MONITORING REPORT

GREEN LAKE ALUM TREATMENT 2016

Prepared for
Seattle Parks and Recreation

Prepared by
Herrera Environmental Consultants, Inc.

In association with
Tetra Tech, Inc.

HERRERA

Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will copy correctly when duplexed.

MONITORING REPORT

GREEN LAKE ALUM TREATMENT 2016

Prepared for
Seattle Parks and Recreation
800 Maynard Avenue South
Seattle, Washington 98134-1336

Prepared by
Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206-441-9080

In association with
Tetra Tech, Inc.
1420 Fifth Avenue, Suite 550
Seattle, Washington 98101
Telephone: 206-883-9300

August 31, 2017

CONTENTS

APPENDICES

TABLES

FIGURES

EXECUTIVE SUMMARY

Green Lake is an important recreational and aesthetic resource for Seattle residents and park visitors. Although the lake is heavily used, enjoyment of it has been diminished due to poor water quality related to intense blooms of cyanobacteria (blue-green algae), which have plagued the lake since at least 1916. Over the years, various techniques for reducing phosphorus concentrations have been used to reduce the amount of cyanobacteria in Green Lake. The most effective efforts to improve water quality and reduce cyanobacteria were lake-wide applications of aluminum sulfate (alum) in 1991 and 2004.

Alum treatments inactivate the internal cycling of inorganic and organic phosphorus. The alum is applied near the water surface, removing phosphorus from the water column as it flocculates and settles. It then covers the bottom sediments to further prevent the internal release of phosphorus from the sediments.

Although water quality goals for Green Lake have been met since the 2004 alum treatment, those goals are based on average summer measurements of total phosphorus (less than 25 micrograms per liter [µg/L]) and Secchi depth (water clarity greater than 2.5 meters [8.2 feet]). In recent years (2012 through 2014), toxic cyanobacteria scums have occurred in isolated areas of the lake. High concentrations of microcystin, detected in scum samples, have resulted in closure of the lake to direct contact recreational use (swimming) for substantial periods. Microcystin is a cyanotoxin produced by some cyanobacteria but no other algae.

The January 2015 Green Lake Phytoplankton Study (Herrera 2015a) documented effects of the 1991 and 2004 alum treatments on the amount and type of phytoplankton (algae and cyanobacteria) in the lake, and identified significant water quality degradation in recent years. The study provided Seattle Parks and Recreation with the recommended next steps for controlling cyanobacteria and addressing additional lake needs. The recommendations included preparation and implementation of a plan to treat Green Lake with alum as soon as possible to control cyanobacteria and prevent lake closures.

A phosphorus management plan was submitted to the Washington State Department of Ecology (Ecology) for an Aquatic Plant and Algae Management General Permit to perform the alum treatment (Herrera 2015b). The plan provides background information about the lake and detailed information on the methodologies and procedures used during the 2016 alum treatment.

The 2016 alum treatment occurred over a 6-day period from April 5 through April 10, 2016. A total of 81,744 gallons of aluminum sulfate and 40,905 gallons of sodium aluminate were applied to the lake. The volumes of chemicals applied are similar to those planned, but the applied alum dose was determined to be 9.6 mg Al/L, which is higher than planned dose of 8.2 mg Al/L due to a higher aluminum concentration in the sodium aluminate and a lower

updated value for the lake volume. The 2016 dose is approximately 40 percent of the 23.0 mg Al/L dose applied in 2004 and is slightly more than the 8.6 mg Al/L dose applied in 1991. As done in 2004, liquid alum was applied concurrently with liquid sodium aluminate (alkaline buffer) at a ratio of 2:1 by volume to ensure that the water pH did not decrease below 6.0.

In accordance with the phosphorus management plan (Herrera 2016b), engineering oversight and short-term water quality monitoring were conducted before, during, and 2 weeks after the treatment to ensure proper material application, prevent potential impacts to fish from low or high pH, and meet permit requirements. In addition, a public involvement plan was used to inform and educate park users and nearby residents of the alum treatment.

The short-term water quality objectives were met. The average lake pH ranged from 7.3 to 7.9, which meets the objective of between 6.0 and 8.7. The average alkalinity in the lake was greater than 42 mg/L, which meets the objective of greater than 12 mg/L.

Although the treatment did not change the pH or dissolved oxygen concentrations in the lake, minor fish mortality was observed during the alum treatment period. With the exception of a few carp, all fish found dead prior to and during the alum treatment appeared to be recently stocked trout; and no resident fish mortality was observed. Fish mortality data collected by monitoring staff and community members indicate that less than 1 percent of the 15,000 planted trout, or approximately 100 fish, died during the alum treatment. Post-treatment observations indicate that the dead trout were removed from the lake within a few days by cormorants, eagles, and osprey. The near-neutral pH observed indicates that the applied alum would not cause acute toxicity to fish or other aquatic organisms. In addition, gill conditions of the dead trout were not indicative of chemical toxicity; and no resident fish mortality was observed, with the exception of a few carp. Due to the effects of being transferred to a new habitat, planted trout are more sensitive to environmental stress factors than resident fish in Green Lake. In addition to stress caused by the alum application, the loss of planted trout may have been due to stress from increased water clarity, bird predation, and fishing pressure.

Post-treatment monitoring was performed on 11 occasions from May through October 2017 and determined that the following long-term water quality objectives were met:

- Summer average total phosphorus concentration shall be less than 20 µg/L (which was reduced for the 2016 treatment from the previous goal of 25 µg/L).
- Summer average Secchi depth (water clarity) shall exceed 2.5 meters (8.2 feet) (which has not changed since the 1991 treatment).
- The lake shall not be closed to recreational uses due to toxic cyanobacteria (which was added for the 2016 treatment).

Analysis of phytoplankton samples showed that the average cyanobacteria abundance increased to 20 percent in 2016 compared 13 percent in 2008 and 8 percent 2013, while the group Chrysophyta (61 percent) continued to dominate the phytoplankton composition. However,

those cyanobacteria present were not comprised of toxin producing species formerly observed in the lake. One exception is that two samples contained *Phormidium*, which had not been previously observed in Green Lake but is a known producer of anatoxin-a. The lake was not closed in 2016 to recreational uses due to toxic cyanobacteria. The Washington State guideline of 6 µg/L for the cyanotoxin microcystin was not exceeded in 2016, and previously had been exceeded on at least one occasion in 2013, 2014, and 2015.

The 2016 treatment is expected to meet water quality goals for at least 10 years, based on the long-term effect of the 2004 treatment and assuming external phosphorus inputs to the lake remain relatively low. Long-term water quality monitoring will be continued through the King County Volunteer Monitoring Program and the Washington State Toxic Algae Program to determine if the water quality goals will continue to be met.

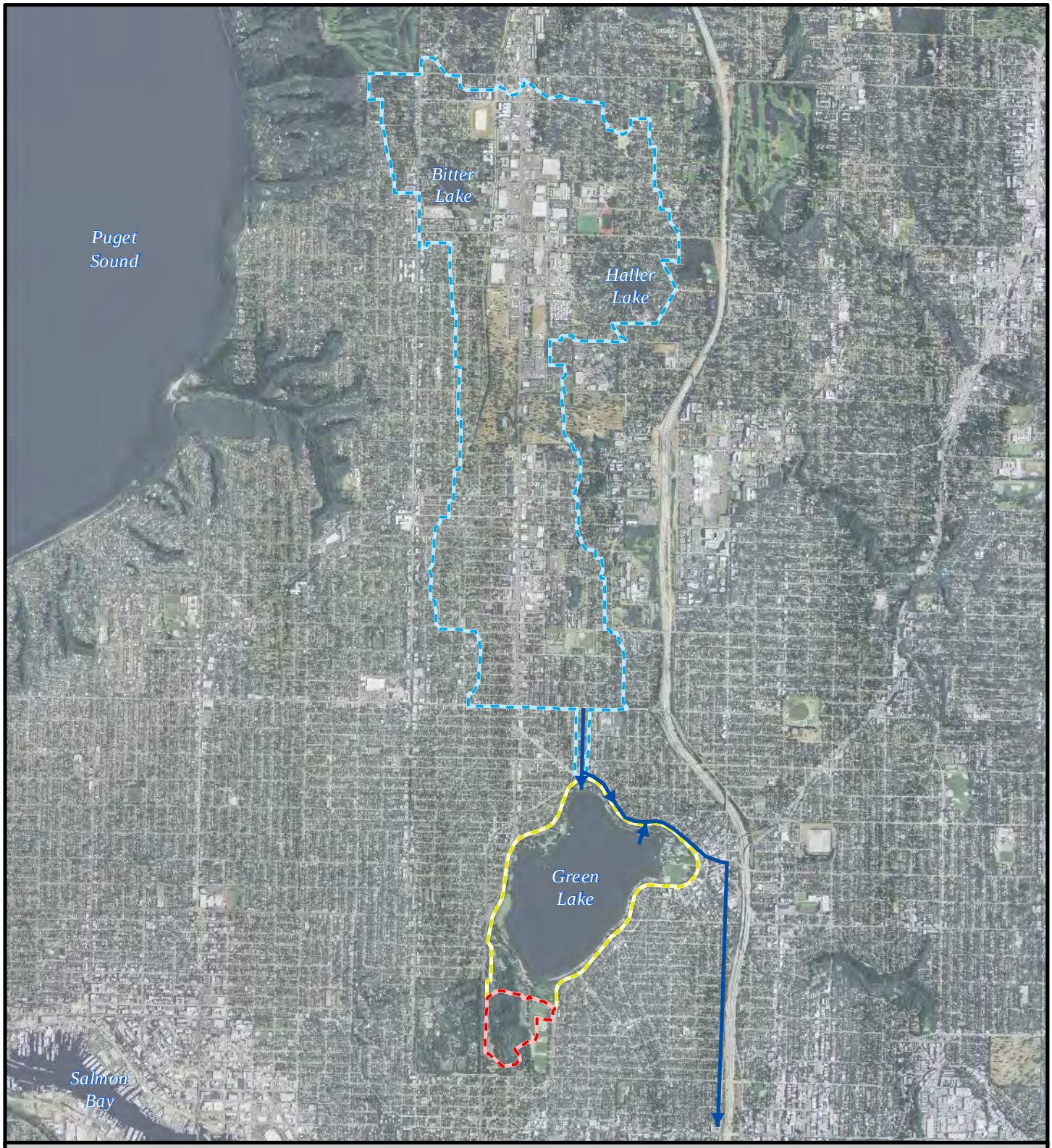
1. INTRODUCTION

Green Lake is a shallow, eutrophic lake located just north of downtown Seattle (Figure 1). Green Lake is surrounded by Green Lake Park, which is owned and managed by Seattle Parks and Recreation. This urban lake is classified as eutrophic (rich in nutrients and algae) because it has produced excessive amounts phytoplankton (free-floating algae), primarily due to elevated concentrations of phosphorus that promote growth of these algae. The phytoplankton group of particular concern is cyanobacteria; a group commonly referred to as blue-green algae that are actually photosynthetic bacteria.

Green Lake is an important recreational and aesthetic resource for city residents. Although the lake is heavily used, enjoyment of it has been diminished due to poor water quality. Intense blooms of cyanobacteria have plagued the lake since at least 1916 (KCM 1995). Various techniques have been used to reduce the amount of cyanobacteria by reducing phosphorus concentrations (Herrera 2003). The most significant recent efforts to improve water quality and reduce cyanobacteria have been lake-wide applications of aluminum sulfate (alum) in 1991, 2004, and 2016.

Although water quality goals had been met between the 2004 and 2016 alum treatment, those goals were based on average lake conditions. During recent years (2012 through 2014), toxic cyanobacteria scums occurred in isolated areas of the lake. High concentrations of microcystin detected in scum samples have resulted in closure of the lake to direct contact recreational use (swimming) for substantial periods. Microcystin is a cyanotoxin produced by some cyanobacteria but no other algae.

The Green Lake Phytoplankton Study (Herrera 2015a) recently documented effects of the 1991 and 2004 alum treatments on the amount and type of phytoplankton in the lake. The study evaluated nutrient and phytoplankton relationships and trends using data collected since 1959. Cyanotoxin data were analyzed from algae scum samples and beach water samples collected at the lake since 2007, and algae scum accumulation patterns were examined using observation data collected for the lake over the past 2 years. The study also documented current cyanobacteria monitoring protocols, public notification, and lake closure procedures used by Green Lake stakeholders. Finally, the study provided Seattle Parks and Recreation with recommendations on the next steps for controlling phytoplankton and addressing additional lake needs. Those recommendations included preparation and implementation of a plan to treat Green Lake with alum as soon as possible to control cyanobacteria and prevent lake closures (Herrera 2015b).



Legend

- Densmore Basin
- Nearshore Basin
- Woodland Park Basin
- Densmore and Lake Drain

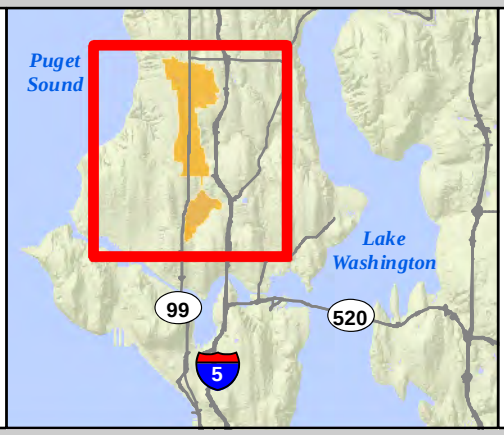


Figure 1.
Green Lake Watershed.

N

0 1,750 3,500 7,000 Feet

HERRERA

USDA, Aerial (2013)

K:\Projects\Y2013\13-05709-001\Project\PMP\vicinity_map.mxd (11/9/2015)

The phosphorus management plan provided background information about the lake and detailed information on a third alum treatment planned to occur in late March or early April 2016. The plan was submitted to the Washington State Department of Ecology (Ecology) for an Aquatic Plant and Algae Management General Permit, which addresses alum treatment restrictions in Table 4 and monitoring requirements in Section S6.B (Ecology 2016). The plan included treatment specifications that were used to hire an experienced contractor to perform the 2016 alum treatment.

This report describes how the 2016 alum treatment was performed, presents methods and results of engineering oversight and water quality monitoring conducted during the treatment, and presents and evaluates post-treatment water quality monitoring results collected during the first summer following the treatment.

2. ALUM TREATMENT ACTIVITIES

Since the first lake alum treatment in 1991, the City has undertaken numerous management efforts to help maintain the reduced phosphorus concentrations achieved after that treatment. Such measures have included diverting stormwater, biomanipulation, public education, and milfoil harvesting. However, such measures have not proved effective over the long term at maintaining the total phosphorus concentrations at the original summer target level of less than 25 µg/L. Therefore, a second alum treatment was performed in 2004 that effectively reduced the internal sediment loading of phosphorus within the lake for over 10 years. Although the summer phosphorus goal has been met each year since 2004, cyanobacteria blooms resulted in lake closures in 2012, 2013, and 2014. Because of the success of the 1991 and 2004 alum treatments in controlling sediment phosphorus sources, the City proposes a third alum treatment during the spring of 2016.

Alum treatments inactivate the internal cycling of inorganic and organic phosphorus. The alum is applied near the water surface and it removes phosphorus from the water column as it flocculates and settles. It then covers the bottom sediments to further prevent the internal release of phosphorus from the sediments.

Sediment phosphorus analysis was performed in 2015 to evaluate effects of the 2004 alum treatment, and determine the amount of alum needed in 2016 to inactivate sediment phosphorus in Green Lake and meet water quality goals in the future. The sediment phosphorus analysis, alum treatment design, permit conditions, and a cost estimate were included in the 2016 alum treatment plan (Herrera 2015b).

Using the sediment analysis results, the calculated aluminum dose ranged from 18.3 to 41.2 grams of aluminum per square meter (g Al/m^2) and averaged 30.4 g Al/m^2 among the four core stations tested (Table 1). An additional 1.6 g Al/m^2 was added to account for total phosphorus in the water column. The total aluminum dose recommended was 32.0 g Al/m^2 on an areal basis, which was determined to be equivalent to a total aluminum dose of 8.2 mg Al/L on lake volume basis. The proposed dose of 8.2 mg Al/L is approximately one-third of the 23.0 mg Al/L dose applied in 2004 and similar to the 8.6 mg Al/L dose applied in 1991. The dose recommended for sediment inactivation (7.8 mg Al/L) is much less than that applied in 2004 (17.2 mg Al/L) due to a lower amount of bioavailable phosphorus in the lake sediments, and the dose planned for water binding (0.4 mg Al/L) is much less than that applied in the 2004 (5.8 mg Al/L) due to the lower amount of total phosphorus present in the water column.

Table 1. Mean Sediment Phosphorus Content and Aluminum Dose Planned for the 2016 Green Lake Alum Treatment.				
	Mobile + Biogenic P (mg/g)		Al Dose (g Al/m^2) at 9:1 Al:P	
Site	0 to 10 centimeter	0 to 20 centimeter	0 to 10 centimeter	0 to 20 centimeter
Index Station	–	0.159	–	35.8
Station A	0.167	–	18.3	–
Station B	–	0.250	–	41.2
Littoral Station	0.295	–	26.3	–
		Average sediment Al dose:	30.4	
		+ Water column Al dose:[a]	1.6	
		= Total Al dose:	**32.0**	

[a] Based on an a total phosphorus concentration of 20 µg/L (20 milligrams per cubic meter) in the lake water.

mg/g = milligrams of phosphorus per gram dry weight of sediment

g AL/m^2 = grams of aluminum per square meter

Al:P = aluminum to phosphorus ratio

It was recommended that the 2016 treatment occur in March or April when the water temperature is moderate, the amount of aquatic plant (milfoil) and algae growth are relatively low, and recreational activity on the lake is also low. The 2016 alum treatment was planned to occur between March 21 and April 22, 2016, to avoid interference with a rowing regatta on March 19 and 20 and opening day of fishing on April 23, 2016. The treatment was expected to be completed within 10 working days. As performed in 1991 and 2004, liquid alum was applied concurrently with liquid sodium aluminate at a ratio of 2:1 by volume to ensure that the water pH does not decrease below 6.0. Sodium aluminate has been shown to be an effective buffer at this ratio.

The recommended dose was anticipated to meet water quality goals for at least 10 years, based on the long-term effect of the 2004 treatment and assuming external phosphorus inputs to the lake remain relatively low.

Chemical materials and the application procedures followed the technical specifications (Herrera 2015b) to achieve maximum effectiveness with protection of fish and other aquatic organisms. The technical specifications include additional details on the materials and application procedures to ensure proper handling, dosing, floc formation, and distribution of the materials in the lake. The technical specifications also include requirements for public notification and equipment calibration and maintenance that are specified in the Aquatic Plant and Algae Management Permit (Permit) issued the Washington Department of Ecology (Ecology 2016). The Permit-required water quality monitoring results are presented in Section 4.

2.1. CHEMICAL MATERIALS

HAB Aquatic Solutions applied a total of 81,744 gallons of liquid aluminum sulfate (alum) from 20 truckloads and 40,905 gallons of liquid sodium aluminate (buffer) from 13 truckloads. The materials were applied simultaneously at a volumetric ratio of 2:1 (alum: sodium aluminate) at varying rates to provide a consistent aluminum concentration in the water. The average aluminum (Al) content of alum was 8.15 percent as aluminum oxide (Al_2O_3) by weight and the average Al content of sodium aluminate was 18.96 percent as Al_2O_3 by weight. The Al concentration was calculated from multiplying the Al content by the specific gravity (1.335 for alum and 1.47 for sodium aluminate) and the mass ratio for two moles of Al (54 grams) to one mole of Al_2O_3 (102 grams), and converting units to obtain Al concentrations of 0.218 kilograms per gallon (kg/gallon) for alum and 0.561 kg/gallon for sodium aluminate. Based on these material volumes and aluminum concentrations, 17,820 kg of aluminum was added from the alum and 22,866 kg of aluminum was added from the buffer, for a total aluminum dose of 40,686 kg.

The aluminum dose was calculated on an area basis from dividing the total mass applied by the total lake area of 256.6 acres (103.8 hectares). This area was obtained from King County (2007) and is slightly less than the historically reported lake area of 259 acres (105 hectares). The aluminum dose was also calculated on a concentration basis from dividing the total mass applied by the total lake volume of 4.25 million cubic meters determined from a hydrographic survey performed on March 16, 2004, when the water surface elevation was 164.2 feet (NAV88 datum) (Herrera 2004). The areal dose was 39.2 mg Al/m^2, and the concentration dose was 9.57 mg Al/L based on the amount of aluminum applied (40,686 kg), and these revised values for lake area and volume.

The lake volume used for the dose calculation is slightly greater than the historically reported lake volume of 4.12 million cubic meters (Herrera 2003 and 2015b). The 2004 hydrographic survey reported a maximum depth of 27 feet (8.2 meters), which is less than the historically reported maximum depth of 30 feet (9.1 meters) (Herrera 2003 and 2015b). Dividing the lake volume by the updated lake area of 256.6 acres (103.8 hectares) yields a mean (average) depth of 13.4 feet (4.1 meters), which is slightly greater than the historically reported mean depth of 12.8 feet (3.9 meters).

The volume of chemicals applied was similar to that planned at 81,680 gallons of alum and 40,840 gallons of sodium aluminate. The actual aluminum dose applied was higher than planned (39.2 versus 32 g/m^2 and 9.6 versus 8.2 mg/L) because the aluminum content of sodium aluminate was higher than that assumed in the plan (19.0 versus 16.3 percent as Al_2O_3), and the lake area and volume were lower than those assumed in the plan (103.8 versus 105 hectares and 4.25 versus 4.98 million cubic meters).

The alum and sodium aluminate was drinking water treatment grade as specified by the National Sanitation Foundation (NSF), and contained no substances in quantities capable of producing deleterious or injurious effects on public health or water quality.

2.2. STAGING AND PREPARATION

HAB Aquatic Solutions staged the treatment in parking lot and shoreline area located immediately north of the Small Craft Center (Figure 2). Temporary, on-shore storage tanks were deployed in the parking lot for staging the chemicals to ensure that the application of alum and sodium aluminate is successfully completed in the required applications time frame of 10 working days. On-shore and on-board chemical storage tanks and associated spill containment equipment met local, state, and federal regulations. No structural damage or chemical spills occurred at the staging area. HAB Aquatic Solutions conducted all operations in such a way as to:

- Comply with any and all permit conditions for this project, including the posting of signs around the lake.
- Prevent damage to the lake, equipment, and surrounding properties.
- Prevent damage to the aquatic environment from hydraulic fluid leaks by using a biodegradable hydraulic fluid in all equipment.
- Prevent damage to the lake by ensuring that no aquatic invasive species are introduced into the lake. This shall include decontaminating all equipment and gear that will come into contact with lake water prior to bringing such equipment to the staging area.
- Maintain orderly appearance at the staging area an on the treatment vessel while the treatment is occurring.
- Prevent damage to the aquatic environment from the use of on-shore storage tanks at the staging area.
- Prevent damage to all utilities and below ground infrastructure at the staging area.

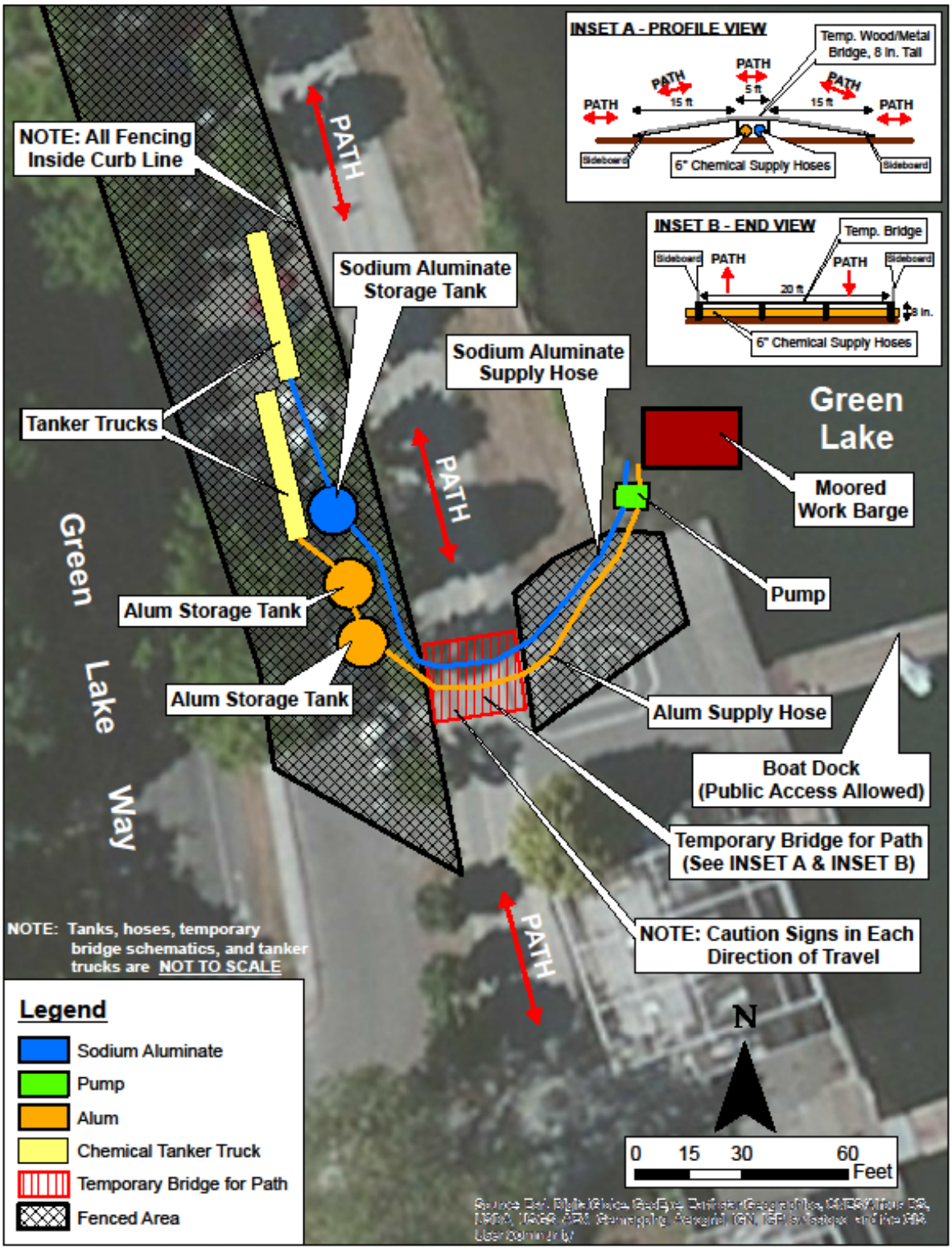


Figure 2. Green Lake 2016 Alum Treatment Staging Area.

2.3. CHEMICAL APPLICATION

The alum and sodium aluminate application was performed by HAB Aquatic Solutions over a 6-day period from April 5 through April 10, 2016. Mobilization occurred on April 4 and demobilization was completed on April 11, 2016. The application occurred after the lake water temperature has risen to over 5.5°C (42° F) throughout the first 4 meters of the water column, and when the wind speed was less than or equal to 15 mph at the lake surface, as required by the permit.

A mixture of liquid aluminum sulfate (alum) and liquid sodium aluminate (buffer) was injected below the lake surface from a boat (see photographs in Figure 3). The alum and sodium aluminate did not come in contact with one another outside of the water. The boat was controlled by a global positioning system (GPS) to continuously adjust the application rate of liquid alum and sodium aluminate mixture based on boat speed and water depth. This ensured complete and uniform chemical coverage during application.

The boat contained chemical storage tanks with secondary containment, and applicator equipment for even chemical distribution. The system of chemical distribution met the required minimum application rate of 20,000 gallons per day of combined alum and sodium aluminate. The chemicals were delivered to the lake water from a boom system at an approximate depth of 1 to 2 inches below the water surface from a minimum of 12 pairs of alum and sodium aluminate injection tubes (nozzles or small hoses) spaced 8 to 12 inches between pairs, and with the alum and sodium aluminate injection tubes within each pair spaced 2 to 4 inches apart.

In accordance with the Ecology permit, the lake pH and alkalinity were monitored in surface water samples as described in Section 4. Work was to be suspended if the pH of lake water is consistently less than 6.0 (±0.05) or greater than 8.7 (±0.05) in the collected water samples. The threshold for re-starting treatment was a pH between 6.2 and 8.4 (±0.05) and an alkalinity of at least 12 mg/L (±0.5 mg/L). Work was not suspended due to pH and alkalinity testing was not required because pH thresholds were not exceeded during the treatment.

Work was not suspended due to pH or other water quality concerns. However, work was terminated early on the fifth day due to concerns about an observed fish kill consisting of approximately 100 of the 15,000 recently planted trout (see Section 3). Treatment resumed the next morning when it was determined that the fish mortality was not due lake water quality or aluminum toxicity, and no additional abnormal fish behavior or loss were observed.

Figure 3. Staging Area and Application Photographs for the 2016 Green Lake Alum Treatment.

2.4. PERMIT CONDITIONS

The alum treatment was conducted in accordance with Ecology's Aquatic Plant and Algae Management General Permit (Ecology 2016), which included the following conditions:

- Timing restrictions:
  - None for fish or other priority species.
  - Early spring or fall treatment if aquatic plant biomass interferes with inactivation of sediment phosphorus.
- Lake use restrictions or advisories:
  - None.
- Treatment restrictions:
  - Application must cease when wind speed is greater than 15 miles per hour.
  - Powdered alum must be mixed with water to form a slurry before applying to the water surface.
  - The pH of lake water during treatment must remain between 6.0 and 8.5 based on lake average.
  - Only aluminum compounds suitable for water treatment may be used.
  - Buffering materials must be available for use.
- Monitoring requirements:
  - Minimum monitoring is one surface water pH measurement in the morning prior to any alum addition and one surface water pH measurement 1 hour after alum addition has stopped for that day.
  - Monitoring for pH must continue for the duration of the treatment and for 24 hours following treatment completion.
  - Monitoring locations must be representative of water body-wide conditions.
- Other restrictions:
  - A jar test must be completed prior to whole lake treatments only if a buffer other than sodium aluminate is used or a ratio of liquid alum to liquid sodium aluminate differs from 2:1 by volume.

- An onsite storage facility is required for any treatment requiring 9,000 gallons of alum or more, or the project proponent must have a plan to store any unused alum or buffering products.

HAB Aquatic Solutions provided and installed all required shoreline and public access notification signs per the posting requirements of the Ecology permit. General signage requirements included the following:

- Use the template provided in the permit.
- Post signs no more than 48 hours prior to treatment.
- Post signs so that they are secure from the normal effects of weather and water currents, but cause minimal damage to property.
- Make best efforts to ensure that the signs remain in place and are legible until removed.
- Remove all signs between 2 and 10 days after the treatment ends.

HAB Aquatic Solutions posted nine shoreline public access areas with 2- by 3-foot signs in accordance with permit requirements. In addition, one 8.5- by 11-inch sign was posted approximately 100 feet apart along the remaining lake shoreline in accordance with permit requirements.

2.5. Cost

The total project budget for the 2016 alum treatment project was $700,000. The total contractor cost for the alum application equaled $320,876, which was similar to the material and application cost ($323,453 excluding taxes and contingency) estimated in the Phosphorus Management Plan (Herrera 2015b). In addition to the cost of the alum application, the budget includes costs for pretreatment sediment analysis, development of the Phosphorous Management Plan, public outreach, permitting, project management, water quality monitoring, reporting, and City staff time.

3. ALUM TREATMENT OBSERVATIONS

The alum treatment was observed by a qualified Resident Engineer from Tetra Tech during each day of treatment to record material quantities, observe application procedures, and modify application procedures if needed. Daily application logs are presented in Appendix A. The Resident Engineer reviewed water quality data provided by a qualified Water Quality Monitor from Herrera Environmental Consultants (Herrera) on a regular basis.

3.1. ALUM APPLICATION

The alum application generally went according to the plan with the exception of two minor delays that extended the application to a total of 6 consecutive days from Tuesday, April 5, through Sunday, April 10, 2016. Application rates were reduced on the second day (April 6, 2016) due to boat motor repair and on the fifth day (April 9, 2016) due to concerns about trout mortality (described in the following section). Material quantities and application areas for each day are summarized in Table 3 from the daily application logs. A map of the application track lines and an aerial photograph taken on the fourth day of treatment are presented in Figure 4.

Table 3. Daily Application Amounts and Areas for the 2016 Green Lake Alum Treatment.

Date	Start Time	End Time	Alum Applied (gallons)	Sodium Aluminate Applied (gallons)	Application Area (acres)	Application Location
4/5/2016	800	1856	16,625	8,440	106	West
4/6/2016	1057	1859	11,406	5,771	73	Center/NW
4/7/2016	700	1850	13,007	6,561	83	Center
4/8/2016	655	1916	14,339	6,984	91	Center/NE
4/9/2016	712	1520	11,242	5,224	69	East
4/10/2016	739	1950	15,625	7,925	96	Center
Total	**–**	**–**	**81,744[a]**	**40,905**	**518**	**–**

[a] Total volume of alum is reduced from the reported daily sum of 82,244 gallons based on actual volumes in bills of lading

The total amount of materials applied (81,744 gallons of alum and 40,905 gallons of sodium aluminate) is slightly more than the planned amounts (81,680 gallons of alum and 40,840 gallons of sodium aluminate). The materials were applied at a ratio of 2 parts alum to 1 part sodium aluminate at variable rates to achieve a water column average aluminum concentration of 9.6 mg Al/L. Most of the total lake area of 257 acres (104 hectares) was evenly covered twice, generally moving from west to east (see Table 3). Small areas excluded from treatment include shallow waters located nearshore of docks and swimming floats in the northeast, northwest, and southwest portions of the lake (see Figure 4).

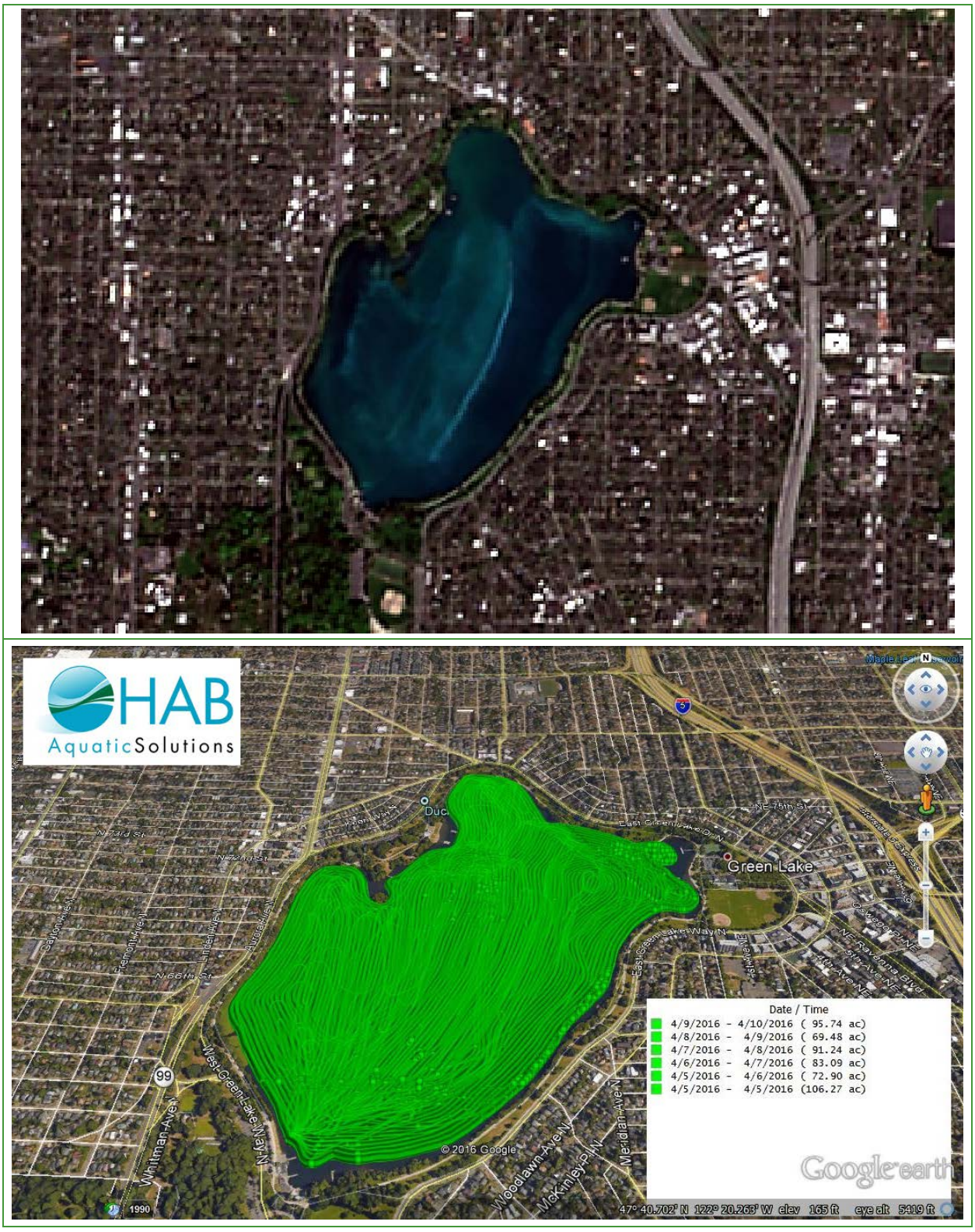


Figure 4. Aerial Photograph on April 8, 2016, and Completed Application Track Lines for the 2016 Green Lake Alum Treatment.

A final inspection of the staging area was conducted on April 11, 2016. All contractor equipment had been removed and the site appeared to be in the same condition it was before the project began. One exception is that a small (2-foot by 2-foot) patch of grass had been disturbed and appropriately seeded by the contractor. An inspection of the lake shoreline on April 14, 2016, confirmed that all of the public notification signs had been removed in accordance with the permit from the Washington Department of Ecology.

3.2. TROUT MORTALITY

Dead trout were observed by monitoring staff both prior to and during the treatment, and reported by several community members. Background information and fish observations are summarized below based on a memorandum prepared on April 11, 2016 (Appendix A).

Prior to the alum treatment, the Washington Department of Fish and Wildlife (WDFW) stocked the lake with an approximately 15,000 catchable rainbow trout. These fish were released on three dates in March (March 8, March 23, and March 28, 2016). WDFW routinely plants trout in Green Lake in the spring and fall, and was notified prior to the spring 2016 planting that the alum treatment would be conducted in early April.

During the alum treatment, fish mortality data were collected by monitoring staff on a daily basis. Additionally, dead fish counts were provided by members of the Green Lake community. Together these observations indicate that less than 1 percent of the 15,000 planted trout, or approximately 100 fish, died during the alum treatment. A fish biologist examined dead trout and observed no signs of chemically damaged gills or burns. Several fish exhibited eroded gills indicative of hatchery damage while others exhibited signs of being handled or caught by fisherman. Post-treatment observations indicate that the dead trout were removed from the lake within a few days by cormorants, eagles, and osprey.

Water quality monitoring data were collected continuously throughout the treatment process and the alum application did not result in any change to pH or dissolved oxygen concentrations in the lake. The near-neutral pH observed indicates that the applied alum would not cause acute toxicity to fish or other aquatic organisms. In addition, gill conditions of the dead trout were not indicative of chemical toxicity. With the exception of a few carp, all fish found dead prior to and during the alum treatment appeared to be recently stocked trout and no resident fish mortality was observed. Due to the effects of movement and being transferred to a new habitat, these fish are more sensitive to environmental stress factors than resident fish in Green Lake. In addition to stress caused by the alum application, the loss of planted trout may have been due to stress from increased water clarity, bird predation, and fishing pressure.

4. WATER QUALITY MONITORING

4.1. TREATMENT GOALS AND WATER QUALITY OBJECTIVES

Water quality monitoring was conducted at Green Lake to protect aquatic biota during the 2016 alum treatment, and to evaluate the short-term and long-term effects of the treatment (Herrera 2015b). The goals of water quality monitoring are to:

- Conduct a jar test before the alum treatment and measure pH in Green Lake during the alum treatment to ensure that pH levels exceed 6.0 for protection of aquatic biota from aluminum toxicity
- Collect water quality data before, during, and after the treatment to evaluate the short-term water quality effects of the alum treatment in the lake to ensure that pH criteria (between 6.0 and 8.7) and alkalinity criteria (greater than 12 mg/L) are met for protection of aquatic biota from aluminum toxicity
- Collect post-treatment water quality data to evaluate the long–term effectiveness of the alum treatment in relation to water quality goals that have been established for Green Lake

Treatment monitoring was performed to determine if the following short-term water quality objectives were met:

- Average lake pH shall be between 6.0 and 8.7
- Average lake alkalinity in the lake shall be greater than 12 mg/L

Post-treatment monitoring was performed to determine if the following long-term water quality objectives were met for first of at least 10 years (2016 through 2025):

- Summer average total phosphorus concentration shall be less than 20 µg/L (which was reduced for the 2016 treatment from the previous goal of 25 µg/L)
- Summer average Secchi depth (water clarity) shall exceed 2.5 meters (8.2 feet) (which has not changed since the 1991 treatment)
- The lake will not be closed to recreational uses due to toxic cyanobacteria (which was added for the 2016 treatment)

Water quality monitoring included the following three components: jar test, treatment monitoring, and post-treatment monitoring. A jar test using the specified dose and different material ratios was conducted on site during the first day of alum treatment to verify that the lake pH would remain above 6.0 during the treatment. Treatment monitoring includes various elements to evaluate short-term effects of the treatment. The monitoring results are discussed below and are presented in Appendix B.

Post-treatment monitoring was conducted during the summer of 2016 to evaluate the long-term effects of alum treatment. Post-treatment monitoring will continue for at least 9 more years. Post-treatment monitoring data were added to the historical database, which is presented in Appendix C.

The following sections describe the sampling locations and the design of each monitoring component. The overall monitoring design is summarized in Table 4.

Table 4. Water Quality Monitoring Design for the Green Lake 2016 Alum Treatment.

Monitoring Component	Sampling Locations[a]	Analytical Parameters	Sampling Frequency
Pre-treatment Jar Test	Near Small Craft Center	Alkalinity, pH	One or more tests
Treatment Monitoring			
Twice daily	Station A, Station B, Index Station (surface, bottom)	Alkalinity (field), dissolved and total Al[b], Secchi depth, temperature/DO/pH/ conductivity profile	Morning before and evening after each day of treatment
Random daily	Treatment sites (surface, bottom)	pH profile and alkalinity (if pH is less than 6.0)	At least every 2 hours during treatment
Short-term impact	Station A, Station B, Index Station (surface, bottom)	Alkalinity, dissolved Al, total Al, sulfate, TP, SRP, nitrate+nitrite, ammonia, fecal coliform, chlorophyll *a*, Secchi depth, temperature/DO/pH/conductivity profile	Day before treatment, and 2 days and 2 weeks after treatment
Post-treatment Monitoring	Index Station (surface)	Chlorophyll *a*, TP, TN, Secchi depth, temperature	12 events from May through October for 10 years

Al = aluminum

TP = total phosphorus

SRP = soluble reactive phosphorus

DO = dissolved oxygen

[a] Treatment sampling stations include Index, Composite A, and Composite B at 1 meter below water surface and 1 meter above lake bottom. Post-treatment sampling includes one composite sample from Composite A and Composite B stations for chlorophyll a and TP, and field measurements at the Index Station.

[b] Dissolved and total aluminum will be analyzed only if the pH is less than 6.0.

4.2. Lake Monitoring Locations

Water quality monitoring was conducted at three stations on Green Lake that have been used for previous monitoring projects to allow for comparison to historical data. The monitoring stations include (see Figure 5):

- Index Station: Located at the deepest (approximately 8 meters) point in Green Lake, which is near the northeast corner of the lake
- Station A: Located in a moderately deep (approximately 5 meters) portion of Green Lake near the northwest corner of the lake
- Station B: Located in a moderately deep (approximately 4 meters) portion of Green Lake near the south end of the lake

4.3. Jar Test

Jar tests of pH were conducted on the first day of alum treatment at the alum treatment staging area located near the Small Craft Center on the southwest shore of Green Lake. This pH testing was performed using the alum treatment chemicals, dose, and application method provided by the treatment contractor with the water quality conditions present at the time of application.

Four testing vessels consisting of 5-gallon plastic buckets were filled with lake water and tested for pH. Three vessels were treated with aluminum sulfate and sodium aluminate directly taken from the storage tanks, and added in three different ratios (2.2:1, 2.0:1, and 1.8:1) of alum and sodium aluminate to ensure correct buffering under current treatment conditions. One vessel was left untreated as a control. The pH of the treated and control waters was tested at 2, 15, 30, and 60 minutes after dosing.

The jar test results showed an acceptable range in pH at all times (ranging from 6.9 to 7.4; see Table 5). The alum application proceeded as planned using a ratio of 2:1.

Table 5. pH Jar Test Results for the 2016 Green Lake Alum Treatment.

	Test 1	Test 2	Test 2	Control
Aluminum dose (mg/L)	8.2	8.2	8.2	0
Ratio of liquid alum to sodium aluminate by volume	2.2:1	2.0:1	1.8:1	–
pH before dose	7.34	7.34	7.28	7.31
pH at 2 minutes	6.95	7.31	7.12	7.34
pH at 15 minutes	6.93	7.28	7.12	7.31
pH at 30 minutes	6.95	7.31	7.16	7.35
pH at 1 hour	6.97	7.28	7.12	7.28

Legend

- 2015 sediment station
- 2004 sediment station
- Water quality station
- Inlet
- Outlet
- Bathymetry contour (5-ft)

Aquatic Plants (Herrera 2005)

- Dense Eurasian watermilfoil
- Sparse Eurasian watermilfoil
- White water lillies

Wetlands (SUNP 2005)

- Palustrine Forested Wetland
- Palustrine Scrub-Shrub Wetland

Figure 5.
Green Lake Sampling Stations.

N

0 325 650 1,300 Feet

HERRERA

USDA, Aerial (2013)

K:\Projects\Y2013\13-05709-001\Project\monitoring_stations_2015.mxd (11/9/2015)

4.4. TREATMENT MONITORING

Treatment monitoring was conducted by Herrera monitoring staff over a 6-day period from April 5 to April 10, 2016. Water quality monitoring for the treatment component included the following three elements:

- Twice-daily monitoring (in the morning before treatment began and in the afternoon or evening when treatment concluded for the day) to verify that pH criteria (between 6.0 and 8.7) and the alkalinity criterion (greater than 12 mg/L) were met at established monitoring stations.

- Random monitoring of pH during the alum application at treatment sites was conducted approximately once every 2 hours at specific treatment locations after allowing for 1 hour of alum settling.

- Short-term impact monitoring before and after the alum treatment to evaluate short-term impacts on various water quality parameters at established monitoring stations.

Observations of alum treatment activities, floc formation, and potential fish and wildlife impacts were made during random daily monitoring. Dead trout were observed by monitoring staff both prior to and during the treatment, and reported by several community members; more information is provided in Section 3.2 and Appendix A.

4.4.1. Twice-Daily Monitoring

Twice-daily monitoring consisted of measuring field parameters at Station A, Station B, and Index Station in the morning before treatment began, and in the afternoon or evening when treatment ended. Field parameters included Secchi depth and vertical profiles of temperature, dissolved oxygen, pH, and conductivity at 1-meter intervals. In addition, total alkalinity was tested in the field on water samples collected from 1 meter below the water surface and 1 meter above the lake bottom at each of the three stations.

Twice-daily monitoring results are presented in Appendix B. Data were collected as planned with the exception that alkalinity samples were collected only once per day on treatment days 2 through 6 (evening of day 5 and mornings of remaining days) because high alkalinity was observed throughout the treatment period (greater than 40 mg/L on average and well above the 12 mg/L criterion).

Daily mean values for both stations and all depths are presented in Table 6. For comparison, this table includes daily mean values for short-term monitoring conducted before and after the treatment (described below). These results show that average water quality conditions in Green Lake did not vary much before, during, and after treatment for pH (7.3 to 7.9), alkalinity (41.8 to 45.2 mg $CaCO_3$/L), and temperature (12.1 to 13.2°C). Secchi depth increased from 2.7 meters prior to treatment to a maximum of 5.8 meters at 2 days after treatment (Post-Treatment Day 2).

Conductivity also increased during the treatment from 148 to 198 microsiemens per centimeter (µS/cm), and continued to increase to a maximum value of 294 µS/cm at 2 weeks after treatment.

Table 6. Daily Mean Values of Field Parameters at Stations A, B, and Index for the 2016 Green Lake Alum Treatment.

Event	Date	pH	Alkalinity (mg/L)	Temp. (°C)	DO (mg/L)	Cond. (µS/cm)	Secchi Depth (meters)
Pretreatment	4/4/2016	7.61	45.2	12.2	10.3	148	2.7
Treatment Day 1	4/5/2016	7.50	45.0	12.2	10.4	157	2.8
Treatment Day 2	4/6/2016	7.39	43.6	12.1	10.4	167	3.5
Treatment Day 3	4/7/2016	7.39	43.6	12.4	10.4	175	3.5
Treatment Day 4	4/8/2016	7.52	43.6	12.9	10.3	185	3.7
Treatment Day 5	4/9/2016	7.30	43.5	13.2	10.3	198	4.5
Treatment Day 6	4/10/2016	7.34	41.8	12.9	10.3	154	5.0
Post-Treatment Day 2	4/12/2016	7.38	42.5	12.6	10.5	161	5.8
Post-Treatment Day 14	4/25/2016	7.87	42.5	12.3	11.0	294	4.6

NA – Sample not analyzed.

4.4.2. Random Daily Monitoring

Random daily monitoring consisted of measuring pH at the treatment site during the alum application at a frequency of at least once every 2 hours. The pH was measured at 1-meter intervals at the location where alum was applied approximately 1 hour before the time of sample collection. The 1-hour delay in sampling allowed for settling of the alum floc and stabilization of water quality conditions.

Random daily monitoring results are summarized in Table 7 and are presented in Appendix B. Data were collected as planned with the exception that data were occasionally collected at a frequency greater than 2 hours apart due to additional time needed for other observations and boat maintenance.

Table 7. Random Daily pH Data Summary for the 2016 Green Lake Alum Treatment.

Event	Date	No. of Samples[a]	Average pH	Minimum pH	Maximum pH
Treatment Day 1	4/5/2016	12	7.46	7.36	7.56
Treatment Day 2	4/6/2016	10	7.39	7.17	7.57
Treatment Day 3	4/7/2016	10	7.41	7.21	7.77
Treatment Day 4	4/8/2016	8	7.61	7.48	8.02
Treatment Day 5	4/9/2016	6	7.37	7.15	7.54
Treatment Day 6	4/10/2016	8	7.34	7.20	7.41

[a] Samples collected 1 meter from the surface and 1 meter from the bottom at locations treated 1 hour prior to sampling.

The monitoring results show that lake pH ranged from 7.2 to 8.0 at the random sites and averaged approximately 7.4 during the treatment. None of the pH results were outside the acceptable range of between 6.0 and 8.7 for the average lake pH.

4.4.3. Short-Term Impact Monitoring

Short-term impact monitoring consisted of measuring field parameters and collecting water samples from 1 meter below the water surface and 1 meter above the lake bottom at each of the following three stations: Station A, Station B, and Index. A total of six water samples were collected from the lake on three occasions: 1) the day before the first day of treatment, 2) 2 days following the last day of treatment, and 3) 2 weeks following the last day of treatment. The collected samples were analyzed for the following parameters:

- Secchi depth (field measurement)
- Temperature (field measurement at 1-meter intervals)
- Dissolved oxygen (field measurement at 1-meter intervals)
- pH (field measurement at 1-meter intervals)
- Conductivity (field measurement at 1-meter intervals)
- Total alkalinity
- Dissolved aluminum
- Total aluminum
- Sulfate
- Soluble reactive phosphorus
- Total phosphorus
- Nitrate+nitrite nitrogen
- Ammonia nitrogen
- Total nitrogen
- Chlorophyll *a*
- Fecal coliform bacteria (surface grab only)

Field and laboratory results of short-term impact monitoring are presented in Appendix B. All data were collected as planned with the exception that fecal coliform samples collected on 4/12/2016 were not analyzed due to laboratory oversight. The laboratory results were validated in accordance with the Water Quality Monitoring Plan (WQMP) (Appendix E of the Green Lake Phosphorus Management Plan [Herrera 2015b]).

In general, quality control criteria defined in the WQMP were met, resulting in no data qualification or corrective action with the following exception:

- Five fecal coliform results were qualified as estimated (J) based on low colony counts falling outside of ideal range of 20 to 60 (Table 8).

Table 8. Fecal Coliform Bacteria Results and Associated Qualifiers.

Sample ID	Date Sampled	Laboratory Result (CFU/100 mL)	Validated Result (CFU/100 mL)	Qualifier
B-S	4/12/2016	1	1	J
I-S	4/12/2016	2	2	J
Index-S	4/25/2016	4	4	J
A-S	4/25/2016	8	8	J
B-S	4/25/2016	10	10	J

CFU = Colony forming unit

mL = milliliters

J = Value is considered an estimate

Laboratory results of short-term impact monitoring are summarized as mean values for surface and bottom water samples collected at the two stations in Table 9. These results show that the alum treatment reduced total phosphorus concentrations in surface and bottom waters at 2 days (13 and 8 µg/L, respectively) and 2 weeks (10 and 13 µg/L, respectively) after treatment compared to pretreatment (18 and 23 µg/L, respectively). Total nitrogen concentrations exhibited a similar pattern. Soluble phosphorus and nitrate+nitrite nitrogen were not detected before or after the treatment.

Chlorophyll *a* concentrations (amount of algae) in surface and bottom water initially decreased following the treatment, from 4 µg/L before treatment to 1 µg/L at 2 days after treatment, and then increased to 3 µg/L at 2 weeks after treatment. The initial decrease in algae concentrations improved Secchi depth (water clarity) from 2.7 to 5.8 meters (see Table 6), indicating that a sufficient amount of alum was applied to create enough floc to settle algae and other suspended particles present in the lake. Secchi depth decreased when algae concentrations increased at 2 weeks after treatment.

The alum treatment increased concentrations of aluminum and sulfate in the surface and bottom waters for at least 2 weeks after treatment. Average total aluminum concentrations increased from 0.1 mg/L before treatment to 0.25 mg/L at 2 days after treatment, and then decreased to 0.17 mg/L at 2 weeks after treatment. Average dissolved aluminum concentrations

increased from undetected (less than 0.003 mg/L) to 0.10 mg/L at 2 days after treatment and to 0.12 mg/L at 2 weeks after treatment.

Table 9. Mean Values of Lab Parameters for Surface and Bottom Water Samples Collected at Stations A, B, and Index for the 2016 Green Lake Alum Treatment.

Parameter	Pretreatment		2-Day Post-Treatment		2-Week Post-Treatment	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
Total phosphorus (µg/L)	18	23	13	8	10	13
Soluble reactive phosphorus (µg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (mg $CaCO_3$/L)	45.2	45.3	42.9	42.1	42.9	42.1
Sulfate (mg/L)	4.6	4.8	26.0	23.4	25.4	23.4
Chlorophyll *a* (µg/L)	3.8	4.0	1.1	1.3	2.5	2.8
Phaeophytin *a* (µg/L)	0.5	1.2	0.2	0.5	0.3	0.6
Total aluminum (mg/L)	0.084	0.115	0.244	0.250	0.162	0.177
Dissolved aluminum (mg/L)	<0.003	<0.003	0.103	0.102	0.119	0.113
Ammonia (mg/L)	0.013	0.014	0.021	0.017	<0.010	<0.010
Nitrate+nitrite nitrogen (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Nitrogen (mg/L)	0.300	0.322	0.197	0.203	0.300	0.259
Fecal coliform bacteria (CFU/100 ml)	1	–	–	–	7	–

4.5. Post-Treatment Monitoring

Long-term water quality monitoring was conducted by the King County Lake Stewardship Program in 2016 and will be continued for at least 9 more years. The objective of post-treatment monitoring is to evaluate whether the total phosphorus goal (summer mean value less than 20 µg/L) and Secchi depth goal (summer mean value greater than 2.5 meters) for Green Lake are being met. To reduce the potential for toxic cyanobacteria blooms, the total phosphorus goal was reduced for the 2016 alum treatment from the goal of 25 µg/L established for the 2004 alum treatment, which was reduced from the goal of 30 µg/L established for the 1991 alum treatment. The design of post-treatment monitoring generally follows that used for Green Lake since the first alum treatment in 1991.

Post-treatment monitoring occurred on 11 occasions from May through October 2016. Secchi depth was measured and water samples were collected from the Index Station at a depth of 1 meter. The surface samples were analyzed for the following parameters:

- Temperature (field measurement)
- Total phosphorus
- Total nitrogen
- Chlorophyll *a*

Surface samples were also analyzed for soluble reactive phosphorus, nitrate+nitrite nitrogen, ammonia nitrogen, and total nitrogen on two occasions (2/26/16 and 8/30/16).

Water quality data were compiled through 2014 and evaluated by Herrera (2015). This database was supplemented with data for 2015 and 2016 (King County 2017) for this report. Data were categorized into the following summer study periods and associated years of data:

- **Pre 1991 Alum Treatment:** 1959, 1981, 1989, and 1990
- **Post 1991 Alum Treatment:** 1992 through 1995
- **Post 2004 Alum Treatment:** 2004 through 2013 (10 years)
- **Pre 2016 Alum Treatment:** 2014 and 2015
- **Post 2016 Alum Treatment:** 2016

Water quality data for surface samples collected in 2016 are presented in Table 10 and included in the updated database in Appendix C. The 2016 results are presented graphically in comparison to other study years and summarized separately below for each water quality parameter. See Herrera (2015a) for additional graphs and discussion of historical monthly trends and other data patterns.

Table 10. Year 1 Post-Treatment Water Quality Data for the 2016 Green Lake Alum Treatment.

Date	Temp. (°C)	Secchi Depth (meters)	Chloro. *a* (µg/L)	Total P (µg/L)	SRP (µg/L)	Total N (µg/L)	NO3+ NO4-N (µg/L)	NH4-N (µg/L)	TN:TP Ratio
5/9/2016	19.0	6.5	1.1	12.6	–	211	–	–	17
5/24/2016	–	5.8	2.5	18.6	0.5	224	5[a]	3.4	12
6/6/2016	22.0	6.8	1.5	13.3	–	269	–	–	20
6/20/2016	19.5	4.4	2.0	17.7	–	248	–	–	14
7/10/2016	20.0	4.5	3.0	17.7	–	258	–	–	15
7/25/2016	23.5	4.7	2.2	18.4	–	314	–	–	17
8/8/2016	22.5	2.9	6.1	13.7	–	286	–	–	21
8/30/2016	22.0	3.2	3.2	19.6	0.8	295	2.5[a]	2.5[a]	15
9/11/2016	19.5	4.3	2.5	16.0	–	299	–	–	19
9/25/2016	18.5	3.7	2.0	14.3	–	251	–	–	18
10/24/2016	14.0	3.9	2.4	15.4	–	270	–	–	18
Mean	20.1	4.6	2.6	16.1	0.7	266	3.8	3.0	17

[a] Parameter was not detected; value is one-half the detection limit.

4.5.1. Water Temperature

Water temperature exhibited a wide range during each summer that was similar among all years (Figure 6). The summer mean temperature was very similar among years, ranging from 17.9 to 20.5 degrees Celsius (°C) and exceeding the Washington State Surface Water Quality Standard of 16°C (based on a 7-day average maximum in lakes; WAC 173-201A) in each study year. Historically, monthly mean temperatures typically increased from approximately 16°C in May to 22°C in July and August, and decreased to 14°C in October (Herrera 2015a). This same pattern was observed in 2016 with the exception that the lake was warmer at 19°C when post-treatment monitoring began in early May 2016 (see Table 10).

4.5.2. Secchi Depth

Secchi depth is a measurement of the turbidity or clarity of surface water that typically relates to the amount of phytoplankton present in the water. The Secchi depth ranged from 2.9 to 6.8 meters during the Year 1 post-treatment monitoring period (Figure 6 and Table 10). The maximum Secchi depth was observed on June 6, 2016. Thereafter, Secchi depth gradually decreased to a low of 2.9 meter on August 8, 2016, before rebounding to 4.3 meters on September 11, 2016.

The mean Secchi depth for the Year 1 (2016) monitoring period was 4.6 meters, which meets the restoration goal of greater than 2.5 meters. The mean Secchi depth of 4.6 meters is greater than 1 meter higher than in 2004, indicating that the water clarity improved more dramatically than the previous alum treatment in 2004 (see Figure 6).

4.5.3. Chlorophyll

Chlorophyll *a* is a measure of phytoplankton biomass and is used to determine trophic state of lakes. A common threshold for eutrophic (high algae) lakes is a summer mean chlorophyll *a* concentration of greater than 7 micrograms per liter (µg/L) (US EPA 2010). A chlorophyll *a* goal has not been established for Green Lake.

Chlorophyll *a* concentrations ranged from 1.1 to 6.1 µg/L during the Year 1 (2016) post-treatment monitoring period (Figure 7 and Table 10). The lowest chlorophyll *a* concentration of 1.1 µg/L was observed initially on May 9, 2016, coinciding with the maximum Secchi depth of 6.5 meters that nearly reached the water depth of 7.2 meters at the Index Station.

Chlorophyll *a* concentrations remained low (2 to 3 µg/L) through October with the exception of the maximum of 6.1 µg/L on August 8, 2016.

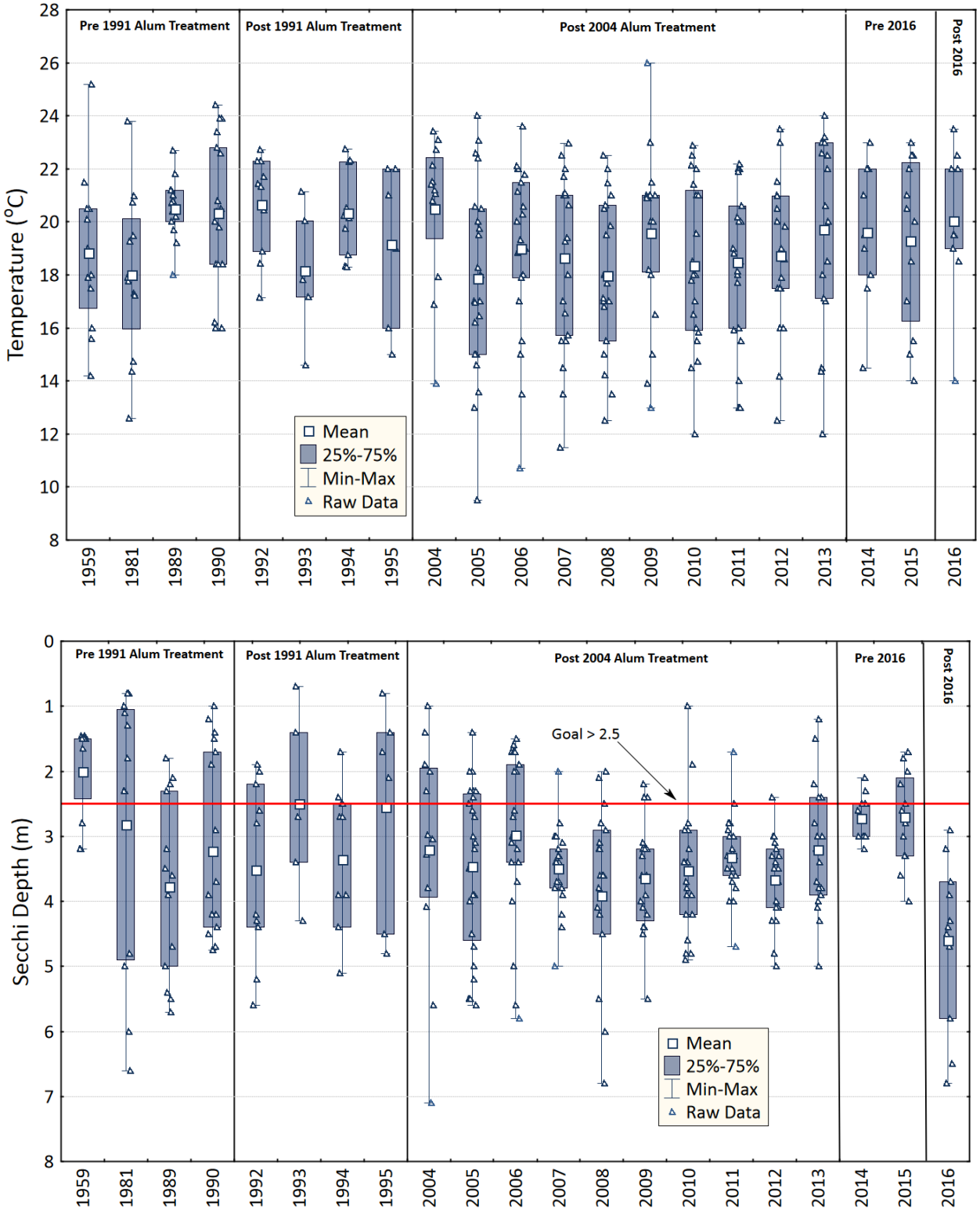


Figure 6. Water Temperature and Secchi Depth by Study Year for Summer in Green Lake.

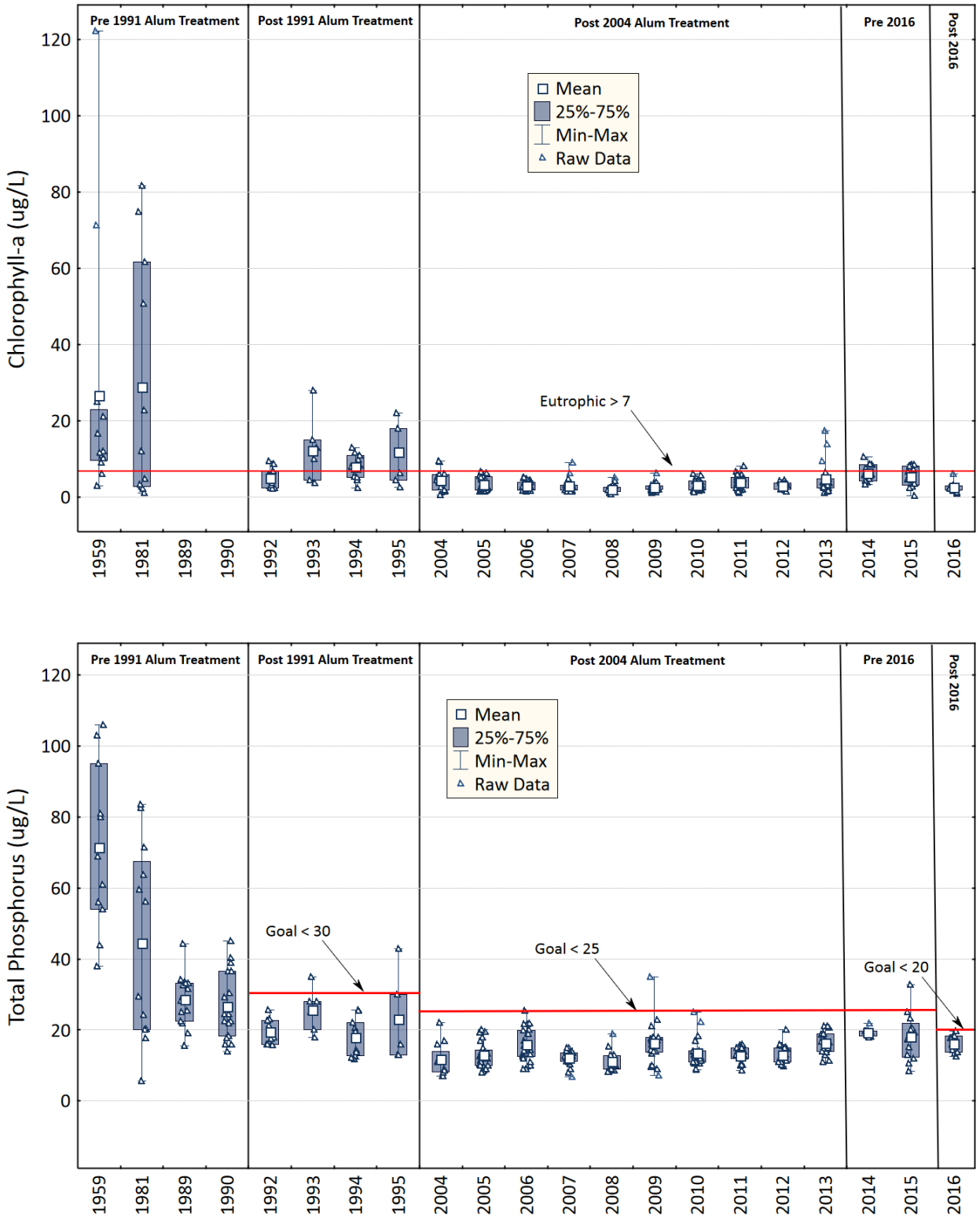


Figure 7. Chlorophyll *a* and Total Phosphorus by Study Year for Summer in Green Lake.

A mean chlorophyll *a* value of 2.6 µg/L was observed during the Year 1 (2016) post-treatment monitoring period, which is much less than the eutrophic threshold of 7 µg/L and is equivalent to the mesotrophic (moderate algae) threshold. The 2016 chlorophyll *a* mean is well below the range observed following the 1991 alum treatment (5.1 to 12.4 µg/L in 1992 through 1995), within the range observed following the 2004 alum treatment (2.2 to 4.9 µg/L in 2004 through 2013), and less than the range observed prior to the 2016 alum treatment (4.9 to 5.5 µg/L in 2014 and 2015). These results indicate that the 2016 alum treatment was effective in maintaining low chlorophyll *a* concentrations (phytoplankton biomass) during the first summer following the treatment.

Phaeophytin *a* is measured to correct the chlorophyll *a* measurement for the presence of degraded phytoplankton pigments, and is used as a relative measure of decayed phytoplankton. Mean concentrations of phaeophytin *a* were low throughout the monitoring period, ranging from 0.2 to 1.2 µg/L, and exhibited a pattern similar to that of chlorophyll *a* (see Table 10). These results indicate that there were low levels of decaying phytoplankton during the monitoring period.

4.5.4. Phosphorus

Total phosphorus is also used to determine the trophic state of lakes because phosphorus is typically the most limiting nutrient for freshwater phytoplankton and relates well with chlorophyll and Secchi depth. Currently, the total phosphorus goal for Green Lake is for the summer mean to be less than 20 µg/L.

Total phosphorus concentrations ranged from 12.6 to 19.6 µg/L during the Year 1 (2016) post-treatment monitoring period (Figure 7 and Table 10). The lowest total phosphorus concentration of 12.6 µg/L was observed on the first monitoring date of May 9, 2016, coinciding with the lowest chlorophyll *a* concentration and highest Secchi depth. Thereafter, total phosphorus fluctuated until reaching a maximum of 19.6 µg/L on August 30, 2016.

A mean total phosphorus value of 16.1 µg/L was observed during the Year 1 (2016) post-treatment monitoring period, which meets the goal of less than 20 µg/L. The 2016 total phosphorus mean is less than the range observed following the 1991 alum treatment (17.9 to 25.7 µg/L in 1992 through 1995), within the range observed following the 2004 alum treatment (11.7 to 16.3 µg/L in 2004 through 2013), and less than the range observed prior to the 2016 alum treatment (16.3 to 18.1 µg/L in 2014 and 2015). These results indicate that the 2016 alum treatment was effective in maintaining low total phosphorus concentrations during the first summer following the treatment.

The two samples analyzed for soluble reactive phosphorus exhibited low concentrations (less than 1 µg/L; see Table 10), indicating that most of the phosphorus was associated with algae and other suspended solids.

4.5.5. Nitrogen

Total nitrogen is the sum of organic nitrogen and dissolved inorganic nitrogen, which is composed of nitrate+nitrite and ammonia nitrogen. Total nitrogen can be the most limiting nutrient for freshwater phytoplankton when total phosphorus is high, which can occur in hypereutrophic lakes that have excessively high nutrients loads (i.e., human or animal waste). There is no total nitrogen goal for Green Lake; limnologists have suggested a total nitrogen threshold of 180 µg/L for eutrophic lakes (Welch 1992).

Total nitrogen concentrations ranged from 211 to 314 µg/L during the Year 1 (2016) post-treatment monitoring period (see Figure 8 and Table 10). The lowest total nitrogen concentration of 211 µg/L was observed on the first monitoring date of May 9, 2016, coinciding with the lowest chlorophyll *a* and total phosphorus concentrations and highest Secchi depth. Thereafter, total nitrogen increased to a maximum of 314 µg/L on July 25, 2016.

A mean total nitrogen value of 266 mg/L was observed during the Year 1 (2016) post-treatment monitoring period. The 2016 total nitrogen mean is less than the range observed following the 1991 alum treatment (286 to 344 µg/L in 1992 through 1995), within the range observed following the 2004 alum treatment (210 to 375 µg/L in 2004 through 2013), and less than the range observed prior to the 2016 alum treatment (387 to 415 µg/L in 2014 and 2015). These results indicate that the 2016 alum treatment was effective in maintaining low total nitrogen concentrations during the first summer following the treatment. Total nitrogen exhibited an increasing trend following the 2004 alum treatment when the summer mean value nearly doubled from 210 µg/L in 2005 to 415 µg/L in 2015 (see Figure 8).

The two samples analyzed for nitrate+nitrite nitrogen and total ammonia nitrogen exhibited low concentrations of dissolved nitrogen (average less than 5 µg/L; see Table 10), indicating that most of the nitrogen was associated with algae and other suspended solids.

4.5.6. Total Nitrogen to Phosphorus Ratio

The total nitrogen to total phosphorus ratio by weight (total N:P) is often used to evaluate which of the two nutrients limit phytoplankton growth. It is generally accepted that phosphorus is the primary limiting nutrient in lakes and nitrogen is the primary limiting nutrient in marine waters. A recent review of nutrient limitation literature concluded that, while phosphorus appears to control phytoplankton growth in oligotrophic lakes over the long term (years), most lakes appear to be limited over the short term (months) by both phosphorus and nitrogen (co-limitation), and possibly by other resources such as iron (Sterner 2008). One study evaluated nutrient relationships in 221 lakes and found phosphorus-limitation consistently at total N:P ratios greater than 22, and nitrogen limitation consistently at total N:P ratios less than 9 (Guildford and Hecky 2000). These limits are included in the total N:P box plot (Figure 8) for reference, with co-limitation assumed to occur between these limits.

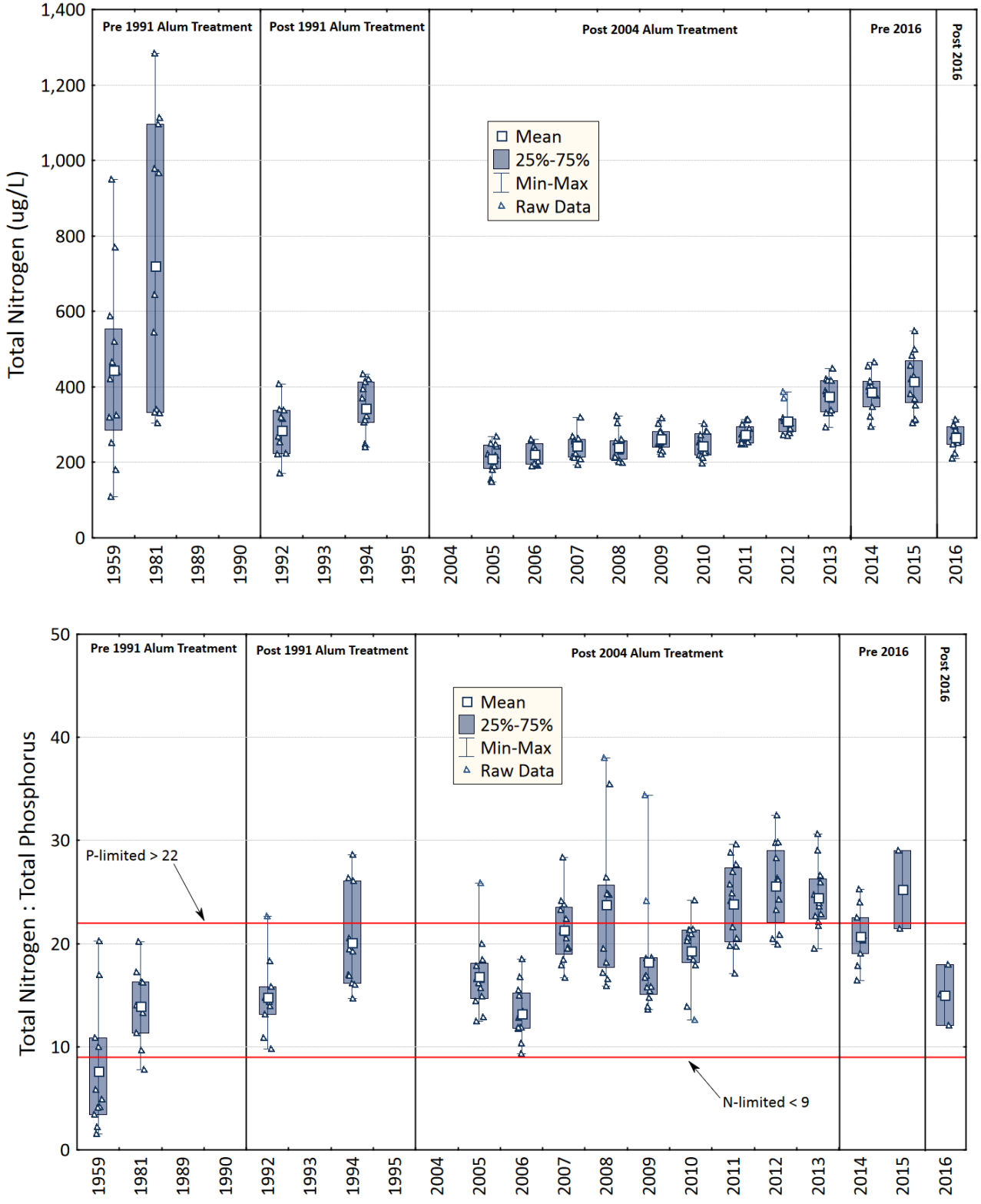


Figure 8. Total Nitrogen and Ratio of Total Nitrogen to Total Phosphorus by Study Year for Summer in Green Lake.

Based on these limits, the summer mean total N:P ratios observed in Green Lake indicate that phytoplankton are typically limited by both nitrogen and phosphorus over the long term, with the exception of possible nitrogen limitation in 1959 and phosphorus limitation in some of the post-2004 alum treatment years (see Figure 8). The summer mean total N:P ratio was lower during the pre-1991 alum treatment period (8 to 14) than the post-1991 (15 to 20), post-2004 treatment period (13 to 26), and the pre-2016 alum treatment period (21 to 25) due to the reduced total phosphorus by the alum treatments. Unexpectedly, the total N:P ratio decreased to 17 in the first year of the post-2016 alum treatment period despite the anticipated reduction of internal phosphorus loading.

The total N:P ratio in Green Lake primarily reflects nutrient proportions within phytoplankton (floating algae) due to the low amounts of dissolved nutrients and other types of suspended solids in the water. Total N:P ratios in algae vary with the type of algae and their nutrient supply. Assuming external nutrient inputs have not substantially changed since the 2004 alum treatment, the inorganic nitrogen supply has been relatively constant while the inorganic phosphorus supply may have increased from the release of soluble phosphorus in sediments deposited in the lake between the 2004 and 2016 alum treatments (but not from release of phosphorus bound to aluminum by the treatments). However, nitrogen uptake by algae may have varied directly with abundance of nitrogen fixing cyanobacteria. The general increase in total N:P ratio following the 2004 alum treatment (see Figure 8) may have been due to increasing amounts of nitrogen fixing cyanobacteria because increasing inputs from internal phosphorus loading would decrease the total N:P ratio. Conversely, the decrease in total N:P ratio following the 2016 alum treatment may be explained by decreasing amounts of nitrogen fixing cyanobacteria because the treatment decreased internal phosphorus loading. This effect of phytoplankton composition on total N:P ratios is supported by phytoplankton observations discussed below.

4.5.7. Phytoplankton

Phytoplankton are microscopic floating plants, mainly algae, that live suspended in bodies of water and that drift about because they cannot move by themselves or because they are too small or too weak to swim effectively against a current. In the presence of sunlight, phytoplankton take up nutrients from the water, producing oxygen though photosynthesis, and providing the food base for most lake organisms, including fish. Phytoplankton populations vary widely from day to day, as life cycles are short. Phytoplankton impact water clarity when they bloom (grow excessively), and certain species of the blue-green algae group (cyanobacteria) form surface scums and produce toxins that present a public health threat. Knowing the abundance of each phytoplankton species is important for understanding the basis of the lake ecosystem, and how it may affect human and wildlife uses.

The King County Lake Stewardship Program includes collection of phytoplankton samples at 1-meter depth for qualitative analysis. The samples collected in 2016 were submitted to Rithron Associates (Missoula, Montana) for quantitative analysis of phytoplankton species biovolume following methods similar to those used historically. The database provided by the laboratory is presented in Appendix D.

Phytoplankton data were compiled though 2013 and evaluated by Herrera (2015a). This database was supplemented with data collected in 2016 for this report. Data were categorized into the following summer study periods and associated years of data:

- **Pre 1991 Alum Treatment:** 1959 and 1981
- **Post 1991 Alum Treatment:** 1992, 1993, and 1994
- **Post 2004 Alum Treatment:** 2008 and 2013
- **Post 2016 Alum Treatment:** 2016

Phytoplankton data are presented and discussed separately for percent composition of phytoplankton groups and biovolume of cyanobacteria species.

4.5.7.1. Group Composition

Phytoplankton composition was determined for each year based on percentages of the total biovolume for the following major phytoplankton groups:

- Cyanaophyta (cyanobacteria/blue-green algae)
- Chlorophyta (green algae)
- Chrysophyta (primarily diatoms and some other genera including Dinobryon)
- Others (primarily flagellated Dinophytes and Cryptophytes)

Phytoplankton group composition results are presented in Figure 9. Before any alum treatment, Green Lake phytoplankton were dominated by cyanobacteria (70 to 73 percent Cyanophyta) and included much lesser amounts of diatoms (15 to 17 percent Chrysophyta), green algae (9 to 10 percent Chlorophyta), and others (3 to 4 percent other groups).

Phytoplankton composition substantially changed in each of the 3 years following the 1991 alum treatment. Cyanobacteria continued to dominate the year following the 1991 alum treatment, but it steadily declined from 70 percent in 1992 to 31 percent in 1994, when there was a similar percentage of diatoms (35 percent Chrysophyta) and lower amounts of other groups (12 percent Chlorophyta and 21 percent other groups). Cyanobacteria abundance reached its lowest point during the post-2004 alum treatment period, when Cyanophyta represented only 13 percent in 2008 and 8 percent in 2013 (see Figure 9). Diatoms were clearly dominant in 2008 (63 percent Chrysophyta), while both diatoms and green algae dominated phytoplankton in 2013 (38 percent Chrysophyta and 43 percent Chlorophyta).

Cyanobacteria abundance increased to 20 percent following the 2016 alum treatment, while Chrysophyta (61 percent) continued to dominate the phytoplankton composition (Figure 9). Although the relative abundance of cyanobacteria increased compared to 2008 and 2013, it was still well below levels observed prior to the three alum treatments. It is possible that cyanobacteria abundance was higher in 2014 than 2013 based on the higher concentrations of microcystin observed in algae scum samples (see *Cyanotoxins*).

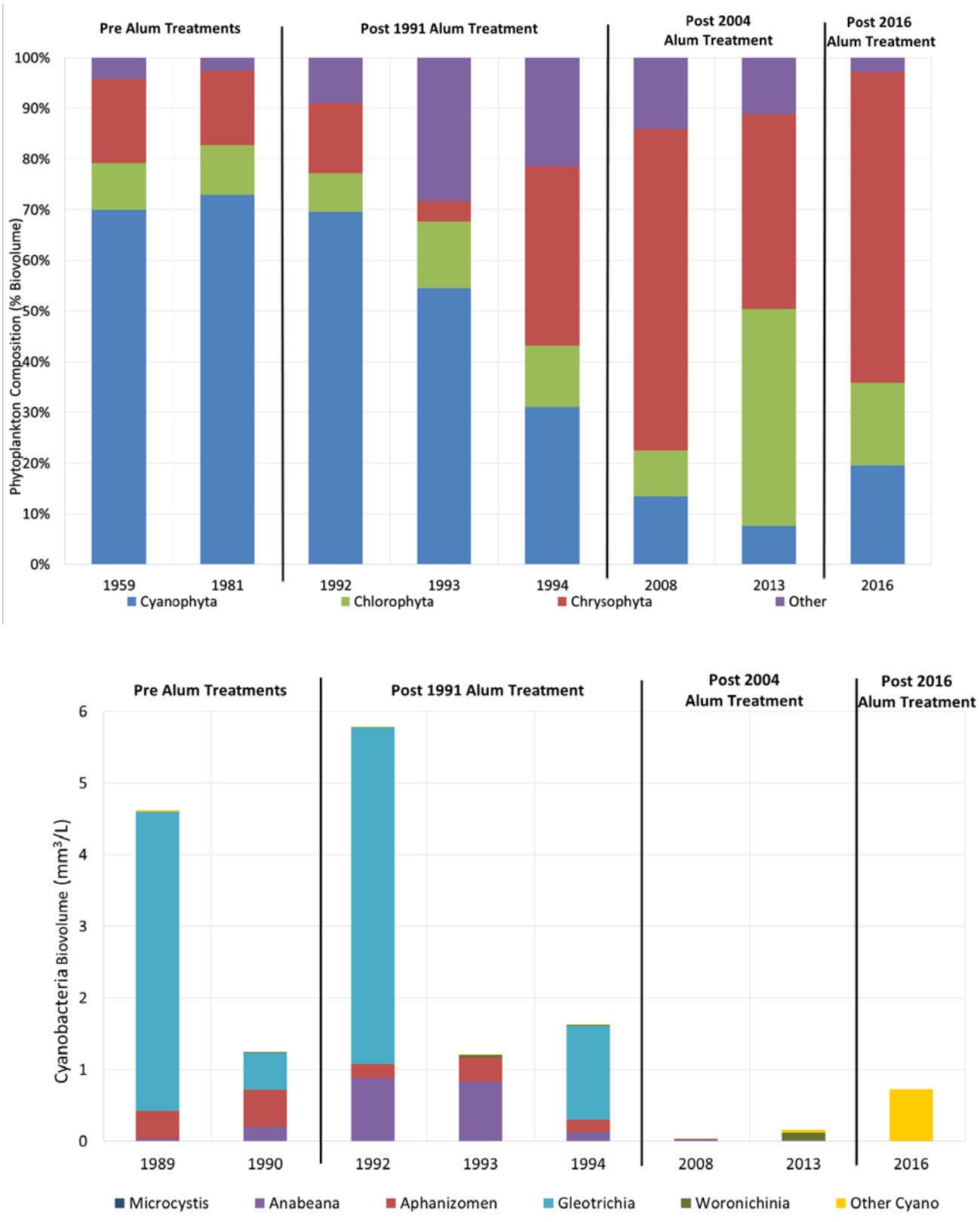


Figure 9. Phytoplankton Group Composition and Cyanobacteria Biovolume by Study Year for Summer in Green Lake.

4.5.7.2. Cyanobacteria Biovolume

Cell biovolume concentration data were compiled for each phytoplankton species and summed for the following cyanobacteria groups:

- **Anabaena** (*A. circinalis, A. spiroides, A. flos-aquae, A. lemmermannii, A. planktonica,* and unknown *Anabaena* species)
- **Aphanizomenon** (*A. flos aquae*)
- **Gloeotrichia** (*G. echinulate*)
- **Microcystis** (*M. aeruginosa and M. wesenbergii*)
- **Woronichinia** (*Coelosphaerium naegelianum,* renamed as *Woronichinia*, and unknown *Woronichinia* species)
- **Other Cyanobacteria** (*Anacystis*, *Aphanocapsa*, *Aphanothece*, *Anathece*, *Chroococcus* sp., *Gomphosphaeria lacustris*, *Oscillatoria*, Oscillatoriaceae, Oscillatoriales – Pseudanabaenaceae, and Nostocales)

Phytoplankton group composition results are presented in Figure 9. The summer mean total cyanobacteria biovolume was 0.73 cubic millimeters per liter (mm^3/L) following the 2016 alum treatment. Historically, cyanobacteria biovolume has varied greatly during previous monitoring, ranging from a low of 0.04 in 2008 to a high of 5.8 mm^3/L in 1992 (see Figure 9). The range of summer mean total cyanobacteria biovolume was similar in the pre-1991 and post-1991 treatment periods (1.2 to 4.6 mm^3/L and 1.2 to 5.8 mm^3/L, respectively), but much lower in the post-2004 treatment period (0.04 to 0.16 mm^3/L). These results clearly show that the 2004 alum treatment substantially reduced cyanobacteria biovolume compared to the 1991 alum treatment.

Cyanobacteria biovolume was higher in the first year following the 2016 alum treatment (0.73 mm^3/L) than the post-2014 alum treatment period sampled in 2008 (0.04 mm^3/L) and 2013 (0.16 mm^3/L). The following groups of cyanobacteria were not observed in Green Lake in 2016:

- **Anabaena** was rarely present in the pre-1991 alum treatment period, but was relatively abundant in the post-1991 and 2004 alum treatment periods.
- **Aphanizomenon** was moderately abundant in each year of the pre- and post-1991 alum treatment periods, and was rarely present in the post-2004 alum treatment period. Aphanizomenon bloomed in the late summer of the pre-1991 alum treatment period, but was commonly present in low amounts throughout the post-1991 alum treatment period.
- **Gloeotrichia** was responsible for the very high biovolume observed in 1989 and 1992, and the moderate biovolume observed in 1994, while it contributed to the moderate

biovolume in 1991 but was not present in 1993. Gloeotrichia was not present in 2008 or 2013 following the 2004 alum treatment when chlorophyll and total phosphorus were low.

- **Microcystis** was rarely observed in the phytoplankton samples with the exception that it dominated cyanobacteria biovolume in September 1990 and September 2013.

- **Woronichinia** represented a very small portion of cyanobacteria biovolume, except for August of 1993 and 1994, and obtained dominance and its highest biovolume in August 2013.

All of the cyanobacteria species observed in 2016 are included in the Other Cyanobacteria group. A total of nine species were observed, including four previously observed genera (*Aphanocapsa, Aphanothece, Chroococcus, Gomphosphaeria aponina*) and five genera that have not been previously observed in lake samples (*Calothrix, Cyanothece aeruginosa, Dolichospermum, Merismopedia tenuissima,* and *Phormidium*). The most abundance species was *Gomphosphaeria aponina,* which exceeded biovolume of 1 mm^3/L in each of the two samples that it was observed, while no other species exceeded a biovolume of 0.01 mm^3/L in any sample. Of the species observed in 2016, only *Phormidium* has been identified as a known producer of cyanotoxins (specifically anatoxins) (US EPA 2017).

The Other Cyanobacteria group was more prevalent in the post-2004 alum treatment period than the previous periods, but it typically did not dominate cyanobacteria with the exception of dominance by Anacystis and Chroococcus in October 2008 and again in May to June 2013. The increased abundance of Other Cyanobacteria after the 2004 and 2016 alum treatments represent a shift in the cyanobacteria composition likely caused by the reduced phosphorus supply.

4.5.8. Cyanotoxins

Additional water quality monitoring of Green Lake is conducted by others to address public health concerns. If a cyanobacteria bloom is observed in Green Lake, King County or a volunteer will collect a surface scum sample for analysis of cyanotoxin (microcystin and anatoxin-a) concentrations, and phytoplankton species presence. In addition, King County Department of Natural Resources will continue monitoring microcystin and fecal coliform bacteria at the swimming beaches in Green Lake.

For the phytoplankton study (Herrera 2015a), cyanotoxin data for in Green Lake were compiled for 2007–2014 from King County and the Washington Department of Ecology's Washington State Toxic Algae Database. The microcystin database was updated for this report with results for surface scum samples collected in 2015 and 2016 (Ecology 2017). Anatoxin-a has never been detected at the swimming beaches, and was rarely detected and only at low levels in surface scum samples.

Microcystin concentrations in algae scum samples have been used since 1999 to close Green Lake to primary contact recreation. Lake recreation closure and opening dates have not been recorded by local or state agencies. Based on press releases and other communication records, lake closures due to scum microcystin concentrations are estimated to have occurred in the following years:

1. **1999** – begin on August 20, 1999, and end in October 1999
2. **2002** – begin on August 5, 2002, and end on January 16, 2003
3. **2003** – begin in August 2003, and end in September 2003
4. **2012** – begin on October 2, 2012, and end November 28, 2012
5. **2013** – begin on September 12, 2013, and end on December 9, 2013
6. **2014** – begin on August 25, 2014, and end December 19, 2014

Microcystin concentrations in algae scum samples collected from 2011 through 2016 at various shore locations in Green Lake are summarized in Table 11. The annual geometric mean concentration of microcystin increased from 15 µg/L 2011 to 68 µg/L in 2012, was highest at 70 µg/L in 2014, decreased to only 0.8 µg/L in 2015, and remained low at 0.5 µg/L in the year after the 2016 alum treatment. The unusually low microcystin concentration in 2015 may have been due to unusual climatic conditions that did not favor growth or toxin production by cyanobacteria. The Washington State guideline of 6 µg/L was exceeded on at least one occasion in every year except 2016. Anabaena was the cyanobacteria genera most often identified as dominant in scum samples collected in 2011 through 2014, and no cyanobacteria were dominant in scum samples collected in 2015 and 2016.

Table 11. Microcystin in Shore Scum Samples by Year from Green Lake.

Year	Number of Samples	Percent Exceeding Guideline[a]	Geometric Mean (µg/L)	Maximum Value (µg/L)	Dominant Cyanobacteria
2011	3	67%	15	64	Anabaena, Gloeotrichia
2012	6	100%	68	419	Anabaena, Gloeotrichia
2013	17	76%	17	613	Anabaena, Microcystis
2014	41	73%	70	25,000	Anabaena
2015	11	9%	0.8	55	None
2016	3	0%	0.5	5	None

[a] Percentage of sample results exceeding Washington State Guideline of 6 µg/L (micrograms per liter).

5. CONCLUSIONS

The 2016 alum treatment occurred over a 6-day period from April 5 through April 10, 2016. A total of 81,744 gallons of aluminum sulfate and 40,905 gallons of sodium aluminate were applied to the lake. The volumes of chemicals applied are similar to those planned, but the applied alum dose was determined to be 9.6 mg Al/L, which is higher than planned dose of 8.2 mg Al/L due to a higher aluminum concentration in the sodium aluminate and a lower updated value for the lake volume. The 2016 dose is approximately 40 percent of the 23.0 mg Al/L dose applied in 2004 and is slightly more than the 8.6 mg Al/L dose applied in 1991. As done in 2004, liquid alum was applied concurrently with liquid sodium aluminate (alkaline buffer) at a ratio of 2:1 by volume to ensure that the water pH did not decrease below 6.0.

In accordance with the phosphorus management plan (Herrera 2015b), engineering oversight and short-term water quality monitoring were conducted before, during, and 2 weeks after the treatment to ensure proper material application, prevent potential impacts to fish from low or high pH, and meet permit requirements. In addition, a public involvement plan was used to inform and educate park users and nearby residents of the alum treatment.

The short-term water quality objectives were met. The average lake pH ranged from 7.3 to 7.9, which meets the objective of between 6.0 and 8.7. The average alkalinity in the lake was greater than 42 mg/L, which meets the objective of greater than 12 mg/L.

Although the treatment did not change the pH or dissolved oxygen concentrations in the lake, minor fish mortality was observed during the alum treatment period. With the exception of a few carp, all fish found dead prior to and during the alum treatment appeared to be recently stocked trout; and no resident fish mortality was observed. Fish mortality data collected by monitoring staff and community members indicate that less than 1 percent of the 15,000 planted trout, or approximately 100 fish, died during the alum treatment. Post-treatment observations indicate that the dead trout were removed from the lake within a few days by cormorants, eagles, and osprey. The near-neutral pH observed indicates that the applied alum would not cause acute toxicity to fish or other aquatic organisms. In addition, gill conditions of the dead trout were not indicative of chemical toxicity and no resident fish mortality was observed, with the exception of a few carp. Due to the effects of being transferred to a new habitat, planted trout are more sensitive to environmental stress factors than resident fish in Green Lake. In addition to stress caused by the alum application, the loss of planted trout may have been due to stress from increased water clarity, bird predation, and fishing pressure.

Post-treatment monitoring was performed on 11 occasions from May through October 2017 and determined that the following long-term water quality objectives were met:

- Summer average total phosphorus concentration shall be less than 20 µg/L (which was reduced for the 2016 treatment from the previous goal of 25 µg/L).

- Summer average Secchi depth (water clarity) shall exceed 2.5 meters (8.2 feet) (which has not changed since the 1991 treatment).

- The lake shall not be closed to recreational uses due to toxic cyanobacteria (which was added for the 2016 treatment).

Analysis of phytoplankton samples showed that the average cyanobacteria abundance increased to 20 percent in 2016 compared 13 percent in 2008 and 8 percent 2013, while the group Chrysophyta (61 percent) continued to dominate the phytoplankton composition. However, those cyanobacteria present were not comprised of toxin producing species formerly observed in the lake. One exception is that two samples contained *Phormidium*, which had not been previously observed in Green Lake but is a known producer of anatoxin-a. The lake was not closed in 2016 to recreational uses due to toxic cyanobacteria. The Washington State guideline of 6 µg/L for the cyanotoxin microcystin was not exceeded in 2016, and previously had been exceeded on at least one occasion in 2013, 2014, and 2015.

The 2016 treatment is expected to meet water quality goals for at least 10 years, based on the long-term effect of the 2004 treatment and assuming external phosphorus inputs to the lake remain relatively low. Long-term water quality monitoring will be continued through the King County Volunteer Monitoring Program and the Washington State Toxic Algae Program to determine if the water quality goals will continue to be met.

6. REFERENCES

Ecology. 2016. Water Quality, Aquatic Plant and Algae Management General Permit. Washington Department of Ecology, Olympia, Washington. Effective April 1, 2016. <http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/aquatic_plants/aquatic_plant_permit_index.html>.

Ecology. 2017. Washington State Toxic Algae, Freshwater Algae Bloom Monitoring Program. Washington Department of Ecology, Olympia, Washington. <https://www.nwtoxicalgae.org/Default.aspx>.

Guilford, S.J. and R.E. Hecky. 2000. Total Nitrogen, Total Phosphorus, and Nutrient Limitation in Lakes and Oceans: Is there a common Relationship? Limnology and Oceanography 45:1213–1223.

Herrera. 2003. Green Lake Alum Treatment Study. Prepared for City of Seattle Parks and Recreation, Seattle, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington.

Herrera. 2004. Treatment Monitoring Report, Green Lake 2004 Alum Treatment. Prepared for the City of Seattle Parks and Recreation, Seattle, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington. September 30.

Herrera. 2015a. Data Analysis Report, Green Lake Phytoplankton Study. Prepared for the City of Seattle Parks and Recreation, Seattle, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington. January 21.

Herrera. 2015b. Phosphorus Management Plan, Green Lake Alum Treatment 2016. Prepared for the City of Seattle Parks and Recreation, Seattle, Washington, by Herrera Environmental Consultants, Inc., Seattle, Washington. December 22.

King County. 2017. King County Small Lakes Information and Data, Green-1 Lake. King County Department of Natural Resources and Parks, Seattle, Washington. <http://green2.kingcounty.gov/SmallLakes/lakepage.aspx?SiteID=15#RelatedLinks>.

KCM. 1995. Green Lake Phase IIC Restoration Project Volume 1 – Project Completion Report. Prepared for City of Seattle Parks and Recreation, Seattle, Washington, by KCM, Inc., Seattle, Washington. August.

US EPA. 2017. Cyanobacteria/Cyanotoxins. US Environmental Protection Agency. Accessed March 2017. <https://www.epa.gov/nutrient-policy-data/cyanobacteriacyanotoxins#what4>.

Welch, E.B. 1992. Ecological Effects of Wastewater. Cambridge University Press, New York, New York.

APPENDIX A

Daily Application Logs

SEATTLE PARKS AND RECREATION

Green Lake Alum Treatment 2016

EXPORT TRANSMITTAL FORM AS SEPARATE DOCUMENT & RESET FORM

Contract No.	2016-023
Submittal Date	6-Apr-16

SUBMITTAL TRANSMITTAL FORM

TRANSMITTAL TO:	**Seattle Parks and Recreation Department**	
◉ First Submittal	800 Maynard Avenue South	
○ Resubmittal	Seattle, WA 98134	
Parks PM:	Chris Mueller, E-Mail: chris.mueller@seattle.gov	(206) 684-0998
FROM:	**HAB Aquatic Solutions**	**Subcontractor (If Applicable)**
	5100 Van Dorn Street, #6096	
	Lincoln, NE 68506	

DESCRIPTION OF SUBMITTAL ITEM	**TYPE OF SUBMITTAL**
Daily Application Log for 4/5/16	Quality Assurance

Supplier	**Manufacturer**

Spec Section Number	**Title of Spec Section**	**Drawing No./Detail Reference**
13 11 00	Green Lake Alum Treatment Technical	

CHECK ALL THAT APPLY

☑ Submitted for review and approval	☐ Substitution request (include RAMS form)
☐ Resubmitted for review and approval	☐ Complies with Contract requirements
☐ Will be available to meet construction schedule	☐ One copy retained by sender
☑ Other remarks: Submittal #1	

HAB Aquatic Solutions hereby certifies that the information submitted herewith complies with requirements of the referenced contract documents.

SIGNATURE	**TITLE**	**DATE**

REVIEW AND RESPONSE

RESPONSE TO:	**HAB Aquatic Solutions**	**ATTENTION:**
	5100 Van Dorn Street, #6096	
	Lincoln, NE 68506	
BY:	Seattle Parks and Recreation Department	**Date Transmitted**

CHECK ONE RESPONSE

☐ Approved	☐ Conditionally approved as noted / Resubmit required
☐ Approved as noted	☐ Rejected / Resubmit
☐ Not subject to review	☐ Revise / Resubmit
☐ No action required	☐ Submission incomplete / Resubmit
☐ Other as noted	

NOTES

RESPONDER'S	**TITLE**	**DATE**
Harry Kelly	City Rep	4/6/16

Green Lake Alum Treatment 2016
PW# 2016-023
Daily Application Log

Date: April 5, 2016

Application start time: 8:00
Application end time: 18:56

Workforce: 3

Weather conditions: cloudy to partly cloudy, winds 5 -10 mph, high temp of 58 F

Quantity of alum applied: 16,625
Quantity of sodium aluminate applied: 8,440
(exact volumes will be determined from bills of lading at end of project)

Approximate application location area: 106
(lake will be covered twice)

Summary of alum deliveries
5 tucks
% Al2O3 = 8.20, 8.11, 8.09, 8.20, 8.13

Summary of sodium aluminate deliveries:

3 trucks

% Al2O3 = 18.96, 18.96, 18.96

SEATTLE PARKS AND RECREATION

Green Lake Alum Treatment 2016

EXPORT TRANSMITTAL FORM AS SEPARATE DOCUMENT & RESET FORM

Contract No. 2016-023

Submittal Date 6-Apr-16

SUBMITTAL TRANSMITTAL FORM

TRANSMITTAL TO: Seattle Parks and Recreation Department
800 Maynard Avenue South
Seattle, WA 98134

- (•) First Submittal
- ( ) Resubmittal

Parks PM: Chris Mueller, E-Mail: chris.mueller@seattle.gov (206) 684-0998

FROM: HAB Aquatic Solutions
5100 Van Dorn Street, #6096
Lincoln, NE 68506

Subcontractor (If Applicabl

DESCRIPTION OF SUBMITTAL ITEM: Daily Application Log for 4/6/16

TYPE OF SUBMITTAL: Quality Assurance

Supplier:

Manufacturer:

Spec Section Number	Title of Spec Section	Drawing No./Detail Referen
13 11 00	Green Lake Alum Treatment Technical	

CHECK ALL THAT APPLY

- [x] Submitted for review and approval
- [ ] Resubmitted for review and approval
- [ ] Will be available to meet construction schedule
- [x] Other remarks: Submittal #2
- [ ] Substitution request (include RAMS form)
- [ ] Complies with Contract requirements
- [ ] One copy retained by sender

HAB Aquatic Solutions hereby certifies that the information submitted herewith complies with requirements of the referenced contract documents.

SIGNATURE	TITLE	DATE

REVIEW AND RESPONSE

RESPONSE TO: HAB Aquatic Solutions
5100 Van Dorn Street, #6096
Lincoln, NE 68506

ATTENTION:

BY: Seattle Parks and Recreation Department

Date Transmitted

CHECK ONE RESPONSE

- [x] Approved
- [ ] Approved as noted
- [ ] Not subject to review
- [ ] No action required
- [ ] Other as noted
- [ ] Conditionally approved as noted / Resubmit required
- [ ] Rejected / Resubmit
- [ ] Revise / Resubmit
- [ ] Submission incomplete / Resubmit

NOTES

RESPONDER'S	TITLE	DATE
Harry Libby	City Rep	4/7/16

Green Lake Alum Treatment 2016
PW# 2016-023
Daily Application Log

Date: April 6, 2016

Application start time: 10:57
Application end time: 18:59

Workforce: 3

Weather conditions: partly cloudy, winds 5 -12 mph, high temp of 67 F

Quantity of alum applied: 11,406
Quantity of sodium aluminate applied: 5,771
(exact volumes will be determined from bills of lading at end of project)

Approximate application location area: 73
(lake will be covered twice)

Summary of alum deliveries
4 tucks
% Al2O3 = 8.20, 8.11, 8.09, 8.20, 8.13

Summary of sodium aluminate deliveries:

3 trucks

% Al2O3 = 18.96, 18.96, 18.96

Project Summary to date:

Quantity of alum applied: 28,031

Quantity of sodium aluminate applied: 14,211

(exact volumes will be determined from bills of lading at end of project)

Approximate application location area: 179

(lake will be covered twice)

Summary of alum deliveries

9 tucks

Summary of sodium aluminate deliveries:

6 trucks

SEATTLE PARKS AND RECREATION

Green Lake Alum Treatment 2016

EXPORT TRANSMITTAL FORM AS SEPARATE DOCUMENT & RESET FORM

Contract No.	2016-023
Submittal Date	8-Apr-16

SUBMITTAL TRANSMITTAL FORM

TRANSMITTAL TO:	**Seattle Parks and Recreation Department**	
◉ First Submittal	800 Maynard Avenue South	
○ Resubmittal	Seattle, WA 98134	
Parks PM:	Chris Mueller, E-Mail: chris.mueller@seattle.gov	(206) 684-0998
FROM:	**HAB Aquatic Solutions**	**Subcontractor (If Applicable)**
	5100 Van Dorn Street, #6096	
	Lincoln, NE 68506	

DESCRIPTION OF SUBMITTAL ITEM	TYPE OF SUBMITTAL
Daily Application Log for 4/7/16	Quality Assurance

Supplier	Manufacturer

Spec Section Number	Title of Spec Section	Drawing No./Detail Reference
13 11 00	Green Lake Alum Treatment Technical	

CHECK ALL THAT APPLY

- ☑ Submitted for review and approval
- ☐ Resubmitted for review and approval
- ☐ Will be available to meet construction schedule
- ☑ Other remarks: Submittal #3
- ☐ Substitution request (include RAMS form)
- ☐ Complies with Contract requirements
- ☐ One copy retained by sender

HAB Aquatic Solutions hereby certifies that the information submitted herewith complies with requirements of the referenced contract documents.

SIGNATURE	TITLE	DATE

REVIEW AND RESPONSE

RESPONSE TO:	**HAB Aquatic Solutions**	**ATTENTION:**
	5100 Van Dorn Street, #6096	
	Lincoln, NE 68506	
BY:	Seattle Parks and Recreation Department	**Date Transmitted**

CHECK ONE RESPONSE

- ☐ Approved
- ☐ Approved as noted
- ☐ Not subject to review
- ☐ No action required
- ☐ Other as noted
- ☐ Conditionally approved as noted / Resubmit required
- ☐ Rejected / Resubmit
- ☐ Revise / Resubmit
- ☐ Submission incomplete / Resubmit

NOTES

RESPONDER'S	TITLE	DATE
[signature]	City Rep	4/8/16

Green Lake Alum Treatment 2016
PW# 2016-023
Daily Application Log

Date: April 7, 2016

Application start time: 7:00
Application end time: 18:50

Workforce: 3

Weather conditions: partly cloudy, winds 5 -12 mph, high temp of 67 F

Quantity of alum applied: 13,007
Quantity of sodium aluminate applied: 6,561
(exact volumes will be determined from bills of lading at end of project)

Approximate application location area: 83
(lake will be covered twice)

Summary of alum deliveries
2 trucks

Summary of sodium aluminate deliveries:
2 trucks

Project Summary to date:

Quantity of alum applied: 41,038
Quantity of sodium aluminate applied: 20,772
(exact volumes will be determined from bills of lading at end of project)

Approximate application location area: 262
(lake will be covered twice)

Summary of alum deliveries
11 trucks

Summary of sodium aluminate deliveries:
8 trucks

SEATTLE PARKS AND RECREATION

Green Lake Alum Treatment 2016

EXPORT TRANSMITTAL FORM AS SEPARATE DOCUMENT & RESET FORM

Contract No. 2016-023

Submittal Date 9-Apr-16

SUBMITTAL TRANSMITTAL FORM

TRANSMITTAL TO:	**Seattle Parks and Recreation Department**	
◉ First Submittal	800 Maynard Avenue South	
○ Resubmittal	Seattle, WA 98134	
Parks PM:	Chris Mueller, E-Mail: chris.mueller@seattle.gov	(206) 684-0998
FROM:	**HAB Aquatic Solutions**	**Subcontractor (If Applicable)**
	5100 Van Dorn Street, #6096	
	Lincoln, NE 68506	

DESCRIPTION OF SUBMITTAL ITEM		**TYPE OF SUBMITTAL**
Daily Application Log for 4/8/16		Quality Assurance
Supplier	**Manufacturer**	

Spec Section Number	**Title of Spec Section**	**Drawing No./Detail Reference**
13 11 00	Green Lake Alum Treatment Technical	

CHECK ALL THAT APPLY

- ☑ Submitted for review and approval
- ☐ Resubmitted for review and approval
- ☐ Will be available to meet construction schedule
- ☑ Other remarks: Submittal #4
- ☐ Substitution request (include RAMS form)
- ☐ Complies with Contract requirements
- ☐ One copy retained by sender

HAB Aquatic Solutions hereby certifies that the information submitted herewith complies with requirements of the referenced contract documents.

SIGNATURE	**TITLE**	**DATE**

REVIEW AND RESPONSE

RESPONSE TO:	**HAB Aquatic Solutions**	**ATTENTION:**
	5100 Van Dorn Street, #6096	
	Lincoln, NE 68506	
BY:	Seattle Parks and Recreation Department	**Date Transmitted**

CHECK ONE RESPONSE

- ☐ Approved
- ☐ Approved as noted
- ☐ Not subject to review
- ☐ No action required
- ☐ Other as noted
- ☐ Conditionally approved as noted / Resubmit required
- ☐ Rejected / Resubmit
- ☐ Revise / Resubmit
- ☐ Submission incomplete / Resubmit

NOTES

RESPONDER'S	**TITLE**	**DATE**
Harry Gibbons	City's Rep	4/9/16

Green Lake Alum Treatment 2016
PW# 2016-023
Daily Application Log

Date: April 8, 2016

Application start time: 6:55
Application end time: 19:16

Workforce: 3

Weather conditions: partly cloudy, winds 0 -8 mph, high temp of 74 F

Quantity of alum applied: 14,339
Quantity of sodium aluminate applied: 6,984
(exact volumes will be determined from bills of lading at end of project)

Approximate application location area: 91
(lake will be covered twice)

Summary of alum deliveries
3 trucks

Summary of sodium aluminate deliveries:
3 trucks

Project Summary to date:

Quantity of alum applied: 55,377
Quantity of sodium aluminate applied: 27,756
(exact volumes will be determined from bills of lading at end of project)

Approximate application location area: 262
(lake will be covered twice)

Summary of alum deliveries
14 trucks

Summary of sodium aluminate deliveries:
11 trucks

SEATTLE PARKS AND RECREATION

Green Lake Alum Treatment 2016

EXPORT TRANSMITTAL FORM AS SEPARATE DOCUMENT & RESET FORM

V Contract No.	2016-023
Submittal Date	10-Apr-16

SUBMITTAL TRANSMITTAL FORM

TRANSMITTAL TO:	Seattle Parks and Recreation Department	
◉ First Submittal	800 Maynard Avenue South	
○ Resubmittal	Seattle, WA 98134	
Parks PM:	Chris Mueller, E-Mail: chris.mueller@seattle.gov	(206) 684-0998
FROM:	HAB Aquatic Solutions 5100 Van Dorn Street, #6096 Lincoln, NE 68506	Subcontractor (If Applicable)

DESCRIPTION OF SUBMITTAL ITEM	TYPE OF SUBMITTAL
Daily Application Log for 4/9/16	Quality Assurance

Supplier	Manufacturer

Spec Section Number	Title of Spec Section	Drawing No./Detail Reference
13 11 00	Green Lake Alum Treatment Technical	

CHECK ALL THAT APPLY

- ☑ Submitted for review and approval
- ☐ Resubmitted for review and approval
- ☐ Will be available to meet construction schedule
- ☑ Other remarks: Submittal #5
- ☐ Substitution request (include RAMS form)
- ☐ Complies with Contract requirements
- ☐ One copy retained by sender

HAB Aquatic Solutions hereby certifies that the information submitted herewith complies with requirements of the referenced contract documents.

SIGNATURE	TITLE	DATE

REVIEW AND RESPONSE

RESPONSE TO:	HAB Aquatic Solutions 5100 Van Dorn Street, #6096 Lincoln, NE 68506	ATTENTION:
BY:	Seattle Parks and Recreation Department	Date Transmitted

CHECK ONE RESPONSE

- ☒ Approved
- ☐ Approved as noted
- ☐ Not subject to review
- ☐ No action required
- ☐ Other as noted
- ☐ Conditionally approved as noted / Resubmit required
- ☐ Rejected / Resubmit
- ☐ Revise / Resubmit
- ☐ Submission incomplete / Resubmit

NOTES

RESPONDER'S	TITLE	DATE
[signature]	City's Rep	4/11/16

Green Lake Alum Treatment 2016
PW# 2016-023
Daily Application Log

Date: April 9, 2016

Application start time: 7:12
Application end time: 15:20

Workforce: 3

Weather conditions: partly cloudy, winds 0 - 5 mph, high temp of 65 F

Quantity of alum applied: 11,242
Quantity of sodium aluminate applied: 5,224
(exact volumes will be determined from bills of lading at end of project)

Approximate application location area: 69
(lake will be covered twice)

Summary of alum deliveries
4 trucks

Summary of sodium aluminate deliveries:
1 trucks

Project Summary to date:

Quantity of alum applied: 66,119
Quantity of sodium aluminate applied: 32,980
(exact volumes will be determined from bills of lading at end of project)

Approximate application location area: 331
(lake will be covered twice)

Summary of alum deliveries
18 trucks

Summary of sodium aluminate deliveries:
12 trucks

SEATTLE PARKS AND RECREATION

Green Lake Alum Treatment 2016

EXPORT TRANSMITTAL FORM AS SEPARATE DOCUMENT & RESET FORM

PW Contract No. 2016-023

Submittal Date 11-Apr-16

SUBMITTAL TRANSMITTAL FORM

TRANSMITTAL TO: Seattle Parks and Recreation Department
800 Maynard Avenue South
Seattle, WA 98134

(●) First Submittal
( ) Resubmittal

Parks PM: Chris Mueller, E-Mail: chris.mueller@seattle.gov (206) 684-0998

FROM: HAB Aquatic Solutions
5100 Van Dorn Street, #6096
Lincoln, NE 68506

Subcontractor (If Applicable)

DESCRIPTION OF SUBMITTAL ITEM	TYPE OF SUBMITTAL
Daily Application Log for 4/10/16	Quality Assurance

Supplier	Manufacturer

Spec Section Number	Title of Spec Section	Drawing No./Detail Reference
13 11 00	Green Lake Alum Treatment Technical	

CHECK ALL THAT APPLY

- [x] Submitted for review and approval
- [ ] Resubmitted for review and approval
- [ ] Will be available to meet construction schedule
- [x] Other remarks: Submittal #6
- [ ] Substitution request (include RAMS form)
- [ ] Complies with Contract requirements
- [ ] One copy retained by sender

HAB Aquatic Solutions hereby certifies that the information submitted herewith complies with requirements of the referenced contract documents.

SIGNATURE	TITLE	DATE

REVIEW AND RESPONSE

RESPONSE TO: HAB Aquatic Solutions
5100 Van Dorn Street, #6096
Lincoln, NE 68506

ATTENTION:

Date Transmitted

BY: Seattle Parks and Recreation Department

CHECK ONE RESPONSE

- [x] Approved
- [ ] Approved as noted
- [ ] Not subject to review
- [ ] No action required
- [ ] Other as noted
- [ ] Conditionally approved as noted / Resubmit required
- [ ] Rejected / Resubmit
- [ ] Revise / Resubmit
- [ ] Submission incomplete / Resubmit

NOTES

RESPONDER'S	TITLE	DATE
[signature]	City Rep	4/11/16

Green Lake Alum Treatment 2016
PW# 2016-023
Daily Application Log

Date: April 10, 2016

Application start time: 7:39
Application end time: 19:50

Workforce: 3

Weather conditions: cloudy to partly cloudy, winds 0 - 5 mph, high temp of 60 F

Quantity of alum applied: 15,625 gallons
Quantity of sodium aluminate applied: 7,925 gallons

Approximate application location area: 96
(lake will be covered twice)

Summary of alum deliveries
2 trucks

Summary of sodium aluminate deliveries:
1 truck

Project Summary:

Quantity of alum applied: 81,744 gallons
Quantity of sodium aluminate applied: 40,905 gallons
(These are exact volumes and verified from bills of lading)

Final alum to sodium aluminate ratio: 2.00

Approximate application location area: 427 acres
(application zone was covered approximately twice)

Summary of alum deliveries
20 trucks

Summary of sodium aluminate deliveries:
13 trucks

Dates of application: 4/5/16 to 4/10/16 (6 days)

Herrera Environmental Consultants, Inc.

Memorandum

To	Chris Mueller, Seattle Parks and Recreation
cc	Harry Gibbons, Tetra Tech, Inc.
From	Rob Zisette, Herrera Environmental Consultants
Date	April 11, 2016
Subject	Trout Mortality at Green Lake

The 2016 Green Lake alum treatment was performed as planned by HAB Aquatic Solutions from Tuesday April 5 through Sunday April 10, 2016. Trout mortality was observed by treatment monitoring personnel before the treatment began on Tuesday April 5, 2016. The first reported trout mortality reported by local citizens was made on Friday April 8, 2016, and these trout were also observed by treatment monitoring personnel with Herrera and Tetra Tech. This memorandum was prepared to summarize those observations and assess potential causes of the observed mortality.

Trout Plant Information

Green Lake was planted with a total of 15,038 catchable rainbow trout (2.4 to 2.5 fish per pound) on three occasions in March 2016 (5,000 on March 8, 6,225 on March 23, and 3,813 on March 28). The Washington Department of Fish and Wildlife (WDFW) routinely plants catchable rainbow trout in Green Lake in the spring and fall. WDFW had been notified prior to this spring 2016 planting that the alum treatment would likely begin on April 11, and had planned for the planting to occur one month prior to the treatment (Justin Spinelli, WDFW, personal communication). The 2016 trout plant was completed two weeks after the expected planting date and the alum treatment began a week earlier than the expected treatment start date. WDFW is not aware of reports of trout mortality at any other lake to date this year.

Fish Mortality Observations

Monitoring personnel observed one dead trout at the alum treatment staging area (located at the Small Craft Center) and four other trout near the view stand on the other side of the Small Craft Center in the morning of April 5 before the treatment began and no additional dead trout were observed until Friday April 8. Shallow waters were surveyed by boat from the staging area to the community center (South/East shore) and the area from the community center to the Densmore drain (North shore). A total of 19 dead trout (ranging in size from 10 to 14 inches), one distressed trout (gasping at the surface belly up), and one dead carp were observed. The fish biologist from Tetra Tech examined the trout and observed no signs of chemically damaged gills or burns. Two trout exhibited eroded gills that is indicative of hatchery damage. Three trout

exhibited signs of being handled or caught by fisherman, as indicated by a cut on the mouth or body. Most of the trout observed were estimated to have been dead for two or three days based on gill color and some with signs of onset of rigor mortis.

Monitoring personnel surveyed the entire lake shore area (with the exception of fishing and swimming areas) by boat on Saturday April 9. A total of 62 dead trout were observed, ranging in size from approximate 10 to 14 inches. In addition, two or three trout exhibited stressed behavior by flopping or skimming the water surface. The treatment was terminated early at 3:30 pm due to concerns about the apparent increase in trout mortality and stressed behavior. Portions of the lake shore were surveyed again by boat on the morning of Sunday April 10 and no additional mortality was observed in the near shore area. The increased water clarity allowed for inspection of deeper areas and no dead trout were observed at depths greater than 10 feet. Based on these observations and the acceptable water quality monitoring results, the contractor was instructed to complete the treatment.

I inspected several shore locations this morning to determine if there had been any additional mortality and to collect recently dead fish for analysis by WDFW. However, no recently dead or stressed fish were observed. Only three dead trout were observed along the south shore, two dead trout and one dead carp were observed on the north shore, and no dead fish were observed on the west or east shore. I collected two dead trout that appeared to have been dead from at least two days. These specimens will not be submitted to WDFW because I was not able to collect the requested minimum of 5 recently dead trout.

The lake shore was inspected from shore on a daily basis by local resident Garrett Munger as part of his algae scum monitoring at 31 established shore locations, beginning at approximately 9:00 am each day (Garett Munger, personal communication). Other than an occasional dead fish adjacent to a fisherman, no dead fish were observed by Mr. Munger until Friday April 8. Mr. Munger increased his survey intensity at that time when he first observed dead trout near the community center. The total number of dead trout observed were 52 on April 8, 65 on April 9, 68 on April 10. He observed very few dead trout on April 11 and reduced the intensity of his survey. Shore observations by Mr. Munger generally agree with boat observations by monitoring personal.

These observations indicate that less than 1 percent of the 15,000 planted trout died during the alum treatment. Most of the trout mortality occurred after two days of treatment in the evening of April 7 or morning of April 8, with some additional mortality occurring through the evening of April 9, and no additional mortality during the last day or day after the treatment. The lack of dead trout observed on April 11 indicates that most of the dead trout were removed from the lake by predators including the observed cormorants, eagles, and osprey.

Water Quality Monitoring Data

Water quality monitoring data were collected according the monitoring plan. The alum treatment did not change pH or dissolved oxygen concentrations in the lake. The lake pH ranged from 7.3 to 7.7 before treatment, and exhibited a similar range during treatment. Dissolved oxygen

concentrations ranged from 9 to 11 mg/L before treatment and exhibited a similar range during treatment. Water clarity (Secchi depth) increased from approximately 3 meters before treatment to 4 meters on April 6-8, and then to 6 meters on April 9–10.

Conclusions

The alum treatment had no definable effect on trout mortality because the lake temperature, pH, or dissolved oxygen were not changed by the alum treatment. The near-neutral pH observed indicates that the applied aluminum would not have been acutely toxicity to fish or other aquatic organisms. Bioaccumulation of aluminum at toxicity levels in fish tissue would have to occur over months before seeing any metabolic effect of metal toxicity without significant changes in pH and dissolved oxygen within the water column. In addition, gill conditions of the dead trout were not indicative of chemical toxicity. The loss of less than 1 percent of the planted trout during the alum treatment may have been due to additional stress to these hatchery fish from increased water clarity, predation, and fishing pressure.

APPENDIX B

Treatment Monitoring Results

Table B-1. 2016 Green Lake Alum Treatment – Twice Daily Monitoring Data.

Date	Day-Event	Station	Time	Depth (meters)	Temp. °C	DO (mg/L)	pH	Cond. (µS/cm)	Total Alkalinity (mg/L)	Secchi Depth (meters)	Bottom Depth (meters)
4/5/2016	1-evening	Index	1833	0.1	12.3	10.6	7.60	153		2.7	7.2
4/5/2016	1-evening	Index	1835	1.0	12.3	10.5	7.55	153	49.8		
4/5/2016	1-evening	Index	1836	2.0	12.3	10.5	7.52	152			
4/5/2016	1-evening	Index	1837	3.0	12.3	10.5	7.50	153			
4/5/2016	1-evening	Index	1838	4.0	12.3	10.4	7.49	153			
4/5/2016	1-evening	Index	1839	5.0	12.2	10.4	7.48	153			
4/5/2016	1-evening	Index	1840	6.0	12.2	10.4	7.47	153			
4/5/2016	1-evening	Index	1841	7.0	11.6	8.7	7.34	154	43.1		
4/5/2016	1-evening	A	1858	0.1	12.1	10.8	7.54	162		2.8	4.8
4/5/2016	1-evening	A	1859	1.0	12.1	10.7	7.50	162	44.7		
4/5/2016	1-evening	A	1901	2.0	12.2	10.6	7.49	163			
4/5/2016	1-evening	A	1902	3.0	12.2	10.6	7.48	164			
4/5/2016	1-evening	A	1903	4.0	12.2	10.5	7.47	164	44.0		
4/5/2016	1-evening	B	1918	0.1	12.1	10.8	7.58	156		3.2	3.2
4/5/2016	1-evening	B	1920	1.0	12.1	10.5	7.50	156	44.3		
4/5/2016	1-evening	B	1921	2.0	12.1	10.4	7.48	157			
4/5/2016	1-evening	B	1922	3.0	12.1	10.4	7.47	157	44.3		
4/6/2016	2-morning	Index	740	0.1	11.9	10.5	7.40	162		3.4	
4/6/2016	2-morning	Index	742	1.0	11.9	10.3	7.39	162	43.9		
4/6/2016	2-morning	Index	743	2.0	11.9	10.3	7.39	162			
4/6/2016	2-morning	Index	744	3.0	11.9	10.3	7.38	162			
4/6/2016	2-morning	Index	745	4.0	11.9	10.2	7.38	165			
4/6/2016	2-morning	Index	748	5.0	11.9	10.2	7.38	163			
4/6/2016	2-morning	Index	750	6.0	11.9	10.2	7.37	163			
4/6/2016	2-morning	Index	752	7.0	11.8	9.9	7.35	162	44.0		
4/6/2016	2-morning	A	721	0.1	11.8	10.6	7.33	173		3.7	
4/6/2016	2-morning	A	722	1.0	11.8	10.5	7.35	173	43.3		
4/6/2016	2-morning	A	723	2.0	11.8	10.4	7.36	170			
4/6/2016	2-morning	A	724	3.0	11.9	10.4	7.36	170			
4/6/2016	2-morning	A	726	4.0	11.9	10.3	7.36	170	43.5		
4/6/2016	2-morning	B	655	0.1	11.8	10.3	7.23	158			3.4
4/6/2016	2-morning	B	702	1.0	11.8	10.2	7.24	158	43.0		
4/6/2016	2-morning	B	703	2.0	11.8	10.2	7.26	158			

Table B-1. 2016 Green Lake Alum Treatment – Twice Daily Monitoring Data.

Date	Day-Event	Station	Time	Depth (meters)	Temp. °C	DO (mg/L)	pH	Cond. (µS/cm)	Total Alkalinity (mg/L)	Secchi Depth (meters)	Bottom Depth (meters)
4/6/2016	2-morning	B	704	3.0	11.8	10.2	7.27	159	43.7		
4/6/2016	2-evening	Index	1845	0.1	13.1	10.6	7.44	165		4.1	
4/6/2016	2-evening	Index	1846	1.0	13.1	10.5	7.44	164			
4/6/2016	2-evening	Index	1847	2.0	13.1	10.5	7.44	165			
4/6/2016	2-evening	Index	1848	3.0	13.0	10.5	7.44	166			
4/6/2016	2-evening	Index	1848	4.0	12.2	10.5	7.43	162			
4/6/2016	2-evening	Index	1849	5.0	11.9	10.4	7.43	159			
4/6/2016	2-evening	Index	1850	6.0	11.9	10.4	7.42	164			
4/6/2016	2-evening	Index	1851	7.0	11.8	10.1	7.39	165			
4/6/2016	2-evening	A	1902	0.1	12.1	10.7	7.49	170		3.8	
4/6/2016	2-evening	A	1904	1.0	12.1	10.7	7.48	170			
4/6/2016	2-evening	A	1904	2.0	12.1	10.7	7.48	170			
4/6/2016	2-evening	A	1905	3.0	12.1	10.7	7.48	171			
4/6/2016	2-evening	A	1906	4.0	12.0	10.6	7.48	171			
4/6/2016	2-evening	B	1918	0.1	12.4	10.7	7.45	178		2.8	
4/6/2016	2-evening	B	1918	1.0	12.5	10.6	7.41	180			
4/6/2016	2-evening	B	1919	2.0	12.4	10.6	7.39	180			
4/6/2016	2-evening	B	1920	3.0	12.4	10.5	7.37	179			
4/7/2016	3-morning	Index	634	0.1	12.2	10.3	7.18	170		4.0	
4/7/2016	3-morning	Index	635	1.0	12.2	10.3	7.19	170	44.1		
4/7/2016	3-morning	Index	636	2.0	12.2	10.3	7.21	171			
4/7/2016	3-morning	Index	637	3.0	12.1	10.3	7.27	172			
4/7/2016	3-morning	Index	638	4.0	12.0	10.4	7.28	177			
4/7/2016	3-morning	Index	639	5.0	11.9	10.3	7.28	177			
4/7/2016	3-morning	Index	640	6.0	11.7	10.0	7.25	167			
4/7/2016	3-morning	Index	640	7.0	11.6	9.2	7.18	168	44.7		
4/7/2016	3-morning	A	649	0.1	12.0	10.6	7.38	171		3.9	
4/7/2016	3-morning	A	650	1.0	12.0	10.5	7.40	170	42.4		
4/7/2016	3-morning	A	650	2.0	12.0	10.5	7.42	171			
4/7/2016	3-morning	A	651	3.0	12.0	10.5	7.42	170			
4/7/2016	3-morning	A	652	4.0	12.0	10.5	7.43	171	43.8		
4/7/2016	3-morning	B	700	0.1	11.9	10.7	7.44	176			
4/7/2016	3-morning	B	701	1.0	12.0	10.5	7.44	176	43.0		

Table B-1. 2016 Green Lake Alum Treatment – Twice Daily Monitoring Data.

Date	Day-Event	Station	Time	Depth (meters)	Temp. °C	DO (mg/L)	pH	Cond. (µS/cm)	Total Alkalinity (mg/L)	Secchi Depth (meters)	Bottom Depth (meters)
4/7/2016	3-morning	B	702	2.0	12.0	10.5	7.43	176			
4/7/2016	3-morning	B	702	3.0	12.0	10.4	7.44	176	43.3		
4/7/2016	3-evening	Index	1851	0.1	13.3	10.4	7.47	174		3.9	
4/7/2016	3-evening	Index	1852	1.0	13.3	10.4	7.47	174			
4/7/2016	3-evening	Index	1853	2.0	13.3	10.4	7.46	175			
4/7/2016	3-evening	Index	1853	3.0	13.3	10.4	7.46	175			
4/7/2016	3-evening	Index	1854	4.0	12.6	10.5	7.46	175			
4/7/2016	3-evening	Index	1855	5.0	12.4	10.4	7.45	179			
4/7/2016	3-evening	Index	1856	6.0	12.0	10.2	7.44	175			
4/7/2016	3-evening	Index	1856	7.0	11.7	9.1	7.33	170			
4/7/2016	3-evening	A	1904	0.1	12.8	10.5	7.48	184		3.0	
4/7/2016	3-evening	A	1905	1.0	12.8	10.5	7.45	185			
4/7/2016	3-evening	A	1906	2.0	12.4	10.5	7.45	181			
4/7/2016	3-evening	A	1906	3.0	12.4	10.5	7.45	177			
4/7/2016	3-evening	A	1907	4.0	12.2	10.4	7.42	194			
4/7/2016	3-evening	B	1921	0.1	13.1	10.6	7.49	178			3.2
4/7/2016	3-evening	B	1922	1.0	13.0	10.5	7.48	178			
4/7/2016	3-evening	B	1923	2.0	13.0	10.5	7.48	179			
4/7/2016	3-evening	B	1924	3.0	13.0	10.5	7.48	180			
4/8/2016	4-morning	Index	640	0.1	12.8	10.4	7.38	177		4.6	
4/8/2016	4-morning	Index	642	1.0	12.8	10.4	7.41	176	42.7		
4/8/2016	4-morning	Index	643	2.0	12.8	10.4	7.42	176			
4/8/2016	4-morning	Index	644	3.0	12.8	10.4	7.42	182			
4/8/2016	4-morning	Index	645	4.0	12.4	10.4	7.44	177			
4/8/2016	4-morning	Index	646	5.0	12.3	10.1	7.42	180			
4/8/2016	4-morning	Index	647	6.0	12.0	9.8	7.40	176			
4/8/2016	4-morning	Index	648	7.0	11.6	8.3	7.30	172	44.8		
4/8/2016	4-morning	A	655	0.1	12.5	10.7	7.45	182			4.3
4/8/2016	4-morning	A	656	1.0	12.6	10.5	7.49	183	43.1		
4/8/2016	4-morning	A	657	2.0	12.6	10.5	7.50	184			
4/8/2016	4-morning	A	658	3.0	12.5	10.5	7.50	183			
4/8/2016	4-morning	A	658	4.0	12.4	10.4	7.52	180	42.7		
4/8/2016	4-morning	B	706	0.1	12.7	10.6	7.58	184			3.2

Table B-1. 2016 Green Lake Alum Treatment – Twice Daily Monitoring Data.

Date	Day-Event	Station	Time	Depth (meters)	Temp. °C	DO (mg/L)	pH	Cond. (µS/cm)	Total Alkalinity (mg/L)	Secchi Depth (meters)	Bottom Depth (meters)
4/8/2016	4-morning	B	707	1.0	12.8	10.5	7.58	184	44.0		
4/8/2016	4-morning	B	708	2.0	12.8	10.4	7.58	185			
4/8/2016	4-morning	B	709	3.0	12.6	10.3	7.58	188	44.0		
4/8/2016	4-evening	Index	1858	0.1	14.0	10.4	7.56	202		3.2	
4/8/2016	4-evening	Index	1900	1.0	13.9	10.4	7.61	201			
4/8/2016	4-evening	Index	1901	2.0	13.9	10.4	7.75	204			
4/8/2016	4-evening	Index	1902	3.0	13.4	10.4	7.54	194			
4/8/2016	4-evening	Index	1903	4.0	13.0	10.3	7.51	190			
4/8/2016	4-evening	Index	1904	5.0	12.5	10.2	7.52	183			
4/8/2016	4-evening	Index	1904	6.0	12.2	9.7	7.49	179			
4/8/2016	4-evening	Index	1906	7.0	12.0	8.8	7.44	176			
4/8/2016	4-evening	A	1915	0.1	13.3	10.5	7.53	192		3.8	
4/8/2016	4-evening	A	1915	1.0	13.3	10.5	7.52	192			
4/8/2016	4-evening	A	1916	2.0	13.0	10.5	7.55	186			
4/8/2016	4-evening	A	1916	3.0	12.9	10.4	7.56	190			
4/8/2016	4-evening	A	1917	4.0	12.9	10.4	7.61	196			
4/8/2016	4-evening	B	1936	0.1	13.5	10.6	7.65	187			
4/8/2016	4-evening	B	1937	1.0	13.6	10.5	7.63	188			
4/8/2016	4-evening	B	1938	2.0	13.6	10.5	7.61	187			
4/8/2016	4-evening	B	1939	3.0	13.6	10.4	7.60	187			
4/9/2016	5-morning	Index	641	0.1	13.0	10.4	7.18	196		5.8	
4/9/2016	5-morning	Index	643	1.0	13.1	10.4	7.21	196			
4/9/2016	5-morning	Index	643	2.0	13.1	10.4	7.21	196			
4/9/2016	5-morning	Index	644	3.0	13.0	10.4	7.22	194			
4/9/2016	5-morning	Index	644	4.0	13.0	10.3	7.23	194			
4/9/2016	5-morning	Index	645	5.0	12.6	10.2	7.27	182			
4/9/2016	5-morning	Index	646	6.0	12.2	10.1	7.27	183			
4/9/2016	5-morning	Index	647	7.0	11.8	8.3	7.20	183			
4/9/2016	5-morning	A	655	0.1	12.9	10.5	7.25	193			4.4
4/9/2016	5-morning	A	655	1.0	12.9	10.4	7.28	198			
4/9/2016	5-morning	A	656	2.0	13.0	10.4	7.29	194			
4/9/2016	5-morning	A	657	3.0	12.9	10.4	7.29	195			
4/9/2016	5-morning	A	658	4.0	12.9	10.4	7.30	195			

Table B-1. 2016 Green Lake Alum Treatment – Twice Daily Monitoring Data.

Date	Day-Event	Station	Time	Depth (meters)	Temp. °C	DO (mg/L)	pH	Cond. (µS/cm)	Total Alkalinity (mg/L)	Secchi Depth (meters)	Bottom Depth (meters)
4/9/2016	5-morning	B	709	0.1	13.0	10.4	7.39	194			3.2
4/9/2016	5-morning	B	709	1.0	13.0	10.4	7.38	193			
4/9/2016	5-morning	B	710	2.0	13.1	10.3	7.37	190			
4/9/2016	5-morning	B	711	3.0	13.0	10.3	7.37	193			
4/9/2016	5-evening	Index	1802	0.1	14.5	10.3	7.34	202		5.8	
4/9/2016	5-evening	Index	1803	1.0	14.3	10.4	7.34	202	42.3		
4/9/2016	5-evening	Index	1803	2.0	14.0	10.3	7.34	206			
4/9/2016	5-evening	Index	1804	3.0	13.7	10.4	7.34	203			
4/9/2016	5-evening	Index	1805	4.0	13.6	10.4	7.34	204			
4/9/2016	5-evening	Index	1805	5.0	13.3	10.4	7.32	204			
4/9/2016	5-evening	Index	1806	6.0	12.4	10.0	7.31	192			
4/9/2016	5-evening	Index	1807	7.0	11.9	8.8	7.25	192	43.4		
4/9/2016	5-evening	A	1823	0.1	14.0	10.6	7.33	203			4.5
4/9/2016	5-evening	A	1824	1.0	14.0	10.5	7.31	202	44.0		
4/9/2016	5-evening	A	1825	2.0	13.5	10.6	7.31	206			
4/9/2016	5-evening	A	1826	3.0	13.2	10.5	7.29	205			
4/9/2016	5-evening	A	1826	4.0	13.2	10.4	7.29	206	43.5		
4/9/2016	5-evening	B	1845	0.1	13.8	10.6	7.37	205			3.2
4/9/2016	5-evening	B	1845	1.0	13.6	10.5	7.34	204	43.6		
4/9/2016	5-evening	B	1846	2.0	13.4	10.5	7.29	211			
4/9/2016	5-evening	B	1846	3.0	13.3	10.5	7.29	203	44.1		
4/10/2016	6-morning	Index	701	0.1	13.3	10.5	7.26	148		6.6	
4/10/2016	6-morning	Index	703	1.0	13.4	10.4	7.30	147	42.2		
4/10/2016	6-morning	Index	703	2.0	13.3	10.4	7.32	148			
4/10/2016	6-morning	Index	704	3.0	13.2	10.4	7.31	151			
4/10/2016	6-morning	Index	705	4.0	13.1	10.4	7.31	149			
4/10/2016	6-morning	Index	706	5.0	13.0	10.3	7.31	151			
4/10/2016	6-morning	Index	707	6.0	12.1	9.5	7.29	143			
4/10/2016	6-morning	Index	708	7.0	11.7	8.2	7.23	142	43.4		
4/10/2016	6-morning	A	715	0.1	13.0	10.6	7.37	151			4.5
4/10/2016	6-morning	A	716	1.0	12.9	10.6	7.36	151	41.1		
4/10/2016	6-morning	A	717	2.0	13.0	10.5	7.36	151			
4/10/2016	6-morning	A	717	3.0	12.9	10.5	7.36	151			

Table B-1. 2016 Green Lake Alum Treatment – Twice Daily Monitoring Data.

Date	Day-Event	Station	Time	Depth (meters)	Temp. °C	DO (mg/L)	pH	Cond. (µS/cm)	Total Alkalinity (mg/L)	Secchi Depth (meters)	Bottom Depth (meters)
4/10/2016	6-morning	A	718	4.0	13.0	10.5	7.36	150	41.5		
4/10/2016	6-morning	B	728	0.1	12.4	10.8	7.41	157			3.2
4/10/2016	6-morning	B	730	1.0	12.7	10.5	7.36	157	41.0		
4/10/2016	6-morning	B	730	2.0	12.7	10.5	7.36	156			
4/10/2016	6-morning	B	731	3.0	12.6	10.4	7.35	156	41.5		
4/10/2016	6-evening	Index	1910	0.1	13.3	10.6	7.45	155		5.5	
4/10/2016	6-evening	Index	1912	1.0	13.3	10.5	7.41	153			
4/10/2016	6-evening	Index	1913	2.0	13.3	10.5	7.41	153			
4/10/2016	6-evening	Index	1914	3.0	13.1	10.5	7.40	156			
4/10/2016	6-evening	Index	1915	4.0	13.1	10.5	7.37	164			
4/10/2016	6-evening	Index	1916	5.0	12.9	10.5	7.34	163			
4/10/2016	6-evening	Index	1917	6.0	12.6	10.0	7.34	151			
4/10/2016	6-evening	Index	1917	7.0	11.8	8.4	7.27	144			
4/10/2016	6-evening	A	1925	0.1	13.3	10.7	7.43	153			
4/10/2016	6-evening	A	1926	1.0	13.2	10.7	7.42	153			
4/10/2016	6-evening	A	1927	2.0	13.3	10.7	7.41	153			
4/10/2016	6-evening	A	1928	3.0	13.2	10.6	7.39	155			
4/10/2016	6-evening	A	1928	4.0	13.1	10.6	7.31	160			
4/10/2016	6-evening	B	1935	0.1	12.8	10.6	7.29	162			
4/10/2016	6-evening	B	1936	1.0	13.1	10.5	7.23	164			
4/10/2016	6-evening	B	1937	2.0	13.0	10.5	7.21	162			
4/10/2016	6-evening	B	1938	3.0	13.0	10.4	7.19	164			
4/10/2016	6-evening	B	1938	0.1	13.0	10.4	7.18	163			

Table B-2. 2016 Green Lake Alum Treatment – Random Daily Treatment Monitoring Data.

Date	Time	Day - Event	Depth (meters)	pH	Cond. (uS/cm)	Comments
4/5/2016	1040	1-1	1.0	7.41	185	Near Duck Island
4/5/2016	1045	1-1	2.2	7.38	185	
4/5/2016	1150	1-2	1.0	7.48	158	Near Duck Island
4/5/2016	1155	1-2	2.4	7.38	157	
4/5/2016	1320	1-3	1.0	7.48	155	South end
4/5/2016	1325	1-3	4.0	7.38	153	
4/5/2016	1435	1-4	1.0	7.55	170	
4/5/2016	1440	1-4	2.9	7.53	174	
4/5/2016	1545	1-5	1.0	7.46	154	
4/5/2016	1550	1-5	2.5	7.36	158	
4/5/2016	1720	1-6	1.0	7.56	160	~200m south of Station A
4/5/2016	1725	1-6	3.2	7.49	161	
4/6/2016	1207	2-1	1.0	7.17	187	Near Duck Island
4/6/2016	1212	2-1	2.0	7.32	186	
4/6/2016	1230	2-2	1.0	7.50	167	Central portion of lake
4/6/2016	1235	2-2	3.0	7.57	174	
4/6/2016	1510	2-3	1.0	7.50	173	Central, near 2-2 location
4/6/2016	1515	2-3	2.6	7.47	173	
4/6/2016	1650	2-4	1.0	7.49	176	~100m NE of Station B
4/6/2016	1655	2-4	2.5	7.37	177	
4/6/2016	1800	2-5	1.0	7.34	177	~30m SW of Station B
4/6/2016	1805	2-5	2.2	7.18	187	
4/7/2016	845	3-1	1.0	7.25	175	Next to SW shoreline
4/7/2016	850	3-1	1.2	7.29	176	Shallow
4/7/2016	1100	3-2	1.0	7.37	173	~80m east of Station A
4/7/2016	1105	3-2	3.6	7.37	169	
4/7/2016	1210	3-3	1.0	7.77	194	Near Station A, HAB passed by temp station multiple times recently
4/7/2016	1215	3-3	3.6	7.21	190	Near Station A, HAB passed by temp station multiple times recently
4/7/2016	1650	3-4	1.0	7.45	185	West-central
4/7/2016	1655	3-4	2.2	7.41	189	
4/7/2016	1805	3-5	1.0	7.53	180	West-central
4/7/2016	1810	3-5	2.4	7.46	186	
4/8/2016	1115	4-1	1.0	7.56	202	
4/8/2016	1120	4-1	3.2	8.02	200	
4/8/2016	1310	4-2	1.0	7.60	-	
4/8/2016	1315	4-2	3.3	7.59	-	
4/8/2016	1440	4-3	1.0	7.55	184	
4/8/2016	1445	4-3	3.2	7.48	189	
4/8/2016	1720	4-4	1.0	7.56	196	~100m east of staging area
4/8/2016	1725	4-4	3.0	7.48	196	
4/9/2016	1040	5-1	1.0	7.32	196	Near south shore
4/9/2016	1045	5-1	4.1	7.19	198	
4/9/2016	1235	5-2	1.0	7.52	202	~100m west of Station B
4/9/2016	1240	5-2	2.7	7.54	220	
4/9/2016	1420	5-3	1.0	7.51	213	Near aqua theater

Table B-2. 2016 Green Lake Alum Treatment – Random Daily Treatment Monitoring Data.

Date	Time	Day - Event	Depth (meters)	pH	Cond. (uS/cm)	Comments
4/9/2016	1425	5-3	2.2	7.15	233	Worked stopped due to stressed/ dead trout observed in afternoon
4/10/2016	1110	6-1	1.0	7.41	154	NE-central location
4/10/2016	1115	6-1	3.3	7.39	156	
4/10/2016	1250	6-2	1.0	7.33	161	~200m west of Station B
4/10/2016	1255	6-2	2.4	7.33	159	
4/10/2016	1520	6-3	1.0	7.38	158	~150m S/SE of Duck Island
4/10/2016	1525	6-3	3.0	7.32	156	
4/10/2016	1720	6-4	1.0	7.36	159	S/SW portion of lake
4/10/2016	1725	6-4	2.8	7.20	161	

Table B-3. 2016 Green Lake Alum Treatment – Short-Term Impact Monitoring Data.

Event	Station	Date	Time	Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Secchi Depth (meters)	Bottom Depth (meters)	Sample Depth (meters)	Total Phosphorus (µg/L)	Soluble Reactive Phosphorus (µg/L)	Total Alkalinity (mg/L)	Sulfate (mg/L)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)	Total Aluminum (mg/L)	Dissolved Aluminum (mg/L)	Ammonia (mg/L)	NO3+NO2 (mg/L)	Total Nitrogen (mg/L)	Fecal Coliform (CFU/100 mL)
PreTreat	Index	4/4/16	1348	0.1	12.5	10.7	7.75	149	2.7	7.3													
PreTreat	Index	4/4/16	1349	1.0	12.5	10.7	7.71	148			1.0	20	<1.0	45.2	4.68	4.3	0.3	0.086	<0.003	0.012	<0.010	0.285	2 J
PreTreat	Index	4/4/16	1350	2.0	12.5	10.6	7.70	148															
PreTreat	Index	4/4/16	1351	3.0	12.4	10.6	7.69	148															
PreTreat	Index	4/4/16	1352	4.0	12.2	10.5	7.66	149															
PreTreat	Index	4/4/16	1353	5.0	12.0	10.5	7.63	148															
PreTreat	Index	4/4/16	1354	6.0	12.0	10.4	7.61	148			6.3	24	<1.0	45.2	5.05	3.6	1.4	0.161	<0.003	0.014	<0.010	0.349	
PreTreat	Index	4/4/16	1355	7.0	10.4	8.1	7.41	154															
PreTreat	A	4/4/16	1320	0.1	12.8	10.6	7.71	148	2.3	4.6													
PreTreat	A	4/4/16	1321	1.0	12.8	10.6	7.69	148			1.0	19	<1.0	44.6	4.37	3.9	0.8	0.105	<0.003	0.014	<0.010	0.262	<1
PreTreat	A	4/4/16	1322	2.0	12.7	10.6	7.69	148															
PreTreat	A	4/4/16	1323	3.0	12.3	10.5	7.67	148			3.2	20	<1.0	44.8	4.49	3.2	0.8	0.11	<0.003	0.014	<0.010	0.273	
PreTreat	A	4/4/16	1324	4.0	12.0	10.5	7.63	148															
PreTreat	B	4/4/16	1246	0.1	12.5	10.3	7.54	148	3.3	3.3													
PreTreat	B	4/4/16	1245	1.0	12.4	10.2	7.49	148			1.0	14	<1.0	45.8	4.70	3.2	0.4	0.062	<0.003	<0.010	<0.010	0.353	1 J
PreTreat	B	4/4/16	1244	2.0	11.7	9.7	7.41	148			2.2	26	<1.0	45.8	4.85	5.2	1.3	0.075	<0.003	<0.010	<0.010	0.343	
PreTreat	B	4/4/16	1242	3.0	11.6	9.6	7.39	148															
2-DayPost	Index	4/12/16	1426	0.1	12.6	10.4	7.41	157	5.8	7.2													
2-DayPost	Index	4/12/16	1427	1.0	12.7	10.4	7.40	159			1.0	13	<1.0	43.8	25.6	1.2	<0.1	0.262	0.110	0.021	<0.010	0.180	NA
2-DayPost	Index	4/12/16	1428	2.0	12.5	10.5	7.40	158															
2-DayPost	Index	4/12/16	1429	3.0	12.5	10.5	7.40	158															
2-DayPost	Index	4/12/16	1430	4.0	12.5	10.5	7.40	158															
2-DayPost	Index	4/12/16	1431	5.0	12.6	10.4	7.39	158															
2-DayPost	Index	4/12/16	1432	6.0	12.5	10.4	7.39	161			6.2	8	<1.0	41.8	17.2	1.6	0.5	0.227	0.107	0.015	<0.010	0.209	
2-DayPost	Index	4/12/16	1433	7.0	12.5	10.4	7.39	160															
2-DayPost	A	4/12/16	1450	0.1	12.5	10.7	7.40	163	-	4.2													
2-DayPost	A	4/12/16	1451	1.0	12.6	10.5	7.39	163			1.0	8	<1.0	42.8	25.1	1.1	<0.1	0.256	0.101	0.018	<0.010	0.223	NA
2-DayPost	A	4/12/16	1452	2.0	12.6	10.5	7.38	163															
2-DayPost	A	4/12/16	1453	3.0	12.6	10.5	7.37	160			3.2	8	<1.0	42	26.9	1.1	<0.1	0.285	0.099	0.023	<0.010	0.225	
2-DayPost	A	4/12/16	1455	4.0	12.6	10.4	7.36	164															
2-DayPost	B	4/12/16	1510	0.1	12.6	10.5	7.36	161	-	3.1													
2-DayPost	B	4/12/16	1512	1.0	12.6	10.5	7.35	163			1.0	18	<1.0	42	27.4	0.9	0.2	0.213	0.100	0.023	<0.010	0.187	NA
2-DayPost	B	4/12/16	1513	2.0	12.7	10.4	7.35	163			2.1	8	<1.0	42.4	26.1	1.1	<0.1	0.238	0.100	0.015	<0.010	0.175	
2-DayPost	B	4/12/16	1514	3.0	12.7	10.4	7.35	162															
2-WkPost	Index	4/25/16	1325	0.1	12.5	11.0	7.83	293	4.6	7.2													
2-WkPost	Index	4/25/16	1326	1.0	12.4	11.0	7.83	294			1.0	10	<1.0	43.8	25.3	2.5	0.5	0.166	0.117	<0.010	<0.010	0.433	4 J
2-WkPost	Index	4/25/16	1327	2.0	12.4	11.0	7.83	294															
2-WkPost	Index	4/25/16	1328	3.0	12.3	11.0	7.84	294															
2-WkPost	Index	4/25/16	1329	4.0	12.3	11.0	7.85	292															
2-WkPost	Index	4/25/16	1330	5.0	12.1	11.0	7.83	294															
2-WkPost	Index	4/25/16	1331	6.0	12.1	11.0	7.82	293			6.2	15	<1.0	41.8	25.3	3.2	0.7	0.191	0.110	<0.010	<0.010	0.316	
2-WkPost	Index	4/25/16	1332	7.0	12.1	10.9	7.80	294															
2-WkPost	A	4/25/16	1347	0.1	12.5	11.1	7.89	295	-	4.2													
2-WkPost	A	4/25/16	1348	1.0	12.5	11.1	7.89	294			1.0	10	<1.0	42.8	23.9	2.5	0.4	0.155	0.122	<0.010	<0.010	0.270	8 J
2-WkPost	A	4/25/16	1349	2.0	12.3	11.1	7.92	296															
2-WkPost	A	4/25/16	1350	3.0	12.2	11.2	7.94	296			3.2	13	<1.0	42	21.6	2.8	0.6	0.172	0.118	<0.010	<0.010	0.235	
2-WkPost	A	4/25/16	1351	4.0	12.2	11.2	7.95	296															
2-WkPost	B	4/25/16	1412	0.1	12.4	11.0	7.88	295	-	3.1													
2-WkPost	B	4/25/16	1413	1.0	12.4	11.0	7.87	295			1.0	10	<1.0	42	27.0	2.5	0.1	0.165	0.117	<0.010	<0.010	0.198	10 J
2-WkPost	B	4/25/16	1414	2.0	12.4	11.0	7.88	295			2.1	11	<1.0	42.4	23.4	2.5	0.5	0.167	0.112	<0.010	<0.010	0.227	
2-WkPost	B	4/25/16	1415	3.0	12.4	11.0	7.88	295															

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	**HER080-23**	**PAGE 1**	
REPORT DATE:	**05/16/16**		
DATE SAMPLED:	**04/04/16**	**DATE RECEIVED:**	**04/04/16**

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL

CASE NARRATIVE

Six water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages. Results for fecal coliform will follow as a separate report.

SAMPLE DATA

SAMPLE ID	TOTAL-P (mg/L)	SRP (mg/L)	ALKALINITY (mg/CaCO3/L)	SULFATE (mg/L)	CHLOR_a (ug/L)	PHAEO_a (ug/L)
A-S	0.019	<0.001	44.6	4.37	3.9	0.8
A-B	0.020	<0.001	44.8	4.49	3.2	0.8
B-S	0.014	<0.001	45.8	4.70	3.2	0.4
B-B	0.026	<0.001	45.8	4.85	5.2	1.3
I-S	0.020	<0.001	45.2	4.68	4.3	0.3
I-B	0.024	<0.001	46.2	5.05	3.6	1.4

SAMPLE ID	TOTAL Al (mg/L)	DISS. Al (mg/L)	AMMONIA (mg/L)	N03+N02 (mg/L)	TOTAL-N (mg/L)
A-S	0.105	<0.003	0.014	<0.010	0.262
A-B	0.110	<0.003	0.014	<0.010	0.273
B-S	0.062	<0.003	<0.010	<0.010	0.353
B-B	0.075	<0.003	<0.010	<0.010	0.343
I-S	0.086	<0.003	0.012	<0.010	0.285
I-B	0.161	<0.003	0.014	<0.010	0.349

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: **HER080-23** **PAGE 2**

REPORT DATE: **05/16/16**

DATE SAMPLED: **04/04/16** **DATE RECEIVED:** **04/04/16**

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL

QA/QC DATA WATER

QC PARAMETER	TOTAL-P (mg/L)	SRP (mg/L)	ALKALINITY (mgCaCO3/l)	SULFATE (mg/L)	CHLOR_a (ug/L)	PHAEO_a (ug/L)
METHOD	EPA 365.1	EPA 365.1	SM18 2320B	SM18 4500SO4E	SM1810200H	SM1810200H
DATE ANALYZED	04/12/16	04/06/16	04/11/16	04/21/16	05/03/16	05/03/16
DETECTION LIMIT	0.002	0.001	1.00	1.00	0.1	0.1
DUPLICATE						
SAMPLE ID	I-B	I-B	I-B	BATCH	BATCH	BATCH
ORIGINAL	0.024	<0.001	46.2	26.1	9.5	0.9
DUPLICATE	0.021	<0.001	46.6	26.0	10	1.0
RPD	13.33%	NC	0.86%	0.38%	5.13%	10.53%
SPIKE SAMPLE						
SAMPLE ID	I-B	I-B		BATCH		
ORIGINAL	0.024	<0.001		26.1		
SPIKED SAMPLE	0.073	0.019		36.0		
SPIKE ADDED	0.050	0.020		10.0		
% RECOVERY	98.00%	95.00%	NA	99.00%	NA	NA
QC CHECK						
FOUND	0.092	0.042	99.5	9.98		
TRUE	0.094	0.039	100	10.0		
% RECOVERY	97.87%	107.69%	99.50%	99.80%	NA	NA
BLANK	<0.002	<0.001	NA	<1.00	NA	NA

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: **HER080-23**

REPORT DATE: **05/16/16**

DATE SAMPLED: **04/04/16** **DATE RECEIVED:** **04/04/16**

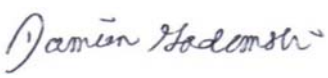
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL

QA/QC DATA WATER

QC PARAMETER	TOTAL Al (mg/L)	DISS. Al (mg/L)	AMMONIA (mg/L)	N03+N02 (mg/L)	TOTAL-N (mg/L)
METHOD	EPA 200.8	EPA 200.8	SM184500NH3H	SM184500N03F	SM204500NC
DATE ANALYZED	04/08/16	04/05/16	04/14/16	04/14/16	04/18/16
DETECTION LIMIT	0.003	0.003	0.010	0.010	0.050
DUPLICATE					
SAMPLE ID	BATCH	BATCH	I-B	I-B	I-B
ORIGINAL	0.078	<0.003	0.014	<0.010	0.349
DUPLICATE	0.078	<0.003	0.015	<0.010	0.338
RPD	0.00%	NC	6.90%	NC	3.20%
SPIKE SAMPLE					
SAMPLE ID	BATCH	BATCH	I-B	I-B	I-B
ORIGINAL	0.078	<0.003	0.014	<0.010	0.349
SPIKED SAMPLE	0.556	0.534	0.213	0.209	1.37
SPIKE ADDED	0.500	0.500	0.200	0.200	1.00
% RECOVERY	95.60%	106.80%	99.50%	104.50%	102.10%
QC CHECK					
FOUND	0.503	0.500	0.327	0.401	0.508
TRUE	0.500	0.500	0.324	0.408	0.490
% RECOVERY	100.60%	100.00%	100.93%	98.28%	103.67%
BLANK	<0.003	<0.003	<0.010	<0.010	<0.050

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:



Damien Gadomski
Project Manager

Lab/Cor, Inc.
7619 6th Ave NW
Seattle, WA 98117

Analysis Report Cover

Final Report

A Professional Service Corporation in the Northwest

Phone: (206) 781-0155
http://www.labcor.net

Job Number: 160330 **SEA**

Report Number: 160330R01

Report Date: 4/6/2016

Client: IEH Analytical Laboratories

Address: 3927 Aurora Ave N
Seattle, WA 98103

Project Name: Unavailable at Login

Project No.:

PO Number:

PWS ID:

Reference No.:

Enclosed please find results for samples submitted to our laboratory. A list of samples and analyses follows:

Lab/Cor Sample #	Client Sample # and Description	Analysis	Analysis Notes	Date Received:
160330 - S1	01 - A-5, WA Water ID#: 11918703	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/5/2016
160330 - S2	02 - B-5, WA Water ID#: 11918704	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/5/2016
160330 - S3	03 - I-5, WA Water ID#: 11918705	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/5/2016
160330 - S4	NEGCTRL - Negative Control, WA Water ID#: 11918706	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/5/2016
160330 - S5	POSCTRL - Positive Control, WA Water ID#: 11918707	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/5/2016
160330 - S6	Blank - Run #1 Blank, WA Water ID#: 11918708	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/5/2016
160330 - S7	Blank - Final Run Blank, WA Water ID#: 11918709	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/5/2016

Lab/Cor, Inc.
7619 6th Ave NW
Seattle, WA 98117

Final Report

Phone: (206) 781-0155
http://www.labcor.net

A Professional Service Corporation in the Northwest

Job Number: 160330 **SEA**
Client: IEH Analytical Laboratories
Project Name: Unavailable at Login

Report Number: 160330R01
Report Date: 4/6/2016

SM 9222D G1c1- Fecal Coliform/ E.coli - CFU

The presence of Fecal Coliform and E. coli from waters and/or environmental sources are tested using the following standard methods:

SM9222 D&G1c1:
Qualitative and Quantitative analysis of Fecal Coliforms and E. coli using a Membrane Filtration procedure begins with selecting a volume of sample that will yield optimal colony counts. Several aliquots are filtered onto sterile, gridded, 0.1um MCE filters. The filters are then placed onto a culture dish containing fecal coliform selective medium. The samples are then incubated in a water bath at 44.5 ± 0.2 ℃ for 24 ± 2 hours.

Upon completion of incubation, positive fecal coliform colonies will produce various shades of blue while negative non-fecal coliform colonies will produce a gray to cream colored colony. Fecal Coliform densities are then calculated and reported as CFU/ 100ml.

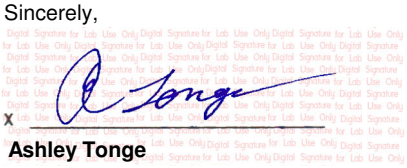
After completion of the fecal coliform enumeration, the gridded filter is removed from the fecal coliform selective medium and transferred to a nutrient agar substrate containing 4-methylumbelliferyl-b-d-glucuronide (MUG). The samples are then incubated at 35 ± 0.5 ℃ for 4 hours. The sample is placed beneath a 365nm ultraviolet lamp to determine the presence of Escherichia coli. A colony producing a blue fluorescence around the periphery is diagnostic for the presence of E. coli.

Disclaimer

The results reported relate only to the samples tested or analyzed; the laboratory is not responsible for data collected by personnel who are not affiliated with the laboratory. Results reported in both structures/cm3 and structures/mm2 are dependent on the sample volume and area. These parameters are measured and recorded by non-laboratory personnel and are not covered by the laboratory's accreditation. Interpretation of these results is the sole responsibility of the client.

If further clarification of these results is needed, please call us. Thank you for allowing the staff at Lab/Cor, Inc. the opportunity to provide you with the analytical services.

Sincerely,



Ashley Tonge
Technician/Analyst

Lab/Cor, Inc.
7619 6th Ave NW
Seattle, WA 98117

Final Report

Phone: (206) 781-0155
http://www.labcor.net

A Professional Service Corporation in the Northwest

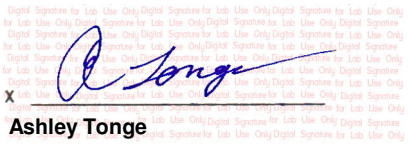
SM 9222D G1c1- Fecal Coliform/ E.coli - CFU

Job Number: 160330 **SEA**
Client: IEH Analytical Laboratories
Project Name: Unavailable at Login

Report Number: 160330R01
Date Received: 4/5/2016

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S1	01 - A-5, WA Water ID#: 11918703	**FECAL COLIFORM**	<1	CFU/ 100ml	0 - 3.7	4/4/2016		AT 4/6/2016
S2	02 - B-5, WA Water ID#: 11918704	**FECAL COLIFORM**	1	CFU/ 100ml	0.1 - 5.6	4/4/2016		AT 4/6/2016
S3	03 - I-5, WA Water ID#: 11918705	**FECAL COLIFORM**	2	CFU/ 100ml	0.2 - 7.2	4/4/2016		AT 4/6/2016
S4	NEGCTRL - Negative Control, WA Water ID#: 11918706	**FECAL COLIFORM**	<1	CFU/ 100ml	0 - 3.7	4/5/2016		AT 4/6/2016
S5	POSCTRL - Positive Control, WA Water ID#: 11918707	**FECAL COLIFORM**	32	CFU/ 100ml	26.3 - 37.7	4/5/2016		AT 4/6/2016
S6	Blank - Run #1 Blank, WA Water ID#: 11918708	**FECAL COLIFORM**	<1	CFU/ 100ml	0 - 3.7	4/5/2016		AT 4/6/2016
S7	Blank - Final Run Blank, WA Water ID#: 11918709	**FECAL COLIFORM**	<1	CFU/ 100ml	0 - 3.7	4/5/2016		AT 4/6/2016

Reviewed by:



Ashley Tonge
Technician/Analyst

HER080-23

IEH Analytical Laboratories

3927 Aurora Ave N • Seattle • WA • 98103
P: 206-632-2715 F: 206-632-2417

Chain of Custody Form

REPORT TO:
Client: HERRERA ENV. CONS.
Address: 2200 6TH AVE, SUITE 1100
SEATTLE, WA 98199
Contact: ROB ZISETTE
Email: RZISETTE@HERRERAINC.COM
Phone: 206 441 9080 Fax:

INVOICE TO: (IF DIFFERENT FROM REPORT)
Client:
Address:
Contact:
Email:
Phone: Fax:

PROJECT INFORMATION
Quote No.:
Client PO:
Client Project:

Reporting/Invoicing Format
☐ Fax ☒ Email ☐ Mail

Turn Around Time (TAT)*
☐ Next Day ☐ 2 Business Day
☐ 3 Business Day ☒ Standard
Specific Date:
*Advanced notice required for Rush Analysis

Sample Disposal
☐ Hold ☒ Dispose ☐ Return

LAB USE ONLY
Containers Received
Case File Number
Temp
Lab ID

SAMPLING		SAMPLE DESCRIPTION	Number of Containers	Analysis Requested														
Date (mm-dd-yy)	Matrix	(This Will Appear On The Report)		TOTAL ALKALINITY EPA 200.7	DISS. ALUMINUM EPA 200.8	TOTAL P EPA 365.1	ORP SM 2580B	NO3+NO2 EPA 353.2	NH4 EPA 350.1	TOTAL N SM 4500 NC	CHLOROPHYLL SM 10200 H	TOTAL ALKALINITY EPA 310.1	SULFATE EPA 375.4	FECAL COLIFORM SM 9222D				
04-04-16	WATER	A-S	4	X									X	X				
		A-B	3	X									X					
		B-S	4	X									X	X				
		B-B	3	X									X					
		I-S	4	X									X	X				
		I-B	3	X									X					

ME
3:30
3:40
13:00
13:10
14:05
14:10

Sample Retension Policy: Environmental - 90 days; Food & Perishables - 14 days

Comments: Fecals should be < 10 cfu/100mL, filter 100 and 10mL

Sampled By: ALEX SVENDSEN	Date: 4/4/16	Time: 1100
Received By: SINA SONN	Date: 4/4/16	Time: 1500
Relinquished to IAL By (Signature):	Date: 4/4/16	Time: 1500

Shipped By:
Shipping Reference:
Received at IAL By:
Date: 4/4/16
Time: 1500

Total (21)

Data Quality Assurance Worksheet

G

By G. Catarra

Project Name/No./Client: Green Lake Alum Treatment 2016 / 13-05709-001 / Seattle Parks and Recreation

Date 3/7/2017 Page 1 of 2

Laboratory/Parameters: Aquatic Research: Total phosphorus, SRP, alkalinity, sulfate, chloro_a, phaeo_a, total and dissolved Al, ammonia, nitrate+nitrite, total nitrogen.
LabCor: fecal coliform bacteria

Checked: initials RZ

Sample Date/Sample ID: 4/04/2016 / A-S, A-B, B-S, B-B, I-S, I-B

date 3/23/17

Parameter	Completeness/ Methodology	Pre-preservation Holding Times (hours)		Total Holding Times (days)		Method Blanks Reporting Limit	Matrix Spikes/ Surrogate Recovery (%)		Lab Control Samples Recovery (%)		Lab Duplicates RPD (%)		Field Duplicates RPD (%)		Instrument Calibration/ Performance	ACTION
		Reported	Goal	Reported	Goal		Reported	Goal	Reported	Goal	Reported	Goal[1]	Reported	Goal[1]		
Total Phosphorus	OK / EPA 365.1	NA	**NA**	8	**≤28**	≤0.002 mg/L 0.002 mg/L	I-B 98	**±25**	98	**±20**	I-B 13	**≤ 20**	NS	**NA**	OK	NONE
SRP	OK / EPA 365.1	<48	**≤48**	2	**≤2**	≤0.001 mg/L 0.001 mg/L	I-B 95	**±25**	108	**±20**	I-B NC	**≤ 20**	NS	**NA**	OK	NONE
Alkalinity	OK / EPA 310.1	NA	**NA**	7	**≤14**	≤1.0 mg/L 1.0 mg/L	NA	**NA**	100	**±20**	I-B 0.9	**≤ 20**	NS	**NA**	OK	NONE
Sulfate	OK / EPA 375.4	NA	**NA**	17	**≤28**	≤1.0 mg/L 1.0 mg/L	BATCH 99	**±25**	100	**±20**	Batch 0.4	**≤ 20**	NS	**NA**	OK	NONE
Chloro_a	OK / SM 10200H	NA	**NA**	29	**≤28**	≤0.1 µg/L 0.1 µg/L	NA	**NA**	NA	**NA**	Batch 5.1	**≤ 20**	NS	**NA**	OK	MINOR HT EXCEEDANCE (1 DAY), NO FLAG.
Phaeo_a	OK / SM 10200H	NA	**NA**	29	**≤28**	≤0.1 mg/L 0.1 mg/L	NA	**NA**	NA	**±20**	Batch 11	**≤ 20**	NS	**NA**	OK	MINOR HT EXCEEDANCE (1 DAY), NO FLAG.

[1] If the sample or duplicate value is less than five times the reporting limit, the difference is calculated rather than the relative percent difference (RPD). The QA goal is a difference <2 times the detection limit instead of the number indicated in the goal column.
NA – not applicable or not available; NC – not calculable due to one or more values below the detection limit; NS – field duplicate not sampled.

Data Quality Assurance Worksheet

By G. Catarra

Project Name/No./Client: Green Lake Alum Treatment 2016 / 13-05709-001 / Seattle Parks and Recreation

Date 3/7/2017 Page 2 of 2

Laboratory/Parameters: Aquatic Research: Total phosphorus, SRP, alkalinity, sulfate, chloro_a, phaeo_a, total and dissolved aluminum, ammonia, nitrate+nitrite, total nitrogen.
LabCor: fecal coliform bacteria

Checked: initials RZ

Sample Date/Sample ID: 4/04/2016 / A-S, A-B, B-S, B-B, I-S, I-B

date 3/23/17

Parameter	Completeness/ Methodology	Pre-preservation Holding Times (hours)		Total Holding Times (days)		Method Blanks Reporting Limit	Matrix Spikes/ Surrogate Recovery (%)		Lab Control Samples Recovery (%)		Lab Duplicates RPD (%)		Field Duplicates RPD (%)		Instrument Calibration/ Performance	ACTION
		Reported	Goal	Reported	Goal		Reported	Goal	Reported	Goal	Reported	Goal[1]	Reported	Goal[1]		
Total Al	OK/ EPA 200.8	NA	**NA**	4	**≤180**	≤0.003 mg/L 0.003 mg/L	BATCH 96	**±25**	101	**±10**	Batch 0	**≤ 20**	NS	**NA**	OK	NONE
Diss Al	OK/ EPA 200.8	24	**≤48**	1	**≤180**	≤0.003 mg/L 0.003 mg/L	BATCH 107	**±20**	100	**±15**	Batch NC	**≤ 20**	NS	**NA**	OK	NONE
Ammonia	OK/ EPA 350.1	NA	**NA**	10	**≤28**	≤0.010 mg/L 0.010 mg/L	I-B 100	**±25**	101	**±20**	I-B 6.9	**≤ 20**	NS	**NA**	OK	NONE
Nitrate + Nitrite	OK/ EPA 200.8	NA	**NA**	10	**≤28**	≤0.010 mg/L 0.010 mg/L	I-B 104	**±25**	98	**±20**	I-B NC	**≤ 20**	NS	**NA**	OK	NONE
Total nitrogen	OK / SM 4500NC	NA	**NA**	14	**≤28**	≤0.050 mg/L 0.050 mg/L	I-B 102	**±25**	104	**±20**	I-B 3.2	**≤ 20**	NS	**NA**	OK	NONE
Fecal Coliform	OK / SM 9222D	NA	**NA**	<1.5	**≤1.5**	≤1 cfu/100 1 cfu/100	NA	**NA**	NA	**NA**	NA	**≤ 35**	NS	**NA**	OK	FLAG B-S AND I-S "J" DUE TO LOW COUNTS.

[1] If the sample or duplicate value is less than five times the reporting limit, the difference is calculated rather than the relative percent difference (RPD). The QA goal is a difference <2 times the detection limit instead of the number indicated in the goal column.
NA – not applicable or not available; NC – not calculable due to one or more values below the detection limit; NS – field duplicate not sampled.

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	**HER080-25**	**PAGE 1**	
REPORT DATE:	**05/16/16**		
DATE SAMPLED:	**04/12/16**	**DATE RECEIVED:**	**04/12/16**

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL

CASE NARRATIVE

Six water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

SAMPLE DATA

SAMPLE ID	TOTAL-P (mg/L)	SRP (mg/L)	ALKALINITY (mg/CaCO3/L)	SULFATE (mg/L)	CHLOR_a (ug/L)	PHAEO_a (ug/L)
INDEX-S	0.013	<0.001	43.8	25.6	1.2	<0.1
INDEX-B	0.008	<0.001	41.8	17.2	1.6	0.5
A-S	0.008	<0.001	42.8	25.1	1.1	<0.1
A-B	0.008	<0.001	42.0	26.9	1.1	<0.1
B-S	0.018	<0.001	42.0	27.4	0.9	0.2
B-B	0.008	<0.001	42.4	26.1	1.1	<0.1

SAMPLE ID	TOTAL Al (mg/L)	DISS. Al (mg/L)	AMMONIA (mg/L)	N03+N02 (mg/L)	TOTAL-N (mg/L)
INDEX-S	0.262	0.110	0.021	<0.010	0.180
INDEX-B	0.227	0.107	0.015	<0.010	0.209
A-S	0.256	0.101	0.018	<0.010	0.223
A-B	0.285	0.099	0.023	<0.010	0.225
B-S	0.213	0.100	0.023	<0.010	0.187
B-B	0.238	0.100	0.015	<0.010	0.175

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: **HER080-25** **PAGE 2**

REPORT DATE: **05/16/16**

DATE SAMPLED: **04/12/16** **DATE RECEIVED:** **04/12/16**

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL

QA/QC DATA WATER

QC PARAMETER	TOTAL-P (mg/L)	SRP (mg/L)	ALKALINITY (mgCaCO3/l)	SULFATE (mg/L)	CHLOR_a (ug/L)	PHAEO_a (ug/L)
METHOD	EPA 365.1	EPA 365.1	SM18 2320B	SM18 4500SO4E	SM1810200H	SM1810200H
DATE ANALYZED	04/18/16	04/14/16	04/26/16	04/21/16	05/07/16	05/07/16
DETECTION LIMIT	0.002	0.001	1.00	1.00	0.1	0.1
DUPLICATE						
SAMPLE ID	BATCH	B-B	BATCH	B-B	BATCH	BATCH
ORIGINAL	0.007	<0.001	13.1	26.1	13	3.6
DUPLICATE	0.007	<0.001	13.2	26.0	12	3.6
RPD	0.00%	NC	0.76%	0.38%	8.70%	1.48%
SPIKE SAMPLE						
SAMPLE ID	BATCH	B-B		B-B		
ORIGINAL	0.007	<0.001		26.1		
SPIKED SAMPLE	0.054	0.022		36.0		
SPIKE ADDED	0.050	0.020		10.0		
% RECOVERY	94.00%	110.00%	NA	99.00%	NA	NA
QC CHECK						
FOUND	0.092	0.041	99.8	9.98		
TRUE	0.094	0.039	100	10.0		
% RECOVERY	97.87%	105.13%	99.80%	99.80%	NA	NA
BLANK	<0.002	<0.001	NA	<1.00	NA	NA

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: **HER080-25** **PAGE 3**

REPORT DATE: **05/16/16**

DATE SAMPLED: **04/12/16** **DATE RECEIVED:** **04/12/16**

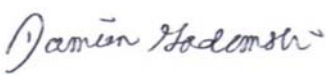
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL

QA/QC DATA WATER

QC PARAMETER	TOTAL Al (mg/L)	DISS. Al (mg/L)	AMMONIA (mg/L)	N03+N02 (mg/L)	TOTAL-N (mg/L)
METHOD	EPA 200.7	EPA 200.8	SM184500NH3H	SM184500N03F	SM204500NC
DATE ANALYZED	04/18/16	04/18/16	04/14/16	04/14/16	04/27/16
DETECTION LIMIT	0.030	0.003	0.010	0.010	0.050
DUPLICATE					
SAMPLE ID	BATCH	B-B	B-B	B-B	BATCH
ORIGINAL	0.097	0.100	0.015	<0.010	0.345
DUPLICATE	0.099	0.100	0.015	<0.010	0.338
RPD	1.83%	0.00%	0.00%	NC	2.05%
SPIKE SAMPLE					
SAMPLE ID	BATCH	B-B	B-B	B-B	BATCH
ORIGINAL	0.097	0.100	0.015	<0.010	0.345
SPIKED SAMPLE	5.18	0.608	0.223	0.212	1.39
SPIKE ADDED	5.00	0.500	0.200	0.200	1.00
% RECOVERY	101.64%	101.60%	104.00%	106.00%	104.50%
QC CHECK					
FOUND	0.482	0.507	0.312	0.402	0.485
TRUE	0.500	0.500	0.324	0.408	0.490
% RECOVERY	96.40%	101.40%	96.30%	98.53%	98.98%
BLANK	<0.030	<0.003	<0.010	<0.010	<0.050

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:



Damien Gadomski
Project Manager

HERRERA
2200 Sixth Avenue | Suite 1100
Seattle, Washington | 98121
p 206 441 9080 | f 206 441 9108

Chain of Custody Record

HER080-25

Project Name:	Project Number:	Client:
Green Lake Alum Treatment	13-05709-001	Herrera Environmental Consultants
Report To:		Copy To:
Rob Zisette		
Sampled By:		Delivery Method:
Alex Svendsen		
Laboratory:	Requested Completion Date:	Total No. of Containers:
Lab Use:		

Sample ID	Date	Time	Sample Type (see codes)	Preservative? (Y/N)	Matrix (see codes)	Number of Containers	Total Alkalinity (EPA 310.1)	Total Aluminum (EPA 200.7)	Dissolved Aluminum (EPA 200.8)	Sulfate (EPA 375.4)	Solubie Reactive Phosphorus (EPA 365.1)	Total Phosphorus (EPA 365.1)	Nitrate + Nitrite Nitrogen (EPA 353.2)	Ammonia Nitrogen (EPA 350.1)	Total Nitrogen (SM 4500 NC)	Chlorophyll a (SM 102000 H)	Fecal Coliform Bacteria (SM 9222 D)	Lab ID No.
INDEX-S	4/12/16	1440	G	N	SW	4	X	X	X	X	X	X	X	X	X	X	8	
INDEX-B		1445				3												
A-S		1458				4											X	
A-B		1503				3												
B-S		1515				4											X	
B-B		1520				3												

9.100

Comments/Special Instructions: Fecals will be < 10 CFU/100 mL

Relinquished by (Name/CO/	Signature	Date/Time	Received By (Name/CO)	Signature	Date/Time
Alex Svendsen (HEC)		4/12/16 1635	Mitch Kirilka		4/12/16 16:35 (10)
Relinquished by (Name/CO/	Signature	Date/Time	Received By (Name/CO)	Signature	Date/Time

total

Sample Type: G=Grab C=Composite

Matrix Codes: A=Air GW=Groundwater SE=Sediment SO=Soil SW=Surface Water W=Water (blanks) M=Material O=Other (specify)

Data Quality Assurance Worksheet

G

By G. Catarra

Project Name/No./Client: Green Lake Alum Treatment 2016 / 13-05709-001 / Seattle Parks and Recreation

Date 3/7/2017 Page 1 of 2

Laboratory/Parameters: Aquatic Research: Total phosphorus, SRP, alkalinity, sulfate, chloro_a, phaeo_a, total & dissolved Al, ammonia, nitrate+nitrite, total nitrogen.

Checked: initials RZ

Sample Date/Sample ID: 4/12/2016 / Index-S, Index-B, A-S, A-B, B-S, B-B

date 3/23/17

Parameter	Completeness/ Methodology	Pre-preservation Holding Times (hours)		Total Holding Times (days)		Method Blanks Reporting Limit	Matrix Spikes/ Surrogate Recovery (%)		Lab Control Samples Recovery (%)		Lab Duplicates RPD (%)		Field Duplicates RPD (%)		Instrument Calibration/ Performance	ACTION
		Reported	Goal	Reported	Goal		Reported	Goal	Reported	Goal	Reported	Goal[1]	Reported	Goal[1]		
Total Phosphorus	OK / EPA 365.1	NA	**NA**	6	**≤28**	≤0.002 mg/L 0.002 mg/L	BATCH 94	**±25**	98	**±20**	Batch 0	**≤ 20**	NS	**NA**	OK	NONE
SRP	OK / EPA 365.1	<48	**≤48**	2	**≤2**	≤0.001 mg/L 0.001 mg/L	B-B 110	**±25**	105	**±20**	B-B NC	**≤ 20**	NS	**NA**	OK	NONE
Alkalinity	OK / EPA 310.1	NA	**NA**	14	**≤14**	≤1.0 mg/L 1.0 mg/L	NA	**NA**	100	**±20**	Batch 0.8	**≤ 20**	NS	**NA**	OK	NONE
Sulfate	OK / EPA 375.4	NA	**NA**	9	**≤28**	≤1.0 mg/L 1.0 mg/L	B-B 99	**±25**	100	**±20**	B-B 0.4	**≤ 20**	NS	**NA**	OK	NONE
Chloro_a	OK / SM 10200H	NA	**NA**	25	**≤28**	≤0.1 µg/L 0.1 µg/L	NA	**NA**	NA	**NA**	Batch 8.7	**≤ 20**	NS	**NA**	OK	NONE
Phaeo_a	OK / SM 10200H	NA	**NA**	25	**≤28**	≤0.1 mg/L 0.1 mg/L	NA	**NA**	NA	**±20**	Batch 1.5	**≤ 20**	NS	**NA**	OK	NONE

[1] If the sample or duplicate value is less than five times the reporting limit, the difference is calculated rather than the relative percent difference (RPD). The QA goal is a difference <2 times the detection limit instead of the number indicated in the goal column.
NA – not applicable or not available; NC – not calculable due to one or more values below the detection limit; NS – field duplicate not sampled.

Data Quality Assurance Worksheet

By G. Catarra

Project Name/No./Client: Green Lake Alum Treatment 2016 / 13-05709-001 / Seattle Parks and Recreation

Date 3/7/2017 Page 2 of 2

Laboratory/Parameters: Aquatic Research: Total phosphorus, SRP, alkalinity, sulfate, chloro_a, phaeo_a, total and dissolved Al, ammonia, nitrate+nitrite, total nitrogen.

Checked: initials RZ

Sample Date/Sample ID: 4/12/2016 / Index-S, Index-B, A-S, A-B, B-S, B-B

date 3/23/17

Parameter	Completeness/ Methodology	Pre-preservation Holding Times (hours)		Total Holding Times (days)		Method Blanks Reporting Limit	Matrix Spikes/ Surrogate Recovery (%)		Lab Control Samples Recovery (%)		Lab Duplicates RPD (%)		Field Duplicates RPD (%)		Instrument Calibration/ Performance	ACTION
		Reported	Goal	Reported	Goal		Reported	Goal	Reported	Goal	Reported	Goal[1]	Reported	Goal[1]		
Total Al	OK/ EPA 200.7	NA	**NA**	6	**≤180**	≤0.03 mg/L 0.03 mg/L	BATCH 102	**±25**	96	**±10**	Batch 1.8	**≤ 20**	NS	**NA**	OK	NONE
Diss Al	OK/ EPA 200.8	<48	**≤48**	6	**≤180**	≤0.003 mg/L 0.003 mg/L	B-B 102	**±20**	101	**±15**	B-B 0	**≤ 20**	NS	**NA**	OK	NONE.
Ammonia	OK/ EPA 350.1	NA	**NA**	2	**≤28**	≤0.010 mg/L 0.010 mg/L	B-B 104	**±25**	96	**±20**	B-B 0	**≤ 20**	NS	**NA**	OK	NONE
Nitrate + Nitrite	OK/ EPA 200.8	NA	**NA**	2	**≤28**	≤0.010 mg/L 0.010 mg/L	B-B 106	**±25**	98	**±20**	B-B NC	**≤ 20**	NS	**NA**	OK	NONE
Total nitrogen	OK / SM 4500NC	NA	**NA**	15	**≤28**	≤0.050 mg/L 0.050 mg/L	BATCH 104	**±25**	99	**±20**	Batch 2.0	**≤ 20**	NS	**NA**	OK	NONE
Fecal Coliform	OK / SM 9222D	NA	**NA**		**≤1.5**	≤1 cfu/100 1 cfu/100		**NA**		**NA**		**≤ 35**		**NA**	OK	NOT ANALYZED DUE TO LAB OVERSIGHT.

[1] If the sample or duplicate value is less than five times the reporting limit, the difference is calculated rather than the relative percent difference (RPD). The QA goal is a difference <2 times the detection limit instead of the number indicated in the goal column.

NA – not applicable or not available; NC – not calculable due to one or more values below the detection limit; NS – field duplicate not sampled.

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	**HER080-27**	**PAGE 1**	
REPORT DATE:	**05/18/16**		
DATE SAMPLED:	**04/25/16**	**DATE RECEIVED:**	**04/25/16**

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL

CASE NARRATIVE

Six water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages. Results for fecal coliform will follow as a separate report.

SAMPLE DATA

SAMPLE ID	TOTAL-P (mg/L)	SRP (mg/L)	ALKALINITY (mg/CaCO3/L)	SULFATE (mg/L)	CHLOR_a (ug/L)	PHAEO_a (ug/L)
INDEX-S	0.010	<0.001	43.8	25.3	2.5	0.5
INDEX-B	0.015	<0.001	41.8	25.3	3.2	0.7
A-S	0.010	<0.001	42.8	23.9	2.5	0.4
A-B	0.013	<0.001	42.0	21.6	2.8	0.6
B-S	0.010	<0.001	42.0	27.0	2.5	0.1
B-B	0.011	<0.001	42.4	23.4	2.5	0.5

SAMPLE ID	TOTAL Al (mg/L)	DISS. Al (mg/L)	AMMONIA (mg/L)	N03+N02 (mg/L)	TOTAL-N (mg/L)
INDEX-S	0.166	0.117	<0.010	<0.010	0.433
INDEX-B	0.191	0.110	<0.010	<0.010	0.316
A-S	0.155	0.122	<0.010	<0.010	0.270
A-B	0.172	0.118	<0.010	<0.010	0.235
B-S	0.165	0.117	<0.010	<0.010	0.198
B-B	0.167	0.112	<0.010	<0.010	0.227

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: **HER080-27** **PAGE 2**

REPORT DATE: **05/18/16**

DATE SAMPLED: **04/25/16** **DATE RECEIVED:** **04/25/16**

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL

QA/QC DATA WATER

QC PARAMETER	TOTAL-P (mg/L)	SRP (mg/L)	ALKALINITY (mgCaCO3/l)	SULFATE (mg/L)	CHLOR_a (ug/L)	PHAEO_a (ug/L)
METHOD	EPA 365.1	EPA 365.1	SM18 2320B	SM18 4500SO4E	SM1810200H	SM1810200H
DATE ANALYZED	05/02/16	04/27/16	05/03/16	04/27/16	05/17/16	05/17/16
DETECTION LIMIT	0.002	0.001	1.00	1.00	0.1	0.1
DUPLICATE						
SAMPLE ID	B-B	B-B	BATCH	B-B	BATCH	BATCH
ORIGINAL	0.011	<0.001	65.7	23.4	4.7	3.3
DUPLICATE	0.012	<0.001	65.8	23.5	5.6	3.6
RPD	8.70%	NC	0.15%	0.10%	17.48%	8.70%
SPIKE SAMPLE						
SAMPLE ID	B-B	B-B		B-B		
ORIGINAL	0.011	<0.001		23.4		
SPIKED SAMPLE	0.062	0.021		33.1		
SPIKE ADDED	0.050	0.020		10.0		
% RECOVERY	102.00%	105.00%	NA	96.57%	NA	NA
QC CHECK						
FOUND	0.098	0.040	100	9.53		
TRUE	0.094	0.039	100	10.0		
% RECOVERY	104.26%	102.56%	100.00%	95.30%	NA	NA
BLANK	<0.002	<0.001	NA	<1.00	NA	NA

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: **HER080-27** **PAGE 3**

REPORT DATE: **05/18/16**

DATE SAMPLED: **04/25/16** **DATE RECEIVED:** **04/25/16**

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL

QA/QC DATA WATER

QC PARAMETER	TOTAL Al (mg/L)	DISS. Al (mg/L)	AMMONIA (mg/L)	N03+N02 (mg/L)	TOTAL-N (mg/L)
METHOD	EPA 200.8	EPA 200.8	SM184500NH3H	SM184500N03F	SM204500NC
DATE ANALYZED	04/27/16	04/26/16	04/14/16	04/14/16	04/18/16
DETECTION LIMIT	0.003	0.003	0.010	0.010	0.050
DUPLICATE					
SAMPLE ID	B-B	B-B	B-B	B-B	B-B
ORIGINAL	0.167	0.117	<0.010	<0.010	0.227
DUPLICATE	0.176	0.114	<0.010	<0.010	0.266
RPD	4.90%	2.60%	NC	NC	15.60%
SPIKE SAMPLE					
SAMPLE ID	B-B	B-B	B-B	B-B	B-B
ORIGINAL	0.167	0.117	<0.010	<0.010	0.227
SPIKED SAMPLE	4.90	0.626	0.203	0.206	1.27
SPIKE ADDED	5.00	0.500	0.200	0.200	1.00
% RECOVERY	94.58%	101.80%	101.51%	102.91%	104.68%
QC CHECK					
FOUND	0.476	0.509	0.329	0.404	0.496
TRUE	0.500	0.500	0.324	0.408	0.490
% RECOVERY	95.20%	101.80%	101.58%	98.92%	101.22%
BLANK	<0.003	<0.003	<0.010	<0.010	<0.050

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski

Damien Gadomski
Project Manager

Lab/Cor, Inc.
7619 6th Ave NW
Seattle, WA 98117

Analysis Report Cover

Final Report

A Professional Service Corporation in the Northwest

Phone: (206) 781-0155
http://www.labcor.net

Job Number: 160411 **SEA**

Report Number: 160411R01

Report Date: 4/27/2016

Client: IEH Analytical Laboratories

Address: 3927 Aurora Ave N
Seattle, WA 98103

Project Name: Herrera

Project No.:

PO Number:

PWS ID:

Reference No.:

Enclosed please find results for samples submitted to our laboratory. A list of samples and analyses follows:

Lab/Cor Sample #	Client Sample # and Description	Analysis	Analysis Notes	Date Received:
160411 - S1	01 - Index-S, WA Water ID#: 11918778	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/26/2016
160411 - S2	02 - A-S, WA Water ID#: 11918779	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/26/2016
160411 - S3	03 - B-S, WA Water ID#: 11918780	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/26/2016
160411 - S4	NEGCTRL - Negative Control, WA Water ID#: 11918781	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/26/2016
160411 - S5	POSCTRL - Positive Control, WA Water ID#: 11918782	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/26/2016
160411 - S6	Blank - Run #1 Blank, WA Water ID#: 11918783	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/26/2016
160411 - S7	Blank - Final Run Blank, WA Water ID#: 11918784	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		4/26/2016

Lab/Cor, Inc.
7619 6th Ave NW
Seattle, WA 98117

Final Report

Phone: (206) 781-0155
http://www.labcor.net

A Professional Service Corporation in the Northwest

Job Number: 160411 **SEA**
Client: IEH Analytical Laboratories
Project Name: Herrera

Report Number: 160411R01
Report Date: 4/27/2016

SM 9222D G1c1- Fecal Coliform/ E.coli - CFU

The presence of Fecal Coliform and E. coli from waters and/or environmental sources are tested using the following standard methods:

SM9222 D&G1c1:
Qualitative and Quantitative analysis of Fecal Coliforms and E. coli using a Membrane Filtration procedure begins with selecting a volume of sample that will yield optimal colony counts. Several aliquots are filtered onto sterile, gridded, 0.1um MCE filters. The filters are then placed onto a culture dish containing fecal coliform selective medium. The samples are then incubated in a water bath at 44.5 ± 0.2 ℃ for 24 ± 2 hours.

Upon completion of incubation, positive fecal coliform colonies will produce various shades of blue while negative non-fecal coliform colonies will produce a gray to cream colored colony. Fecal Coliform densities are then calculated and reported as CFU/ 100ml.

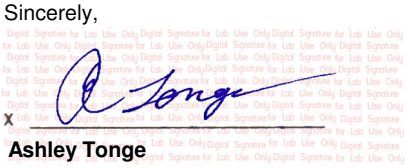
After completion of the fecal coliform enumeration, the gridded filter is removed from the fecal coliform selective medium and transferred to a nutrient agar substrate containing 4-methylumbelliferyl-b-d-glucuronide (MUG). The samples are then incubated at 35 ± 0.5 ℃ for 4 hours. The sample is placed beneath a 365nm ultraviolet lamp to determine the presence of Escherichia coli. A colony producing a blue fluorescence around the periphery is diagnostic for the presence of E. coli.

Disclaimer

The results reported relate only to the samples tested or analyzed; the laboratory is not responsible for data collected by personnel who are not affiliated with the laboratory. Results reported in both structures/cm3 and structures/mm2 are dependent on the sample volume and area. These parameters are measured and recorded by non-laboratory personnel and are not covered by the laboratory's accreditation. Interpretation of these results is the sole responsibility of the client.

If further clarification of these results is needed, please call us. Thank you for allowing the staff at Lab/Cor, Inc. the opportunity to provide you with the analytical services.

Sincerely,



Ashley Tonge
Technician/Analyst

Lab/Cor, Inc.
7619 6th Ave NW
Seattle, WA 98117

Final Report

Phone: (206) 781-0155
http://www.labcor.net

A Professional Service Corporation in the Northwest

SM 9222D G1c1- Fecal Coliform/ E.coli - CFU

Job Number: 160411 **SEA**
Client: IEH Analytical Laboratories
Project Name: Herrera

Report Number: 160411R01
Date Received: 4/26/2016

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S1	01 - Index-S, WA Water ID#: 11918778	**FECAL COLIFORM**	4	CFU/ 100ml	0.4 - 14.4	4/25/2016	3:15 PM	AT 4/27/2016
S2	02 - A-S, WA Water ID#: 11918779	**FECAL COLIFORM**	8	CFU/ 100ml	2 - 20.4	4/25/2016	1:40 PM	AT 4/27/2016
S3	03 - B-S, WA Water ID#: 11918780	**FECAL COLIFORM**	10	CFU/ 100ml	3.2 - 23.4	4/25/2016	2:05 PM	AT 4/27/2016
S4	NEGCTRL - Negative Control, WA Water ID#: 11918781	**FECAL COLIFORM**	<1	CFU/ 100ml	0 - 3.7	4/26/2016	11:00 AM	AT 4/27/2016
S5	POSCTRL - Positive Control, WA Water ID#: 11918782	**FECAL COLIFORM**	146	CFU/ 100ml	133.9 - 158.1	4/26/2016	11:00 AM	AT 4/27/2016
S6	Blank - Run #1 Blank, WA Water ID#: 11918783	**FECAL COLIFORM**	<1	CFU/ 100ml	0 - 3.7	4/26/2016	11:00 AM	AT 4/27/2016
S7	Blank - Final Run Blank, WA Water ID#: 11918784	**FECAL COLIFORM**	<1	CFU/ 100ml	0 - 3.7	4/26/2016	11:00 AM	AT 4/27/2016

Reviewed by:

X

Ashley Tonge
Technician/Analyst

HERRERA
2200 Sixth Avenue | Suite 1100
Seattle, Washington | 98121
p 206 441 9080 | f 206 441 9108

Chain of Custody Record HER0806-27

Project Name:	Project Number:	Client:
Green Lake Alum Treatment	13-05709-001	Herrera Environmental Consultants
Report To:		Copy To:
Rob Zisette		
Sampled By:		Delivery Method:
Alex Svendsen		Hand
Laboratory:	Requested Completion Date:	Total No. of Containers:
IEH	Std	~~8~~ 21
Lab Use:		

Sample ID	Date	Time	Sample Type (see codes)	Preser-vative? (Y/N)	Matrix (see codes)	Number of Containers	Total Alkalinity (EPA 310.1)	Total Aluminum (EPA 200.7)	Dissolved Aluminum (EPA 200.8)	Sulfate (EPA 375.4)	Soluble Reactive Phosphorus (EPA 365.1)	Total Phosphorus (EPA 365.1)	Nitrate + Nitrite Nitrogen (EPA 353.2)	Ammonia Nitrogen (EPA 350.1)	Total Nitrogen (SM 4500 NC)	Chlorophyll a (SM 102000 H)	Fecal Coliform Bacteria (SM 9222 D)	Lab ID No.
INDEX-S	4/25/16	1315	G	N	SW	4	X	X	X	X	X	X	X	X	X	X	X	
INDEX-B	↓	1320	↓	↓	↓	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
A-S		1340				4											X	
A-B		1345				3												
B-S		1405				4											X	
B-B	↓	1410	↓	↓	↓	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		

Comments/Special Instructions:

Relinquished by (Name/CO/	Signature	Date/Time	Received By (Name/CO)	Signature	Date/Time
Alex Svendsen/HEC		4/25/16 1535			
Relinquished by (Name/CO/	Signature	Date/Time	Received By (Name/CO)	Signature	Date/Time
S-Sonn		4/25/16 5:35			

Sample Type: G=Grab C=Composite **Matrix Codes:** A=Air GW=Groundwater SE=Sediment SO=Soil SW=Surface Water W=Water (blanks) M=Material O=Other (specify)

total (21) temp: 12.4°C

Data Quality Assurance Worksheet

G

By G. Catarra

Project Name/No./Client: Green Lake Alum Treatment 2016 / 13-05709-001 / Seattle Parks and Recreation

Date 3/7/2017 Page 1 of 2

Laboratory/Parameters: Aquatic Research: Total phosphorus, SRP, alkalinity, sulfate, chloro_a, phaeo_a, total and dissolved Al, ammonia, nitrate+nitrite, total nitrogen.
LabCor: fecal coliform bacteria

Checked: initials RZ

Sample Date/Sample ID: 4/25/2016 / Index-S, Index-B, A-S, A-B, B-S, B-B

date 3/23/17

Parameter	Completeness/ Methodology	Pre-preservation Holding Times (hours)		Total Holding Times (days)		Method Blanks Reporting Limit	Matrix Spikes/ Surrogate Recovery (%)		Lab Control Samples Recovery (%)		Lab Duplicates RPD (%)		Field Duplicates RPD (%)		Instrument Calibration/ Performance	ACTION
		Reported	Goal	Reported	Goal		Reported	Goal	Reported	Goal	Reported	Goal[1]	Reported	Goal[1]		
Total Phosphorus	OK / EPA 365.1	NA	**NA**	7	**≤28**	≤0.002 mg/L 0.002 mg/L	B-B 102	**±25**	104	**±20**	B-B 8.7	**≤ 20**	NS	**NA**	OK	NONE
SRP	OK / EPA 365.1	<48	**≤48**	2	**≤2**	≤0.001 mg/L 0.001 mg/L	B-B 105	**±25**	103	**±20**	B-B NC	**≤ 20**	NS	**NA**	OK	NONE
Alkalinity	OK / EPA 310.1	NA	**NA**	8	**≤14**	≤1.0 mg/L 1.0 mg/L	NA	**NA**	100	**±20**	Batch 0.2	**≤ 20**	NS	**NA**	OK	NONE
Sulfate	OK / EPA 375.4	NA	**NA**	2	**≤28**	≤1.0 mg/L 1.0 mg/L	B-B 97	**±25**	95	**±20**	B-B 0.1	**≤ 20**	NS	**NA**	OK	NONE
Chloro_a	OK / SM 10200H	NA	**NA**	23	**≤28**	≤0.1 µg/L 0.1 µg/L	NA	**NA**	NA	**NA**	Batch 17	**≤ 20**	NS	**NA**	OK	NONE
Phaeo_a	OK / SM 10200H	NA	**NA**	23	**≤28**	≤0.1 mg/L 0.1 mg/L	NA	**NA**	NA	**±20**	Batch 8.7	**≤ 20**	NS	**NA**	OK	NONE

[1] If the sample or duplicate value is less than five times the reporting limit, the difference is calculated rather than the relative percent difference (RPD). The QA goal is a difference <2 times the detection limit instead of the number indicated in the goal column.
NA – not applicable or not available; NC – not calculable due to one or more values below the detection limit; NS – field duplicate not sampled.

Data Quality Assurance Worksheet

By G. Catarra

Project Name/No./Client: Green Lake Alum Treatment 2016 / 13-05709-001 / Seattle Parks and Recreation

Date 3/7/2017 Page 2 of 2

Laboratory/Parameters: Aquatic Research: Total phosphorus, SRP, alkalinity, sulfate, chloro_a, phaeo_a, total & dissolved aluminum, ammonia, nitrate+nitrite, total nitrogen.
LabCor: fecal coliform bacteria

Checked: initials RZ

Sample Date/Sample ID: 4/25/2016 / Index-S, Index-B, A-S, A-B, B-S, B-B

date 3/23/17

Parameter	Completeness/ Methodology	Pre-preservation Holding Times (hours)		Total Holding Times (days)		Method Blanks Reporting Limit	Matrix Spikes/ Surrogate Recovery (%)		Lab Control Samples Recovery (%)		Lab Duplicates RPD (%)		Field Duplicates RPD (%)		Instrument Calibration/ Performance	ACTION
		Reported	Goal	Reported	Goal		Reported	Goal	Reported	Goal	Reported	Goal[1]	Reported	Goal[1]		
Total Al	OK/ EPA 200.8	NA	**NA**	2	**≤180**	≤0.003 mg/L 0.003 mg/L	B-B 95	**±25**	95	**±10**	B-B 4.9	**≤ 20**	NS	**NA**	OK	NONE
Diss Al	OK/ EPA 200.8	24	**≤48**	1	**≤180**	≤0.003 mg/L 0.003 mg/L	B-B 102	**±20**	102	**±15**	B-B 2.6	**≤ 20**	NS	**NA**	OK	NONE
Ammonia	OK/ EPA 350.1	NA	**NA**	19	**≤28**	≤0.010 mg/L 0.010 mg/L	B-B 102	**±25**	102	**±20**	B-B NC	**≤ 20**	NS	**NA**	OK	NONE
Nitrate + Nitrite	OK/ EPA 200.8	NA	**NA**	19	**≤28**	≤0.010 mg/L 0.010 mg/L	B-B 103	**±25**	99	**±20**	B-B NC	**≤ 20**	NS	**NA**	OK	NONE
Total nitrogen	OK / SM 4500NC	NA	**NA**	23	**≤28**	≤0.050 mg/L 0.050 mg/L	B-B 105	**±25**	101	**±20**	B-B 16	**≤ 20**	NS	**NA**	OK	NONE
Fecal Coliform	OK / SM 9222D	NA	**NA**	<1.5	**≤1.5**	≤1 cfu/100 1 cfu/100	NA	**NA**	NA	**NA**	NA	**≤ 35**	NS	**NA**	OK	FLAG ALL "J" DUE TO LOW PLATE COUNTS.

APPENDIX C

Long-Term Water Quality Monitoring Database

Table C-1. Green Lake Long-Term Water Quality Monitoring Database.

Data Source	Sample Period	Sample Year	Sample Month	Sample Date	Station	Sample Depth	Total P	Chlor *a*	Secchi	Temp	Total N	NO2+3 N	NH3 N	Inorg N	Org N	TKN	SRP	Total N:P	TP:Chlor a
						m	µg/L	µg/L	m	ºC	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	none	
Sylvester 1960	Pretreat 1	1959	5	5/14/1959	Multiple	0-7.6 median	38	11.1	1.7	15.6	770	470	-	-	-	300	2	20.3	3.4
Sylvester 1960	Pretreat 1	1959	5	5/28/1959	Multiple	0-7.6 median	44	10.2	1.7	17.5	440	200	-	-	-	240	6	10.0	4.3
Sylvester 1960	Pretreat 1	1959	6	6/17/1959	Multiple	0-7.6 median	-	12.1	1.5	18	320	20	-	-	-	300	0	-	
Sylvester 1960	Pretreat 1	1959	6	6/25/1959	Multiple	0-7.6 median	106	122.2	1.5	20.5	520	20	-	-	-	500	0	4.9	0.9
Sylvester 1960	Pretreat 1	1959	7	7/7/1959	Multiple	0-7.6 median	54	3.0	2.1	20.5	587	87	400	487	100	500	33	10.9	18.0
Sylvester 1960	Pretreat 1	1959	7	7/21/1959	Multiple	0-7.6 median	61	21.2	2.1	25.2	252	172.2	0	172	80	80	0	4.1	2.9
Sylvester 1960	Pretreat 1	1959	8	8/4/1959	Multiple	0-7.6 median	80	71.3	1.5	21.5	465	195	0	195	270	270	24	5.8	1.1
Sylvester 1960	Pretreat 1	1959	8	8/17/1959	Multiple	0-7.6 median	69	25.0	1.5	20.1	108	8.2	-	-	-	100	30	1.6	2.8
Sylvester 1960	Pretreat 1	1959	8	8/26/1959	Multiple	0-7.6 median	103	6.2	1.5	19	420	40	250	290	130	380	58	4.1	16.6
Sylvester 1960	Pretreat 1	1959	9	9/8/1959	Multiple	0-7.6 median	81	11.7	3.2	17.9	180	40	20	60	120	140	40	2.2	6.9
Sylvester 1960	Pretreat 1	1959	9	9/25/1959	Multiple	0-7.6 median	56	16.7	3.2	16	950	20	760	780	170	930	28	17.0	3.4
Sylvester 1960	Pretreat 1	1959	10	10/15/1959 12	Multiple	0-7.6 median	95	9.1	2.8	14.2	325	15.2	140	155	170	310	10	3.4	10.4
URS 1983	Pretreat 1	1981	5	5/11/1981	Index	0-5 mean	24.2	2.9	4.8	14.7	340	5.3	13.0	18	321	-	3.2	14.0	8.4
URS 1983	Pretreat 1	1981	5	5/28/1981	Index	0-5 mean	5.6	1.3	6.0	17.8	1096	7.8	18.8	27	1070	-	1.4	195.5	4.5
URS 1983	Pretreat 1	1981	6	6/11/1981	Index	0-5 mean	20.3	2.4	6.6	17.3	331	5.0	19.3	24	306	-	6.7	16.3	8.6
URS 1983	Pretreat 1	1981	6	6/24/1981	Index	0-5 mean	17.7	3.5	5.0	17.9	304	5.0	17.0	22	282	-	2.1	17.2	5.1
URS 1983	Pretreat 1	1981	7	7/13/1981	Index	0-5 mean	29.4	4.9	2.3	19.3	333	7.3	18.0	25	307	-	0.8	11.3	6.0
URS 1983	Pretreat 1	1981	7	7/29/1981	Index	0-5 mean	20.1	-	2.3	20.8	-	8.3	10.5	19	-	-	2.9	-	
URS 1983	Pretreat 1	1981	8	8/10/1981	Index	0-5 mean	56.3	12.2	1.8	23.8	545	10.3	30.8	41	504	-	3.3	9.7	4.6
URS 1983	Pretreat 1	1981	8	8/28/1981	Index	0-5 mean	82.6	22.8	1.3	21.0	644	39.3	52.8	92	552	-	15.9	7.8	3.6
URS 1983	Pretreat 1	1981	9	9/10/1981	Index	0-5 mean	71.4	50.8	0.8	19.5	978	18.8	30.8	50	928	-	5.8	13.7	1.4
URS 1983	Pretreat 1	1981	9	9/24/1981	Index	0-5 mean	83.7	74.8	0.8	17.2	1113	-	-	-	-	-	5.5	13.3	1.1
URS 1983	Pretreat 1	1981	10	10/6/1981	Index	0-5 mean	59.5	61.6	1.1	14.4	967	10.0	19.0	29	938	-	2.0	16.2	1.0
URS 1983	Pretreat 1	1981	10	10/20/1981 12	Index	0-5 mean	63.7	81.7	1.0	12.6	1284	10.0	13.8	24	1261	-	4.0	20.2	0.8
Barbiero 1991	Pretreat 1	1989	6	6/24/1989	Index	0-4 mean	22.0	-	3.9	18.0	-	-	-	-	-	-	3.9		
Barbiero 1991	Pretreat 1	1989	6	6/30/1989	Index	0-4 mean	15.6	-	4.7	20.2	-	-	-	-	-	-	3.9		
Barbiero 1991	Pretreat 1	1989	7	7/7/1989	Index	0-4 mean	19.0	-	5.7	19.7	-	-	-	-	-	-	3.7		
Barbiero 1991	Pretreat 1	1989	7	7/15/1989	Index	0-4 mean	25.4	-	5.0	20.8	-	-	-	-	-	-	4.4		
Barbiero 1991	Pretreat 1	1989	7	7/22/1989	Index	0-4 mean	25.1	-	5.4	21.2	-	-	-	-	-	-	3.9		
Barbiero 1991	Pretreat 1	1989	7	7/27/1989	Index	0-4 mean	22.4	-	5.5	22.7	-	-	-	-	-	-	4.1		
Barbiero 1991	Pretreat 1	1989	8	8/2/1989	Index	0-4 mean	32.7	-	3.5	21.2	-	-	-	-	-	-	4.9		
Barbiero 1991	Pretreat 1	1989	8	8/10/1989	Index	0-4 mean	28.3	-	3.2	21.8	-	-	-	-	-	-	4.1		
Barbiero 1991	Pretreat 1	1989	8	8/16/1989	Index	0-4 mean	31.7	-	2.3	21.0	-	-	-	-	-	-	4.1		
Barbiero 1991	Pretreat 1	1989	8	8/25/1989	Index	0-4 mean	44.4	-	1.8	20.7	-	-	-	-	-	-	4.4		
Barbiero 1991	Pretreat 1	1989	8	8/31/1989	Index	0-4 mean	33.2	-	2.2	20.4	-	-	-	-	-	-	1.5		
Barbiero 1991	Pretreat 1	1989	9	9/6/1989	Index	0-4 mean	33.7	-	3.9	20.0	-	-	-	-	-	-	4.6		
Barbiero 1991	Pretreat 1	1989	9	9/14/1989	Index	0-4 mean	33.2	-	3.6	20.2	-	-	-	-	-	-	4.1		
Barbiero 1991	Pretreat 1	1989	9	9/20/1989 14	Index	0-4 mean	34.1	-	2.1	19.2	-	-	-	-	-	-	3.7		
Barbiero 1991	Pretreat 1	1990	5	5/19/1990	Index	0-4 mean	15.9	-	4.7	16.0	-	-	-	-	-	-	1.2		
Barbiero 1991	Pretreat 1	1990	5	5/24/1990	Index	0-4 mean	15.9	-	4.8	16.0	-	-	-	-	-	-	2.4		
Barbiero 1991	Pretreat 1	1990	6	6/14/1990	Index	0-4 mean	13.9	-	4.4	16.2	-	-	-	-	-	-	2.4		
Barbiero 1991	Pretreat 1	1990	6	6/22/1990	Index	0-4 mean	18.3	-	4.2	18.4	-	-	-	-	-	-	2.4		
Barbiero 1991	Pretreat 1	1990	6	6/26/1990	Index	0-4 mean	17.8	-	4.2	20.4	-	-	-	-	-	-	2.0		
Barbiero 1991	Pretreat 1	1990	7	7/3/1990	Index	0-4 mean	22.4	-	3.9	20.5	-	-	-	-	-	-	2.4		

Table C-1. Green Lake Long-Term Water Quality Monitoring Database.

Data Source	Sample Period	Sample Year	Sample Month	Sample Date	Station	Sample Depth m	Total P µg/L	Chlor *a* µg/L	Secchi m	Temp °C	Total N µg/L	NO2+3 N µg/L	NH3 N µg/L	Inorg N µg/L	Org N µg/L	TKN µg/L	SRP µg/L	Total N:P none	TP:Chlor a
Barbiero 1991	Pretreat 1	1990	7	7/10/1990	Index	0-4 mean	22.4	-	4.2	22.6	-	-	-	-	-	-	2.4		
Barbiero 1991	Pretreat 1	1990	7	7/18/1990	Index	0-4 mean	24.4	-	4.5	24.4	-	-	-	-	-	-	2.0		
Barbiero 1991	Pretreat 1	1990	7	7/23/1990	Index	0-4 mean	22.0	-	4.7	23.4	-	-	-	-	-	-	3.4		
Barbiero 1991	Pretreat 1	1990	7	7/31/1990	Index	0-4 mean	24.4	-	3.7	22.8	-	-	-	-	-	-	2.4		
Barbiero 1991	Pretreat 1	1990	8	8/7/1990	Index	0-4 mean	29.3	-	2.9	23.9	-	-	-	-	-	-	3.4		
Barbiero 1991	Pretreat 1	1990	8	8/15/1990	Index	0-4 mean	40.2	-	1.2	23.9	-	-	-	-	-	-	3.7		
Barbiero 1991	Pretreat 1	1990	8	8/28/1990	Index	0-4 mean	39.0	-	1.9	20.8	-	-	-	-	-	-	3.9		
Barbiero 1991	Pretreat 1	1990	9	9/3/1990	Index	0-4 mean	36.6	-	1.5	20.0	-	-	-	-	-	-	3.7		
Barbiero 1991	Pretreat 1	1990	9	9/11/1990	Index	0-4 mean	36.6	-	1.4	19.8	-	-	-	-	-	-	3.4		
Barbiero 1991	Pretreat 1	1990	9	9/19/1990	Index	0-4 mean	30.5	-	1.7	18.4	-	-	-	-	-	-	3.7		
Barbiero 1991	Pretreat 1	1990	9	9/26/1990	Index	0-4 mean	45.1	-	1.0	18.4	-	-	-	-	-	-	3.7		
KCM 1995	Posttreat 1	1992	5	5/19/1992	Index	0-6 mean	15.8	2.4	4.3	18.9	172	15	24	39	132	-	0.5	10.9	6.6
KCM 1995	Posttreat 1	1992	6	6/8/1992	Index	0-6 mean	21.3	5.8	5.6	21.4	316	9	30	39	278	-	5.3	14.9	3.7
KCM 1995	Posttreat 1	1992	6	6/19/1992	Index	0-6 mean	18.8	2.4	5.2	20.4	269	12	23	35	235	-	5.5	14.4	7.8
KCM 1995	Posttreat 1	1992	7	7/2/1992	Index	0-6 mean	16.0	2.3	4.4	22.7	223	11	8	19	204	-	3.3	13.9	7.0
KCM 1995	Posttreat 1	1992	7	7/16/1992	Index	0-6 mean	23.0	3.2	4.2	21.7	340	7	7	13	326	-	3.3	14.8	7.2
KCM 1995	Posttreat 1	1992	8	8/6/1992	Index	0-6 mean	25.8	6.9	2.0	22.3	338	13	34	47	291	-	2.9	13.1	3.7
KCM 1995	Posttreat 1	1992	8	8/20/1992	Index	0-6 mean	18.0	9.6	1.9	22.3	407	17	7	23	384	-	5.5	22.6	1.9
KCM 1995	Posttreat 1	1992	9	9/3/1992	Index	0-6 mean	16.0	8.8	2.2	21.3	253	19	12	30	223	-	2.5	15.8	1.8
KCM 1995	Posttreat 1	1992	9	9/14/1992	Index	0-6 mean	17.5	3.7	2.8	18.4	320	18	26	44	276	-	2.0	18.3	4.7
KCM 1995	Posttreat 1	1992	10	10/1/1992	Index	0-6 mean	22.8	6.0	2.6	17.2	223	31	31	62	161	-	3.5	9.8	3.8
KCM 1995	Posttreat 1	1993	5	5/11/1993	Index	0-6 mean	18.0	10.0	1.4	14.6	-	5	27	32	-	-	4	-	1.8
KCM 1995	Posttreat 1	1993	6	6/4/1993	Index	0-6 mean	35.0	28.0	0.7	17.2	-	48	91	139	-	-	3	-	1.3
KCM 1995	Posttreat 1	1993	7	7/2/1993	Index	0-6 mean	28.0	13.0	3.4	17.8	-	5	118	123	-	-	4	-	2.2
KCM 1995	Posttreat 1	1993	8	8/6/1993	Index	0-6 mean	25.0	3.7	4.3	21.1	-	73	214	287	-	-	3	-	6.8
KCM 1995	Posttreat 1	1993	9	9/2/1993	Index	0-6 mean	28.0	15.0	2.7	20.0	-	13	73	86	-	-	4	-	1.9
KCM 1995	Posttreat 1	1993	10	10/13/1993	Index	0-6 mean	20.0	4.5	-	-	-	20	84	104	-	-	4	-	4.4
KCM 1995	Posttreat 1	1994	5	5/11/1994	Index	0-6 mean	12.8	2.5	5.1	18.3	248	5	32	37	210	-	1.0	19.4	5.1
KCM 1995	Posttreat 1	1994	5	5/25/1994	Index	0-6 mean	11.8	5.5	5.1	18.8	307	17	34	51	256	-	4.0	26.1	2.1
KCM 1995	Posttreat 1	1994	6	6/8/1994	Index	0-6 mean	14.3	7.7	3.9	18.3	241	17	19	36	206	-	2.5	16.9	1.9
KCM 1995	Posttreat 1	1994	6	6/22/1994	Index	0-6 mean	12.3	4.5	4.4	20.2	323	11	15	26	297	-	1.8	26.4	2.7
KCM 1995	Posttreat 1	1994	7	7/6/1994	Index	0-6 mean	13.8	11.8	2.7	19.7	394	26	41	67	328	-	2.3	28.7	1.2
KCM 1995	Posttreat 1	1994	7	7/20/1994	Index	0-6 mean	25.8	11.0	2.5	22.7	435	30	62	92	342	-	2.8	16.9	2.3
KCM 1995	Posttreat 1	1994	8	8/10/1994	Index	0-6 mean	25.5	8.0	2.4	22.3	413	12	22	34	379	-	0.5	16.2	3.2
KCM 1995	Posttreat 1	1994	8	8/24/1994	Index	0-6 mean	19.3	8.4	2.7	22.3	371	25	41	65	306	-	2.3	19.2	2.3
KCM 1995	Posttreat 1	1994	9	9/7/1994	Index	0-6 mean	20.5	13.0	1.7	20.5	421	5	11	16	404	-	1.8	20.5	1.6
KCM 1995	Posttreat 1	1994	9	9/23/1994	Index	0-6 mean	22.0	5.3	3.9	20.2	324	9	40	49	275	-	2.8	14.7	4.2
KCM 1995	Posttreat 1	1994	10	10/12/1994	Index	0-6 mean	19.5	9.8	2.5		312	14	23	37	275	-	0.8	16.0	2.0
Herrera 2003	Pretreat2	1995	5	5/5/1995	CompA+B	0-4 comp	16.0	2.6	4.8	16	-	-	-	-	-	-	3.0	-	6.2
Herrera 2003	Pretreat2	1995	5	5/22/1995	CompA+B	0-4 comp	13.0	4.5	4.5	19	-	-	-	-	-	-	9.0	-	2.9
Herrera 2003	Pretreat2	1995	6	6/27/1995	CompA+B	0-4 comp	13.0	18.0	2.1	22	-	-	-	-	-	-	1.0	-	0.7
Herrera 2003	Pretreat2	1995	7	7/14/1995	CompA+B	0-4 comp	23.0	18.0	1.7	22	-	-	-	-	-	-	2.0	-	1.3
Herrera 2003	Pretreat2	1995	9	9/1/1995	CompA+B	0-4 comp	30.0	22.0	1.4	21	-	-	-	-	-	-	3.0	-	1.4

Table C-1. Green Lake Long-Term Water Quality Monitoring Database.

Data Source	Sample Period	Sample Year	Sample Month	Sample Date	Station	Sample Depth m	Total P µg/L	Chlor *a* µg/L	Secchi m	Temp ℃	Total N µg/L	NO2+3 N µg/L	NH3 N µg/L	Inorg N µg/L	Org N µg/L	TKN µg/L	SRP µg/L	Total N:P none	TP:Chlor a
Herrera 2003	Pretreat2	1995	10	10/12/1995	CompA+B	0-4 comp	43.0	6.4	0.8	15	-	-	-	-	-	-	-	-	6.7
Herrera 2003	NA	1996	5	5/7/1996	CompA+B	0-4 comp	17.0	5.9	2.9	14	-	-	-	-	-	-	2.0	-	2.9
Herrera 2003	NA	1996	6	6/12/1996	CompA+B	0-4 comp	26.0	6.7	2.2	19	-	-	-	-	-	-	15.0	-	3.9
Herrera 2003	NA	1996	7	7/9/1996	CompA+B	0-4 comp	13.0	3.9	3.4	21	-	-	-	-	-	-	2.0	-	3.3
Herrera 2003	NA	1996	8	8/9/1996	CompA+B	0-4 comp	16.0	5.6	3.5	22	-	-	-	-	-	-	2.0	-	2.9
Herrera 2003	NA	1999	9	9/13/1999	CompA+B	0-4 comp	51.0	68.0	0.5	20	-	-	-	-	-	-	2.0	-	0.8
Herrera 2003	NA	2000	5	5/4/2000	CompA+B	0-4 comp	28.0	6.4	1.1	15	-	-	-	-	-	-	2.0	-	4.4
Herrera 2003	NA	2000	6	6/13/2000	CompA+B	0-4 comp	28.0	9.1	2.4	16	-	-	-	-	-	-	4.0	-	3.1
Herrera 2003	NA	2000	7	7/17/2000	CompA+B	0-4 comp	23.0	3.8	3.1	22	-	-	-	-	-	-	3.0	-	6.1
Herrera 2003	NA	2002	8	8/29/2002	Index	1.0	57.6	-	1.1	-	-	0.005	-	-	-	-	11.3	-	
FOGL 2003	NA	2003	6	6/15/2003	Dock	-	-	-	1.5	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	6	6/24/2003	Dock	-	-	-	1.7	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	7	7/22/2003	Dock	-	-	-	1.9	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	7	7/31/2003	Dock	-	-	-	0.8	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	8	8/21/2003	Dock	-	-	-	0.9	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	8	8/30/2003	Dock	-	-	-	0.8	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	9	9/7/2003	Dock	-	-	-	0.4	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	9	9/14/2003	Dock	-	-	-	0.5	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	10	10/2/2003	Dock	-	-	-	0.7	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	10	10/12/2003	Dock	-	-	-	1.0	-	-	-	-	-	-	-	-	-	
FOGL 2003	NA	2003	10	10/19/2003	Dock	-	-	-	1.6	-	-	-	-	-	-	-	-	-	
Herrera 2005	Posttreat2	2004	5	5/14/2004	CompA+B	0-4 comp	7.0	4.0	3.3	20.8	-	-	-	-	-	-	-	-	1.8
Herrera 2005	Posttreat2	2004	5	5/25/2004	CompA+B	0-4 comp	12.0	0.7	7.1	21.1	-	-	-	-	-	-	-	-	17.1
Herrera 2005	Posttreat2	2004	6	6/8/2004	CompA+B	0-4 comp	9.0	2.7	4.1	21.5	-	-	-	-	-	-	-	-	3.3
Herrera 2005	Posttreat2	2004	6	6/23/2004	CompA+B	0-4 comp	7.0	1.5	5.6	22.1	-	-	-	-	-	-	-	-	4.7
Herrera 2005	Posttreat2	2004	7	7/9/2004	CompA+B	0-4 comp	8.0	6.1	3.0	21.2	-	-	-	-	-	-	-	-	1.3
Herrera 2005	Posttreat2	2004	7	7/22/2004	CompA+B	0-4 comp	8.5	4.5	3.0	23.4	-	-	-	-	-	-	-	-	1.9
Herrera 2005	Posttreat2	2004	8	8/5/2004	CompA+B	0-4 comp	22.0	5.3	2.3	23.1	-	-	-	-	-	-	-	-	4.2
Herrera 2005	Posttreat2	2004	8	8/23/2004	CompA+B	0-4 comp	17.0	9.3	1.9	22.7	-	-	-	-	-	-	-	-	1.8
Herrera 2005	Posttreat2	2004	9	9/2/2004	CompA+B	0-4 comp	12.0	9.6	2.0	21.4	-	-	-	-	-	-	-	-	1.3
Herrera 2005	Posttreat2	2004	9	9/16/2004	CompA+B	0-4 comp	16.0	1.8	1.0	17.9	-	-	-	-	-	-	-	-	8.9
Herrera 2005	Posttreat2	2004	10	10/7/2004	CompA+B	0-4 comp	11.0	5.9	1.4	16.9	-	-	-	-	-	-	-	-	1.9
Herrera 2005	Posttreat2	2004	10	10/20/2004	CompA+B	0-4 comp	11.0	1.9	3.8	13.9	-	-	-	-	-	-	-	-	5.8
King County	Posttreat2	2005	5	5/9/2005	Index	1.0	8.4	1.5	5.2	16.2	155	-	-	-	-	-	-	18	5.6
King County	Posttreat2	2005	5	5/23/2005	Index	1.0	13.1	1.7	3.9	17	189	10	5	15	174	-	2.0	14	7.8
King County	Posttreat2	2005	6	6/6/2005	Index	1.0	10.4	2.3	4.0	18	269	-	-	-	-	-	-	26	4.5
King County	Posttreat2	2005	6	6/20/2005	Index	1.0	10.1	2.0	4.7	20	180	-	-	-	-	-	-	18	5.1
King County	Posttreat2	2005	7	7/11/2005	Index	1.0	9.5	1.8	3.2	20.5	149	-	-	-	-	-	-	16	5.3
King County	Posttreat2	2005	8	8/1/2005	Index	1.0	11.4	2.5	3.1	24	189	-	-	-	-	-	-	17	4.6

Table C-1. Green Lake Long-Term Water Quality Monitoring Database.

Data Source	Sample Period	Sample Year	Sample Month	Sample Date	Station	Sample Depth m	Total P µg/L	Chlor *a* µg/L	Secchi m	Temp ℃	Total N µg/L	NO2+3 N µg/L	NH3 N µg/L	Inorg N µg/L	Org N µg/L	TKN µg/L	SRP µg/L	Total N:P none	TP:Chlor a
King County	Posttreat2	2005	8	8/15/2005	Index	1.0	12.6	2.8	3.5	19.5	208	-	-	-	-	-	-	17	4.5
King County	Posttreat2	2005	8	8/29/2005	Index	1.0	19.5	2.5	2.0	17	243	10	5	15	228	-	2.0	12	7.8
King County	Posttreat2	2005	9	9/11/2005	Index	1.0	19.3	6.2	1.4	15	249	-	-	-	-	-	-	13	3.1
King County	Posttreat2	2005	9	9/26/2005	Index	1.0	14.9	4.7	2.5	13	222	-	-	-	-	-	-	15	3.2
King County	Posttreat2	2005	10	10/9/2005	Index	1.0	13.4	5.5	2.3	15	217	-	-	-	-	-	-	16	2.4
King County	Posttreat2	2005	10	10/24/2005 12	Index	1.0	12.4	6.4	2.3	9.5	248	-	-	-	-	-	-	20	1.9
Parks 2005	Posttreat2	2005	5	5/6/2005	CompA+B	0-4 comp	8.0	2.3	5.6	18.0	-	-	-	-	-	-	-	-	3.5
Parks 2005	Posttreat2	2005	5	5/25/2005	CompA+B	0-4 comp	11.0	1.6	5.5	16.5	-	-	-	-	-	-	-	-	6.9
Parks 2005	Posttreat2	2005	6	6/7/2005	CompA+B	0-4 comp	1.0	2.0	5.0	18.3	-	-	-	-	-	-	-	-	0.5
Parks 2005	Posttreat2	2005	6	6/21/2005	CompA+B	0-4 comp	20.0	1.8	4.5	20.6	-	-	-	-	-	-	-	-	11.1
Parks 2005	Posttreat2	2005	7	7/11/2005	CompA+B	0-4 comp	9.0	2.1	3.9	-	-	-	-	-	-	-	-	-	4.3
Parks 2005	Posttreat2	2005	7	7/21/2005	CompA+B	0-4 comp	10.0	2.3	5.5	22.6	-	-	-	-	-	-	-	-	4.3
Parks 2005	Posttreat2	2005	8	8/3/2005	CompA+B	0-4 comp	12.0	2.4	3.0	23.1	-	-	-	-	-	-	-	-	5.0
Parks 2005	Posttreat2	2005	8	8/22/2005	CompA+B	0-4 comp	-	-	2.4	22.4	-	-	-	-	-	-	-	-	
Parks 2005	Posttreat2	2005	9	9/9/2005 9	CompA+B	0-4 comp	-	-	2.0	19.8	-	-	-	-	-	-	-	-	
King County	Posttreat2	2006	5	5/8/2006	Index	1.0	16.2	2.5	3.2	15	192	-	-	-	-	-	-	12	6.6
King County	Posttreat2	2006	5	5/22/2006	Index	1.0	13.1	2.1	4.0	18	196	10	5	15	181	-	2.0	15	6.2
King County	Posttreat2	2006	6	6/5/2006	Index	1.0	12.5	1.7	3.7	19	194	-	-	-	-	-	-	16	7.4
King County	Posttreat2	2006	6	6/18/2006	Index	1.0	14.4	2.0	3.1	19	241	-	-	-	-	-	-	17	7.2
King County	Posttreat2	2006	7	7/9/2006	Index	1.0	13.1	1.7	3.4	23.6	242	-	-	-	-	-	-	18	7.9
King County	Posttreat2	2006	7	7/31/2006	Index	1.0	21.7	3.8	1.7	22	257	-	-	-	-	-	-	12	5.8
King County	Posttreat2	2006	8	8/14/2006	Index	1.0	19.9	2.9	1.7	22	234	-	-	-	-	-	-	12	6.9
King County	Posttreat2	2006	8	8/28/2006	Index	1.0	21.7	3.5	1.5	21.5	257	10	5	15	242	-	2.4	12	6.2
King County	Posttreat2	2006	9	9/11/2006	Index	1.0	15.5	2.8	1.9	20	198	-	-	-	-	-	-	13	5.5
King County	Posttreat2	2006	9	9/24/2006	Index	1.0	21.8	4.1	3.0	17	203	-	-	-	-	-	-	9	5.4
King County	Posttreat2	2006	10	10/8/2006	Index	1.0	25.4	4.5	2.7	15.5	262	-	-	-	-	-	-	10	5.7
King County	Posttreat2	2006	10	10/22/2006 12	Index	1.0	14.1	5.1	2.6	13.5	189	-	-	-	-	-	-	13	2.8
Parks 2006	Posttreat2	2006	5	5/19/2006	CompA+B	0-4 comp	9.0	1.5	5.6	17.9	-	-	-	-	-	-	-	-	6.0
Parks 2006	Posttreat2	2006	6	6/7/2006	CompA+B	0-4 comp	11.0	2.0	5.0	19.3	-	-	-	-	-	-	-	-	5.5
Parks 2006	Posttreat2	2006	6	6/16/2006	CompA+B	0-4 comp	9.0	2.8	3.4	18.8	-	-	-	-	-	-	-	-	3.2
Parks 2006	Posttreat2	2006	7	7/12/2006	CompA+B	0-4 comp	17.0	3.7	2.0	21.1	-	-	-	-	-	-	-	-	4.6
Parks 2006	Posttreat2	2006	7	7/21/2006	CompA+B	0-4 comp	12.0	2.9	3.0	21.8	-	-	-	-	-	-	-	-	4.1
Parks 2006	Posttreat2	2006	8	8/14/2006	CompA+B	0-4 comp	20.0	3.9	2.0	22.1	-	-	-	-	-	-	-	-	5.1
Parks 2006	Posttreat2	2006	8	8/25/2006	CompA+B	0-4 comp	19.0	4.8	1.6	20.3	-	-	-	-	-	-	-	-	4.0
Parks 2006	Posttreat2	2006	9	9/8/2006 8	CompA+B	0-4 comp	19.0	5.3	1.7	20.6	-	-	-	-	-	-	-	-	3.6
King County	Posttreat2	2007	5	5/7/2007	Index	1.0	12.5	3.5	3.1	14.5	209	-	-	-	-	-	-	17	3.6
King County	Posttreat2	2007	5	5/21/2007	Index	1.0	12.5	2.8	2.0	15.5	224	10	17	27	197	-	3.8	18	4.5
King County	Posttreat2	2007	6	6/4/2007	Index	1.0	6.8	2.1	4.4	21	193	-	-	-	-	-	-	28	3.2
King County	Posttreat2	2007	6	6/18/2007	Index	1.0	9.0	2.7	3.3	18	214	-	-	-	-	-	-	24	3.4
King County	Posttreat2	2007	7	7/9/2007	Index	1.0	13.1	1.8	3.5	22.5	257	-	-	-	-	-	-	20	7.2
King County	Posttreat2	2007	7	7/30/2007	Index	1.0	14.1	2.0	4.2	22	260	-	-	-	-	-	-	18	7.1
King County	Posttreat2	2007	8	8/13/2007	Index	1.0	11.1	1.9	3.8	21	268	-	-	-	-	-	-	24	6.0

Table C-1. Green Lake Long-Term Water Quality Monitoring Database.

Data Source	Sample Period	Sample Year	Sample Month	Sample Date	Station	Sample Depth m	Total P µg/L	Chlor *a* µg/L	Secchi m	Temp ºC	Total N µg/L	NO2+3 N µg/L	NH3 N µg/L	Inorg N µg/L	Org N µg/L	TKN µg/L	SRP µg/L	Total N:P none	TP:Chlor a
King County	Posttreat2	2007	8	8/27/2007 12	Index	1.0	13.5	2.4	3.9	21	263	10	5	15	248	-	3.3	19	5.6
King County	Posttreat2	2007	9	9/10/2007	Index	1.0	10.4	1.6	3.8	21	213	-	-	-	-	-	-	20	6.5
King County	Posttreat2	2007	9	9/24/2007	Index	1.0	11.7	3.0	2.8	17	248	-	-	-	-	-	-	21	3.9
King County	Posttreat2	2007	10	10/8/2007	Index	1.0	11.4	6.4	3.7	13.5	255	-	-	-	-	-	-	22	1.8
King County	Posttreat2	2007	10	10/22/2007 12	Index	1.0	13.7	9.1	3.0	11.5	319	-	-	-	-	-	-	23	1.5
Parks 2007	Posttreat2	2007	4	4/14/2007	CompA+B	0-4 comp	11.0	1.9	3.4	11.8	-	-	-	-	-	-	-	-	5.8
Parks 2007	Posttreat2	2007	5	5/15/2007	CompA+B	0-4 comp	13.0	3.2	3.0	15.7	-	-	-	-	-	-	-	-	4.1
Parks 2007	Posttreat2	2007	5	5/23/2007	CompA+B	0-4 comp	13.0	3.2	3.4	15.5	-	-	-	-	-	-	-	-	4.1
Parks 2007	Posttreat2	2007	6	6/6/2007	CompA+B	0-4 comp	15.0	2.7	3.3	19.3	-	-	-	-	-	-	-	-	5.6
Parks 2007	Posttreat2	2007	6	6/22/2007	CompA+B	0-4 comp	8.0	1.6	3.7	19.4	-	-	-	-	-	-	-	-	5.0
Parks 2007	Posttreat2	2007	7	7/11/2007	CompA+B	0-4 comp	14.0	1.6	3.4	23.0	-	-	-	-	-	-	-	-	8.8
Parks 2007	Posttreat2	2007	7	7/23/2007	CompA+B	0-4 comp	13.0	2.4	3.4	21.7	-	-	-	-	-	-	-	-	5.4
Parks 2007	Posttreat2	2007	8	8/22/2007	CompA+B	0-4 comp	11.0	2.7	5.0	20.6	-	-	-	-	-	-	-	-	4.1
Parks 2007	Posttreat2	2007	8	8/30/2007	CompA+B	0-4 comp	13.0	3.2	3.4	21.1	-	-	-	-	-	-	-	-	4.1
Parks 2007	Posttreat2	2007	9	9/26/2007 10	CompA+B	0-4 comp	15.0	4.8	3.2	16.6	-	-	-	-	-	-	-	-	3.1
King County	Posttreat2	2008	5	5/5/2008	Index	1.0	8.2	2.5	3.8	13.5	204	-	-	-	-	-	-	25	3.2
King County	Posttreat2	2008	5	5/19/2008	Index	1.0	8.6	1.9	3.6	17	305	10	5	15	290	-	2.0	35	4.5
King County	Posttreat2	2008	6	6/2/2008	Index	1.0	12.8	2.7	2.1	17	212	-	-	-	-	-	-	17	4.8
King County	Posttreat2	2008	6	6/15/2008	Index	1.0	10.2	2.5	3.2	15	199	-	-	-	-	-	-	20	4.1
King County	Posttreat2	2008	6	6/30/2008	Index	1.0	8.5	1.3	4.5	22	323	-	-	-	-	-	-	38	6.6
King County	Posttreat2	2008	7	7/21/2008	Index	1.0	8.1	1.3	3.6	22.5	214	-	-	-	-	-	-	26	6.5
King County	Posttreat2	2008	8	8/11/2008	Index	1.0	9.9	1.9	2.9	21	236	-	-	-	-	-	-	24	5.2
King County	Posttreat2	2008	8	8/25/2008	Index	1.0	12.6	1.6	2.8	20.5	229	10	5	15	214	-	2.0	18	7.8
King County	Posttreat2	2008	9	09/08/08	Index	1.0	10.6	1.3	4.2	19.5	262	-	-	-	-	-	-	25	8.1
King County	Posttreat2	2008	9	09/22/08	Index	1.0	15.4	1.6	3.2	18	245	-	-	-	-	-	-	16	9.9
King County	Posttreat2	2008	10	10/06/08	Index	1.0	10.2	1.9	6.8	15.5	253	-	-	-	-	-	-	25	5.5
King County	Posttreat2	2008	10	10/20/08 12	Index	1.0	11.7	0.8	6.8	12.5	201	-	-	-	-	-	-	17	14.8
Parks 2008	Posttreat2	2008	5	5/30/2008	CompA+B	0-4 comp	10.0	2.1	3.1	17.7	-	-	-	-	-	-	-	-	4.8
Parks 2008	Posttreat2	2008	6	6/11/2008	CompA+B	0-4 comp	13.0	5.3	2.5	14.2	-	-	-	-	-	-	-	-	2.5
Parks 2008	Posttreat2	2008	6	6/20/2008	CompA+B	0-4 comp	9.0	2.7	3.6	17.1	-	-	-	-	-	-	-	-	3.3
Parks 2008	Posttreat2	2008	7	7/2/2008	CompA+B	0-4 comp	10.0	1.5	5.5	21.5	-	-	-	-	-	-	-	-	6.7
Parks 2008	Posttreat2	2008	8	8/21/2008	CompA+B	0-4 comp	13.0	4.3	2.0	20.6	-	-	-	-	-	-	-	-	3.0
Parks 2008	Posttreat2	2008	9	9/17/2008 6	CompA+B	0-4 comp	10.0	1.6	6.0	19.9	-	-	-	-	-	-	-	-	6.3
King County	Posttreat2	2009	5	5/4/2009	Index	1.0	16.9	1.3	5.5	15	249	-	-	-	-	-	-	15	13.0
King County	Posttreat2	2009	5	5/18/2009	Index	1.0	17.1	2.9	4.4	16.5	233	5	2.5	7.5	225.5	-	2.0	14	5.9
King County	Posttreat2	2009	6	6/1/2009	Index	1.0	17.6	1.6	4.1	20	278	-	-	-	-	-	-	16	11.0
King County	Posttreat2	2009	6	6/15/2009	Index	1.0	17.9	3.3	2.4	21.5	302	-	-	-	-	-	-	17	5.4
King County	Posttreat2	2009	6	6/29/2009	Index	1.0	13.4	3.2	3.3	20	250	-	-	-	-	-	-	19	4.2
King County	Posttreat2	2009	7	7/13/2009	Index	1.0	22.8	3.7	2.2	20	317	-	-	-	-	-	-	14	6.2
King County	Posttreat2	2009	8	8/3/2009	Index	1.0	9.5	2.0	4.2	26	229	-	-	-	-	-	-	24	4.8
King County	Posttreat2	2009	8	8/16/2009	Index	1.0	16.9	1.2	4.5	21	282	-	-	-	-	-	-	17	14.1
King County	Posttreat2	2009	8	8/31/2009	Index	1.0	14.4	2.6	3.9	21	222	5	6.6	11.6	210.4	-	2.0	15	5.5

Table C-1. Green Lake Long-Term Water Quality Monitoring Database.

Data Source	Sample Period	Sample Year	Sample Month	Sample Date	Station	Sample Depth m	Total P µg/L	Chlor *a* µg/L	Secchi m	Temp ℃	Total N µg/L	NO2+3 N µg/L	NH3 N µg/L	Inorg N µg/L	Org N µg/L	TKN µg/L	SRP µg/L	Total N:P none	TP:Chlor a
King County	Posttreat2	2009	9	9/14/2009	Index	1.0	7.3	2.5	3.2	20	251	-	-	-	-	-	-	34	2.9
King County	Posttreat2	2009	9	9/28/2009	Index	1.0	13.9	2.3	3.2	18	258	-	-	-	-	-	-	19	6.0
King County	Posttreat2	2009	10	10/19/2009 12	Index	1.0	17.8	2.2	3.2	13	280	-	-	-	-	-	-	16	8.2
Parks 2009	Posttreat2	2009	5	5/12/2009	CompA+B	0-4 comp	21.0	2.7	3.2	13.9	-	-	-	-	-	-	-	-	7.8
Parks 2009	Posttreat2	2009	5	5/28/2009	CompA+B	0-4 comp	16.0	2.4	4.5	18.2	-	-	-	-	-	-	-	-	6.7
Parks 2009	Posttreat2	2009	6	6/9/2009	CompA+B	0-4 comp	18.0	2.4	3.1	20.9	-	-	-	-	-	-	-	-	7.5
Parks 2009	Posttreat2	2009	6	6/22/2009	CompA+B	0-4 comp	18.0	2.4	3.1	20.9	-	-	-	-	-	-	-	-	7.5
Parks 2009	Posttreat2	2009	7	7/24/2009	CompA+B	0-4 comp	17.0	6.4	2.4	20.1	-	-	-	-	-	-	-	-	2.7
Parks 2009	Posttreat2	2009	8	8/26/2009	CompA+B	0-4 comp	10.0	1.6	4.4	21.0	-	-	-	-	-	-	-	-	6.3
Parks 2009	Posttreat2	2009	9	9/3/2009	CompA+B	0-4 comp	4.0	4.0	3.6	21.0	-	-	-	-	-	-	-	-	1.0
Parks 2009	Posttreat2	2009	9	9/18/2009 8	CompA+B	0-4 comp	9.0	2.1	4.0	21.0	-	-	-	-	-	-	-	-	4.3
King County	Posttreat2	2010	5	5/10/2010	Index	1.0	10.6	1.8	4.9	14.5	198	-	-	-	-	-	-	19	5.9
King County	Posttreat2	2010	5	5/24/2010	Index	1.0	12.3	4.1	1.0	15.5	220	-	2.5	-	-	-	2.0	18	3.0
King County	Posttreat2	2010	6	6/6/2010	Index	1.0	10.6	2.6	4.8	17	218	-	-	-	-	-	-	21	4.1
King County	Posttreat2	2010	6	6/20/2010	Index	1.0	18.3	4.6	1.9	16.5	254	-	-	-	-	-	-	14	4.0
King County	Posttreat2	2010	7	7/11/2010	Index	1.0	11.3	1.7	3.4	22	241	-	-	-	-	-	-	21	6.6
King County	Posttreat2	2010	7	7/25/2010	Index	1.0	8.8	1.9	3.9	22.5	213	-	-	-	-	-	-	24	4.6
King County	Posttreat2	2010	8	8/8/2010	Index	1.0	10.9	1.9	3.9	21	228	-	-	-	-	-	-	21	5.7
King County	Posttreat2	2010	8	8/23/2010	Index	1.0	22.3	4.3	2.9	21	281	-	16	-	-	-	2.1	13	5.2
King County	Posttreat2	2010	9	9/13/2010	Index	1.0	12.7	3.4	3.2	18	272	-	-	-	-	-	-	21	3.7
King County	Posttreat2	2010	9	9/27/2010	Index	1.0	12.2	2.6	4.2	18	225	-	-	-	-	-	-	18	4.7
King County	Posttreat2	2010	10	10/11/2010	Index	1.0	13.9	6.2	2.9	16	281	-	-	-	-	-	-	20	2.2
King County	Posttreat2	2010	10	10/26/2010 12	Index	1.0	14.2	5.8	2.9	12	303	-	-	-	-	-	-	21	2.4
Parks 2010	Posttreat2	2010	5	5/10/2010	CompA+B	0-4 comp	25.0	3.2	4.8	14.7	-	-	-	-	-	-	-	-	7.8
Parks 2010	Posttreat2	2010	6	6/1/2010	CompA+B	0-4 comp	14.0	2.1	3.7	15.8	-	-	-	-	-	-	-	-	6.7
Parks 2010	Posttreat2	2010	6	6/11/2010	CompA+B	0-4 comp	17.0	4.3	4.2	17.8	-	-	-	-	-	-	-	-	4.0
Parks 2010	Posttreat2	2010	7	7/1/2010	CompA+B	0-4 comp	13.0	4.5	3.4	19.6	-	-	-	-	-	-	-	-	2.9
Parks 2010	Posttreat2	2010	7	7/15/2010	CompA+B	0-4 comp	14.0	2.1	3.8	22.1	-	-	-	-	-	-	-	-	6.7
Parks 2010	Posttreat2	2010	8	8/5/2010	CompA+B	0-4 comp	9.0	1.3	4.6	22.9	-	-	-	-	-	-	-	-	6.9
Parks 2010	Posttreat2	2010	8	8/26/2010	CompA+B	0-4 comp	11.0	2.1	2.8	21.4	-	-	-	-	-	-	-	-	5.2
Parks 2010	Posttreat2	2010	9	9/21/2010 8	CompA+B	0-4 comp	13.0	3.7	3.4	18.5	-	-	-	-	-	-	-	-	3.5
King County	Posttreat2	2011	5	5/9/2011	Index	1.0	10.2	4.4	3.6	13	254	-	-	-	-	-	-	25	2.3
King County	Posttreat2	2011	5	5/22/2011	Index	1.0	12.6	6.0	3.3	16	248	-	6.2	-	-	-	2	20	2.1
King County	Posttreat2	2011	6	6/6/2011	Index	1.0	12.1	5.3	2.5	19	248	-	-	-	-	-	-	20	2.3
King County	Posttreat2	2011	6	6/19/2011	Index	1.0	15.8	4.5	1.7	18	270	-	-	-	-	-	-	17	3.6
King County	Posttreat2	2011	7	7/10/2011	Index	1.0	12.2	3.3	3.3	20	263	-	-	-	-	-	-	22	3.7
King County	Posttreat2	2011	7	7/25/2011	Index	1.0	8.7	1.2	4.7	20	251	-	-	-	-	-	-	29	7.3
King County	Posttreat2	2011	8	8/8/2011	Index	1.0	9.9	2.1	4.0	22	274	-	-	-	-	-	-	28	4.7
King County	Posttreat2	2011	8	8/22/2011	Index	1.0	10.5	2.0	3.8	22	311	-	9.4	-	-	-	2	30	5.2
King County	Posttreat2	2011	9	9/12/2011	Index	1.0	10.2	2.5	3.3	22	275	-	-	-	-	-	-	27	4.1
King County	Posttreat2	2011	9	9/26/2011	Index	1.0	15.2	3.6	3.0	18.5	301	-	-	-	-	-	-	20	4.2
King County	Posttreat2	2011	10	10/10/2011	Index	1.0	12.2	6.7	3.7	15.5	314	-	-	-	-	-	-	26	1.8

Table C-1. Green Lake Long-Term Water Quality Monitoring Database.

Data Source	Sample Period	Sample Year	Sample Month	Sample Date	Station	Sample Depth m	Total P µg/L	Chlor *a* µg/L	Secchi m	Temp ℃	Total N µg/L	NO2+3 N µg/L	NH3 N µg/L	Inorg N µg/L	Org N µg/L	TKN µg/L	SRP µg/L	Total N:P none	TP:Chlor a
King County	Posttreat2	2011	10	10/24/2011 12	Index	1.0	12.0	6.3	4.0	13	290	-	-	-	-	-	-	24	1.9
Parks 2011	Posttreat2	2011	5	5/13/2011	CompA+B	0-4 comp	12.0	4.8	3.5	14.0	-	-	-	-	-	-	-	-	2.5
Parks 2011	Posttreat2	2011	5	5/26/2011	CompA+B	0-4 comp	8.3	0.6	2.9	15.9	-	-	-	-	-	-	-	-	13.8
Parks 2011	Posttreat2	2011	6	6/10/2011	CompA+B	0-4 comp	13.0	6.0	2.8	17.7	-	-	-	-	-	-	-	-	2.2
Parks 2011	Posttreat2	2011	6	6/23/2011	CompA+B	0-4 comp	14.0	2.1	3.0	20.2	-	-	-	-	-	-	-	-	6.7
Parks 2011	Posttreat2	2011	7	7/8/2011	CompA+B	0-4 comp	14.0	2.1	3.0	20.2	-	-	-	-	-	-	-	-	6.7
Parks 2011	Posttreat2	2011	8	8/11/2011	CompA+B	0-4 comp	16.0	1.6	3.5	21.9	-	-	-	-	-	-	-	-	10.0
Parks 2011	Posttreat2	2011	8	8/30/2011	CompA+B	0-4 comp	15.0	2.4	3.2	22.2	-	-	-	-	-	-	-	-	6.3
Parks 2011	Posttreat2	2011	9	9/15/2011	CompA+B	0-4 comp	15.0	2.4	2.8	20.6	-	-	-	-	-	-	-	-	6.3
Parks 2011	Posttreat2	2011	9	9/29/2011 9	CompA+B	0-4 comp	13.0	2.1	3.5	18.1	-	-	-	-	-	-	-	-	6.2
King County	Posttreat2	2012	5	5/6/2012	Index	1.0	13.1	4.6	2.4	16	273	-	-	-	-	-	-	21	2.9
King County	Posttreat2	2012	5	5/21/2012	Index	1.0	11.4	4.0	3.5	17.5	277	-	2.5	-	-	-	2	24	2.9
King County	Posttreat2	2012	6	6/4/2012	Index	1.0	11.6	3.3	3.1	17.5	270	-	-	-	-	-	-	23	3.5
King County	Posttreat2	2012	6	6/18/2012	Index	1.0	10.9	3.1	3.0	17.5	287	-	-	-	-	-	-	26	3.5
King County	Posttreat2	2012	7	7/9/2012	Index	1.0	9.7	2.6	3.4	21	289	-	-	-	-	-	-	30	3.8
King County	Posttreat2	2012	7	7/23/2012	Index	1.0	11.4	3.3	3.5	20.5	370	-	-	-	-	-	-	32	3.5
King County	Posttreat2	2012	8	8/7/2012	Index	1.0	10.2	1.9	5.0	23.5	304	-	-	-	-	-	-	30	5.4
King County	Posttreat2	2012	8	8/20/2012	Index	1.0	12.4	1.9	4.8	23	318	-	11	-	-	-	2	26	6.4
King County	Posttreat2	2012	9	9/9/2012	Index	1.0	15.1	2.2	4.1	20	309	-	-	-	-	-	-	20	6.9
King County	Posttreat2	2012	9	9/24/2012	Index	1.0	14.8	3.8	4.1	19	387	-	-	-	-	-	-	26	3.9
King County	Posttreat2	2012	10	10/8/2012	Index	1.0	11	3.4	4.0	16	311	-	-	-	-	-	-	28	3.2
King County	Posttreat2	2012	10	10/22/2012 12	Index	1.0	15.6	2.9	4.3	12.5	311	-	-	-	-	-	-	20	5.4
Parks 2012	Posttreat2	2012	5	5/2/2012	CompA+B	0-4 comp	16.0	3.3	4.3	14.2	-	-	-	-	-	-	-	-	4.8
Parks 2012	Posttreat2	2012	5	5/30/2012	CompA+B	0-4 comp	13.0	3.7	3.7	17.9	-	-	-	-	-	-	-	-	3.5
Parks 2012	Posttreat2	2012	6	6/27/2012	CompA+B	0-4 comp	31.0	6.0	3.0	18.6	-	-	-	-	-	-	-	-	5.2
Parks 2012	Posttreat2	2012	7	7/24/2012	CompA+B	0-4 comp	12.0	3.2	3.3	21.0	-	-	-	-	-	-	-	-	3.8
Parks 2012	Posttreat2	2012	8	8/28/2012	CompA+B	0-4 comp	15.0	2.1	3.3	21.5	-	-	-	-	-	-	-	-	7.1
Parks 2012	Posttreat2	2012	9	9/18/2012 6	CompA+B	0-4 comp	20.0	1.6	3.2	19.8	-	-	-	-	-	-	-	-	12.5
King County	Posttreat2	2013	5	5/6/2013	Index	1.0	16.5	2.5	4.3	17	389	-	-	-	-	-	-	24	6.6
King County	Posttreat2	2013	5	5/20/2013	Index	1.0	14.6	2.8	4.0	18	331	-	9	-	-	-	2	23	5.2
King County	Posttreat2	2013	6	6/3/2013	Index	1.0	13.0	2.5	3.9	18.5	337	-	-	-	-	-	-	26	5.2
King County	Posttreat2	2013	6	6/16/2013	Index	1.0	13.7	1.2	3.8	20	420	-	-	-	-	-	-	31	11.4
King County	Posttreat2	2013	7	7/1/2013	Index	1.0	11.0	1.6	3.4	24	293	-	-	-	-	-	-	27	6.9
King County	Posttreat2	2013	7	7/15/2013	Index	1.0	11.4	1.8	5.0	22.5	331	-	-	-	-	-	-	29	6.3
King County	Posttreat2	2013	7	7/29/2013	Index	1.0	16.7	9.6	4.1	23	382	-	-	-	-	-	-	23	1.7
King County	Posttreat2	2013	8	8/12/2013	Index	1.0	14.8	3.1	3.8	23	366	-	-	-	-	-	-	25	4.8
King County	Posttreat2	2013	8	8/26/2013	Index	1.0	19.1	3.3	1.2	22	372	-	17	-	-	-	0.6	19	5.8
King County	Posttreat2	2013	9	9/8/2013	Index	1.0	18.8	4.9	2.2	23	416	-	-	-	-	-	-	22	3.8
King County	Posttreat2	2013	9	9/30/2013	Index	1.0	20.7	17.4	1.5	14.5	449	-	-	-	-	-	-	22	1.2
King County	Posttreat2	2013	10	10/21/2013 12	Index	1.0	17.4	6.6	3.0	12	417	-	-	-	-	-	-	24	2.6
Parks 2013	Posttreat2	2013	5	5/1/2013	CompA+B	0-4 comp	19.0	3.7	3.2	14.4	-	-	-	-	-	-	-	-	5.1
Parks 2013	Posttreat2	2013	5	5/29/2013	CompA+B	0-4 comp	14.0	4.0	3.0	17.1	-	-	-	-	-	-	-	-	3.5

Table C-1. Green Lake Long-Term Water Quality Monitoring Database.

Data Source	Sample Period	Sample Year	Sample Month	Sample Date	Station	Sample Depth m	Total P µg/L	Chlor *a* µg/L	Secchi m	Temp ℃	Total N µg/L	NO2+3 N µg/L	NH3 N µg/L	Inorg N µg/L	Org N µg/L	TKN µg/L	SRP µg/L	Total N:P none	TP:Chlor a
Parks 2013	Posttreat2	2013	6	6/20/2013	CompA+B	0-4 comp	16.0	3.3	2.4	20.6	-	-	-	-	-	-	-	-	4.8
Parks 2013	Posttreat2	2013	7	7/18/2013	CompA+B	0-4 comp	15.0	2.7	3.7	22.6	-	-	-	-	-	-	-	-	5.6
Parks 2013	Posttreat2	2013	8	8/20/2013	CompA+B	0-4 comp	21.0	3.2	2.4	23.2	-	-	-	-	-	-	-	-	6.6
Parks 2013	Posttreat2	2013	9	9/19/2013 6	CompA+B	0-4 comp	21.0	14.0	2.8	19.7	-	-	-	-	-	-	-	-	1.5
King County	Pretreat3	2014	5	5/4/2014	Index	1.0	19.6	4.0	3.2	14.5	322	-	-	-	-	-	-	16	5.0
King County	Pretreat3	2014	5	5/19/2014	Index	1.0	21.8	5.9	3.0	17.5	389	10	4.3	6.8	382.2	-	0.7	18	3.7
King County	Pretreat3	2014	6	6/2/2014	Index	1.0	19.7	4.9	3.0	19.0	401	-	-	-	-	-	-	20	4.0
King County	Pretreat3	2014	6	6/16/2014	Index	1.0	18.2	5.8	2.3	18.0	378	-	-	-	-	-	-	21	3.2
King County	Pretreat3	2014	6	6/30/2014	Index	1.0	18.3	4.4	2.5	19.5	348	-	-	-	-	-	-	19	4.2
King County	Pretreat3	2014	7	7/21/2014	Index	1.0	19.7	3.3	3.0	22.0	400	-	-	-	-	-	-	20	5.9
King County	Pretreat3	2014	8	8/11/2014	Index	1.0	18.4	7.6	3.0	23.0	415	-	-	-	-	-	-	23	2.4
King County	Pretreat3	2014	8	8/25/2014	Index	1.0	18.0	8.6	2.5	22.0	455	10	39.3	41.8	413.2	-	0.7	25	2.1
King County	Pretreat3	2014	9	9/8/2014	Index	1.0	19.4	10.6	2.1	21.0	466	-	-	-	-	-	-	24	1.8
King County	Pretreat3	2014	9	9/22/2014	Index	1.0	-	8.7	2.6	19.5	-	-	-	-	-	-	-	-	
King County	Pretreat3	2014	10	10/6/2014	Index	1.0	19.2	9.8	3.0	17.0	469	-	-	-	-	-	-	24	2.0
King County	Pretreat3	2014	10	10/20/2014	Index	1.0	19.5	11.0	3.2	15.0	552	-	-	-	-	-	-	28	1.8
King County	Pretreat3	2015	5	5/4/15	Index	1.0	13.0	4.5	3.0	15.5	351	-	-	-	-	-	-	27	2.9
King County	Pretreat3	2015	5	5/18/15	Index	1.0	10.5	2.9	3.3	17.0	305	2.5	3	5.5	300	-	0.5	29	3.7
King County	Pretreat3	2015	6	6/1/15	Index	1.0	8.4	0.5	4.0	20.0	313	-	-	-	-	-	-	37	16.8
King County	Pretreat3	2015	6	6/14/15	Index	1.0	25.0	3.7	3.3	22.0	483	-	-	-	-	-	-	19	6.8
King County	Pretreat3	2015	6	6/29/15	Index	1.0	11.9	2.5	3.6	23.0	368	-	-	-	-	-	-	31	4.8
King County	Pretreat3	2015	7	7/13/15	Index	1.0	15.1	4.8	2.5	22.5	421	-	-	-	-	-	-	28	3.2
King County	Pretreat3	2015	7	7/27/15	Index	1.0	19.3	7.2	2.2	21.0	419	-	-	-	-	-	-	22	2.7
King County	Pretreat3	2015	8	8/10/15	Index	1.0	17.3	6.8	2.8	22.5	382	-	-	-	-	-	-	22	2.5
King County	Pretreat3	2015	8	8/24/15	Index	1.0	23.3	8.6	1.8	20.5	500	0	0	0	500	-	0	21	2.7
King County	Pretreat3	2015	9	9/14/15	Index	1.0	20.5	8.6	2.0	18.5	456	-	-	-	-	-	-	22	2.4
King County	Pretreat3	2015	10	10/5/15	Index	1.0	32.8	8.3	1.7	15.0	548	-	-	-	-	-	-	17	3.9
King County	Pretreat3	2015	10	10/19/15	Index	1.0	20.2	8.2	2.6	14.0	429	-	-	-	-	-	-	21	2.5
King County	Posttreat3	2016	5	5/9/16	Index	1.0	12.6	1.1	6.5	19.0	211	-	-	-	-	-	-	17	11.5
King County	Posttreat3	2016	5	5/24/16	Index	1.0	18.6	2.5	5.8	-	224	5	3.4	8.4	216	-	0.5	12	7.4
King County	Posttreat3	2016	6	6/6/16	Index	1.0	13.3	1.5	6.8	22.0	269	-	-	-	-	-	-	20	9.0
King County	Posttreat3	2016	6	6/20/16	Index	1.0	17.7	2.0	4.4	19.5	248	-	-	-	-	-	-	14	8.8
King County	Posttreat3	2016	7	7/10/16	Index	1.0	17.7	3.0	4.5	20.0	258	-	-	-	-	-	-	15	5.8
King County	Posttreat3	2016	7	7/25/16	Index	1.0	18.4	2.2	4.7	23.5	314	-	-	-	-	-	-	17	8.2
King County	Posttreat3	2016	8	8/8/16	Index	1.0	13.7	6.1	2.9	22.5	286	-	-	-	-	-	-	21	2.2
King County	Posttreat3	2016	8	8/30/16	Index	1.0	19.6	3.2	3.2	22.0	295	2.5	2.5	5	290	-	0.8	15	6.1
King County	Posttreat3	2016	9	9/11/16	Index	1.0	16.0	2.5	4.3	19.5	299	-	-	-	-	-	-	19	6.5
King County	Posttreat3	2016	9	9/25/16	Index	1.0	14.3	2.0	3.7	18.5	251	-	-	-	-	-	-	18	7.1
King County	Posttreat3	2016	10	10/24/16	Index	1.0	15.4	2.4	3.9	14.0	270	-	-	-	-	-	-	18	6.5

Red values are 1/2 detection limit for undetected values

APPENDIX D

Phytoplankton Data

Table D-1. Green Lake Phytoplankton Data for Summer of 2016.

Sample ID	Sample Station Name	Sample Client ID	Sample Date Collected	Sample Habitat	Sample Type	Division	Group	Taxon	Comment	NCU Count	Cell Count	Density NCU/mL	Density Cells/mL	Biovolume (um^3/mL)
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Chlamydomonas		2	2	3.08	3.08	2087.46
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Closterium		1	1	1.54	1.54	1736.88
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Monoraphidium		3	3	4.61	4.61	35.45
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Oocystis		31	31	47.69	47.69	23677.29
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Pediastrum boryanum		3	35	4.61	53.84	51793.12
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Planktosphaeria gelatinosa		2	11	3.08	16.92	1710.90
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Schroederia	S. cf setigera/S. cf robusta	112	112	172.29	172.29	15995.92
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Sphaerocystis		3	42	4.61	64.61	24099.78
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Achnanthes		1	1	1.54	1.54	354.44
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Achnanthidium		1	1	1.54	1.54	36.08
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Aulacoseira	2 species	43	97	66.15	149.21	66562.58
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Cocconeis		2	2	3.08	3.08	712.81
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Cyclotella		2	2	3.08	3.08	4149.63
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Dinobryon divergens		178	178	273.81	273.81	38922.22
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Fragilaria		4	8	6.15	12.31	2717.47
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Gloeobotrys	Gloeobotrys cf limneticus	5	31	7.69	47.69	2912.95
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Gomphonema		1	1	1.54	1.54	166.32
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Mallomonas		1	1	1.54	1.54	837.98
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Navicula		1	1	1.54	1.54	148.60
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Nitzschia		2	2	3.08	3.08	303.11
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Stephanodiscus		2	2	3.08	3.08	144427.98
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Tabellaria		8	8	12.31	12.31	3516.56
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Pyrrhophyta	Others	Ceratium hirundinella		1	1	1.54	1.54	13148.82
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Cryptophyta	Others	Cryptomonas		8	8	12.31	12.31	575.06
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Euglenophyta	Others	Phacus		1	1	1.54	1.54	36024.02
HEC16GLPH001	A734 - GREEN LK	P65276-16	5/22/2016	Surface Water	Grab	Euglenophyta	Others	Trachelomonas		2	2	3.08	3.08	2459.02
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Chlamydomonas		2	2	2.47	2.47	150.60
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Elakatothrix gelatinosa		3	15	3.71	18.54	841.36
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Monoraphidium		4	4	4.94	4.94	135.05
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Oocystis	2 species	86	202	106.31	249.70	108986.20
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Pediastrum boryanum		1	12	1.24	14.83	2460.33
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Planktosphaeria gelatinosa		9	9	11.13	11.13	2292.94
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Scenedesmus ellipticus		2	16	2.47	19.78	46041.04
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Schroederia	S. cf setigera/S. cf robusta	160	160	197.78	197.78	2349.79
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Sphaerocystis		5	22	6.18	27.19	1207.00
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Aulacoseira	2 species	11	52	13.60	64.28	265547.46
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Dinobryon divergens		29	36	35.85	44.50	3762.73
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Fragilaria		1	1	1.24	1.24	61.55
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Gloeobotrys	Gloeobotrys cf limneticus	28	110	34.61	135.97	12679.50
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Mallomonas		2	2	2.47	2.47	633.03
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Nitzschia		1	1	1.24	1.24	68.54
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Stephanodiscus		1	1	1.24	1.24	6348.54
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Tabellaria		7	10	8.65	12.36	3019.11
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Undetermined Chrysophyte	cf. Kephyrion	17	17	21.01	21.01	733.51
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Chroococcus		4	8	4.94	9.89	68.75
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Pyrrhophyta	Others	Ceratium hirundinella		1	1	1.24	1.24	4946.02
HEC16GLPH002	A734 - GREEN LK	P65382-6	6/5/2016	Surface Water	Grab	Cryptophyta	Others	Cryptomonas	2 species	28	28	34.61	34.61	3358.03
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Dictyosphaerium pulchellum		1	6	1.15	6.92	142.46
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Elakatothrix gelatinosa		1	4	1.15	4.61	255.22
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Monoraphidium		6	6	6.92	6.92	301.83
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Mougeotia		1	2	1.15	2.31	10206.55
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Oocystis		21	39	24.23	44.99	56481.47

This page intentionally left blank

Table D-1. Green Lake Phytoplankton Data for Summer of 2016.

Sample ID	Sample Station Name	Sample Client ID	Sample Date Collected	Sample Habitat	Sample Type	Division	Group	Taxon	Comment	NCU Count	Cell Count	Density NCU/mL	Density Cells/mL	Biovolume (um^3/mL)
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Pediastrum boryanum		9	144	10.38	166.13	23154.72
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Pediastrum duplex		1	7	1.15	8.08	282.05
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Scenedesmus		1	2	1.15	2.31	5207.24
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Scenedesmus ellipticus		2	10	2.31	11.54	24136.33
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Schroederia	S. cf setigera/S. cf robusta	52	52	59.99	59.99	2632.25
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Sphaerocystis		3	10	3.46	11.54	1032.95
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Staurastrum		6	6	6.92	6.92	9193.41
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Tetrastrum		1	4	1.15	4.61	278.24
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Achnanthidium		4	4	4.61	4.61	217.41
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Asterionella		11	11	12.69	12.69	5511.69
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Aulacoseira		147	587	169.60	677.23	1899176.20
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Cocconeis		5	5	5.77	5.77	4332.91
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Cyclotella		1	1	1.15	1.15	22.83
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Cymbella		1	1	1.15	1.15	251.14
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Diatoma		2	2	2.31	2.31	56.22
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Dinobryon divergens		68	82	78.45	94.60	3678.92
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Epithemia		1	1	1.15	1.15	445.93
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Fragilaria		11	31	12.69	35.76	11710.35
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Gloeobotrys	Gloeobotrys cf limneticus	7	40	8.08	46.15	4517.37
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Gomphonema		1	1	1.15	1.15	198.09
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Navicula		2	2	2.31	2.31	1009.22
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Nitzschia		2	2	2.31	2.31	118.44
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Rhopalodia		1	1	1.15	1.15	1752.88
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Stephanodiscus		6	6	6.92	6.92	254123.28
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Tabellaria		3	3	3.46	3.46	1244.01
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Undetermined Chrysophyte	cf. Kephyrion	9	9	10.38	10.38	228.40
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Aphanocapsa	A. cf delicatissima	8	250	9.23	288.43	136.35
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Aphanothece	Aphanothece cf. clathrata	3	75	3.46	86.53	159.14
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Cyanothece aeruginosa		2	2	2.31	2.31	784.73
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Dolichospermum		2	12	2.31	13.84	11487.47
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Merismopedia tenuissima		1	18	1.15	20.77	485.94
HEC16GLPH003	A734 - GREEN LK	P65541-6	7/10/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Phormidium		1	12	1.15	13.84	3197.73
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Cosmarium		3	3	8.65	8.65	90008.10
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Monoraphidium		3	3	8.65	8.65	162.78
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Oocystis	2 species	11	37	31.73	106.72	143794.49
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Pediastrum boryanum		1	32	2.88	92.30	8946.05
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Planktosphaeria gelatinosa		4	9	11.54	25.96	1811.29
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Quadrigula	Quadrigula cf. korsikovii	1	18	2.88	51.92	1681.64
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Schroederia	S. cf setigera/S. cf robusta	19	19	54.80	54.80	2772.47
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Staurastrum		1	1	2.88	2.88	2836.48
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Asterionella		1	1	2.88	2.88	438.92
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Aulacoseira		21	202	60.57	582.62	1615866.98
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Dinobryon divergens		298	380	859.51	1096.02	113153.88
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Fragilaria		1	3	2.88	8.65	1971.88
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Nitzschia		2	2	5.77	5.77	400.47
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Surirella		1	1	2.88	2.88	118034.56
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Undetermined Chrysophyte	cf. Kephyrion	3	3	8.65	8.65	262.88
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Aphanocapsa	A. cf delicatissima	5	125	14.42	360.53	254.69
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Aphanothece	Aphanothece cf. clathrata	2	120	5.77	346.11	309.24
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Chroococcus		2	15	5.77	43.26	126.76
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Dolichospermum		3	42	8.65	121.14	64157.26
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Gomphosphaeria aponina		2	56	5.77	161.52	1294791.57

This page intentionally left blank

Table D-1. Green Lake Phytoplankton Data for Summer of 2016.

Sample ID	Sample Station Name	Sample Client ID	Sample Date Collected	Sample Habitat	Sample Type	Division	Group	Taxon	Comment	NCU Count	Cell Count	Density NCU/mL	Density Cells/mL	Biovolume (um^3/mL)
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Merismopedia tenuissima		4	38	11.54	109.60	10464.83
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Cryptophyta	Others	Cryptomonas	2 species	15	15	43.26	43.26	7521.79
HEC16GLPH004	A734 - GREEN LK	P65729-6	8/8/2016	Surface Water	Grab	Cryptophyta	Others	Plagioselmis	Plagioselmis cf. nannoplanctica	10	10	28.84	28.84	1749.20
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Crucigenia		1	4	1.10	4.40	287.21
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Dictyosphaerium pulchellum		2	26	2.20	28.57	2213.12
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Monoraphidium		21	21	23.07	23.07	308.51
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Oocystis	2 species	87	286	95.59	314.25	265531.68
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Pediastrum boryanum		1	16	1.10	17.58	1994.09
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Quadrigula	Quadrigula cf. korsikovii	2	2	2.20	2.20	126.82
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Scenedesmus ellipticus		1	4	1.10	4.40	8523.46
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Schroederia		65	65	71.42	71.42	1621.51
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Sphaerocystis		2	15	2.20	16.48	1114.34
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Staurastrum		1	1	1.10	1.10	1075.20
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Achnanthidium		3	3	3.30	3.30	92.67
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Asterionella		1	1	1.10	1.10	154.55
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Aulacoseira		62	338	68.12	371.38	1664434.93
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Cocconeis		1	1	1.10	1.10	4175.23
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Cyclotella		3	3	3.30	3.30	568.77
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Dinobryon divergens		30	43	32.96	47.25	4678.09
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Fragilaria		5	9	5.49	9.89	2241.44
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Gloeobotrys	Gloeobotrys cf limneticus	7	35	7.69	38.46	2722.44
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Gomphonema		1	1	1.10	1.10	462.79
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Navicula		5	5	5.49	5.49	7607.41
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Nitzschia		3	3	3.30	3.30	461.75
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Stephanodiscus		4	4	4.40	4.40	118833.39
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Undetermined Chrysophyte	cf Kephyrion	3	3	3.30	3.30	154.73
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Aphanocapsa	A. cf delicatissima	11	275	12.09	302.16	79005.37
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Aphanothece	A.cf clathrata	37	560	40.65	615.31	733.61
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Chroococcus		1	30	1.10	32.96	92.50
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Dolichospermum		5	26	5.49	28.57	15891.96
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Gomphosphaeria aponina		22	440	24.17	483.46	2769028.49
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Merismopedia tenuissima		13	120	14.28	131.85	9913.19
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Pyrrhophyta	Others	Ceratium hirundinella		1	1	1.10	1.10	9070.46
HEC16GLPH005	A734 - GREEN LK	P65991-6	9/12/2016	Surface Water	Grab	Cryptophyta	Others	Cryptomonas		1	1	1.10	1.10	113.83
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Coelastrum pulchrum		1	24	0.71	16.95	573384.38
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Crucigenia		1	4	0.71	2.83	192.90
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Monoraphidium		2	2	1.41	1.41	25.12
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Mougeotia		1	1	0.71	0.71	406.98
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Oocystis		31	60	21.90	42.38	25001.03
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Paradoxia multiseta		2	4	1.41	2.83	75.83
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Pediastrum boryanum		2	14	1.41	9.89	1178.93
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Quadrigula	Quadrigula cf. korsikovii	2	12	1.41	8.48	492.85
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Scenedesmus		1	4	0.71	2.83	1166.31
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Schroederia	S. cf setigera	19	19	13.42	13.42	205.66
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chlorophyta	Chlorophyta	Tetraedron minimum		2	2	1.41	1.41	211.88
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Achnanthes		4	4	2.83	2.83	401.68
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Achnanthidium		4	4	2.83	2.83	74.04
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Asterionella		34	104	24.02	73.46	12010.50
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Aulacoseira	2 species	146	568	103.13	401.21	909578.58
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Botryococcus		1	35	0.71	24.72	539691.02
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Cocconeis		2	2	1.41	1.41	1506.80
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Cyclotella		3	3	2.12	2.12	535.02

This page intentionally left blank

Table D-1. Green Lake Phytoplankton Data for Summer of 2016.

Sample ID	Sample Station Name	Sample Client ID	Sample Date Collected	Sample Habitat	Sample Type	Division	Group	Taxon	Comment	NCU Count	Cell Count	Density NCU/mL	Density Cells/mL	Biovolume (um^3/mL)
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Dinobryon divergens		24	30	16.95	21.19	2411.72
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Epithemia		2	2	1.41	1.41	695.02
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Fragilaria		12	23	8.48	16.25	3485.81
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Gloeobotrys	Gloeobotrys cf limneticus	1	12	0.71	8.48	1097.70
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Gomphonema		1	1	0.71	0.71	97.74
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Navicula		6	6	4.24	4.24	856.32
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Nitzschia		12	12	8.48	8.48	1908.37
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Pinnularia		1	1	0.71	0.71	551.16
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Stephanodiscus		2	2	1.41	1.41	32193.08
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Bacillariophyta	Chrysophyta	Surirella		3	3	2.12	2.12	2631.65
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Chrysophyta	Chrysophyta	Undetermined Chrysophyte	cf Kephyrion	17	17	12.01	12.01	503.25
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Aphanocapsa		10	350	7.06	247.22	119.99
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Aphanothece		14	490	9.89	346.11	374.01
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Calothrix		1	8	0.71	5.65	1498.40
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Chroococcus		1	35	0.71	24.72	43.69
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Dolichospermum		11	93	7.77	65.69	64634.54
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Merismopedia tenuissima		4	32	2.83	22.60	2556.16
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Cyanophyta	Cyanophyta	Phormidium		1	30	0.71	21.19	26323.31
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Cryptophyta	Others	Cryptomonas	2 species	14	14	9.89	9.89	1470.46
HEC16GLPH006	A734 - GREEN LK	P66146-6	10/9/2016	Surface Water	Grab	Cryptophyta	Others	Plagioselmis	Plagioselmis cf. nannoplanctica	8	8	5.65	5.65	264.54

This page intentionally left blank