golden)

Method				EPA200.7	EPA200.7	EPA200.7	EPA200.7	EPA200.7	EPA200.7	EPA200.7	EPA200.7	EPA200.7	EPA200.7	EPA200.7	EPA200.7	EPA200.7
DL				variable	variable	variable	variable	variable	variable	0.004	0.004	0.01	0.01	0.001	0.001	0.030
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample Date	Sample Time	Sample Type	Location ID	Cadmium, Dissolved	Cadmium, Total	Chromium, Dissolved	Chromium, Total	Copper, Dissolved	Copper, Total	Iron, Dissolved	Iron, Total	Lead, Dissolved	Lead, Total	Manganese, Dissolved	Manganese, Total	Zinc, Dissolved
7/20/2016		CE	CC59	<0.001	0.002	NT	NT	0.003	0.054	0.05	8.42	<0.01	0.045	0.126	0.378	0.029
7/23/2016		CE	CC59	<0.001	0.005	NT	NT	<0.002	0.06	0.04	27.23	<0.01	0.03	<0.02	0.32	<0.02
8/17/2016		CE	CC59	<0.001	0.002	NT	NT	0.003	0.056	0.027	9.6	<0.01	0.15	0.114	0.42	0.058
8/30/2016		CE	CC59	<0.001	0.007	NT	NT	<0.002	0.075	0.102	38.26	<0.01	0.154	0.029	1.71	<0.02

Clear Creek Event Autosample

Method				EPA200.7	SM5310B	Contractor	Contractor	Contractor	Contractor	Contractor				
DL				0.030	0.5									
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Sample Date	Sample Time	Sample Type	Location ID	Zinc, Total	Carbon, Total Organic	Nitrogen - Ammonia (Auto. Phenate)	Nitrogen - TKN Kjeldahl	NO2/NO3 as N. 353.2	Phosphorus - Total, Auto Asc. Acid Red.	Solids - Total Suspended, 105	Notes	Conclusion	Field Notes	Lab Notes
7/20/2016		CE	CC59	0.257	2.97	<0.05	0.5	0.12	0.17	152				
7/23/2016		CE	CC59	0.32	3.58	<0.05	1.5	0.14	0.47	492				
8/17/2016		CE	CC59	0.36	2.22	0.11	0.4	0.22	0.11	134				
8/30/2016		CE	CC59	0.306	8.21	<0.05	10.3	0.35	1.37	1240				

Standley Lake

Sample Date	Sample Time	Sample Type	Location ID	Chlorophyll a, Field	Conductivity, Specific	ORP Oxidation Reduction Potential	Oxygen, Dissolved	pH	Temp	Turbidity	Secchi Depth,	Nitrogen, Ammonia (Salicylate)	Nitrogen, Nitrate+Nitrite	Nitrogen, Total Nitrogen	Algae	Chlorophyll a, Lab (Methanol)	UV 254	Gross Alpha	Gross Alpha, Uncertainty
Method				electrode	SM2510B	electrode	SM4500OG	SM4500H+B	SM2550B	SM2130B	Secchi Disk	SM4500NH3H	SM4500NO3I	SM4500NO3I	FlowCAM	SM10200H	SM5910B	SM7110B	SM7110B
DL				1.0	10	1	1.0	1.0	1.0	1.0	0.1	0.01	0.01	0.02	1	1.0	0.001	variable	variable
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	4	3	3	2	2
Max decimals				1	0	0	1	1	1	1	2	2	2	2	0	1	3	1	1
Reporting Units				µg/L	µS/cm	mv	mg/L	s.u.	°C	NTU	m	mg/L	mg/L	mg/L	ct/mL	µg/L	10 cm^{-1}	pCi/L	pCi/L
03/01/16		G	SL 10-00	1.5	394	401	10.8	8	2.8	1.8	3							1.4	1.8
03/01/16		C	SL 10-PZ									0.03	0.07	0.28	408	3.1	0.308	3.1	2.2
03/01/16		G	SL 10-70	4.5	397	384	10.6	8	2.7	1.8		0.03	0.07	0.32			0.318	1.8	1.4
03/16/16		G	SL 10-00	< 1	403	354	10.5	7.7	3.9	1.2	4.2								
03/16/16		C	SL 10-PZ									0.05	0.06	0.36	208	1.7	0.297		
03/16/16		G	SL 10-70	4.8	416	342	10.2	7.8	3.1	2.8		0.02	0.07	0.23			0.295		
04/04/16		G	SL 10-00	< 1	424	332	10.4	7.7	6.3	1.5	4.7								
04/04/16		C	SL 10-PZ									0.03	0.07	0.22	257	2.1	0.3		
04/04/16		G	SL 10-70	4.4	417	326	9.7	7.7	3.6	4.3		0.04	0.07	0.24			0.296		
04/20/16		G	SL 10-00	< 1	414	367	10.1	8	7	1.6	4.2								
04/20/16		C	SL 10-PZ									0.04	0.07	0.46	235	2.5	0.284		
04/20/16		G	SL 10-70	5	413	355	9.1	8	5.9	3.7		0.04	0.05	0.26			0.287		
05/09/16		G	SL 10-00	< 1	420	212	9.9	8	9.5	1.9	3.7								
05/09/16		C	SL 10-PZ									0.03	0.03	0.28	338	5.8	0.312		
05/09/16		G	SL 10-70	8.6	421	207	9	8	6.6	5.6		0.04	0.04	0.3			0.301		
05/23/16		G	SL 10-00	1.1	414	170	9.5	8.1	13.1	1.5	3.7								
05/23/16		C	SL 10-PZ									0.03	0.02	0.26	242	4.5	0.34		
05/23/16		G	SL 10-70	6.4	416	178	7.8	8.1	7.3	3.4		0.07	0.05	0.29			0.31		
06/06/16		G	SL 10-00	< 1	406	294	8.7	8.3	17.4	1.3	4							2.7	1.9
06/06/16	11:15	C	SL 10-PZ									0.01	< 0.01	0.27	365	4.8	0.35	0.9	1.6
06/06/16	11:35	G	SL 10-70	1.9	417	298	5.3	8.1	7.2	3.9		0.13	0.04	0.37			0.302	2.4	1.9
06/20/16		G	SL 10-00	< 1	383	233	7.8	8.3	19.8	1.1	4.9								
06/20/16		C	SL 10-PZ									0.01	< 0.01	0.23	265	2.3	0.416		
06/20/16		G	SL 10-70	< 1	414	200	3.4	7.3	7.6	4.4		0.13	0.04	0.43			0.31		
07/05/16		G	SL 10-00	< 1	361	200	7.8	8.3	20.2	1	5.1								
07/05/16		C	SL 10-PZ									0.03	<0.01	0.2	156	2.5	0.403		
07/05/16	11:30	G	SL 10-70	< 1	413	197	2	7.3	7.9	3.8		0.31	0.05	0.56			0.32		
07/25/16	11:45	G	SL 10-00	< 1	347	170	7.6	8.4	21.3	< 1	5.8								
07/25/16		C	SL 10-PZ									0.03	< 0.01	0.3	117	2.9	0.382		
07/25/16		G	SL 10-70	< 1	412	181	< 1	7.1	8.6	9.8		0.13	0.18	0.65			0.313		
07/25/16		G	69-00																
08/08/16		G	SL 10-00	< 1	341	266	7.5	8.5	21	1	5.5								
08/08/16		C	SL 10-PZ									0.04	0.01	0.25	78	2.1	0.365		
08/08/16		G	SL 10-70	< 1	411	204	< 1	7.1	9.1	9.1		0.04	0.27	0.58			0.306		
08/23/16		G	SL 10-00	< 1	336	305	7.5	8.4	20.4	1	5.4								
08/23/16	11:30	C	SL 10-PZ									0.04	< 0.01	0.24	237	1.4	0.371		
08/23/16	12:00	G	SL 10-70	< 1	413	251	< 1	7.3	9.4	4.6		0.23	0.15	0.59			0.323		
09/06/16		G	SL 10-00	< 1	332	361	7.6	8.2	19	1.6	3.9							1.5	1.4
09/06/16	11:30	C	SL 10-PZ									0.02	< 0.01	0.14	139	1.7	0.355	1	1.6
09/06/16	12:00	G	SL 10-70	< 1	409	124	< 1	7.3	10.5	5.6		0.2	0.11	0.43			0.34	1.7	1.9
09/19/16		G	SL 10-00	< 1	333	326	7.5	8.2	17.7	1.7	3.7								
09/19/16		C	SL 10-PZ									0.03	< 0.01	0.17	148	2.7	0.351		
09/19/16		G	SL 10-70	< 1	415	109	< 1	7.3	10	5.9		0.1	< 0.01	0.24			0.344		
10/10/16		G	SL 10-00	5.8	339	345	8.2	8.1	12.8	2.6	2.3								
10/10/16	10:00	C	SL 10-PZ									0.04	0.01	0.23	212	4.5	0.345		
10/11/16	8:50	G	SL 10-70	6	338	310	7.7	7.9	12.5	8.4		0.02	< 0.01	0.2			0.33		
10/24/16		G	SL 10-00	7	337	337	8.2	8.1	12.7	3	2.3								
10/24/16		C	SL 10-PZ									0.02	< 0.01	0.16	522	6.6	NT		
10/24/16		G	SL 10-70	6	338	310	7.7	7.9	12.5	8.4		0.04	< 0.01	0.2			NT		
11/08/16		G	SL 10-00	< 1	340	338	8.4	8	12	3	2.1								

Standley Lake																			
Method				electrode	SM2510B	electrode	SM4500OG	SM4500H+B	SM2550B	SM2130B	Secchi Disk	SM4500NH3H	SM4500NO3I	SM4500NO3I	FlowCAM	SM10200H	SM5910B	SM7110B	SM7110B
DL				1.0	10	1	1.0	1.0	1.0	1.0	0.1	0.01	0.01	0.02	1	1.0	0.001	variable	variable
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	4	3	3	2	2
Max decimals				1	0	0	1	1	1	1	2	2	2	2	0	1	3	1	1
Reporting Units				µg/L	µS/cm	mv	mg/L	s.u.	°C	NTU	m	mg/L	mg/L	mg/L	ct/mL	µg/L	$10\ cm^{-1}$	pCi/L	pCi/L
Sample Date	Sample Time	Sample Type	Location ID	Chlorophyll a, Field	Conductivity, Specific	ORP Oxidation Reduction Potential	Oxygen, Dissolved	pH	Temp	Turbidity	Secchi Depth,	Nitrogen, Ammonia (Salicylate)	Nitrogen, Nitrate+Nitrite	Nitrogen, Total Nitrogen	Algae	Chlorophyll a, Lab (Methanol)	UV 254	Gross Alpha	Gross Alpha, Uncertainty
11/08/16		C	SL 10-PZ									0.03	< 0.01	0.18	118	4.5	NT		
11/08/16		G	SL 10-70	3.5	341	304	8.1	7.9	11.3	7.8		0.02	< 0.01	0.16			NT		
11/21/16		G	SL 10-00	< 1	324	351	8.6	8	9.8	2.4	2.8								
11/21/16	11:30	C	SL 10-PZ									0.02	0.01	0.2	203	1.9	NT		
11/21/16	12:00	G	SL 10-70	1.2	360	336	7.7	7.8	8.9	11		0.02	0.02	0.21			NT		
12/06/16		G	SL 10-00	3.8	351	197	9.7	8	4.8	2.4	3							1.6	1.7
12/06/16	10:40	C	SL 10-PZ									0.02	0.03	0.27	182	2.3	0.323	0.4	1.5
12/06/16	10:00	G	SL 10-70	4.3	352	194	9.5	8	4.7	2.3		0.02	0.03	0.3			0.321	0.7	1.5
12/27/16		G	SL 10-00	1.2	364	383	11.3	8.1	1	2.8	2.4								
12/27/16	11:30	C	SL 10-PZ									0.04	0.03	0.29	173	4.6	0.33		
12/27/16	12:00	G	SL 10-70	13.2	364	365	10.8	8.1	1.5	3.2		0.02	0.03	0.26			0.315		

Standley Lake

Sample Date	Sample Time	Sample Type	Location ID	Gross Beta	Gross Beta, Uncertainty	Phosphorus, Dissolved (DRP)	Phosphorus, Total	Arsenic, Dissolved	Arsenic, Total	Barium, Dissolved	Barium, Total	Beryllium, Dissolved	Beryllium, Total	BTEX, Benzene	BTEX, Ethylbenzene	BTEX, Toluene	BTEX, Xylenes	Cadmium, Dissolved	Cadmium, Total	Carbon, Total Organic	Chromium, Dissolved
Method				SM7110B	SM7110B	SM4500PE	SM4500PE	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA524.2	EPA524.2	EPA524.2	EPA524.2	EPA200.8	EPA200.8	SM5310B	EPA200.8
DL				variable	variable	0.0025	0.0025	0.00015	0.00015	0.00010	0.00010	0.00015	0.00015	0.0005	0.0005	0.0005	0.0005	0.00010	0.00010	0.5	0.00050
Max Sig figs				2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Max decimals				1	1	4	4	5	5	5	5	4	4	4	4	4	4	5	5	1	5
Reporting Units				pCi/L	pCi/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
03/01/16		G	SL 10-00	1.1	2.2																
03/01/16		C	SL 10-PZ	0	2.2	< 0.0025	0.01	NT	NT	NT	NT	NT	NT					NT	NT	NT	NT
03/01/16		G	SL 10-70	0	2.2	< 0.0025	0.0087	NT	NT	NT	NT	NT	NT					NT	NT	NT	NT
03/16/16		G	SL 10-00																		
03/16/16		C	SL 10-PZ			< 0.0025	LE														
03/16/16		G	SL 10-70			< 0.0025	0.0101														
04/04/16		G	SL 10-00																		
04/04/16		C	SL 10-PZ			< 0.0025	0.0083													1.7	
04/04/16		G	SL 10-70			< 0.0025	0.0121													1.7	
04/20/16		G	SL 10-00																		
04/20/16		C	SL 10-PZ			< 0.0025	0.009														
04/20/16		G	SL 10-70			< 0.0025	0.0086														
05/09/16		G	SL 10-00																		
05/09/16		C	SL 10-PZ			< 0.0025	0.0091													2	
05/09/16		G	SL 10-70			< 0.0025	0.0126													NT	
05/23/16		G	SL 10-00																		
05/23/16		C	SL 10-PZ			0.0038	0.0103														
05/23/16		G	SL 10-70			< 0.0025	0.0094														
06/06/16		G	SL 10-00	2	2.2																
06/06/16	11:15	C	SL 10-PZ	0.6	2.1	< 0.0025	0.0093	0.00052	0.00028	0.052	0.054	<0.000054	<0.000054					0.000027	0.000082	1.9	0.001
06/06/16	11:35	G	SL 10-70	0	2.2	< 0.0025	0.0093	0.00049	0.00037	0.054	0.056	<0.000054	<0.000054					0.000017	0.000057	2.3	0.0012
06/20/16		G	SL 10-00																		
06/20/16		C	SL 10-PZ			< 0.0025	0.0093														
06/20/16		G	SL 10-70			< 0.0025	0.0091														
07/05/16		G	SL 10-00																		
07/05/16		C	SL 10-PZ			< 0.0025	0.0072													2.3	
07/05/16	11:30	G	SL 10-70			0.0035	0.0128													2	
07/25/16	11:45	G	SL 10-00																		
07/25/16		C	SL 10-PZ			< 0.0025	0.0075													NT	
07/25/16		G	SL 10-70			< 0.0025	0.0132													NT	
07/25/16		G	69-00											<0.0005	<0.0005	<0.0005	<0.0005				
08/08/16		G	SL 10-00																		
08/08/16		C	SL 10-PZ			< 0.0025	0.0074													2.4	
08/08/16		G	SL 10-70			< 0.0025	0.0172													1.9	
08/23/16		G	SL 10-00																		
08/23/16	11:30	C	SL 10-PZ			< 0.0025	0.0059														
08/23/16	12:00	G	SL 10-70			< 0.0025	0.0128														
09/06/16		G	SL 10-00	0	2.1																
09/06/16	11:30	C	SL 10-PZ	0.1	2.1	< 0.0025	0.0073	0.00062	0.00048	0.046	0.048	<0.000054	<0.000054					0.000018	<0.000012	2.2	<0.000088
09/06/16	12:00	G	SL 10-70	3.9	2.5	0.0078	0.0176	0.00045	0.00054	0.052	0.058	<0.000054	<0.000054					0.000015	<0.000012	2	<0.000088
09/19/16		G	SL 10-00																		
09/19/16		C	SL 10-PZ			< 0.0025	0.008														
09/19/16		G	SL 10-70			< 0.0025	0.0076														
10/10/16		G	SL 10-00																		
10/10/16	10:00	C	SL 10-PZ			< 0.0025	0.0098													2.3	
10/11/16	8:50	G	SL 10-70			0.0026	0.0128													2.2	
10/24/16		G	SL 10-00																		
10/24/16		C	SL 10-PZ			< 0.0025	0.0108														
10/24/16		G	SL 10-70			< 0.0025	0.0179														
11/08/16		G	SL 10-00																		

Standley Lake																					
Method				SM7110B	SM7110B	SM4500PE	SM4500PE	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA524.2	EPA524.2	EPA524.2	EPA524.2	EPA200.8	EPA200.8	SM5310B	EPA200.8
DL				variable	variable	0.0025	0.0025	0.00015	0.00015	0.00010	0.00010	0.00015	0.00015	0.0005	0.0005	0.0005	0.0005	0.00010	0.00010	0.5	0.00050
Max Sig figs				2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Max decimals				1	1	4	4	5	5	5	5	4	4	4	4	4	4	5	5	1	5
Reporting Units				pCi/L	pCi/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample Date	Sample Time	Sample Type	Location ID	Gross Beta	Gross Beta, Uncertainty	Phosphorus, Dissolved (DRP)	Phosphorus, Total	Arsenic, Dissolved	Arsenic, Total	Barium, Dissolved	Barium, Total	Beryllium, Dissolved	Beryllium, Total	BTEX, Benzene	BTEX, Ethylbenzene	BTEX, Toluene	BTEX, Xylenes	Cadmium, Dissolved	Cadmium, Total	Carbon, Total Organic	Chromium, Dissolved
11/08/16		C	SL 10-PZ			< 0.0025	0.0118													2.1	
11/08/16		G	SL 10-70			< 0.0025	0.014													LE	
11/21/16		G	SL 10-00																		
11/21/16	11:30	C	SL 10-PZ			< 0.0025	0.0115														
11/21/16	12:00	G	SL 10-70			0.003	0.0125														
12/06/16		G	SL 10-00	0	2.3																
12/06/16	10:40	C	SL 10-PZ	0.6	2.1	< 0.0025	0.0093	0.00036	0.00047	0.047	0.05	<0.000054	<0.000054					0.000028	<0.000012	2	<0.000088
12/06/16	10:00	G	SL 10-70	0	2.1	< 0.0025	0.012	0.00036	0.00057	0.047	0.05	<0.000054	<0.000054					0.000017	<0.000012	1.9	<0.000088
12/27/16		G	SL 10-00																		
12/27/16	11:30	C	SL 10-PZ			< 0.0025	0.0117														
12/27/16	12:00	G	SL 10-70			< 0.0025	0.0105														

Standley Lake																				
Method				**EPA200.8**	**SM9221D**	**EPA200.8**	**EPA200.8**	**EPA130.2**	**EPA200.7**	**EPA200.7**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA245.1**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**
DL				**0.00050**	**1**	**0.00025**	**0.00025**	**5**	**0.01**	**0.01**	**0.00020**	**0.00020**	**0.00025**	**0.00025**	**0.0002**	**0.00050**	**0.00050**	**0.005**	**0.005**	**0.00050**
Max Sig figs				**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Max decimals				**5**	**0**	**5**	**5**	**0**	**3**	**3**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**4**	**4**	**5**
Reporting Units				**mg/L**	**cfu/100mL**	**mg/L**	**mg/L**	**mg/L as CaCO3**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Sample Date	**Sample Time**	**Sample Type**	**Location ID**	**Chromium, Total**	**E. coli,**	**Copper, Dissolved**	**Copper, Total**	**Hardness, Total**	**Iron, Dissolved**	**Iron, Total**	**Lead, Dissolved**	**Lead, Total**	**Manganese, Dissolved**	**Manganese, Total**	**Mercury, Total**	**Molybdenum, Dissolved**	**Molybdenum, Total**	**Nickel, Dissolved**	**Nickel, Total**	**Selenium, Dissolved**
03/01/16		G	SL 10-00		10															
03/01/16		C	SL 10-PZ	NT		NT	NT	130	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
03/01/16		G	SL 10-70	NT	5	NT	NT	130	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
03/16/16		G	SL 10-00																	
03/16/16		C	SL 10-PZ																	
03/16/16		G	SL 10-70																	
04/04/16		G	SL 10-00		< 1															
04/04/16		C	SL 10-PZ																	
04/04/16		G	SL 10-70		147															
04/20/16		G	SL 10-00																	
04/20/16		C	SL 10-PZ																	
04/20/16		G	SL 10-70																	
05/09/16		G	SL 10-00		< 1															
05/09/16		C	SL 10-PZ					110												
05/09/16		G	SL 10-70		< 1			120												
05/23/16		G	SL 10-00																	
05/23/16		C	SL 10-PZ																	
05/23/16		G	SL 10-70																	
06/06/16		G	SL 10-00		< 1															
06/06/16	11:15	C	SL 10-PZ	0.0004		0.0015	0.0022	120	< 0.0026	0.071	< 0.000038	0.00024	0.00028	0.0071	<0.000042	0.0028	0.0028	0.0028	0.00082	0.00059
06/06/16	11:35	G	SL 10-70	0.00032	< 1	0.00085	0.0014	130	< 0.0026	0.075	< 0.000038	0.00026	0.00088	0.13	<0.000042	0.0027	0.0028	0.003	0.00096	0.00051
06/20/16		G	SL 10-00																	
06/20/16		C	SL 10-PZ																	
06/20/16		G	SL 10-70																	
07/05/16		G	SL 10-00		< 1															
07/05/16		C	SL 10-PZ																	
07/05/16	11:30	G	SL 10-70		1															
07/25/16	11:45	G	SL 10-00																	
07/25/16		C	SL 10-PZ																	
07/25/16		G	SL 10-70																	
07/25/16		G	69-00																	
08/08/16		G	SL 10-00		< 1															
08/08/16		C	SL 10-PZ																	
08/08/16		G	SL 10-70		14															
08/23/16		G	SL 10-00		15															
08/23/16	11:30	C	SL 10-PZ																	
08/23/16	12:00	G	SL 10-70		25															
09/06/16		G	SL 10-00		1															
09/06/16	11:30	C	SL 10-PZ	0.00016		0.0013	0.0019	100	0.01	0.098	0.000078	0.00028	0.0014	0.0068	<0.000042	0.0027	0.0027	0.0024	0.00077	0.00069
09/06/16	12:00	G	SL 10-70	0.00034	44	0.00055	0.0016		0.022	0.32	0.00012	0.00073	1.2	1.3	<0.000042	0.0034	0.0037	0.0028	0.0013	0.00076
09/19/16		G	SL 10-00																	
09/19/16		C	SL 10-PZ																	
09/19/16		G	SL 10-70																	
10/10/16		G	SL 10-00		6															
10/10/16	10:00	C	SL 10-PZ																	
10/11/16	8:50	G	SL 10-70		13															
10/24/16		G	SL 10-00																	
10/24/16		C	SL 10-PZ					116												
10/24/16		G	SL 10-70					116												
11/08/16		G	SL 10-00		9															

Standley Lake																				
Method				**EPA200.8**	**SM9221D**	**EPA200.8**	**EPA200.8**	**EPA130.2**	**EPA200.7**	**EPA200.7**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA245.1**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**
DL				**0.00050**	**1**	**0.00025**	**0.00025**	**5**	**0.01**	**0.01**	**0.00020**	**0.00020**	**0.00025**	**0.00025**	**0.0002**	**0.00050**	**0.00050**	**0.005**	**0.005**	**0.00050**
Max Sig figs				**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Max decimals				**5**	**0**	**5**	**5**	**0**	**3**	**3**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**4**	**4**	**5**
Reporting Units				**mg/L**	**cfu/100mL**	**mg/L**	**mg/L**	**mg/L as CaCO3**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Sample Date	**Sample Time**	**Sample Type**	**Location ID**	**Chromium, Total**	**E. coli,**	**Copper, Dissolved**	**Copper, Total**	**Hardness, Total**	**Iron, Dissolved**	**Iron, Total**	**Lead, Dissolved**	**Lead, Total**	**Manganese, Dissolved**	**Manganese, Total**	**Mercury, Total**	**Molybdenum, Dissolved**	**Molybdenum, Total**	**Nickel, Dissolved**	**Nickel, Total**	**Selenium, Dissolved**
11/08/16		C	SL 10-PZ																	
11/08/16		G	SL 10-70		61															
11/21/16		G	SL 10-00																	
11/21/16	11:30	C	SL 10-PZ																	
11/21/16	12:00	G	SL 10-70																	
12/06/16		G	SL 10-00		31															
12/06/16	10:40	C	SL 10-PZ	0.00016		0.00094	0.0014	136	0.0029	0.14	0.000049	0.0004	0.0002	0.015	0.0026	0.0026	0.0011	0.00087	0.00042	0.00084
12/06/16	10:00	G	SL 10-70	0.000088	41	0.00086	0.0012	NT	0.0045	0.12	0.000049	0.0004	0.00028	0.015	0.0027	0.0027	0.0011	0.00088	0.00056	0.0005
12/27/16		G	SL 10-00																	
12/27/16	11:30	C	SL 10-PZ																	
12/27/16	12:00	G	SL 10-70																	

Standley Lake																		
Method				EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	SM2540D	EPA200.8	EPA200.8	EPA200.7				
DL				0.00050	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	1	0.0025	0.0025	0.050				
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3				
Max decimals				5	5	5	5	5	5	5	0	4	4	2				
Reporting Units				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Sample Date	Sample Time	Sample Type	Location ID	Selenium, Total	Silver, Dissolved	Silver, Total	Strontium, Dissolved	Strontium, Total	Vanadium, Dissolved	Vanadium, Total	Solids, Total Suspended	Zinc, Dissolved	Zinc, Total	Silicon, Dissolved	Notes	Conclusion	Field Notes	Lab Notes
03/01/16		G	SL 10-00															E coli analyzed by BDCWWTF
03/01/16		C	SL 10-PZ	NT	NT	NT	NT	NT	NT	NT	<5	NT	NT	1.1				Silicon, hardness and TSS analyzed by SGS
03/01/16		G	SL 10-70	NT	NT	NT	NT	NT	NT	NT	<5	NT	NT	1.2				Silicon, hardness and TSS analyzed by SGS; E coli analyzed by BDCWWTF
03/16/16		G	SL 10-00															
03/16/16		C	SL 10-PZ											0.94				Silicon analyzed by SGS, T-PO4 bottle broke (LE)
03/16/16		G	SL 10-70											1.1				Silicon analyzed by SGS
04/04/16		G	SL 10-00															
04/04/16		C	SL 10-PZ								NT			0.99				Silicon analyzed by SGS
04/04/16		G	SL 10-70								NT			1.2				Silicon analyzed by SGS
04/20/16		G	SL 10-00															
04/20/16		C	SL 10-PZ											0.6				Silicon analyzed by SGS
04/20/16		G	SL 10-70											0.65				Silicon analyzed by SGS
05/09/16		G	SL 10-00															
05/09/16		C	SL 10-PZ								< 5			0.29				Silicon analyzed by SGS
05/09/16		G	SL 10-70								< 5			0.48				Silicon analyzed by SGS
05/23/16		G	SL 10-00															
05/23/16		C	SL 10-PZ											0.052				Silicon analyzed by SGS
05/23/16		G	SL 10-70											0.4				Silicon analyzed by SGS
06/06/16		G	SL 10-00															
06/06/16	11:15	C	SL 10-PZ	0.00053	<0.000014	0.000055	0.22	0.24	0.0006	0.0005	<5	0.0037	0.0063	<0.1				Silicon analyzed by SGS
06/06/16	11:35	G	SL 10-70	0.00096	<0.000014	0.000034	0.23	0.25	0.00057	0.00031	<5	0.0081	0.012	0.67				Silicon analyzed by SGS
06/20/16		G	SL 10-00															
06/20/16		C	SL 10-PZ											0.39				Silicon analyzed by SGS
06/20/16		G	SL 10-70											0.94				Silicon analyzed by SGS
07/05/16		G	SL 10-00															
07/05/16		C	SL 10-PZ								<5			0.48				Silicon analyzed by SGS
07/05/16	11:30	G	SL 10-70								<5			1.2				Silicon analyzed by SGS
07/25/16	11:45	G	SL 10-00															
07/25/16		C	SL 10-PZ								<5			0.83				Silicon analyzed by SGS
07/25/16		G	SL 10-70								<5			1.1				Silicon analyzed by SGS
07/25/16		G	69-00															
08/08/16		G	SL 10-00															
08/08/16		C	SL 10-PZ								<5			0.98				Silicon analyzed by SGS
08/08/16		G	SL 10-70								10			1.2				Silicon analyzed by SGS
08/23/16		G	SL 10-00															
08/23/16	11:30	C	SL 10-PZ											1.1				Silicon analyzed by SGS
08/23/16	12:00	G	SL 10-70											1.6				Silicon analyzed by SGS
09/06/16		G	SL 10-00															
09/06/16	11:30	C	SL 10-PZ	<0.00015	<0.000014	0.000087	0.17	0.2	0.00088	0.00073	<5	0.0046	0.0066	1.4				
09/06/16	12:00	G	SL 10-70	0.00032	<0.000014	0.000093	0.21	0.24	0.00051	0.00059	<5	0.0082	0.013	1.8				
09/19/16		G	SL 10-00															
09/19/16		C	SL 10-PZ											1.6				
09/19/16		G	SL 10-70											2				
10/10/16		G	SL 10-00															
10/10/16	10:00	C	SL 10-PZ								NT			1.6				Silicon analyzed by EEA
10/11/16	8:50	G	SL 10-70								NT			1.8				Silicon analyzed by EEA
10/24/16		G	SL 10-00															
10/24/16		C	SL 10-PZ								<1			1.3				
10/24/16		G	SL 10-70								3			1.4				
11/08/16		G	SL 10-00															

Standley Lake

Method				**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**EPA200.8**	**SM2540D**	**EPA200.8**	**EPA200.8**	**EPA200.7**				
DL				**0.00050**	**0.0005**	**0.0005**	**0.0005**	**0.0005**	**0.0005**	**0.0005**	**1**	**0.0025**	**0.0025**	**0.050**				
Max Sig figs				**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**				
Max decimals				**5**	**5**	**5**	**5**	**5**	**5**	**5**	**0**	**4**	**4**	**2**				
Reporting Units				**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**				
Sample Date	**Sample Time**	**Sample Type**	**Location ID**	**Selenium, Total**	**Silver, Dissolved**	**Silver, Total**	**Strontium, Dissolved**	**Strontium, Total**	**Vanadium, Dissolved**	**Vanadium, Total**	**Solids, Total Suspended**	**Zinc, Dissolved**	**Zinc, Total**	**Silicon, Dissolved**	**Notes**	**Conclusion**	**Field Notes**	**Lab Notes**
11/08/16		C	SL 10-PZ								6			1				
11/08/16		G	SL 10-70								12			1				TOC sample frozen no data
11/21/16		G	SL 10-00															
11/21/16	11:30	C	SL 10-PZ											0.99				Silicon analyzed by SGS
11/21/16	12:00	G	SL 10-70											1.2				Silicon analyzed by SGS
12/06/16		G	SL 10-00															
12/06/16	10:40	C	SL 10-PZ	0.94	<0.000014	0.00012	0.21	0.21	0.00023	0.00054	1	0.0069	0.0063	0.96				
12/06/16	10:00	G	SL 10-70	0.96	<0.000014	<0.000014	0.21	0.2	0.00024	0.00041	1	0.0085	0.0058	0.94				
12/27/16		G	SL 10-00															
12/27/16	11:30	C	SL 10-PZ											0.84				
12/27/16	12:00	G	SL 10-70											0.84				

Appendix D – Regulation 85 Water-Quality Monitoring Data – 2016

Appendix D. Regulation 85 Data for WWTP Effluent in Clear Creek Watershed

Facility	Date	Flow (MGD)	Ammonia	Total Kjeldahl Nitrogen	Nitrate	Nitrite	Nitrate + Nitrite	Total Inorganic Nitrogen	Total Nitrogen	Total Phosphorus
			(mg/L)							
Blackhawk Central City Sewerage District										
	1/12/2016	0.329	ND	1.4				5.5	6.9	0.09
	2/16/2016	0.426	ND	1.6				10.4	12	0.15
	3/15/2016	0.366	ND	1.1				8.6	9.7	0.06
	4/12/2016	0.386	ND	1.2				5.38	6.58	0.07
	5/17/2016	0.373	ND	1.2				7.87	9.07	0.08
	6/15/2016	0.465	ND	1.2				5	6.2	0.1
	7/12/2016	0.402	ND	0.96				4.5	5.46	0.06
	8/9/2016	0.34	ND	1				4.21	5.21	0.08
	9/20/2016	0.322	ND	0.8				3.3	4.1	0.06
	10/18/2016	0.253	ND	1.1				3.6	4.6	0.04
	11/14/2016	0.301	ND	0.97				4.2	5.17	0.05
	12/13/2016	0.315	ND	0.94				4.6	5.54	0.04
Central Clear Creek Sanitation District										
	1/7/2016	0.031	0.09	0.5	28.54	ND	28.54	28.63	29.01	1.43
	2/15/2016	0.032	0.11	1.5	24.3	ND	24.3	24.42	25.82	1.39
	3/10/2016	0.032	0.12	2.4	26.15	ND	26.15	26.27	28.54	1.35
	4/7/2016	0.033	0.11	1.5	22.8	ND	22.8	22.91	24.29	1.2
	5/4/2016	0.046	0.33	1.8	19.96	ND	19.96	20.28	21.75	1.09
	6/8/2016	0.052	0.67	2.6	18.04	ND	18.04	18.71	20.61	2.18
	7/5/2016	0.059	0.27	0.4	26.62	ND	26.62	26.89	26.98	1.53
	8/3/2016	0.039	0.1	0.2	24.43	ND	24.43	24.54	24.65	1.66
	9/20/2016	0.034	0.1	0.2	37.16	ND	37.16	37.26	37.37	2.35
	10/10/2016	0.043	1.77	2.7	42.45	ND	42.45	44.22	45.18	4.65
	11/14/2016	0.033	0.15	0.6	44.51	ND	44.51	44.66	45.11	1.98
	12/5/2016	0.027	6.98	10	35.05	ND	35.05	42.03	45.02	1.69
Town of Empire										
	6/14/2016		5.25	7.9			0.25	5.5	8.13	1.95
	7/12/2016		3.95	5.4			ND	3.95	5.44	1.96
	8/10/2016		8.4	10.5			ND	8.4	10.54	2.56

Appendix D. Regulation 85 Data for WWTP Effluent in Clear Creek Watershed

Facility	Date	Flow (MGD)	Ammonia (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate + Nitrite (mg/L)	Total Inorganic Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Town of Georgetown										
	1/6/2016	0.271	0.35	1.5			2.37	2.72	3.87	0.1
	3/2/2016	0.184	2.86	2.9			1.91	4.77	4.8	0.01
	5/4/2016	0.197	2.59	3.9			2.45	5.03	6.3	0.03
	7/13/2016	0.343	0.42	0.08			1.15	1.57	1.9	0.09
	9/7/2016	0.215	6.71	7.2			1.14	7.85	8.4	0.56
	11/2/2016	0.146	14.5	15.2			0.82	15.32	16.1	0.16
Town of Idaho Springs										
	1/2016		0.51	2.5	ND	ND	ND	0.51	2.5	0.71
	3/2016		2.47	4.8	0.08	ND	0.08	2.55	4.86	0.49
	5/2016		2.16	3.5	ND	ND	ND	2.16	3.52	0.24
	7/2016		0.16	2.6	0.75	ND	0.75	0.91	3.33	0.45
	9/2016		0.34	1.3	ND	ND	ND	0.34	1.32	0.76
	11/2016		0.26	1.4	ND	ND	ND	0.29	1.45	1.36
Loveland Ski Area										
	1/15/2016	0.012	67.13	69.7	ND	ND	ND	67.13	69.69	7.37
	1/25/2016	0.007	97.2							
	1/26/2016	0.015	80.97							
	1/27/2016	0.004	87.31							
	1/29/2016	0.012	71.25							
	2/19/2016	0.011	66.14	73.7	0.07	ND	0.07	66.22	73.79	4.78
	3/31/2016	0.013	55.68	56.5	ND	ND	ND	55.68	56.51	4.26
	4/15/2016	0.011	13.67	19.7	ND	ND	ND	13.67	19.66	0.8
	5/13/2016	0.014	0.05	1.3	ND	ND	ND	0.05	1.26	0.19
	6/10/2016	0.010	0.07	2.4	4.74	ND	4.74	4.8	7.16	0.32
	7/18/2016	0.009	0.2	1.8	10.12	ND	10.12	10.32	11.92	0.51
	8/16/2016	0.004	0.24	2.2	18.73	ND	18.73	18.97	20.91	0.64
	9/13/2016	0.010	0.14	1.3	5.07	ND	5.07	5.21	6.37	0.9
	10/10/2016	0.007	0.05	1	7.53	ND	7.53	7.58	8.55	0.8
	11/8/2016	0.004	0.16	0.3	12.92	ND	12.92	13.08	13.25	0.87
	12/20/2016	0.015	82.21	84	ND	ND	ND	82.21	84.02	3.81

Appendix D. Regulation 85 Data for WWTP Effluent in Clear Creek Watershed

Facility	Date	Flow (MGD)	Ammonia	Total Kjeldahl Nitrogen	Nitrate	Nitrite	Nitrate + Nitrite	Total Inorganic Nitrogen	Total Nitrogen	Total Phosphorus
			(mg/L)							
St. Marys Glacier W&S District										
	1/4/2016		0.09	2.4			15.24	15.33	17.62	1.2
	3/2/2016		ND	2.4			16.84	16.86	19.23	1.89
	6/8/2016		0.94	1.8			0.99	1.93	2.82	0.23
	7/5/2016		1.51	2.4			2.06	3.57	4.42	0.15
	9/28/2016		0.06	0.9			9.55	9.62	10.42	0.6
	12/21/2016		1.82	3.6			14.41	16.23	17.97	0.29

ND-Not Detected