

2018 Annual Report

Clear Creek / Standley Lake Watershed Agreement



July 31, 2019

2018 Clear Creek Watershed Annual Report

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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

Report photographs contributed by the Cities of Westminster, Thornton, and Northglenn; and the Clear Creek Watershed Foundation.

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2018

Highlights

- **Stakeholders focused resources on protecting and enhancing water quality in the Clear Creek and Standley Lake watersheds.**
- **Increased lake monitoring during the hypoxic period provided further insights into nutrient dynamics.**
- **Standley Lake nutrient and chlorophyll a patterns and magnitude were similar to previous years.**
- **The chlorophyll a standard was once again met in 2018.**

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Standley Lake profiler

PURPOSE OF REPORT

This report provides a summary of the accomplishments and collaborative efforts to enhance and protect water quality in the Clear Creek Watershed and Standley Lake in 2018. This document fulfills the reporting requirements set forth in the Clear Creek Standley Lake Watershed Agreement, providing results from best management practices (BMPs) and control efforts, as well as results from the monitoring program in 2018. Additional information pertaining to the agreement, monitoring plan, and in-depth water-quality analyses, are included in the Supplemental Information sections.



Pelican at Standley Lake

1. THE 1993 AGREEMENT

In 1993, the Clear Creek/Standley Lake Watershed Agreement (1993 Agreement) was signed by a contingent of governmental and private entities to address water-quality issues and concerns within the Clear Creek watershed, specifically as they affect the water quality in Standley Lake. The 1993 Agreement shaped the Watershed Monitoring Program and has resulted in a long term, robust data set that is used to both monitor the success of water-quality actions and to inform future projects. To continue efforts to protect Standley Lake water quality, a numeric chlorophyll a standard was implemented in 2009.

Chlorophyll a Standard

In 2009, the Water Quality Control Commission adopted a numeric chlorophyll a standard for Standley Lake. A 4.0 µg/L chlorophyll a standard was established as a protective measure for this drinking water supply reservoir. The standard is evaluated on an annual basis using the average of the nine monthly averages of observed data for the period from March through November.



Standley Lake

2. THE SETTING

CLEAR CREEK WATERSHED AND THE UPPER BASIN

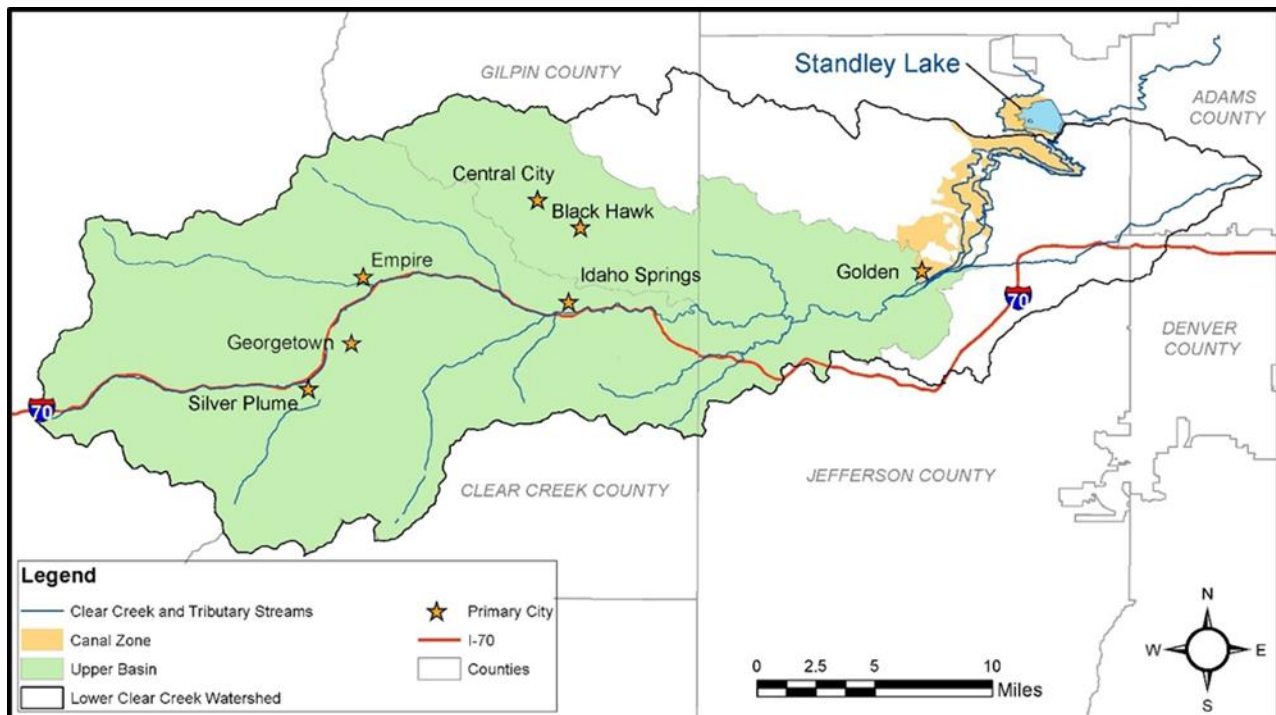


Figure 1. The Standley Lake Watershed: Upper Basin and Canal Zone



Rafters on Clear Creek

The Upper Clear Creek Watershed covers 450 square miles and is located west of Denver, Colorado, with headwaters at the Continental Divide (Figure 1). The Upper Basin of the watershed is the portion above the headgates for the three canals supplying Standley Lake. It extends from the headwaters downstream to near the City of Golden. In addition to supplying drinking water for 350,000 residents in the watershed (including the Cities of Northglenn, Thornton and Westminster), Clear Creek provides water for recreational, agricultural, and industrial purposes.

2. THE SETTING

CANAL ZONE

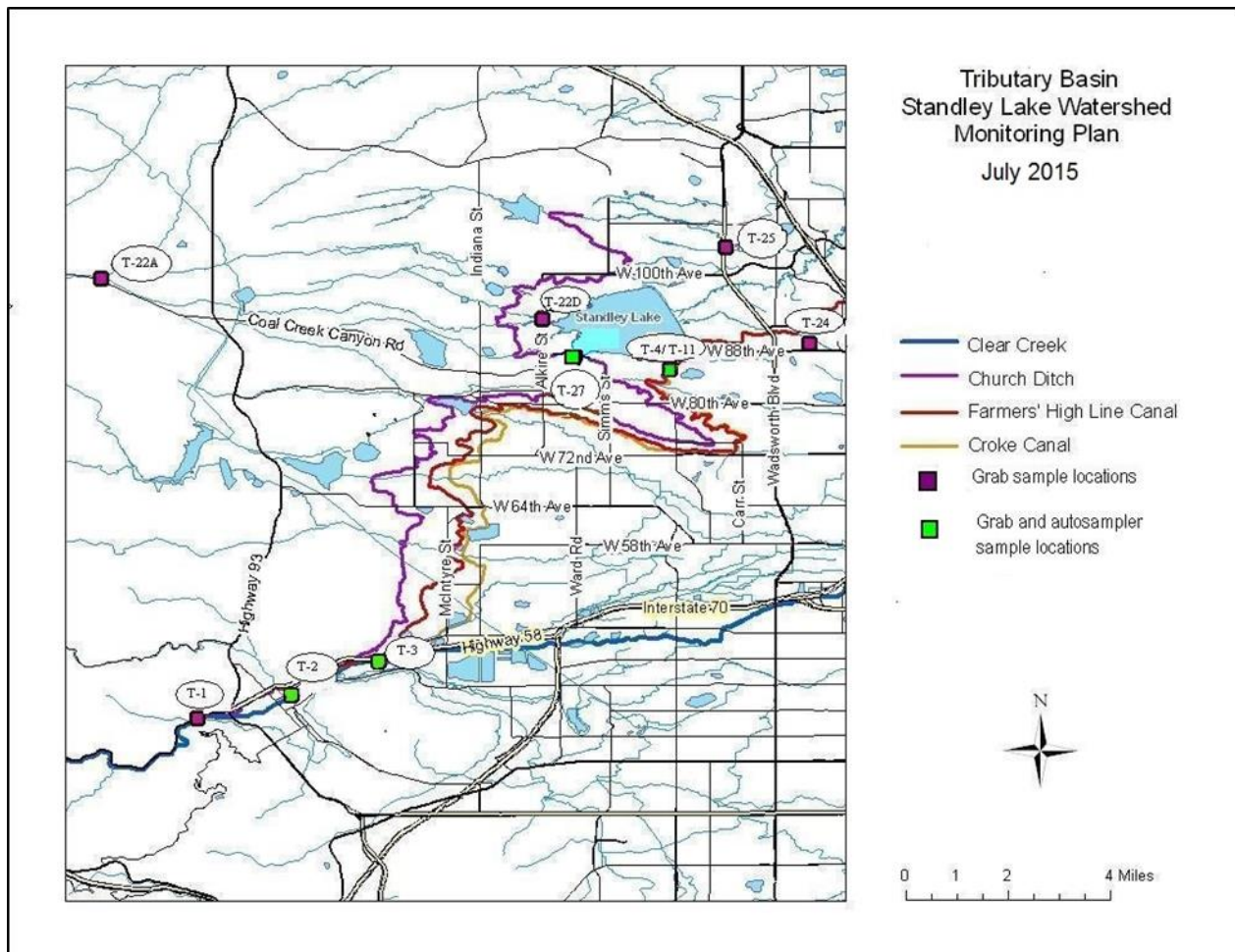
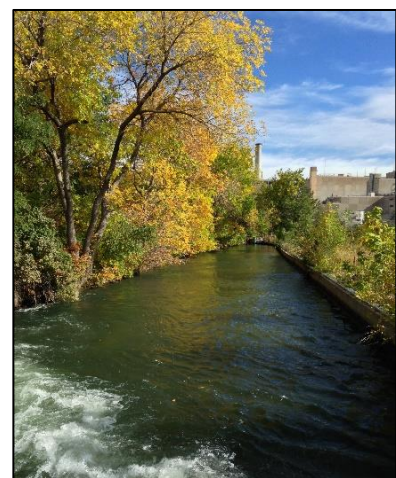


Figure 2. The Canal Zone Showing the Three Canals that Divert Water from Clear Creek to Standley Lake

The Canal Zone is the drainage area that includes three canals that divert water from Clear Creek into Standley Lake: Church Ditch (Church), Farmers' High Line Canal (FHL), and the Croke Canal (Croke) (Figure 2). The three canals are low-gradient, earthen, open, and unlined. In addition, they are subject to nonpoint-source loading from adjacent horse and cattle operations, other agricultural operations, and residential properties (some with on-site wastewater treatment systems, OWTS). To protect Standley Lake water quality, efforts have been made since the 1990s to reduce the majority of storm water inputs/runoff into the Clear Creek canals. As a result, ~80% of stormwater inputs have been hydrologically disconnected from the canals. The Kinnear Ditch Pipeline (KDPL), which provides flow from the Fraser River, South Boulder Creek, and Coal Creek, also contributes water to Standley Lake (< 6%).



The Farmers' High Line Canal

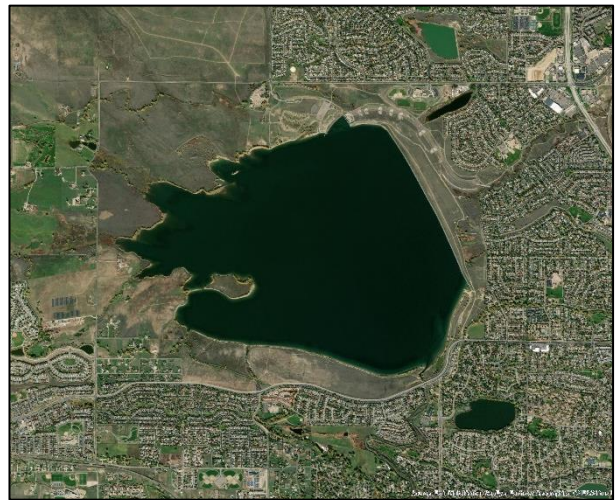
2. THE SETTING



Standley Lake

STANDLEY LAKE

Standley Lake is a municipal and agricultural reservoir located in Jefferson County, Colorado. Construction of the dam was completed in 1912 and in 1963, the City of Westminster expanded the reservoir to its present storage capacity of 43,000 acre-feet. The reservoir is a direct-use drinking water supply for over 300,000 consumers in Northglenn, Thornton, and Westminster. The reservoir also provides recreation opportunities as well as water to farms located in Adams and Weld counties. It is owned and operated by the Farmers' Reservoir and Irrigation Company (FRICO) and is the third largest reservoir in the Denver metropolitan area, covering approximately 1,200 acres. Standley Lake receives the majority of its inflows from the Clear Creek Watershed via three canals. Through the [Watershed Monitoring Program](#), the lake is monitored regularly during the ice-free period.



Aerial image of Standley Lake



Kayakers enjoying Standley Lake



Merganser on Standley Lake

3A. 2018 ACCOMPLISHMENTS – THE UPPER BASIN

MONITORING IN THE UPPER BASIN

Flow measurements are collected at four locations. Water-quality samples are collected at 15 stations throughout the watershed to monitor the concentrations of nutrients, select metals, and other key constituents. Upper Basin monitoring activities have been designed to evaluate the relative contributions of various nutrient sources, the effectiveness of BMPs, waste water treatment facility (WWTF) operational changes, and nutrient reductions from WWTF upgrades. The Watershed Monitoring



Taking a grab sample of Clear Creek at CC26 (Lawson)

Program uses a combination of ambient grab samples, 24-hour ambient composite samples, and the automated collection of composite event samples to assess water quality. In 2018, a total of 68 samples were collected in the Upper Basin of the watershed (Table 1).

Table 1. Samples Taken in the Upper Basin, 2018

Type of Sample	Total Number of Samples Collected
Grab samples	44
Ambient composites	21
Storm-triggered composites	3

Sample Types for the Upper Basin

Grab samples provide a water quality snapshot in time.

Composite samples provide a more complete picture of water quality fluctuations over the course of the 24-hour sampling period. Two types of composite samples are collected:

- **Ambient samples** are collected on a periodic basis over a 24-hour period during base flow.
- **Event samples** are collected during storms when elevated turbidity/conductivity triggers the autosamplers.



Clear Creek at CC26 (Lawson)

3A. 2018 ACCOMPLISHMENTS – THE UPPER BASIN


WASTEWATER TREATMENT FACILITIES AND REGULATION 85

Of the nine wastewater treatment facilities (WWTFs) in the Upper Basin, only the Black Hawk / Central City Sanitation District facility (design capacity of 2.0 MGD) is subject to Regulation 85 effluent limits and monthly monitoring requirements. Minor dischargers (less than 1 MGD design capacity) are required to sample once every two months at a minimum. This applies to the seven domestic WWTFs in the watershed: Loveland Ski Area, Georgetown, Empire, Central Clear Creek, Idaho Springs, St. Mary's, and Clear Creek High School. Effluent nutrient concentrations for these WWTFs and Henderson Mine are summarized in Table 2. WWTFs are required to monitor total inorganic nitrogen and total phosphorus, per Regulation 85. Since this report focuses on total nitrogen (TN) and total phosphorus (TP), TN is reported here.

Regulation 85

In 2012, the Water Quality Control Commission (WQCC) adopted Regulation 85 (CDPHE, 2012), the Nutrients Management Control Regulation, which establishes numeric limits for nutrient concentrations in WWTF effluent.

Table 2. Effluent Nutrient Concentrations and Flows from WWTFs in the Clear Creek Watershed for 2018*

Location	WWTF	Average Flow (MGD)	Total Phosphorus (mg/L)			Total Nitrogen (mg/L)		
			Min	Max	Average	Min	Max	Average
Upstream  Downstream	Loveland Ski Area	0.007	0.22	5.82	2.86	5.01	101.73	45.53
	Henderson Mine**	1.360	0.005	0.005	0.005	1.15	2.50	1.71
	Georgetown	0.249	0.01	0.08	0.05	2.50	4.10	3.07
	Empire	0.026	0.05	1.41	0.29	14.62	46.94	31.29
	Central Clear Creek	0.030	1.13	10.09	3.83	5.25	34.58	22.17
	Idaho Springs	0.288	0.24	1.16	0.57	0.67	9.98	2.94
	Black Hawk/Central City	0.293	0.02	0.15	0.09	4.30	8.27	6.49
	Clear Creek High School	0.003	6.49	16.79	11.13	10.22	69.94	33.22

* Data for St. Mary's WWTF were not available.

** TP data for Henderson Mine were all non-detect and are reported here at ½ the detection limit.

WWTF Improvements

The City of Idaho Springs Wastewater Treatment Facility (WWTF) completed construction of its sludge handling facility in March of 2018. This included installation of an Ishigaki screw press to dewater digester biosolids. The City continued working towards expansion of the facility after finishing its Activated Granular Sludge pilot project. The City plans to expand its current treatment facility's hydraulic capacity from 0.6 MGD to 0.995 MGD through the installation of two aerobic digestors, a new headworks, moving the solids handling facility to the new site, and repurposing their current digester into a pre-EQ basin. The City also plans to work towards converting its sequential batch reactor basins to the activated granular sludge process.

The Town of Georgetown coordinated with the Town of Silver Plume to install a flow meter on the Silver Plume sewer line before it connects to the Georgetown line. The data will provide a statistical record of flow between the municipalities.

NONPOINT SOURCE CONTROL

This section highlights key accomplishments in 2018 for nonpoint source pollution control and monitoring in the Upper Basin. It also includes OWTS monitoring / regulation and the remediation of abandoned mines.

The City of Golden (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 2018, Golden administered 30 stormwater quality construction permits, and conducted 648 erosion and sediment control inspections. These inspections resulted in 392 written and 32 verbal notifications of violation. In addition, eight stop-work orders were issued.

Golden's Stormwater Maintenance Program performs annual inspections on all private storm sewer systems requiring routine cleaning and maintenance. Twice a year, the City's stormwater division cleans and inspects municipal inlets, increasing the efficiency of the system and removing pollutants that would be discharged to the creek. Sumps in manholes and sediment traps are utilized to remove solids from the stormwater system. In 2018, 302 cubic yards (CY) of sediment and debris were removed from the system.

Golden continued its partnership with Colorado School of Mines and ReNUWIt to investigate pollutant removal through a Biohydrochemical Enhancements for Streamwater Treatment (BEST) engineered streambed.

Jefferson County maintains an erosion and sediment control program as part of its MS4 permit. 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. The County's efforts concentrate on construction site runoff control, post-construction site runoff control, and pollution prevention/good housekeeping. In 2018, Jefferson County performed 4,425 construction permit inspections, 72 post-construction permit inspections, and 40 construction permit enforcement actions. More information about Jefferson County's municipal stormwater program is contained in their Colorado Discharge Permit System (CDPS) Stormwater Permit Annual Report.

Gilpin County updated its OWTS Regulations to ensure compliance with updates to Water Quality Control Commission Regulation 43 for effective protection of water quality in the area. These updates went into effect on August 24, 2018. Gilpin County began pursuing ways to better prevent and quickly respond to forest fires, floods, and other natural disasters, as well as safe guard its residents, visitors, and natural resources by coordinating local and regional assets. Accomplishments in 2018 include:

- Working with property owners to secure emergency service access and evacuation routes across private property;
- Passing Resolution 18-14 recommending full funding and permanent reauthorization of the Land and Water Conservation Fund; and
- Continuing to audit its Emergency Operations Plan, Hazard Mitigation Plan, and Annual Operation Plan.

3A. 2018 ACCOMPLISHMENTS – THE UPPER BASIN

EMERGENCY RESPONSE AND ILLICIT DISCHARGES

Clear Creek County Office of Emergency Management 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 system is initiated when incidents / spills into Clear Creek or its tributaries occur. In 2018, the call-down system was activated twice for one incident of a semi-trailer truck in Clear Creek with possible release of diesel fuel.

Illicit Discharges in The City of Golden and Jefferson County

The City of Golden responded to 30 reports of illicit discharges to the storm system resulting in:

- 12 written warnings;
- 24 verbal warnings; and
- 2 cases where clean-up costs were levied.

Jefferson County responded to 29 reports of illicit discharges to the storm system resulting in 28 permit enforcement actions.

RESTORATION ACTIVITIES

Dredging Georgetown Lagoon

The Town of Georgetown partnered with the City of Black Hawk for a large dredging project of the Georgetown lagoon in the fall of 2018. 79,000 CY of sediment were removed from the site. The Town will be conducting a bathymetric survey of the lagoon and Georgetown Lake in 2019 to establish the current volume of water in the reservoir.



Georgetown Lagoon dredging project

Leavenworth Creek Watershed Restoration Project

Trout Unlimited (TU) and the US Forest Service (USFS) have been involved in on-the-ground restoration in the Leavenworth Creek Watershed since 2014. This is a headwater stream flowing into South Clear Creek and is a drinking water source for The Town of Georgetown. The watershed is home to numerous mines including the Santiago Mine and the Waldorf Mine. Below the Waldorf Mine, there is an extensive swath of dispersed tailings.

Water-quality samples collected between 2011 and 2013 at 27 sites in the Leavenworth Creek upper watershed showed elevated concentrations of cadmium, lead, zinc, and copper above benchmark screening levels. Zinc loading rates increased from 8.2 tons/yr upstream of the dispersed tailings to 12.5 tons/yr below the dispersed area. These sampling results initiated the restoration projects in the watershed. First, TU and the USFS installed a rip-rap ditch in 2015 to prevent surface erosion and sheet flow from the dispersed tailings entering Leavenworth Creek.

3A. 2018 ACCOMPLISHMENTS – THE UPPER BASIN

Once this ditch was constructed, TU and the USFS began restoration at the Santiago Mine, a popular recreation site within the watershed. Soil sampling at the mine had revealed elevated arsenic, lead, and iron above recreational and interpretative visitor regulatory levels. In 2016, project partners removed approximately 5,000 CY of tailings material from the Santiago Mine, constructed erosion controls, restored the historic mill building on site, and worked with the Colorado Division of Reclamation, Mining, and Safety to secure the mine's adit entrance.

In 2017, TU and the USFS completed restoration of the Waldorf dispersed tailings area to:

- Reduce sediment loading from the tailings into Leavenworth Creek;
- Eliminate potential exposure pathways for visitors and animals; and
- Establish native vegetation throughout the floodplain.

Tailing restoration included amending the tailings material with limestone, compost, Biochar, and Richlawn (a natural fertilizer). Project partners also built a small repository for approximately 1,000 CY of tailings. The entirety of the project area was seeded with native seed and covered with weed-free agricultural straw and WoodStraw. During this 2017 project, construction crews also revegetated the slopes at the Santiago Mine.

In 2018, project partners completed necessary vegetation maintenance on the dispersed tailings areas and constructed buck and rail fencing at the Santiago Mine. Soil testing throughout the dispersed tailings in 2018 indicated that the pH of soils in all restored areas are circumneutral and will support healthy native plant growth now and into the future.



Santiago Mine before (top) and after (bottom) restoration

PUBLIC EDUCATION AND OUTREACH

The City of Golden's website provides information on how to report illicit discharges and where to properly dispose of household hazardous chemicals. Additionally, in 2018, articles on nutrient management were published in the Golden Informer, including information on pet waste, bulk landscape materials, and fall fertilizing. The City continued to promote water conservation and nutrient management through its partnership with Resource Central offering programs such as the Water-Wise Landscape Seminar, Garden In A Box, and Slow the Flow.

Jefferson County continues to provide opportunities for residents and visitors to the watershed to learn about and be involved in programs that promote water quality and environmental stewardship. Jefferson County, through its MS4 and floodplain management programs, continues to participate in a number of public events to reach diverse audiences.

3A. 2018 ACCOMPLISHMENTS – THE UPPER BASIN

The Rooney Road Recycling Center provides critical recycling and disposal services for household hazardous waste and electronics. In 2018, the facility collected over 570,000 pounds of household hazardous waste. The City of Golden and Jefferson County both continued to provide support and participation with the Rooney Road facility.

The City of Arvada’s Drug Take-Back Program

Arvada collected 1,470 pounds of prescription drugs in 2018.

The Clear Creek County Transfer Station held a one-day collection event for receiving material from residents of Clear Creek County. In 2018, a total of 46 citizens (12 more citizens than 2017) utilized the facility for hazardous waste disposal. The facility collected around 416 gallons of hazardous waste and shipped out 24 - 4’x4’x4’ gaylord boxes of household paints to PaintCare.

3B. 2018 ACCOMPLISHMENTS – THE CANAL ZONE

MONITORING IN THE CANAL ZONE

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 from Clear Creek and again at the inlets into the lake. The KDPL is sampled upstream in Coal Creek and near the inlet into Standley Lake. Figure 2 shows the headgate and inlet monitoring locations for each canal. Routine monitoring for the Canal Zone is described in detail in the [Watershed Monitoring Program](#). A total of 85 samples were taken in the Canal Zone in 2018. Sample types include: grab samples, ambient composites, storm triggered composites (event), and first flush composites. Table 4 breaks down the number of samples collected by type in the Canal Zone in 2018. These samples are important for assessing how water quality changes along each canal as well as quantifying loading into the lake.

Table 4. Samples Taken in the Canal Zone, 2018

Type of Sample	Number of Samples Collected
Grab samples	63
Ambient	13
Storm-triggered composites	4
First flush	5

First Flush Samples

First flush samples are collected during the initiation of water delivery to Standley Lake and provide data on the quality of the water entering the lake during the seasonal start-up of the canals.



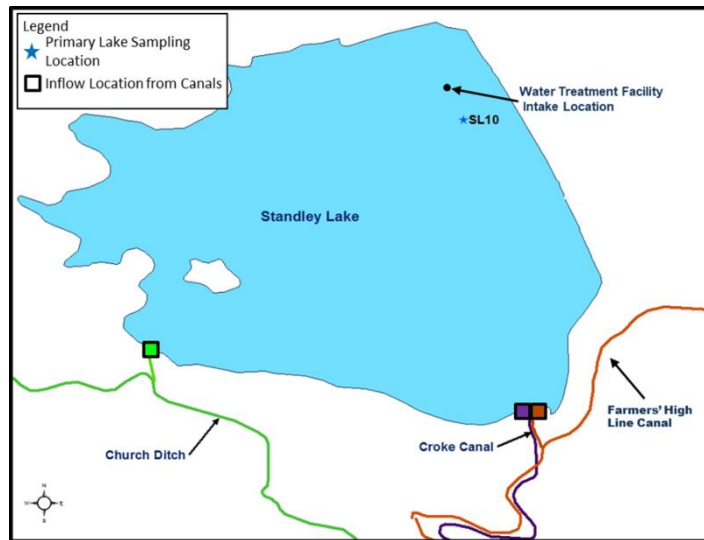
Croke Canal

CANAL IMPROVEMENTS

The Farmers’ Reservoir and Irrigation Company removed trees from the canal banks on the Croke Canal using a tractor mounted mower and chemical spraying when the canal was off. In 2018, one large construction project occurred during the widening of Indiana Street at 72nd Ave. The Croke Canal was not running when construction work was being performed. Thus, impacts to water quality in the canal were minimal.

3C. 2018 ACCOMPLISHMENTS – STANDLEY LAKE

MONITORING AT STANDLEY LAKE



Standley Lake is monitored throughout the year when ice is not present. The lake is sampled in multiple locations, however, SL10 (Figure 3) is the most pertinent to this report because it is the deepest site. This site is located near the municipal supply intakes and is the location of the automated profiler. Daily lake profiles are taken and biweekly samples are also collected at the surface, through the photic zone, and at the bottom.

Figure 3. Standley Lake Sampling Location and Locations of Canal Inflows



The Standley Lake profiler

The Standley Lake Profiler is equipped with a multi-probe sonde which provides measurements of water temperature, dissolved oxygen, pH, conductivity, turbidity, oxidation/reduction potential (ORP), and chlorophyll a concentrations.

Standley Lake Monitoring 2018

Daily Profiles: Standley Lake water quality is measured four times per day for approximately 10 months per year using an automated profiler. Measurements are taken every meter, from the surface to within 2 meters of the bottom.

Water-Quality Sampling: Samples are collected in the lake at three depths. Grab samples are taken at the surface and one meter from the bottom. A composite sample is taken over the extent of the photic zone (at two times the measured Secchi depth). In 2018, 70 water-quality samples were collected on the lake.

Zooplankton Samples: Zooplankton tows are taken once every two weeks.



The Standley Lake sampling boat

AQUATIC INVASIVE SPECIES MANAGEMENT AND PREVENTION

Eurasian Water Milfoil (EWM) is an aquatic invasive species that established in Standley Lake in 1998 and has been managed with the addition of EWM weevils, an herbivorous insect with a preference for EWM. Weevils have been stocked in Standley Lake on five separate occasions from 2002-2011, leading to observed declines in EWM densities. An EWM survey was not conducted in 2018.



EWM weevil

How do we sample for mussels?

Zooplankton tows target the microscopic larval mussel stage and is an early detection method.

Substrate samples help detect juvenile mussels that have started the attachment phase of the life cycle.

Shoreline surveys are performed when water levels are low and target adult mussels that may be attached to hard surfaces.

Zebra and Quagga Mussels are a non-native aquatic invasive species that can be introduced to new water bodies by the unintentional transfer of organisms from an infested water body, often via boats or fishing bait. To protect Standley Lake from these species, an intensive boat inspection and decontamination program was implemented in 2008. Additionally, no live aquatic baits are allowed in the reservoir. Standley Lake is monitored for mussels via three methods: zooplankton tows, substrate samplers, and shoreline surveys. Zooplankton tows are performed every two weeks at the lake inlets and the boat ramp/outlet area. Substrate samples are monitored by Colorado Parks and Wildlife and are placed at several locations in the lake. A shoreline survey is performed when water levels are at their lowest. All sampling efforts in 2018 showed that the lake continues to remain free of zebra and quagga mussels.

MODELING

The Standley Lake Cities completed an upgrade to a full two-dimensional hydrodynamic water-quality model (CE-QUAL-W2) for the Standley Lake Water-Quality Model. The upgraded model provides a greater suite of model uses, including the ability to investigate the impacts of reservoir management using both the upper and lower outlet structures. The effort also included updating the period of simulation to include five additional years of recent data.

PUBLIC EDUCATION AND OUTREACH



Westminster staff presenting at the Water Festival

The 2018 Youth Water Festival took place on May 10, 2018. Fourth and fifth graders from the water service areas of Thornton, Northglenn, and Westminster participated in the annual event at Front Range Community College in Westminster. Over 1,100 students, teachers and parents attended the event, which offered a day of fun and educational workshops featuring active learning and hands-on activities. The Festival's workshops were designed to teach students about water conservation, water chemistry, the water cycle, local water

supplies, water treatment, Colorado water law, aquatic wildlife, ecology and more. For a well-rounded experience, each class of about thirty students was scheduled to attend five to six workshops on different topics during the day. Fifty presenters from local, state, federal, non-profit, and private businesses provided the time and energy needed to make this a successful event. Water conservation kits were provided to attending schools prior to the Youth Water Festival. Teachers incorporated water conservation in their curriculum and asked students to use the kit at home with their families. Each kit contained a 5-minute shower timer, toilet leak dye tablets, a rain gauge, a flow bag, and an instruction sheet. Teachers created assignments for each piece in the kit and kids and parents learned about their water usage together.

4A. 2018 NUTRIENT AND TSS LOADING – THE UPPER BASIN

Loading of total suspended solids (TSS), TP, and TN in the Upper Basin was quantified in 2018. Two sampling locations were included in this analysis: the upper station (CC26) and the lower station (CCAS59/60). Details about these sampling locations are provided in the [Watershed Monitoring Program](#). Ambient grab and autosampler data from the two stations were used to quantify nutrient loadings from upstream to downstream and provide an assessment of water quality in the upper watershed. The results are presented in Figures 4-6. Due to lower than average flows and concentrations, loads of TSS, TP, and TN were all lower (28-63% lower) in 2018, as compared to the 2013-2017 average at both locations.

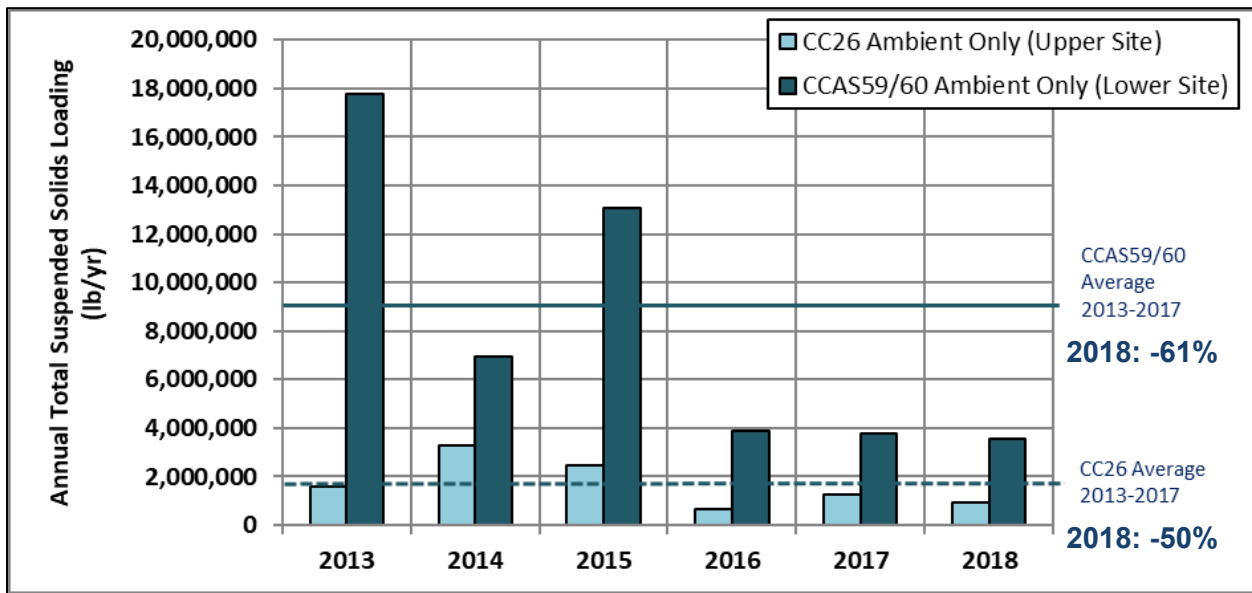


Figure 4. TSS Loads with Percent Change in 2018 for the Upper Station (CC26) and Lower Station (CCAS59/60)

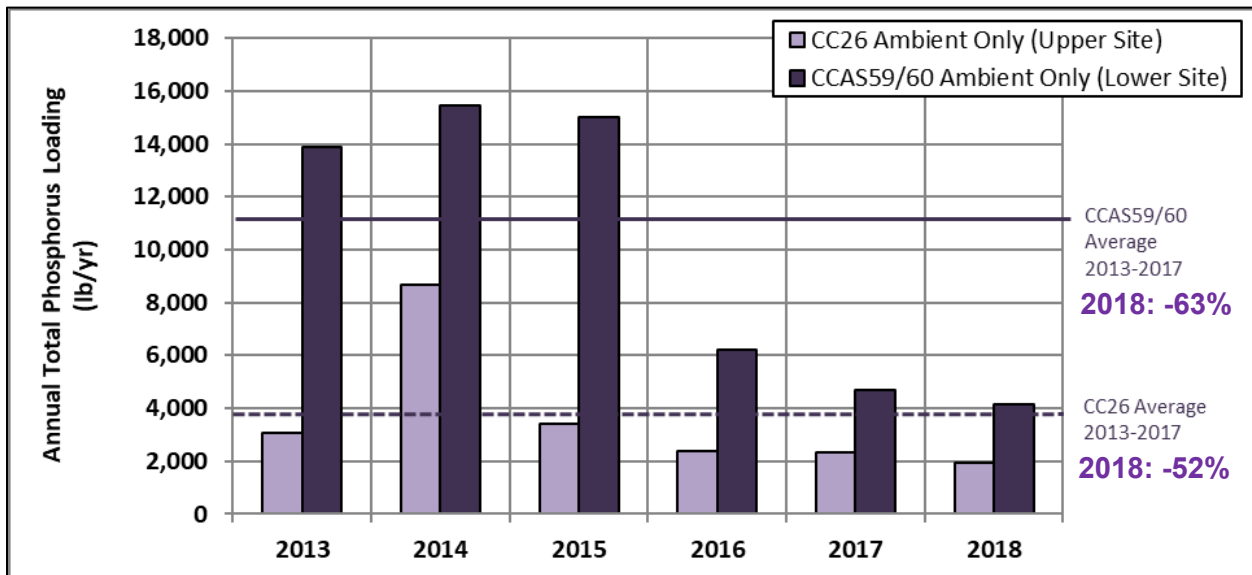


Figure 5. TP Loads with Percent Change in 2018 for the Upper Station (CC26) and Lower Station (CCAS59/60)

4A. 2018 NUTRIENT AND TSS LOADING – THE UPPER BASIN

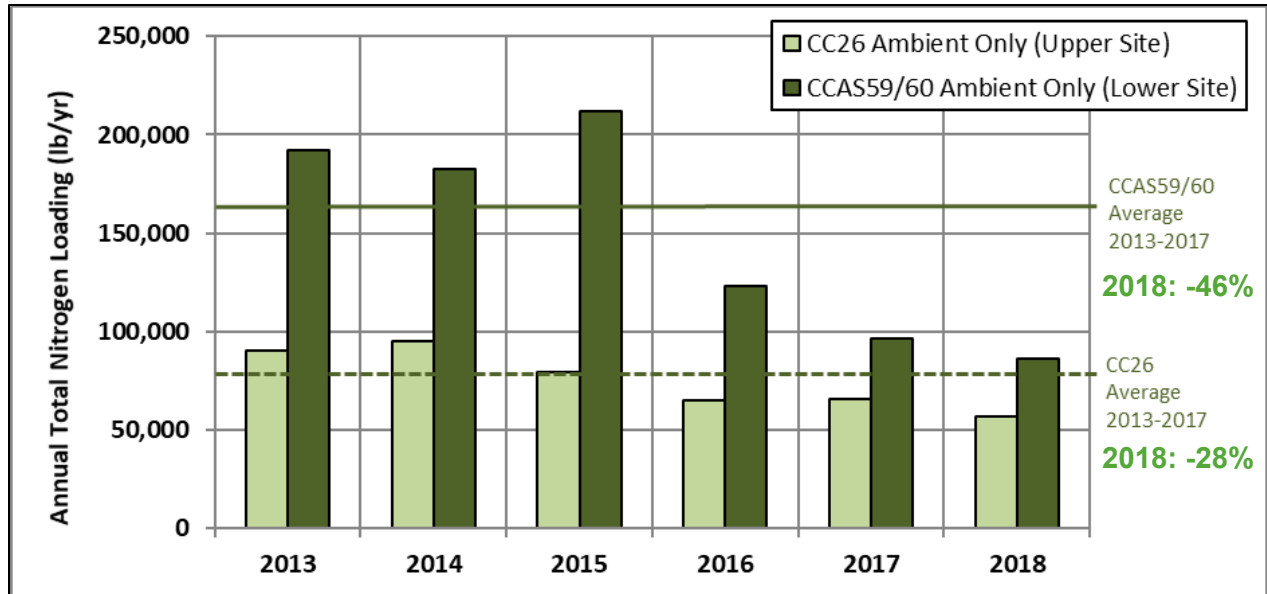


Figure 6. TN Loads with Percent Change in 2018 for the Upper Station (CC26) and Lower Station (CCAS59/60)

4B. 2018 NUTRIENT AND TSS LOADING – THE CANAL ZONE

Loads for TSS, TP, and TN from the four sources entering Standley Lake are presented in Figures 7-9. Percentages of flow contributions are provided in Figure 10. Percentages of TP load contributions by source are provided as an example to compare percentages of loading to flow. The FHL continues to contribute the largest fraction of the total annual loads to the reservoir for TSS, TP, and TN (65%, 60%, and 49% respectively). This contribution is expected as it is the primary canal used during runoff in spring and provides 62% of the total annual inflow to the reservoir. The Croke Canal is the second largest contributor of total annual loads, contributing over a third of the total TSS and TP, and almost half of the TN loads entering the reservoir (34%, 37%, and 47% respectively).

4B. 2018 NUTRIENT AND TSS LOADING – THE CANAL ZONE

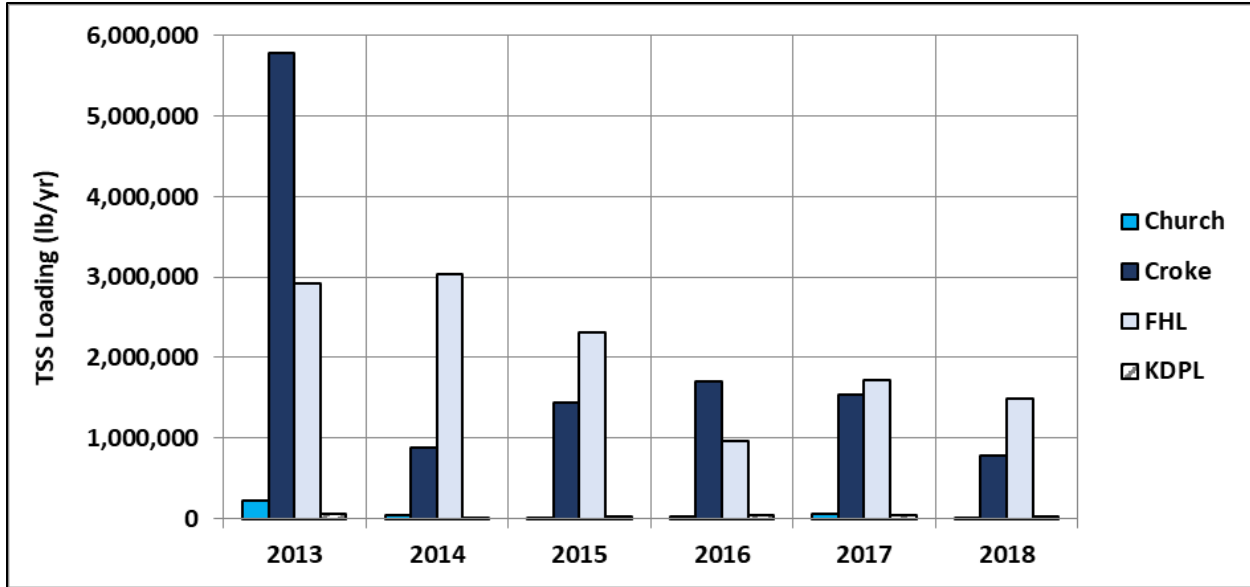


Figure 7. Total Suspended Solids Loading Into Standley Lake by Source, 2013-2018

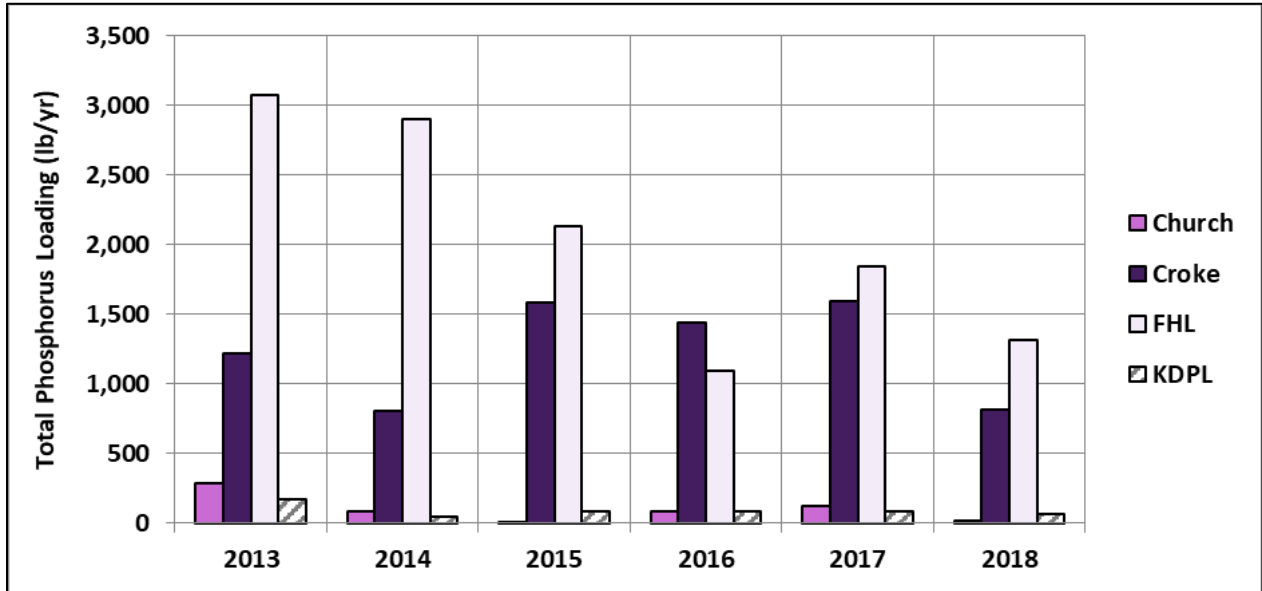


Figure 8. Total Phosphorus Loading Into Standley Lake by Source, 2013-2018

4B. 2018 NUTRIENT AND TSS LOADING – THE CANAL ZONE

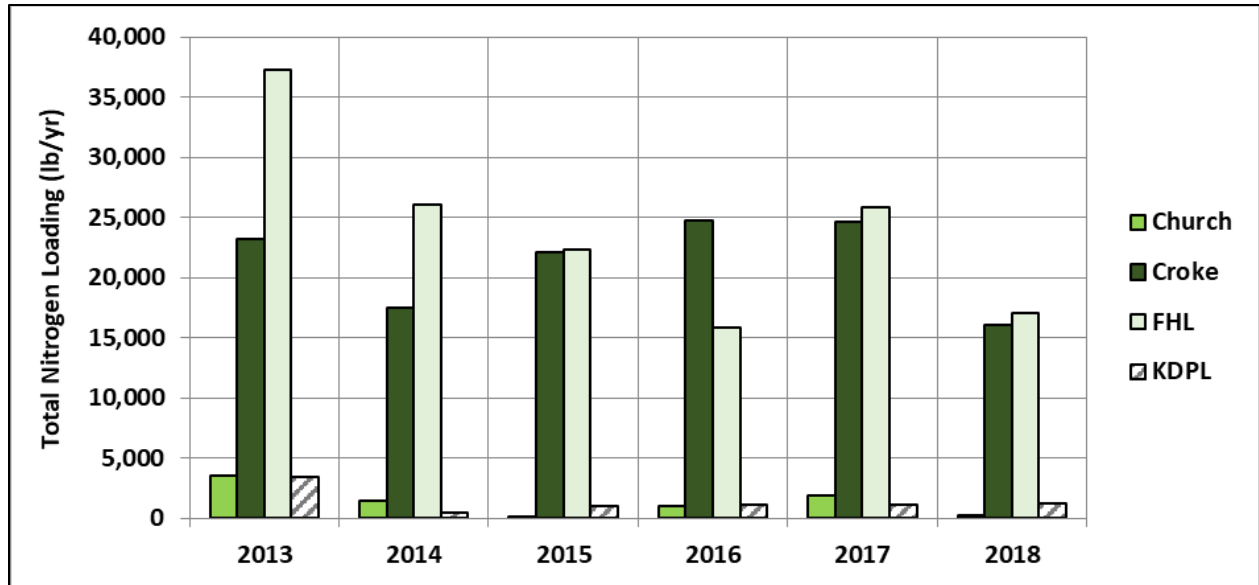


Figure 9. Total Nitrogen Loading Into Standley Lake by Source, 2013-2018

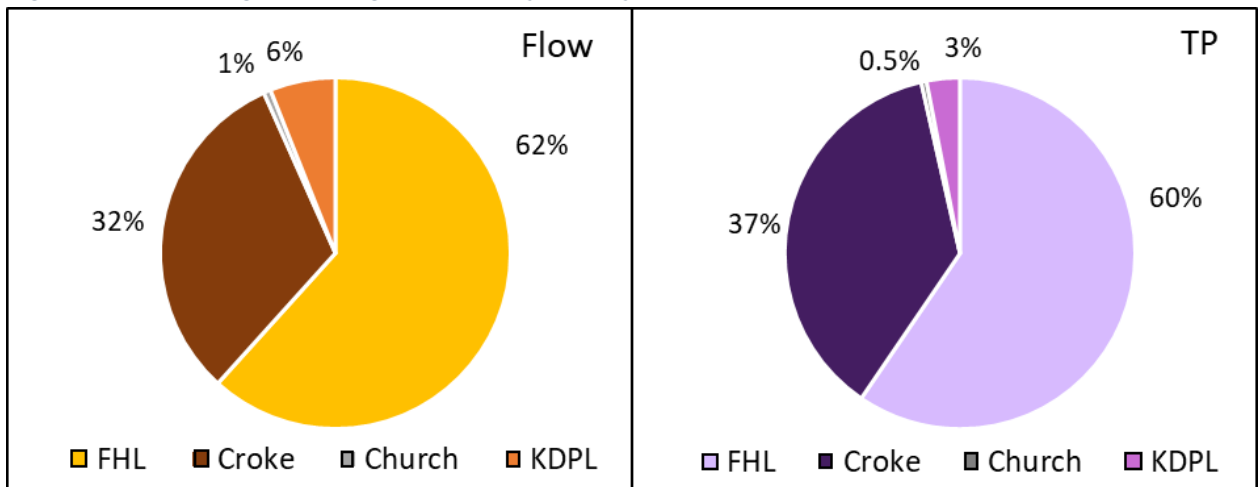


Figure 10. Annual Contributions of Flow and Total Phosphorus by Each of the Four Sources Entering Standley Lake, 2018



The Croke Canal and FHL Canal, Standley Lake's two largest flow contributors

4C. 2018 NUTRIENT AND TSS LOADING - STANDLEY LAKE

TOTAL SUSPENDED SOLIDS, PHOSPHORUS, AND NITROGEN LOADING INTO AND OUT OF STANDLEY LAKE

Estimated annual TSS TP and TN loads into Standley Lake are presented in Figures 11-13. TSS, TP, and TN loads into the reservoir in 2018 were 50%, 41%, and 32% lower than the 2013-2017 average, respectively. All loads into the reservoir were below average this year because total flow into the reservoir was 31% lower than the 2013-2017 average. TSS, TP, and TN loads leaving the reservoir were all lower than the 2013-2017 average (14%, 5%, and 9% lower, respectively). As with previous years, loadings of TSS, TP, and TN into the lake were greater than outflow, indicating some level of nutrient and sediment retention.

Nutrient Retention in Reservoirs

Phosphorus tends to be closely associated with **total suspended solids** through particle-associated transport and tends to be retained with sediment.

Nitrogen can be retained through biological uptake and deposition of particulate organic carbon to the bottom sediment.

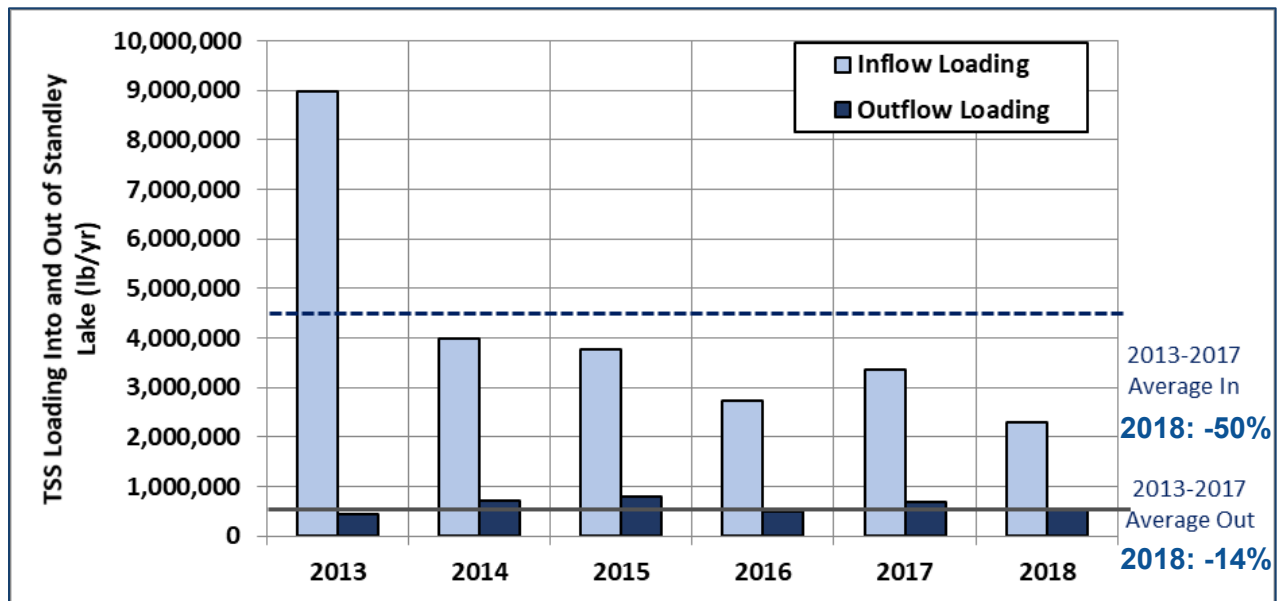


Figure 11. Total Suspended Solids Loading Into and Out of Standley Lake, 2013-2018

4C. 2018 NUTRIENT AND TSS LOADING - STANDLEY LAKE

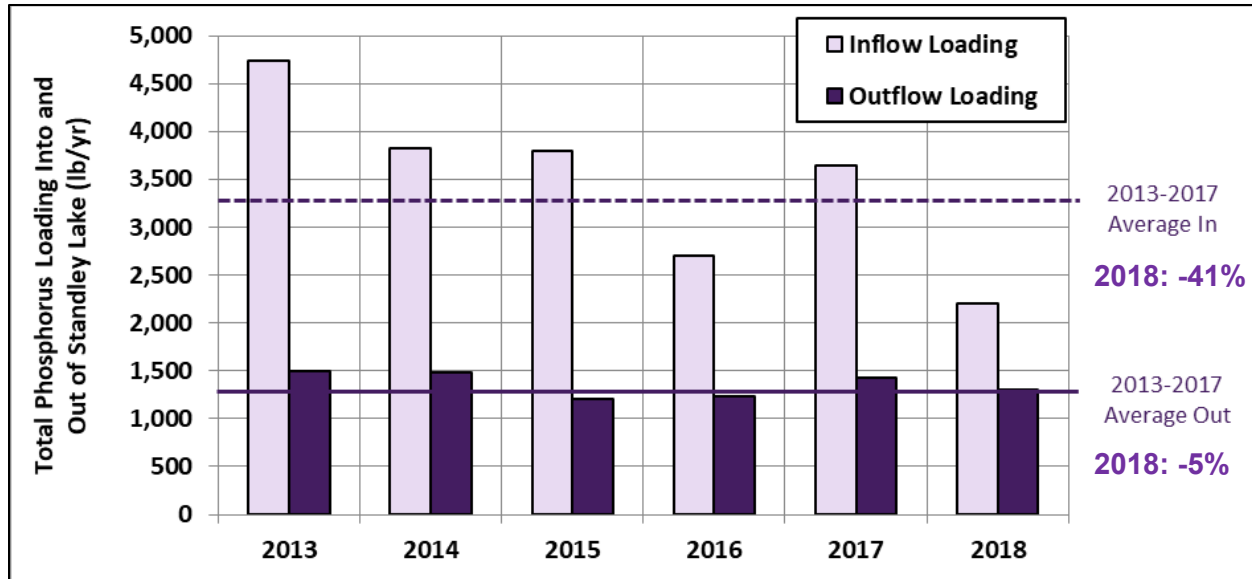


Figure 12. Total Phosphorus Loading Into and Out of Standley Lake, 2013-2018

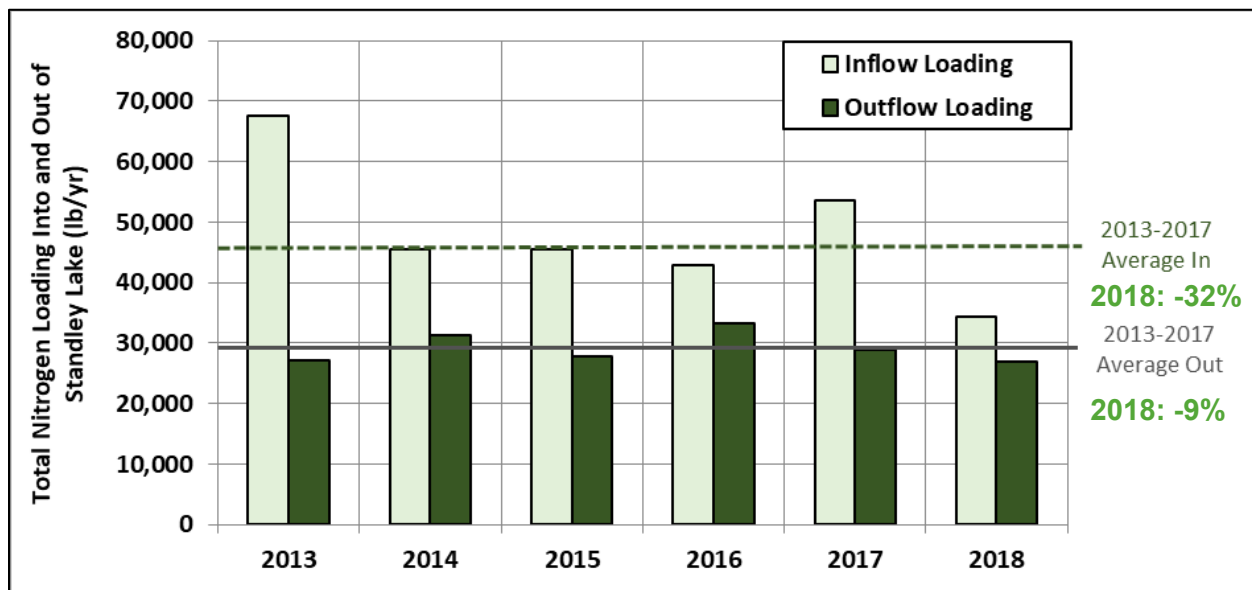


Figure 13. Total Nitrogen Loading Into and Out of Standley Lake, 2013-2018

Influence of the 2013 Floods

Data collected during the 2013 floods are included in all of the loading calculations presented in this report. It can be helpful to also evaluate averages excluding such large infrequent events. Therefore, loading estimates in 2018 were also compared to the 2014-2017 average (removing 2013). Using this comparison (i.e., excluding 2013), 2018 TSS loads were 34% below average, TP loads were 37% below average, and TN loads were 26% below average. These percentages are comparable to the percent differences presented in Figures 11-13, and therefore do not change the overall interpretation of relative loading patterns into the reservoir in 2018.

5A. 2018 WATER-QUALITY RESULTS – THE UPPER BASIN

FLOWS

Snowpack¹ in 2018 was below the average of the previous five years, but not as low as 2012 (Figure 14). It is also notable that the snowpack completely melted earlier than is typical (by the beginning of June).

Hydrographs from Upper Basin locations CC26 (Clear Creek at Lawson Gage) and CC60 (Clear Creek upstream of the Church headgate, Golden, CO) are shown in Figure 15. The snowmelt-dominated pattern is consistent with previous years. The annual flows at the upper station were 42% lower than the average of the previous five years. The flows at the lower station were 47% below the average of the previous five years. This was due to lower than average precipitation values and snowpack in the Upper Basin. Additionally, runoff peaked earlier in 2018 due to warmer than average temperatures in May.

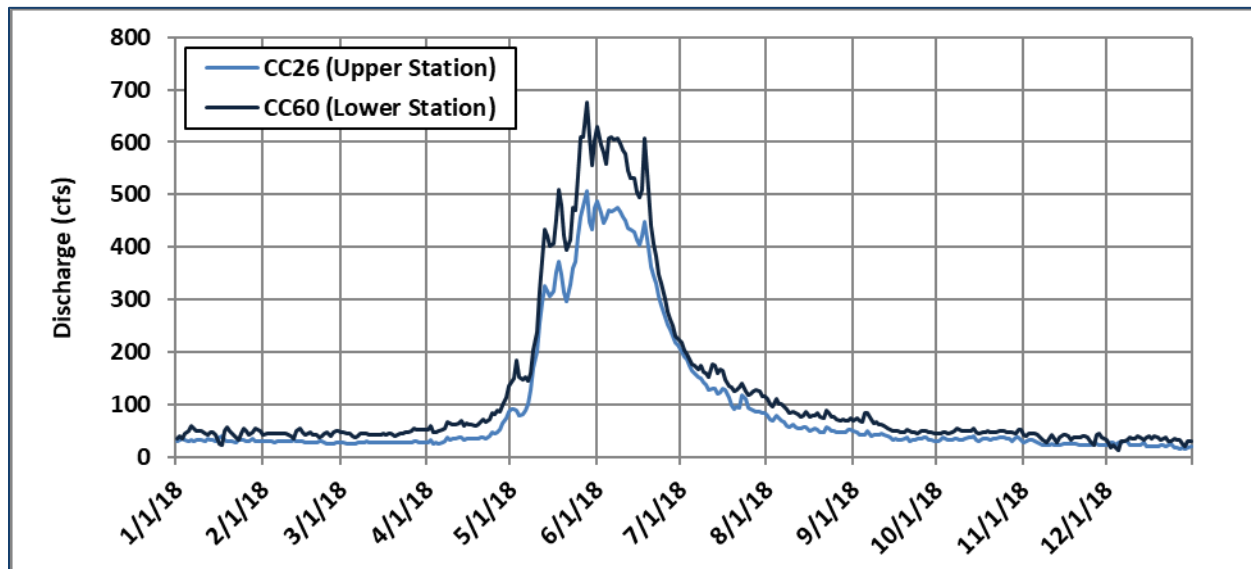
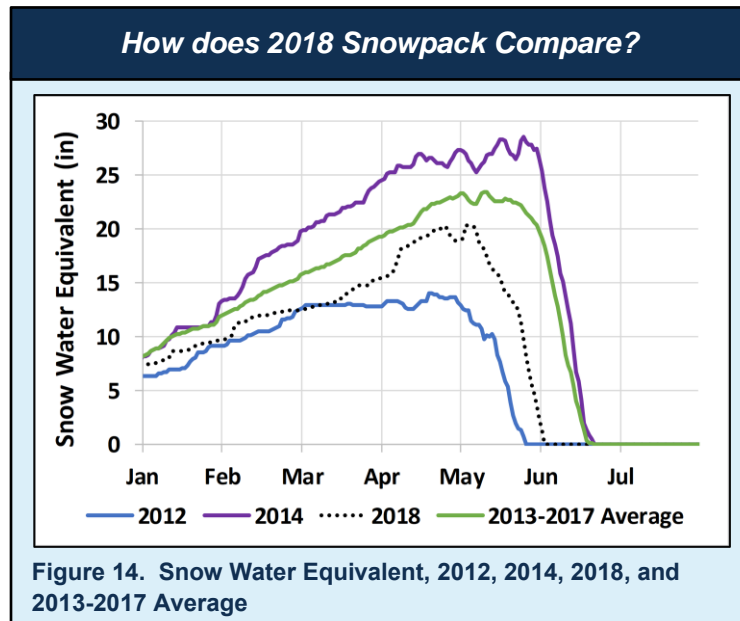


Figure 15. 2018 Clear Creek Hydrographs for the Upper Station (CC26) and the Lower Station (CC60)

¹ Snowpack data from Natural Resources Conservation Service (NRCS) SNOTEL site 602: Loveland Basin (NRCS, 2019)

5A. 2018 WATER-QUALITY RESULTS – THE UPPER BASIN

CONCENTRATIONS

Upper Basin concentrations for TSS and TP in 2018 followed typical patterns with higher concentrations during runoff conditions in May. Conversely, TN displayed a pattern opposite of TSS and TP with lower concentrations during runoff conditions due to the dilution of sources during the higher flow periods. TN concentrations in Clear Creek tend to decrease as flow increases due to dilution of sources. As such, TN concentrations were higher in August likely due to lower than average flows. Most of the monthly TSS and TP concentrations were below average leading to lower Upper Basin loads overall. This was primarily due to the low flow conditions; sample timing has missed peak flow periods (and possible peak concentrations) in the past, but was well distributed across the hydrograph in 2018. Ranges of observed concentrations and volume-weighted concentrations are provided in the [Data Analysis and Interpretation Supplement](#). Volume-weighted average concentrations at CC60 were below average in 2018 for TSS, TP, and TN.

5B. 2018 WATER-QUALITY RESULTS – THE CANAL ZONE

CANAL ZONE TSS, TP, AND TN CONCENTRATIONS

Results of water-quality analyses for the Canal Zone are highlighted in this section. Constituents for the Farmers' High Line and Croke Canals are the focus because they are the largest contributors of flow to Standley Lake (62% and 29% on average, respectively). Samples taken in the Canal Zone in 2018 were consistent with previous years. A substantial increase in TSS and TP concentrations from the headgate to the entry point into the lake continue to be notable in the Croke Canal (Figure 16, Figure 17, right). The FHL shows a smaller difference between the two sampling locations. TN for both canals showed less difference between the headgate and entry point to the lake (Figure 18).

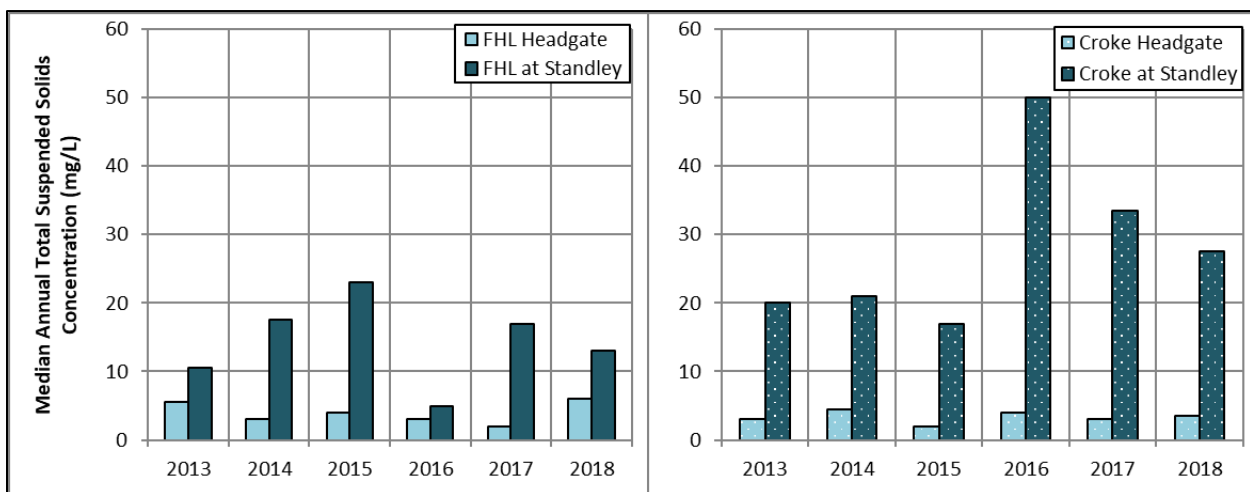


Figure 16. Median Total Suspended Solids in FHL (left) and Croke (right) Canals

5B. 2018 WATER-QUALITY RESULTS – THE CANAL ZONE

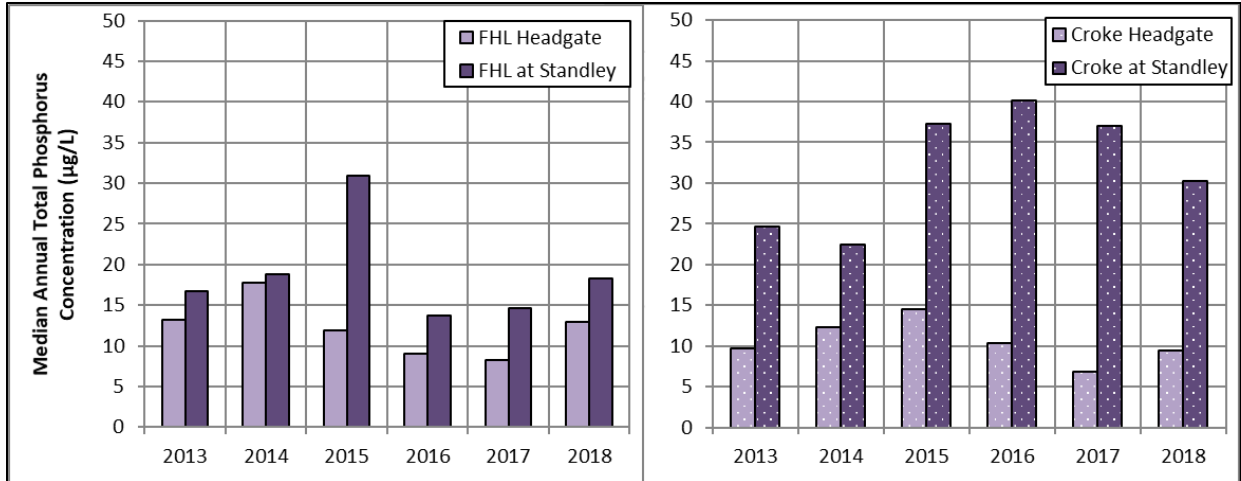


Figure 17. Median Total Phosphorus Concentrations in FHL (left) and Croke (right) Canals

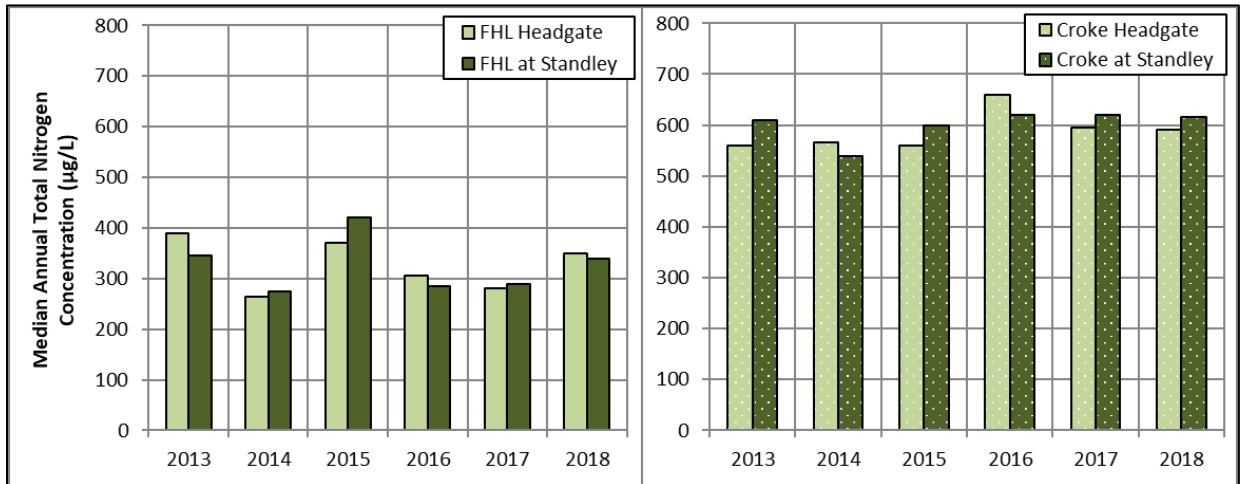


Figure 18. Median Total Nitrogen Concentrations in FHL (left) and Croke (right) Canals

LAKE CONTENTS

While 2018 was a dry year, Standley Lake began the year at capacity resulting in lower inflows to the reservoir during spring. This resulted in the lower loadings mentioned previously. Demand increased in the late summer, but due to dry conditions, inflows to the reservoir did not match demand. This resulted in Standley Lake ending the year with the lowest levels observed in the previous five years (Figure 19).

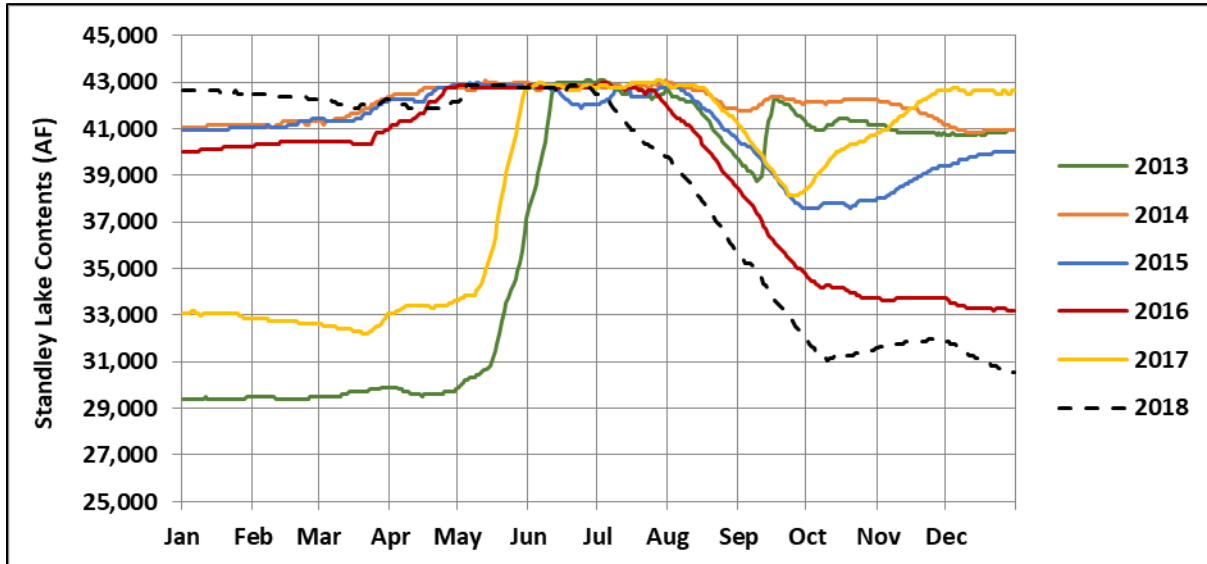


Figure 19. Standley Lake Contents, 2013-2018



Standley Lake in December 2018 with extensive shoreline exposed due to low lake levels

5C. 2018 WATER-QUALITY RESULTS –STANDLEY LAKE

TEMPERATURE

For the second year in a row, Standley Lake experienced unusual stratification due to outlet operations. Operations up until 2016 involved the exclusive use of the lower intake (66 ft, 20 m, below full pool). In 2017, water was withdrawn from the upper intake (36 ft, 10m, below full pool), starting on August 1. In 2018, the upper intake structure was opened progressively; it was first opened 12% on April 23, 25% on May 1, and 50% on May 3. The lower intake remained at 100% until July 19 when the upper intake was set to 100% and the lower intake was closed. This resulted in a similar pattern to 2017, with warmer water released from the reservoir, increasing the amount of thermal energy removed, and lowering overall reservoir temperatures (Figure 20). Due to the earlier operational change in 2018, Standley Lake experienced even cooler temperatures in the lower depths of the lake than in 2017. This operational change kept the thermocline from dropping resulting in a larger, colder hypolimnion. Turnover occurred on October 27, 2018 which is the latest turnover date since October 27, 2015.

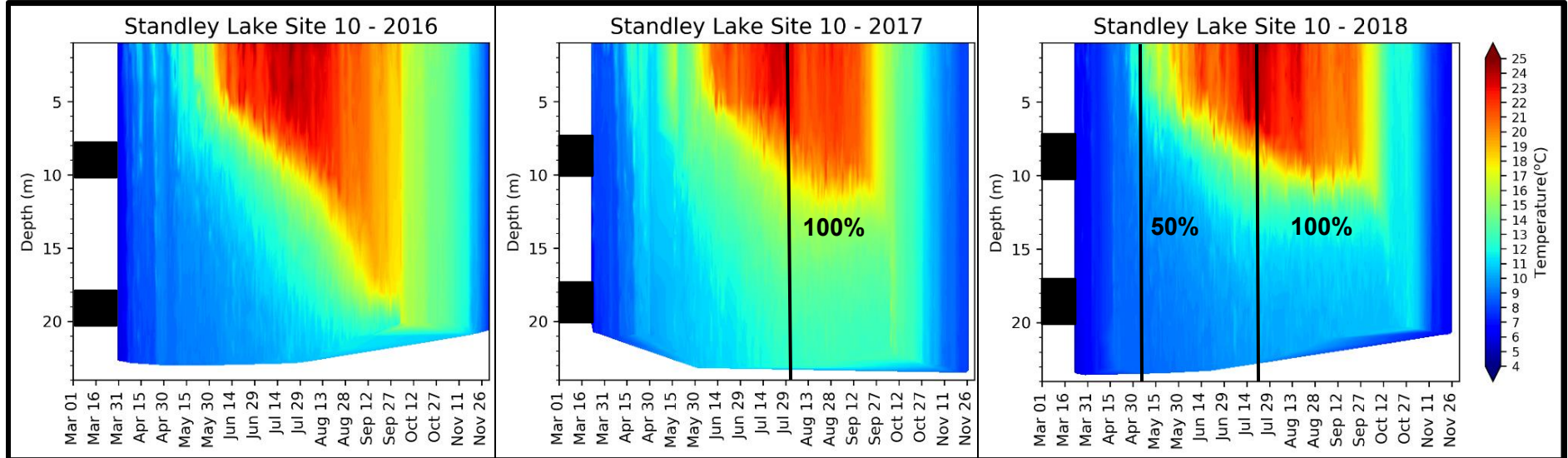


Figure 20. Contour Plots of Temperature in Standley Lake in 2016, 2017, and 2018 the Black Lines Indicate the Dates When the Outlet Depths Changed, the Black Bars Indicate the Range of the Approximate Outlet Depths Based on Water Surface Elevation

DISSOLVED OXYGEN

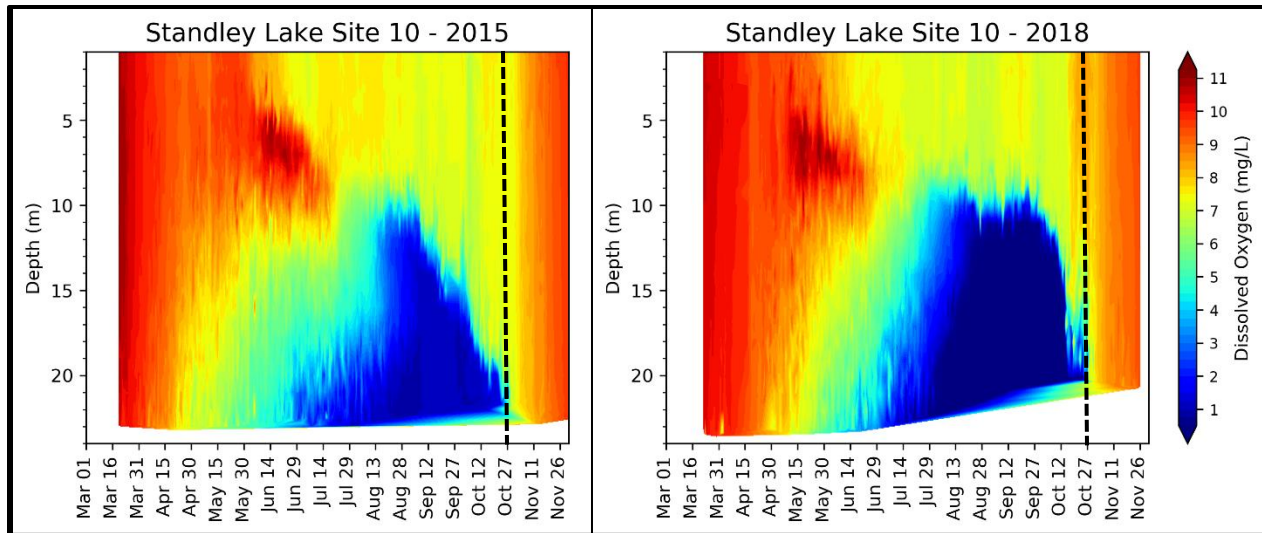


Figure 21. Contour Plot of Dissolved Oxygen in Standley Lake, March-December 2015 and 2018, Black Dashed Lines Indicate Turnover Dates

Data from 2018 show a typical pattern of decreased oxygen concentrations in the hypolimnion with the onset of stratification in mid-May. In contrast with 2017, hypoxic conditions began on a typical date (July 5) but turnover occurred late (October 27) matching the latest turnover date recorded from 2002-2017. The larger hypolimnion resulting from the operational changes allowed the area of hypoxia to extend higher into the reservoir and produced lower DO values at the bottom of the reservoir, compared to a pre-operational change year such as 2015 (Figure 21). Late turnover allowed for another year with an above average number of days of hypoxia (Figure 22). Longer periods of hypoxia provide the potential for higher anaerobic internal loads of nutrients.

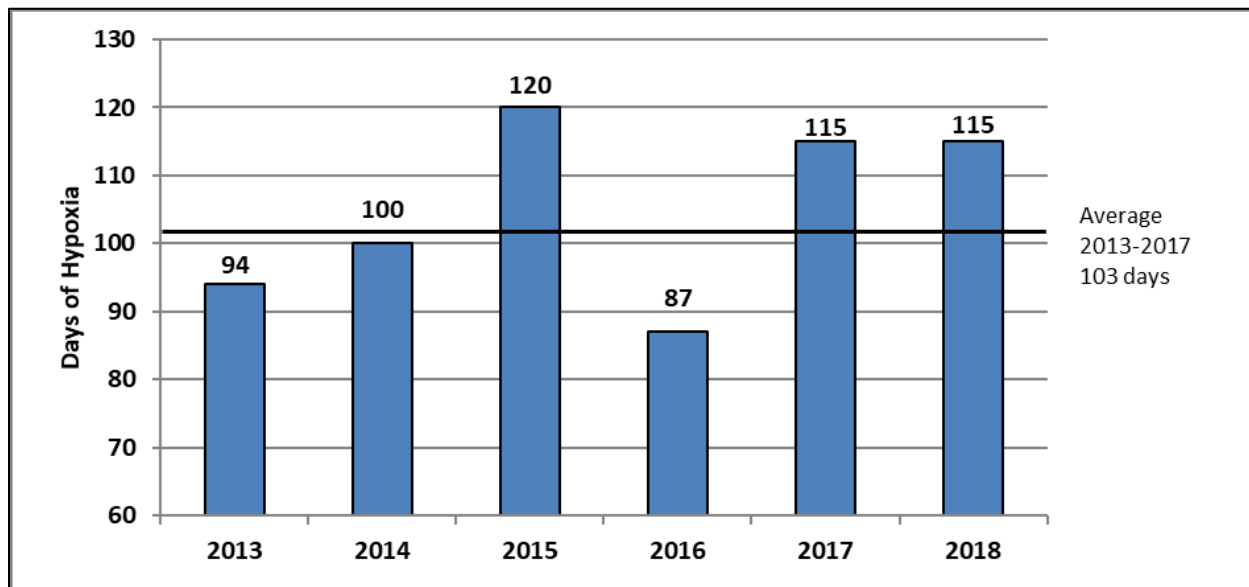


Figure 22. Days of Hypoxia (DO < 2.0 mg/L), 2013-2018

NUTRIENTS

Total Phosphorus

Phosphorus measurements are made in the photic zone and at the bottom of Standley Lake (Figure 23). Photic zone phosphorus concentrations were low and displayed little variation throughout the year. Monitoring occurred weekly during the late summer in 2018 and provided more insight to the patterns of nutrient release during the hypoxic period. The most notable observations were concentrations of 135 µg/L and 134 µg/L at the bottom of the reservoir on September 10 and October 16, respectively. An increase in TP concentrations in the fall is typical and indicative of sediment release of nutrients as a result of hypoxia in the hypolimnion. The long-term record of phosphorus observations at the bottom is shown in Figure 24 and provides perspective on this year's observations. While the observations in 2018 were higher than most years, they were still within the range of observations since 1999. As in 2017, the longer period of hypoxic conditions likely contributed to these high observations. However, the magnitude was lower in 2018 as compared to 2017 because the reservoir was cooler overall. Lower temperatures decrease the rate of nutrient releases from sediment.

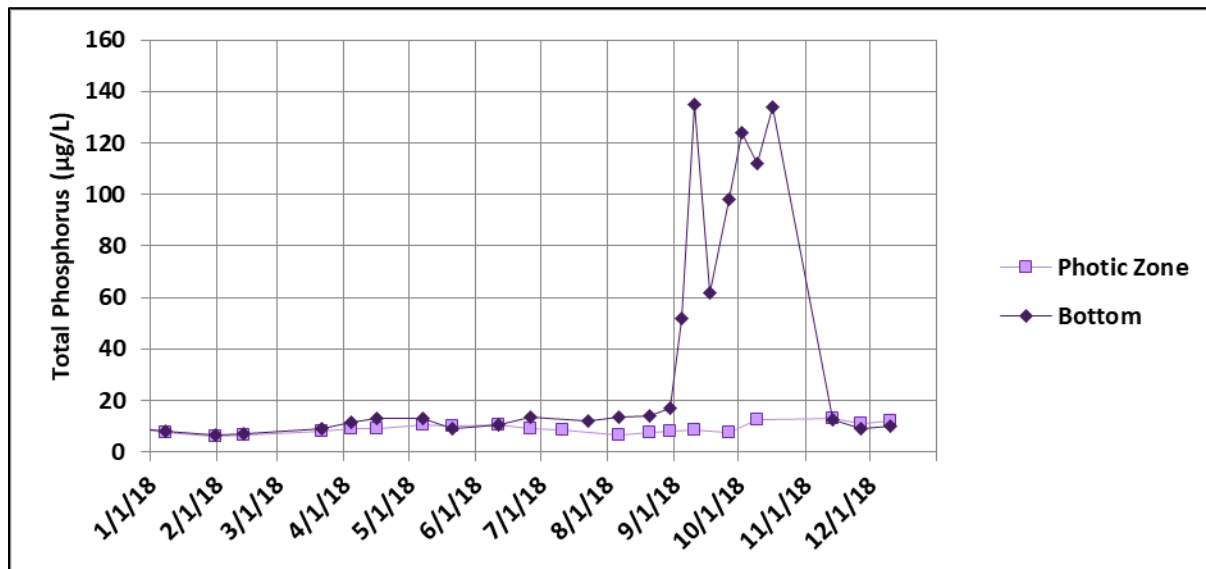


Figure 23. Total Phosphorus Concentrations in Standley Lake, 2018

5C. 2018 WATER-QUALITY RESULTS – STANDLEY LAKE

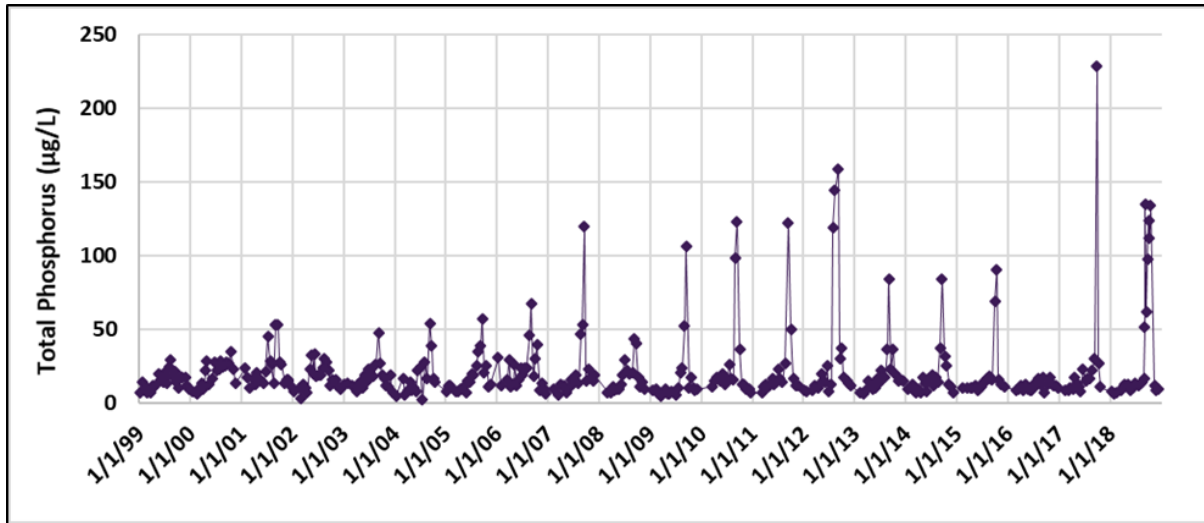


Figure 24. Total Phosphorus Concentrations at the Bottom of Standley Lake, 1999-2018

Total Nitrogen

TN concentrations in Standley Lake are displayed in Figure 25. TN concentrations at the bottom of the lake exhibited a peak concentration of 880 µg/L on June 26. The pattern of higher concentrations at the bottom in early summer reflects plunging canal inflows. The photic zone showed smaller amounts of variability. Evidence of nutrient release from the sediment is demonstrated in the fall with elevated concentrations near the bottom corresponding with the TP increases.

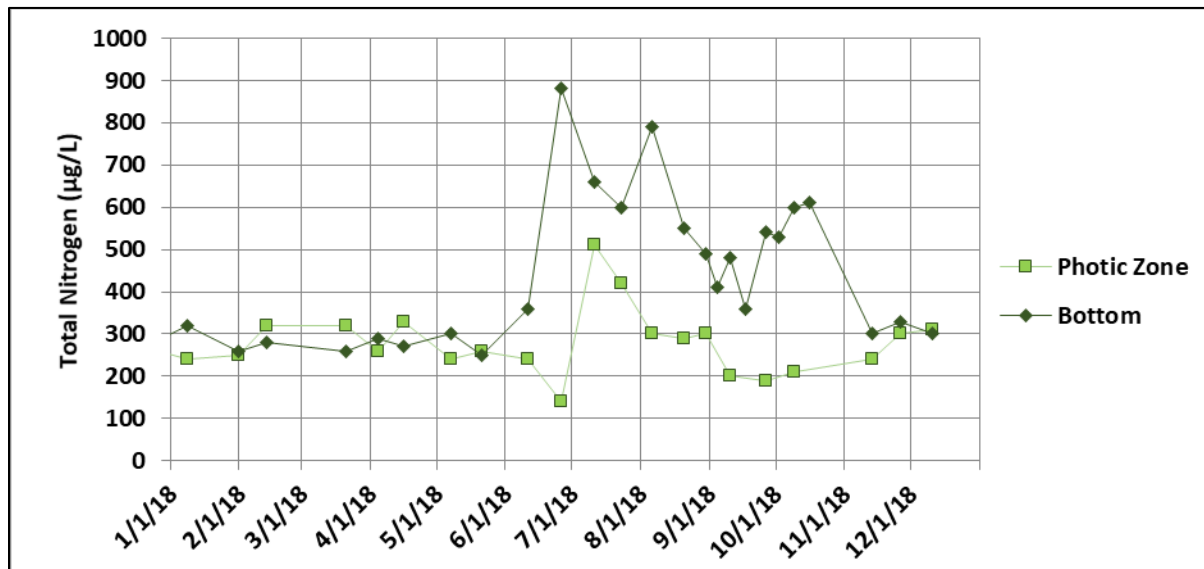


Figure 25. Total Nitrogen Concentrations in Standley Lake, 2018

CHLOROPHYLL *a*

Chlorophyll *a* concentrations measured in the photic zone are shown in Figure 26. March through November is the relevant period for standards assessment and is indicated with the grey box. The maximum concentration measured in 2018 was 7.9 µg/L on May 21, 2018 which corresponded with a bloom of two diatoms; *Stephanodiscus* and *Asterionella*. The bloom affected the water treatment process by reducing filter run times. This algae bloom is likely a response to the FHL inflows which started on April 7th, and resulted in increased nutrient availability for algal growth.

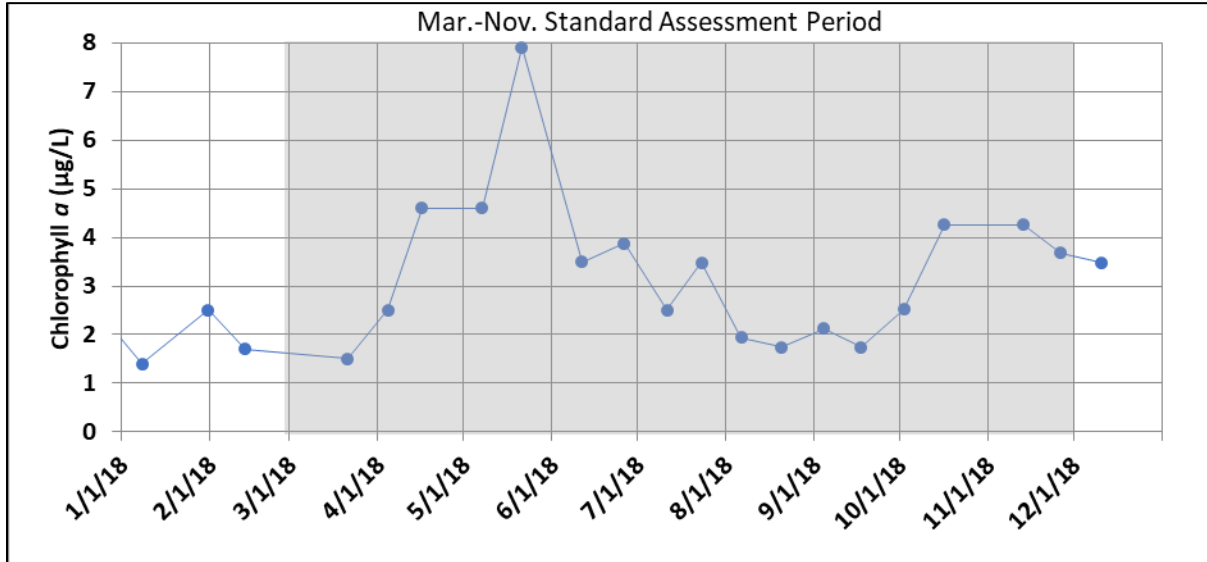


Figure 26. Chlorophyll *a* Concentrations in Standley Lake, 2018 (March-November Assessment Period in Grey)

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 the nine monthly averages of observed data for the 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. For 2018, the value of the assessment metric was 3.2 ug/L (Figure 27). While the operational changes in 2018 caused significant changes in temperature and dissolved oxygen in the hypolimnion of the reservoir, there were no observed impacts on chlorophyll *a* dynamics.

Did we meet the chlorophyll *a* standard?

Yes, the standard for chlorophyll *a* in Standley Lake was met in 2018. The 2018 average is compliant 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-through-November average concentration below 4.4 µg/L. Every year in the five-year period from 2014 to 2018 has had a March-November average concentration below 4.0 µg/L.

5C. 2018 WATER-QUALITY RESULTS – STANDLEY LAKE

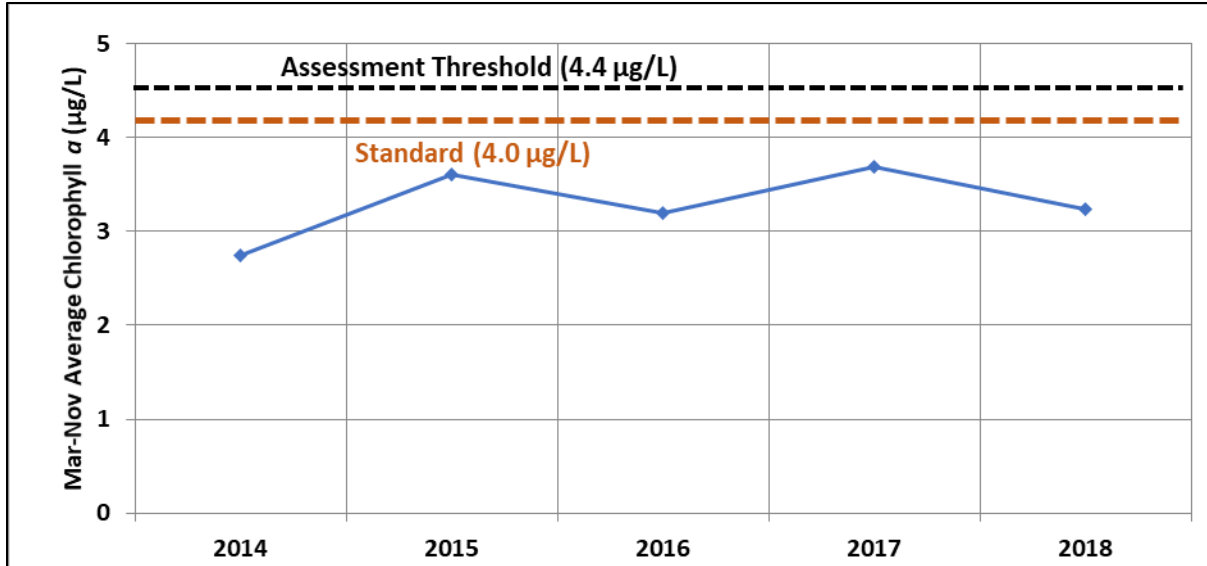


Figure 27. March-November Average Chlorophyll a Concentrations, 2014-2018

6. SUMMARY

Collaborative efforts made by UCCWA members, the Standley Lake Cities, and other parties to the 1993 Agreement continue to be successful in enhancing, protecting, and improving water quality in Standley Lake and Clear Creek. This success is evident based on consistent reservoir and watershed monitoring. Wastewater treatment plant upgrades, canal improvements, illicit discharge responses, public outreach events, and a wide host of other BMPs are all ways that the parties to The Agreement continue to contribute to water quality protection and enhancement.

The Clear Creek Watershed had acceptable water quality in 2018 and showed no signs of degradation from the previous five years for the constituents evaluated. Flow rates at both the upper station (CC26) and the lower station (CC60) were lower than average due to low snowpack and low precipitation.

Water-quality measurements in the Canal Zone indicate that nonpoint sources provide additional TSS and nutrients to the canals before flowing into Standley Lake. While the FHL and the Croke Canal run parallel to each other, the Croke Canal stands out with higher concentrations even during times of steady flow rates. The data again indicate that significant amounts of TSS and phosphorus are added to the canal as water flows from Clear Creek to the reservoir.

Standley Lake water quality in 2018 was similar to that of the previous five years. Standley Lake began the year at full capacity, decreasing the amount of water that came into the lake during the spring, and causing a reduction in loads coming into the reservoir. Lower flows coming into the lake and higher demands resulted in the reservoir ending the year at its lowest level in the previous 5 years. Once again, Standley Lake exhibited a period of stratification and hypoxia in the hypolimnion, this period lasted an above average number of days due to late turnover. Changes in lake operations (using the upper intake during summer) resulted in a larger, colder, hypolimnion in the reservoir. Increased monitoring during the hypoxic period provided more information on nutrient releases from the sediment, with two peak TP concentrations observed in September and October. The peak TP measurement at the bottom of the reservoir was within the range of previous observations, but was still the third highest of the historical observations (1999-2018). The period of hypoxia in 2018 matched the duration of the 2017 hypoxic period (when the highest historic TP measurement was observed), but the magnitude of the observations in 2018 did not match 2017 observations due, in part, to the lower temperatures in the hypolimnion.

Evaluating the long-term effects of changes in operations will require a longer period of record. The observed nutrient concentrations followed typical patterns and were within the magnitude of previous years. Despite the long hypoxia and high peak nutrient concentrations in the hypolimnion, the chlorophyll *a* standard was once again met in 2018, with an average March-November chlorophyll *a* concentration of 3.2 µg/L. These data demonstrate the effectiveness of the efforts to manage, enhance, and protect water quality made by collaborating entities. Further explanations and detailed analyses of 2018 water-quality monitoring results are detailed in [the Data Analysis and Interpretation Supplement](#).

REFERENCES

- 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.
- Hydros Consulting 2018. Clear Creek / Standley Lake Watershed Agreement. 2017 Annual Report. October 1, 2018.
- Natural Resources Conservation Service (NRCS). 2019. SNOTEL 602: Loveland Basin, CO. April 4, 2019. <https://wcc.sc.egov.usda.gov/nwcc/site?sitenum=602>.

SUPPLEMENTAL INFORMATION

- Supplemental Information 1 - Clear Creek/Standley Lake Watershed Agreement
- Supplemental Information 2 - Upper Clear Creek/Standley Lake Watershed Water Quality Monitoring Plan
- Supplemental Information 3 - Clear Creek / Standley Lake Data Analysis and Interpretation - 2018
- Supplemental Information 4 - Clear Creek, Canal, and Standley Lake Water Quality Monitoring Data - 2018

ACRONYMS

- AF - Acre Feet
- BEST - Biohydrochemical Enhancements for Streamwater Treatment
- BMP - Best Management Practice
- CC26 - Clear Creek Sampling Station: Clear Creek at Lawson Gage
- 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. Storm Location Operated by City of Golden
- CCAS59 - Clear Creek Autosampler Station: Clear Creek 2 Miles West of Highway 58/US6 in Golden
- CC60 - Clear Creek Sampling Station: Clear Creek upstream of the Church Ditch Headgate
- CDPHE - Colorado Department of Public Health and Environment

ADDITIONAL INFORMATION

CDPS - Colorado Discharge Permit System

CDWA - Church Ditch Water Authority

Church - Church Ditch

Croke - Croke Canal

CY - Cubic Yards

EWM - Eurasian Water Milfoil

FHL - Farmers' High Line Canal

FRICO - Farmers' Reservoir and Irrigation Company

KDPL - Kinnear Ditch Pipeline

MGD - Millions of Gallons per Day

MS4 - Municipal Separate Storm Sewer System

NRCS - Natural Resources Conservation Service

ORP - Oxidation-Reduction Potential

OWTS - On-site Wastewater Treatment System

TN - Total Nitrogen

TP - Total Phosphorus

TSS - Total Suspended Solids

TU - Trout Unlimited

UCCWA - Upper Clear Creek Watershed Association

USFS - United States Forest Service

WQCC - Water Quality Control Commission

WWTF - Wastewater Treatment Facility



SUPPLEMENTAL INFORMATION 1
CLEAR CREEK/STANDLEY LAKE WATERSHED AGREEMENT

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.



SUPPLEMENTAL INFORMATION 2
UPPER CLEAR CREEK/STANDLEY LAKE WATERSHED WATER
QUALITY MONITORING PLAN

Upper Clear Creek/Standley Lake Watershed

Water Quality Monitoring Plan



Standley Lake courtesy of Eric Scott

December 2017

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- C Sampling Instructions and Forms
- D Sampling Location Photographs and GPS Coordinates
- E Travel times along Clear Creek and FHL Canal
- F Program Participants Contact Information
- G Changes from the Previous Version of the Plan

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
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 UCC 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 24-hour ambient samples, and
- the automated collection of event samples.

UCC – AMBIENT GRAB SAMPLES

Program Coordination and Sampling Team: Thornton

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 15 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.

Since 2013, Wastewater Treatment Plant (WWTP) effluent samples collected by treatment plant staff 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 *	Feb	Apr	May	Oct	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	
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
SFCC = South Fork Clear Creek

WFCC = West Fork Clear Creek
NFCC = North Fork Clear Creek

WTP = Water Treatment Plant
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 (field)	SM 2550 B	1.0 °C	Thornton
pH (field)	SM 4500-H+ B-2000	1.0 Std Units	Thornton
Conductivity (field)	SM 2510 B-1997	10 µS/cm	Thornton
Turbidity (field)	ASTM D7315	1.0 NTU	Thornton
Dissolved Oxygen (field)	ASTM D888-09 (C)	1.0 mg/L	Thornton
Stream Depth	Staff gage reading	0.1 ft	Thornton

- Table Notes:
- 1) SM refers to the 23rd 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, CC50, CC52, CC53, and CC60 during the **Long** Schedule events. TOC is analyzed on all four creek grab samples during the **Short** Schedule events.
 - 4) YSI/Xylem ProDSS or 6-series sondes are used for field measurements.

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), CC15 on the West Fork below Berthoud (staff gage), and CC26 at Lawson (recording gage). The SLC provide financial support for the Department of Natural Resources staff gage at CC30 on Fall River at the mouth. 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 and Sampling Team - *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	500 mL	Rectangular plastic	Phosphorus series	Northglenn	Instructions, COCs and one field data sheet
	4	500 mL	Plastic jug	TSS	Thornton	
	4	125 mL	Rectangular brown 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 field equipment 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 field parameters (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

<u>POINT</u>	<u>DIRECTIONS AND DESCRIPTION OF LOCATION</u>
CC26	Travel westbound I-70 to exit at Lawson. Travel frontage road through Lawson. Immediately before the I-70 overpass, on your right, is a parking area. Sample creek at gage and USGS sampling station by bridge. [RECORDING GAGE] (39-45-57N/105-37-32W) Sample TOC
CC40	Traveling eastbound on I-70 take US 6 exit. Pull off in parking area just east of the off ramp. (Tributary Restaurant is across the road) Sample approx. 100 yards east of stop sign below recording gage. (39-44-47N/105-26-08W) [RECORDING GAGE] Sample TOC
CC50	Travel Hwy 119 eastbound toward US 6. Approximately 2 miles downstream of the Black Hawk/Central City WWTP and ¼ mile upstream from intersection is a pullout area to the right immediately before the junction. Sample at the recording gage. (39-44-56N/105-23-57W) [RECORDING GAGE] Sample TOC
CC60	Approximately 1 mile west of the intersection of Hwy 58 and US 6. Park in the pullout on the south side of highway and walk down (or drive) downhill to the Church Ditch diversion structure. Go across the bridge and sample from the main stem of Clear Creek. Do <u>not</u> sample from Church Ditch. (39-45-11N/105-14-40W) Sample TOC

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

UCC – AMBIENT GRAB SAMPLES

Program Coordination and Sampling Teams - 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.
- 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 15 bottle kits: 8 kits Creek Team A and 7 kits for Creek Team 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	500 mL	Rectangular plastic	Phosphorus series	Northglenn	One set of: Instructions, COCs and one field data sheet
	8	500 mL	Plastic jug	TSS	Thornton	
	8	125 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, CC50 and CC60)	7	500 mL	Rectangular plastic	Phosphorus series	Northglenn	One set of: Instructions, COCs and one field data sheet
	7	500 mL	Plastic jug	TSS	Thornton	
	7	125 mL	Rectangular plastic	Nitrogen series	Westminster	
	4	40 mL	Glass vial	TOC	Thornton	
QC	4	2 L	1:1 HCl rinsed Rectangular plastic	QC spikes and dups for Golden	Thornton	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.

On Clear Creek sampling day (Long Schedule):

- Calibrate field equipment 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.
- At each sample location, collect samples and analyze for field parameters (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, 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 Thornton staff.
- Complete the COC for the QC samples.
- Return to the Thornton Lab when sampling is completed. Relinquish the QC samples to the Thornton Lab staff.
- Thornton's 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 one copy of each team's field data sheet for Westminster to use for logging in the samples to the electronic spreadsheet.
- The field samples and prepared QC 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: May, Oct

Sample bottles: Creek sites: One 500mL rectangular (phosphorus series), one 500 mL (TSS), one 125 mL (nitrogen series) and one 40 mL amber glass vial (TOC) as required.

<u>POINT</u>	<u>DIRECTIONS AND DESCRIPTION OF LOCATION</u>
CC05	I-70 westbound to Exit 221 (Bakerville); go south back over Interstate (left). Park at call box. Take sample upstream of parking area, read gage located downstream. [STAFF GAGE] (39-41-31N/105-48-15W) 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 inlet and park on the right side of road. Sample from stream above lake inlet point. [RECORDING GAGE] (39-41-11N/105-42-00W)
CC25	Return towards but do not enter I-70. Instead take the frontage road (Alvarado Road) back towards Empire. Travel on the road approximately 3.3 miles until you see a large dirt pull off on the left, across the road from the cemetery. You'll need to hop the barb wire fence to access the creek. Sample near the culvert under I-70. (39-45-05N/105-39-45W)
CC26	Continue approximately 2.3 miles down Alvarado Road towards and 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] (39-45-57N/105-37-32W) 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. (39-44-26N/105-31-17W)
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. DO NOT PARK BY COVERED WAGON!!! [RECORDING GAGE] (39-42-58N/105-34-15W) Sample TOC
CC52	Exit I-70 eastbound at Beaver Brook/Floyd Hill (Exit #247). Turn Left to 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.(39-43-7N/105-22-4W) 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. (39-42-50N/105-21-42W) 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: May, Oct

Sample bottles: Creek sites: One 500 mL rectangular (phosphorus series), one 500 mL (TSS), one 125 mL (nitrogen series) and one 40 mL amber glass vial (TOC) as required.

<u>POINT</u>	<u>DIRECTIONS AND DESCRIPTION OF LOCATION</u>
CC15	Travel west on US 40 through Empire. Begin at Empire Dairy King and continue 6.0 miles west on US 40. There is a large pullout on the creek side of highway with a large stump in the middle of the pullout located a ¼ mile past mile marker 250. Sample directly below the stump at the creek. Staff gage is along the north bank of stream next to a tree at the stream's edge. (39-46-05N/105-47-36W) [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 to Westbound I-70. Immediately after turning onto road/ramp, there is a large open space on right side of road/ramp. Park in open space and cross road to the Colorado Dept. of Transportation (CDOT) fence enclosing their maintenance yard. Enter fence and sample approximately 100 feet downstream of bridge at recording gage. (39-45-23N/105-39-34W) [RECORDING GAGE] Sample TOC
CC30	East on I-70. Exit 238 (Fall River Road/St. Mary's Glacier). Approximately 100 yards up Fall River Road, there is a small turnout on right by a wooden support wall. Cross road and sample creek at staff gage. (39-45-23N/105-33-20W) [Read the STAFF GAGE and record on the field data sheet]
CC40	Traveling eastbound on I-70 take US 6 exit. Pull off in parking area just east of the off ramp. (Tributary Restaurant is across the road) Sample approximately 100 yards east of stop sign below recording gage. (39-44-47N/105-26-08W) [RECORDING GAGE] Sample TOC
CC44	Continue east on US 6 to 119. Drive west on 119 to Black Hawk. From the Black Hawk intersection travel westbound approximately 1 mile on Hwy 119. There is a small wooden building and parking area on the left side of the road. This is the Black Hawk water intake. Walk approximately 100 feet upstream and sample at staff gage. (39-44-56N/105-23-57W) [STAFF GAGE] Record the staff gage and sample near there.
CC50	Continue on Hwy 119 eastbound toward US 6. Approximately 1 mile downstream of the Black Hawk/Central City WWTP and ¼ mile upstream from intersection is a pullout area to the right immediately before the junction. Sample at the recording gage. (39-44-56N/105-23-57W) [RECORDING GAGE] Sample TOC

- CC60 Site is approximately 1 mile west of intersection of Hwy 58 and US 6. Park in the pullout on the south side of highway and walk down (or drive) downhill to the Church Ditch diversion structure. Go across the bridge and sample from the main stem of Clear Creek. Do not sample from Church Ditch. (39-45-11N/105-14-40W)
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 Thornton 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. 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 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 plastic HCl-washed, 16-ounce “milk type” bottles.

Two labs receive spike and duplicate samples from this program:

- Northglenn for low level total phosphorus analysis.
- Westminster for total nitrogen analysis.

Starting 2018, the bottles are marked with (##) corresponding to the date of the sampling (for example, “051418” for May 14, 2018). 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 Thornton'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:

1. the new (##) number discussed earlier
2. the Clear Creek sample site number that was selected for preparation of the QC samples
3. 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. The respective labs will collect their samples from Thornton.

UCC AUTOSAMPLER 24-HOUR AMBIENT SAMPLES

Program Coordination and Sampling Team: Westminster

Autosampler sites were selected at strategic locations in the watershed in order to assess diurnal variations in water quality in Clear Creek. The 24-hour ambient composites are collected with programmable automatic sampling devices. Each of the 12 sample bottles represents a two hour time period, resulting from collecting equal volumes of sample in each of two consecutive hours; therefore, 24 hours of samples are collected in 12 bottles. The 12 discrete samples are composited into one 24-hour sample 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 most of the autosampler sites year-round to continuously monitor in-stream conditions for temperature, conductivity, pH, ORP and turbidity. From April through October, or as weather conditions permit, a depth/pressure probe may be installed at some locations. YSI/Xylem multi-probe sondes are deployed at each autosampler location. The sample locations are equipped with data loggers and cellular telephone modems for remote monitoring of water quality conditions in the watershed and to remotely control activation of the autosamplers.

UCC AUTOSAMPLER 24-HOUR AMBIENT SAMPLES

Sample Locations

CCAS26	Mainstem of CC at USGS Lawson gage
CCAS49	Mainstem of CC above the confluence with the North Fork
CCAS50	North Fork of CC above confluence with Mainstem of CC at USGS gage
CCAS59*	Mainstem of CC above Golden and Church Ditch diversions

*In 2016, Westminster assumed responsibility for sample collection at and maintenance of the new autosampler location at CCAS59 installed approximately 100 feet upstream of the City of Golden’s CC59 station.

UCC AUTOSAMPLER 24-HOUR AMBIENT SAMPLES

Flow Monitoring

USGS gages provide the average daily flow associated with the 24-hour composite samples for the ambient autosamplers. Flow data is obtained directly from the gage stations at CC26 and CC50 to correlate with CCAS26 and CCAS50, respectively. Flow data from the gage at CC40 is used to correlate to CCAS49 because there are rarely significant inflows to or diversions from Clear Creek between CC40 and CCAS49.

The flow data associated with CCAS59 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 CCAS59.

UCC AUTOSAMPLER 24-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 (field)	SM 4500-H+ B-2000	1.0 Std Units	Westminster
Temperature (field)	SM 2550 B	1.0 °C	Westminster
Conductivity (field)	SM 2510 B-1997	10 µS/cm	Westminster
Turbidity (field)	ASTM D7315	1.0 NTU	Westminster
Total and Dissolved Cadmium	EPA 200.8	0.0005 mg/L	Westminster Contract Laboratory
Total and Dissolved Copper	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Iron	EPA 200.7	0.02 mg/L	Westminster Contract Laboratory
Total and Dissolved Lead	EPA 200.8	0.0005 mg/L	Westminster Contract Laboratory
Total and Dissolved Manganese	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Zinc	EPA 200.8	0.02 mg/L	Westminster Contract Laboratory

Table Notes: 1) SM refers to the 23rd 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 may be analyzed by commercial laboratories that have demonstrated proficiency in analyzing complex matrices for nutrients.
- 5) Metals will be analyzed in May, July and October on the Creek intended to capture low, medium and high ambient canal flows delivered to Standley Lake.
- 6) YSI/Xylem 6-series or EXO sondes are used for field measurements.

UCC AUTOSAMPLER 24-HOUR AMBIENT SAMPLES

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 sonde with field probes for turbidity, temperature, conductivity and pH

- Depth/pressure sensor
- Recording gage at CC26 – Operated and maintained by USGS
- Staff gage and recording gage at CC50 – Operated and maintained by USGS
- Rain gage at CC59 – Operated and maintained by Clear Creek Consultants for the City of Golden
- 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). Though samples will only be collected in bottles 1-12, a full rack of sample bottles is required to secure sample bottles in place.
- Continuous recording datalogger
- Cellular modem and antenna at CC26, CC50 and CCAS59

UCC AUTOSAMPLER 24-HOUR AMBIENT SAMPLES

Autosampler Operation

On a monthly basis between April and October, autosamplers are set to collect time-weighted discrete samples for a 24-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, activation of 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 distributor 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
- 12 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
- One 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
 - 500mL square plastic – phosphorus series (Northglenn)
 - 125 mL brown plastic – nitrogen series (Westminster)
 - 500 mL plastic bottle – TSS (Thornton)
 - 40 mL amber glass vial with septa cap – TOC (Thornton)
 - 500 mL round plastic – total metals (Westminster)
 - 500 mL round plastic – dissolved metals (Westminster)
- 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.
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. Compositing of samples in the field is performed by pouring off equal volumes into a 3-liter (or larger) pre-cleaned bottle. Refer to the Sample Compositing Procedure Step 1 below. Aliquot the composited sample into the individual sample bottles that correspond to the analytes to be tested. Save the remaining volume of any individual high turbidity samples to take back to the lab for possible further testing. Discard remaining sample in the remaining autosampler bottles. Return used autosampler bottles to the lab for cleaning.
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 Westminster Semper Water Quality Laboratory for splitting and distribution.

UCC AUTOSAMPLER 24-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 12 bottles into a composite bottle.
2. Perform turbidity, temperature, pH and conductivity measurements on composited samples. Enter data on the Sampling Form.
3. Use the well mixed composited sample to fill the appropriate sample bottles.
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. 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 City of Westminster 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

CCAS49 Event	Mainstem of CC above the confluence with the North Fork
CCAS50 Event	North Fork of CC above confluence with Mainstem of CC at USGS gage
CCAS59 Event	Mainstem of CC above Golden and Church Ditch diversions

UCC AUTOSAMPLERS – EVENT SAMPLES

Flow Monitoring

Westminster will obtain the 15 minute interval flow data from the USGS gage at CC61 (Clear Creek at Golden) to correlate to CCAS59. 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 CCAS49. 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 24-hour ambient samples. Westminster will collect storm samples triggered at CCAS49, CCAS50, and CCAS59 and send them out to their contract laboratory for metals analysis. Independently from this Monitoring Plan, the City of Golden will perform metals analyses collected at CC59 event samples using EPA Method 200.8. Some samples may be analyzed outside the EPA recommended holding time for some parameters based on the random nature of the storm event triggering. Golden and the Standley Lake cities have agreed to share their data. The SLC will submit all other autosampler event samples to a commercial lab for metals testing.

UCC AUTOSAMPLERS – EVENT SAMPLES

Program Coordination: Westminster (and Golden)

Field Sampling Teams: Westminster (and Golden)

The event autosampler program was initiated in 2006 to assess the pollutant concentrations mobilized during significant snow melt (runoff) or rain events at the 24-hour ambient locations CCAS49, CCAS50 and CCAS59. 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 25 minute running average exceeds a predetermined turbidity level (for example, 100 NTU). The autosampler at CCAS50 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. Westminster coordinates sampling at CCAS49,

CCAS50 and CCAS59. Golden is in charge of CC59, independently from this Monitoring Plan. Golden and the Standley Lake cities have agreed to share their data.

UCC AUTOSAMPLERS - EVENT SAMPLES

Field Equipment

Storm event sampling utilizes the same equipment listed in the previous section for the 24-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 24-hr ambient sampling.

Sample Compositing

Sample compositing is performed similarly to the procedure described in the previous section for 24-hr ambient sampling; however, fewer or more samples may be composited based on the intensity 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 to provide lake outflow data used to determine lake outflow loadings. 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 (field)	SM 2550 B	1.0 °C	Northglenn	Monthly
pH (field)	SM 4500-H+ B-2000	1.0 Std Units	Northglenn	Monthly
Conductivity (field)	SM 2510 B-1997	10 µS/cm	Northglenn	Monthly
Turbidity (field)	ASTM D7315	1.0 NTU	Northglenn	Monthly
Dissolved Oxygen (field)	ASTM D888-09 (C)	1.0 mg/L	Northglenn	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	Westminster Contract Lab	Monthly
Total and Dissolved Manganese	EPA 200.8	0.002 mg/L	Westminster Contract Lab	Monthly
Total and Dissolved Zinc	EPA 200.8	0.020 mg/L	Westminster Contract Lab	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 Contract Lab	Quarterly
Total and Dissolved Arsenic	EPA 200.8	0.001 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Barium	EPA 200.8	0.002 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Beryllium	EPA 200.8	0.002 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Cadmium	EPA 200.8	0.0005 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Chromium	EPA 200.8	0.001 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Copper	EPA 200.8	0.002 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Lead	EPA 200.8	0.0005 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Molybdenum	EPA 200.8	0.002 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Nickel	EPA 200.8	0.002 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Selenium	EPA 200.8	0.005 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Silver	EPA 200.8	0.002 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Strontium	EPA 200.7	0.002 mg/L	Westminster Contract Lab	Quarterly
Total and Dissolved Vanadium	EPA 200.8	0.0005 mg/L	Westminster Contract Lab	Quarterly
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 23rd 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 may be analyzed by commercial laboratories that have demonstrated proficiency in analyzing complex matrices for nutrients.
 - 5) YSI/Xylem ProDSS used for field measurements.

TRIB SAMPLES

Program Coordination and Sampling Team (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 field equipment.
- Analyze the Trip Blank for field parameters.
- 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	125 mL	Plastic	E. coli	Thornton
9	500 mL	Plastic	Total Metals	Westminster
9	500 mL	Plastic	Dissolved Metals	Westminster
9	125 mL	Brown plastic	Nitrogen series	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
- YSI/Xylem ProDSS 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, if necessary.
2. Starting with T-24, collect field samples in the order detailed in the next section at 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 field parameters and record data in the field notebook.
8. Repeat the process at each location.
9. Return to Westminster's Semper WTP. Receive T-25 sample from Westminster staff if necessary. 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 Excel spreadsheet 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.
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-01 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

T-27 is located on the south side of Standley Lake at the Church Ditch delivery structure. From Alkire, take 88th Ave east. Open Standley Lake Park gate number 23-D using a master lock key number 2006. Drive north down the trail; it curves east and intersects with a trail going south. Drive down the south trail to the delivery structure.

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

TRIB CONTINUOUS MONITORING

Program Coordination and Sampling Team (Westminster)

At least one 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. Sondes were installed at the new Church Ditch inlet (T-27) in 2009, the FHL headgate (T-02) in 2014 and the Croke headgate (T-03) in 2015 to provide continuous in-stream monitoring of pH, ORP, turbidity, temperature and conductivity during the winter months when the canal is diverting water. Remote access to the data logger data facilitates monitoring of water quality at these inflow locations to Standley Lake. The FHL headgate station is also equipped with a tipping-bucket rain gauge.

TRIB CONTINUOUS MONITORING

Sample Locations

CCAST02	FHL at Headgate on MSCC
CCAST03	Croke Canal at Headgate on MSCC
CCAST04	Croke Canal approximately 0.5 mile from Standley Lake inlet
CCAST11	Farmers Highline Canal approximately 0.5 mile from Standley Lake inlet
CCAST27	Church Ditch at Standley Lake inlet

Table Note: Limited 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 24-HOUR AMBIENT SAMPLES

Program Coordination: Westminster

Field Sampling Teams: Westminster

Autosampler sites in the Tributary Basin are located at the canal headgates and inlets to Standley Lake. The 24-hour ambient composites are collected with programmable automatic sampling devices as described in the UCC autosampler 24-hr ambient program section of this plan in order to assess any water quality impacts introduced to or removed from the canals.

Ambient samples are collected approximately seven times per year on a monthly schedule starting in April and ending in October as a continuation of the UCC autosampler 24-hr ambient sample program.

Time of travel is estimated between CCAS59 and T-02, then a time of travel table is used to set the start time for sample collection at T-11 in order to capture the same slug of water collected at the upstream sites. Composite samples are not collected on the Croke Canal or Church Ditch due to season of operation or limited flow volumes.

TRIB AUTOSAMPLER 24-HOUR AMBIENT SAMPLES

Sample Locations

CCAST02	FHL at Headgate on MSCC
CCAST03	Croke Canal at Headgate on MSCC
CCAST04	Croke Canal approximately 0.5 mile from Standley Lake inlet
CCAST11	Farmers Highline Canal approximately 0.5 mile from Standley Lake inlet
CCAST27	Church Ditch at Standley Lake inlet

TRIB AUTOSAMPLER 24-HOUR AMBIENT SAMPLES

Flow Monitoring

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

TRIB AUTOSAMPLER 24-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 Cadmium	EPA 200.8	0.0005 mg/L	Westminster Contract Lab
Total and Dissolved Copper	EPA 200.8	0.002 mg/L	Westminster Contract Lab
Total and Dissolved Iron	EPA 200.7	0.05 mg/L	Westminster Contract Lab
Total and Dissolved Lead	EPA 200.8	0.0005 mg/L	Westminster Contract Lab
Total and Dissolved Manganese	EPA 200.8	0.002 mg/L	Westminster Contract Lab
Total and Dissolved Zinc	EPA 200.8	0.020 mg/L	Westminster Contract Lab
pH (field)	SM 4500-H+ B-2000	1.0 Std Units	Westminster
Temperature (field)	SM 2550 B	1.0 °C	Westminster
Conductivity (field)	SM 2510 B-1997	10 µS/cm	Westminster
Turbidity (field)	ASTM D7315	1.0 NTU	Westminster

- Table Notes:
- 1) SM refers to the 23rd 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 may be analyzed by commercial laboratories that have demonstrated proficiency in analyzing complex sample matrices for nutrients.
 - 5) Metals will be analyzed in May, July and October on the canals operating at that time intended to capture low, medium and high canal flows delivered to Standley Lake.
 - 6) YSI/Xylem 6-series or EXO sondes are used for field measurements.

TRIB AUTOSAMPLER 24-HOUR AMBIENT SAMPLES

Program Coordination and Sampling Team (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
- Sondes equipped with dedicated field probes for turbidity, temperature, conductivity and pH
- Depth/pressure sensor
- Rain gage at T-02 and T-04/T-11
- 24 discrete HCl rinsed autosampler bottles with caps. Bottles must be numbered and inserted in the designated position in autosampler (positions numbered 1 through 12). Though samples will only be collected in bottles 1-12, a full rack of sample bottles is required to secure sample bottles in place.
- Continuous recording datalogger
- Cellular modem and antenna at T-02, T-03 (to be installed Fall 2015), T-04/T-11 and T27
- Weather conditions collected at T-27 include air temperature, relative humidity, wind speed and wind direction.

TRIB AUTOSAMPLER 24-HOUR AMBIENT SAMPLES

Autosampler Operation

On a monthly basis between April and October, autosamplers are set to collect time-weighted discrete samples for a 24 hour period. The autosamplers are located at the canal headgates and 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 (CCAS59), 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. Time of travel estimates have not been established for the Croke Canal. The Ditch operators assist in estimating when water will arrive at Standley Lake after the ditch is turned on.

Autosampler Setup:

Equipment required:

- 24 discrete HCl rinsed autosampler bottles with caps. Though samples will only be collected in bottles 1-12, a full rack of sample bottles is required to secure sample bottles in place.
- 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 distributor 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
- One 3-liter Nalgene bottle (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
 - 500 mL square plastic – phosphorus series (Northglenn)
 - 125 mL brown plastic – nitrogen series (Westminster)
 - 500 mL plastic bottle – TSS (Thornton)

- 40 mL amber glass vial with septa cap – TOC (Thornton)
- 500 mL non-preserved total metals (Westminster)
- 500 mL non-preserved bottle – dissolved metals (Westminster)
- 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.
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 a 3-liter (or larger) pre-cleaned bottle. The 12 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 sample splitting and distribution.

TRIB AUTOSAMPLER 24-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.
2. Perform turbidity, temperature, pH and conductivity measurements on the composited sample. Enter data on the Sampling Form.
3. Use the well mixed composite sample 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 and metals, 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 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 and Sampling Team (Westminster)

The event autosampler program was initiated on the Tributaries in 2009 at CCAST11 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. Automated collection of storm event samples was initiated in 2014 at the headgates for the FHL and in 2015 in the Croke Canal. These locations trigger sample collection when the turbidity is 200 NTU or greater. The events samples primarily collected on the Croke Canal and Church Ditch are considered first flush samples when water is first delivered to the lake during seasonal startup of the canal/ditch.

TRIB AUTOSAMPLERS EVENT MONITORING

Sample Locations

Localized events may trigger sample collection at any of the Trib Autosampler Continuous Monitoring locations.

CCAST02 Event	FHL at Headgate on MSCC
CCAST03 Event	Croke Canal at Headgate on MSCC
CCAST04 Event	Croke Canal approximately 0.5 mile from Standley Lake inlet
CCAST11 Event	Farmers Highline Canal approximately 0.5 mile from Standley Lake inlet
CCAST27 Event	Church Ditch at Standley Lake inlet

Table Note: Historical data from these locations may be 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 suite of analytical parameters listed below.

Analyte	Analytical Method Reference	Reporting Limit Goal	Responsible Laboratory
Temperature (field)	SM 2550 B	1.0 °C	Westminster
pH (field)	SM 4500-H+ B-2000	1.0 Std Units	Westminster
Conductivity (field)	SM 2510 B-1997	10 µS/cm	Westminster
Turbidity (field)	ASTM D7315	1.0 NTU	Westminster
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
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	Westminster Contract Laboratory
Total and Dissolved Barium	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Beryllium	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Cadmium	EPA 200.8	0.0005 mg/L	Westminster Contract Laboratory
Total and Dissolved Chromium	EPA 200.8	0.001 mg/L	Westminster Contract Laboratory
Total and Dissolved Copper	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Iron	EPA 200.7	0.05 mg/L	Westminster Contract Laboratory
Total and Dissolved Lead	EPA 200.8	0.0005 mg/L	Westminster Contract Laboratory
Total and Dissolved Manganese	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Molybdenum	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Nickel	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Selenium	EPA 200.8	0.005 mg/L	Westminster Contract Laboratory
Total and Dissolved Silver	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Strontium	EPA 200.7	0.001 mg/L	Westminster Contract Laboratory
Total and Dissolved Vanadium	EPA 200.8	0.0005 mg/L	Westminster Contract Laboratory
Total and Dissolved Zinc	EPA 200.8	0.020 mg/L	Westminster Contract Laboratory
Total Hardness (as CaCO ₃)	EPA 130.2	5 mg/L	Thornton
E. coli	SM 9221 D	1 cfu/100mL	Thornton

- Table Notes:
- 1) SM refers to the 23rd 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.
 - 5) YSI/Xylem 6-series or EXO sondes are used for field measurements.

TRIB AUTOSAMPLER EVENT SAMPLES

Field Equipment

Storm event sampling utilizes the same equipment listed in the previous section for the 24-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 24-hr ambient sampling.

Sample Compositing

Sample compositing is performed similarly to the procedure described in the previous section for 24-hr ambient sampling; however, fewer samples are typically composited based on the intensity 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 225 meters south of the lower lake outlet structure, between the lake outlets and the two main inlets to the lake. 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 near 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 2 meters off the bottom and every meter in between. The profiler data is telemetered using a cellular telephone modem 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 2550 B	1.0 °C
pH	SM 4500-H+ B-2000	1.0 Std Units
Conductivity	SM 2510 B-1997	10 µS/cm
Turbidity	ASTM D7315	1.0 NTU
Dissolved Oxygen	ASTM D888-09 (C)	1.0 mg/L
Chlorophyll	YSI (optical probe)	1.0 µg/L
ORP	SM 2580 A	1.0 mv

Table Notes: 1) SM refers to the 23rd Edition of Standard Methods for the Examination of Water and Wastewater.

2) Reporting limits are matrix dependent and may be increased for complex matrices.

3) YSI/Xylem EXO sondes are used for all lake profile measurements.

SL – BIMONTHLY GRAB SAMPLES

Program Coordination and Sampling Team: 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 as long as the lake is not frozen and weather permits. 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 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 two meters above the lake bottom. (The depth of the lake is 23.7 meters (77.75 ft) when the lake is full at gage height 96)
SL 69-00	SL surface at the boat dock
T-24	The lower lake outlet (T-24) is located at an elevation approximately 2 meters higher than sample point SL 10-70

SL – BIMONTHLY GRAB SAMPLES

Analytical Parameters

Analyte	Analytical Method Reference	Reporting Limit Goal	Responsible Laboratory
Temperature (field)	SM 2550 B	1.0 °C	Westminster
pH (field)	SM 4500-H+ B-2000	1.0 Std Units	Westminster
Conductivity (field)	SM 2510 B-1997	10 µS/cm	Westminster
Turbidity (field)	ASTM D7315	1.0 NTU	Westminster
Dissolved Oxygen (field)	ASTM D888-09 (C)	1.0 mg/L	Westminster
ORP (field)	YSI (electrode)	1 mv	Westminster
Chlorophyll (field)	YSI (electrode)	1.0 µg/L	Westminster
Secchi Depth (field)	Secchi disk	0.1 meter	Westminster
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 <i>a</i>	SM 10200-H	1.0 µg/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	SM 5310 B	0.5 mg/L	Thornton
Total Suspended Solids	SM 2540 D	1 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
Total and Dissolved Arsenic	EPA 200.8	0.001 mg/L	Westminster Contract Laboratory
Total and Dissolved Barium	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Beryllium	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Cadmium	EPA 200.8	0.0005 mg/L	Westminster Contract Laboratory
Total and Dissolved Chromium	EPA 200.8	0.001 mg/L	Westminster Contract Laboratory
Total and Dissolved Copper	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Iron	EPA 200.7	0.05 mg/L	Westminster Contract Laboratory
Total and Dissolved Lead	EPA 200.8	0.0005 mg/L	Westminster Contract Laboratory
Total and Dissolved Manganese	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Molybdenum	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Nickel	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Selenium	EPA 200.8	0.005 mg/L	Westminster Contract Laboratory
Total and Dissolved Silver	EPA 200.8	0.002 mg/L	Westminster Contract Laboratory
Total and Dissolved Strontium	EPA 200.7	0.001 mg/L	Westminster Contract Laboratory
Total and Dissolved Vanadium	EPA 200.8	0.0005 mg/L	Westminster Contract Laboratory
Total and Dissolved Zinc	EPA 200.8	0.020 mg/L	Westminster Contract Laboratory
Dissolved Silica	EPA 200.8	0.1 mg/L	Westminster Contract Laboratory
Total Mercury	EPA 245.1	0.0002 mg/L	Westminster Contract Laboratory

- Table Notes: 1) SM refers to the 23rd 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) YSI/Xylem EXO sondes are used for all lake field measurements except for secchi depth.

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.

Month	Lake Sample Location	Analytes												
		Hand Profile	Secchi depth	Rads	E coli	Zooplankton	Nutrients	Metals	Algae	Chlorophyll <i>a</i>	TOC	TSS	Total Hardness	BTEX
January 1 st 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	
January 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							
February 1 st week	10-00	X	X		X	X								
	10-PZ						X		X	X	X	X		
	10-70	X			X		X				X	X		
February 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							
March 1 st week	10-00	X	X	X	X	X								
	10-PZ			X			X	X	X	X	X	X	X	
	10-70	X		X	X		X	X			X	X	X	
March 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							
April 1 st week	10-00	X	X		X	X								
	10-PZ						X		X	X	X	X		
	10-70	X			X		X				X	X		
April 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							

Month	Lake Sample Location	Analytes												
		Hand Profile	Secchi depth	Rads	E coli	Zooplankton	Nutrients	Metals	Algae	Chlorophyll <i>a</i>	TOC	TSS	Total Hardness	BTEX
May 1st week	10-00	X	X		X	X								
	10-PZ						X		X	X	X	X		
	10-70	X			X		X				X	X		
May 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							
June 1 st week	10-00	X	X	X	X	X								
	10-PZ			X			X	X	X	X	X	X	X	
	10-70	X		X	X		X	X			X	X	X	
June 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							
July 1 st week	10-00	X	X		X	X								
	10-PZ						X		X	X	X	X		
	10-70	X			X		X				X	X		
July 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							
	69-00													X
August 1 st week	10-00	X	X		X	X								
	10-PZ						X		X	X	X	X		
	10-70	X			X		X				X	X		
August 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							
September 1 st week	10-00	X	X	X	X	X								
	10-PZ			X			X	X	X	X	X	X	X	
	10-70	X		X	X		X	X			X	X		

Month	Lake Sample Location	Analytes												
		Hand Profile	Secchi depth	Rads	E coli	Zooplankton	Nutrients	Metals	Algae	Chlorophyll α	TOC	TSS	Total Hardness	BTEX
September 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							
October 1 st week	10-00	X	X		X	X								
	10-PZ						X		X	X	X	X		
	10-70	X			X		X				X	X		
October 3 rd week	10-00	X	X			X								
	10-PZ						X	X	X	X			X	
	10-70	X					X	X					X	
November 1 st week	10-00	X	X		X	X								
	10-PZ						X		X	X	X	X		
	10-70	X			X		X				X	X		
November 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							
December 1 st week	10-00	X	X	X	X	X								
	10-PZ			X			X	X	X	X	X	X	X	
	10-70	X		X	X		X	X			X	X	X	
December 3 rd week	10-00	X	X			X								
	10-PZ						X		X	X				
	10-70	X					X							

- Table notes:
- 1) Hand Profile includes collecting data using the sonde for temperature, pH, conductivity, turbidity, DO, chlorophyll and ORP at 0.1 meter intervals from the surface of the lake to 10 meters depth, then at 1 meter intervals to the bottom of the lake.
 - 2) Rads includes Gross Alpha and Gross Beta.
 - 3) The full list of metals will be analyzed during the first week of Jan, Mar, June, Sept and Dec and the third week in October (after turnover).
 - 4) Only total and dissolved arsenic will be analyzed during the first week of October.
 - 5) 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.
 - 6) Total Hardness is reported as CaCO₃.

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	500 mL	Rectangular plastic	Northglenn
Nitrogen series, UV-254	125 mL	Rectangular brown plastic	Westminster
Rads	1 L	Plastic	Westminster
Zooplankton	250 mL	Plastic	Westminster
Algae	1 L	Plastic	Westminster
Chlorophyll <i>a</i>	1 L	Brown plastic	Westminster
Total metals, Total Hg	500 mL	Plastic	Westminster
Dissolved metals	500 mL	Plastic	Westminster
TOC	40 mL	Glass vial	Thornton
TSS, Total Hardness	500 mL	Plastic jug	Thornton
E. coli	125 mL	Plastic	Thornton
BTEX	3 x 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 by the laboratory 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 EXO2 Sonde – calibrated for hand profile
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 Loggernet 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 EXO2 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 a YSI EXO2 sonde for the hand profile. While the Profiler is deployed, also calibrate a YSI 6600 sonde to swap out.

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.
- Connect the end of the tube to the hose barb on 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 μ m 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 (*Myriophyllum sibiricum*). The hybrid species is more robust and grows even quicker than the Eurasian watermilfoil.

Annual surveys of weevil populations in the lake were performed by contractors until 2013, but beginning in 2014 will be performed by the City of Westminster.

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.

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 IGA 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 a secure internet host site. The City of Thornton is responsible for backing up 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 data entry of the analytical results for their assigned analyses into the spreadsheet. On a semi-annual 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.

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 formats 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.



SUPPLEMENTAL INFORMATION - 3
CLEAR CREEK / STANDLEY LAKE DATA ANALYSIS
AND INTERPRETATION - 2018

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2018 UPPER BASIN WATER QUALITY

I. INTRODUCTION

This document serves as a supplement to the 2018 Clear Creek / Standley Lake Watershed Annual Report. It describes an analysis of 2018 water-quality data in the Upper Basin, Canal Zone, and Standley Lake, and compares data from 2018 to data from the previous five years (2013-2017). Constituents included in this analysis are discharge (flow), total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN). Constituent concentrations that are below the detection limit are analyzed and reported at ½ the detection limit.

II. UPPER BASIN FLOWS AND WATER QUALITY

This section describes an analysis of water-quality data in the Upper Basin in 2018. The analysis is based on data from two sampling locations CC26 (the upper station - Clear Creek at Lawson Gage) and CCAS59/60 (the lower station - Clear Creek upstream of the Church Ditch headgate). 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 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 including and excluding the event samples (e.g. storm event samples).

DISCHARGE

The annual hydrographs for Upper Basin locations CC26 and CC60 (Figure 1) both show a snowmelt-dominated pattern with the rising limb beginning in early May and the falling limb extending through summer. The hydrographs both showed flashy periods during peak runoff in response to precipitation events.

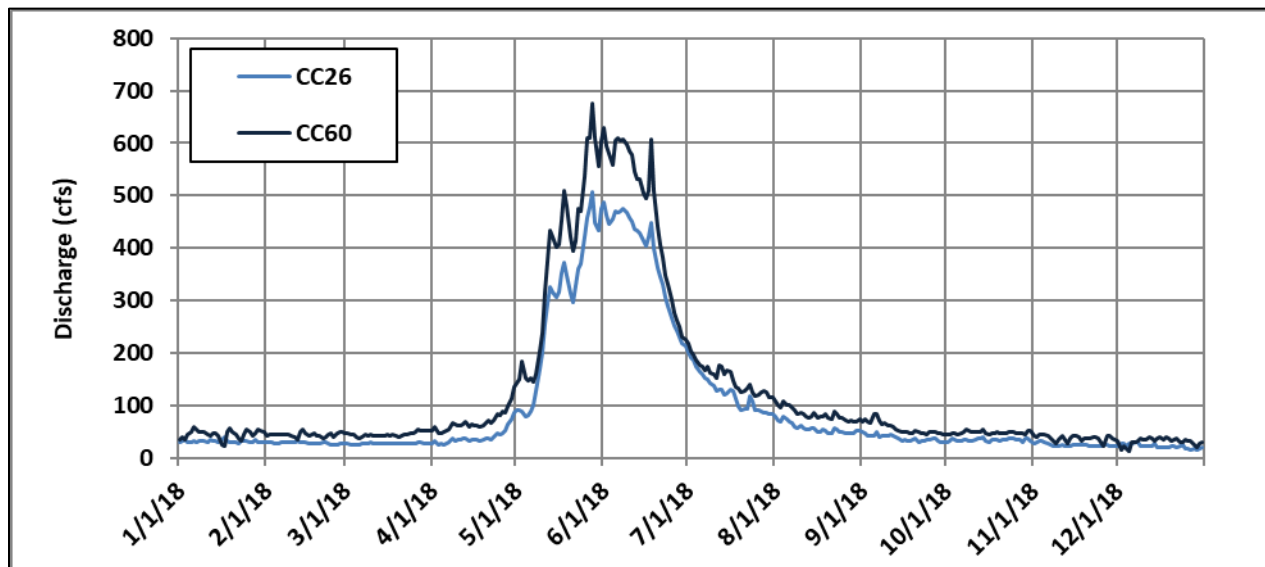


Figure 1. 2018 Clear Creek Hydrographs for the Upper Station (CC26) and the Lower Station (CC60)

Total annual flows at the upper station (CC26) of 66,260 AF were 42% below the 2013-2017 average of 114,015 AF. Total annual flows at the lower station (CC60) of 88,595 AF were 47%

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below the 2013-2017 average of 165,914 AF. Lower total flows from both stations indicate a low flow year and reflect the lower than average precipitation in the Clear Creek Watershed in 2018. Precipitation was lower at both the upper and lower stations, 41% and 70%, respectively¹. Total annual flow volumes for the two locations (2013-2018) are presented in Figure 2. The 2013-2017 average flow volume is included for reference.

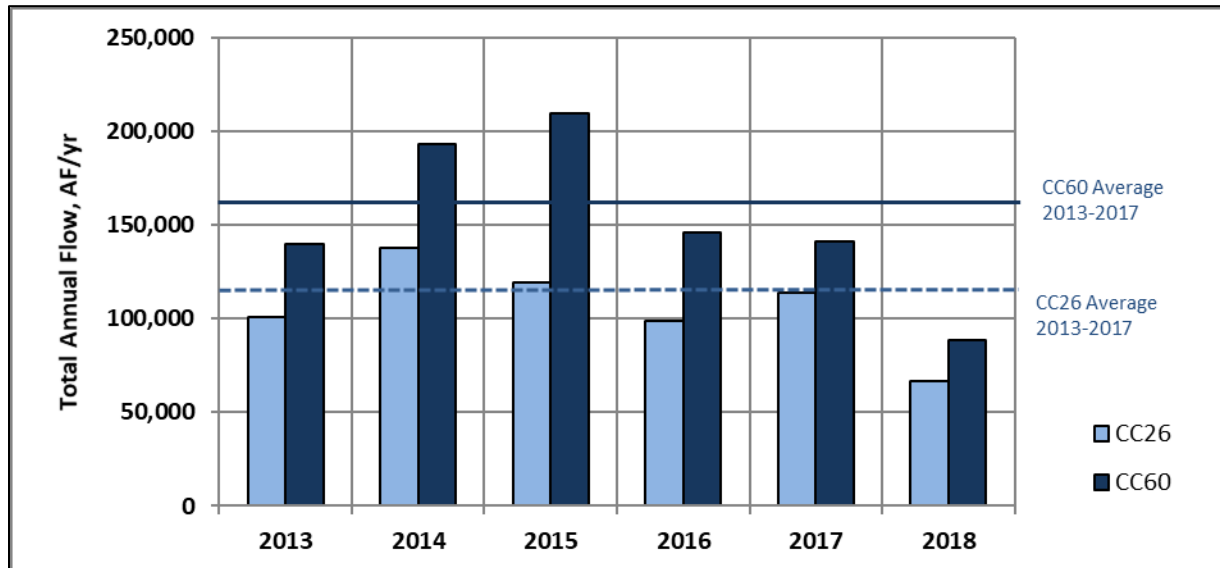


Figure 2. Total Annual Flow in Clear Creek at CC26 and CC60, 2013-2018

Hydrographs from CC60 for 2013-2018 are shown in Figure 3. The patterns and timing of yearly snowmelt-driven flows are consistent with previous years, but the magnitude of the flows is lower than the previous five years. The duration of the runoff period was also lower than the previous five years, with snowmelt runoff occurring sooner and ceasing earlier at the end of June due to warmer than average (4-5 degrees higher) temperatures in May¹.

¹ Precipitation and air temperature data from the upper station are from Cabin Creek weather station located southwest of Georgetown, CO. NOAA station ID: GHCND: USC00051186 (National Weather Service, 2019). Precipitation and air temperature data from the lower station are from Golden 3SW weather station located southwest of Golden, CO. CSU station ID: 053387 (National Weather Service, 2019).

2018 UPPER BASIN WATER QUALITY

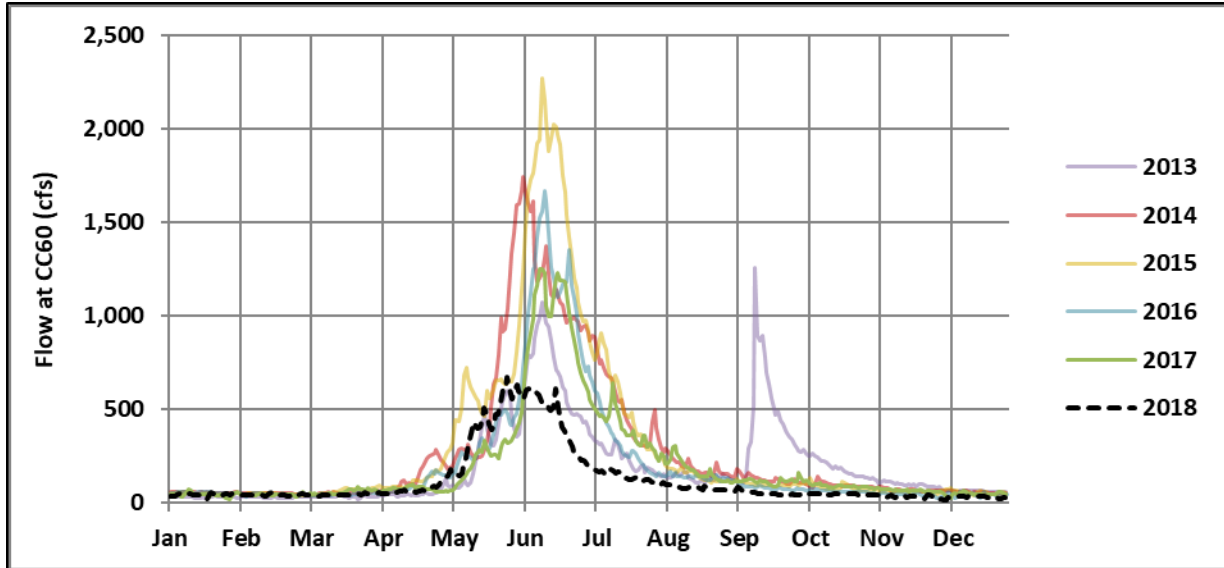


Figure 3. Annual Clear Creek Hydrographs for 2013-2018 (CC60)

WATER QUALITY AND NUTRIENT LOADING

Total Suspended Solids

Total suspended solids concentrations from 2018 ambient composite and grab samples for CCAS59/60 and CC26 are displayed in Figure 4. The maximum observed concentration for the upper station was 9 mg/L on May 9. The maximum observed concentration of TSS was 19 mg/L at the lower station (CCAS59) on May 29. Consistent with previous years, TSS concentrations at the upper station (CC26) were lower than concentrations observed at the lower station.

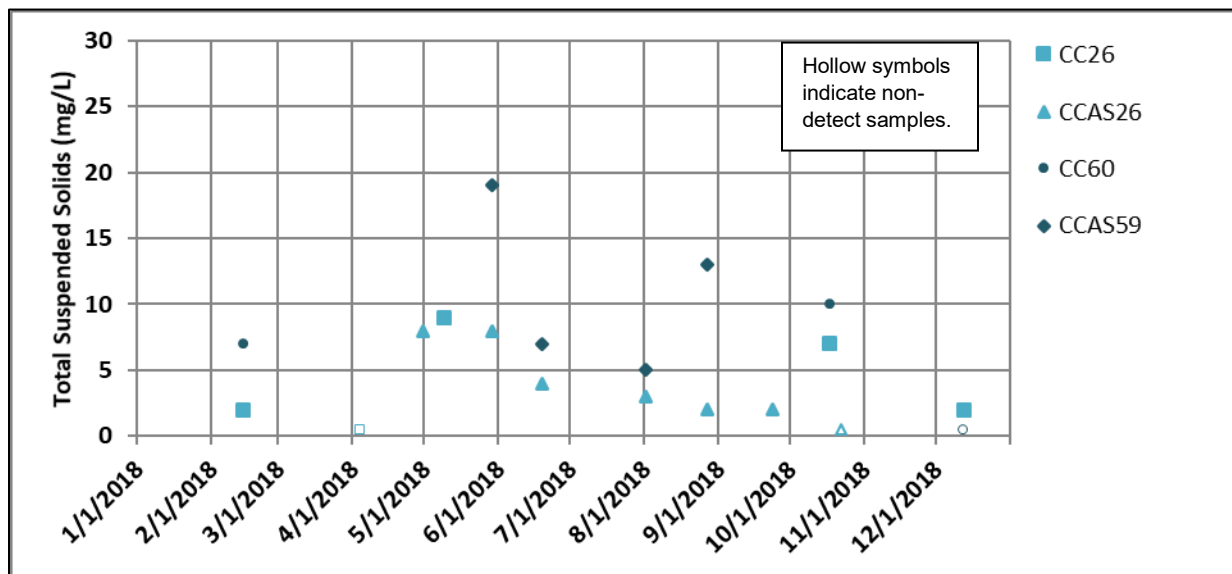


Figure 4. Total Suspended Solids Concentrations (Non-Event) in the Upper Basin, 2018

2018 UPPER BASIN WATER QUALITY

TSS sample results from the previous six years are presented in Figure 5. 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. Peak concentrations in 2018 for CC26 and CCAS59/60 were similar to previous years with higher concentrations corresponding to the runoff period in spring and early summer.

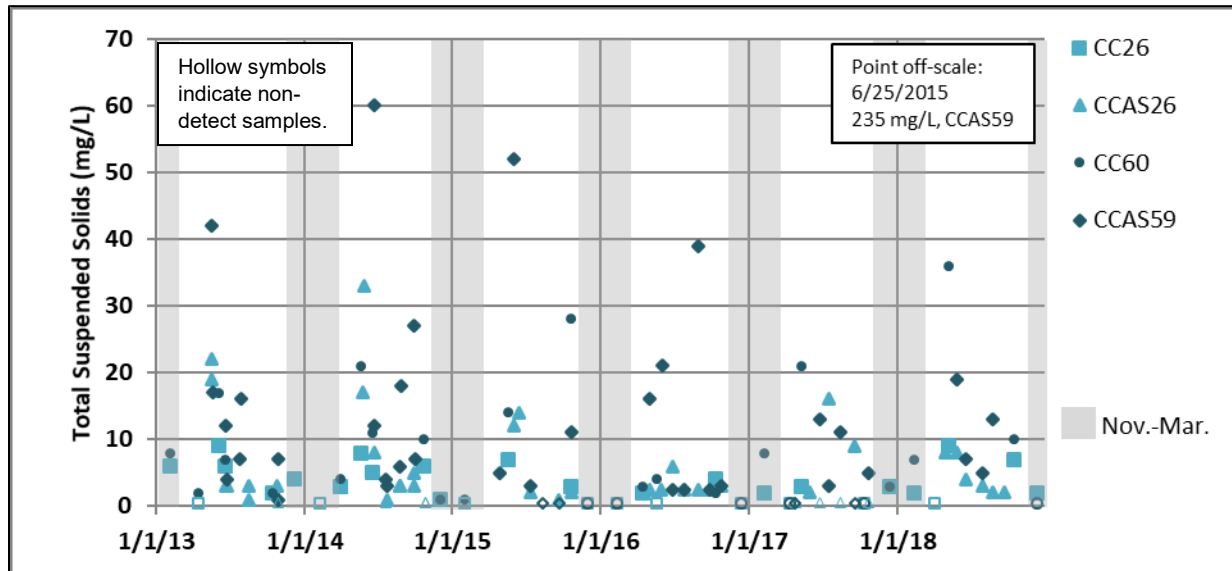


Figure 5. Total Suspended Solid Concentrations (Non-Event) in the Upper Basin, 2013-2018

Average monthly TSS concentrations at the lower station in 2018 are compared to the average and range of the previous five years (2013-2017) for the runoff season in Table 1. The runoff season is typically April through July, however, May, June, and August are shown below due to samples not being taken in April or July. Because runoff began sooner and occurred primarily in May, concentrations are above average in May and below average in June. All concentrations are still within the range observed in the previous five years.

Table 1. Monthly Average Total Suspended Solids Concentrations (Non-Event) in the Upper Basin at CCAS59/60, Red Values are Below Detection Limit and are Reported as ½ the Detection Limit (0.5 mg/L)

Month	2018 Average TSS (mg/L)	2013-2017 Average TSS (mg/L)	2013-2017 Range of TSS (mg/L)
May	27.5	19.3	4.0 – 42.0
June	7.0*	37.2	2.5 – 235.0
August	9.0	14.9	0.5 – 39.0

* "Average" based on one observed value

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. Consistent with previous analyses, 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 2018 and compared to estimates from 2013-2017 (Figure 6). Loads at the upper station were 50% lower than the average of the previous five years. Loads

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at the lower station were 61% below average, this is expected given the lower than average flows observed.

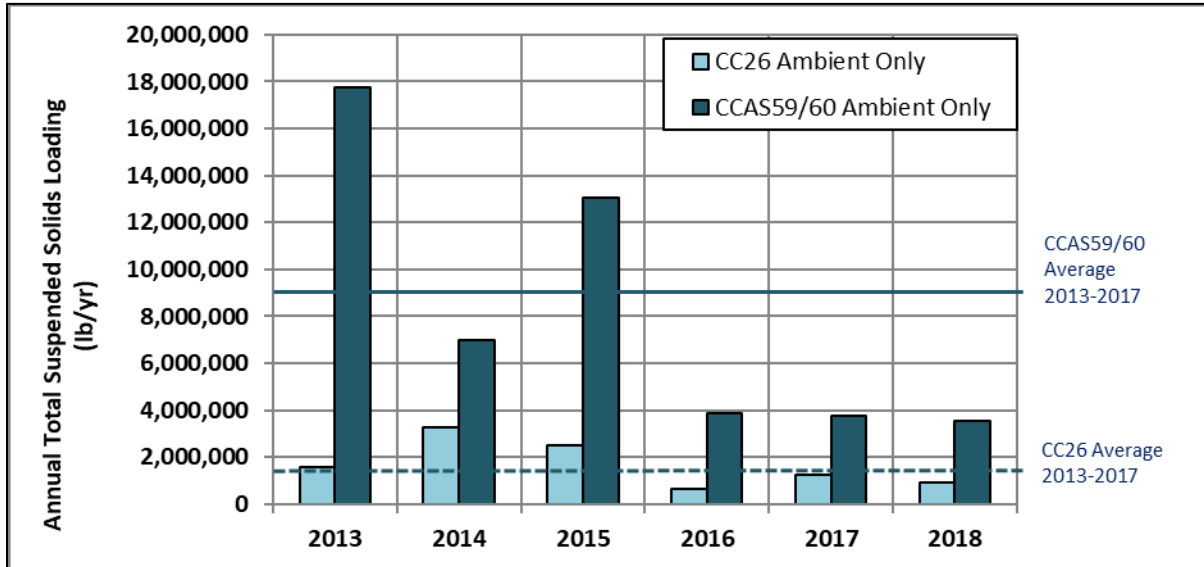


Figure 6. Total Suspended Solids Load Estimates in the Upper Basin, 2013-2018

Volume-weighted concentrations were computed at the two key locations for the past six years (Figure 7). They were calculated by summing the annual load and dividing by the annual flow volume. Volume-weighted concentrations in 2018 were below average but slightly higher than 2016 and 2017.

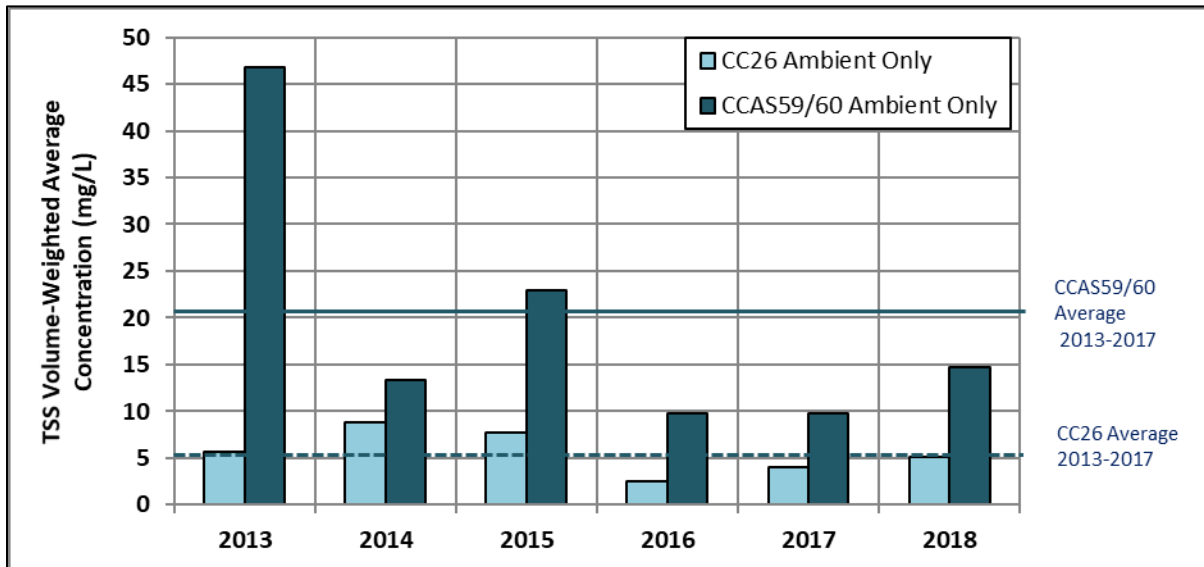


Figure 7. Total Suspended Solids Volume-Weighted Concentration Estimates in the Upper Basin, 2013-2018

The previous two years (2016 and 2017) had typical flows with lower calculated loads due to sample timing. For consistency, sample timing was explored in 2018 as well.

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Figure 8 shows the sample timing in relation to the hydrograph, it is apparent that sampling events were well spread out over the peaks in the hydrograph, indicating that the lower than average loads were likely due to the lower flows (Figure 3) and not sample timing. Samples on the rising limb of the hydrograph are crucial to improving the accuracy of loading estimates as the rising limb typically has higher concentrations.

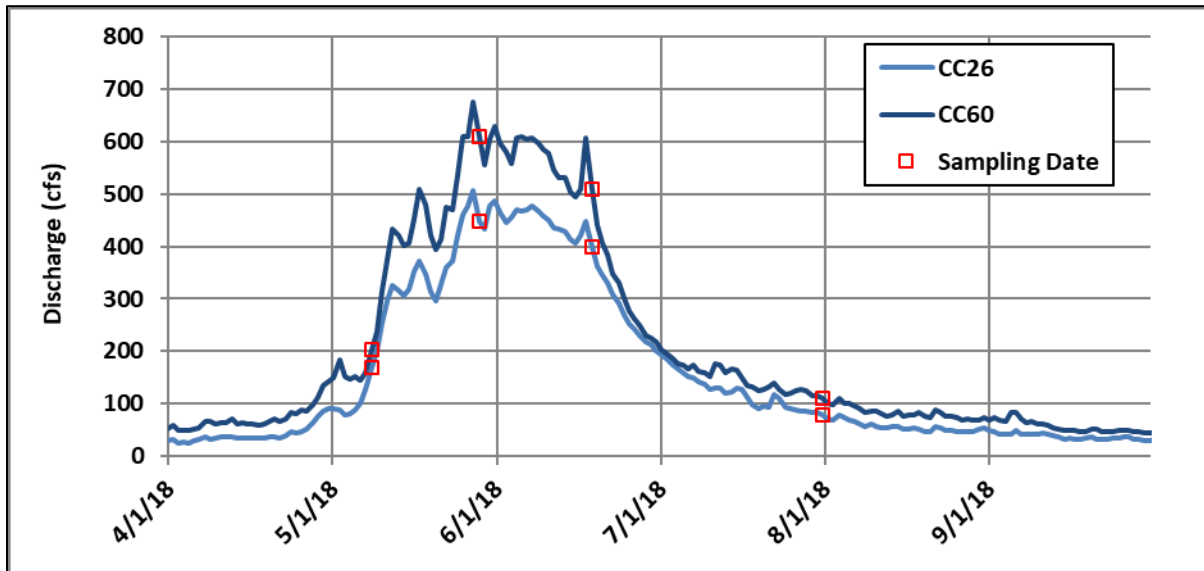


Figure 8. Sample Timing and Flow at CC26 and CC60

Total Phosphorus

Total phosphorus concentrations from grab samples and ambient composites in the Upper Basin are displayed in Figure 9. For both stations, peak concentrations occurred during the beginning of the runoff period with the highest concentration on April 30 (19.1 $\mu\text{g/L}$) for CC26, and May 9 (30.5 $\mu\text{g/L}$) for CC60.

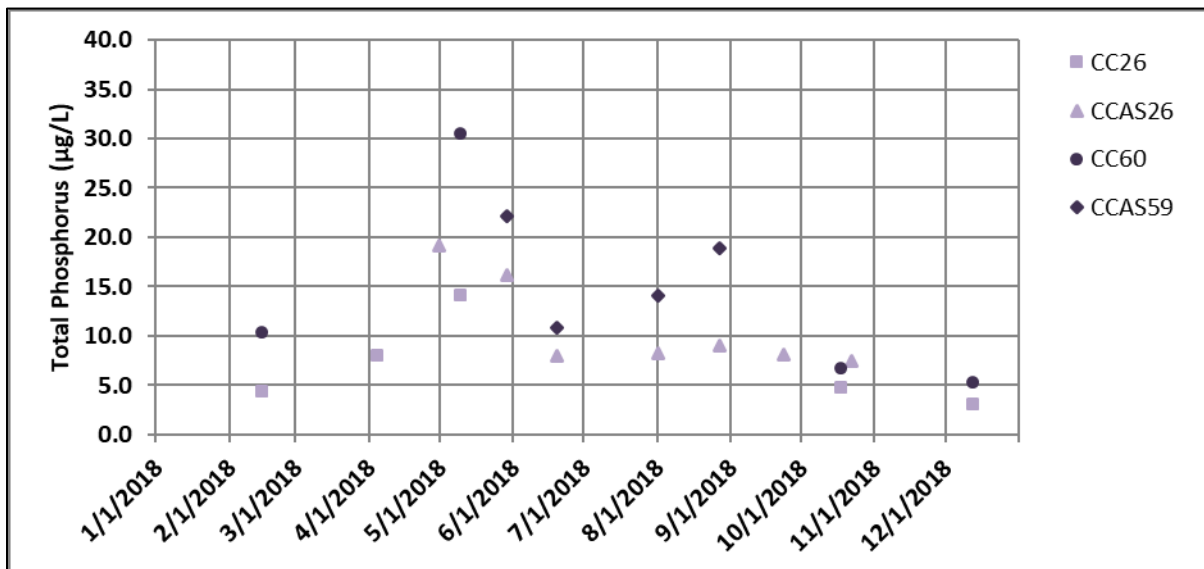


Figure 9. Total Phosphorus Concentrations (Non-Event) in the Upper Basin, 2018

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Total phosphorus concentrations from ambient and grab samples for the period of 2013-2018 are displayed in Figure 10. Previous years (2013-2015) have shown TP concentrations increasing during the snowmelt period, while this pattern was not strongly observed in 2016 and 2017, higher concentration samples taken in 2018 more closely correspond with the runoff period. Sample results still fell within the range of the previous two years due to lower than average flows.

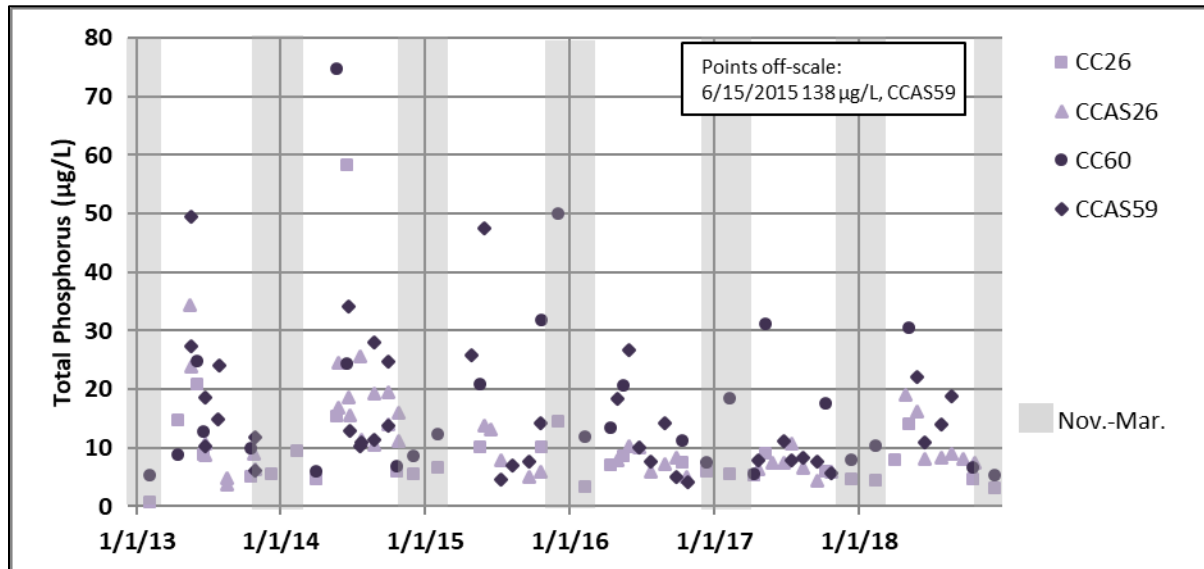


Figure 10. Total Phosphorus Concentrations (Non-Event) in the Upper Basin, 2013-2018

Monthly average TP concentrations for May, June and August 2018 and the 2013-2017 average and range are shown in Table 2. All runoff months were within the observed range of the last five years.

Table 2. Monthly Average Total Phosphorus Concentrations (Non-Event) in the Upper Basin at CCAS59/60

Month	2018 Average TP (µg/L)	2013-2017 Average TP (µg/L)	2013-2017 Range of TP (µg/L)
May	26.4	34.7	18.4 – 74.7
June	10.9*	31.0	10.1 – 138.0
August	16.5	13.8	7.1 – 28.1

* "Average" based on one observed value

Non-storm event TP loading at CC26 and CCAS59/60 was calculated for 2018 and compared to estimates from 2013-2017 (Figure 11). Loads in 2018 were lower than the 2013-2017 average, consistent with TSS loads. Loads for CC26 and CCAS59/60 were 52% and 63% lower than the average, respectively. This load decrease is similar to 2016 and 2017 and is expected given the generally lower concentrations measured. As with the TSS observations, lower flows in 2018 are driving the lower than average loads.

2018 UPPER BASIN WATER QUALITY

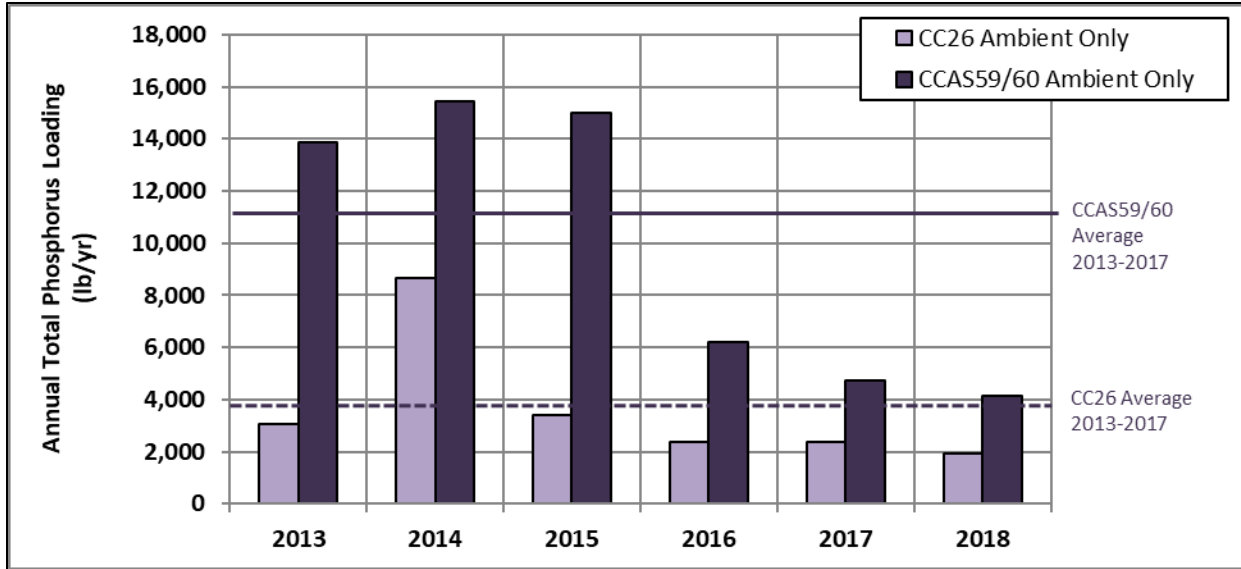


Figure 11. Annual Total Phosphorus Loading Estimates in the Upper Basin, 2013-2018

Volume-weighted concentrations (annual load divided by annual volume) of TP at CC26 and CCAS59/60 are presented in Figure 12 for 2013-2018. In 2018, volume-weighted concentrations at CCAS59/60 were lower than the average of the previous five years, but higher than the last year, highlighting the influence of flows on loading estimates.

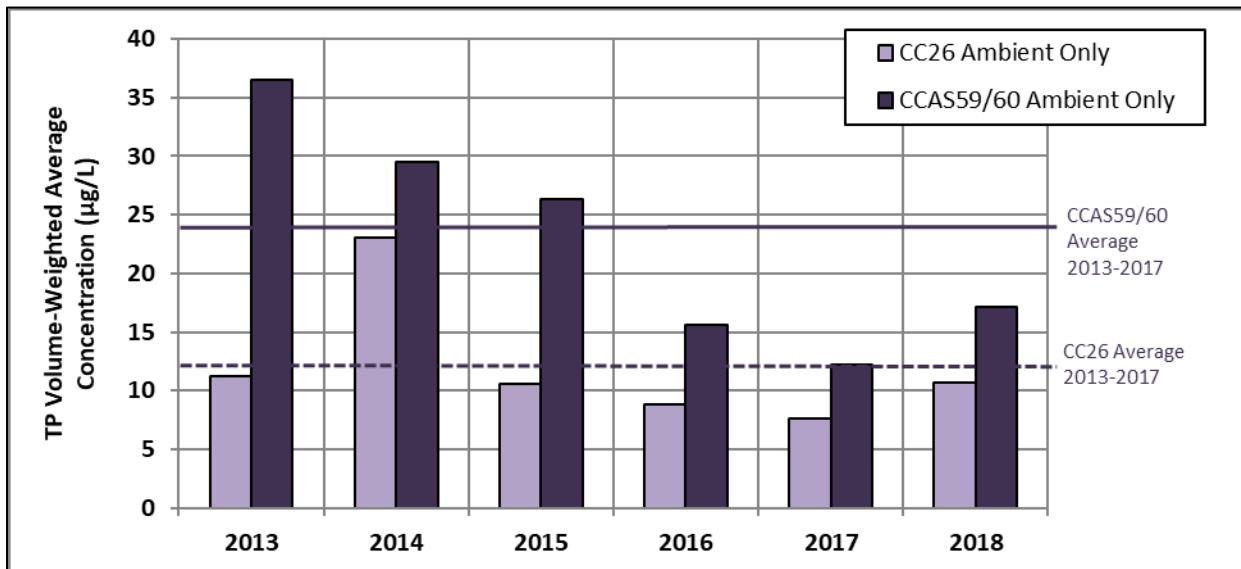


Figure 12. Volume-Weighted Total Phosphorus Concentration Estimates in the Upper Basin, 2013-2018

Total Nitrogen

Total nitrogen concentrations from grab and composite sample data collected in the Upper Basin for 2018 are presented in Figure 13. Both stations follow a seasonal pattern with higher concentrations in the winter and early spring months. This pattern is the opposite of patterns observed in TSS and TP. This is due to differences in the mechanisms of nitrogen loading. The

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maximum concentration at CCAS26 of 640 µg/L was observed on August 1. The maximum ambient concentration of 570 µg/L was observed on December 12 at CC60.

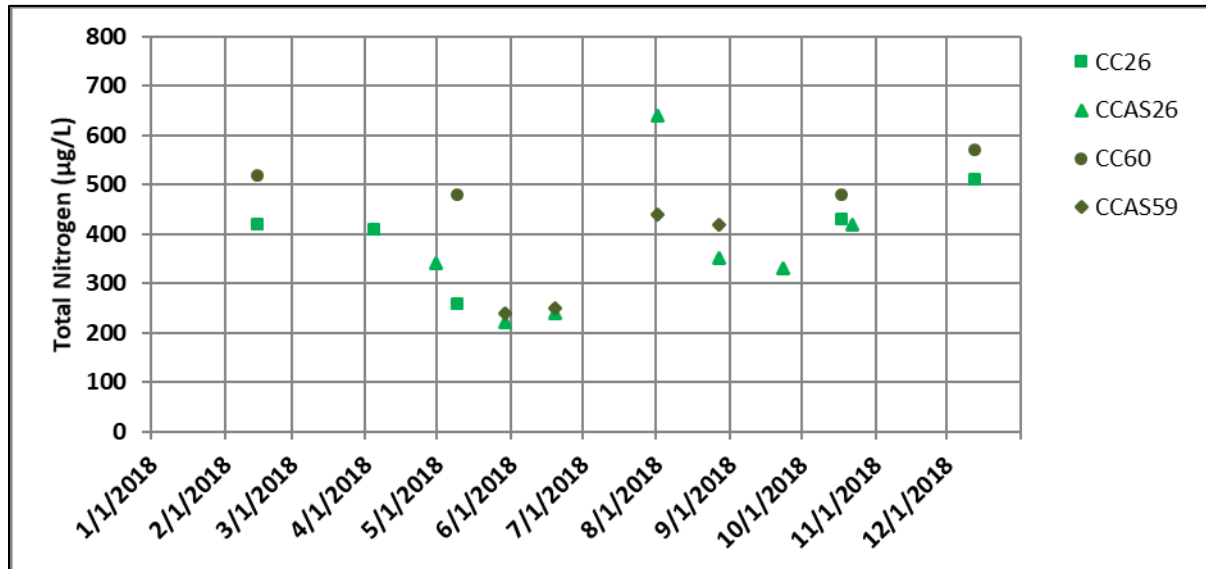


Figure 13. Total Nitrogen Concentrations (Non-Event) in the Upper Basin, 2018

A temporal pattern of lower TN concentrations in summer and higher concentrations during the winter low-flow period (typically November to March) is typically observed each year for both stations. This pattern is driven by the dilution of sources during periods of higher flow, but due to lower flows in 2018, this pattern is not as strongly exhibited. This is evidenced by the lowest concentrations in 2018 occurring during peak runoff in May and June, followed by higher concentrations in late summer instead of fall.

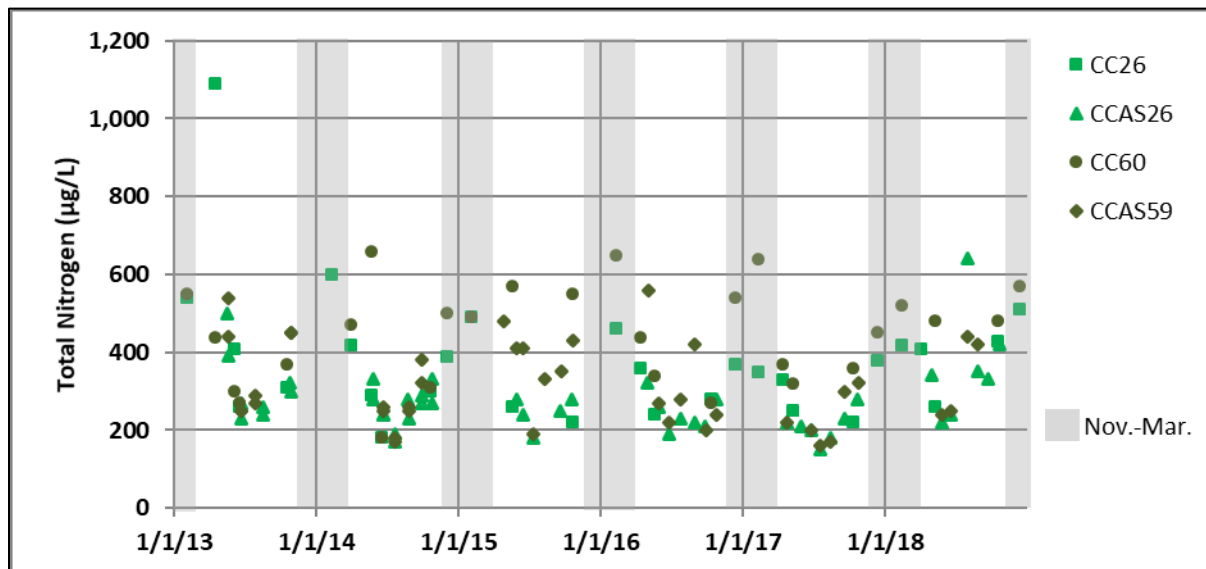


Figure 14. Total Nitrogen Concentrations (Non-Event) in the Upper Basin, 2013-2018

2018 UPPER BASIN WATER QUALITY

A comparison of monthly average TN concentrations at CCAS59/60 for 2018 and the 2013-2017 average for the runoff period is displayed in Table 3. February and December are included in this table because TN concentrations tend to be highest during the winter months. The ambient results for TN are lower than the average of previous years for the two runoff months shown. All of the months with observed data fell within the observed range with the exception of August and December. August had higher than average concentrations due to the flows decreasing at the end of June preventing typical dilution seen in summer. December also had higher than average concentrations, likely due to the lower than average flows for the year.

Table 3. Monthly Average Total Nitrogen Concentrations (Non-Event) in the Upper Basin at CCAS59/60

Month	2018 Average TN (µg/L)	2013-2017 Average of TN (µg/L)	2013-2017 Range of TN (µg/L)
February	520*	582.5	490 – 650
May	360	490	320 – 660
June	250*	272.5	180 – 410
August	430	286	170 – 420
December	570*	496.7	450 – 540

* "Average" based on one observed value

Loads in 2018 for CC26 and CCAS59/60 were lower (28% and 46% respectively) than the average of the previous five years (Figure 15). This is expected given the lower than average flows.

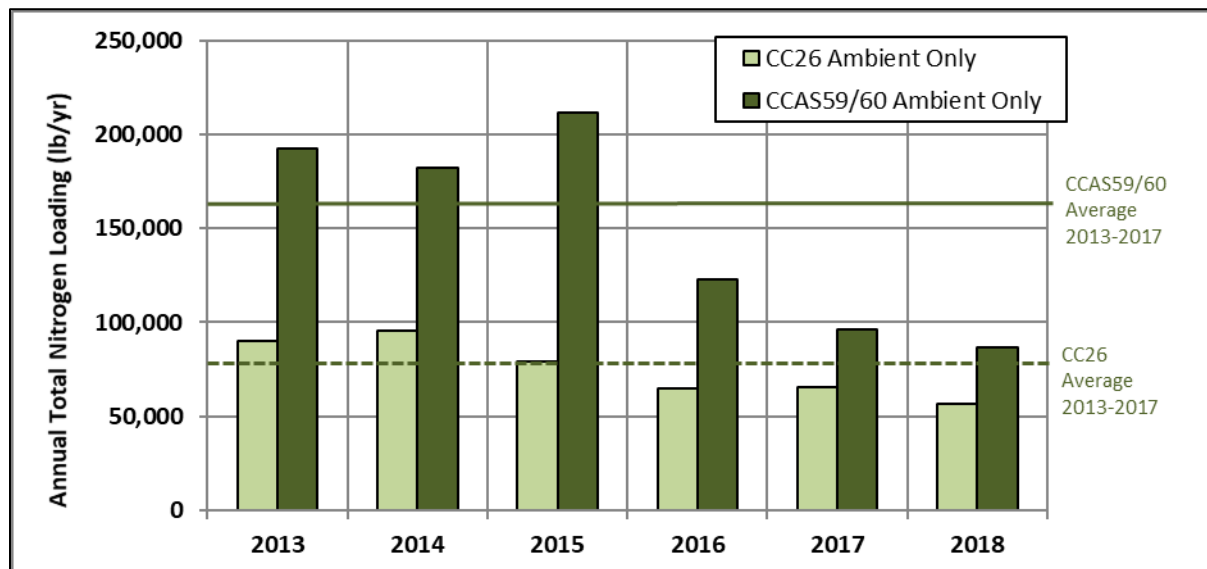


Figure 15. Total Nitrogen Loading Estimates in the Upper Basin, 2013-2018

Volume-weighted concentrations (annual load divided by annual volume) of TN at CC26 and CCAS59/60 are presented in Figure 16 for 2013-2018. Volume-weighted average concentrations for CC26 were 23% above average, and slightly above (0.4%) average for CCAS59/60. This is likely due to the lack of dilution resulting from lower flows.

2018 UPPER BASIN WATER QUALITY

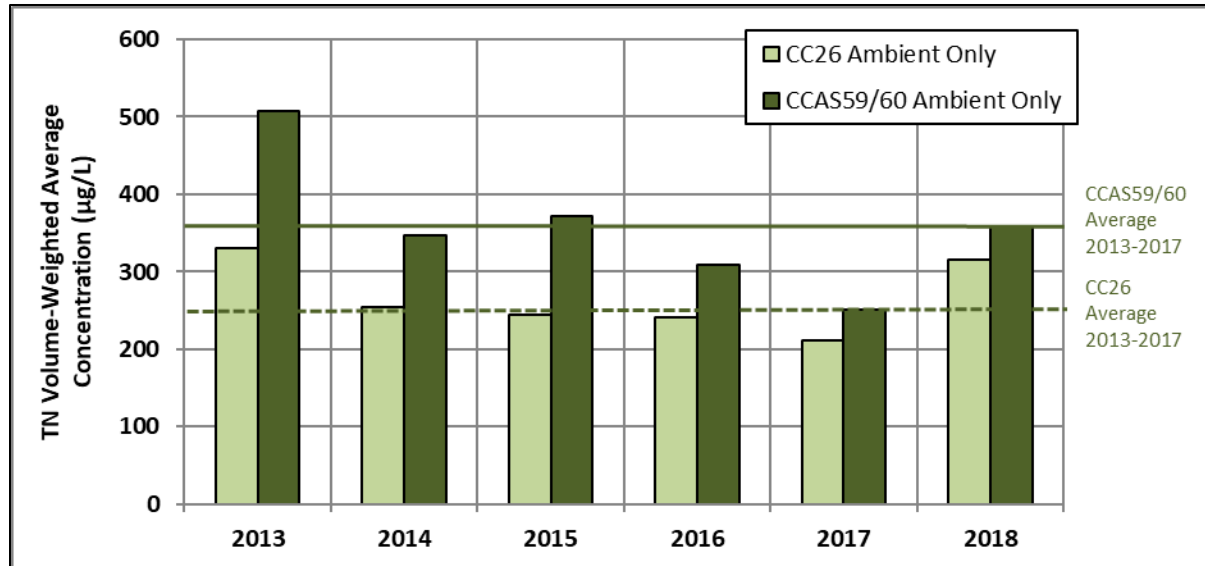


Figure 16. Volume-Weighted Total Nitrogen Concentration Estimates in the Upper Basin, 2013-2018

STORM LOADING EVENTS

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, event-triggered sampling results at station CC59 are included for analysis in this section. 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.

In June, July, and September 2018, three event-triggered samples were collected at CC59. The effects of these storms on loading estimates are presented in Table 4 and Figure 17. Incorporating these event samples into the loading calculations increases the annual loads of TN (2%), TP (40%), and TSS (35%). The effects are even more apparent in loading estimates for the individual months (Table 4).

The effects of a single storm event are exemplified by the June 18 event. This single-day event is estimated to have contributed 885 lbs of TN, 1,046 lbs of TP, and 596,853 lbs of TSS loading. These amounts represent a substantial fraction of the annual loading (TN: 1%, TP: 25%, TSS: 17%); and represent a substantial fraction of the loading differences seen in Figure 17. The large loading estimates for this event are the result of the high concentrations measured on this date (TN: 520 µg/L; TP: 330 µg/L, and TSS: 189 mg/L). Storm event loads were not as impactful this year as they have been in previous years. While observed storm concentrations were higher than ambient, they were not as high as observed storms such as in 2017 when a single storm resulted in concentrations of 3,295 µg/L, 1,900 µg/L, and 1,840 mg/L for TN, TP, and TSS, respectively at CC59. This demonstrates that not all storm events have high

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concentrations, and correspondingly large impacts on annual totals. For context, the previous three years of event load TSS graphs (with and without storm events) are provided in Figure 18. Interestingly, 2018 TSS loads increased by 35% during the three storm events, and 2017 TSS loads increased 142% based upon two storm events. The differences in percentages highlight the variability within storm events, making comparisons of the effects of storm events on a year-to-year basis more difficult. 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 4. Effect of Storm Events on Annual and Monthly Loading at CCAS59/60 Compared to Non-Event Loading

Time Period	Increase in TN Loading with Storm Events	Increase in TP Loading with Storm Events	Increase in TSS Loading with Storm Events
2018 (Annual Load)	2%	40%	35%
June 2018 (Monthly Load)	5%	96%	74%
July 2018 (Monthly Load)	9%	160%	386%
September 2018 (Monthly Load)	9%	54%	82%

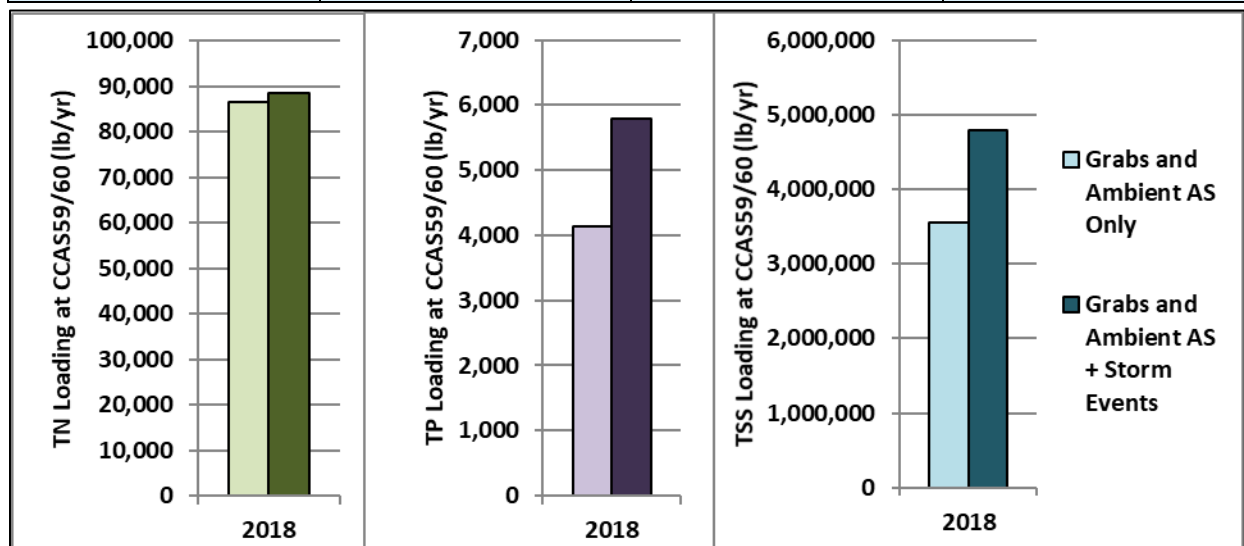


Figure 17. Total Nitrogen, Total Phosphorus, and Total Suspended Solids Loading in 2018 With and Without Storm Events (Ambient Samples Collected at CCAS59/CC60, Storm Event Samples Collected at CC59)

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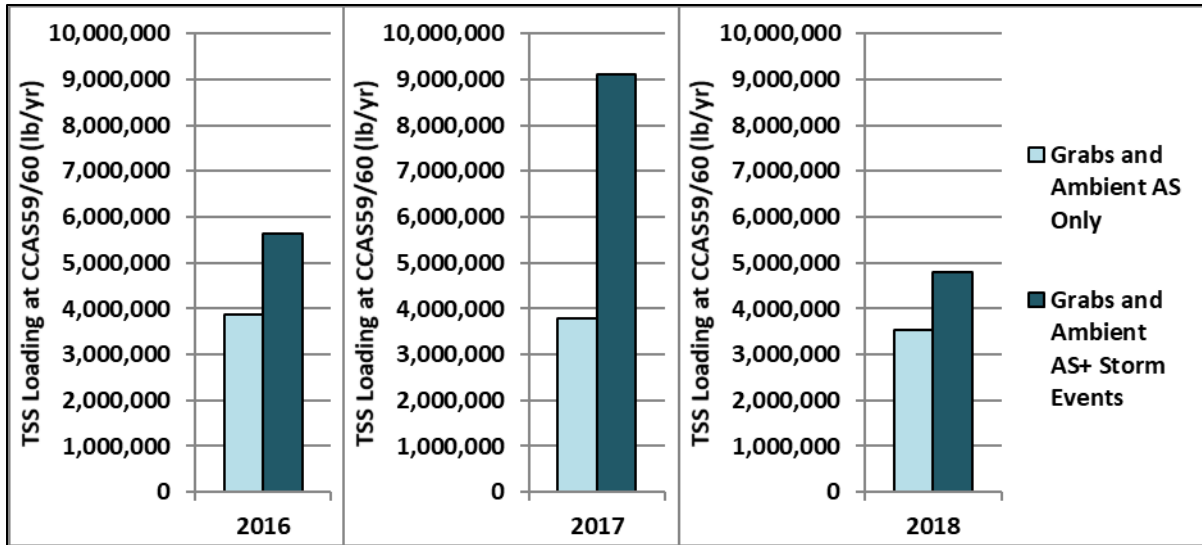


Figure 18. Total Suspended Solids Loading in 2016, 2017, and 2018 With and Without Storm Events

III. CANAL ZONE FLOWS AND WATER QUALITY

The Upper Basin is the source for the water diverted into the inflow canals that lead to Standley Lake. This section presents the timing and volume of flows for the inflow canals. In addition, a description of water-quality changes along the two major inflow (FHL and Croke) canals from their points of diversion on Clear Creek to the reservoir are included.

FLOWS FROM CANALS AND KDPL

Water enters Standley Lake via four conveyances: Church Ditch, Croke Canal, Farmers' High Line Canal (FHL), and Kinnear Ditch Pipeline (KDPL). Inflows for 2018 from each of these sources are shown in Figure 19. During the irrigation season (April to October), the FHL Canal was the dominant source of inflows. Starting in July, 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 cessation of flows from FHL in early November, the Croke Canal provided the only inflow to Standley Lake until early April.

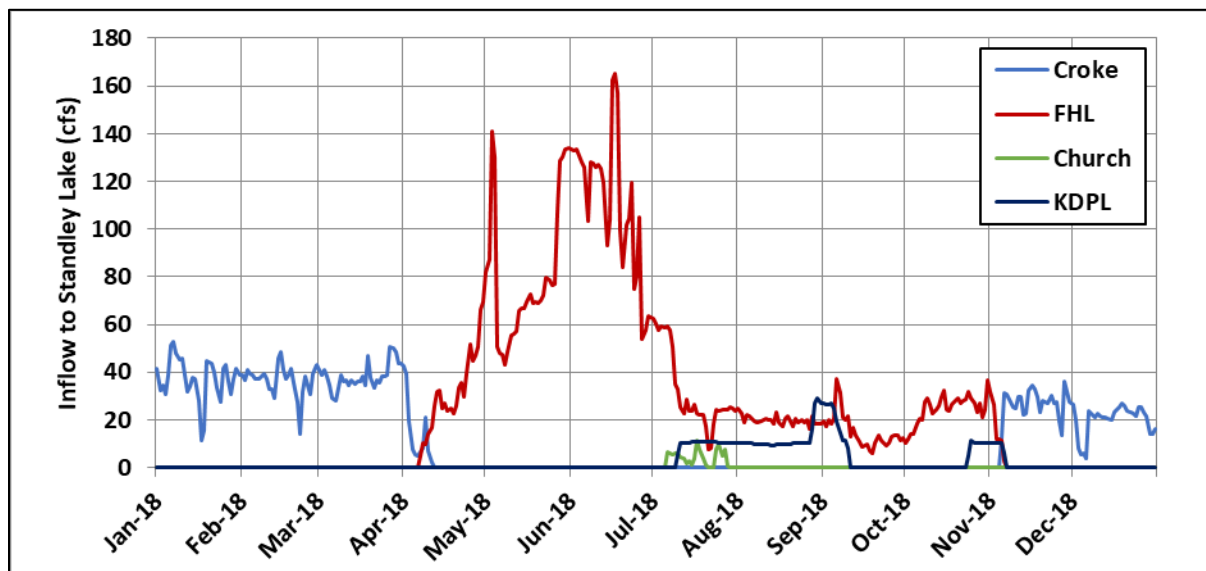


Figure 19. Inflow to Standley Lake, 2018

CHANGES IN WATER QUALITY FOR THE FHL AND CROKE CANALS

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. Median annual concentrations were calculated for TSS, TP, and TN. These medians were calculated for the

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canal headgate and at the release points into the lake for the Croke and FHL. For the Croke Canal, there is substantial increase in TSS concentrations between the headgate and the release point (Figure 20, right). The increase in TSS is associated with a corresponding increase in TP (Figure 21, Figure 20, right). However, there is little difference between locations for TN (Figure 22, right). In contrast, less difference is observed in the FHL between headgate and turnout for TSS, TP, or TN (Figures 20-22, left). The specific sources of TSS and associated TP along the Croke Canal are unknown at this time.

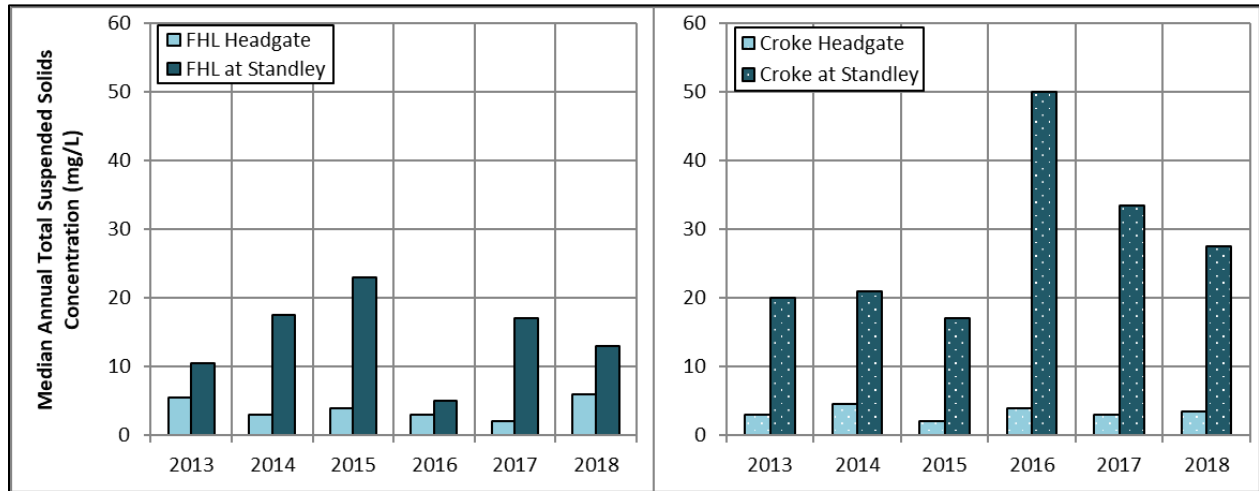


Figure 20. Median Total Suspended Solids Concentrations in FHL (left) and Croke (right) Canals

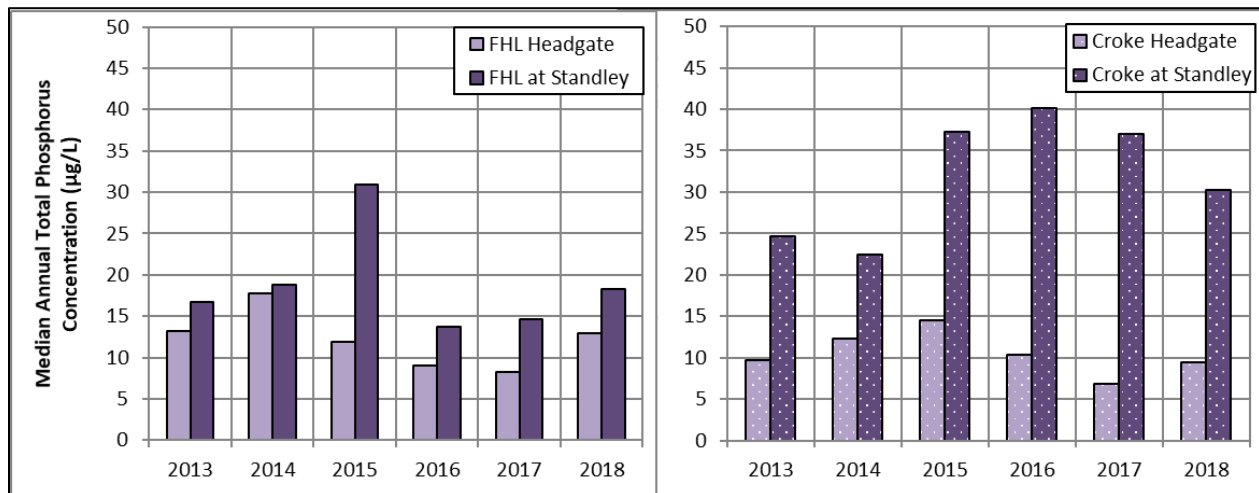


Figure 21. Median Total Phosphorus Concentrations in FHL (left) and Croke (right) Canals

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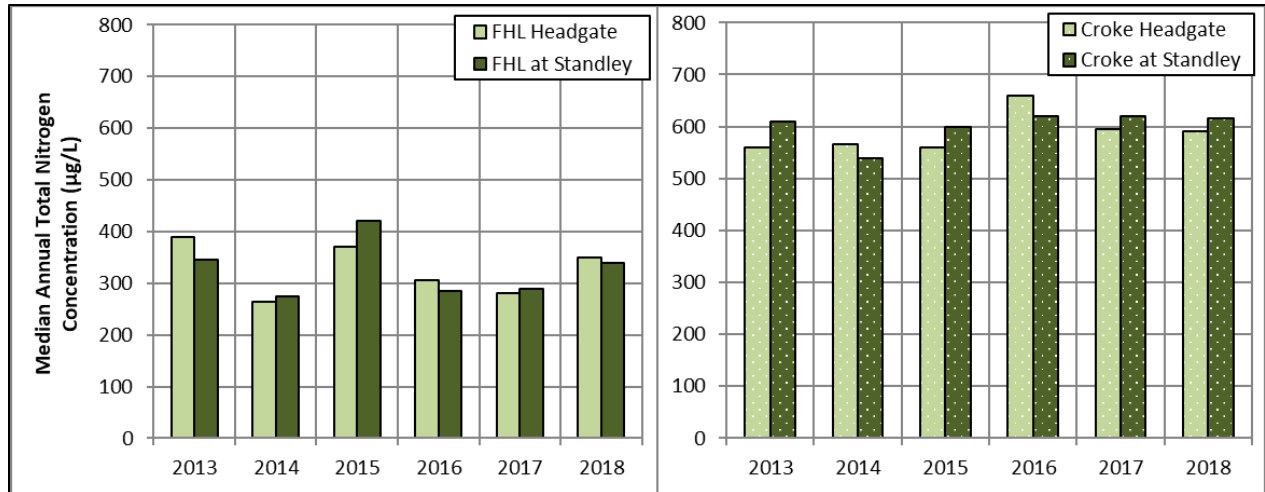


Figure 22. Median Total Nitrogen Concentrations in FHL (left) and Croke (right) Canals

2018 loadings per unit of discharge (lbs per AF) for the Croke and FHL canals are shown in Table 5 compared to the 2014-2017 average (2013 is excluded due to the influence of the floods). Total loads for TN, TP, and TSS were summed and divided by total inflows for the year (AF), providing the amount of loading (lbs) attributed to one AF of discharge. Comparing the two canals in 2018 showed that while the Croke Canal on average contributes 29% more TSS, 27% more TP, and 50% more TN than the FHL per AF, percentages in 2018 decreased greatly for TSS and TP (to 3% and 17% respectively). This change is due to lower than average concentrations observed in the Croke Canal at Standley Lake. Because the Croke is a winter canal and remains at a relatively consistent flow for the duration of the season (November-March), changes in loads are highly dependent on concentrations. FHL concentrations were consistent with previous years.

Although concentrations in the Croke Canal were lower, they were still higher than concentrations observed in the FHL. This is primarily due to the Croke Canal having higher concentrations at baseline flow rates when compared to the FHL, as shown with TP in Figure 23. TN and TSS concentrations follow a similar pattern as TP, with consistently higher concentrations at baseline flow rates. Reasons for higher baseline concentrations in the Croke Canal remain unknown.

Mechanistically, it is known that TSS and TP concentrations tend to increase when flows increase due to bank scour and particle transport. Higher concentrations observed in the Croke appear to be independent of flow rate, as opposed to the FHL which appears to demonstrate an increase in concentrations with increased flow. Additionally, the Croke occasionally runs in May or June when water is available and the reservoir is low (see Hydros, 2018). This has happened four times since 2010 (2010, 2011, 2013, 2017). When this has occurred and a sample was taken (three of the four years), the concentrations have been consistent with concentrations taken during low winter flow rates. Reasons the Croke Canal concentrations do not seem to follow a pattern with respect to flow are unclear. When flows do increase in May and June however, there is a resulting increase in loads because loading calculations are dependent on flow. This is likely the reason for the larger fractions of loads observed in the

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Croke in 2017 (Hyrdos, 2018). The absence of the Croke running in May or June, lower than average concentrations of TP and TSS, and lower flows overall are the reasons the fraction of TSS and TP loads this year contributed by the Croke were more aligned with the fraction of flow contributed. Interestingly, the Croke continued to contribute roughly half of the TN load, this is expected because concentrations in the Croke tend to be close to 50% higher than the FHL. Although the canals are close in proximity, the higher concentrations observed continue to show that a large amount of nutrient and TSS nonpoint source loading occurs as water moves through the Croke Canal.

Table 5. Croke Canal and the FHL Canal, Loading (lbs) Per Unit of Discharge (AF), 2018 Compared to the 2014-2017 Average

Croke Canal vs. FHL Canal (lbs of loading/AF)				
Constituent	Croke		Farmers' High Line	
	2018	2014-2017 Average	2018	2014-2017 Average
TSS	80.8	109.2	78.7	78.0
TP	0.08	0.11	0.07	0.08
TN	1.66	1.74	0.9	0.9

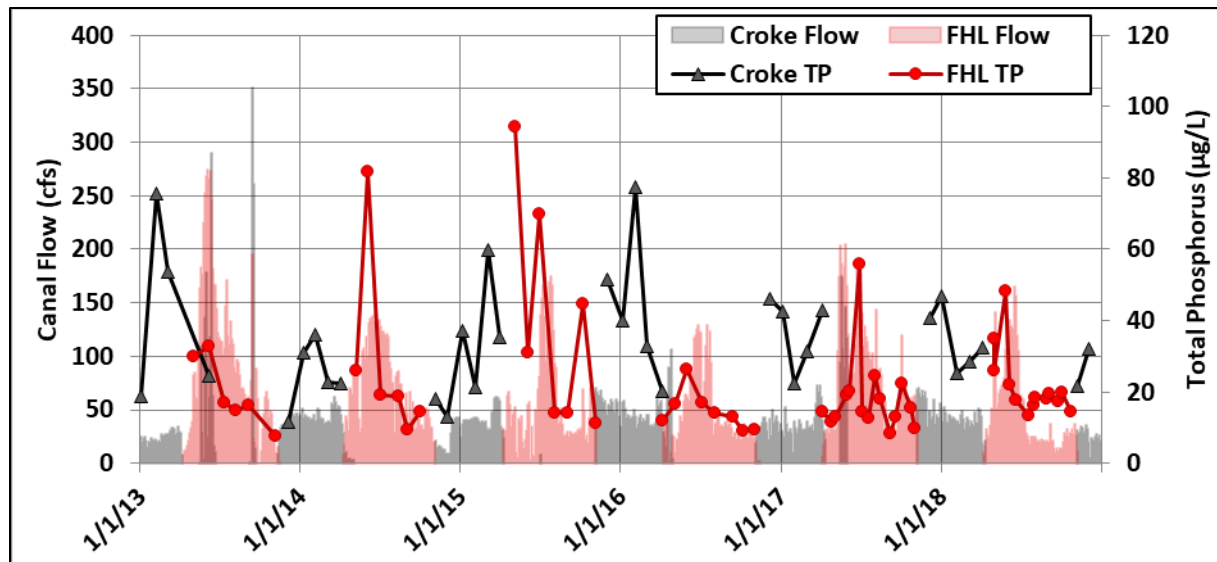


Figure 23. Flow and Measured Concentrations in the Croke and FHL Canals at Standley Lake, 2013-2018

IV. 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.

FLOWS AND CONTENTS

Seasonal patterns and daily flow rates for the four inflows to Standley Lake were presented previously (Figure 19). Annual flow volumes for each source during the period of 2013 to 2018 are shown in Figure 24. The FHL and Croke Canals are the largest sources of water to Standley Lake providing 62% and 32%, respectively, of the total inflows. Church Ditch and KDPL inflows provide a smaller percentage of the total inflows (6% combined).

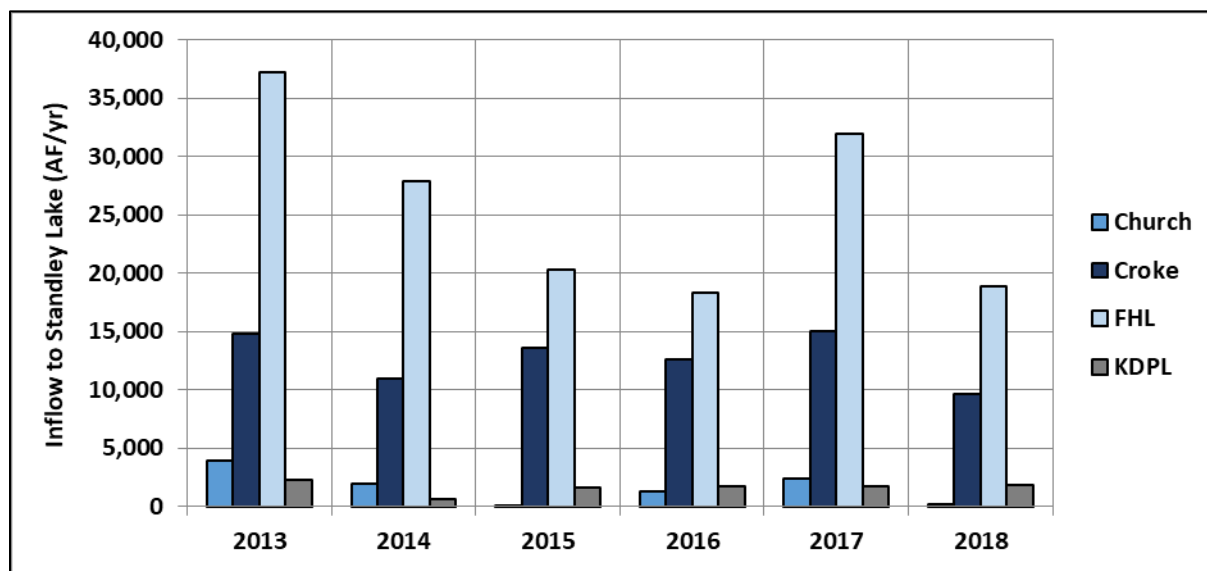


Figure 24. Inflow Volumes to Standley Lake by Source, 2013-2018

Standley Lake contents for the period of 2013-2018 are displayed in Figure 25. Contents were calculated from gage-height measurements using the elevation-area-volume relationship for the lake. In the beginning of 2018, lake contents were higher than the previous five years, this led to decreased inflows to the lake during Spring. Dry conditions increased demand and decreased inflows resulting in a large drawdown. Standley Lake ended the year with the lowest levels observed in December in the last five years.

2018 STANDLEY LAKE WATER QUALITY

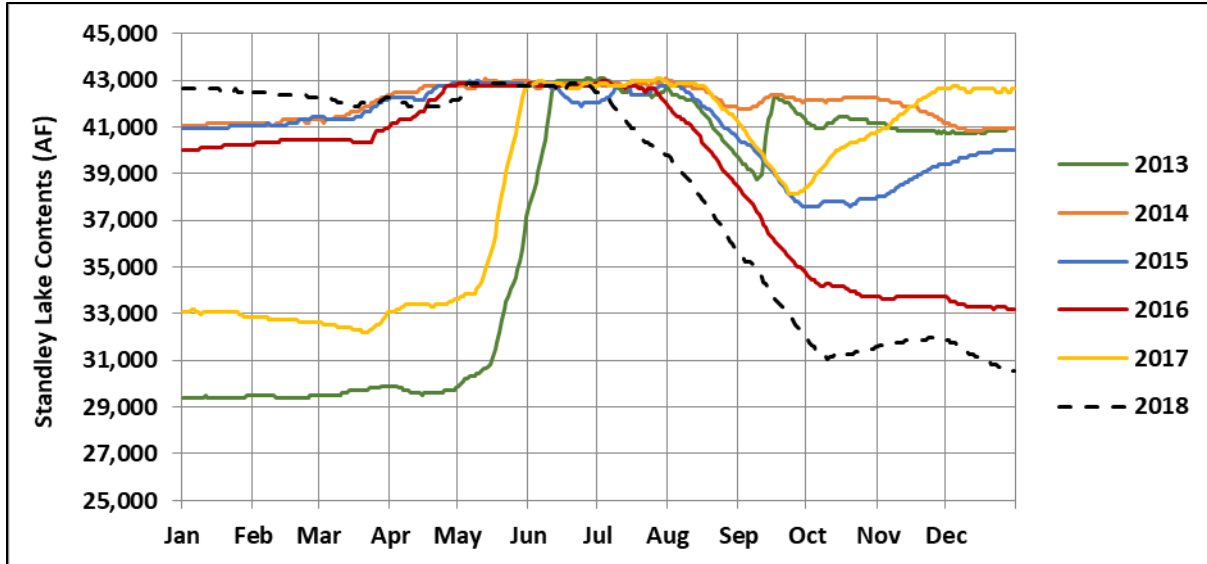


Figure 25. Standley Lake Contents, 2013-2018

Total inflow and outflow rates to/from the lake in 2018 are presented in Figure 26. Inflows are less than outflows from the beginning of the year until May when inflows increased briefly during the runoff period. Due to higher lake levels starting the year, inflows were not as substantial as previous years, additionally, as discussed in the Upper Basin section, flows were lower than average in the watershed. As such, inflows to Standley lake were 31% lower than the previous 5 years. Because outflow in Standley Lake is dependent on drinking water demands, it is relatively consistent over the years barring unusual weather patterns. In 2018, outflows in Standley Lake were 8% higher than the previous five years, likely due to drier conditions in 2018.

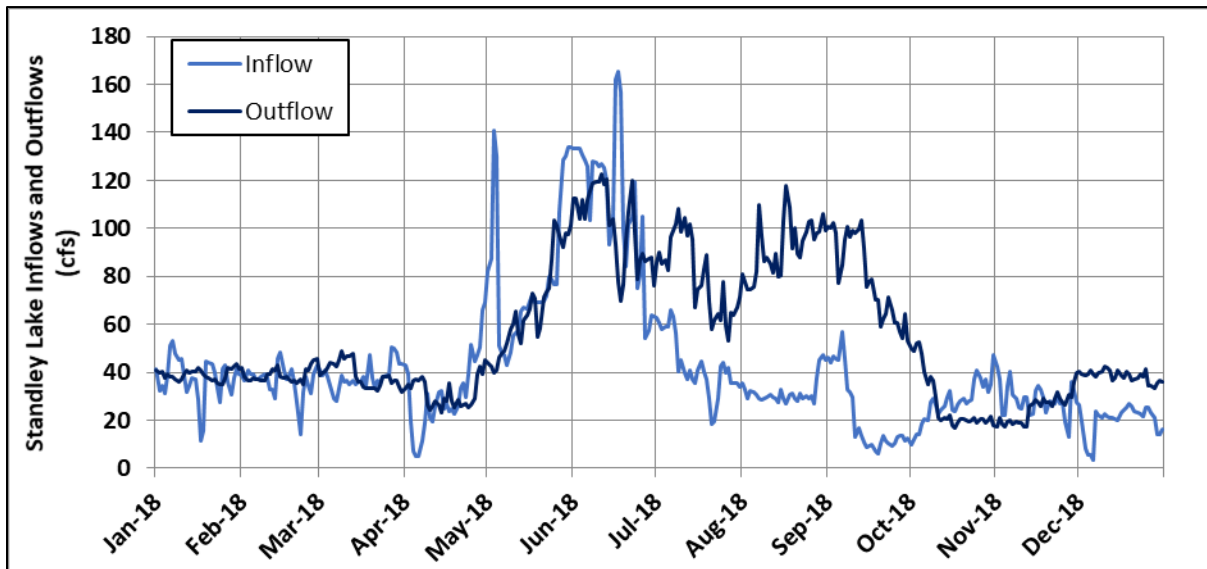


Figure 26. Inflows to and Outflows from Standley Lake, 2018

2018 STANDLEY LAKE WATER QUALITY

Overall, the largest outflows occurred during the summer and fall. Total measured annual inflow (the sum of all four sources) and outflow for 2013-2018 are presented in Figure 27.

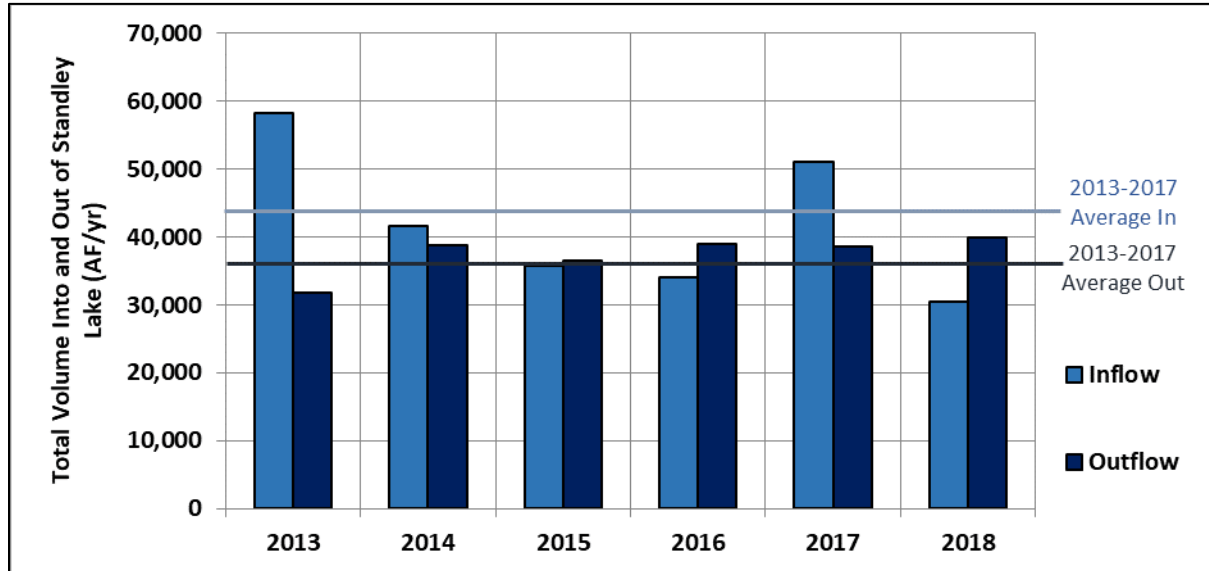


Figure 27. Total Measured Annual Standley Lake Inflow and Outflow, 2013-2018

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 flows and concentrations on a daily basis. To compute daily concentrations, a mid-point function was used to fill concentrations between the available sample data. Event samples collected on the canals include 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. All of the loading calculations presented in this section include the 2013 floods. In some cases, the inclusion of 2013 causes ∞ values. As such, 2018 total loads into the lake are compared to the average of previous years with and without 2013 included.

Total Suspended Solids

Total suspended solids loading into Standley Lake for the 2013-2018 period is presented by source in Figure 28. The Croke and FHL canals, the largest contributors of water to the reservoir, delivered the largest TSS loads (Figure 28). Consistent with most years, the FHL contributed the largest (65%) portion of the annual TSS load. This is expected as the canal provided 62% of the total annual inflow to the reservoir. The Croke Canal contributed 34% of the annual TSS load and 32% of the total annual inflow to the reservoir.

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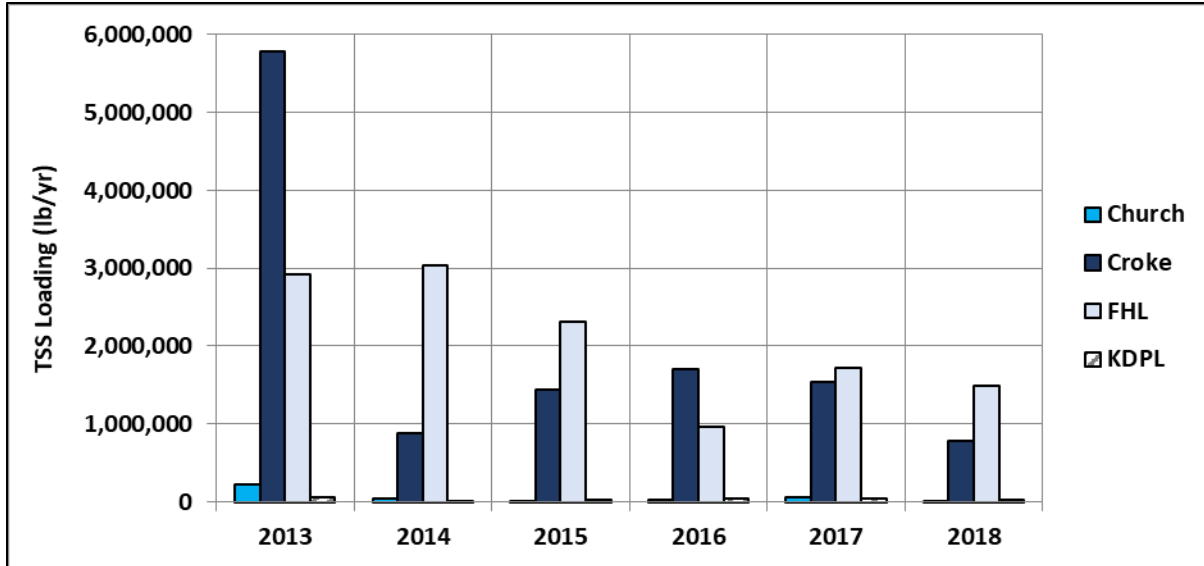


Figure 28. Total Suspended Solids Loading Into Standley Lake by Source, 2013-2018

Estimated annual TSS loadings into and out of Standley Lake for 2013-2018 are shown in Figure 29. Non-storm event loading of total suspended solids in 2018 was below (-50%) the average of the past five years, however, as mentioned in the 2017 annual report (Hydros, 2018) the average is driven higher due to large contributions of TSS from the 2013 flood. When removing 2013 from the average calculations, 2018 TSS loads are 34% below the 2014-2017 average. Loadings of total suspended solids into the lake were greater than outflow, indicating some level of solids retention. Loads leaving the reservoir were 14% lower than the previous five years.

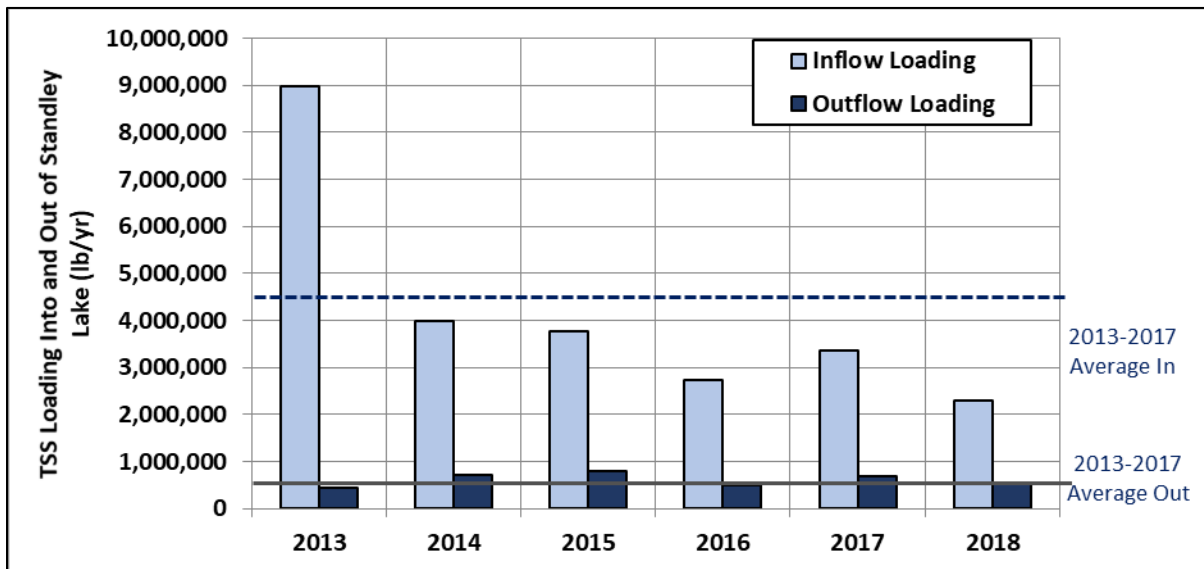


Figure 29. Total Suspended Solids Loading Into and Out of Standley Lake, 2013-2018

Volume-weighted TSS concentrations into Standley Lake are presented in Figure 30 by source. The Croke had the highest volume-weighted concentration, but was only slightly higher than the

2018 STANDLEY LAKE WATER QUALITY

FHL this year. The KDPL was the lowest consistent with previous years. The combined average of the canals (28 mg/L) in 2018 was 25% lower than the 2013-2017 average (37 mg/L).

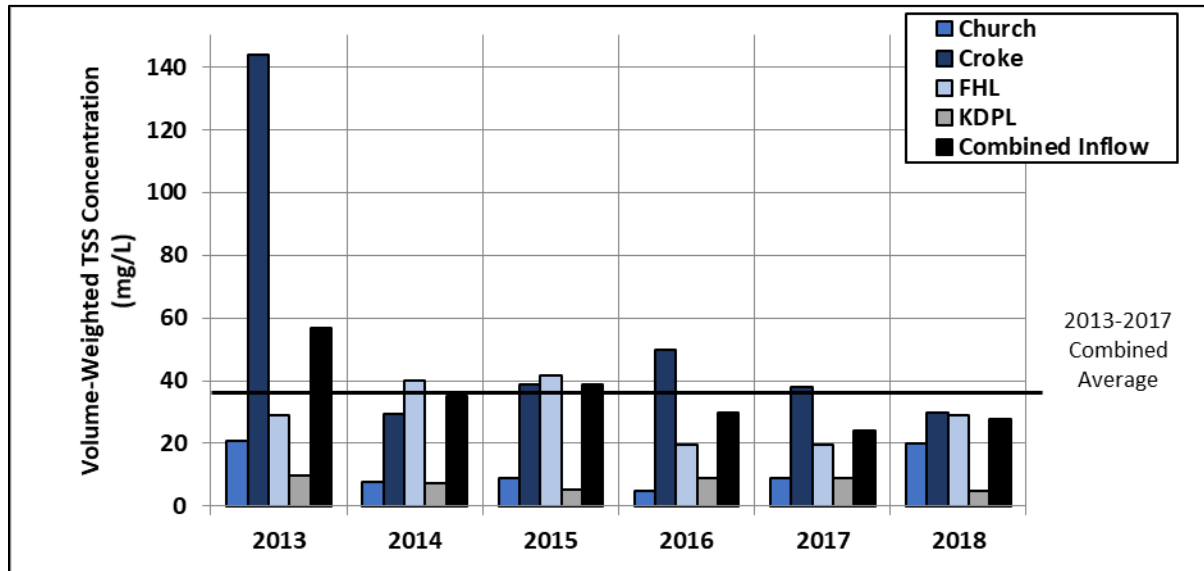


Figure 30. Volume-Weighted Total Suspended Solids Concentrations Into Standley Lake by Source, 2013-2018

Total Phosphorus

Total phosphorus loading into Standley Lake for the 2013-2018 time period is presented by source in Figure 31. Similar to TSS loadings, the FHL and Croke Canals contributed the largest TP loads (60% and 37% respectively).

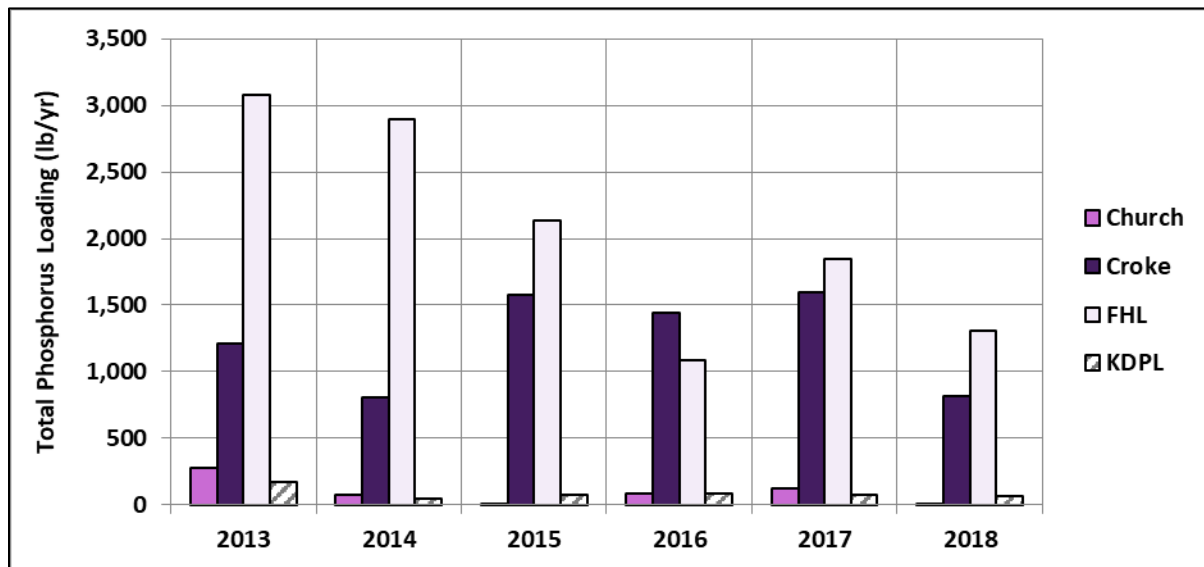


Figure 31. Total Phosphorus Loading Into Standley Lake by Source, 2013-2018

Estimated annual TP loadings into and out of Standley Lake for 2013-2018 are shown in Figure 32. Non-storm event loading of total phosphorus in 2018 was below (-41%) the average of the

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past five years. Removing 2013 from the average calculations, TP loads were only 37% below the 2014-2017 average. As with previous years, loadings of total phosphorus into the lake were greater than outflow, indicating some level of phosphorus retention. TP loads leaving the lake were 5% lower than the 2013-2017 average.

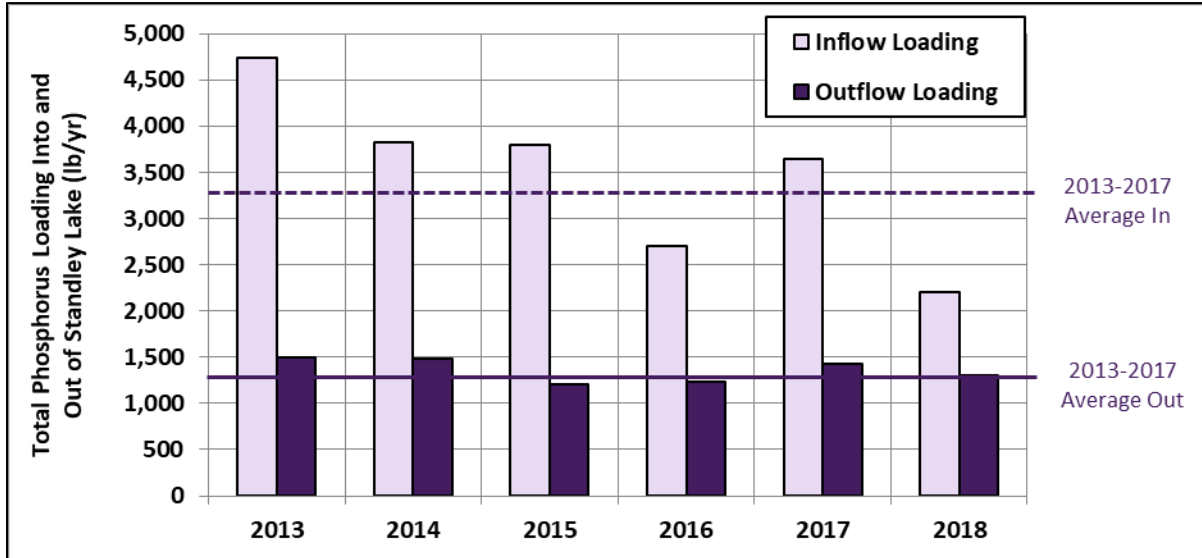


Figure 32. Total Phosphorus Loading Into and Out of Standley Lake, 2013-2018

The volume-weighted TP concentrations into Standley Lake are presented in Figure 33 by source. The Croke had the highest volume-weighted concentration and KDPL the lowest. The combined average of the canals (27 $\mu\text{g/L}$) in 2018 was 16% lower than the 2013-2017 average (32 $\mu\text{g/L}$).

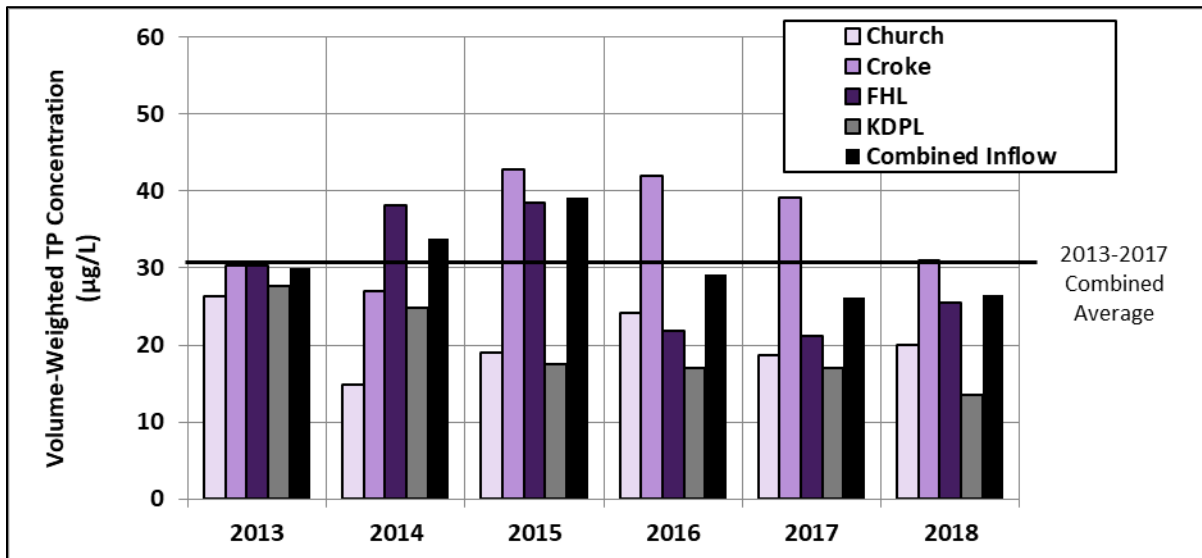


Figure 33. Volume-Weighted Total Phosphorus Concentrations Into Standley Lake by Source, 2013-2018

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Total Nitrogen

Total nitrogen loading into Standley Lake, based on data from ambient grab and ambient composite samples, is grouped by source and displayed in Figure 34. Combined TN loading into and out of the lake is presented in Figure 35. The FHL contributed the largest portion of the annual TN load (49%). As noted with TSS, though the Croke canal only contributed 32% of the total inflow to the lake, it contributed a higher percentage (47%) of the annual TN load. TN loads entering the reservoir in 2018 were 32% lower than the 2013-2017 average. Removing 2013 from the average calculations, TN loads were only 26% below the 2014-2017 average. The outflow TN load in 2018 was also lower (-9%) than the 2013-2017 average. Consistent with previous years, loading into the reservoir was higher than loads leaving the reservoir, indicating that nitrogen is being retained. Nitrogen can be retained in a reservoir through biological uptake and deposition of particulate organic carbon to the bottom sediment.

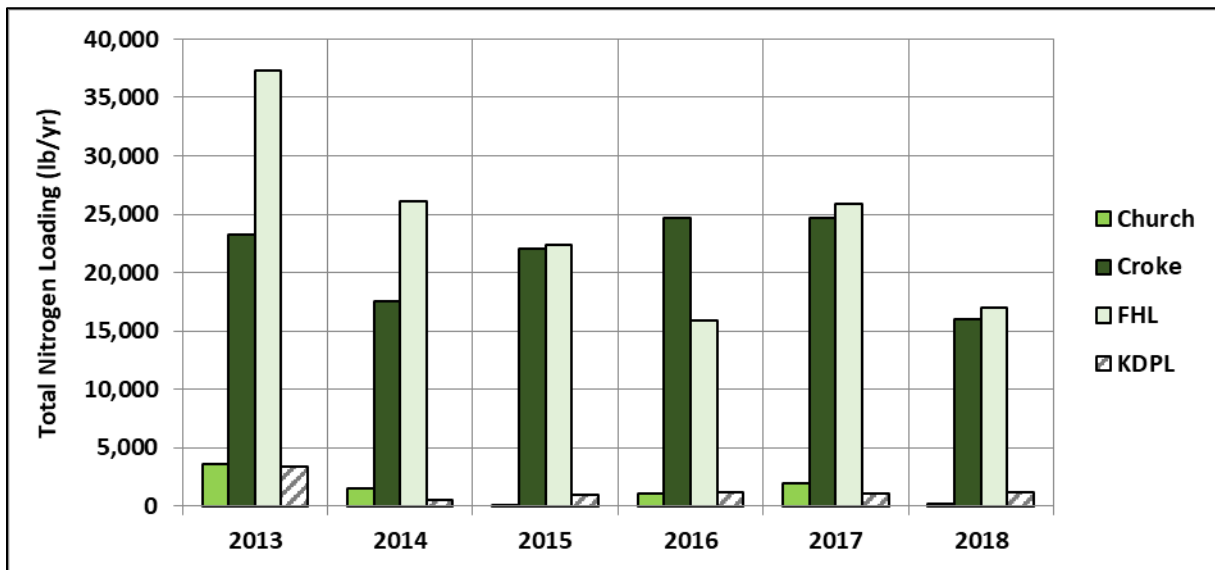
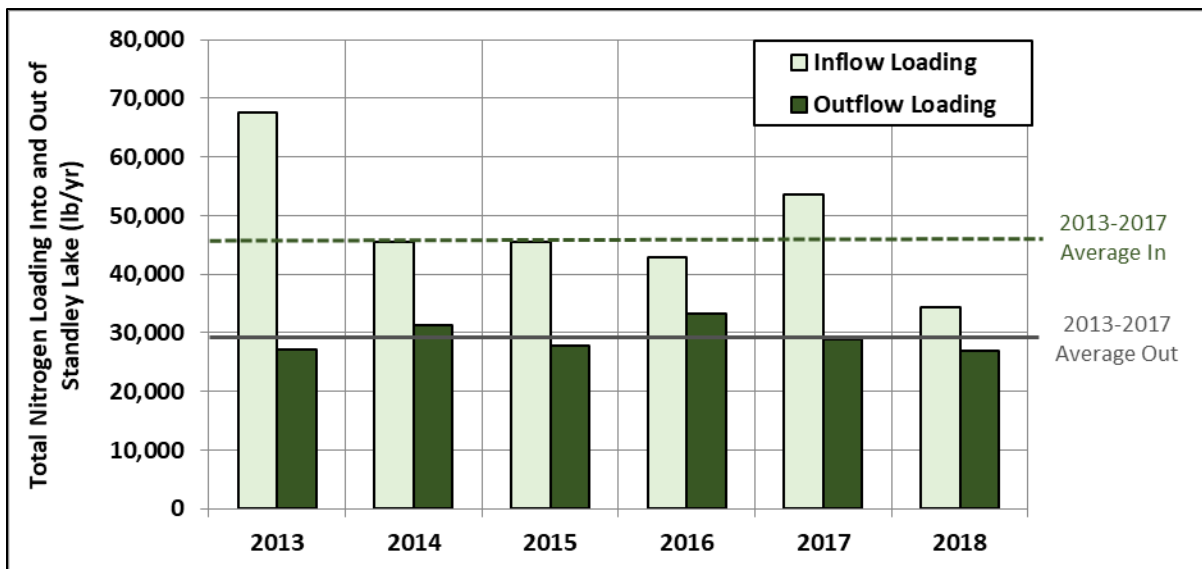


Figure 34. Total Nitrogen Loading Into Standley Lake by Source, 2013-2018



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Figure 35. Total Nitrogen Loading Into and Out of Standley Lake, 2013-2018

Volume-weighted total nitrogen concentrations into the lake are presented in Figure 36. The combined average from all sources in 2018 (415 µg/L) was slightly lower (-3%) than the 2013-2017 average of 429 µg/L.

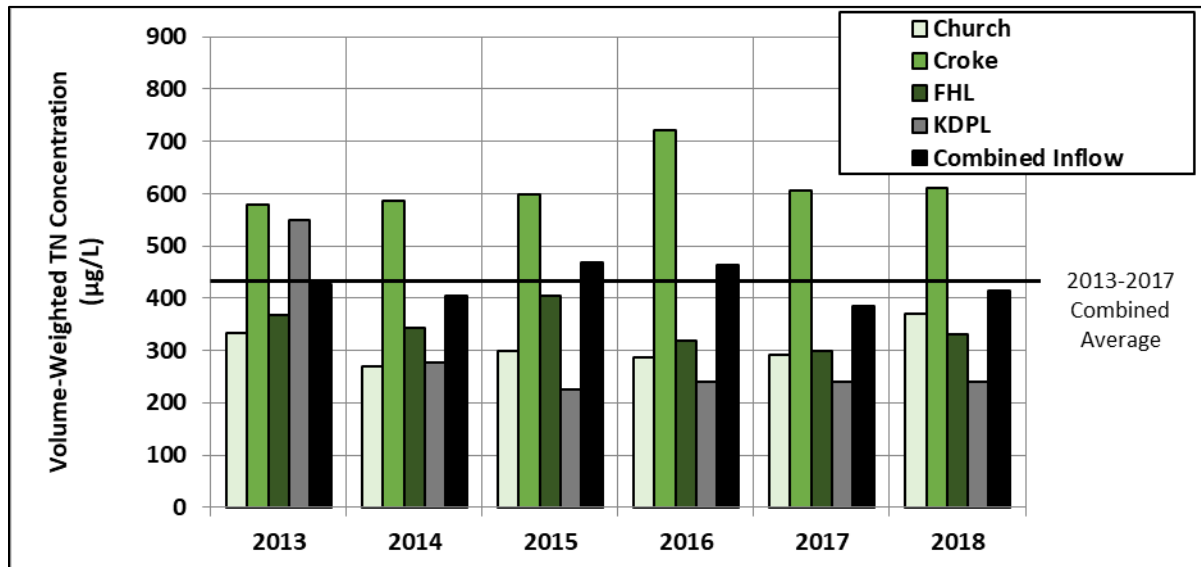


Figure 36. Volume-Weighted Total Nitrogen Concentrations Into Standley Lake by Source, 2013-2018

STORM EVENT LOADS TO THE LAKE

Load estimates to the lake that include storm-event-triggered autosampler data are described in this section. In 2018, there were two instances where an autosampler was triggered by a storm event. They occurred on July 14 and August 15 on the FHL canal at the inflow location to the reservoir. Storm event samples were assumed to represent conditions for the full 24-hour period on the sample date.

A comparison of nutrient loading into Standley Lake from FHL in 2018 with and without the sampled storm events is shown in Figure 37. The lighter bars in the figure represent the estimated loading, excluding storm-event autosampler data. The darker bars include the storm event listed above. Incorporation of the observed storm event yields a 6% increase for TSS, a 5% increase in loading for TP, and an 1% increase for TN. These estimates are based on only two storm events and are underestimates of the actual loading.

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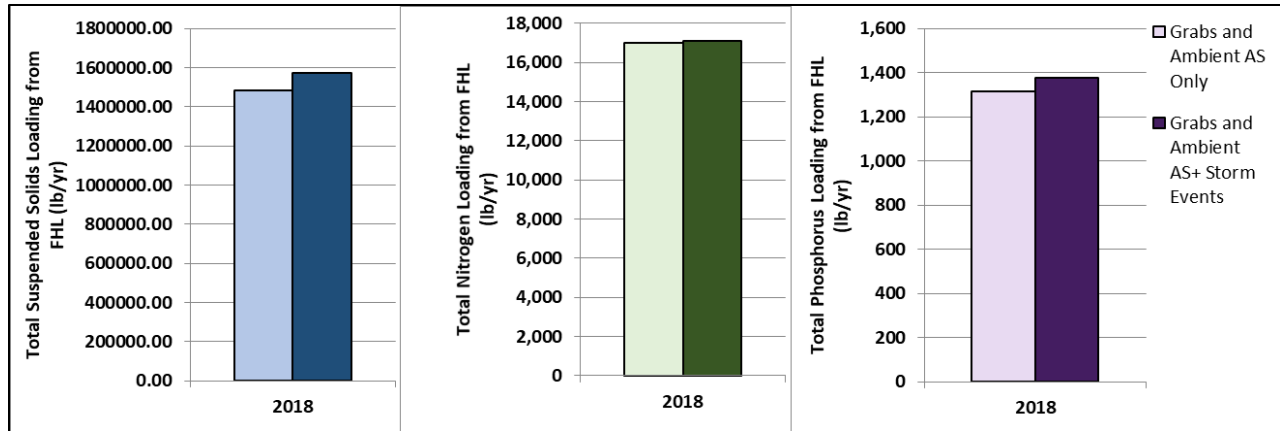


Figure 37. Total Suspended Solids, Total Nitrogen, and Total Phosphorus Loading in 2018 With and Without Storm Events

V. STANDLEY LAKE WATER QUALITY

In this section, the in-reservoir water-quality responses at sampling location SL-10 to the hydrology and nutrient loads are discussed. 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 automated lake profiler station. The water-quality indicators discussed here include temperature, dissolved oxygen (DO), TP, TN, chlorophyll *a*, and water clarity.

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TEMPERATURE

Temperature is crucial in water-quality monitoring in reservoirs because it drives stratification patterns. It is typical for deep reservoirs to experience stratification during the summer and this stratification can lead to lowered dissolved oxygen levels in the hypolimnion. 2018 was the second year in a row that Standley Lake experienced cooler hypolimnion temperatures due to changes in the intake structure operations. In years where only the lower intake is used (e.g. 2016), the thermocline gradually deepens as the summer progresses, reaching the lower depths of the reservoir (~ 20 m) until fall turnover. In 2018, the upper intake structure was opened progressively; it was first opened 12% on April 23, 25% on May 1, and 50% on May 3. The lower intake remained at 100% until July 19 when the upper intake was set to 100% and the lower intake was closed. This resulted in a similar pattern to 2017, with warmer water releasing from the reservoir, increasing the amount of thermal energy removed, and lowering overall reservoir temperatures. Figure 38 shows contour plots of temperature for the last three years. Due to the earlier operational change in 2018, Standley Lake experienced even cooler temperatures in the lower depths of the lake than in 2017. Turnover occurred on October 27, 2018 which is equivalent to the latest turnover date recorded (October 27, 2015).

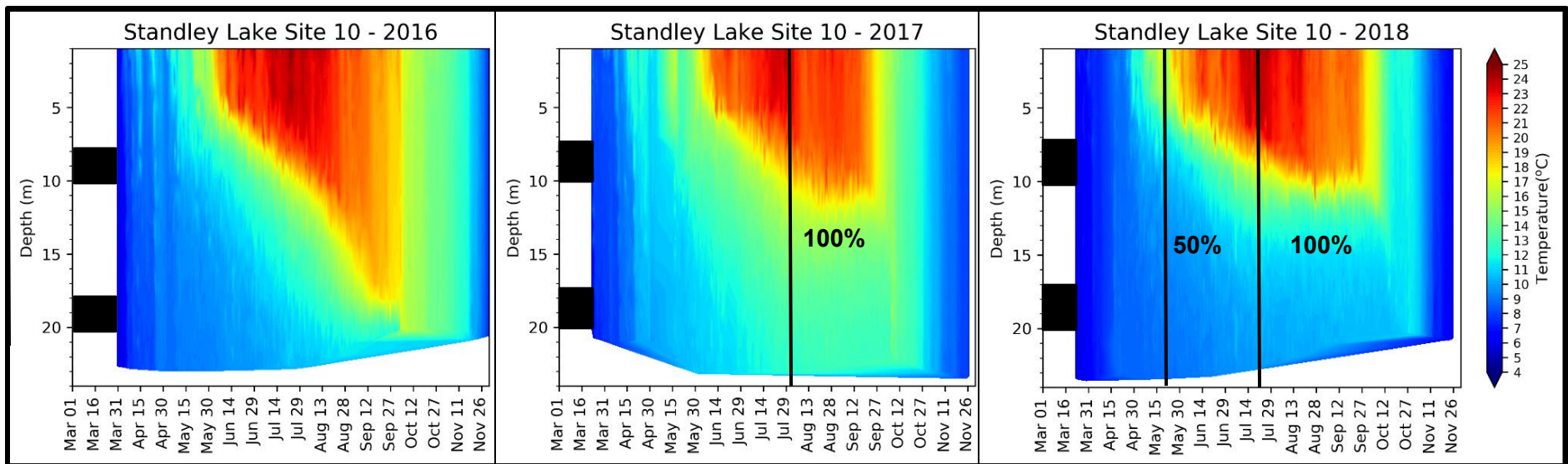


Figure 38. Contour Plots of Temperature in Standley Lake in 2016, 2017, and 2018 the Black Lines Indicate the Dates When the Outlet Depths Changed, the Black Bars Indicate the Range of the Approximate Outlet Depths Based on Water Surface Elevation

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) at the bottom. This is common for stratified reservoirs in Colorado. In 2018, DO concentrations started dropping in late June and hypoxic conditions were well developed by the beginning of August. These hypoxic conditions were maintained until turnover in late October. A contour plot of dissolved oxygen concentrations in Standley Lake for March through November 2018 is provided in Figure 39.

Dissolved oxygen concentrations measured at the top and bottom of Standley Lake through 2018 are displayed in Figure 40. 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 late June, 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 39), the divergence between surface and bottom DO concentrations is extinguished with turnover in late October.

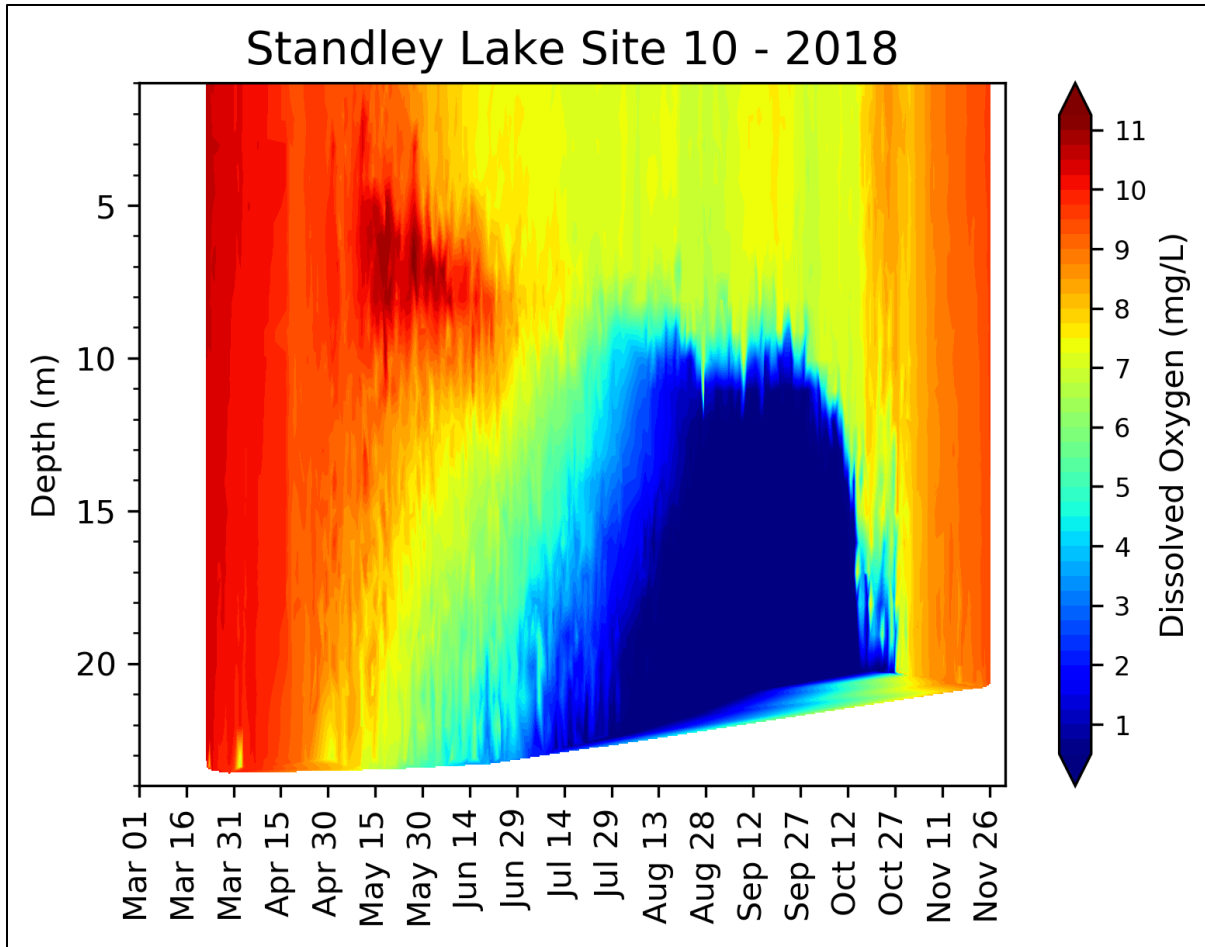


Figure 39. Contour Plot of Dissolved Oxygen in Standley Lake, March-November 2018

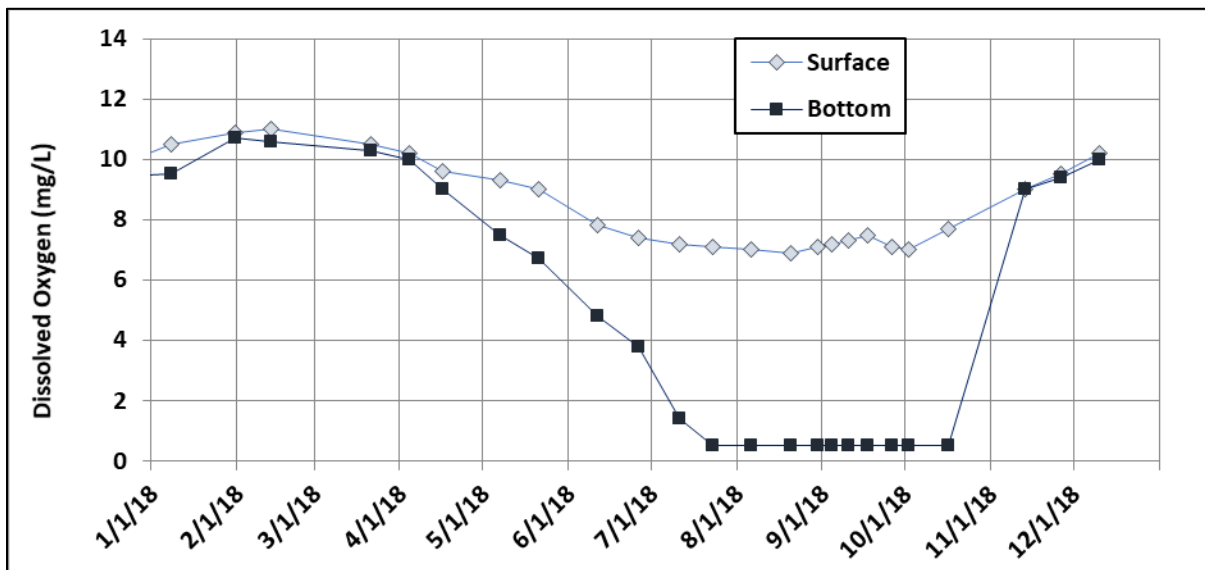


Figure 40. Dissolved Oxygen Concentrations in Standley Lake from Manual Profiles, 2018

Hypoxic conditions at the reservoir bottom started on a normal date, the 2018 seasonal dissolved oxygen patterns closely match those observed in previous years in Standley Lake, as shown in Figure 41.

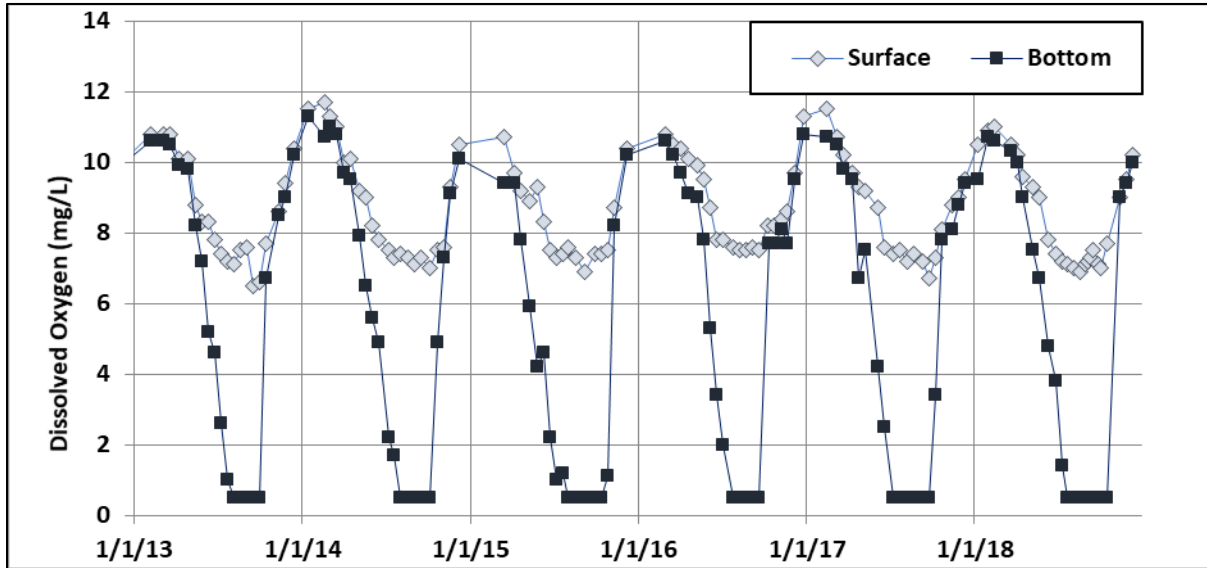


Figure 41. Dissolved Oxygen Concentrations in Standley Lake from Manual Profiles, 2013-2018

DAYS OF HYPOXIA

Hypoxia occurs each year in the hypolimnion of Standley Lake, but the start date, end date, and duration vary from year-to-year. Similar to 2017, the pattern of hypoxia extended well into the higher levels of the water column (Figure 39), however, the timing was different from 2017. In 2017 the hypoxic period started on June 17 and ended October 9, 2017. In 2018, the hypoxic period began on July 5 and ended late on October 27, 2018. The days of hypoxia (115 days) were the same as 2017 despite the temporal difference (Figure 42), this was above the 2013-2017 average of 103 days. Longer periods of hypoxia provide the potential for higher anaerobic internal loads of nutrients.

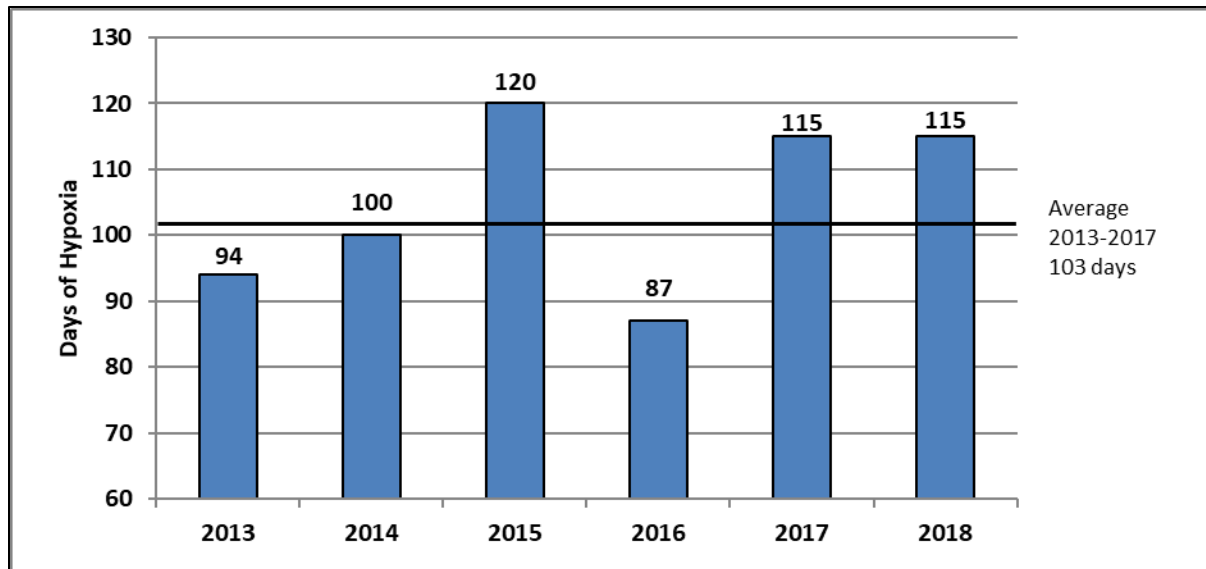


Figure 42. Days of Hypoxia (DO < 2.0 mg/l), 2013-2018

NUTRIENTS

Total Phosphorus

Total phosphorus concentrations observed in Standley Lake in 2018 are displayed in Figure 43. Measurements are made in the photic zone, defined as twice the Secchi depth, and at the bottom of Standley Lake. In 2018, monitoring was increased from bi-weekly to weekly during late summer targeting the time period when sediment release of nutrients typically occurs. The most notable observations during this period were bottom of the lake TP concentrations of 135 µg/L and 134 µg/L on September 10 and October 16, respectively. This increase in TP concentrations in fall is indicative of sediment release of nutrients as a result of hypoxia in the hypolimnion. Dissolved phosphorus (DP) data compared to TP data collected on the same dates are displayed in Figure 44 and reinforce sediment releases as the source. The photic zone displayed little variation throughout the year.

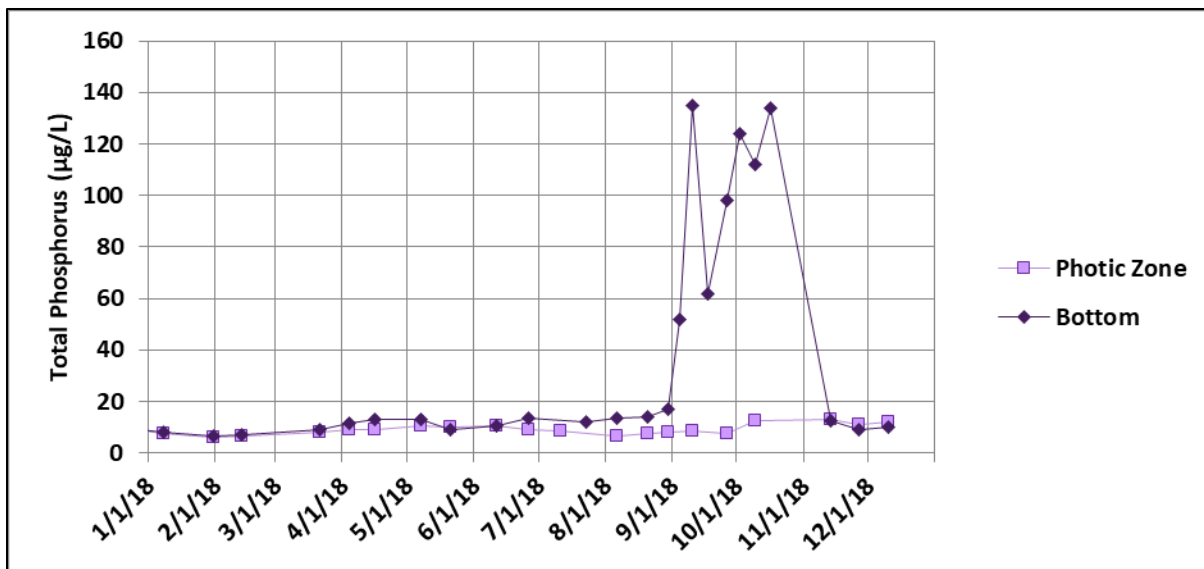


Figure 43. Total Phosphorus Concentrations in Standley Lake, 2018

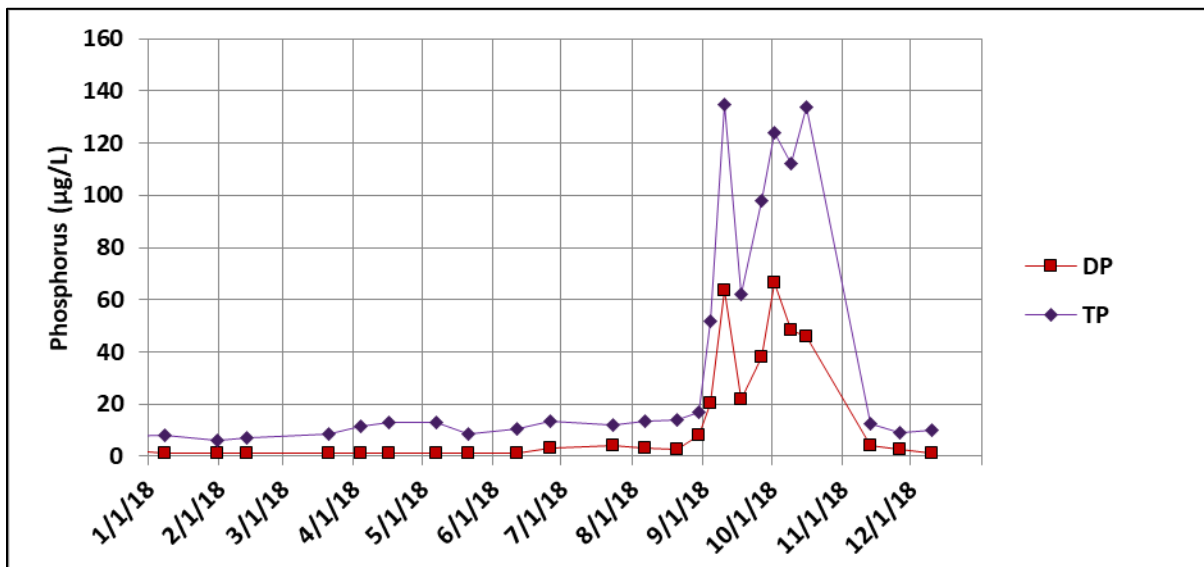


Figure 44. Total and Dissolved Phosphorus Concentrations in Standley Lake, Bottom, 2018

The observed pattern of sediment releases in late summer/fall is typical of previous years. For perspective, TP observations since 1999 are shown in Figure 45. 2018, while higher than most years, was within the range of TP release from the sediment observed in the long-term record. As in 2017, the longer period of hypoxic conditions likely contributed to these high observations, but the magnitude was lower than 2017 because the reservoir was cooler overall. Lower temperatures can decrease the intensity of nutrient release from sediments.

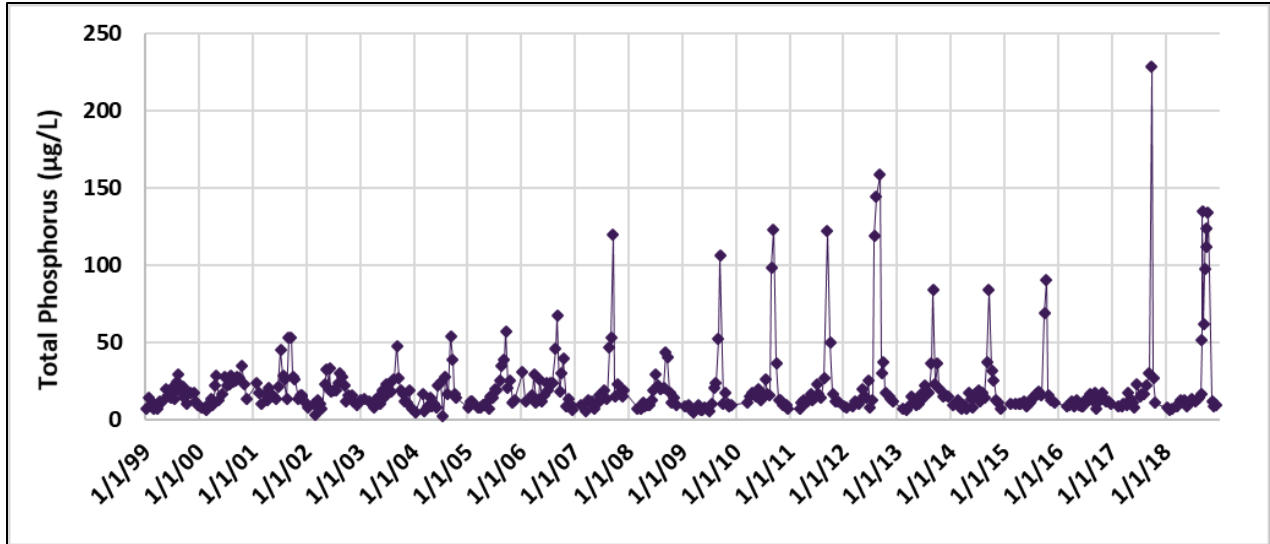


Figure 45. Total Phosphorus Concentrations in Standley Lake, Bottom, 1999-2018

Total Nitrogen

Total nitrogen concentrations in Standley Lake are displayed in Figure 46. TN concentrations at the bottom of the lake exhibited a peak concentration of 880 µg/L on June 26. The pattern of higher concentrations in early summer reflects plunging of canal inflows. The photic zone showed smaller amounts of variability. Evidence of sediment release of nitrogen is demonstrated in the fall with elevated concentrations near the bottom corresponding with the TP increases.

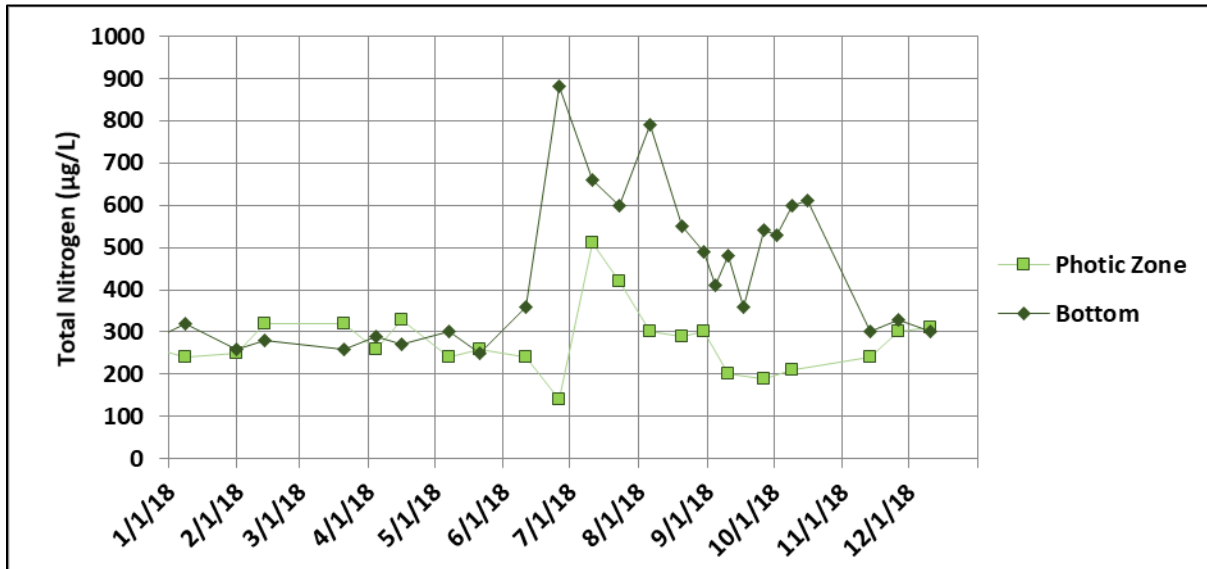


Figure 46. Total Nitrogen Concentrations in Standley Lake, 2018

Concentrations of TN in the lake for 2013-2018 are shown in Figure 47. Overall, TN concentration ranges observed in 2018 at the bottom and in the photic zone were comparable to

previous years. The 2018 average TN concentrations (441 µg/L hypolimnion, 281 µg/L photic zone) were 19% higher in the hypolimnion and 9% higher in the photic zone when compared with the 2013-2017 annual average concentrations. The large increase in average concentration in the hypolimnion this year may be driven by the increased targeted sampling, increasing sample frequency during periods where concentrations are higher can increase the annual average of the observed concentrations.

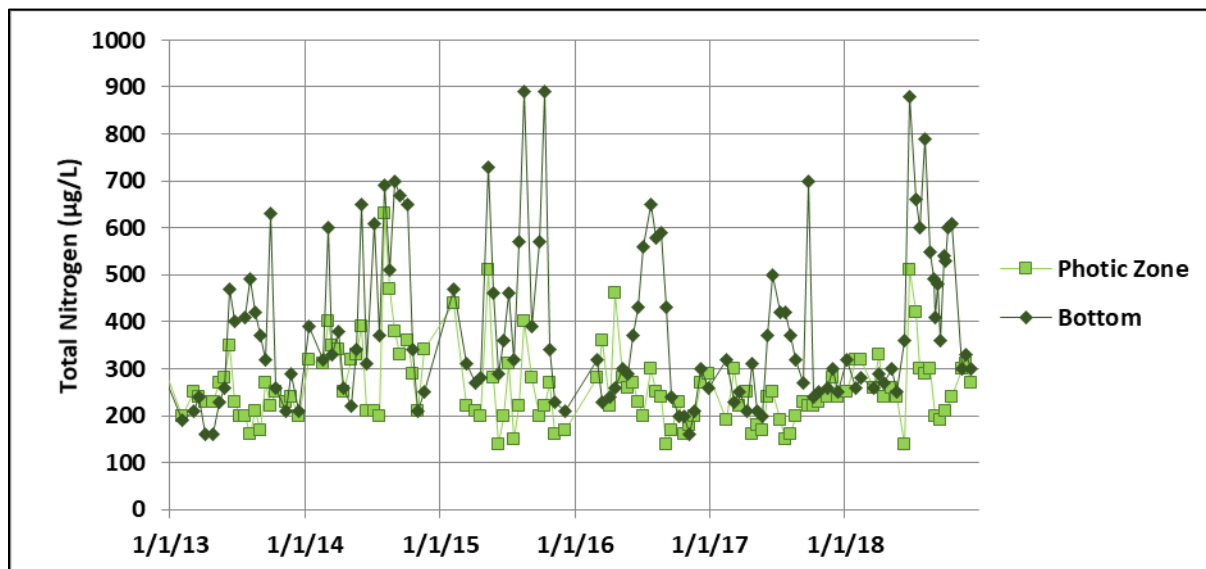


Figure 47. Total Nitrogen Concentrations in Standley Lake, 2013-2018

CHLOROPHYLL *a*

Chlorophyll *a* concentrations observed in Standley Lake in 2018 are presented in Figure 48. March through November is the relevant period for standards assessment and this period is indicated by the grey box. The maximum concentration measured in 2018 was 7.9 µg/L and occurred on May 21, 2018.

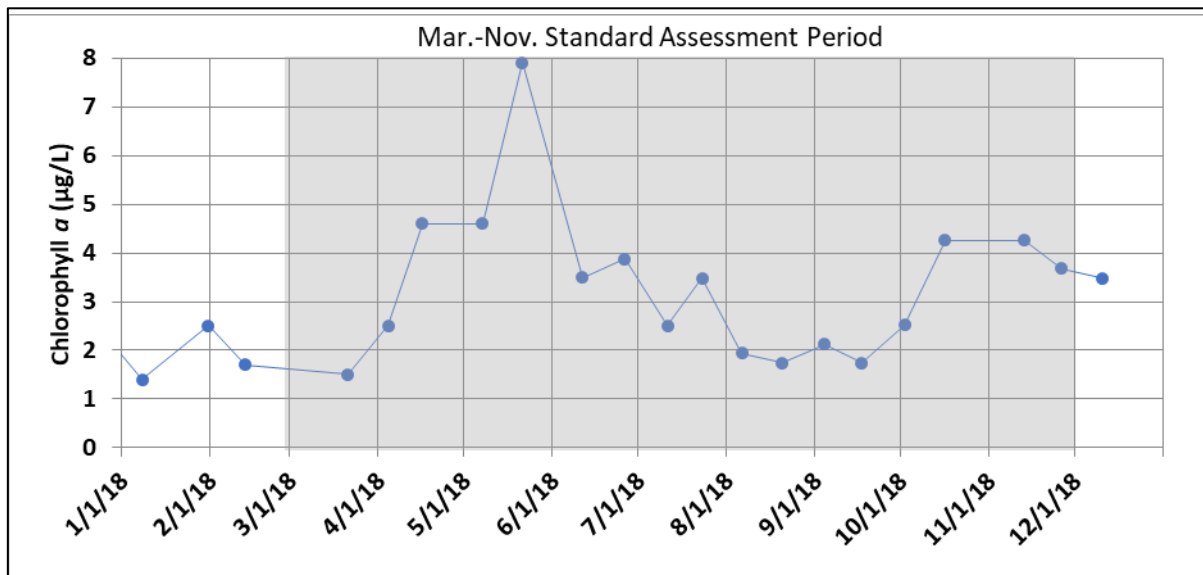


Figure 48. Chlorophyll a Concentrations in Standley Lake, 2018 (March-November Assessment Period in Grey)

Chlorophyll a observations from 2013-2018 are shown in Figure 49. In addition, a contour plot of chlorophyll a concentrations in Standley Lake for March to November 2018 is shown in Figure 51. Temporally, the patterns were consistent with previous years with a peak in the spring and increased concentrations after fall turnover. The spring bloom was dominated by two diatoms; *Stephanodiscus* and *Asterionella*. The bloom affected the water treatment process by reducing filter run times. The contour plot shows the bloom extended through mid-June, but was not captured in the mid-June photic zone composite sample because it developed just below the photic zone (~6m).

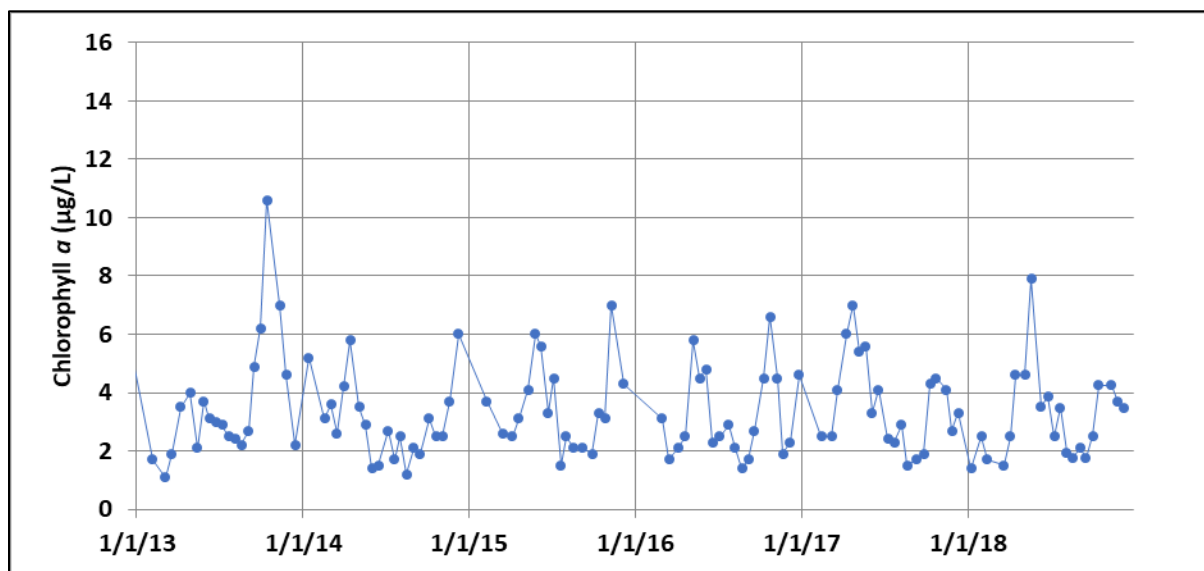


Figure 49. Chlorophyll a Concentrations in Standley Lake, 2013-2018

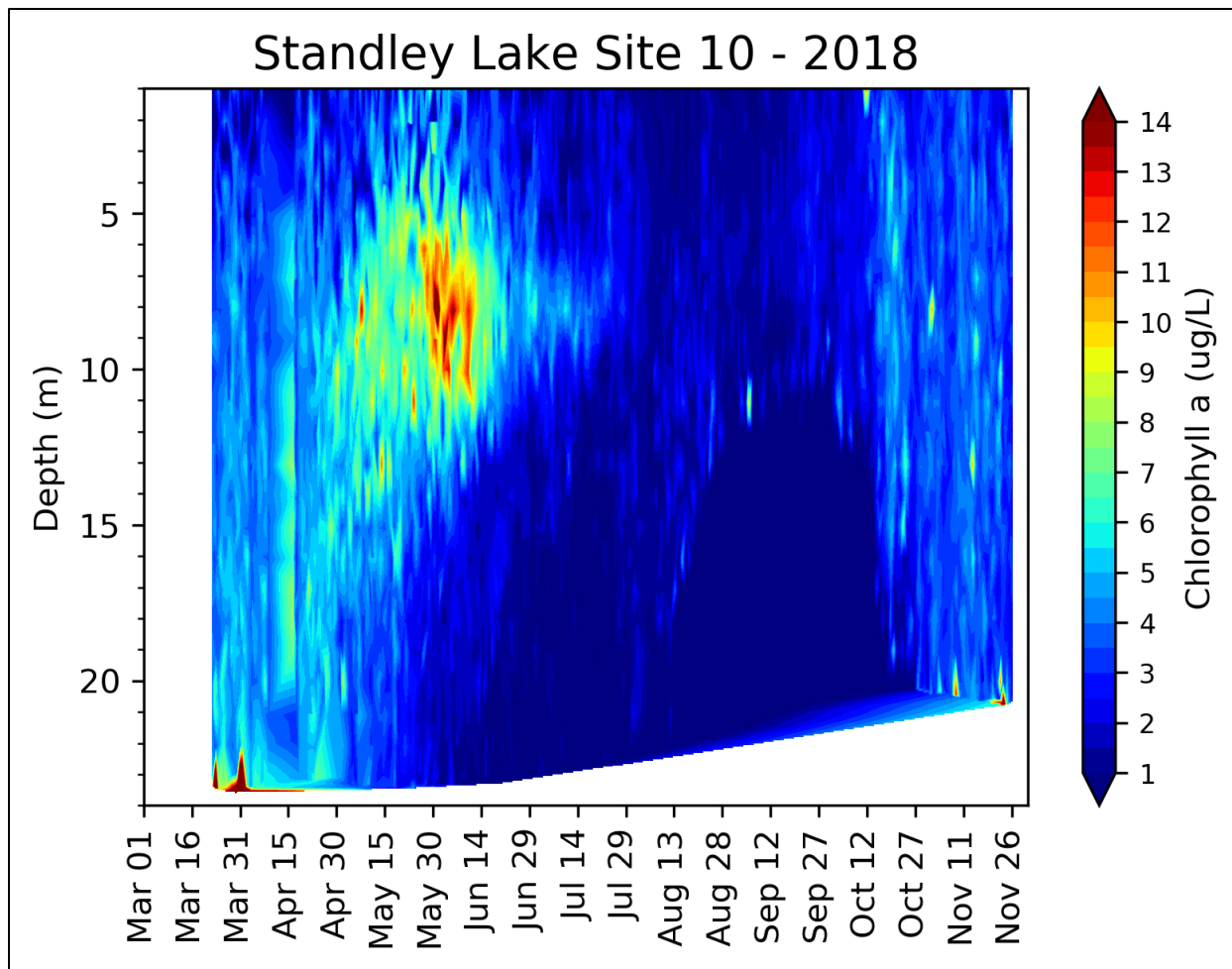


Figure 50. Contour Plot of Chlorophyll a Concentrations in Standley Lake, 2018

A chlorophyll a standard of 4.0 $\mu\text{g/L}$ was established in 2009 for Standley Lake. This standard is evaluated on an annual basis using the average of the nine monthly averages of observed data for 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 $\mu\text{g/L}$. The 2018 average was 3.2 $\mu\text{g/L}$ (Figure 51). This average is calculated as the average of the nine monthly averages of the measurements from the photic zone for the period of March through November.

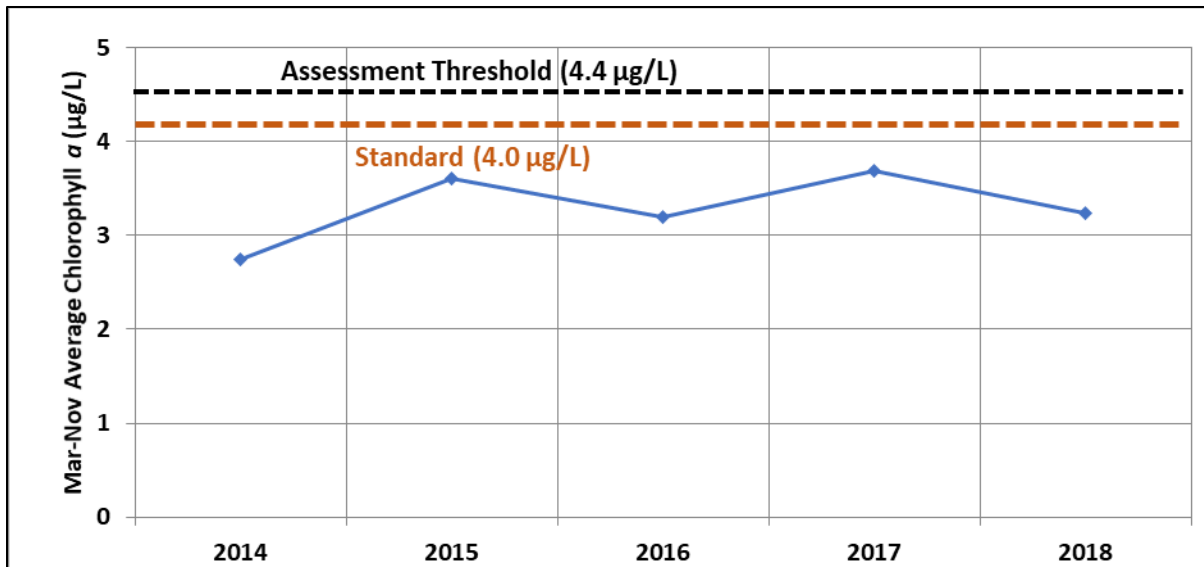


Figure 51. March-November Average Chlorophyll a Concentrations, 2014-2018

The standard for chlorophyll a in Standley Lake was met in 2018. The 2018 average is compliant 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-through-November average concentration below 4.4 µg/L. Every year in the five-year period from 2014 to 2018 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.

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 2018 are shown in Figure 52. The measure of clarity with the greatest depth (7.6 m) occurred on January 8, 2018. Through the year clarity is variable, reflecting a combination of effects such as inflowing suspended solids, algal growth, particle settling, and stratification.

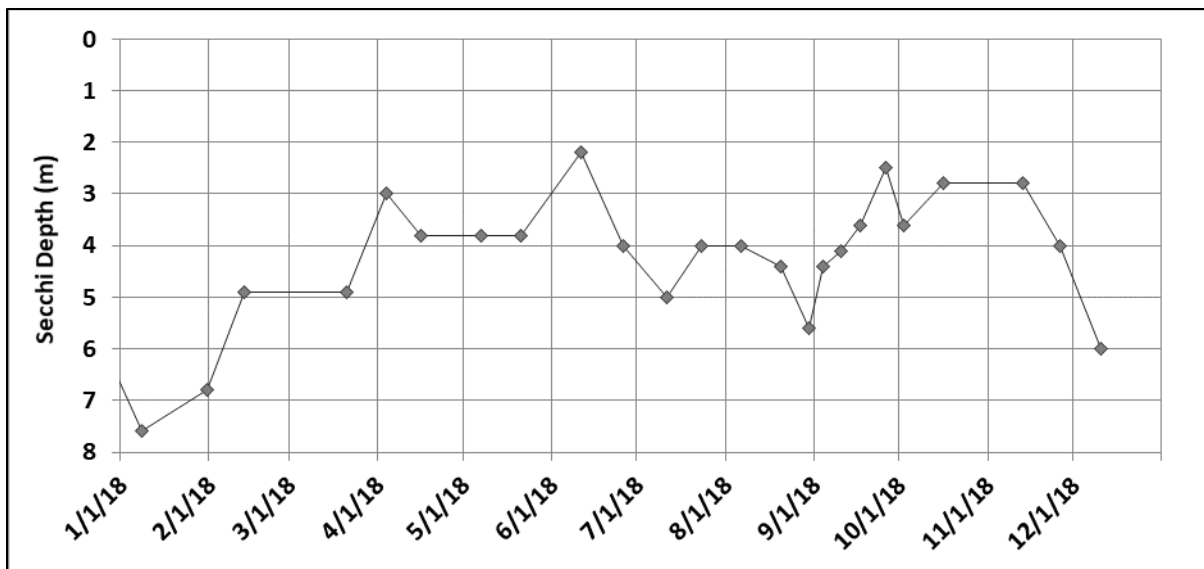


Figure 52. Clarity as Measured by Secchi Depth in Standley Lake, 2018

Individual Secchi-depth measurements for the past six years are shown in Figure 53. The observation on January 8, 2018 was the highest Secchi depth recorded for Standley Lake over the period 2002-2018. This date corresponds to the minimum 2018 chlorophyll a measurement of 1.4 ug/L. Average annual Secchi depths for 2013-2018 can be found in Figure 54. The annual average (4.2 m) and range of Secchi depths observed in 2018 were consistent with the range of those observed in recent years.

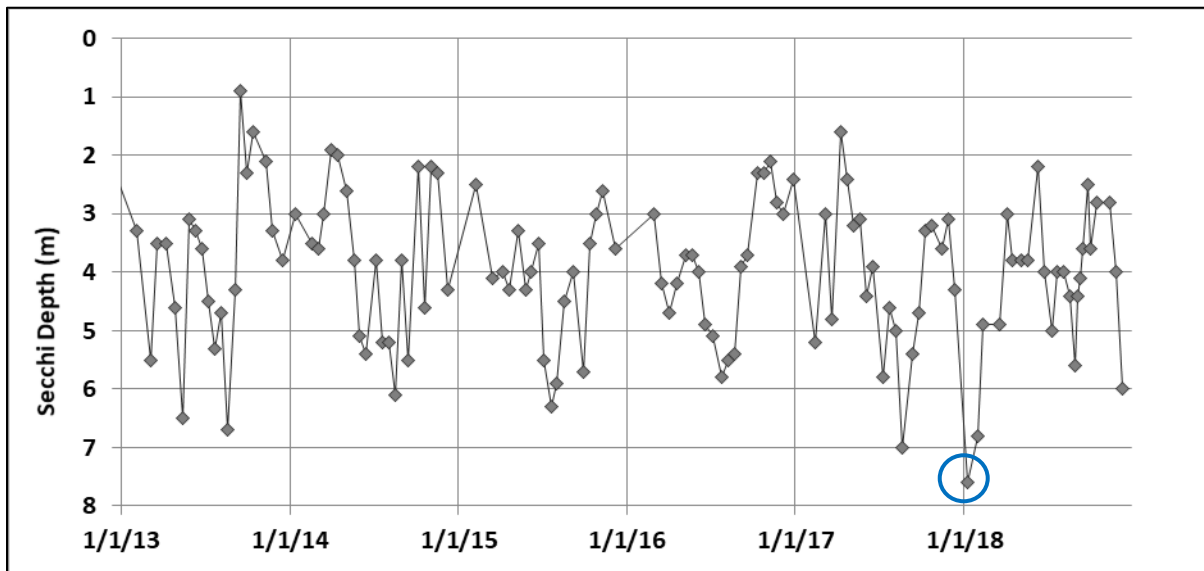


Figure 53. Clarity as Measured by Secchi Depth in Standley Lake, 2013-2018

2018 STANDLEY LAKE WATER QUALITY

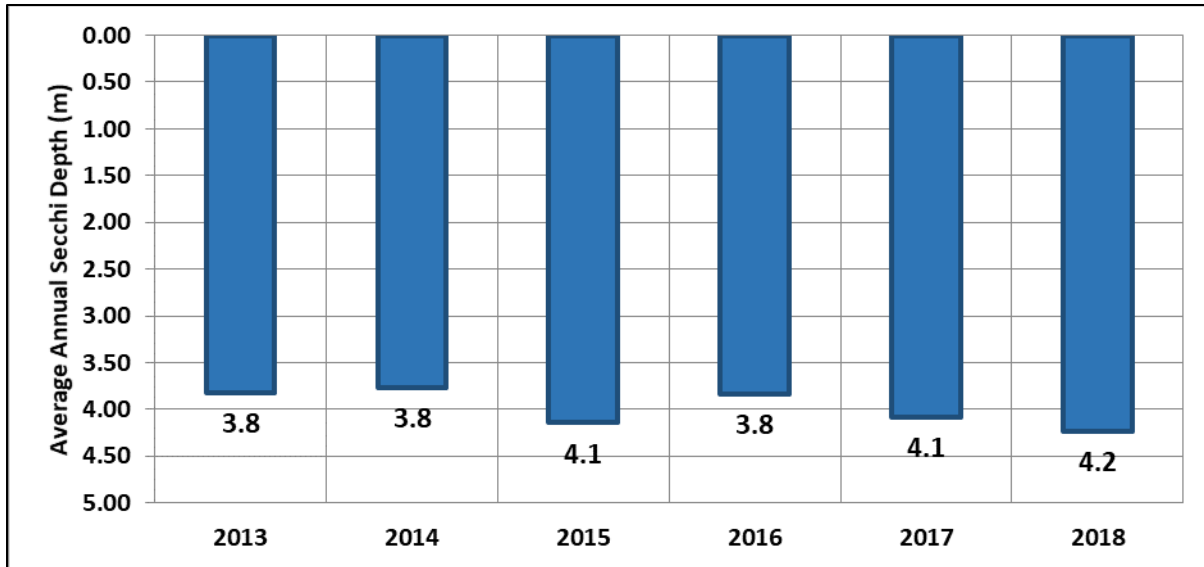


Figure 54. Average Annual Secchi Depth in Standley Lake, 2013-2018

ADDITIONAL INFORMATION

REFERENCES

Hydros Consulting 2018. Clear Creek / Standley Lake Watershed Agreement. 2017 Annual Report. October 1, 2018.

National Weather Service 2019. NOAA Online Weather Data.
<https://w2.weather.gov/climate/xmacis.php?wfo=bou>

ACRONYMS

AF - Acre Feet

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

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. Storm water-Only Location Operated by City of Golden

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

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

CFS - Cubic Feet per Second

FHL - Farmers' High Line Canal

Church - Church Ditch

Croke - Croke Canal

DO - Dissolved Oxygen

DP - Dissolved Phosphorus

KDPL - Kinnear Ditch Pipeline

NOAA - National Oceanic and Atmospheric Administration

ORP - Oxidation-Reduction Potential

TN - Total Nitrogen

TP - Total Phosphorus

TSS - Total Suspended Solids

USGS - United States Geological Survey



SUPPLEMENTAL INFORMATION 4
CLEAR CREEK, CANAL, AND STANDLEY LAKE WATER QUALITY
MONITORING DATA - 2018

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
02/14/18	10:15	G	CC 26	2.6	7.8	399	10.1	1.3	0.9	2	0.02	0.29	0.42	< 0.0025	0.0044				
02/14/18	10:41	G	CC 40	1	7.6	403	10.9	3.7	1	3	<0.01	0.34	0.46	< 0.0025	0.0077	3.44 staff			
02/14/18	10:59	G	CC 50	4.6	7.6	813	10.2	1.9	1.6	4	<0.01	0.42	0.57	< 0.0025	0.0090				
02/14/18	11:25	G	CC 60	1.8	7.5	458	10.7	2.1	1.1	7	<0.01	0.37	0.52	< 0.0025	0.0104				
04/04/18	10:30	G	CC 26	3.2	7.1	444	9.1	1.2	1.1	<1	0.03	0.27	0.41	< 0.0025	0.008				
04/04/18	11:00	G	CC 40	3.3	7.1	452	9.1	<1	1.3	<1	0.02	0.34	0.51	0.0056	0.0178				
04/04/18	11:25	G	CC 50	5.4	7.1	638	9.1	2.6	1.9	3	0.01	0.36	0.56	< 0.0025	0.0165				
NS	NS		CC 60													Not sampled - road work			
05/09/18	9:31	G	CC 05	4.8	8.1	315	10.9	4.1	4.6	5	<0.01	0.09	0.26	< 0.0025	0.0154				
05/09/18	10:00	G	CC 10	6	8.5	120	10.6	<1		2	<0.01	0.11	0.23	0.0026	0.008				
05/09/18	10:10	G	CC 15	4.7	7.4	399	9.7	3.1		5	0.07	0.21	0.37	0.0033	0.0094				
05/09/18	10:33	G	CC 20	5.9	7.6	328	9.9	4.1	2.8	9	0.04	0.17	0.32	0.0033	0.0127				
05/09/18	10:15	G	CC 25	10.8	8.1	424	9.6	3.4		5	<0.01	0.12	0.22	0.0026	0.0107				
05/09/18	10:26	G	CC 26	8.5	8.1	390	10.3	5.3	2.9	9	0.02	0.14	0.26	0.0028	0.0141				
05/09/18	9:41	G	CC 30	4.7	7.6	63	10.4	3.8		9	<0.01	0.06	0.21	0.0037	0.0204				
05/09/18	11:03	G	CC 34	9.3	8.3	345	10.4	6.5	3	13	0.01	0.13	0.25	0.0028	0.02				
05/09/18	10:46	G	CC 35	7.5	8.6	75	10.8	1.7	4	5	<0.01	0.06	0.21	0.0042	0.0149				
05/09/18	9:22	G	CC 40	8.2	7.8	346	9.9	11.1	3	22	<0.01	0.14	0.31	0.0029	0.0222				
05/09/18	13:00	G	CC 44	7.8	7.7	76	8.6	5.9		14	<0.01	0.02	0.15	0.005	0.017				
NS	NS		CC 45													Not sampled			
05/09/18	13:23	G	CC 50	11.1	7.6	213	9	13.9	3.2	23	<0.01	0.08	0.24	0.0048	0.0251				
05/09/18	13:01	G	CC 52	14.3	8.2	508	9.6	9.8	3.6	10	0.01	0.35	0.5	0.0037	0.0184				
05/09/18	12:50	G	CC 53	16.5	8.3	520	9.3	2.3	3.1	8	0.01	0.28	0.43	0.0068	0.0191				
05/09/18	13:55	G	CC 60	12.4	7.9	333	9.1	19.4	3	36	<0.01	0.14	0.48	0.003	0.0305				
05/09/18		QC	CCP050918												0.0254				
05/09/18		QC	CCD050918										0.5		0.0129				
05/09/18		QC	CCN050918										0.72						
10/17/18	10:00	G	CC 05	1.7	7.2	293	9.3	<1	1.1	5	0.01	0.31	0.41	0.0029	0.003			staff gage = 3.58	
10/17/18	10:22	G	CC 10	5.1	7.4	140	9.3	<1		5	<0.01	0.13	0.23	0.0027	0.0029				
10/17/18	9:49	G	CC 15	1.7	7.1	819	10.2	<1		4	0.21	0.61	0.83	0.0041	0.0043			staff gage = 3.8	
10/17/18	10:07	G	CC 20	1	7.4	473	11	<1	1.1	5	0.11	0.32	0.49	0.0031	0.023				
10/17/18	10:50	G	CC 25	3	7.4	250	9.7	<1		7	0.03	0.19	0.33	0.0027	0.0047				
10/17/18	11:10	G	CC 26	2.1	7.3	334	10.2	<1	1.2	7	0.08	0.25	0.43	0.0027	0.0048				
10/17/18	9:28	G	CC 30	<1	7.5	98	11.3	1		7	<0.01	0.13	0.25	0.0044	0.0065			staff gage = <0.9	
10/17/18	11:41	G	CC 34	2.7	7.4	318	10.4	<1		7	0.02	0.29	0.4	0.0039	0.0052				
10/17/18	11:30	G	CC 35	1.9	7.8	78	10	<1	1.6	12	<0.01	0.05	0.1	0.0042	0.012				
10/17/18	9:17	G	CC 40	2.5	7.5	364	11.3	<1	1.3	4	0.03	0.27	0.45	< 0.0025	0.0052			staff gage = 3.4	
10/17/18	10:40	G	CC 44	1	7.7	128	10.9	<1		7	<0.01	<0.01	0.1	0.0034	0.0041				
NS	NS		CC 45													Not sampled			
10/17/18	10:54	G	CC 50	4.8	7.4	845	10.3	<1	2	8	0.01	0.62	0.71	0.0026	0.006			staff gage = 3.9	
10/17/18	11:55	G	CC 52	3.8	7.5	657	10.3	1.5	2.7	8	<0.01	0.31	0.45	0.0032	0.0041				
NS	NS		CC 53													Not sampled		No flow	
10/17/18	11:22	G	CC 60	3.7	7.9	424	11.4	<1	1.2	10	<0.01	0.28	0.48	0.0039	0.0067				
10/18/18	9:40	QC	CCP101818												0.0124				
10/18/18	9:40	QC	CCD101818										0.47		0.0061				
10/18/18	9:40	QC	CCN101818										0.68						
12/12/18	10:30	G	CC 26	NT	NT	NT	NT	NT	1.1	2	0.04	0.31	0.51	0.003	0.0031				
12/12/18	10:53	G	CC 40	NT	NT	NT	NT	NT	0.9	<1	0.03	0.38	0.53	0.0047	0.0054				
12/12/18	11:15	G	CC 50	NT	NT	NT	NT	NT	1.9	<1	0.01	0.56	0.78	0.0036	0.0045				
12/12/18	11:45	G	CC 60	NT	NT	NT	NT	NT	1	<1	0.02	0.44	0.57	< 0.0025	0.0053				

Tribs				SM2510B	SM4500OG	SM4500H+B	SM2550B	SM2130B	SM4500PE	SM4500PE	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM7110B	SM7110B
Method				10	1.0	1.0	1.0	1	0.0025	0.0025	0.01	0.01	0.02	variable	variable
Reporting Limit Goal				3	3	3	3	3	3	3	3	3	3	2	2
Max Sig figs				0	1	1	1	1	4	4	2	2	2	1	1
Max decimals				0	1	1	1	1	4	4	2	2	2	1	1
Reporting Units				µS/cm	mg/L	s.u.	°C	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L
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
01/03/18	9:25	G	Trib 01	494	11.9	7.7	1.3	0.7	<0.0025	0.0041	0.03	0.45	0.57		
01/03/18	9:35	G	Trib 02	522	10.2	7.8	7.7	0.8	0.0034	0.0067	0.04	0.5	0.66		
01/03/18	9:50	G	Trib 03	512	9.6	8	8.8	1.2	0.003	0.0091	0.03	0.48	0.64		
01/03/18	10:25	G	Trib 04	520	10.7	8	4	14.1	0.0048	0.0469	0.04	0.48	0.76		
01/03/18	NS	G	Trib 11												
01/03/18	NS	G	Trib 22a												
01/03/18	NS	G	Trib 22d												
01/03/18	8:45	G	Trib 24	360	9.6	7.9	10.3	0.8	<0.0025	0.0062	0.02	0.08	0.24		
01/03/18	NS	G	Trib 25												
01/03/18	NS	G	Trib 27 (New Church Ditch Inlet)												
02/07/18	9:25	G	Trib 01	469	11.7	7.9	2.1	4	0.0036	0.0062	0.01	0.36	0.48		
02/07/18	9:35	G	Trib 02	545	11.2	7.8	4.3	3.9	0.0037	0.0067	0.01	0.42	0.54		
02/07/18	9:40	G	Trib 03	505	10.4	7.9	7	4.6	0.0027	0.0068	0.02	0.4	0.54		
02/07/18	10:25	G	Trib 04	518	10.4	8	14.8	4.9	0.0048	0.0254	0.01	0.37	0.55		
02/07/18	NS	G	Trib 11												
02/07/18	NS	G	Trib 22a												
02/07/18	NS	G	Trib 22d												
02/07/18	8:45	G	Trib 24	366	10.6	7.9	7.9	2.9	<0.0024	0.0082	0.01	0.1	0.25		
02/07/18	NS	G	Trib 25												
02/07/18	NS	G	Trib 27 (New Church Ditch Inlet)												
03/07/18	9:15	G	Trib 01	483	11.6	7.7	3.5	<0.1	<0.0025	0.0057	0.03	0.44	0.58	2	2.1
03/07/18	9:30	G	Trib 02	478	10	7.7	8.3	<0.1	0.0027	0.0073	0.03	0.46	0.6	3.3	2.4
03/07/18	9:45	G	Trib 03	497	9.6	7.8	9.3	23.7	0.0028	0.0081	0.03	0.47	0.68	2.4	2.6
03/07/18	10:20	G	Trib 04	520	9.9	7.9	6.6	37.1	0.0052	0.0284	0.02	0.44	0.68	3.9	2.9
03/07/18	NS	G	Trib 11												
03/07/18	NS	G	Trib 22a												
03/07/18	NS	G	Trib 22d												
03/07/18	8:35	G	Trib 24	347	10.5	7.8	8.5	0.5	<0.0025	0.0093	0.02	0.11	0.28	4.4	2.4
03/07/18	NS	G	Trib 25												
03/07/18	NS	G	Trib 27 (New Church Ditch Inlet)												
04/04/18	9:15	G	Trib 01	618	11.1	7.5	4.1	1	<0.0025	0.0068	<0.01	0.29	0.5		
04/04/18	9:30	G	Trib 02	620	9.5	7.5	11	2.2	0.0033	0.008	<0.01	0.28	0.42		
04/04/18	9:45	G	Trib 03	614	9.2	7.5	11.8	2.7	0.0031	0.0097	0.01	0.3	0.49		
04/04/18	10:25	G	Trib 04	622	9.5	7.8	8.9	11.8	0.0162	0.0325	0.01	0.15	0.4		
04/04/18	NS	G	Trib 11												
04/04/18	NS	G	Trib 22a												
04/04/18	NS	G	Trib 22d												
04/04/18	8:40	G	Trib 24	324	9.5	7.6	11.3	1.6	<0.0025	0.0092	<0.01	0.1	0.31		
04/04/18	NS	G	Trib 25												
04/04/18	NS	G	Trib 27 (New Church Ditch Inlet)												
05/02/18	9:40	G	Trib 01	451	9.5	7.8	9.7	5	0.0034	0.018	0.02	0.17	0.3		
05/02/18	9:50	G	Trib 02	459	9.1	7.7	11.7	5.4	0.0068	0.0256	0.04	0.19	0.39		
05/02/18	10:05	G	Trib 03	526	8.2	7.7	12.4	3	0.0038	0.014	0.03	0.19	0.34		
05/02/18	NS	G	Trib 04												
05/02/18	10:40	G	Trib 11	472	8.2	7.8	12.8	9.7	0.0045	0.0259	0.03	0.17	0.35		
05/02/18	NS	G	Trib 22a												

Tribs				SM2510B	SM4500OG	SM4500H+B	SM2550B	SM2130B	SM4500PE	SM4500PE	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM7110B	SM7110B
Method				10	1.0	1.0	1.0	1	0.0025	0.0025	0.01	0.01	0.02	variable	variable
Reporting Limit Goal				3	3	3	3	3	3	3	3	3	3	2	2
Max Sig figs				0	1	1	1	1	4	4	2	2	2	1	1
Max decimals				μS/cm	mg/L	s.u.	°C	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L
Reporting Units															
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
05/02/18	NS	G	Trib 22d												
05/02/18	9:00	G	Trib 24	387	8.4	7.7	14.5	3	0.0028	0.0138	0.02	0.09	0.24		
05/02/18	NS	G	Trib 25												
05/02/18	NS	G	Trib 27 (New Church Ditch Inlet)												
06/07/18	9:00	G	Trib 01	116	11.3	7.9	12.6	2.1	0.0028	0.0132	0.02	0.08	0.15	1.9	1.4
06/07/18	9:10	G	Trib 02	117	11.6	7.7	12.6	1.5	0.0025	0.0123	0.02	0.08	0.17	1.1	1.3
06/07/18	9:30	G	Trib 03	117	11.2	7.7	13.8	4.5	0.0037	0.0222	<0.01	0.08	0.2	1.6	1.5
06/07/18	NS	G	Trib 04												
06/07/18	10:00	G	Trib 11	126	10.3	7.6	17.1	4.5	0.0039	0.022	0.02	0.06	0.19	1.2	1.2
06/07/18	NS	G	Trib 22a												
06/07/18	NS	G	Trib 22d												
06/07/18	8:20	G	Trib 24	367	9.1	7.7	14.4	1.6	<0.0025	0.009	0.03	0.08	0.2	3.2	2.4
06/07/18	NS	G	Trib 25												
06/07/18	NS	G	Trib 27 (New Church Ditch Inlet)												
07/18/18	9:20	G	Trib 01	211	8.1	7.5	17.9	5.2	<0.0025	0.0174	<0.01	0.09	0.34		
07/18/18	9:35	G	Trib 02	220	8	7.6	18.9	5.9	<0.0025	0.0193	<0.01	0.1	0.3		
07/18/18	9:50	G	Trib 03	237	7.6	7.6	21.6	3.7	<0.0025	0.0141	0.02	0.1	0.33		
NS	NS	G	Trib 04												
07/18/18	11:05	G	Trib 11	221	8.2	7.7	22.9	3.5	0.0037	0.0135	<0.01	0.02	0.22		
NS	NS	G	Trib 22a												
07/18/18	10:30	G	Trib 22d	66	8.8	7.8	14.6	1.9	0.0075	0.0121	0.03	0.03	0.3		
07/18/18	8:25	G	Trib 24	368	4.7	7.2	16.9	4.5	0.0046	0.0121	0.01	0.1	0.36		
NS	NS	G	Trib 25												
07/18/18	10:45	G	Trib 27 (New Church Ditch Inlet)	213	7.4	7.3	21	6.8	0.0075	0.02	<0.01	0.07	0.37		
08/01/18	9:10	G	Trib 01	252	8.3	7.5	16.3	0.7	0.0035	0.0087	0.01	0.11	0.31		
08/01/18	9:30	G	Trib 02	263	8.4	7.7	16.7	0.7	0.0027	0.0058	0.01	0.11	0.35		
08/01/18	9:40	G	Trib 03	279	7.8	7.8	19.2	0.5	0.003	0.0082	<0.01	0.2	0.44		
NS	NS	G	Trib 04												
08/01/18	10:45	G	Trib 11	249	8.4	7.7	19.6	2.3	0.0029	0.0163	<0.01	0.06	0.31		
NS	NS	G	Trib 22a												
08/01/18	10:20	G	Trib 22d	62.6	9.4	7.8	12.6	1.3	0.0047	0.0116	0.02	0.02	0.25		
08/01/18	8:30	G	Trib 24	344	4.5	7.8	19.2	3.2	0.0036	0.0136	0.02	0.02	0.27		
NS	NS	G	Trib 25												
NS	NS	G	Trib 27 (New Church Ditch Inlet)												
09/05/18	9:20	G	Trib 01	302	8.5	7.8	15.4	4.1	0.0068	0.0177	0.02	0.2	0.38	1.6	2
09/05/18	9:35	G	Trib 02	307	8.2	7.8	17	17.2	0.0144	0.0401	0.03	0.27	0.6	2.5	2.1
09/05/18	9:50	G	Trib 03	312	7.9	7.8	16.7	20.6	0.072	0.136	0.09	0.36	1.1	1.9	1.8
NS	NS	G	Trib 04												
09/05/18	10:45	G	Trib 11	281	8.1	7.7	17.4	4	0.0025	0.0195	<0.01	0.12	0.37	1.5	1.8
NS	NS	G	Trib 22a												
09/05/18	10:30	G	Trib 22d	57.6	9.1	7.8	13.1	2.2	0.0058	0.0147	0.02	0.04	0.22	0.5	1
09/05/18	8:40	G	Trib 24	318	5.7	7.7	21	2.7	0.0051	0.0164	0.01	0.02	0.21	1	1.4
NS	NS	G	Trib 25												
NS	NS	G	Trib 27 (New Church Ditch Inlet)												
10/03/18	9:30	G	Trib 01	346	10.7	7.9	0.7	12.6	0.003	0.0086	<0.01	0.09	0.26		

SM7110B	SM7110B	SM5310B	SM2540D	SM9221D	EPA200.7	EPA200.7	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA130.2	SM4110A	SM4110A	SM4110A	EPA200.8	EPA200.8	EPA200.8
variable	variable	0.5	1	1	0.01	0.01	0.00025	0.00025	0.0025	0.0025	5	5	10	0.1	0.00015	0.00015	0.0001
2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	1	1	0	0	3	3	5	5	4	4	0	0	0	1	5	5	5
pCi/L	pCi/L	mg/L	mg/L	cfu/100mL	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
Gross Beta	Gross Beta, Uncertainty	Carbon, Total Organic	Solids, Total Suspended	E. coli,	Iron, Dissolved	Iron, Total	Manganese, Dissolved	Manganese, Total	Zinc, Dissolved	Zinc, Total	Hardness, Total	Chloride	Sulfate	Bromide	Arsenic, Dissolved	Arsenic, Total	Barium, Dissolved
		1.8	27	1	<0.0026	0.16	0.00029	0.041	0.011	0.016							
<3.9	2.1	2.6	7	4	0.028	0.21	0.017	0.078	0.041	0.069	40	10	17		0.00015	0.0011	0.017
<4	2.1	2.7	4	10	0.028	0.2	0.017	0.081	0.042	0.07	44	9	17		0.00013	0.0012	0.018
<4.1	2.3	2.5	16	77	0.027	0.95	0.041	0.28	0.04	0.15	44	9	17		0.0002	0.0014	0.018
<4.0	2.3	2.6	26	51	0.022	0.33	0.004	0.093	0.025	0.066	46	9	18		0.00019	0.0013	0.019
<4.2	2.3	2.1	<1	<1	<0.0026	0.079	0.00024	0.03	0.0086	0.02	112	35	62		0.00048	0.0015	0.048
		1.8	4	23	0.016	0.42	0.0046	0.06	0.037	0.074							
		1.7	10	58	0.015	0.45	0.0083	0.066	0.035 S	0.019 S							
		1.9	6	121	0.014	0.26	0.012	0.06	0.025	0.044							
		1.8	7	140	0.012	0.25	0.00061	0.051	0.0075	0.025							
		4.8	5	131	0.036	0.15	0.00054	0.0099	0.0045	0.014							
		1.9	2	<1	<0.0026	0.24	0.00036	0.064	0.012	0.073							
		2.1	20	461	0.015	0.65	0.00033	0.091	0.0094	0.081							
		1.4	NT	17	0.014	0.074	0.011	0.033	0.045	0.066	92						
		1.5	NT	44	0.015	0.069	0.018	0.036	0.043	0.058	100						
		1.7	NT	73	0.017	0.066	0.05	0.069	0.032	0.044	108						
		1.6	NT	140	0.014	0.23	0.013	0.063	0.0097	0.03	92						
		4.3	NT	53	0.039	0.16	0.0035	0.013	0.002	0.0047	40						
		1.9	NT	1	<0.0026	0.17	0.001	0.05	0.012	0.016	120						
<4	2.4	2.1	9	144	0.011	0.49	0.00077	0.07	0.037	0.075	104	28	59		0.00022	0.00081	0.04
4.5	2.3	3	27	1300	0.016	1.4	0.00045	0.088	0.03	0.074	108	29	55		0.00037	0.0028	0.043
6.3	2.5	7.4	33	>2420	0.046	1.6	0.00095	0.1	0.016	0.046	96	33	43		0.00075	0.0031	0.029
<4.1	2.4	2.2	12	435	0.011	0.39	0.00052	0.069	0.011	0.035	108	19	60		0.00038	0.0022	0.039
<4	2.2	3.9	5	43	0.06	0.18	0.00072	0.002	0.0023	0.0044	34	2	5		0.000098	0.0021	0.013
<4	2.3	2.1	4	<1	0.0041	0.12	0.00018	0.028	0.0073	0.01	108	29	51		0.00051	0.0007	0.048
		1.4	5	5	NT	0.037	NT	0.019	NT	0.064							

EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8
0.0001	0.001	0.001	0.00010	0.00010	0.00050	0.00050	0.00025	0.00025	0.00020	0.00020	0.00050	0.00050	0.005	0.005	0.00050	0.00050
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	5	5
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
Barium, Total	Beryllium, Dissolved	Beryllium, Total	Cadmium, Dissolved	Cadmium, Total	Chromium, Dissolved	Chromium, Total	Copper, Dissolved	Copper, Total	Lead, Dissolved	Lead, Total	Molybdenum, Dissolved	Molybdenum, Total	Nickel, Dissolved	Nickel, Total	Selenium, Dissolved	Selenium, Total
							0.0031	0.006								
0.021	<0.000054	<0.000054	0.00014	0.00024	<0.000088	0.00022	0.0023	0.0044	0.0002	0.0018	0.0014	0.0018	0.00063	0.00078	<0.00015	0.00026
0.022	<0.000054	0.00012	0.00013	0.00027	<0.000088	0.0002	0.0024	0.0047	0.0002	0.0018	0.0014	0.0018	0.00073	0.00081	<0.00015	<0.00015
0.03	<0.000054	0.00022	0.00012	0.00066	<0.000088	0.00099	0.0025	0.014	0.00024	0.0077	0.0015	0.0023	0.00075	0.0018	0.00015	<0.00015
0.024	<0.000054	<0.000054	0.000064	0.00025	<0.000088	0.00053	0.0028	0.0064	0.00013	0.0026	0.0017	0.002	0.00068	0.0012	<0.00015	<0.00015
0.05	<0.000054	0.00025	0.000024	0.000017	<0.000088	<0.000088	0.0036	0.0059	<0.000038	0.0005	0.0025	0.0027	0.0017 S	0.0012 S	0.00046 S	0.00043 S
0.047	<0.000054	0.00028	0.000094	0.00032	<0.000088	0.0005	0.0023	0.0052	<0.000038	0.0016	0.0023	0.0032	0.0016 S	0.00091 S	0.00035	0.00061
0.054	<0.000054	0.00037	0.000046	0.00032	<0.000088	0.0014	0.0028	0.0072	<0.000038	0.0028	0.0024	0.0027	0.0019 S	0.0016 S	0.00043 S	0.00046 S
0.04	<0.000054	0.00028	0.00002	0.0002	0.00012	0.0012	0.0033	0.0063	0.000044	0.0024	0.002	0.0021	0.0018 S	0.0016 S	0.00066 S	0.00052 S
0.043	<0.000054	0.00062	<0.000012	0.00018	<0.000088	0.00041	0.0023	0.0048	<0.000038	0.0019	0.00027	0.003	0.0016 S	0.00083 S	0.00028	0.00056
0.015	<0.000054	0.00071	<0.000012	0.000014	<0.000088	0.00023	0.00072	0.001	<0.000038	0.00025	0.00063	0.00075	<0.00032	<0.00032	<0.00015	0.0007
0.049	<0.000054	<0.000054	<0.000012	0.000027	<0.000088	0.00017	0.0043	0.0069	<0.000038	0.00089	0.0027	0.0034	0.0018 S	0.0008 S	0.00048 S	0.00038

EPA200.8	EPA200.8	EPA200.7	EPA200.7	EPA200.8	EPA200.8			
0.0005	0.0005	0.0020	0.0020	0.00003	0.00003			
3	3	3	3	3	3			
5	5	5	5	5	5			
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			
Silver, Dissolved	Silver, Total	Strontium Dissolved ICAP	Strontium Total	Vanadium Dissolved ICAP/MS	Vanadium Total ICAP/MS	Notes	Conclusion	Field Notes
						Not sampled		
						Not sampled		
						Not sampled		
0.000014	0.000035	0.066	0.076	0.00018	0.00046			
<0.000014	0.000029	0.068	0.077	0.00018	0.00041			
<0.000014	0.00011	0.067	0.079	0.00023	0.0014			
						Not sampled		
0.000015	0.000042	0.073	0.086	0.00022	0.0012			
						Not sampled		
						Not sampled		
<0.000014	0.000019	0.21	0.24	0.00041	0.00054			
						Not sampled		
						Not sampled		
						Not sampled		
						Not sampled		
						Not sampled		
						Not sampled		
						Not sampled		
						Not sampled		
						Not sampled		
						Not sampled		
						Not sampled		
						Not sampled		
<0.000014	0.000027	0.18	0.19	0.00022	0.0015			
<0.000014	0.000034	0.19	0.2	0.00043	0.0034			
<0.000014	<0.000014	0.19	0.2	0.0015	0.0048			
						Not sampled		
<0.000014	0.000015	0.018	0.019	0.00027	0.0018			
						Not sampled		
<0.000014	<0.000014	0.039	0.04	0.00018	0.0015			
<0.000014	0.000017	0.2	0.2	0.00048	0.0013			
						Not sampled		
						Not sampled		

Tribs

Method				SM2510B	SM4500OG	SM4500H+B	SM2550B	SM2130B	SM4500PE	SM4500PE	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM7110B	SM7110B
Reporting Limit Goal				10	1.0	1.0	1.0	1	0.0025	0.0025	0.01	0.01	0.02	variable	variable
Max Sig figs				3	3	3	3	3	3	3	3	3	3	2	2
Max decimals				0	1	1	1	1	4	4	2	2	2	1	1
Reporting Units				µS/cm	mg/L	s.u.	°C	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L
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
10/03/18	9:50	G	Trib 02	353	9.4	8	0.8	18.6	0.0027	0.0071	<0.01	0.09	0.21		
NS	NS	G	Trib 03												
NS	NS	G	Trib 04												
10/03/18	10:25	G	Trib 11	379	9.3	7.9	3.9	17.8	0.0029	0.0199	<0.01	0.06	0.24		
NS	NS	G	Trib 22a												
NS	NS	G	Trib 22d												
10/03/18	8:50	G	Trib 24	329	6.9	7.6	18.9	2.2	0.0058	0.0186	<0.01	0.03	0.2		
NS	NS	G	Trib 25												
NS	NS	G	Trib 27 (New Church Ditch Inlet)												
11/07/18	9:10	G	Trib 01	410	11.3	7.6	2.9	0.7	0.0034	0.0054	0.02	0.28	0.45		
11/07/18	9:25	G	Trib 02	416	11.2	7.7	3.9	0.5	0.004	0.0082	0.01	0.27	0.42		
11/07/18	9:40	G	Trib 03	430	9.6	8	8.7	2.3	0.0041	0.0125	0.02	0.28	0.47		
11/07/18	10:40	G	Trib 04	451	9.5	7.8	5.6	5.6	0.0104	0.0217	<0.01	0.18	0.39		
NS	NS	G	Trib 11												
NS	NS	G	Trib 22a												
NS	NS	G	Trib 22d												
11/07/18	8:20	G	Trib 24	338	8.4	7.6	13.2	1.6	0.004	0.0102	<0.01	0.03	0.24		
NS	NS	G	Trib 25												
NS	NS	G	Trib 27 (New Church Ditch Inlet)												
12/05/18	9:00	G	Trib 01	615	11.4	7.7	2.3	0.8	0.0031	0.0069	0.01	0.62	0.75	2.5	2.5
NS	NS	G	Trib 02												
12/05/18	9:25	G	Trib 03	621	9.6	7.9	7	1.1	0.0062	0.0141	0.05	0.66	0.88	1.5	2.3
12/05/18	9:55	G	Trib 04	651	11.1	7.9	4.4	11	0.0099	0.0321	0.03	0.45	0.76	2.2	2.9
NS	NS	G	Trib 11												
NS	NS	G	Trib 22a												
NS	NS	G	Trib 22d												
12/05/18	8:15	G	Trib 24	398	9.5	7.7	11.6	1.2	0.0052	0.0113	0.01	0.03	0.24	0.8	1.9
NS	NS	G	Trib 25												
NS	NS	G	Trib 27 (New Church Ditch Inlet)												

SM7110B	SM7110B	SM5310B	SM2540D	SM9221D	EPA200.7	EPA200.7	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA130.2	SM4110A	SM4110A	SM4110A	EPA200.8	EPA200.8	EPA200.8
variable	variable	0.5	1	1	0.01	0.01	0.00025	0.00025	0.0025	0.0025	5	5	10	0.1	0.00015	0.00015	0.0001
2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	1	1	0	0	3	3	5	5	4	4	0	0	0	1	5	5	5
pCi/L	pCi/L	mg/L	mg/L	cfu/100mL	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
Gross Beta	Gross Beta, Uncertainty	Carbon, Total Organic	Solids, Total Suspended	E. coli,	Iron, Dissolved	Iron, Total	Manganese, Dissolved	Manganese, Total	Zinc, Dissolved	Zinc, Total	Hardness, Total	Chloride	Sulfate	Bromide	Arsenic, Dissolved	Arsenic, Total	Barium, Dissolved
		1.4	4	32	NT	0.044	NT	0.023	NT	0.052							
		1.6	14	123	NT	0.31	NT	0.065	NT	0.033							
		1.9	6	4	NT	0.097	NT	0.02	NT	0.003							
		1.3	2	<1	0.01	0.065	0.038	0.051	0.11	0.12							
		1.2	3	6	0.0093	0.083	0.049	0.066	0.11	0.12							
		1.2	4	39	0.011	0.13	0.018	0.061	0.071	0.094							
		1.8	13	1554	0.016	0.38	0.00071	0.044	0.052	0.054							
		2	<1	6	0.0029	0.045	0.0011	0.023	0.0044	0.0077							
4.6	2.6	1.3	<1	<1	0.0093	0.046	0.046	0.059	0.15	0.18	216	52	117		0.00018	0.00015	0.058
5	2.5	1.5	6	124	0.026	0.22	0.055	0.093	0.09	0.1	216	64	117		0.0003	0.00026	0.063
3.9	2.4	1.8	21	114	0.02	1.1	0.0087	0.1	0.036	0.1	216	59	102		0.00084	0.0015	0.058
4.4	2.3	1.9	<1	7	0.0027	0.036	0.0019	0.011	0.0062	0.0071	148	32	58		0.00034	0.00032	0.045

Ambient Autosamplers (with TH metals)

Method				SM2550B	SM4500H+B	SM2510B	SM2130B	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM4500PE	SM4500PE	SM5310B	SM2540D	EPA200.8	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	0.00010
Max Sig figs				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	1	0	5	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	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	Barium, Dissolved
04/30/18	2:00	24C	CC AS 26	12.9	8	541	6.1	0.02	0.23	0.34	0.0177	0.0191	2.1	8			
04/30/18	12:00	24C	CC AS 49	13.9	7.8	464	8.2	0.01	0.18	0.37	< 0.0025	0.0279	2.5	18			
04/30/18	12:00	24C	CC AS 50	13.4	8	322	20.2	0.01	0.21	0.43	0.0031	0.0296	3.2	30			
04/30/18	NS	NS	CC AS 59														
05/01/18	3:30	24C	CC AS T2	19	7.5	460	7.2	0.01	0.17	0.35	< 0.0025	0.0213	2.2	10			
05/01/18	12:30	24C	CC AS T11	15.8	7.6	474	18	0.02	0.17	0.34	0.0026	0.0348	2.1	48			
05/29/18	6:30	24C	CC AS 26	11.6	7.3	115	4.5	<0.01	0.09	0.22	0.003	0.0162	3	8			
05/29/18	10:35	24C	CC AS 49	13.8	7.2	56	13.1	<0.01	0.09	0.25	0.0033	0.0251	3.3	32			
05/29/18	14:35	G	CC AS 50	12.1	7.2	140	7.3	<0.01	0.03	0.12	0.0041	0.0114	3	7			
05/29/18	15:20	24C	CC AS 59	23.8	7.8	120	8.5	<0.01	0.09	0.24	0.0031	0.0222	3.9	19			
05/29/18	16:45	24C	CC AS T2	23.6	7.7	126	8.7	<0.01	0.09	0.22	0.0027	0.0199	3.1	15			
05/30/18	1:05	24C	CC AS T11	22	7.7	109	28.9	<0.01	0.09	0.29	0.0042	0.0483	3.2	87			
6/19/2018	7:30	24C	CC AS 26	11.9	7.9	126	<1	<0.01	0.09	0.24	< 0.0025	0.008	2.2	4			
6/19/2018	11:20	24C	CC AS 49	14.5	7.7	119	<1	<0.01	0.08	0.32	0.0027	0.0263	2.3	33			
6/19/2018	11:20	24C	CC AS 50	14.6	7.8	206	2.7	<0.01	0.07	0.26	0.0037	0.0133	3.2	7			
6/19/2018	15:50	24C	CC AS 59	21.2	7.6	126	4.7	0.01	0.08	0.25	0.0036	0.0109	2.8	7			
6/19/2018	17:15	24C	CC AS T2	21.9	7.7	130	3.5	<0.01	0.08	0.26	< 0.0025	0.0118	2.7	5			
6/20/2018	11:35	G	CC AS T11	17.2	7.7	137	6.2	0.01	0.07	0.44	0.0037	0.0177	2.5	10			
8/1/2018	4:30	24C	CC AS 26	13.3	7.9	240	<1	0.03	0.14	0.64	0.0026	0.0083	2.3	3			
8/1/2018	13:00	24C	CC AS 49	20.5	7.8	228	6.9	<0.01	0.16	0.49	0.0071	0.0334	1.7	18			
7/31/2018	21:00	24C	CC AS 50	20.7	8	568	14.1	0.01	0.43	1.1	0.0053	0.0433	4	20			
8/1/2018	23:01	24C	CC AS 59	25.9	7.8	245	1.5	0.03 <0.01	0.15	0.44	< 0.0025	0.0141	2.3	5			
8/2/2018	2:00	24C	CC AS T2	26.2	7.8	252	2.1		0.13	0.51	< 0.0025	0.013	1.5	6			
8/2/2018	12:20	24C	CC AS T11	23.7	8	254	6.6	0.01	0.08	0.43	0.0027	0.0183	1.9	13			
8/27/2018	0:30	G	CC AS 26	14	7.8	255	2.2	0.02	0.14	0.35	0.0028	0.009	1.5	2			
8/27/2018	10:35	24C	CC AS 49	22.1	8	256	3.7	<0.01	0.11	0.46	0.0037	0.0291	1.8	8			
8/27/2018	10:35	G	CC AS 50	21.1	8.2	640	1.9	0.04	0.63	1.01	0.0052	0.0189	2.8	5			
8/27/2018	22:30	24C	CC AS 59	25.2	7.8	273	7	<0.01	0.12	0.42	0.0043	0.0189	4.6	13			
8/28/2018	2:00	24C	CC AS T2	24.9	7.8	296	5.3	<0.01	0.14	0.49	0.0028	0.0133	2.1	6			
8/28/2018	12:45	24C	CC AS T11	22.3	7.5	301	7.7	0.02	0.09	0.4	0.003	0.018	2	19			

EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.7	EPA200.7	EPA200.8	EPA200.8	EPA200.8	EPA200.8				
0.00032	0.00050	0.00050	0.00001	0.00001	0.00200	0.00200	0.00003	0.00003	0.0025	0.0025				
3	3	3	3	3	3	3	3	3	3	3				
5	5	5	5	5	5	5	5	5	4	4				
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Nickel Total	Selenium, Dissolved	Selenium, Total	Silver dissolved	Silver Total	Strontium Dissolved ICAP	Strontium ICAP	Vanadium Dissolved	Vanadium Total	Zinc, Dissolved	Zinc, Total	Notes	Conclusion	Field Notes	Lab Notes
											Start time 3:00 on 4/29/18, end time is 2:00 on 4/30/18.			
											Start time 13:00 on 4/29/18, end time is 12:00 on 4/30/18.			
											Start time 13:00 on 4/29/18, end time 12:00 on 4/30/18.			
											Not Sampled, construction			
											Start time 4:30 on 4/30/18, end time 3:30 on 5/1/18.			
											Start time 13:30 on 4/30/18, end time 12:30 on 5/1/18.			
									0.036	0.071	Start time 0730 on 5/28/18, end time 0630 on 5/29/18.			
									0.074	0.085	Start time 1135 on 5/28/18, end time 1035 on 5/29/18.			
									0.04	0.16	Grab sample collected		AS failure	
									0.037	0.12	Start time 1620 on 5/28/18, end time 1520 on 5/29/18.			
									0.034	0.11	Start time 1745 on 5/28/18, end time 1645 on 5/29/18.			
									0.024	0.26	Start time 0205 on 5/29/18, end time 0105 on 5/30/18.			
											Start time 0830 on 6/18/18, end time 0730 on 6/19/18.			
											Start time 1220 on 6/18/18, end time 1120 on 6/19/18.			
											Start time 1220 on 6/18/18, end time 1120 on 6/19/18.			
											Start time 1650 on 6/18/18, end time 1550 on 6/19/18.			
											Start time 1815 on 6/18/18, end time 1715 on 6/19/18.			
											Grab sample collected			
											Start time 0530 on 7/31/18, end time 0430 on 8/01/18.			
											Start time 1400 on 7/31/18, end time 1300 on 08/01/18.			
											Bottles 1-4. Start time 1400 on 7/31/18, end time 2100 on 7/31/18.			
											Start time 0001 on 08/01/18, end time 2301 on 8/01/18.			
											Start time 0300 on 8/01/18, end time 0200 on 08/02/18.			
											Start time 1320 on 8/01/18, end time 1220 on 08/02/18.			
											Grab sample collected			
											Start time 1135 on 8/26/18, end time 1035 on 08/27/18.			
											Grab sample collected			
											Start time 2330 on 08/26/18, end time 2230 on 8/27/18.			
											Start time 0300 on 8/27/18, end time 0200 on 08/28/18.			
											Start time 1345 on 8/27/18, end time 1245 on 08/28/18.			

Ambient Autosamplers (with TH metals)

Method				SM2550B	SM4500H+B	SM2510B	SM2130B	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM4500PE	SM4500PE	SM5310B	SM2540D	EPA200.8	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	0.00010
Max Sig figs				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	1	0	5	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	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	Barium, Dissolved
9/23/2018	21:30	24C	CC AS 26	12.7	7.8	316	4.8	0.04	0.19	0.33	< 0.0025	0.0081	1.5	2			
9/24/2018	9:10	24C	CC AS 49	17.5	7.9	301	7	0.03	0.14	0.34	0.0027	0.0227	1.9	12			
9/24/2018	9:10	24C	CC AS 50	15.3	7.8	726	5.8	0.01	0.76	0.92	0.0033	0.0131	3.1	10			
	NS	NS	CC AS 59														
9/25/2018	3:00	24C	CC AS T2	20.9	7.8	340	5	0.03	0.14	0.35	< 0.0025	0.0096	1.6	6			
9/25/2018	14:40	24C	CC AS T11	17.6	7.8	342	10.7	0.01	0.07	0.29	0.0025	0.0174	1.7	19			
10/22/2018	12:40	G	CC AS 26	4.8	7.8	334	2.1	0.02	0.28	0.42	< 0.0025	0.0074	1.1	<1			
10/22/2018	10:15	24C	CC AS 49	12.2	8	325	3.4	0.03	0.26	0.45	0.0036	0.0148	1.4	<1			
10/22/2018	10:15	24C	CC AS 50	11.4	7.9	826	1.4	<0.01	0.86	1.1	0.0032	0.0258	2.6	<1			
	NS	NS	CC AS 59														
10/23/2018	5:50	24C	CC AS T2	16.8	7.9	391	7.8	<0.01	0.27	0.45	< 0.0025	0.0058	1.6	<1			
10/23/2018	16:55	24C	CC AS T11	14.3	7.8	397	5.2	<0.01	0.22	0.42	< 0.0025	0.0144	2.4	10			

EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.7	EPA200.7	EPA200.8	EPA200.8	EPA200.8	EPA200.8				
0.00032	0.00050	0.00050	0.00001	0.00001	0.00200	0.00200	0.00003	0.00003	0.0025	0.0025				
3	3	3	3	3	3	3	3	3	3	3				
5	5	5	5	5	5	5	5	5	4	4				
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Nickel Total	Selenium, Dissolved	Selenium, Total	Silver dissolved	Silver Total	Strontium Dissolved ICAP	Strontium ICAP	Vanadium Dissolved	Vanadium Total	Zinc, Dissolved	Zinc, Total	Notes	Conclusion	Field Notes	Lab Notes
											Start time 2230 on 09/22/18, end time 2130 on 09/23/18.			
											Start time 1010 on 09/23/18, end time 0910 on 09/24/18.			
											Start time 1010 on 09/23/18, end time 0910 on 09/24/18.			
											Not sampled			
											Start time 0300 on 09/24/18, end time 0300 on 09/25/18.			
											Start time 1540 on 09/24/18, end time 1440 on 09/25/18.			
									0.065	0.084	Grab sample collected		autosampler failure	
									0.086	0.12	Start time 1115 on 10/21/18, end time 1015 on 10/22/18.			
									0.22	0.25	Start time 1115 on 10/21/18, end time 1015 on 10/22/18.			
											Not sampled			
									0.052	0.068	Start time 0650 on 10/22/18, end time 0550 on 10/23/18.			
									0.028	0.067	Start time 1755 on 10/22/18, end time 1655 on 10/23/18.			

Event Autosamplers (with TH metals)																		
Method				SM2550B	SM4500H+B	SM2510B	SM2130B	SM4500NH3H	SM4500NO3I	SM4500NO3I	SM4500PE	SM4500PE	SM4500NH3H	EPA 300.0	SM4500NorgB	Calc	SM4500PE	SM4500PE
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
Max Sig figs				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
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
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	Phosphorus, Dissolved (SRP)	Phosphorus, Total
04/08/18	11:30	CE	CC AS T11	12.3	8	506	3.2	0.01	0.2	0.37	< 0.0025	0.0132						
04/08/18	23:01	CE	CC AS T2	13.4	7.8	507	1.8	0.01	0.26	0.39	< 0.0025	0.0095						
04/09/18	11:30	CE	CC AS T11	12.1	7.9	508	3.4	0.01	0.17	0.35	0.0046	0.0165						
07/12/18	19:59	CE	CC AS 49	8.7	7.2	215	1070	0.02	0.18	0.52	< 0.0025	0.602						
07/12/18	17:22	CE	CC AS 50	9.6	7.6	441	2200	0.01	0.42	2.24	0.006	4.38						
07/13/18	2:08	CE	CC AS T2	8.4	7.4	232	393	0.02	0.24	0.95	0.0096	0.292						
07/14/18	2:37	CE	CC AS T11	22.5	7.5	234	180	0.04	0.24	0.92	0.0114	0.161						
08/14/18	19:46	CE	CC AS T2	24.5	7.4	234	1370	0.15	0.64	16.7	0.0233	3.04						
08/15/18	19:09	CE	CC AS T11	13.3	7.5	254	445	0.25	0.64	0.37	0.0081	0.408						
11/06/18	15:25	CE	CC AS T3	11.3	7.9	428	4.8	0.01	0.25	0.46	0.0031	0.0122						
11/06/18	12:10	CE	CC AS T4	9.9	7.8	472	17.6	<0.01	0.08	0.36	0.0078	0.029						

SM5310B	SM2540D	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.7	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8
0.5	1	0.00015	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
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	0	5	5	5	5	5	5	5	5	5	5	5	5	3	3	5	5	5	5	5
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
Carbon, Total Organic	Solids, Total Suspended	Arsenic, Dissolved	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
1.9	3	0.00033	0.0016	0.054 S	0.051 S	<0.000054	<0.000054	0.00018	0.00026	0.00012	0.00012	0.003	0.0042	0.0068	0.15	0.000054	0.00059	0.0014	0.03	0.0027
1.6	1	0.00024	0.00065	0.058 S	0.053 S	<0.000054	<0.000054	0.00038	0.00048	0.00022	0.0005	0.0066	0.0056	0.012	0.06	0.00018	0.00063	0.037	0.07	0.0023
1.9	2	0.00033	0.0014	0.053 S	0.052 S	<0.000054	<0.000054	0.00018	0.00028	0.00047	0.0006	0.0028	0.0039	0.013	0.099	0.00007	0.00061	0.003	0.03	0.0027 S
2.9	1160	0.0012	0.094	0.02	0.38	<0.000054	0.0012	0.001	0.056	0.00022	0.048	0.0035	0.38	NT	NT	0.00051	2.8	0.032	2.1	0.00096
8.7	5320	0.00067	0.041	0.046	2.5	<0.000054	0.0094	0.00029	0.015	0.00012	0.26	0.009	1.4	NT	NT	0.000092	0.97	0.3	12	0.0021
3.5	492	0.0006	0.032	0.036	0.29	<0.000054	0.0009	0.00012	0.0025	0.00032	0.033	0.0046	0.21	NT	NT	0.00023	0.45	0.0035	1.2	0.002
2.8	212	0.0005	0.018	0.036	0.14	<0.000054	0.00045	0.000056	0.0021	0.000099	0.0098	0.0031	0.08	NT	NT	0.00016	0.29	0.00087	0.73	0.0017
14.6	5400	0.001	0.039	0.052	1.9	<0.000054	0.013	0.000046	0.005	0.00036	0.36	0.0031	0.36	0.13	210	0.00022	0.29	0.0074	6.1	0.0067 S
5.8	536	0.00077	0.0099	0.049	0.24	<0.000054	0.0016	0.000052	0.00095	0.0005	0.03	0.0036	0.052	0.48	20	0.0005	0.038	0.0033	0.69	0.004 S
1.6	8	0.00016	0.0003	0.049	0.052	<0.000054	<0.000054	0.000061	0.00036	<0.000088	0.0004	0.0022	0.014	0.018	0.55	0.0001	0.002	0.031	0.12	0.0022
2.7	22	0.00078	0.0014	0.051	0.061	<0.000054	0.000055	<0.000012	0.00027	<0.000088	0.0013	0.0017	0.0083	0.025	0.9	0.00022	0.0062	0.0012	0.0075	0.0028

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	SM9221D				
0.00050	0.00050	0.00050	0.00050	0.00050							0.0025	0.0025	1				
3	3	3	3	3							3	3	3				
5	5	5	5	5							4	4	0				
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	cfu/100mL				
Molybdenum, Total	Nickel, Dissolved	Nickel, Total	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
0.0027	0.0019	0.002	0.00045 S	0.00016 S	<0.000014	0.000015	0.3	0.31	0.00011	0.0004	0.049	0.05	First Flush. Bottles 1-12. Start time 12:30 on 4/7/18, end time 11:30 on 4/8/18.				
0.0023	0.0019	0.0034	0.00043	0.00084	<0.000014	0.00002	0.27	0.27	<0.000034	0.0013	0.086	0.11	First Flush. Bottles 1-12. Start time 0:01 on 4/8/18, end time 23:01 on 4/8/18.		Time of travel in FHL between T2 and T11 not incorporated into sampling for these first flush samples.		
0.0026 S	0.0016	0.0022	0.00039 S	<0.000014	<0.000014	0.000024	0.29	0.3	0.00011	0.00023	0.043	0.051	First Flush. Bottles 1-12. Start time 12:30 on 4/8/18, end time 11:30 on 4/9/18.		Time of travel in FHL between T2 and T11 not incorporated into sampling for these first flush samples.		
0.0042	0.0026	0.034	0.00018	0.00044	<0.000014	0.012			<0.000034	0.052	0.16	1.4	Bottles 1-9. Start time 1710 on 7/12/18, end time at 1959 on 7/12/18. Retrieved on 7/13/18				
0.0029	0.0031	0.23	0.00069	0.0023	<0.000014	0.012			0.000069	0.32	0.025	3.4	Bottles 1-12. Start time 1437 on 7/12/18, end time at 1722 on 7/12/18. Retrieved on 7/13/18				
0.0028	0.0011	0.028	0.00016	0.0004	<0.000014	0.0042			0.000057	0.038	0.028	0.66	Bottles 1-21. Start time 2108 on 7/12/18, end time 0208 on 7/13/18.				
0.0023	0.00088	0.0095	0.00024 S	0.00015 S	<0.000014	0.0024			<0.000034	0.014	0.024	0.52	Bottles 1-2. Start time 0222 on 7/14/18, end time 0237 on 07/14/18.				
0.0032 S	0.0023	0.25	0.00048	0.0011	0.00002	0.00092	0.14	0.57	0.0011	0.27	0.0034	1.2	Bottles 1-9. Start time 1746 on 8/14/18, end time 1946 on 8/14/18.				
0.0032 S	0.0022	0.026	0.0005 S	<0.00015 S	<0.000014	0.000022	0.15	0.21	0.0009	0.04	0.0099	0.29	Bottles 1-9. Start time 1709 on 8/15/18, end time 1909 on 08/15/18.				
0.0024	0.0016 S	0.0012 S	0.00026 S	0.00017 S	<0.000014	0.000022	0.26	0.27	<0.000034	0.00052	0.059	0.096	Croke First Flush. Bottles 1-12. Start time 1625 on 11/05/18, end time 1525 on 11/06/18.				
0.0029	0.0017 S	0.0015 S	0.0004 S	0.00034 S	0.000021	0.000087	0.32 S	0.31 S	0.00031	0.0016	0.016	0.063	Croke First Flush. Bottles 1-12. Start time 1310 on 11/05/18, end time 1210 on 11/06/18.				

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	EPA200.7	EPA200.7	SM5310B	Contractor	Contractor
DL				variable	variable	variable	variable	variable	variable	0.004	0.004	0.01	0.01	0.001	0.001	0.030	0.030	0.5			
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
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	Zinc, Total	Carbon, Total Organic	Nitrogen - Ammonia (Auto. Phenate)	Nitrogen - TKN Kjeldahl	
6/18/2018		CE	CC 59 Event	< 0.0005	0.001	NT	NT	< 0.01	0.06	0.04	13.7	0.0006	0.208	0.122	0.55	0.059	0.29	5.36	< 0.2	0.5	
7/13/2018		CE	CC 59 Event	< 0.0005	0.003	NT	NT	< 0.01	0.292	0.032	70.26	0.0007	2.03	0.285	0.979	0.048	0.781	3.35	0.05	1.2	
9/6/2018		CE	CC 59 Event	< 0.0005	0.001	NT	NT	< 0.01	0.053	0.013	19.35	< 0.0005	0.19	0.037	0.676	0.038	0.328	3.38	< 0.2	1	

Contractor	Contractor	Contractor			EPA200.7	EPA200.7						
mg/L	mg/L	mg/L	C	NTU	mg/L	mg/L	umho/cm2	SU				
NO2/NO3 as N. 353.2	Phosphorus - Total, Auto Asc. Acid Red.	Solids - Total Suspended, 105	Temperature	Turbidity - Nephelometric	Aluminum, Sol. - ICP	Aluminum, Total - ICP	Conductivity	pH	Notes	Conclusion	Field Notes	Lab Notes
0.02	0.33	189	12.8	155	0.033	6.18	143	7.23				
0.18	0.58	604	15.7	901	0.027	23.3	237	7.43				
0.32	0.22	252	12.4	264	0.022	9.35	336	7.81				

STANDLEY LAKE																		
Method				electrode	SM2510B	electrode	SM4500OG	SM4500H+B	SM2550B	SM2130B	Secchi Disk	SM4500NH3H	SM4500NO3I	SM4500NO3I	FlowCAM	SM10200H	SM5910B	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
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	4	3	3	2
Max decimals				1	0	0	1	1	1	1	2	2	2	2	0	1	3	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
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
01/08/18		G	SL 10-00	2.6	320	331	10.5	7.9	2.2	0.5	7.6							
01/08/18		C	SL 10-PZ									0.04	0.06	0.25	138	1.4		0.324
01/08/18		G	SL 10-70	1.5	343	322	9.5	7.7	3.4	1.4		0.06	0.12	0.32				0.312
01/31/18		G	SL 10-00	1.3	328	355	10.9	8	2.6	0.6	6.8							
01/31/18		C	SL 10-PZ									0.03	0.08	0.32	242	2.5		0.322
01/31/18		G	SL 10-70	5.3	328	348	10.7	7.9	2.7	0.7		0.03	0.07	0.26				0.314
02/13/18		G	SL 10-00	<1	333	379	11	8	1.9	1.1	4.9							
02/13/18		C	SL 10-PZ									0.03	0.08	0.32	65	1.7		0.31
02/13/18		G	SL 10-70	5.3	332	367	10.6	7.9	2.7	1.4		0.02	0.08	0.28				0.307
03/21/18		G	SL 10-00	<1	349	298	10.5	7.8	6.3	1.8	4.9							
03/21/18		C	SL 10-PZ									0.03	0.09	0.26	100	1.5		0.31
03/21/18		G	SL 10-70	3.6	348	285	10.3	7.8	5.3	2		0.03	0.09	0.26				0.307
04/04/18		G	SL 10-00	<1	348	302	10.2	8	7.5	0.4	3							
04/04/18		C	SL 10-PZ									0.03	0.07	0.33	97	2.5		0.3
04/04/18		G	SL 10-70	5	347	286	10	8	7	2.2		0.03	0.08	0.29				0.294
04/16/18		G	SL 10-00	<1	352	344	9.6	7.9	9.3	1.6	3.8							
04/16/18		C	SL 10-PZ									0.03	0.07	0.24	210	4.6		0.286
04/16/18		G	SL 10-70	5	353	341	9	7.7	8	3.7		0.03	0.07	0.27				0.282
05/07/18		G	SL 10-00	1.6	368	255	9.3	8.3	14	0.1	3.8							
05/07/18		C	SL 10-PZ									0.03	0.04	0.26	215	4.6		0.311
05/07/18		G	SL 10-70	2.4	362	281	7.5	7.6	8.7	1.6		0.08	0.05	0.3				0.284
05/21/18		G	SL 10-00	2.4	364	206	9	8.5	15.5	1.7	3.8							
05/21/18		C	SL 10-PZ									0.02	<0.01	0.24	533	7.9		0.338
05/21/18		G	SL 10-70	2	360	229	6.7	7.4	9	2.1		0.08	0.06	0.25				0.284
06/11/18		G	SL 10-00	<1	344	201	7.8	8.5	20.7	0.9	2.2							0.5
06/11/18		C	SL 10-PZ									<0.01	<0.01	0.14	158	3.5		0.368
06/11/18		G	SL 10-70	1.2	360	224	4.8	7.3	9.2	3.3		0.1	0.06	0.36				1.1
06/26/18		G	SL 10-00	<1	322	263	7.4	8.1	21.8	1.1	4							2.2
06/26/18		C	SL 10-PZ									0.02	<0.01	0.51	195	3.87		0.385
06/26/18		G	SL 10-70	1.1	361	257	3.8	7	9.5	7.6		0.13	0.1	0.88				0.289
07/11/18		G	SL 10-00	<1	316	335	7.2	8.3	24	0.7	5							
07/11/18		C	SL 10-PZ									0.02	<0.01	0.42	53	2.5		0.367
07/11/18		G	SL 10-70	1.8	359	344	1.4	7	9.7	8.7		<0.01	0.25	0.66				0.288
07/23/18		G	SL 10-00	<1	316	87	7.1	8.2	24	1	4							
07/23/18		C	SL 10-PZ									<0.01	<0.01	0.3	133	3.48		0.353
07/23/18		G	SL 10-70	<1	362	111	0.8	6.9	9.9	6.9		0.02	0.25	0.6				0.292
07/23/18		G	69-00															
08/06/18		G	SL 10-00	<1	313	243	7	8.2	22.1	0.9	4							
08/06/18		C	SL 10-PZ									0.02	<0.01	0.29	60	1.94		0.348
08/06/18		G	SL 10-70	<1	366	256	0.4	7	10	4.8		0.03	0.19	0.79				0.285
08/20/18		G	SL 10-00	<1	312	126	6.9	7.9	22.1	1.1	4.4							
08/20/18		C	SL 10-PZ									0.02	<0.01	0.3	52	1.74		0.345
08/20/18		G	SL 10-70	<1	367	120	0.4	6.8	10.1	4.8		0.12	0.11	0.55				0.301
08/30/18		G	SL 10-00	<1	315	289	7.1	8.1	21.4	0.7	5.6							
08/30/18		C	SL 10-PZ												NT			
08/30/18	11:30	G	SL 10-70	<1	368	49	0.4	7	10.3	3.1		0.11	0.09	0.49				0.295
09/04/18		G	SL 10-00	<1	312	324	7.2	8.1	20.6	1.1	4.4							
09/04/18	11:30	C	SL 10-PZ									0.02	<0.01	0.2	32	2.13		0.343
09/04/18	11:45	G	SL 10-70	<1	367	82	0.4	7.1	10.2	3		0.21	0.05	0.41				0.367
09/10/18		G	SL 10-00	1.1	311	279	7.3	8.1	21.6	1.1	4.1							
09/10/18		C	SL 10-PZ												NT			
09/10/18	11:30	G	SL 10-70	4.7	366	16	0.4	7.3	10.2	4.7		0.35	<0.01	0.48				0.415
09/17/18		G	SL 10-00	<1	311	238	7.5	8.2	20.8	1.3	3.6							
09/17/18	10:40	C	SL 10-PZ									0.03	<0.01	0.19	48	1.74		0.33
09/17/18	10:55	G	SL 10-70	<1	362	43	0.4	7.1	10.6	7.4		0.2	0.02	0.36				0.352
09/26/18		G	SL 10-00	1.1	321	317	7.1	8.1	19.3	1.8	2.5							
09/26/18		C	SL 10-PZ												NT			
09/26/18	11:30	G	SL 10-70	<1	378	-95	0.4	7.1	10.4	4.2		0.35	<0.01	0.54				0.418
10/02/18		G	SL 10-00	1.3	323	334	7	7.9	17.2	1.3	3.6							
10/02/18	11:20	C	SL 10-PZ									<0.01	<0.01	0.21	45	2.52		0.312
10/02/18	11:40	G	SL 10-70	<1	378	-43	0.5	7	10.5	5.6		0.37	<0.01	0.53				0.384

SM7110B	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	EPA200.8
variable	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	0.00050
2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	1	1	4	4	5	5	5	5	4	4	4	4	4	4	5	5	1	5	5
pCi/L	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	mg/L
Gross Alpha, Uncertainty	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	Chromium, Total
			< 0.0025	0.0062	0.00042 S	0.0004 S	0.046	0.046	<0.000054	<0.000054					<0.000012	<0.000012	2.4	<0.000088	<0.000088
			< 0.0025	0.0079	0.00043	0.0023	0.047	0.048	<0.000054	<0.000054					0.000021	0.000047	2.3	<0.000088	0.00021
			< 0.0025	0.0066															
			< 0.0025	0.0063															
			< 0.0025	0.0081													2.1		
			< 0.0025	0.0070													2.0		
			< 0.0025	0.009	0.00032	0.0011	0.045	0.047	<0.000054	<0.000054					<0.000012	0.000054		<0.000088	0.00036
			< 0.0025	0.0088	0.00032	0.0012	0.044	0.046	<0.000054	<0.000054					<0.000012	0.000036		<0.000088	0.00027
			< 0.0025	0.0092													2		
			< 0.0025	0.0115													1.8		
			< 0.0025	0.0107															
			< 0.0025	0.0132															
			< 0.0025	0.0099													2.3		
			< 0.0025	0.0132													1.9		
			< 0.0025	0.0106															
			< 0.0025	0.0088															
1.8	<3.9	2.3																	
2	<3.8	2.3	< 0.0025	0.0088	0.00053	0.0014	0.046	0.049	<0.000054	<0.000054					0.000021	0.000037	3.3	<0.000088	0.0001
2.2	<3.9	2.4	< 0.0025	0.0107	0.00046	0.0016	0.049	0.054	<0.000054	<0.000054					<0.000012	0.000018	2.1	<0.000088	0.00012
			< 0.0025	0.0087															
			0.003	0.0137															
			NS	NS													2.9		
			NS	NS													2.2		
			0.0026	0.0064															
			0.0042	0.0119															
											<0.0005	<0.0005	<0.0005	<0.0005					
			0.0033	0.0076													2.5		
			0.0031	0.0134													2		
			0.0033	0.0081															
			0.0028	0.0141															
			0.008	0.0168															
2	<3.9	2.2																	
1.6	<4.1	2.3	0.0027	0.0083	0.0006	0.00066	0.049 S	0.046 S	<0.000054	<0.000054					0.000069	0.000038 S	2.3	0.000088	0.00022
2.3		4	0.0204	0.0516	0.00056	0.00097	0.052 S	0.049 S	<0.000054	<0.000054					0.000028	0.000029	1.9	<0.000088	0.00029
			0.0638	0.135															
			0.0034	0.0076															
			0.022	0.0619															
			0.0381	0.098															
			0.0049	0.0124	0.00057 S	0.00026 S											2		
			0.0666	0.124	0.00065	0.0012											2.2		

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	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8
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	0.00050	0.0005	0.0005	0.0005	0.0005
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
0	5	5	0	3	3	5	5	5	5	5	5	5	4	4	5	5	5	5	5	5
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	mg/L	mg/L	mg/L	mg/L	mg/L
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	Selenium, Total	Silver, Dissolved	Silver, Total	Strontium, Dissolved	Strontium, Total
9.5																				
	0.0011	0.0013	NT	0.0043	0.028	< 0.000038	0.00017	0.0096	0.013	<0.000042	0.0026	0.0025	0.0021 S	0.002 S	0.0006	0.00065	<0.000014	0.000021	0.21	0.2
131.5	0.0012	0.0021	NT	0.006	0.086	0.00005	0.0007	0.022	0.033	<0.000042	0.0025	0.0028	0.0022 S	0.0015 S	0.00056 S	<0.00015 S	<0.000014	0.000014	0.22	0.22
5																				
17																				
<1																				
	0.0013	0.0018	124	0.018	0.073	< 0.000038	0.00045	0.012	0.02	<0.000042	0.0024	0.0028	0.0024 S	0.0021 S	0.00037 S	0.0003 S	<0.000014	0.000016	0.2	0.23
6	0.0012	0.0018	120	0.0033	0.092	< 0.000038	0.00043	0.012	0.022	<0.000042	0.0023	0.0025	0.0022 S	0.002 S	0.00037 S	0.00017 S	<0.000014	<0.000014	0.2	0.22
<1																				
29																				
<1																				
1																				
<1																				
	0.0011	0.0018	144	<0.0026	0.09	<0.000038	0.00026	0.00015	0.0085	<0.000042	0.0025	0.004	0.0015 S	0.0011 S	0.00041	0.00046	<0.000014	0.000024	0.2	0.21
1.5	0.00074	0.0014	138	<0.0026	0.13	<0.000038	0.00047	0.0022	0.13	<0.000042	0.0024	0.003	0.0019 S	0.0015 S	0.00046 S	0.00035 S	0.000028 S	<0.000014 S	0.21	0.22
<1																				
<1																				
1																				
<1																				
7																				
<1																				
	0.0018	0.0019	116	0.0044	0.043	0.000079	0.00036	0.00033	0.0068	<0.000042	0.0028	0.0033	0.002 S	0.0011 S	0.00062 S	0.00021 S	<0.000014	0.000014	0.019	0.2
29.5	0.00051	0.00096	128	0.000025	0.00032	<0.000038	0.00045	1.2	1.3	<0.000042	0.0039	0.0045	0.0026 S	0.0017 S	0.00059 S	0.00039 S	<0.000014	<0.000014	0.22	0.23
1																				
35.5																				

EPA200.8	EPA200.8	SM2540D	EPA200.8	EPA200.8	EPA200.7				
0.0005	0.0005	1	0.0025	0.0025	0.050				
3	3	3	3	3	3				
5	5	0	4	4	2				
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Vanadium, Dissolved	Vanadium, Total	Solids, Total Suspended	Zinc, Dissolved	Zinc, Total	Silicon, Dissolved	Notes	Conclusion	Field Notes	Lab Notes
0.00034 S	0.00033 S	<1	0.011	0.012	1.9				
0.00031 S	<0.000034 S	<1	0.021	0.023	2.4				
					1.6				
					1.6				
		2			1.9				
		6			1.9				
0.00025 S	0.00017 S	3	0.017	0.021	1.6				
0.00024 S	0.00012 S	4	0.016	0.02	1.6				
		1			1.4				
		3			1.4				
		7			0.97				
		6			1.3				
					0.54				
					1.4				
0.00056	0.00074	4	0.0021	0.0054	0.16				
0.00037	0.00068	4	0.01	0.019	1.4				
					0.28				
					1.5				
		4			0.2	Phosphorus samples not collected.			
		7			1.7	Phosphorus samples not collected.			
					0.18				
					1.8				
		1			0.3				
		7			1.8				
					0.44				
					2.1				
						Lake Lite			
						Lake Lite			
		<5				Lake Lite			TSS testing performed by SGS
0.00051	0.00063	2	0.0024	0.0046	0.63				
0.00012	0.00042	5	0.0081	0.011	2.2				
						Lake Lite			
						Lake Lite			
		4				Lake Lite			TSS testing performed by SGS
					0.74				
					2.1				
						Lake Lite			
						Lake Lite			
		6				Lake Lite			TSS testing performed by SGS. SGS PT=0.10 ppm, o-PO4 = 0.12 ppm
		6			0.92				
		12			2.4				

STANDLEY LAKE																		
Method				electrode	SM2510B	electrode	SM4500OG	SM4500H+B	SM2550B	SM2130B	Secchi Disk	SM4500NH3H	SM4500NO3I	SM4500NO3I	FlowCAM	SM10200H	SM5910B	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
Max Sig figs				3	3	3	3	3	3	3	3	3	3	3	4	3	3	2
Max decimals				1	0	0	1	1	1	1	2	2	2	2	0	1	3	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
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
10/09/18		G	SL 10-00															
10/09/18		C	SL 10-PZ												NT			
10/09/18	11:30	G	SL 10-70									0.31	<0.01	0.6			0.392	
10/16/18		G	SL 10-00	<1	326	306	7.7	7.8	12.6	1.5	2.8							
10/16/18		C	SL 10-PZ									0.02	<0.01	0.24	177	4.26	0.315	
10/16/18		G	SL 10-70	<1	377	-45	0.5	7	10.4	4		0.43	<0.01	0.61			0.404	
11/13/18		G	SL 10-00	1.1	339	164	9	7.9	8.4	2.4	2.8							
11/13/18	14:00	C	SL 10-PZ									0.02	<0.01	0.3	112	4.26	0.324	
11/13/18	14:15	G	SL 10-70	3.9	351	170	9	7.9	7.1	4		0.02	0.02	0.3			0.321	
11/26/18		G	SL 10-00	<1	355	197	9.5	8	6	2	4							
11/26/18	11:35	C	SL 10-PZ									0.03	0.02	0.31	118	3.68	0.315	
11/26/18	11:45	G	SL 10-70	1.9	355	209	9.4	8	5.8	2.4		0.03	0.02	0.33			0.308	
12/10/18		G	SL 10-00	<1	351	333	10.2	8	3.5	1.6	6							0.8
12/10/18	11:00	C	SL 10-PZ									0.02	0.02	0.27	118	3.48	0.314	1.6
12/10/18	11:20	G	SL 10-70	2.6	362	327	10	8	3.7	2.2		0.02	0.05	0.3			0.314	1.7
03/19/19		G	SL 10-00	<1	397	239	10.9	8.09	3.9	1.6	5							
03/19/19	12:15	C	SL 10-PZ												232	2.7	0.28	
03/19/19	12:30	G	SL 10-70															0.297
04/02/19		G	SL 10-00															
04/02/19	12:20	C	SL 10-PZ															
04/02/19	13:00	G	SL 10-70															

SM7110B	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	EPA200.8
variable	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	0.00050
2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	1	1	4	4	5	5	5	5	4	4	4	4	4	4	5	5	1	5	5
pCi/L	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	mg/L
Gross Alpha, Uncertainty	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	Chromium, Total
			0.0483	0.112															
			0.003	0.0131	0.00051	0.00053	0.05	0.053	<0.000054	<0.000054					0.000019	0.000018		<0.000088	<0.000088
			0.0458	0.134	0.00091	0.0016	0.046	0.06	<0.000054	<0.000054					<0.000012	<0.000012		<0.000088	0.00013
			0.0033	0.0108													1.9		
			0.0043	0.0123													2		
			0.0029	0.0122															
			0.0029	0.0092															
1.9	<3.7	2.3																	
2.3	<4.1	2.4	0.0029	0.0102	0.00037 S	0.00031 S	0.052 S	0.048 S	<0.000054	<0.000054					<0.000012	<0.000012	1.9	<0.000088	<0.000088
2	<4.1	2.4	<0.0025	0.0099	0.00038 S	0.000091 S	0.051	0.056	<0.000054	<0.000054					0.000013	0.000017	1.8	<0.000088	<0.000088
			<0.005		0.00041	0.00044	0.051	0.058	<0.000054	<0.000054					<0.000012	0.000014		<0.000088	<0.000088
			<0.005		0.0005	<0.00006	0.059	0.059	<0.000054	<0.000054					0.00005	0.000027		<0.000088	<0.000088

SM19221D	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	EPA200.8	EPA200.8	EPA200.8	EPA200.8	EPA200.8
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	0.00050	0.0005	0.0005	0.0005	0.0005
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
0	5	5	0	3	3	5	5	5	5	5	5	5	4	4	5	5	5	5	5	5
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	mg/L	mg/L	mg/L	mg/L	mg/L
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	Selenium, Total	Silver, Dissolved	Silver, Total	Strontium, Dissolved	Strontium, Total
	0.0011	0.0012	120	0.016	0.094	0.000065	0.00031	0.044	0.074	<0.000042	0.0027	0.0028	0.0017 S	0.00061 S	0.00034 S	0.00016 S	<0.000014	<0.000014	0.2	0.21
	0.00027	0.00078	140	0.27	1.1	<0.000038	0.00047	1.4	1.6	<0.000042	0.0033	0.0034	0.0019 S	0.00098 S	0.00037 S	0.00015 S	<0.000014	<0.000014	0.22	0.24
3.5																				
	0.00082 S	0.00076 S	152	0.0037	0.04	<0.000038	0.00012	0.025	0.03	<0.000042	0.0027 S	0.0024 S	0.00085	0.0012	0.0004	0.00022	<0.000014	<0.000014	0.22	0.22
8	0.00083	0.00093	164	0.0047	0.096	0.000049	0.00046	0.024	0.037	<0.000042	0.0026 S	0.0024 S	0.0014	0.0006	0.00034	<0.000015	0.000018 S	<0.000014 S	0.22	0.24
	0.0014	0.0015		<0.0026	0.032	<0.000038	0.00024	0.0074	0.023	<0.000042	0.0025	0.0027	0.00089	0.0011	0.00028	0.00019	<0.000014	<0.000014	0.23	0.24
	0.0012	0.0017		<0.0026	0.089	<0.000038	0.00046	0.01	0.033	<0.000042	0.0028	0.0029	0.0016	0.019	0.00053	0.00042	<0.000014	<0.000014	0.22	0.25

EPA200.8	EPA200.8	SM2540D	EPA200.8	EPA200.8	EPA200.7				
0.0005	0.0005	1	0.0025	0.0025	0.050				
3	3	3	3	3	3				
5	5	0	4	4	2				
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Vanadium, Dissolved	Vanadium, Total	Solids, Total Suspended	Zinc, Dissolved	Zinc, Total	Silicon, Dissolved	Notes	Conclusion	Field Notes	Lab Notes
						Lake Lite			
						Lake Lite			
		<5				Lake Lite			TSS testing performed by SGS. SGS TP=0.42 ppm, o-PO4=0.12 ppm
0.00034	0.00049	6	0.004	0.0055	1.1				
0.00016	0.00046	9	0.0022	0.0063	2.7				
		3			0.88				
		6			1.00				
					0.86				
					0.86				
0.00026 S	0.00016 S	<1	0.0056	0.0057	0.82				
0.00022	0.000087	<1	0.014 S	0.0097 S	1.0				
0.0003	0.0003		0.011	0.012	0.87				
0.00028	0.00036		0.014	0.017	1.1				
									Chloride tested by EEA = mg/L