Lake Campbell Sediment Incubation Study Report

Prepared for
Skagit County

Prepared by
Herrera Environmental Consultants, Inc.

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1. Introduction

This report presents the results of a lake sediment incubation study conducted on Lake Campbell, located on Fidalgo Island in western Skagit County, Washington. This study was performed for Skagit County by Herrera Environmental Consultants, Inc. (Herrera), in partnership with Western Washington University, in response to a recommendation by the 2024 Lake Campbell Lake Cyanobacteria Management Plan (LCMP) (Herrera 2024). This study provides a better estimation of sediment phosphorus release and evaluates the effectiveness of an alum treatment at varying pH and oxygen conditions.

1.1. Background

In 1985, Lake Campbell was treated with aluminum sulfate ("alum") to reduce internal phosphorus sources fueling harmful algae (cyanobacteria) blooms (HABs); however, harmful blooms returned in the summer and fall of 2021, 2022, and 2023, exceeding the Washington State Department of Health recreational cyanotoxin guidelines. The 2024 LCMP, prepared by Herrera, agreed with the findings of previous studies (Entranco 1983, 1987) that phosphorus is the limiting nutrient for algae growth and most phosphorus input to the lake is from internal loading (sediment release) during the summer months. A long-term management approach was recommended, using a buffered aluminum sulfate ("alum") treatment to inactivate phosphorus in the sediments. The applied aluminum binds to mobile phosphorus released due to organic decomposition and chemical reduction and prevents the phosphorus from reaching the water column (Herrera 2024). A follow-up incubation study, addressed in this report, was recommended to better estimate sediment phosphorus release, evaluate the effectiveness of the alum treatment, and determine an optimum buffered alum dose to control toxic cyanobacteria blooms for at least 10 years.

1.2. Objectives

The objectives of the study described in this report include:

- Collect 16 sediment core samples from the deepest location of Lake Campbell (identified as the CAM-DEEP monitoring station in the LCMP)
- Collect vertical depth-profile parameters of temperature, dissolved oxygen, and pH at CAM-DEEP
- Expose 16 sediment cores and overlying water to varying oxygen, pH, and alum treatment conditions via an incubation experiment
- Measure temperature, dissolved oxygen, and pH and collect subsamples for analysis of total phosphorus (TP) and orthophosphate at 5 sampling events during the sediment incubation experiment
- Quantify internal phosphorus content of sediment in Lake Campbell

- Confirm the efficacy of the sediment inactivation alum and sodium aluminate dosage recommended by the LCMP

Each of the study objectives were met.

2. Study Methods

This section provides a high-level overview of the study's methodology. See the QAPP (Herrera 2024) for additional details.

- On August 19, 2024, 16 sediment cores were collected from the deepest location in Lake Campbell (CAM-DEEP) using a hammer corer. Before core collection, a vertical depth-profile of temperature, dissolved oxygen, and pH was completed, with measurements taken at half-meter increments to a depth of 5.0 meters. A 20-liter (L) carboy was filled with filtered (0.45 micron) lake water from a depth of approximately 4.5 meters and subsamples were collected for analysis of total phosphorus (TP) and orthophosphate.
- Eight (8) study groups were established (see Table 1) with a duplicate of each study group. These represent a combination of neutral or high pH (7 or 8.5 units), aerobic or anaerobic oxygen conditions, and alum treatment (no treatment or 18.0 g Al/m^2). The dosage was achieved by adding 0.5 mL of liquid aluminum sulfate (58 mg Al/mL) and 0.25 mL of liquid sodium aluminate buffer (146 mg Al/mL).
- Samples were taken from the sediment cores' overlying water at hour 0 (the start of incubation; HR 0), approximately 12 to 18 hours after beginning incubation (HR 12-18), 46 hours (HR 46), 70 hours (HR 70), and 185 hours (HR 185).
- Each overlying water sample was measured for temperature, dissolved oxygen (DO), and pH, and analyzed for orthophosphate and total phosphorus (TP).

Table 1. Redox Treatments of Sediment Cores.

Core Number	Oxygen Condition	pH Condition	Alum Treated	Description [a, b]
1	Aerobic	Neutral pH (~7)	No	Overlying water was bubbled with ambient air at a rate of 0.500 standard liter per minute (slm) and with CO_2 at a rate of 5.5106 standard cubic centimeters per minute (sccm).
2	Aerobic	Neutral pH (~7)	No	
3	Anaerobic	Neutral pH (~7)	No	Overlying water was bubbled with N_2 gas at a rate of 0.750 slm and with CO_2 at a rate of 7.700 sccm.
4	Anaerobic	Neutral pH (~7)	No	
5	Aerobic	High pH (~8.5)	No	Overlying water was bubbled with ambient air at a rate of 5.600 slm and with CO_2 at a rate of 0.400 sccm.
6	Aerobic	High pH (~8.5)	No	

7	Anaerobic	High pH (~8.5)	No	Overlying water was bubbled with N_2 gas at a rate of 3.700 slm and with CO_2 at a rate of 0.100 sccm.
8	Anaerobic	High pH (~8.5)	No	
9	Aerobic	Neutral pH (~7)	Yes	Overlying water was bubbled with ambient air at a rate of 0.500 slm and with CO_2 at a rate of 5.5106 sccm.
10	Aerobic	Neutral pH (~7)	Yes	0.5 milliliters (mL) of aluminum sulfate (0.0654 g alum) and 0.25 mL of sodium aluminate were added.
11	Anaerobic	Neutral pH (~7)	Yes	Overlying water was bubbled with N_2 gas at a rate of 0.750 slm and with CO_2 at a rate of 7.700 sccm.
12	Anaerobic	Neutral pH (~7)	Yes	0.5 milliliters (mL) of aluminum sulfate and 0.25 mL of sodium aluminate were added.
13	Aerobic	High pH (~8.5)	Yes	Overlying water was bubbled with ambient air at a rate of 5.600 slm and with CO_2 at a rate of 0.400 sccm.
14	Aerobic	High pH (~8.5)	Yes	0.5 milliliters (mL) of aluminum sulfate (0.0654 g alum) and 0.25 mL of sodium aluminate were added.
15	Anaerobic	High pH (~8.5)	Yes	Overlying water was bubbled with N_2 gas at a rate of 3.700 slm and with CO_2 at a rate of 0.100 sccm.
16	Anaerobic	High pH (~8.5)	Yes	0.5 milliliters (mL) of aluminum sulfate (0.0654 g alum) and 0.25 mL of sodium aluminate were added.

[a] In the QAPP, the gas injection was provided in terms of a concentration (e.g., 10,600 ppm CO_2). This table provides the flow rate of the bubbled pure gasses, which was modified throughout the study to maintain the target oxygen and pH conditions. The flow rate listed is of hour 185.

[b] The alum dose calculation is provided in the QAPP.

slm – standard liter per minute; sccm – standard cubic centimeter per minute.

mL – milliliters; g – grams

3. Quality Assurance Review

3.1. Deviations from Work Plan

Sampling was conducted in accordance with the Lake Campbell Phase II Sediment Incubation Study Quality Assurance Project Plan (QAPP) with the following exception:

We suspected the DO sensor measurements were inaccurate due to the continued level of oxygen measured in the anaerobic core study group (an average of 160.8 µmol/L at HR 185) despite being bubbled with pure nitrogen gas. While a minor amount of oxygen generation via photosynthesis may have occurred, the levels of measured oxygen were higher than would be expected in a dark chamber. For this reason, a YSI was used to measure DO at HR 185 (the last sampling event). Substantial differences in measurements were found between the YSI and the DO sensor. It is possible this may have been due to equipment or calibration issues. Based on the observed differences in oxygen concentrations between the aerobic and anaerobic cores during the incubation period, we believe that the anaerobic conditions were maintained for the desired cores.

3.2. Laboratory Data Review

Laboratory reports for the water samples underwent a quality assurance (QA) review, in accordance with the 2024 QAPP. The following deviation from the QAPP was noted during quality assurance review:

- Core 7 at HR 0 had a TP measurement of 459.1 µg P/L. This differed substantially from the rest of the cores at HR 0, which averaged 67.3 µg P/L. This data point was considered an outlier and re-analysis of the sample resulted in a far lower value. Therefore, this value was flagged for rejection (R) and was not used in the calculations.
- Core 3, from an anaerobic study group, at HR 185 was qualified as rejected (R) and not used in the calculations due to elevated measured DO in the sample according to YSI multimeter readings, which may have resulted in depressed orthophosphate and total phosphorus due to oxidation of iron in the sediment.
- The QAPP matrix spike recovery ranged from 80-100 percent. The core 8 (anaerobic, high pH) TP sample at HR 0 had a high spike recovery of 176 percent. The core 12 (anaerobic, neutral pH, alum treated) HR 46 and core 14 (aerobic, high pH, alum treated) HR 70 TP samples had a low recovery rate, 76 percent and 72 percent, respectively. It is possible this may have been due to a matrix interference. These data were qualified as estimated (J).

The quality assurance review determined that the laboratory results are valid and acceptable for use with no further qualification.

4. Results

4.1. Aluminum Concentration

The measured aluminum concentration in the alum sample was 60.1 g/L and in the sodium aluminate sample was 108.0 g/L. For the dosage calculations, the assumed concentrations were 57.9 g/L and 146 g/L, respectively. The aluminum concentration in alum between the assumed and measured were comparable; however, the aluminum concentration in the sodium aluminate was approximately three-quarters that assumed. This resulted in an aluminum dose of 57.1 mg or 15.7 g/m^2, compared to the planned dose of 65.4 mg or 18.0 g/m^2, which is 13 percent lower.

4.2. Physical Measurements of Overlying Water

A comparison of DO, pH, and temperature between the study groups is shown in

Figure 1. Duplicate cores within a study group are represented by red and blue lines labeled with core numbers. The dashed line represents the time alum was added to the cores receiving alum treatment. Conditions prior to treatment are to the left of the dashed line and conditions post-treatment are to the right of the dashed line.

Key DO observations include:

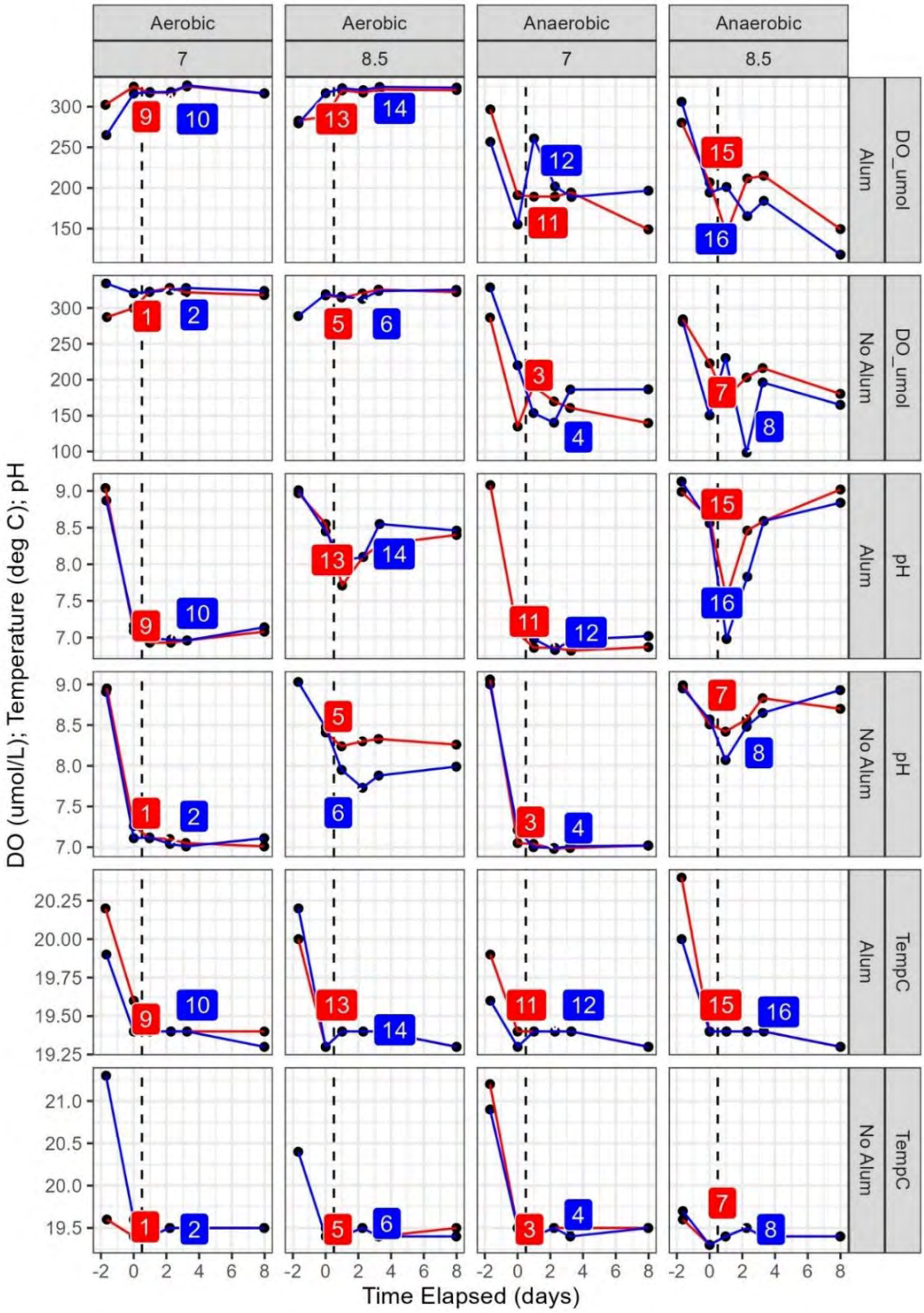
- Oxygen levels in the anaerobic study group were lower than in the aerobic study group. As noted above, there were concerns with the accuracy of the DO sensor, but these results can be interpreted qualitatively such that we are confident that the anaerobic cores experienced depleted oxygen levels during the incubation period.

Key pH observations include:

- The pH measurements in cores not treated with alum remained relatively stable in the neutral pH group, with some variability in the pH 8.5 group (high pH group).
- Core 6, in the aerobic, high pH, untreated experimental group, became more acidic than its duplicate, core 5, and exhibited a higher-than-expected phosphorus concentration and release rate under those lower pH conditions.
- The experimental groups receiving the alum treatment were also dosed with sodium aluminate (a pH buffer). All 8 of 8 cores in this treatment group experienced a drop in pH after the alum dose, with more marked decreases in the high pH group. The decrease in pH was expected due to the acidic nature of the aluminum hydroxide floc forming from the alum reacting with water.
- In the alum treated high pH experimental group, the most substantial drop in pH was observed in anaerobic conditions. For example, cores 15 and 16 had a pH of 8.63 and 8.56 (respectively) prior to the alum dose and a pH of 7.54 and 6.98 (respectively) after the addition of alum. This demonstrates the importance of properly applying alum with a buffer and monitoring pH to avoid impacts on aquatic biota.

For temperature, the key observation was that the temperature of the overlying core water during incubation (averaging 19.4 degrees Celsius (°C) at hour 185) was slightly lower than that of the lake at a depth of 5 meters (20.5 degrees Celsius (°C).

Figure 1. Dissolved Oxygen, Temperature, and pH over time.



4.3. Phosphorus Measurements

A comparison of total phosphorus (TP) and orthophosphate concentrations between the study groups is shown in Figure 2. Duplicate cores within a study group are represented by red and blue lines labeled with core numbers. The dashed line represents the time alum was added to the cores receiving alum treatment. Conditions prior to treatment are to the left of the dashed line and conditions post-treatment are to the right of the dashed line.

Key findings include:

- The concentrations of total phosphorus (TP) and orthophosphate were lower in the aerobic experimental group than in the anaerobic experimental group not treated with alum.
- TP and orthophosphate concentrations remained stable throughout the study in the aerobic groups, except in core 6 (aerobic, high pH, untreated), for which orthophosphate increased by nearly 50 times the original concentration by the end of the study. The higher-than-expected concentration and release rate may be due to natural variation in the samples.
- There was a decrease in TP and an increase in orthophosphate, over time, in the anaerobic, neutral pH group not treated with alum. TP and orthophosphate both increased throughout the study in the anaerobic, high pH, untreated group.
- In all alum dosed cores, at the first sampling event post-alum treatment (HR 12-18), concentrations were less than the detection limits, (5.0 µg/L) in 5 of 8 cores, and (3.0 µg/L) 8 of 8 cores, for TP and orthophosphate, respectively.
- Following the initial substantial decline in TP and orthophosphate in all treated cores after the alum application, concentrations increased slightly through the end of the study. Despite this, TP remained low in alum-treated cores, with an HR 185 average of 6.9 µg P/L for the aerobic neutral pH group, 13.2 µg P/L for the aerobic high pH group, 13.5 µg P/L for the anaerobic neutral pH group, and 16.7 µg P/L for the anaerobic high pH group.
- Orthophosphate remained low throughout the study in all alum-treated groups, with 5 of 8 cores remaining under the detection limit at hour 185. Core 15, in the anaerobic, high pH group, core 14, in the aerobic, high pH group, and core 12 in the anaerobic, neutral pH group still had detectible concentrations of 6.7 µg/L, 3.1 µg/L, and 8.3 µg/L, respectively. Table 2 and Table 3 list TP and orthophosphate concentrations of the overlying core water, respectively, over time.

Figure 2. Concentration of Orthophosphate and Total Phosphorus Over Time.

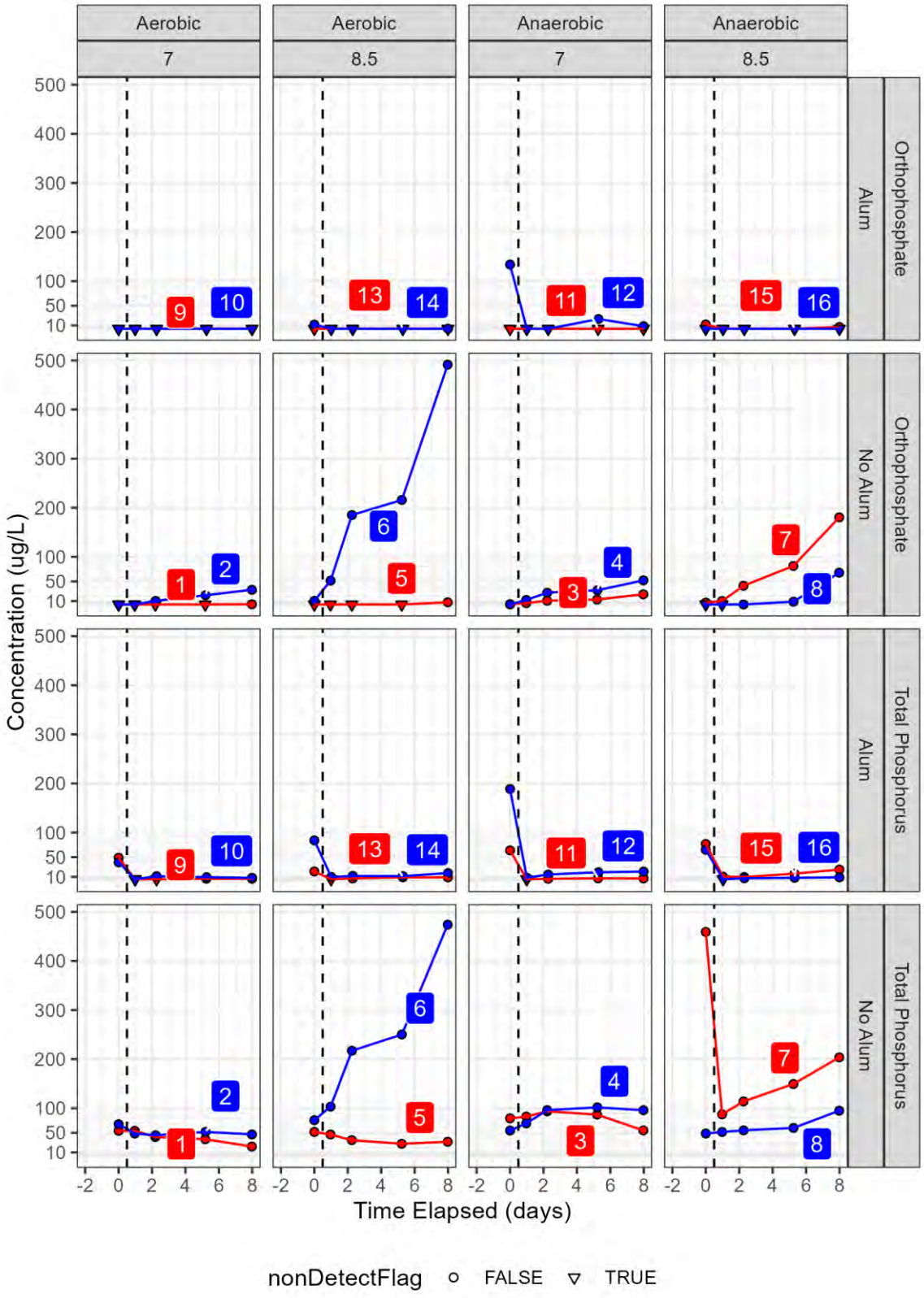


Table 2. Total Phosphorus Concentration and Mass of Overlying Core Water.													
					Total Phosphorus								
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
1	HR0	8/21/2024 10:06	45	40	54.1		49.1	0.0	0.0	0.0	0.0	49.1	NA
1	HR12-18	8/22/2024 9:15	75	75	54.1		49.1	2.4	1.3	-1.2	-1.2	50.3	1.1
1	HR46	8/23/2024 14:50	75	75	41.5		37.7	4.1	2.4	-1.7	-2.8	40.5	-9.8
1	HR70	8/26/2024 14:28	75	75	37.0		33.6	3.1	2.4	-0.7	-3.6	37.1	-3.4
1	HR185	8/29/2024 9:26	75	0	22.1		20.1	2.8	2.4	-0.4	-4.0	24.0	-13.1
2	HR0	8/21/2024 10:11	45	40	67.5		61.3	0.0	0.0	0.0	0.0	61.3	NA
2	HR12-18	8/22/2024 9:22	75	75	48.6		44.1	3.0	1.3	-1.8	-1.8	45.9	-15.4
2	HR46	8/23/2024 15:18	75	75	45.0		40.9	3.6	2.4	-1.3	-3.0	43.9	-2.0
2	HR70	8/26/2024 14:59	75	75	51.9		47.1	3.4	2.4	-1.0	-4.0	51.1	7.2
2	HR185	8/29/2024 9:34	75	0	46.7		42.4	3.9	2.4	-1.5	-5.5	48.0	-3.2

Table 2 (continued). Total Phosphorus Concentration and Mass of Overlying Core Water.														
					Total Phosphorus									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
3	HR0	8/21/2024 10:16	45	40	79.5		72.2	0.0	0.0	0.0	0.0	72.2	NA
3	HR12-18	8/22/2024 9:28	70	70	83.0		75.4	3.6	1.3	-2.3	-2.3	77.7	5.5
3	HR46	8/23/2024 15:33	75	75	93.8		85.2	5.8	2.2	-3.6	-5.9	91.1	13.4
3	HR70	8/26/2024 15:15	150	150	87.1		79.0	7.0	2.4	-4.7	-10.5	89.6	-1.5
3	HR185	8/29/2024 9:42	75	0	55.0	R	49.9	13.1	4.8	-8.3	-18.8	68.7	-20.9
4	HR0	8/21/2024 10:21	45	40	54.6		49.6	0.0	0.0	0.0	0.0	49.6	NA
4	HR12-18	8/22/2024 9:33	75	75	69.2		62.8	2.5	1.3	-1.2	-1.2	64.0	14.4
4	HR46	8/23/2024 15:44	85	85	96.2		87.4	5.2	2.4	-2.8	-4.0	91.4	27.4
4	HR70	8/26/2024 15:41	75	75	101.8		92.5	8.2	2.7	-5.5	-9.5	101.9	10.5
4	HR185	8/29/2024 9:52	75	0	96.0		87.2	7.6	2.4	-5.3	-14.7	101.9	0.0

Table 2 (continued). Total Phosphorus Concentration and Mass of Overlying Core Water.														
					Total Phosphorus									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
5	HR0	8/21/2024 10:26	75	70	51.8		47.1	0.0	0.0	0.0	0.0	47.1	NA
5	HR12-18	8/22/2024 9:36	75	75	46.5		42.2	3.9	2.2	-1.7	-1.7	43.9	-3.2
5	HR46	8/23/2024 16:16	75	75	35.0		31.8	3.5	2.4	-1.1	-2.8	34.6	-9.3
5	HR70	8/26/2024 15:53	75	75	27.7		25.1	2.6	2.4	-0.2	-3.0	28.1	-6.5
5	HR185	8/29/2024 9:58	75	0	31.8		28.8	2.1	2.4	0.3	-2.7	31.5	3.4
6	HR0	8/21/2024 10:31	45	40	75.8		68.8	0.0	0.0	0.0	0.0	68.8	NA
6	HR12-18	8/22/2024 9:51	75	75	103.4		93.9	3.4	1.3	-2.1	-2.1	96.0	27.2
6	HR46	8/23/2024 16:30	75	75	217.2		197.2	7.8	2.4	-5.4	-7.5	204.7	108.7
6	HR70	8/26/2024 16:11	75	75	250.3		227.2	16.3	2.4	-13.9	-21.4	248.6	43.9
6	HR185	8/29/2024 10:00	75	0	474.0		430.4	18.8	2.4	-16.4	-37.8	468.2	219.6

Table 2 (continued). Total Phosphorus Concentration and Mass of Overlying Core Water.														
					Total Phosphorus									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
7	HR0	8/21/2024 10:36	44	39	459.1	R	416.8	0.0	0.0	0.0	0.0	416.8	NA
7	HR12-18	8/22/2024 9:59	75	75	87.6		79.6	20.2	1.2	-19.0	-19.0	98.5	-318.3
7	HR46	8/23/2024 16:45	75	75	113.9		103.4	6.6	2.4	-4.2	-23.1	126.5	28.0
7	HR70	8/26/2024 16:24	75	75	149.4		135.6	8.5	2.4	-6.2	-29.3	164.9	38.4
7	HR185	8/29/2024 10:15	75	0	203.7		184.9	11.2	2.4	-8.8	-38.1	223.0	58.1
8	HR0	8/21/2024 10:46	45	40	48.7	J	44.2	0.0	0.0	0.0	0.0	44.2	NA
8	HR12-18	8/22/2024 10:11	75	75	51.7		46.9	2.2	1.3	-0.9	-0.9	47.9	3.7
8	HR46	8/23/2024 17:00	75	75	55.1		50.0	3.9	2.4	-1.5	-2.4	52.4	4.6
8	HR70	8/26/2024 16:40	75	75	59.9		54.4	4.1	2.4	-1.7	-4.2	58.5	6.1
8	HR185	8/29/2024 10:20	75	0	95.0		86.3	4.5	2.4	-2.1	-6.3	92.5	34.0

Table 2 (continued). Total Phosphorus Concentration and Mass of Overlying Core Water.														
					Total Phosphorus									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
9	HR0	8/21/2024 10:51	43	38	48.6		44.1	0.0	0.0	0.0	0.0	44.1	NA
9	HR12-18	8/22/2024 10:29	79	79	5.0 U		4.5	2.1	1.2	-0.9	-0.9	5.4	-38.7
9	HR46	8/23/2024 17:20	75	75	5.0 U		4.5	0.4	2.5	2.1	1.2	3.3	-2.1
9	HR70	8/26/2024 16:51	85	85	6.0		5.4	0.4	2.4	2.0	3.2	2.2	-1.1
9	HR185	8/29/2024 10:25	75	0	5.9		5.4	0.5	2.7	2.2	5.4	-0.1	-2.3
10	HR0	8/21/2024 10:56	45	40	39.4		35.8	0.0	0.0	0.0	0.0	35.8	NA
10	HR12-18	8/22/2024 10:45	75	75	5.0 U		4.5	1.8	1.3	-0.5	-0.5	5.0	-30.7
10	HR46	8/23/2024 17:30	150	150	11.1		10.1	0.4	2.4	2.0	1.5	8.6	3.5
10	HR70	8/26/2024 17:16	75	75	9.1		8.3	1.7	4.8	3.1	4.6	3.7	-4.9
10	HR185	8/29/2024 10:31	75	0	7.8		7.1	0.7	2.4	1.7	6.3	0.8	-2.9

Table 2 (continued). Total Phosphorus Concentration and Mass of Overlying Core Water.														
					Total Phosphorus									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
11	HR0	8/21/2024 11:01	45	40	63.7		57.8	0.0	0.0	0.0	0.0	57.8	NA
11	HR12-18	8/22/2024 10:58	75	75	5.0 U		4.5	2.9	1.3	-1.6	-1.6	6.1	-51.7
11	HR46	8/23/2024 17:43	75	75	5.9		5.4	0.4	2.4	2.0	0.4	4.9	-1.2
11	HR70	8/26/2024 17:26	75	75	6.9		6.2	0.4	2.4	1.9	2.4	3.9	-1.1
11	HR185	8/29/2024 10:40	75	0	6.5		5.9	0.5	2.4	1.9	4.2	1.7	-2.2
12	HR0	8/21/2024 11:06	45	40	188.8		171.4	0.0	0.0	0.0	0.0	171.4	NA
12	HR12-18	8/22/2024 11:05	75	75	8.1		7.3	8.5	1.3	-7.2	-7.2	14.6	-156.8
12	HR46	8/23/2024 17:55	75	75	14.5	J	13.2	0.6	2.4	1.8	-5.4	18.6	4.1
12	HR70	8/26/2024 18:03	75	75	19.2		17.4	1.1	2.4	1.3	-4.1	21.5	2.9
12	HR185	8/29/2024 10:55	150	0	20.5		18.7	1.4	2.4	0.9	-3.2	21.9	0.3

Table 2 (continued). Total Phosphorus Concentration and Mass of Overlying Core Water.														
					Total Phosphorus									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
13	HR0	8/21/2024 11:11	45	40	20.8		18.9	0.0	0.0	0.0	0.0	18.9	NA
13	HR12-18	8/22/2024 11:15	75	75	5.0 U		4.5	0.9	1.3	0.3	0.3	4.2	-14.7
13	HR46	8/23/2024 18:09	75	75	6.6		6.0	0.4	2.4	2.0	2.3	3.6	-0.6
13	HR70	8/26/2024 18:14	75	75	8.9		8.1	0.5	2.4	1.9	4.2	3.9	0.3
13	HR185	8/29/2024 11:02	75	0	8.9		8.0	0.7	2.4	1.7	5.9	2.1	-1.8
14	HR0	8/21/2024 11:16	45	40	84.2		76.4	0.0	0.0	0.0	0.0	76.4	NA
14	HR12-18	8/22/2024 11:33	75	75	9.5		8.6	3.8	1.3	-2.5	-2.5	11.2	-65.2
14	HR46	8/23/2024 18:24	75	75	11.7		10.6	0.7	2.4	1.7	-0.8	11.5	0.3
14	HR70	8/26/2024 18:22	75	75	11.3	J	10.3	0.9	2.4	1.5	0.7	9.6	-1.9
14	HR185	8/29/2024 11:10	75	0	17.5		15.9	0.8	2.4	1.5	2.2	13.7	4.1

Table 2 (continued). Total Phosphorus Concentration and Mass of Overlying Core Water.														
					Total Phosphorus									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
15	HR0	8/21/2024 11:21	45	40	76.8		69.7	0.0	0.0	0.0	0.0	69.7	NA
15	HR12-18	8/22/2024 12:01	85	85	10.2		9.3	3.5	1.3	-2.2	-2.2	11.5	-58.3
15	HR46	8/23/2024 18:38	75	75	9.4		8.6	0.9	2.7	1.8	-0.4	8.9	-2.6
15	HR70	8/26/2024 18:46	75	75	16.3		14.8	0.7	2.4	1.7	1.3	13.5	4.6
15	HR185	8/29/2024 11:11	75	0	24.6		22.4	1.2	2.4	1.2	2.5	19.9	6.4
16	HR0	8/21/2024 11:26	55	50	64.9		59.0	0.0	0.0	0.0	0.0	59.0	NA
16	HR12-18	8/22/2024 12:15	144	144	5.0 U		4.5	3.6	1.6	-2.0	-2.0	6.5	-52.4
16	HR46	8/23/2024 18:46	75	75	6.9		6.3	0.7	4.6	3.9	1.9	4.4	-2.1
16	HR70	8/26/2024 18:57	75	75	7.9		7.2	0.5	2.4	1.9	3.7	3.4	-1.0
16	HR185	8/29/2024 11:20	75	0	8.9		8.0	0.6	2.4	1.8	5.5	2.5	-0.9

[a] Values immediately followed by "U" signify the measurement was under the TP detection limit of 5.0 µg/L.

J – estimated R – rejected

mL – milliliters µg –micrograms µg/L –micrograms per liter

Table 3. Orthophosphate Concentration and Mass of Overlying Core Water.														
					Orthophosphate									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
1	HR0	8/21/2024 10:06	45	40	3.0 U		2.7	0.0	0.0	0.0	0.0	2.7	NA
1	HR12-18	8/22/2024 9:15	75	75	3.0 U		2.7	0.1	0.6	0.4	0.4	2.3	-0.4
1	HR46	8/23/2024 14:50	75	75	3.0 U		2.7	0.2	1.1	0.8	1.3	1.5	-0.8
1	HR70	8/26/2024 14:28	75	75	3.0 U		2.7	0.2	1.1	0.8	2.1	0.6	-0.8
1	HR185	8/29/2024 9:26	75	0	3.5		3.2	0.2	1.1	0.8	2.9	0.2	-0.4
2	HR0	8/21/2024 10:11	45	40	3.0 U		2.7	0.0	0.0	0.0	0.0	2.7	NA
2	HR12-18	8/22/2024 9:22	75	75	3.0 U		2.7	0.1	0.6	0.4	0.4	2.3	-0.4
2	HR46	8/23/2024 15:18	75	75	10.4		9.4	0.2	1.1	0.8	1.3	8.2	5.9
2	HR70	8/26/2024 14:59	75	75	21.8		19.8	0.8	1.1	0.3	1.5	18.3	10.1
2	HR185	8/29/2024 9:34	75	0	33.0		29.9	1.6	1.1	-0.6	1.0	29.0	10.7

Table 3 (continued). Orthophosphate Concentration and Mass of Overlying Core Water.														
					Orthophosphate									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
3	HR0	8/21/2024 10:16	45	40	3.6		3.3	0.0	0.0	0.0	0.0	3.3	NA
3	HR12-18	8/22/2024 9:28	70	70	5.7		5.2	0.2	0.6	0.4	0.4	4.8	1.5
3	HR46	8/23/2024 15:33	75	75	10.8		9.8	0.4	1.0	0.6	1.0	8.8	4.0
3	HR70	8/26/2024 15:15	150	150	13.2		11.9	0.8	1.1	0.2	1.2	10.7	1.9
3	HR185	8/29/2024 9:42	75	0	23.7	R	21.5	2.0	2.1	0.1	1.4	20.1	9.4
4	HR0	8/21/2024 10:21	45	40	3.2		2.9	0.0	0.0	0.0	0.0	2.9	NA
4	HR12-18	8/22/2024 9:33	75	75	12.3		11.1	0.1	0.6	0.4	0.4	10.7	7.8
4	HR46	8/23/2024 15:44	85	85	27.0		24.5	0.9	1.1	0.1	0.6	24.0	13.2
4	HR70	8/26/2024 15:41	75	75	32.0		29.0	2.3	1.2	-1.1	-0.5	29.6	5.6
4	HR185	8/29/2024 9:52	75	0	52.1		47.3	2.4	1.1	-1.3	-1.9	49.2	19.6

Table 3 (continued). Orthophosphate Concentration and Mass of Overlying Core Water.														
					Orthophosphate									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
5	HR0	8/21/2024 10:26	75	70	3.0 U		2.7	0.0	0.0	0.0	0.0	2.7	NA
5	HR12-18	8/22/2024 9:36	75	75	3.0 U		2.7	0.2	1.0	0.8	0.8	2.0	-0.8
5	HR46	8/23/2024 16:16	75	75	3.0 U		2.7	0.2	1.1	0.8	1.6	1.1	-0.8
5	HR70	8/26/2024 15:53	75	75	3.0 U		2.7	0.2	1.1	0.8	2.4	0.3	-0.8
5	HR185	8/29/2024 9:58	75	0	7.4		6.8	0.2	1.1	0.8	3.3	3.5	3.2
6	HR0	8/21/2024 10:31	45	40	10.5		9.5	0.0	0.0	0.0	0.0	9.5	NA
6	HR12-18	8/22/2024 9:51	75	75	51.5		46.8	0.5	0.6	0.1	0.1	46.7	37.2
6	HR46	8/23/2024 16:30	75	75	185.2		168.1	3.9	1.1	-2.8	-2.7	170.9	124.2
6	HR70	8/26/2024 16:11	75	75	215.9		196.0	13.9	1.1	-12.8	-15.5	211.6	40.7
6	HR185	8/29/2024 10:00	75	0	491.4		446.2	16.2	1.1	-15.1	-30.7	476.9	265.3

Table 3 (continued). Orthophosphate Concentration and Mass of Overlying Core Water.														
					Orthophosphate									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
7	HR0	8/21/2024 10:36	44	39	6.8		6.2	0.0	0.0	0.0	0.0	6.2	NA
7	HR12-18	8/22/2024 9:59	75	75	10.1		9.1	0.3	0.5	0.2	0.2	8.9	2.7
7	HR46	8/23/2024 16:45	75	75	41.1		37.3	0.8	1.1	0.3	0.6	36.8	27.9
7	HR70	8/26/2024 16:24	75	75	81.6		74.0	3.1	1.1	-2.0	-1.5	75.5	38.7
7	HR185	8/29/2024 10:15	75	0	180.4		163.8	6.1	1.1	-5.1	-6.5	170.3	94.8
8	HR0	8/21/2024 10:46	45	40	3.0 U		2.7	0.0	0.0	0.0	0.0	2.7	NA
8	HR12-18	8/22/2024 10:11	75	75	3.0 U		2.7	0.1	0.6	0.4	0.4	2.3	-0.4
8	HR46	8/23/2024 17:00	75	75	3.1		2.8	0.2	1.1	0.8	1.3	1.5	-0.8
8	HR70	8/26/2024 16:40	75	75	8.7		7.9	0.2	1.1	0.8	2.1	5.8	4.3
8	HR185	8/29/2024 10:20	75	0	67.8		61.6	0.6	1.1	0.4	2.5	59.1	53.3

Table 3 (continued). Orthophosphate Concentration and Mass of Overlying Core Water.														
					Orthophosphate									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
9	HR0	8/21/2024 10:51	43	38	3.0 U		2.7	0.0	0.0	0.0	0.0	2.7	NA
9	HR12-18	8/22/2024 10:29	79	79	3.0 U		2.7	0.1	0.5	0.4	0.4	2.3	-0.4
9	HR46	8/23/2024 17:20	75	75	3.0 U		2.7	0.2	1.1	0.9	1.3	1.4	-0.9
9	HR70	8/26/2024 16:51	85	85	3.0 U		2.7	0.2	1.1	0.8	2.1	0.6	-0.8
9	HR185	8/29/2024 10:25	75	0	3.0 U		2.7	0.3	1.2	0.9	3.1	-0.3	-0.9
10	HR0	8/21/2024 10:56	45	40	3.0 U		2.7	0.0	0.0	0.0	0.0	2.7	NA
10	HR12-18	8/22/2024 10:45	75	75	3.0 U		2.7	0.1	0.6	0.4	0.4	2.3	-0.4
10	HR46	8/23/2024 17:30	150	150	3.0 U		2.7	0.2	1.1	0.8	1.3	1.5	-0.8
10	HR70	8/26/2024 17:16	75	75	3.0 U		2.7	0.5	2.1	1.7	2.9	-0.2	-1.7
10	HR185	8/29/2024 10:31	75	0	3.0 U		2.7	0.2	1.1	0.8	3.8	-1.0	-0.8

Table 3 (continued). Orthophosphate Concentration and Mass of Overlying Core Water.														
					Orthophosphate									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
11	HR0	8/21/2024 11:01	45	40	3.0 U		2.7	0.0	0.0	0.0	0.0	2.7	NA
11	HR12-18	8/22/2024 10:58	75	75	3.0 U		2.7	0.1	0.6	0.4	0.4	2.3	-0.4
11	HR46	8/23/2024 17:43	75	75	3.0 U		2.7	0.2	1.1	0.8	1.3	1.5	-0.8
11	HR70	8/26/2024 17:26	75	75	3.0 U		2.7	0.2	1.1	0.8	2.1	0.6	-0.8
11	HR185	8/29/2024 10:40	75	0	3.0 U		2.7	0.2	1.1	0.8	2.9	-0.2	-0.8
12	HR0	8/21/2024 11:06	45	40	133.8		121.5	0.0	0.0	0.0	0.0	121.5	NA
12	HR12-18	8/22/2024 11:05	75	75	3.0 U		2.7	6.0	0.6	-5.5	-5.5	8.2	-113.3
12	HR46	8/23/2024 17:55	75	75	3.0 U		2.7	0.2	1.1	0.8	-4.6	7.3	-0.8
12	HR70	8/26/2024 18:03	75	75	22.9		20.8	0.2	1.1	0.8	-3.8	24.6	17.2
12	HR185	8/29/2024 10:55	150	0	8.3		7.5	1.7	1.1	-0.7	-4.5	12.0	-12.6

Table 3 (continued). Orthophosphate Concentration and Mass of Overlying Core Water.														
					Orthophosphate									
Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
13	HR0	8/21/2024 11:11	45	40	3.0 U		2.7	0.0	0.0	0.0	0.0	2.7	NA
13	HR12-18	8/22/2024 11:15	75	75	3.0 U		2.7	0.1	0.6	0.4	0.4	2.3	-0.4
13	HR46	8/23/2024 18:09	75	75	3.0 U		2.7	0.2	1.1	0.8	1.3	1.5	-0.8
13	HR70	8/26/2024 18:14	75	75	3.0 U		2.7	0.2	1.1	0.8	2.1	0.6	-0.8
13	HR185	8/29/2024 11:02	75	0	3.0 U		2.7	0.2	1.1	0.8	2.9	-0.2	-0.8
14	HR0	8/21/2024 11:16	45	40	11.5		10.4	0.0	0.0	0.0	0.0	10.4	NA
14	HR12-18	8/22/2024 11:33	75	75	3.0 U		2.7	0.5	0.6	0.0	0.0	2.7	-7.7
14	HR46	8/23/2024 18:24	75	75	3.0 U		2.7	0.2	1.1	0.8	0.9	1.8	-0.8
14	HR70	8/26/2024 18:22	75	75	3.0 U		2.7	0.2	1.1	0.8	1.7	1.0	-0.8
14	HR185	8/29/2024 11:10	75	0	3.1		2.9	0.2	1.1	0.8	2.5	0.3	-0.7

Table 3 (continued). Orthophosphate Concentration and Mass of Overlying Core Water.

Core	Batch	Date/Time	Volume Pulled (mL)	Volume Added from Carboy (mL)	Orthophosphate								
					Concentration [a] (µg/L)	Flag	Mass (µg)	Mass Removed Before Sample (µg)	Mass Added Before Sample (µg)	Net Mass Added/ Removed (µg)	Cumulative Mass Added/ Removed (µg)	Corrected Mass (µg)	Change in Mass (µg)
15	HR0	8/21/2024 11:21	45	40	11.7		10.7	0.0	0.0	0.0	0.0	10.7	NA
15	HR12-18	8/22/2024 12:01	85	85	3.0 U		2.7	0.5	0.6	0.0	0.0	2.7	-8.0
15	HR46	8/23/2024 18:38	75	75	3.0 U		2.7	0.3	1.2	0.9	1.0	1.7	-0.9
15	HR70	8/26/2024 18:46	75	75	3.0 U		2.7	0.2	1.1	0.8	1.8	0.9	-0.8
15	HR185	8/29/2024 11:11	75	0	6.7		6.1	0.2	1.1	0.8	2.6	3.4	2.5
16	HR0	8/21/2024 11:26	55	50	3.0 U		2.7	0.0	0.0	0.0	0.0	2.7	NA
16	HR12-18	8/22/2024 12:15	144	144	3.0 U		2.7	0.2	0.7	0.5	0.5	2.2	-0.5
16	HR46	8/23/2024 18:46	75	75	3.0 U		2.7	0.4	2.0	1.6	2.1	0.6	-1.6
16	HR70	8/26/2024 18:57	75	75	3.0 U		2.7	0.2	1.1	0.8	3.0	-0.2	-0.8
16	HR185	8/29/2024 11:20	75	0	3.0 U		2.7	0.2	1.1	0.8	3.8	-1.1	-0.8

[a] Values immediately followed by "U" signify the measurement was under the orthophosphate detection limit of 3.0 µg/L.

J – estimated R – rejected

mL – milliliters µg –micrograms µg/L –micrograms per liter

4.4. Phosphorus Flux Rate

Phosphorus flux rate refers to the rate at which phosphorus (the mass of phosphorus) is released from the sediments into the overlying water, per a specific unit of time. Phosphorus flux rates can give us an indication of the lake's internal loading.

The mass of TP and orthophosphate in the overlying core water was calculated by taking the phosphorus concentration in the core water ($C_{i,j} * V_{i,j}$) at a specific sampling event, adding the concentration of phosphorus in the water removed at the previous sampling event ($VolumeRemoved_{i-1,j} * C_{i-1,j}$), and subtracting the concentration of phosphorus in the water replaced at the same previous sampling event $\left(VolumeReplaced_{i-1,j} * C_{carboy}\right)$. The equation used is listed below:

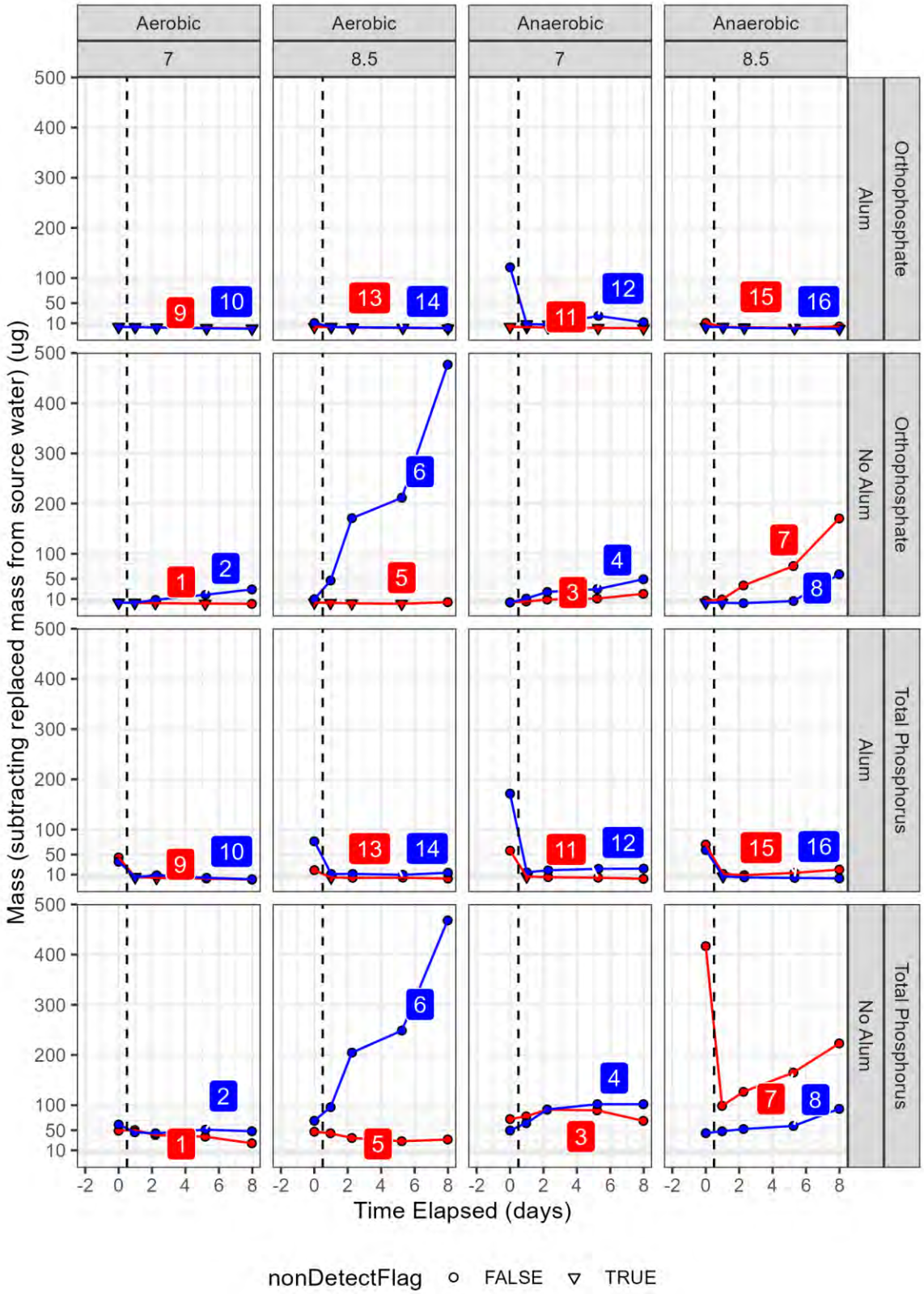
$$Mass_{i,j} = C_{i,j} * V_{i,j} - \left(VolumeReplaced_{i-1,j} * C_{carboy}\right) + (VolumeRemoved_{i-1,j} * C_{i-1,j})$$

Where

- i is the time step, and j is the core
- C is the concentration of phosphorus (TP or orthophosphate)
- V is the volume of the core's overlying water
- *VolumeRemoved* is the volume of overlying water removed from the core
- *VolumeReplaced* is the volume of water used to replace the overlying core water removed
- *carboy* is filtered lake water used to replace the overlying core water

A comparison of the mass of TP and orthophosphate concentrations between the study groups is shown in Figure 3. Duplicate cores within a study group are represented by red and blue lines labeled with core numbers. The dashed line represents the time alum was added to the cores receiving alum treatment. Conditions prior to treatment are to the left of the dashed line and conditions post-treatment are to the right of the dashed line.

Figure 3. Mass of Orthophosphate and Total Phosphorus Over Time.



The flux rate of the alum dosed cores was calculated using a linear regression slope, beginning at the HR 12-18 sampling event and ending at the HR 185 sampling event (the last sampling event). The flux rate of the cores that did not receive alum was calculated using a linear regression slope, beginning at the HR 0 sampling event and ending at the HR 185 sampling event.

Total phosphorus and orthophosphate flux rates are shown in Table 4. Negative flux rates under aerobic and neutral pH conditions are likely indicative of the settling rate of phosphorus (-0.18 to -0.87 $mg/m^2/day$). As mentioned previously, the following samples collected at these specific time steps were not used in the flux rate calculations:

- Core 7 at HR 0 (outlier; total TP concentration differed substantially from the rest of the cores at HR 0)
- Core 3 at HR 185 (removed due to oxygenation of sample, according to YSI)

Table 4. Total Phosphorus and Orthophosphate Flux Rates.

Core	Oxygen Condition	pH Condition	Alum Treated	TP Flux Rate		Orthophosphate Flux Rate	
				($mg/m^2/day$) (regression slope)	Regression p-value	($mg/m^2/day$) (regression slope)	Regression p-value
1	Aerobic	7	No Alum	**-0.87**	**0.007**	**-0.09**	**0.007**
2	Aerobic	7	No Alum	-0.18	0.603	**0.95**	**0.001**
3	Anaerobic	7	No Alum	0.90	0.195	*0.39*	*0.057*
4	Anaerobic	7	No Alum	*1.73*	*0.057*	**1.46**	**0.005**
5	Aerobic	8.5	No Alum	*-0.57*	*0.075*	0.02	0.821
6	Aerobic	8.5	No Alum	**12.93**	**0.006**	**14.93**	**0.008**
7	Anaerobic	8.5	No Alum	**4.70**	**0.006**	**6.04**	**0.023**
8	Anaerobic	8.5	No Alum	**1.52**	**0.021**	*1.74*	*0.084*
9	Aerobic	7	Alum	**-0.20**	**0.027**	**-0.10**	**0.012**
10	Aerobic	7	Alum	-0.23	0.194	**-0.13**	**0.011**
11	Anaerobic	7	Alum	**-0.16**	**0.014**	**-0.09**	**0.012**
12	Anaerobic	7	Alum	0.27	0.103	0.33	0.534

$mg/m^2/day$ –milligrams per square meter per day

Table 4 (continued). Total Phosphorus and Orthophosphate Flux Rates.							
				TP Flux Rate		Orthophosphate Flux Rate	
Core	**Oxygen Condition**	**pH Condition**	**Alum Treated**	**(mg/m^2/day) (regression slope)**	**Regression p-value**	**(mg/m^2/day) (regression slope)**	**Regression p-value**
13	Aerobic	8.5	Alum	-0.07	0.156	**-0.09**	**0.012**
14	Aerobic	8.5	Alum	0.07	0.531	**-0.09**	**0.016**
15	Anaerobic	8.5	Alum	0.37	0.104	0.02	0.755
16	Anaerobic	8.5	Alum	*-0.14*	*0.069*	*-0.12*	*0.054*

mg/m^2/day –milligrams per square meter per day

5. Conclusions and Recommendations

The results agree with the long-standing understanding that oxygen and pH have an impact on total phosphorus and orthophosphate release from sediments in lakes. In the Lake Campbell sediment incubation study, phosphorus concentrations and flux rates generally increased under anaerobic conditions and were further elevated in anaerobic conditions with a higher pH (pH 8.5).

The alum treatment substantially decreased TP and orthophosphate concentration and flux rate. The TP concentration in most cores and the orthophosphate concentration in all cores were below the detection limit in the first sample after the addition of alum (HR 12-18) and remained low through the end of the study. Sodium aluminate was used in alum dosed cores as a pH buffer; however, the treated groups still experienced a decrease in pH, with more impact on the high pH group. If Lake Campbell is treated with alum as the prescribed chemical, the use of a buffer is necessary, and pH should be monitored continuously to avoid ecologically impactful declines in pH.

The aluminum dosage was 13 percent lower than initially planned at 15.7 g/m^2 rather than 18.0 g/m^2 due to lower aluminum concentrations in the sodium aluminate than assumed. This slightly lower dose was still effective as inactivating phosphorus release from the sediments. However, the variation in aluminum concentrations between batches of alum and aluminate stresses the importance of measuring the aluminum concentration prior to the alum treatment in order to appropriately adjust the dosage to achieve the desired areal application.

A literature review, below (Table 5), compares the release rate with similar experiments, including the Entranco (1987) study. The 2024 LCMP estimated the internal loading to be at least 208 kg per year on average. The LCMP estimate was based on the accumulated mass during the summer (June to September) for the years 2017, 2018, 2019, and 2021 from Samish Indian Nation monitoring data. Assuming that sediment release is occurring primarily in the summer growing period (May to October, 184 days), the sediment release rate would be 0.75 mg/m^2/day.

During the summer, we expect the sediment of Lake Campbell to be exposed to elevated pH and low oxygen levels. Because the lake is shallow and has a large fetch, it is expected to undergo wind-induced mixing such that the oxygen levels at the sediment-water interface may increase during those events. This sediment incubation study captured and compared Lake Campbell's dynamic summer conditions (aerobic, anaerobic, and neutral and high pH). In these cores, the phosphorus flux rate ranged from 0.9 to 12.9 mg/m^2/day. These data suggest that the total phosphorus mass released from the sediments in Lake Campbell may greatly exceed the minimum estimate of 208 kg per year. In agreement with the LCMP, this study confirms that there is substantial release of phosphorus from the sediments during the summer and likely throughout the year during low oxygen and/or elevated pH conditions.

This sediment incubation study confirms that the internal release rate is a major source of phosphorus to Lake Campbell and that alum would be an effective strategy to reduce the sediment release rate, the lake water phosphorus concentration, and, ultimately, the algae biomass in the lake.

Table 5. Comparison of Release Rates as Affected by Alum.								
Lake (Source)	**Year**	**Incubation Length**	**Incubation Conditions**				**TP release rate (P mg/m^2/day)**	**Orthophosphate release rate (P mg/m^2/day)**
			Temperature (°C)	**pH**	**Oxygen**	**Alum areal dose (Al g/m^2)**		
Spring Lake, MI (Steinman 2004)	2003	20 days	15.3-23.6	NA	Aerobic	0	low, but detectable	unreported, suspected interference
				NA	Aerobic	6.6	virtually undetectable	
				NA	Anaerobic	0	1.6-29.5	
				NA	Anaerobic	6.6	virtually undetectable	
Lake Erie, WA (Entranco 1987)	1985 Exp I	~1 month	North Site					
			18-22	6.9-7.5	Aerobic	0	NA	0.67
				9-10	Aerobic	0	NA	3.71
				9-10	Aerobic	0.42	NA	2.90
			Mid Site					
			18-22	6.9-7.5	Aerobic	0	NA	0.31
				9-10	Aerobic	0	NA	2.85
				9-10	Aerobic	0.42	NA	2.35
			South Site					
			18-22	6.9-7.5	Aerobic	0	NA	0.05
				9-10	Aerobic	0	NA	1.35
				9-10	Aerobic	0.42	NA	1.08
	1985 Exp II	~1 month	North Site					
			18-22	7.3-7.6	Aerobic	0	NA	2.32
				9-10	Aerobic	0	NA	16.26
				9-10	Aerobic	17.7	NA	0.63

°C – degrees Celsius Al – aluminum P – phosphorus

g/m^2 – gram per square meter mg/m^2/day –milligrams per square meter per day

Table 5 (continued). Comparison of Release Rates as Affected by Alum.								
Lake (Source)	**Year**	**Incubation Length**	**Incubation Conditions**				**TP release rate (P mg/m²/day)**	**Orthophosphate release rate (P mg/m²/day)**
			Temperature (°C)	**pH**	**Oxygen**	**Alum areal dose (Al g/m²)**		
Lake Campbell, WA (Entranco 1987)	1985 Exp I	~1 month	East Site					
			18-22	6.9-7.8	Aerobic	0	NA	0.01
				9-10	Aerobic	0	NA	1.28
				9-10	Aerobic	0.42	NA	1.31
			Mid Site					
			18-22	6.9-7.8	Aerobic	0	NA	0.19
				9-10	Aerobic	0	NA	2.89
				9-10	Aerobic	0.42	NA	3.41
			West Site					
			18-22	6.9-7.8	Aerobic	0	NA	0.04
				9-10	Aerobic	0	NA	1.15
				9-10	Aerobic	0.42	NA	1.31
	1985 Exp II	~1 month	Mid Site					
			18-22	7.4-7.9	Aerobic	0	NA	1.73
				9-10	Aerobic	0	NA	4.70
				9-10	Aerobic	17.7	NA	-0.01

°C – degrees Celsius Al – aluminum P – phosphorus

g/m^2 – gram per square meter $mg/m^2/day$ –milligrams per square meter per day

Table 5 (continued). Comparison of Release Rates as Affected by Alum.								
Lake (Source)	**Year**	**Incubation Length**	**Incubation Conditions**				**TP release rate (P mg/m^2/day)**	**Orthophosphate release rate (P mg/m^2/day)**
			Temperature (°C)	**pH**	**Oxygen**	**Alum areal dose (Al g/m^2)**		
Lake Campbell, WA (this study)	2024	185 hours	19-21	7.0	Aerobic	0	-0.87 to -0.18	-0.09 to 0.95
				8.5	Aerobic	0	-0.57 to 12.93	0.02 to 14.93
				7.0	Anaerobic	0	0.90 to 1.73	0.39 to 1.46
				8.5	Anaerobic	0	1.52 to 4.70	1.74 to 6.04
				7.0	Aerobic	15.7	-0.23 to -0.20	- 0.13 to -0.10
				8.5	Aerobic	15.7	-0.07 to 0.07	-0.09
				7.0	Anaerobic	15.7	-0.16 to 0.27	-0.09 to 0.33
				8.5	Anaerobic	15.7	-0.14 to 0.37	-0.12 to 0.02

°C – degrees Celsius Al – aluminum P – phosphorus

g/m^2 – gram per square meter mg/m^2/day –milligrams per square meter per day

6. References

Entranco, 1987. Erie and Campbell Lakes Final Report, Restoration, Implementation and Evaluation. Entranco Engineers. Kirkland, Washington.

Herrera. 2023. Quality Assurance Project Plan, Lake Campbell Cyanobacteria Management Plan. Prepared for Skagit County by Herrera Environmental Consultants, Inc., Seattle, Washington. September 8, 2023.

Herrera. 2024. Lake Cyanobacteria Management Plan. Prepared for Skagit County by Herrera Environmental Consultants, Inc., Seattle, Washington. June 28, 2024.

Steinman, A., R. Rediske, and K. R. Reddy. 2004. The reduction of internal phosphorus loading using alum in Spring Lake, Michigan. Journal of Environmental Quality 33:2040-2048.

Appendices

Appendix A

Field and Incubation Forms

HERRERA
Science + Planning + Design

Date	Time	Site	Temp (°C)	DO %	DO mg/L	SPC-µS/cm	pH	DEP m
8/19/2024	10:02:01 AM	lake campbell	22.168	168.5	14.68	259.3	9.41	0.046
8/19/2024	10:07:44 AM	lake campbell	21.909	166.9	14.61	258.8	9.41	0.498
8/19/2024	10:09:17 AM	lake campbell	21.557	150.4	13.25	259.1	9.33	0.999
8/19/2024	10:12:43 AM	lake campbell	21.441	140.5	12.41	259.4	9.23	1.499
8/19/2024	10:14:30 AM	lake campbell	21.286	131.8	11.68	259.8	9.15	1.999
8/19/2024	10:17:01 AM	lake campbell	21.229	127.8	11.33	259.9	9.15	2.502
8/19/2024	10:18:40 AM	lake campbell	21.19	123.2	10.94	260.2	9.14	2.999
8/19/2024	10:20:30 AM	lake campbell	21.18	122.4	10.87	260.2	9.14	3.504
8/19/2024	10:25:49 AM	lake campbell	21.111	112.7	10.02	261	9.17	3.997
8/19/2024	10:28:58 AM	lake campbell	20.575	64.4	5.78	266.3	8.64	4.508
8/19/2024	10:30:32 AM	lake campbell	20.484	56.4	5.08	267.2	8.51	5
8/19/2024	10:32:24 AM	lake campbell	21.988	161.7	14.13	259.2	9.47	0.048

YSI_EXO1_Calibration_blank

5/19/24

LL Campbell CM

Calibration Date 5/19/24 Time 6:25

Sonde Serial Number 17M100671

Technician CMM

Barometer @ KBLI (inches/Hg) 30.08 Time 6:35

Corrected Barometer (mm Hg, see notes) 754.2

Barometer on EXO handheld (mmHg) ~~753.00~~ 754.2 (checked on 5/20/2024 ~~previously~~)

(If off more than 2.5 mmHg, see Joan or Mike).

EXO 1 Battery voltage 2.5 V If < **2.3** VDC, replace (2 D cells)

Dissolved Oxygen (ODO) **% Saturation**

Initial Temp (°C) 22.41 Initial DO (mg/l) 8.57 Initial DO (% sat) 98.8

Post Temp (°C) 22.4 Post DO (mg/l) 8.60 Post DO (% sat) 99.2

ODO Gain 1.012384

ODO gain's nominal value is **1**, accurate calibration will only slighly deviate from 1.

Specific Conductance

Cal standard uS/cm 1000 Temp 24.49

Initial read uS/cm 977

Post Cal uS/cm 1001 Temp 24.5

Cond. cell constant 5.1908

An ideal cell constant is 5.1 +/- 10%, **4.59 to 5.61**

pH

Buffer	Temp (°C)	Corrected pH buffer	Initial pH	Initial mV	Post pH	Post mV
4	4.0	24.5	4.03	153.9	4.00	
7	7.0	24.6	7.04	-23.7	7.01	
10	10.00	24.6	10.06	-203.6	10.02	

pH 4 - 7 delta slope 99.87 % mv/decade 59.23

pH 7-10 delta slope mv/decade

mv/decade is the slope, where 59 is the typical value.

Notes on barometer readings:
For KBLI barometer, go to http://www.weather.gov, type in KBLI. Note indicated barometer and time.
Convert to mm Hg: KBLI barometer(inches Hg) x 25.4 = mm Hg
Correct to ES building elvation: 3rd floor: subtract 9.1 from mmHg, 5th floor subract 9.8 from mm Hg.

Notes:

8/19/24

2024 LAKE CAMPBELL PHASE II SEDIMENT INCUBATION STUDY FIELD DATA SHEET

Field Equipment Checklist

- ☑ YSI EXO meter
- ☑ 2 lines of rope, in length to extend to lake bottom, plus 10 feet in excess
- ☑ 5 small bags of ice
- ☑ Flathead screwdriver
- ☑ Core end caps (32)
- ☑ syringe
- ☑ Notepad/pencil/pen
- ☐ ~~Van Dorn / Kemmerer~~ not needed 8/19/24
- ☑ 20 L carboy
- ☑ Peristaltic pump + high capacity 0.45 µm filter
- ☑ Large black garbage bags (4)
- ☑ Cores (16)
- ☑ 60 ml sample bottle for TP
- ☑ Labeling tape
- ☑ Permanent marker
- ☑ Hammer corer
- ☑ Anchor
- ☑ 5 gal buckets (4)
- ☑ Duct tape
- ☑ Nitrile gloves
- ☑ Core plugs (16)
- ☑ 10 ml sample vial for SRP
- ☑ Mini cooler for TP/SRP
- ✓ buoy 8/19/24

Project: Lake Campbell Phase II Sediment Incubation Study Project No.: 24-08365-000

Client Name: Skagit County Field Personnel: Claudia Basso

Rob Zisette

Carmen Archambault

Weather: Sunny, clear, 62°F / 16.67°C

Wind (still, windy, choppy): still

Observations: green algae in water

CAM-DEEP (at deepest point south of island)

Collection date: 8/19/24 Start time: 9:50 am

Depth to bottom (m): 5.5 m End time: 15:00 (3:00pm)

Water color: green

Notes:

Profile Readings:

Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)	pH
0.5	21.89	14.50	166.2	9.42
1.0	21.55	13.23	150.0	9.33
1.5	~~21.44~~ 21.54	12.75	144.7	9.25
2.0	21.27	11.62	131.1	9.15
2.5	21.23	11.29	127.4	9.15
3.0	21.19	10.93	123.2	9.13
3.5	21.18	10.87	122.4	9.14
4.0	21.10	10.04	113.1	9.17
4.5	20.58	5.77	63.9	8.63
5.0	20.48	5.08	56.3	8.51

Notes: surface 0.04 T 22.15°C 10:02am
DO 14.64 mg/L
DO % 167.5
pH 9.42

QC surface post readings: 0.05 10:33am
T 21.98°C
DO 14.2 mg/L
DO % 162.5
pH 9.47

Water Quality Samples Collected* :

Fill in the Sample IDs and depths below. Check the box (X) for each sample bottle filled.

Sample ID (sample site-date)	Sample Time	Sample Depth (m)	TP* (60 mL HDPE) Collect at least 20 mL	SRP */** (10 mL HDPE) Do not collect past 10 mL line
CAM-DEEP-08192024	10:53a	~4.5	X	X

*All water quality samples must be kept on ice or refrigerated until delivered to lab.

**Soluble reactive phosphate samples must be field filtered into bottles using syringes.

Notes: Both TP and SRP samples were filtered (they were subsamples from the 20 L carboy of filtered water.

Label sample bottles with the following:

- Sample ID (sample site-date)
- Date of collection
- Time of collection
- Analytical parameters
- Initials of personnel and client

filtering carboy water 10:~~22~~ am CB 9/17/24 start time
sample depth 15ft from surface (≈ 4.5m)

Sediment Cores Collected* :

Sample ID (core #)	Time Collected	Comments
1	14:02	sediment very soft / odorous, no
2	11:40am	hammering needed
3	11:54am	
4	11:59am	
5	12:10pm	
6	12:20pm	
7	12:24pm	
8	14:07	
9	14:13	
10	14:18	
11	14:25	
12	14:30	
13	14:37	
14	14:44	
15	14:50	
16	15:00	

*All sediment cores must be kept on ice until delivered to lab.

Label cores with the Sample ID (core #).

- starting location 48.437482, -122.616677.
- moving 5 ft NW for each core 2-7
- for 8-16, 1st started 50ft west from starting pt. Moving 3ft W for each core.
- #1 recollected due to sediment fell out while adjusting it.
- secchi depth 11:21am 23.5 inches
- the core sample times were written on waterproof notepad (attached) and transcribed to table above.

1 m from bottom is
15 ft

Core times 8/19/24

1	~~11:32~~ 14:02	13	14:37
2	11:40	14	14:44
3	~~11:40~~ 11:54	15	14:50
4	11:59	16	15:00
5	12:10		
6	12:20		
7	12:24		
8	14:09		
9	14:13		
10	14:18		
11	14:25		
12	14:30		

11:21 sleeve - 23.1/2 inches out

Rite in the Rain.

YSI logged profile readings

Date	Time	Site	°C-17L101532	mmHg-17M100762	DO %-17L103032	DO mg/L-17L103032	SPC-µS/cm-17L101532	pH-17M100773	pH mV-17M100773	DEP m-17L103993	Vpos m-17L103993	Batt V-17M100762
8/19/2024	10:02:01 AM	lake campb	22.168	762.2	168.5	14.68	259.3	9.41	-164.4	0.046	0.046	2.47
8/19/2024	10:07:44 AM	lake campb	21.909	762.2	166.9	14.61	258.8	9.41	-164.8	0.498	0.501	2.45
8/19/2024	10:09:17 AM	lake campb	21.557	762.1	150.4	13.25	259.1	9.33	-159.4	0.999	1	2.46
8/19/2024	10:12:43 AM	lake campb	21.441	762.1	140.5	12.41	259.4	9.23	-153.8	1.499	1.503	2.43
8/19/2024	10:14:30 AM	lake campb	21.286	762.1	131.8	11.68	259.8	9.15	-149.2	1.999	1.999	2.44
8/19/2024	10:17:01 AM	lake campb	21.229	762.1	127.8	11.33	259.9	9.15	-149	2.502	2.502	2.45
8/19/2024	10:18:40 AM	lake campb	21.19	762.1	123.2	10.94	260.2	9.14	-148.2	2.999	2.999	2.44
8/19/2024	10:20:30 AM	lake campb	21.18	762.1	122.4	10.87	260.2	9.14	-148.1	3.504	3.503	2.43
8/19/2024	10:25:49 AM	lake campb	21.111	762.1	112.7	10.02	261	9.17	-150.2	3.997	3.995	2.42
8/19/2024	10:28:58 AM	lake campb	20.575	762.1	64.4	5.78	266.3	8.64	-118.9	4.508	4.511	2.43
8/19/2024	10:30:32 AM	lake campb	20.484	762	56.4	5.08	267.2	8.51	-111.5	5	4.999	2.43
8/19/2024	10:32:24 AM	lake campb	21.988	762	161.7	14.13	259.2	9.47	-167.8	0.048	0.049	2.42

pH Meter Calibration Log

Project Number/Name:	Lake Campbell Sediment Incubation Phase II
Personnel Performing Calibration:	Claudia Basso
pH Meter:	ThermoScientific OrionStar A214
Date/Time:	SN X18241 8/19/24 5:15pm

PRE-Event Calibration	Meter Reading	Buffer / Cal Std	Comments
pH	7.00	7	
	10.00	10	
	NA	4	NA

POST-Event Calibration Check	Meter Reading	Buffer / Cal Std	Comments
pH	NA	7	NA
	10.03	10	
	NA	4	NA

Calibration Procedures:
Rinse Probe Between Each Operation
Rinse with deionized water, then with the solution to be used for calibrating or testing. Use KimWipes® to carefully dab/dry water from probe.

HERRERA

pH Calibration Notes:
1. Perform 3-point calibration, starting with pH 7 buffer, followed by 10 and 4 buffers.
2. Follow calibration instructions in the instrument's user manual.

pH Meter Calibration Log

Project Number/Name:	Lake Campbell Sediment Incubation Phase II
Personnel Performing Calibration:	Claudia Basso
pH Meter: SN X18241	ThermoScientific Orionstar A214
Date/Time:	8/21/24 9:56am

PRE-Event Calibration	Meter Reading	Buffer / Cal Std	Comments
pH	7.00	7	
	10.00	10	
	NA	4	

POST-Event Calibration Check	Meter Reading	Buffer / Cal Std	Comments
pH	6.99	7	
	NA	10	
	NA	4	

Calibration Procedures:
Rinse Probe Between Each Operation
Rinse with deionized water, then with the solution to be used for calibrating or testing. Use KimWipes® to carefully dab/dry water from probe.

HERRERA

pH Calibration Notes:
1. Perform 3-point calibration, starting with pH 7 buffer, followed by 10 and 4 buffers.
2. Follow calibration instructions in the instrument's user manual.

pH Meter Calibration Log

Project Number/Name:	Lake Campbell Sediment Incubation Phase II
Personnel Performing Calibration:	Claudia Basso
pH Meter: SN: X18241	ThermoScientific OrionStar A214
Date/Time:	8/22/24 9:10 am

PRE-Event Calibration	Meter Reading	Buffer / Cal Std	Comments
pH	6.99	7	
	—	10	
	NA	4	

POST-Event Calibration Check	Meter Reading	Buffer / Cal Std	Comments
pH	6.99	7	
	—	10	
	NA	4	

Calibration Procedures:

Rinse Probe Between Each Operation

Rinse with deionized water, then with the solution to be used for calibrating or testing. Use KimWipes® to carefully dab/dry water from probe.

pH Calibration Notes:

1. Perform 3-point calibration, starting with pH 7 buffer, followed by 10 and 4 buffers.
2. Follow calibration instructions in the instrument's user manual.

pH Meter Calibration Log

Project Number/Name:	Lake Campbell Sediment Incubation Phase II
Personnel Performing Calibration:	Claudia Bassó
pH Meter: SN: X18241	Thermo Scientific Orion Star A214
Date/Time:	8/23/24 2:43 pm

PRE-Event Calibration	Meter Reading	Buffer / Cal Std	Comments
pH	7.00	7	
	10.00	10	
	NA	4	

POST-Event Calibration Check	Meter Reading	Buffer / Cal Std	Comments
pH	7.00	7	
	—	10	
	NA	4	

Calibration Procedures:

Rinse Probe Between Each Operation

Rinse with deionized water, then with the solution to be used for calibrating or testing. Use KimWipes® to carefully dab/dry water from probe.

HERRERA

pH Calibration Notes:

1. Perform 3-point calibration, starting with pH 7 buffer, followed by 10 and 4 buffers.
2. Follow calibration instructions in the instrument's user manual.

pH Meter Calibration Log

Project Number/Name:	Lake Campbell Sediment Incubation Phase II
Personnel Performing Calibration:	Claudia Bassó
pH Meter: SN: X18241	ThermoScientific Orion Star A214
Date/Time:	3/24/24 2:16pm

PRE-Event Calibration	Meter Reading	Buffer / Cal Std	Comments
pH	7.00 ~~6.99~~ CB 3/27/24	7	re-calibrate to 7.00 pH
	10.00	10	
	NA	4	

POST-Event Calibration Check	Meter Reading	Buffer / Cal Std	Comments
pH	6.99	7	
	—	10	
	NA	4	

Calibration Procedures:

Rinse Probe Between Each Operation

Rinse with deionized water, then with the solution to be used for calibrating or testing. Use KimWipes® to carefully dab/dry water from probe.

HERRERA

pH Calibration Notes:

1. Perform 3-point calibration, starting with pH 7 buffer, followed by 10 and 4 buffers.
2. Follow calibration instructions in the instrument's user manual.

YSI METER CALIBRATION LOG

Project Number/Name:	Lake Campbell Sediment Incubation Phase II
Personnel Performing Calibration:	Claudia Basso
Meter:	YSI Pro Plus
Date/Time:	8/26/24 1:50pm

PRE-Event Calibration	Meter Reading	Buffer / Cal Std	Comments
pH	NA	7	
	NA	10	
	NA	4	
Conductivity (µS/cm)	NA	0	
Conductivity (µS/cm)	NA	1,413	
DO % Saturation	100.7	100	

POST-Event Calibration Check	Meter Reading	Buffer / Cal Std	Comments
pH	NA	7	
	NA	10	
	NA	4	
Conductivity (µS/cm)	NA	1,413	
DO % Saturation	100.1 ~~100.1~~	100	

Calibration Procedures:

Rinse Multimeter *Sonde* Between Each Operation

Rinse with deionized water, then with the solution to be used for calibrating or testing.

HERRERA

pH Calibration Notes:

1. Perform 3-point calibration, starting with pH 7 buffer, followed by 10 and 4 buffers.
2. Fill calibration cup to bottom line with each pH buffer, ensure all sensors are submerged, wait until meter indicates that it has stabilized, hit "Calibrate/OK".

Conductivity Calibration Notes:

1. Dry the conductivity probe with a lab tissue (e.g., KimWipes®) and calibrate @ 0 µS.
2. Fill the calibration cup to bottom line with 1,413 µS standard and ensure that the temperature/conductivity probes are completely submerged. Unexpectedly low pre-calibration readings may be a result of an incompletely submerged probe.
3. Make sure there are no bubbles in the conductivity sensor.
4. Enter the appropriate standard value (1,413 µS/cm) for Sp Cond. and calibrate once meter indicates that it has stabilized.

Dissolved Oxygen Calibration Notes:

1. Fill calibration cup with ~1/2 inch of water; it should be below the DO sensor cap.
2. Use KimWipes® to carefully dab/dry water from the sensor cap.
3. Invert sonde and gently rest it on the storage cup **without** screwing shut the cup.
4. Wait for the meter to stabilize; when it indicates it has stabilized, hit "Calibrate/OK".
5. To retain calibration accuracy between measurements, keep a small amount of water in the storage cup between sample sites.

pH Meter Calibration Log

Project Number/Name:	Lake Campbell Sediment Incubation Phase II
Personnel Performing Calibration:	Claudia Basso
pH Meter:	Thermo Scientific Orion Star A214
Date/Time:	8/29/24 9:14am

PRE-Event Calibration	Meter Reading	Buffer / Cal Std	Comments
pH	7.02	7	
	10.00	10	
	NA	4	

POST-Event Calibration Check	Meter Reading	Buffer / Cal Std	Comments
pH	7.02	7	
	—	10	
	NA	4	

Calibration Procedures:

Rinse Probe Between Each Operation

Rinse with deionized water, then with the solution to be used for calibrating or testing. Use KimWipes® to carefully dab/dry water from probe.

HERRERA

pH Calibration Notes:

1. Perform 3-point calibration, starting with pH 7 buffer, followed by 10 and 4 buffers.
2. Follow calibration instructions in the instrument's user manual.

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Basso

CB 8/24/24 CORE ~~9~~ 1 – AEROBIC and pH 7 and ~~NO ALUM~~ (NOALLUM)
HIGH CO2 / AIR
~~ALUM~~ (NO ALUM)

Hour	Date	Time	Temp (°C)	D.O. ~~(%)~~ umol/L	D.O. ~~(mg/L)~~	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24 ~~8/23/24~~	6:46pm	19.6 ~~19.8~~	287.2	~~289.7~~	8.95	NO SAMPLE COLLECTED vol pulled (mL) vol replaced	N
0	8/21/24	~~13:30~~	19.4	~~299.8~~ 299.8	~~296.7~~ CB 8/24/24	7.26	10+30* ✓	N
(11=17) 12-18	8/22/24	9:15 AM	19.4	322.6	—	~~7.0~~ 7.11	SRP: 7P 10 + 60 ml +5 replaced ✓	N
~~1R46~~ 48	8/23/24	2:50p	19.5	328.0	—	7.10	~~10~~ 15 + 15 mL + tube + 60 CB 8/25/24 ✓	N
~~1R70~~ 72	8/24/24	2:47	19.5	321.7	—	7.05	15+60 ✓	N
185 ~~168~~	8/29/24	9:26a	19.5	318.0	—	7.01	15+60 —	N

Alum Dose: ~~0~~ uL (~~goal: 500 uL~~) CB 8/21/24

Sodium Aluminate: ~~0~~ uL (~~goal: 250 uL~~) 8/21/24

*actual vol. pulled was 45 mL due to noticed later that tube attached to syringe pulls out an extra 5mL. Only 40 mL was replaced

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No: 24-08365-000
Lab Personnel: Claudia Basso

CORE 2 – AEROBIC and pH 7 and NO ALUM
HIGH CO2 / AIR
NO ALUM

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. ~~umol/L~~ (mg/L) (CB 8/19/24)	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24	5:34 pm	21.3	—	334.2	8.91	VI NO SAMPLE COLLECTED vol. pulled (mL) vol replaced	N
0	8/21/24	~~09:27~~	19.6	—	320.5 ~~334.9~~ CB 8/21/24	7.11	10+30 * mL ✓	N
17 12-18	8/22/24	09:22	19.4	322.3 →		7.12	mL SRP, TP 10 + 60 mL +5 replaced ✓	N
46 ~~48~~	8/23/24	3:18p	19.5	~~324.7~~	324.7	7.04	15 rinse + tube + 60 TP/SRP/pH/DO ✓	N
70 ~~72~~	8/24/24	2:59p	19.5	—	327.9	7.01	15+60 ✓	N
185 ~~188~~	8/29/24	9:34p	19.5	—	323.7	~~7.01~~ 7.11	15+60 —	N

Alum Dose: ∅ uL (goal: 0 uL) 8/21/24

Sodium Aluminate: ∅ uL (goal: 0 uL) 8/21/24

* actual vol pulled 45 mL due to extra 5mL unknown sheet syringe pulled. only 40mL replaced.

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Basso

CORE 3 – ANAEROBIC and pH 7 and NO ALUM
HIGH CO2 / N2
NO ALUM

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. ~~(mg/L)~~ umol/L (8/19/24)	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24	5:48p	21.82 (8/21/24)	—	286.6	9.06	NO SAMPLE COLLECTED vol pulled (mL) / vol. replaced	Y
0	8/21/24		19.5	—	134.9	7.05	10+30 * / ✓	N
~~12~~ 17 ~~18~~	8/22/24	09:28	19.4	—	191.1	7.04	10 + 60 SRP, TP / replaced ✓	N
~~48~~ 46	8/23/24	3:33p	19.5	—	169.9	6.98	15 rinse tube 60 TP/SRP/pH / ✓	N
~~72~~ 70	8/24/24	3:15p	19.5	—	160.7	6.99	(15+60)2 / ✓	Y
~~168~~ 195	8/29/24	9:42a	19.5	—	139.6	7.02	15+60 / —	N

Alum Dose: ~~0~~ uL (goal: 0 uL) 8/21/24

Sodium Aluminate: ~~0~~ uL (goal: 0 uL) 8/21/24

* syringe pulled an extra 5 mL unknown at time tube for total of 45 mL pulled – 40 mL replaced

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study Project No.: 24-08365-000
Client: Skagit County Lab Personnel: Claudia Basso

CORE 4 – ANAEROBIC and pH 7 and NO ALUM
HIGH CO2 / N2
NO ALUM

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. ~~mg/L~~ umol/L 8/19/24	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24	5:57pm	20.9	—	328.7	9.00	NO SAMPLE COLLECTED vol. pulled (mL) vol. replaced	N
0	8/21/24		19.5	—	220.0	7.21	10+30* ✓	N
17 ~~12-18~~	8/22/24	09:33	19.4	—	153.6	7.00	10 +60 SRP, TP +5 replaced ✓	N
46 ~~48~~	8/23/24	3:44p	19.5	—	140.2	6.99	rinse 15 + tube + 30 DO + 40 TP SRP/SRP spike ✓	spike
70 ~~72~~	8/24/24	3:41p	~~19.3 8/24/24~~ 19.4	—	186.3	7.01	15+60 ✓	N
185 ~~168~~	8/29/24	9:52a	19.5	—	186.6	7.02	15+60 —	N

Alum Dose: 0 uL (goal: 0 uL) 8/21/24

Sodium Aluminate: 0 uL (goal: 0 uL) 8/21/24

* syringe tube pulled extra 5mL unknown at time for total of 45 mL, 40 mL replaced

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Bassó

CORE 5 – AEROBIC and pH 8.5 and NO ALUM
LOW CO2 / AIR
NO ALUM

Hour	Date	Time	Temp (°C)	D.O (%)	D.O ~~µmol/L~~ (mg/L)	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24	6:07pm	21.2	—	283.0	9.02	NO SAMPLE COLLECTED vol. pulled (mL) vol replaced	N
0	8/24/24		19.5	—	317.5	8.41	10+30+30 ~~+30~~ * ✓	At ~~0~~ 9/4/24 Y
17 ~~12-18~~	8/27/24	09:36	19.4	—	314.6	8.24	10 + SRP, TP 40 +5 replaced ✓	N
46 ~~48~~	8/30/24	4:16p	19.5	—	320.2	8.30	15 single tube +60 TP/SRP/pH/DO ✓	N
70 ~~72~~	9/24/24	3:53p	19.4	—	325.6	8.33	15+60 ✓	N
135 ~~168~~	9/27/24	9:58a	19.5	—	322.1	8.26	15+60 ✓	N

Alum Dose: ~~0~~ uL (goal: 0 uL) on 9/21/24

Sodium Aluminate: ~~0~~ uL (goal: 0 uL) 9/24/24

* extra 5mL pulled by syringe tube not accounted for - pulled out 75mL, replaced 70 mL

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No: 24-08365-000
Lab Personnel: Claudia Basso

CORE 6 – AEROBIC and pH 8.5 and NO ALUM
LOW CO2 / AIR
NO ALUM

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. (mg/L)	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24	6:15	20.4	—	238.7	9.03	NO SAMPLE COLLECTED vol. pulled (mL) vol. replaced	N
0	8/21/24		19.4	—	319.2	8.47	10+30 * ✓	N
17 ~~12~~/18	8/22/24	09:51	19.4	—	315.8	7.95	10+60 +5 SRP & TP replaced ✓	N
46 ~~48~~	8/23/24	4:30p	19.5	—	312.7	7.73	rinse 15 mL +60 TP/SRP/pH/DO ✓	N
70 ~~72~~	8/24/24	4:11p	19.4	—	323.5	7.88	15+60 ✓	N
175 ~~168~~	8/29/24	10:00a	19.4	—	325.3	7.99	15+60 ~~✓~~	N

~.5cm H2O down

Alum Dose ~~Ø~~ uL (goal: 0 uL) 8/21/24

Sodium Aluminate ~~Ø~~ uL (goal: 0 uL) 8/21/24

* unknown extra 5mL pulled due to syringe tube, total 45 mL pulled, 40 mL replaced.

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Bass

CBS 8/21/24 CORE ~~13~~ 7 – ANAEROBIC and pH 8.5 and ~~NO ALUM~~ NO ALUM CBS 8/21/24
LOW CO2 / N2
~~ALUM~~ NO ALUM

mM

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. (mg/L)	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24 ~~8/23/24~~	7:29pm	19.6	284.1	~~8.30~~ —	8.99	NO SAMPLE COLLECTED vol. pulled (mL) vol replaced	N
0	8/21/24		19.3	222.7	—	8.51	9+30 * ✓ 39mL	N
17 12/18	8/22/24	09:59	19.4	174.2	—	8.42	10 SRP & TP +60 +5 replaced	N
46 48	8/23/24	4:45p	19.5	203.1	—	8.57	new tube 15 +60 TP/SRP ND/ND ✓	N
70 72	8/24/24	4:24p	19.4	216.2	—	8.83	15/60 ✓	N
185 168	8/26/24	10:15a	19.4	180.3	—	8.70	15 +60 —	N

Alum Dose: ~~0~~ uL (~~goal: 500 uL~~) 0 uL CBS 8/21/24

Sodium Aluminate: ~~0~~ uL (~~goal: 280 uL~~) 0 uL CBS 8/21/24

~.25 gm H20 down

* extra 5mL removed by syringe tube unknown, 44 mL pulled, 39 mL replaced

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Basso

CORE ~~16~~ 8 – ANAEROBIC and pH 8.5 and ~~NO ALUM~~ NO ALUM
LOW CO2 / N2
ALUM

µM

volumes out, TP/SRP verification, volumes back in

Hour	Date	Time	Temp (°C)	D.O (%)	D.O (mg/L)	pH	Observations		DUPE?
PRIOR TO BUBBLE START	8/19/24 ~~8/23/24~~	7:34pm	19.7	280.4	—	8.95	NO SAMPLE COLLECTED vol. pulled (mL)	vol. replaced	N
0	8/21/24		19.3	150.3	—	8.57	10+30*	✓	N
17 ~~12~~-18	8/22/24	10:11	19.4	230.2	—	8.07	10+60+5	replaced ✓	N
46 ~~48~~	8/23/24	5:00p	19.5	98.4	—	8.48	15+60	✓	N
70 ~~72~~	8/24/24	4:40p	19.4	196.2	—	8.65	15+60	✓	N
195 ~~168~~	8/26/24	10:20a	19.4	165.0	—	8.93	15+60	✓	N

Alum Dose: ~~0~~ uL (goal: ~~500~~ uL) ~~0~~ uL 8/21/24

Sodium Aluminate: ~~0~~ uL (goal: ~~250~~ uL) ~~0~~ uL 8/21/24

N .5cm
H_2O down

* extra 5mL removed by syringe
total removed 45 mL, 40 replaced

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Lab Personnel: Claudia Basso
Project No.: 24-08365-000

CS 8/21/24 CORE 9 – AEROBIC and pH 7 and ~~NO~~ ALUM
HIGH CO2 / AIR
~~NO~~ ALUM

CS 8/14/24

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. (~~mg~~ mol/L)	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24	5:23 pm	20.2	—	302.3	4.04	VI visit NO SAMPLE COLLECTED vol pulled (mL) vol replaced	N
0	8/21/24		19.6	—	324.6	7.09	10+28 * ✓	N
17 ~~12/18~~	8/22/24	~~10:29 10:37~~ am	19.4	—	317.1	6.93	10+~~14~~ 4 +5 +60 tube fell off syringe, had to pull the additional 4mL to get rid of bubbles ✓	N
~~40 48~~ 46	8/23/24	5:20p	19.4	—	318.5	6.85	15 rinse tube +60 ✓	N
~~70 72~~ 70	8/24/24	4:51p	19.4	—	324.9	6.96	15 rinse tube +30 fill DO +40 TP set spike ✓	spike
~~185 188~~ 185	8/29/24	10:25a	19.4	—	316.2	7.08	15+60 —	N

Alum Dose: 500 uL (goal: ~~0~~ uL) CS 8/21/24 500mL

Sodium Aluminate: 250 uL (goal: ~~0~~ uL) 250mL CS 8/21/24

~ .75cm H2O down

replaced ✓

* realized later syringe tube removing extra 5mL not accounted for, total pulled 43mL, replaced 38mL

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Bastos

CORE 10 – AEROBIC and pH 7 and ~~DO~~ ALUM 8/21/24
HIGH CO2 / AIR
ALUM

Hour	Date	Time	Temp (°C)	D.O. ~~(%)~~ mM	~~D.O. (mg/L)~~	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24 ~~8/22/24~~	~~8:51~~ pm	19.9	265.0 ~~29~~	—	8.87	NO SAMPLE COLLECTED vol pulled (mL) vol replaced	N
0	8/21/24		19.4	316.1	—	7.16	10 + 30 * ✓	N
17 ~~12~~ ~~18~~	8/22/24	10:45 am	19.4	318.0	—	6.99	10 + 60 + 5 TP ISAP replaced ✓	N
46 ~~48~~	8/23/24	5:30 pm	19.4	318.1	—	6.97	rinser 15 tube +60 pH DO sed TP 15+60 ✓	Y
70 ~~72~~	8/24/24	5:16 pm	19.4	326.2	—	6.96	15+60 ✓	N
185 ~~188~~	8/29/24	10:31 am	19.3	316.4	—	7.14	15+60 —	N

Alum Dose: 500 uL (goal: 500 uL) 8/21/24

Sodium Aluminate: 250 uL (goal: 250 uL) 8/21/24

~ 1.0 cm H20 down

* extra 5mL pulled by syringe tube, 45 mL pulled, 40 replaced

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Basso

CORE 11 – ANAEROBIC and pH 7 and ~~NO~~ ALUM 8/19/24
HIGH CO2 / N2
ALUM

Hour	Date	Time	Temp (°C)	D.O ~~(%)~~ µM	D.O ~~(mg/L)~~	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24 ~~8/23/24~~	7:01 pm	19.9	296.6	—	9.08	NO SAMPLE COLLECTED vol pulled (mL) replaced	N
0	8/21/24		19.4	191.2	—	7.06	10+30 * ✓	N
17 ~~12/18~~	8/22/24	10:58	19.4	189.3	—	6.86	10+60 SRP+TP +5 replaced ✓	N
46 ~~48~~	8/23/24	5:43p	19.4	170.5	—	6.78	15 rinse tube +60 +PP/SRP/DO/pH ✓	N
70 ~~72~~	8/24/24	5:26p	19.4	194.4	—	6.82	15+60 ✓	N
185 ~~168~~	8/29/24	10:40a	19.3	149.0	—	6.87	15+60 —	N

Alum Dose: ~~500~~ uL (goal: 500 uL) 8/21/24

Sodium Aluminate: 250 uL (goal: 250 uL) 8/21/24

~ 1.0 cm H_2O down

* ~~extra~~ 5mL pulled due to syringe tube, not realized, actual ~~tot~~ pulled 45mL, replaced 40mL

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Basso

CORE 12 – ANAEROBIC and pH 7 and ~~NO~~ ALUM (on 8/19/24)
HIGH CO2 / N2
ALUM

Hour	Date	Time	Temp (°C)	D.O. ~~(%)~~ (µmol/L)	D.O. (mg/L)	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24 ~~8/23/24~~	7:08am	19.6	256.7	—		NO SAMPLE COLLECTED	N
0	8/21/24		19.3	155.1	—	7.09	vol pulled (mL) 10+30 * replaced ✓	N
17 ~~12~~	8/22/24	11:05am	19.4	260.8	—	6.98	TP/SRP 10+60+5 replaced ✓	N
46 ~~48~~	8/23/24	5:55p	19.4	201.8	—	6.83	tube 15 min +60 TP/SRP/pH DO ✓	N
70 ~~72~~	8/24/24	6:03p	19.4	188.9	—	6.97	15+60 ✓	N
185 ~~168~~	8/29/24	10:55p	19.3	196.6	—	7.02	15+60 15+60 —	Y

Alum Dose: 500 uL (goal: 500 uL) 8/21/24 CB
Sodium Aluminate: 250 uL (goal: 250 uL) 8/21/24 CB

~.5cm
H2O down

* actual vol pulled 45mL due to extra 5 mL tube attached to syringe holds.
Replaced 40 mL

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Bergo

CORE 13 – AEROBIC and pH 8.5 and ~~NO~~ ALUM 8/19/24
LOW CO2 / AIR
ALUM

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. (mg/L)	pH	Observations		DUPE?
PRIOR TO BUBBLE START	~~8/13/24~~ 8/19/24	7:17pm	20.0	282.8	—	8.97	NO SAMPLE COLLECTED vol pulled (mL)	replaced	N
0	8/21/24		19.3	288.1	—	8.55	10+30*	✓	N
17 ~~12~~/18	8/22/24	11:15AM	19.4	320.0	—	7.71	10+60 TP+SRP +5	replaced ✓	N
46 ~~48~~	8/23/24	6:09p	19.4	317.3	—	8.10	15+60	✓	N
70 ~~72~~	8/24/24	6:14p	19.4	321.0	—	8.27	15+60	✓	N
185 ~~168~~	8/27/24	11:02a	19.3	320.4	—	8.40	15+60	—	N

µM

Alum Dose: 500 uL (goal: 500 uL) 8/21/24 cvs

Sodium Aluminate: 250 uL (goal: 250 uL) 8/21/24 cvs

~ .25 cm H2O down

* unaware syringe tube pulled out extra 5 mL for total of 45mL, 40 mL replaced.

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Brasso

CORE 14 – AEROBIC and pH 8.5 and ~~NO~~ ALUM 8/19/24 CB
LOW CO2 / AIR
ALUM mM

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. (mg/L)	pH	Observations		DUPE?
PRIOR TO BUBBLE START	8/19/24 ~~8/23/24~~	7:22pm	20.2	279.5	—	9.01	NO SAMPLE COLLECTED vol pulled (mL)	replaced	N
0	8/21/24		19.3	316.5	—	8.45	10+30 *	✓	N
17 ~~12~~ ~~18~~	8/22/24	11:33a	19.4	322.6	—	8.05	TPSAP 10+60+5	replaced ✓	N
46 ~~48~~	8/23/24	6:24p	19.4	320.3	—	8.10	15+60	✓	N
70 ~~72~~	8/24/24	6:22p	19.4	324.2	—	8.55	15+60	✓	N
195 ~~168~~	8/24/24	11:10a	19.3	323.4	—	8.46	15+60	—	N

Alum Dose: 500 uL (goal: 500 uL) 8/21/24 CB
Sodium Aluminate: 250 uL (goal: 250 uL) 8/21/24 CB

~.5cm H2O down

* unaware syringe tube pulled extra 5mL for total of 45mL, replaced 40mL

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study Project No: 24-08365-000
Client: Skagit County Lab Personnel: Claudia Basso

CB 8/21/24 CORE 7 (15) – ANAEROBIC and pH 8.5 and ~~NO~~ ALUM
LOW CO2 / N2
~~NO~~ ALUM

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. ~~mg/L~~ µmol/L	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24	6:21pm	20.4	—	280.3	8.99	NO SAMPLE COLLECTED vol pulled (mL) replaced	N
0	8/21/24		19.4	—	206.9	8.63	10+30 ✓	N
17 ~~12~~ ~~18~~	8/22/24	12:01p	19.4	—	144.0	7.54	mix pH/DO 10 + 30 pull 1 +5 TRISPH set pH 10 pull 2 ✓	spike replaced ✓
46 ~~42~~ ~~48~~	8/23/24	6:38p	19.4	—	211.6	8.46	15+60 ✓	N
70 ~~72~~	8/24/24	6:46p	19.4	—	215.0	8.59	15+60 ✓	N
135 ~~168~~	8/29/24	11:11a	19.3	—	149.4	9.02	15+60 —	N

Alum Dose: 500 uL (goal: ~~0~~ uL) 500uL CB 8/21/24

Sodium Aluminate: 250 uL (goal: ~~0~~ uL) 250uL CB 8/21/24

pH ✓ at end w/ 7 buffer – 7.02

N. 25 cm H2O down

* syringe tube pulled extra 5mL, total 45mL pulled, 40 mL replaced

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study
Client: Skagit County
Project No.: 24-08365-000
Lab Personnel: Claudia Rosso

CORE ~~8~~ 16 – ANAEROBIC and pH 8.5 and ~~NO~~ ALUM
LOW CO2 / N2
~~NO~~ ALUM

Hour	Date	Time	Temp (°C)	D.O. (%)	D.O. ~~mg/L~~	pH	Observations	DUPE?
PRIOR TO BUBBLE START	8/19/24	6:25pm	20.0	—	306.0	9.13	NO SAMPLE COLLECTED vol pulled (mL) replaced	N
0	8/21/24		19.4	—	194.3	8.56	10+40* ✓	~~AC~~ 8/21/24 spike
17 ~~12~~ 18	8/22/24	12:15pm	19.4	—	201.2	6.98	10+60 +5 pull TP/SRP/DO/pH ✓ 60+4+5 TP/SRP/DO/pH acid bubbles	Y
46 ~~48~~	8/23/24	6:46p	19.4	—	165.3	7.83	15+60 ✓	N
70 ~~72~~	8/24/24	6:57p	19.4	—	184.1	8.59	15+60 ✓	N
115 ~~118~~	8/29/24	11:20a	19.3	—	116.0	8:84	15+60 —	spike

Alum Dose: 500 uL (goal: ~~0~~ uL) 500uL @ 8/21/24

Sodium Aluminate: 250 uL (goal: ~~0~~ uL) 250uL @ 8/21/24

N .25
H2O down

*syringe tube pulled extra 5mL for total of 55mL, 50 mL replaced

2024 LAKE CAMPBELL PHASE II
SEDIMENT INCUBATION STUDY INCUBATION DATA SHEET

Project: Lake Campbell Phase II Sediment Incubation Study Project No.: 24-08365-000
Client: Skagit County Lab Personnel:

DUPLICATE SAMPLE

Hour	CORE	Date	Time	Temp (°C)	Dissolved Oxygen (%)	Dissolved Oxygen ~~(mg/L)~~ umol/L	pH	Observations
0	5 (NONE TAKEN of pH/DO)				—			Vol pulled (mL) ~~error~~ 30 CB 8/22/24
17 12/18	16	8/22/24		19.4	—	182.3	6.96	pH/DO/TP/SRP 60+15
46 48	10	8/23/24	~~8:55p~~	19.4	—	320.1	~~6.96~~ 6.96	60 pH/DO/TP/SRP +15
70 72	3	8/24/24	8:15p	19.5	—	171.4	7.12	15+60
175 168	12	8/29/24	~~10:55a~~ ~~11:00a~~	19.3	—	162.7	7.04	15+60
PRIOR TO BUBBLE STONES	~~7~~ 3	8/19/24	5:48 pm 5:37 pm	21.1	—	~~280.7~~ 286.9	~~8.89~~ 8.91	CB 8/19/24 only DUP of pH/DO/T at same depth

this reflects only volume pulled for duplicates. Individual core sheets show volume pulled for samples + duplicates or spikes

~~an extra 5 ml for total of 35 ml~~
error CB 8/22/24

Table of Contents

Lake Campbell Sediment Incubation Study

CB 3/29/24

Lab A Pilot Study Core Collection + Setup 8/7/24

Objective: To collect 4 sediment cores by hand from Lake Campbell shallow dock area to determine N_2 and CO_2 bubbling rate to be used in future sediment incubation study.
To assist David Shull and Brook Love with set up of atmospheric gas simulator and assist with core set up.
DO, pH instrument calibration will be done as demonstration by D.S.

QA/QC: Calibration of instruments, good lab practices

Methods:

I. Field Sampling (Herrera Methods Memo, 2024; Herrera Sediment Core SOP, 2024)

1. Place 4 core tubes and 8 tube caps in 5 gal bucket and place on level ground by collection site.
2. Using waders and long gloves, enter lake knee to waist deep with one core and cap. Press tube into sediment to a depth of approx 1 ft (1/2 the core). Lift core just enough to place lid on bottom of tube. Lift core out of water, ensuring water is full to the rim. Place top cap on core and place in bucket.
3. Repeat for all cores.
4. Fill bucket with lake water or ice.

II. Assist with set up of atmospheric gas simulator and core set up
(
CB 8/7/24
1. Assist Profs. Shull and Love with set up per their instructions.

III. DO, pH calibration

1. Calibration of instruments will be done as a demonstration by D.S.

CB 8/7/24

CB 8/7/24 Pg1

lab A. Pilot Study Core Collection and Set up 8/7/24

Changes to Procedures: CB 8/7/24

I. Field Sampling Methods

Due to pebbly make-up of sediment, sediment was not able to be collected. We were unable to collect in a deeper area due to the full algal bloom. Collected 5 cores of lake water. Core plugs were also used.

III. DO, pH meter Calibration

pH meter thermoScientific Orion Star A214 not Calibrating. Will use pH meter calibrated in chemistry lab for tomorrow's readings.

CB 8/7/24

Data

~~Materials~~ CB 8/7/24

Table 1. Materials, Reagents, and Instruments

Materials, Reagents, Instruments	Serial/Lot #	Calibrated
DO sensor PreSense Fibox 4	SAAA000 8000073	by D.S. 8/7/24
5 core tubes	—	—
10 core caps	—	—
5 core plugs	—	—

CB 8/7/24

Lab A. Pilot Study Core Collection + Set Up 8/7/24

Field Collection

8/7/24 10:07am
Lake Campbell Sediment incubation - Phase II Pilot Study

- Collection of 4 sediment cores to determine bubbling rate

- Weather: clear, sunny, 60°F / 15.6°C

- lake has algal bloom, green algae throughout water column as far as can be seen. Shallow area of dock has many pebbles and unable to collect sediment. ~~safety~~ CB 8/7/24 Going further into

lake would require unsafe submersion due to toxic bloom. 4 cores filled with water from dock location + 1 additional core.

Sampling coordinates:
N 48°26.5446', W 122°37.0957'

Sampled by Claudia Basso + David Shull.

Results:

N/A

Summary: Gas lines and mass flow devices were connected to incubation chamber. The cores were set up for 4 treatments: High CO_2/Air, High CO_2/N_2, Low CO_2/Air, low CO_2/N_2 - one core for each tx. the 5th core was not used. D.S. to finish set up. DO calibrated and will use pH meter in chemistry lab for measurements tomorrow.

CB 8/7/24

CB 8/7/24 pg 3

Lab B. Pilot Study pH and D.O. measurements 8/8/24

Objective: To check on system set up 8/7/24.
To measure pH and DO from each of the 4 core tx.

QA/QC: Calibration of instruments, good lab practices

Methods:

I. DO measurement and pH measurement

1. Turn on PreSense DO sensor
2. Rinse 60 ml syringe with DI water, followed by a rinse of about 10 ml core water from the first treatment you'll be sampling. Discard rinse water.
3. Insert syringe into port sampling tube of the core you are sampling and fill syringe to 50 ml. Discard of the first CB 8/8/24 several ml and tap syringe to remove air bubbles.
4. Place tube with syringe attached into DO sample vial, ensuring tube is touching bottom of vial, and dispense sample water to overflow. Cap vial. - use a beaker to catch overflow CB
5. On PreSense machine, press menu button ☰, 8/8/24 select 'sensors' using arrows, select the vial # you're working with, press OK.
6. Point green laser at the center of the sensor spot on the bottom of the vial while holding the vial horizontally. Record DO measurement on screen.
~~7. Repeat for each of~~ CB 8/8/24
7. Discard a few ml of the sample water in the DO vial and recap it. Take it to the chemistry lab to measure pH.
8. Turn on the pH meter. Remove probe and rinse with DI water. Dry with Kimwipes. Turn on stirrer, add magnetic stir bar to the vial with the sample and place on stirrer. Place pH probe into vial and record reading when it stabilizes.
9. Remove pH probe and rinse with DI water, dry with kimwipe
10. Retrieve stir bar
11. Repeat DO/pH process for the remaining 3 core tx. Ensure pH probe is placed in storage solution when finished and rinse and refill DO vials with DI water.

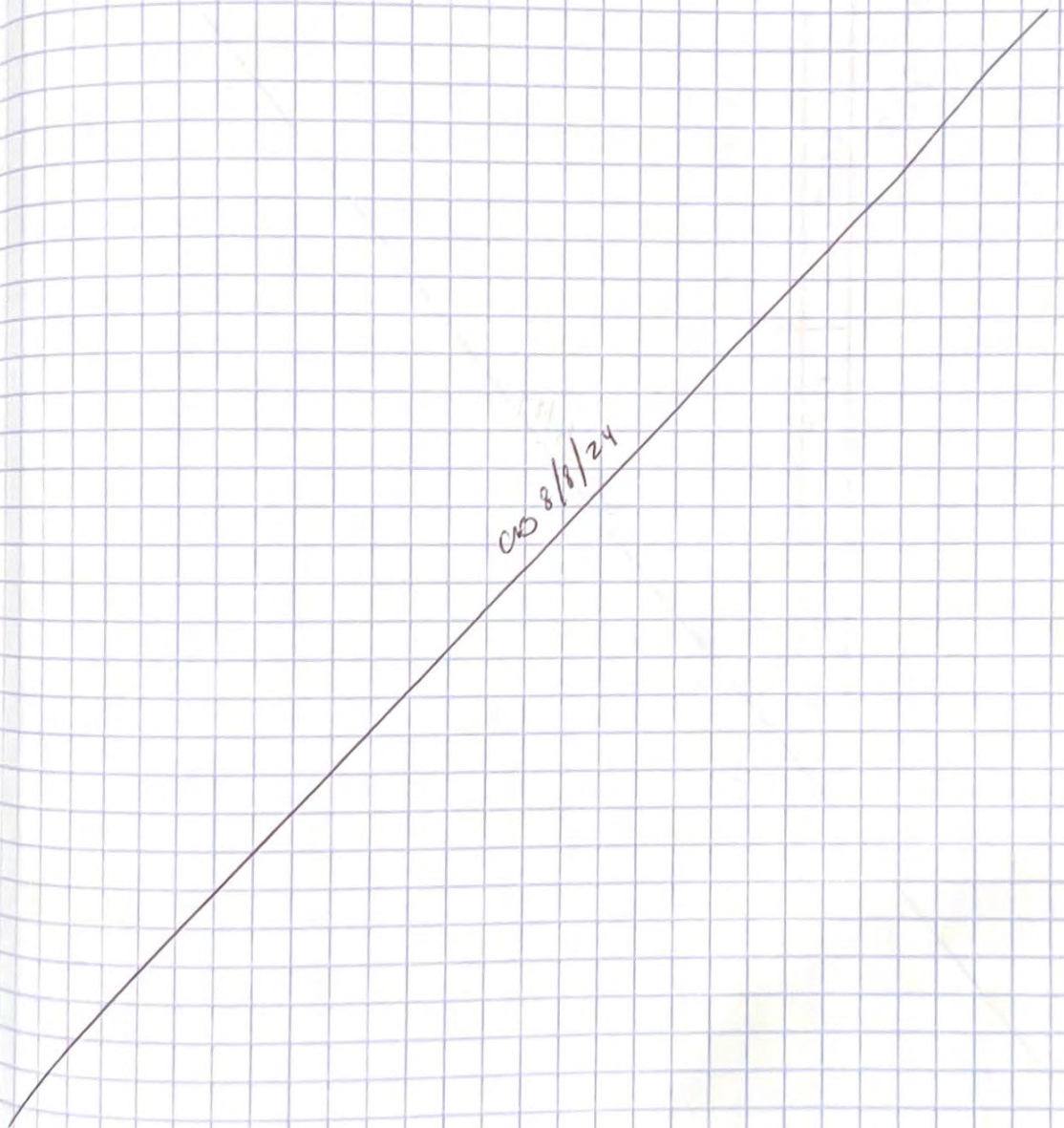
CB 8/8/24

Lab B. Pilot Study pH and DO measurements 8/8/24

Changes to Procedures 8/8/24

I. DO measurement and pH measurement

Green laser sensor was not working, unable to follow steps 1-6 of methods. Instead, DO was measured using YSI Professional Plus meter by submerging the probe into the cores.



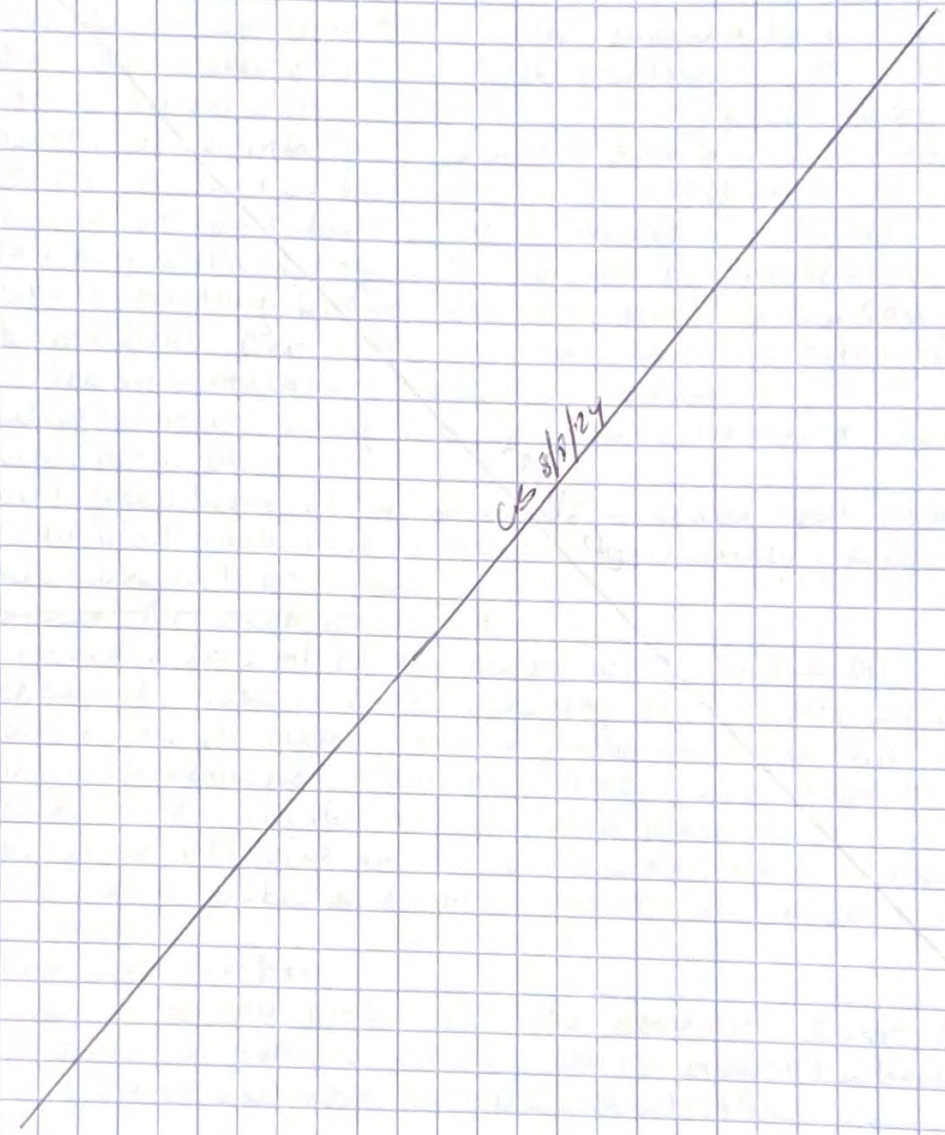
CMD 8/8/24

Lab B Pilot Study pH and DO measurements 8/8/24

Data

Table 1. Reagents and Instruments

Reagents and Instruments	Serial/lot #	Calibrated	
YSI ProPlus	23E100382	CB 8/8/24	possible error
pH ThermoScientific Orion Star A121 meter	407786	Chem lab staff prior to study	



Lake Campbell Phase II Sediment Incubation Study
Pilot Study

Name: Claudia Basso Project Number: 24-08365-000

Date: 8/8/24

Treatment	Time	Dissolved Oxygen	Temperature °C	pH
High CO_2/Air	1:30 pm	98.2% 9.37 mg/L	NA	7.90 11:24 am
* High CO_2/N_2	1:32 pm	83.2% 7.98 mg/L	NA	7.94 11:28 am
* Low CO_2/Air	1:40 pm	10.8% 1.00 mg/L	NA	8.53 11:44 am
Low CO_2/N_2	1:36 pm	3.8% 0.36 mg/L	NA	8.23 11:46 am

Notes: Arrived 10:15 am, checked 4 core tx. *High CO_2/N_2 not bubbling, main tube feeding core tube had come off at some point in night/morning. *Low CO_2/Air core also not bubbling. Unable to identify problem. Leak heard coming from mass flow system. Identified leak coming from N_2 tank connection. Unable to identify leak sheet heard from mass flow system.

N_2 gas tank psi 400 at 1:44pm
CO_2 gas tank psi 600 at 1:44pm
Turned off.

Sent information to/consulted with David Shull.

CB 8/8/24

CB 8/8/24 P87

and DO measurements 8/9/24

Lab B Pilot Study pH and DO measurements 8/8/24

12/8/8 QD

Mass Flow Readings

Treatment	CO_2	N_2	Air
High CO_2/Air	5.992 scc/m	—	*04.52 sl/m ~~0.00~~
High CO_2/N_2	1.100 scc/m	1.420 sl/m	—
Low CO_2/Air	3.401 scc/m	—	14.25 sl/m
low CO_2/N_2	0.300 scc/m	1.501 sl/m	—

* numbers were not fully set on device.

Lab B. Pilot Study pH + DO Measurements 8/8/24

Summary:
Consulted with David Skull. pH 8.53 CB 8/8/24 pH 7.23 CB 8/8/24
The pilot study got closer to achieving the target pH of 8.5 in the low CO_2/Air and low CO_2/N_2 than achieving the target pH of 7.0 in the High CO_2/Air and High CO_2/N_2 (7.94). (pH 7.90)
CO_2 will be increased in these 2 tx of High CO_2/Air and High CO_2/N_2 to lower pH further to target 7.0 pH in second pilot study. The High CO_2/N_2 anoxic tx had a high DO concentration (83.2%, 7.98 mg/L) and the low CO_2/Air tx had a low DO concentration (10.8%, 1.00 mg/L). It's possible an error may have occurred and the N_2 and Air tubes may have been switched. These two treatments were also the ones that were not bubbling. Replumbing will be done in pilot study 2.

CB 8/8/24

CB 8/8/24

Lab C. Pilot 2 Study - water sampling and DO/pH measurements 8/15/24

Objective: To collect 8 cores of Lake Campbell water from the dock to determine N_2 + CO_2 bubbling rate to be used in future sediment incubation study.
The 4 +x target pH: High CO_2/Air ~7 pH
High CO_2/N_2 ~7 pH
Low CO_2/Air ~8.5 pH
CB 8/15/24 ~~High~~ Low CO_2/N_2 ~8.5 pH

QA/QC: Instrument Calibration, good lab practices

Methods:

I. Field Sampling

1. Place 8 core tubes (assembled with stopper and cap at bottom) into tall plastic tub, along with 8 top caps.
2. From the dock, dip a core into the lake and fill it with water until full to the top. Place top cap ~~and~~ on core and place CB 8/15/24
core back into tall plastic container. Repeat with the remaining 7 cores.
3. Transport cores to SPMC.

II. Assist with Core set up

1. Assist D.S. with set up per his instructions.

II. DO/pH measurements

1. For DO measurement, follow methods on pg 4, steps 1-6.

2. For pH measurement: Discard a few ml of sample water in the DO vial ~~and re-cap~~ CB 8/15/24. Turn on pH meter and uncover the small blue hole at the top of the probe.

3. ~~Repeat~~ CB 8/15/24 Continue with methods on pg 4, steps 8 - 10.
4. repeat DO/pH for all cores.

CB 8/15/24

CB 8/15/24
pg 9

Lab C. Pilot 2 Study - Water sampling + DO/pH measurements 8/15/24

Changes to procedures:

II. Assist w/ core set up - in the interest of time, 120 ml of sample water was placed in each of 4 125ml erlenmeyer flasks and each one was bubbled to receive one of the 4 tx.

Data:

Table 1 Reagents and instruments

Reagents and Instruments	Serial/lot #	Calibrated by
DO sensor PreSense Fibox 4	SAHA00800000473	DS/CB 8/15/24
Thermo Scientific Orion Star A214	X18241	DS 8/15/24

Lake Campbell Phase II Sediment Incubation Study
Pilot 2

Name: Claudia Basso Project Number: 2

Date: 8/15/24

Table 1. Core sample parameters TRIAL 1

Treatment	Time	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L) 8/15/24 CB umol/L	Te
Tube white #12 low CO_2/Air	—	—	341.0	
yellow #6 low CO_2/N_2	—	—	81.5	
green #5 high CO_2/N_2	6:45 pm	—	115.7	
red #16 high CO_2/Air	6:50 pm	—	334.3	

CB 8/15/24

DS 10 CB 8/15/24

Lab C. Pilot 2 Study - Water Sampling + DO/pH measurements 8/15/24

Field collection

8/15/24 1:40 pm
Lake Campbell Sediment Incubation Study - Phase II
Pilot 2

- collection of 8 ~~redu~~ core tubes full of lake water to determine bubbling rate. CB 8/15/24

- clear, sunny, 63°F / 17.2 °C

- green algal bloom throughout water column as far as can be seen, although does not appear as severe as 8/7/24.

8 cores filled with water from dock location.

CB 8/15/24

Sampling coordinates:
N 48° 26.5446', W 122° 37.0957'

Sampled by Claudia Basso

CB 8/15/24

CB 8/15/24

Lab C. Pilot 2 Study - Water Sampling + DO/pH measurements

8/15/24

Summary:

The pilot study got closer to reaching the target 7 pH, with the high CO_2/N_2 tx having a pH of 6.99 and the high CO_2/Air tx having a pH of 6.99. The 8.5 pH target was not reached on the 1st trial, with low CO_2/Air having a 9.20 pH and the low CO_2/N_2 having a 9.26 pH. However, in the 2nd trial, after mass air flow adjustments, those 2 tx got very close to the target pH 8.5. Low CO_2/N_2 reached 8.37 and low CO_2/Air reached 8.61.
At some point during the 2nd trial, the N_2 gas ran out, explaining the increase of DO in the low CO_2/N_2 from trial 1 (81.5 umol/L) to trial 2 (143.0 umol/L).

CB 8/15/24

PS 12 CB 8/15/24

Lab D. Sediment Incubation Study - Sediment Core Collection and Incubation Set Up 8/18/24

Objective: To collect 16 sediment cores and overlying water from the CAM-DEEP location of Lake Campbell (48.437482, -122.616677) and set up in incubation chamber in order to expose the cores to differing tx in the following (proceeding) lab.
The goal of the study is to provide a better estimation of sediment phosphorus release and evaluate the effectiveness of an alum tx at varying pH and oxygen conditions.

QA/QC: SOPs, calibration of instruments, good lab practices

Methods:

Field Sampling

(Lake Campbell Phase II Sediment Incubation Study QAPP, 2024; Herrera Sediment Core SOP, 2024)

1. Using boat, go to sampling location CAM-DEEP (48.437482, -122.616677).
2. Water sampling: **Complete Field Data Sheet.**
3. Complete vertical depth-profile by lowering YSI meter through water column. Measure and **record** temp, DO, and pH at depths of half- meter increments, to lake bottom (approx. 5 m deep). At each depth, wait until readings stabilize.
4. Use a peristaltic pump to collect and filter water from lake bottom (1 m above sediment surface) into a 20 L carboy.
5. From the filtered 20 L carboy, collect 2 samples. One 20 mL sample for TP analysis and one 10 mL sample for SRP analysis. **Label** the samples (per field data sheet).
6. Store the carboy and samples in ice until you reach the lab. In lab, store the samples in the freezer and the carboy at 4°C. The subsamples will be sent to IWS for analysis at the end of the study.
7. Collect 16 sediment cores: Use an Aquatic Research Instruments universal percussion corer fitted with a 2-foot-long (0.61 meter) and 2-5/8-inch (68 mm) inner diameter polycarbonate tube and lower it slowly, by hand, into the lake sediment until refusal. Use a second line to raise and lower a hammer to drive the core approx 1 ft (~30 cm) into the sediments.
8. Upon retrieval, immediately cap the tube at the bottom before raising it above the lake surface. On the boat, remove the tube from the core head by unscrewing hose clamps.
9. Examine the core tube to verify at least 20 cm of undisturbed sediment is present and capped at the top. **Label** the core with core number.

   Note: If less than 20 cm is collected, the sediment will be removed from the core, the core tube will be thoroughly rinsed with lake water, and the core will be re-collected at a new location (see step 12).

10. Store the core tube upright in a bucket with ice and covered with black plastic to block light.
11. Repeat steps 7-11 for each core, moving approximately 5 ft along the length of the boat or moving the boat approximately 5 feet by releasing the anchor line.
12. When all core tubes are collected, immediately transport samples to the SPMC for set-up of incubation.

8/19/24

8/19/24 pg 13

Lab D. Sediment Incubation Study - Sediment Core Collection and Incubation Set Up 8/18/24

Sediment incubation set up

(Ogdahl et al., 2014; Lake Campbell Phase II Sediment Incubation Study QAPP, 2024)

1. Adjust core to contain 25 cm of water column overlying the 20 cm of sediment. Slowly remove or add water as needed using collected lake water and a siphon or pipette.

   Note: If cores contain more than 20 cm of sediment, remove excess sediment by removing the bottom cap, carefully releasing sediment from the bottom of the core, and recapping the core to retain 20 cm of sediment. If necessary, a clean plastic disk with an O ring will be placed on the water surface and pushed down to extrude sediment out of the core bottom.

2. Place the 16 sediment cores into a darkened environmental growth chamber, with the temperature maintained to match the ambient bottom water temperature measured in the field.
3. Set up the cores in the chamber core holders and insert the corresponding gas tube with air stone into each core (middle of water column), following Table 1 below. DO NOT turn gases on yet.

Table 1. Redox Treatments of Sediment Cores.

Core Number	Tube	Oxygen Condition	pH Condition	Alum Treated	Description
~~1~~ 9 CG 8/12/24 water 33.5cm	HIGH CO_2/AIR ① ALUM	Aerobic	Neutral pH (~7)	No	Overlying water will be bubbled with ambient air with 10,600 ppm CO2.
2 water 33cm	HIGH CO_2/AIR ②	Aerobic	Neutral pH (~7)	No	
3 water 33cm	HIGH CO_2/N_2 ①	Anaerobic	Neutral pH (~7)	No	Overlying water will be bubbled with N_2 gas and 10,600 ppm CO_2.
4 water 34cm	HIGH CO_2/N_2 ②	Anaerobic	Neutral pH (~7)	No	
5 water 33cm	LOW CO_2/AIR ①	Aerobic	High pH (~8.5)	No	Overlying water will be bubbled with ambient air and 326.3 ppm CO_2.
6 water 31.5	LOW CO_2/AIR ②	Aerobic	High pH (~8.5)	No	
~~7~~ 15 water 33cm	LOW CO_2/N_2 ① ALUM	Anaerobic	High pH (~8.5)	No	Overlying water will be bubbled with N_2 gas and 326.3 ppm CO_2.
8 overlying water 34cm 8/10 date	LOW CO_2/N_2 ② ALUM	Anaerobic	High pH (~8.5)	No	
~~9~~ 1 water 33cm	HIGH CO_2/AIR NO ALUM ①	Aerobic	Neutral pH (~7)	Yes	Overlying water will be bubbled with ambient air with 10600 ppm CO2 and 0.0654 g of alum will be added.
10 water 32.5	HIGH CO_2/AIR ALUM ② ✓	Aerobic	Neutral pH (~7)	Yes	
11 water 34 cm	HIGH CO_2/N_2 ALUM ① ✓	Anaerobic	Neutral pH (~7)	Yes	Overlying water will be bubbled with N_2 gas, 10,600 ppm CO_2 and 0.0654 g of alum will be added.
12 water 35cm	HIGH CO_2/N_2 ALUM ② ✓	Anaerobic	Neutral pH (~7)	Yes	
13 water 34 cm	LOW CO_2/AIR ALUM ① ✓	Aerobic	High pH (~8.5)	Yes	

pg 1/4 CG 8/19/24

Lab D. Sediment Incubation Study - Sediment Core Collection + Incubation Set up 8/19/24

Table 1 Continued. Redox Tx of Sediment Cores

Core Number	Tube	Oxygen Cond.	pH Cond.	Alum tx	Description
14 water 34 cm	LOW CO_2/AIR ALUM (2)	Aerobic	High pH (~8.5)	Yes	Overlying water will be bubbled with ambient air, 326.3 ppm CO_2 and 0.0654 g of alum will be added.
~~15~~ 7 water 32.5cm	LOW CO_2/N_2 NO ALUM (1)	Anaerobic	High pH (~8.5)	Yes	Overlying water will be bubbled with N_2 gas, 326.3 ppm CO_2 and 0.0654 g of alum will be added.
~~16~~ 8 water 33cm	LOW CO_2/N_2 NO ALUM (2)	Anaerobic	High pH (~8.5)	Yes	

CB 8/19/24

4. For the 16 cores, measure T, DO, pH, duplicate, ~~blank~~. **Record on Incubation Data Sheet.**
5. Turn CO2, N2, and Air on and bubble the cores until the water in the cores reach the desired pH and oxygen conditions (equilibrium) shown on table above. **Note the time it took to equilibrate and record mass air flow numbers.**

Note: Step 5 may need to be carried out in 2 days, turning on the gases on the first day and letting the cores bubble throughout the night. The following day, check for desired conditions and record the data.

* initial overlying water upon core arrival.

Changes to Procedures:

N/A

CB 8/19/24

CB 8/19/24 pg 15

Lab D. Sediment Incubation Study - Sediment Core Collection and Incubation Set Up 8/18/24

Data:

Table 2. Reagents and Instruments

Reagents/Instruments	Serial/Lot #	Calibrated
Do Sensor PreSense Fibox4	SAAA00080000073	D.S. 8/15/24
Thermo Scientific OrionStar A214 pH meter	X1824	D.S./CB 8/19/24
N_2	W242221244A	—
CO_2	Lot 33619	—
pH 7 buffer solution	CC788831	—
pH 10 buffer solution	CC787687	—
YSI EXO	17M100671	C.A. 8/19/24

Table 3.
pH Calibration

buffer	reading
7 pH buffer	7.00
10 pH buffer	10.04 calibrated to 10.00

N_2 gas 8:10 pm 2900 psi - new gas tank CB 8/20/24
N_2 gas 4:35 pm 2650 psi

CB 8/19/24

Lab D. Sediment Incubation Study- Sediment Core Collection + Incubation Set-Up 8/19/24

Table 4. Mass Flow Readings

treatment	time	CO_2 (scc/m)	N_2 (sL/m)	Air (sL/m)
low CO_2/N_2	9:38p	0.300	4.001	—
high CO_2/Air	9:38p	4.994	~~0.500~~ 8/19/24	0.500
high CO_2/N_2	9:39p	7.000	0.702	—
low CO_2/Air	9:40p	0.601	—	5.401

Table 5. Parameters Prior to Bubble Start on 8/19/24

Core	Tubing	Target Conditions	Date 8/19/24	Time	Temp (°C)	DO (umol/L)	pH
1	high CO_2/Air ①	Aerobic/pH7	8/19/24	5:23p	20.2	302.3	9.04
2	high CO_2/Air ②	Aerobic/pH7	8/19/24	5:34p	21.3	334.2	8.91
3	high CO_2/N_2 ①	Anaerobic/pH7	8/19/24	5:48p	21.2	286.6	9.06
3DUP	high CO_2/N_2 ①	Anaerobic/pH7	8/19/24	5:39p	21.1	286.9	8.91
4	high CO_2/N_2 ②	Anaerobic/pH7	8/19/24	5:57p	20.9	328.7	9.00
5	low CO_2/Air ①	Aerobic/pH 8.5	8/19/24	6:07p	21.2	~~238.0~~ 8/19/24 283.0	9.02
6	low CO_2/Air ②	Aerobic					

- Parameters 8/19/24 were recorded on the sediment incubation data sheets that will be attached to the last pg. of this study. Data was transcribed to table 5 (pg 18)
- pH 10 buffer reading post measurements: 10.03

CB 8/19/24

CB 8/19/24 pg 17

Lake Campbell Phase II Sediment Incubation Study
Pilot 2

Name: Claudia Basso Project Number: 24-08365-000

Date: 8/15/24

Table 1. Core sample parameters TRIAL 1

Treatment	Time	Dissolved Oxygen (%)	Dissolved Oxygen ~~(mg/L)~~ µmol/L 8/15/24 CB	Temperature (°C)	pH
Tube white #12 yellow #6 green #5 red #16					
low CO_2 / Air	—	—	341.0	16.4	9.20
low CO_2 / N_2	—	—	81.5	16.4	9.26
high CO_2 / N_2	6:45 pm	—	115.7	16.4	6.99
high CO_2 / Air	6:50 pm	—	334.3	16.4	6.99

CB 8/15/24

Notes/Observations: pH meter and DO sensor calibrated by D.S. pH electrode storage solution ~~post~~ pre-readings = 5.64, post-readings = 5.69. CB 8/15/24

Table 2. Core sample parameters TRIAL 2

Treatment	Time	DO (µmol/L)	T (°C)	pH
Tube yellow #6 ~~white #12~~ CB 8/15/24 white #12 ~~yellow #6~~ CB 8/15/24				
low CO_2 / N_2 *	7:10 pm	143.0	16.4	8.37
low CO_2 / Air	7:14 pm	337.1	16.4	8.61

pH electrode storage solution 5.68 pH pre-readings, 5.74 post-readings.

Notes: * At 7:10pm, when we went to take the low CO_2 / N_2 readings, we noticed N_2 tank had ran out of gas.

D.S. Adjusted Air mass flow setting in Low CO_2 / Air.
N_2 mass flow setting in low CO_2 / N_2 shed needs adjusting

CB 8/15/24

Lab D. Sediment Incubation Study- Sediment Core Collection + Incubation Set-Up 8/19/24

Table 4. Mass Flow Readings

treatment	time	CO_2 (scc/m)	N_2 (sL/m)	Air (sL/m)
low CO_2/N_2	9:38p	0.300	4.001	—
high CO_2/Air	9:38p	4.994	~~0.500~~ 8/19/24	0.500
high CO_2/N_2	9:39p	7.000	0.702	—
low CO_2/Air	9:40p	0.601	—	5.401

Table 5. Parameters Prior to Bubble Start on 8/19/24

Core	Tubing	Target Conditions	Date 8/19/24	Time	Temp (°C)	DO (umol/L)	pH
1	high CO_2/Air ①	Aerobic/pH7	8/19/24	5:23p	20.2	302.3	9.04
2	high CO_2/Air ②	Aerobic/pH7	8/19/24	5:34p	21.3	334.2	8.91
3	high CO_2/N_2 ①	Anaerobic/pH7	8/19/24	5:48p	21.2	286.6	9.06
3DUP	high CO_2/N_2 ①	Anaerobic/pH7	8/19/24	5:39p	21.1	286.9	8.91
4	high CO_2/N_2 ②	Anaerobic/pH7	8/19/24	5:57p	20.9	328.7	9.00
5	low CO_2/Air ①	Aerobic/pH 8.5	8/19/24	6:07p	21.2	~~238.0~~ 8/19/24 283.0	9.02
6	low CO_2/Air ②	Aerobic					

- Parameters 8/19/24 were recorded on the sediment incubation data sheets that will be attached to the last pg. of this study. Data was transcribed to table 5 (pg 18)
- pH 10 buffer reading post measurements: 10.03

CB 8/19/24

CB 8/19/24 pg 17

Lab D. Sediment Incubation Study Sediment Core Collection and Incubation Set up 8/19/24

Cores arrived at SPMC on 8/19/24 at 4:14pm and were immediately placed in the incubation chamber @ 20.48°C to match temperature of the Lake at depth 5.0 m.

Table 5. Parameters of sediment core overlying water prior to treatment 8/19/24

	Core	Time	T (°C)	DO (umol/L)	pH
CB 8/21/24	~~1~~ 9	5:23 p	20.2	302.3	9.04
	2	5:34 p	21.3	334.2	8.91
	3	5:48 p	21.2	286.6	9.06
	4	5:57 p	20.9	328.7	9.00
	5	6:07 p	21.2	283.0	9.02
	6	6:15 p	20.4	288.7	9.03
CB 8/21/24	~~7~~ 15	6:21 p	20.4	280.3	8.99
	~~8~~ 16	6:25 p	20.0	306.0	9.13
CB 8/21/24	~~9~~ 1	6:46 p	19.6	287.2	8.95
	10	6:51 p	19.9	265.0	8.87
	11	7:01 p	19.9	296.6	9.08
	12	7:08 p	19.6	256.7	not recorded
	13	7:17 p	20.0	282.8	8.97
CB 8/21/24	14	7:22 p	20.2	279.5	9.01
	~~15~~ 7	7:29 p	19.6	284.1	8.99
	~~16~~ 8	7:34 p	19.7	280.4	8.95
CB 8/21/24	3dup	5:39 p	21.1	286.9	8.91

CB 8/19/24

 CB 9/4/24

8/19/24

2024 LAKE CAMPBELL PHASE II SEDIMENT INCUBATION STUDY FIELD DATA SHEET

Field Equipment Checklist

- ☑ YSI EXO meter
- ☑ 2 lines of rope, in length to extend to lake bottom, plus 10 feet in excess
- ☐ 5 small bags of ice
- ☑ Flathead screwdriver
- ☑ Core end caps (32)
- ☑ syringe
- ☑ Notepad/pencil/pen
- ☐ ~~Van Dorn / Kemmerer~~ not needed 8/19/24
- ☑ 20 L carboy
- ☑ Peristaltic pump + high capacity 0.45 µm filter
- ☑ Large black garbage bags (4)
- ☑ Cores (16)
- ☑ 60 ml sample bottle for TP
- ☑ Labeling tape
- ☑ Permanent marker
- ☑ Hammer corer
- ☑ Anchor
- ☑ 5 gal buckets (4)
- ☑ Duct tape
- ☑ Nitrile gloves
- ☑ Core plugs (16)
- ☑ 10 ml sample vial for SRP
- ☑ Mini cooler for TP/SRP
- ✓ buoy 8/19/24

Project: Lake Campbell Phase II Sediment Incubation Study Project No.: 24-08365-000

Client Name: Skagit County Field Personnel: Claudia Basso

Rob Zisette

Carmen Archambault

Weather: Sunny, clear, 62°F / 16.67°C

Wind (still, windy, choppy): still

Observations: green algae in water

CAM-DEEP (at deepest point south of island)

Collection date: 8/19/24 Start time: 9:50 am

Depth to bottom (m): 5.5 m End time: 15:00 (3:00pm)

Water color: green

Notes:

lab D. Sediment Incubation Study Sediment Core Collection and Incubation set up

Field Data

8/19/24

PS 20 CB 8/9/24

Lab D. Sediment Incubation Study Sediment Core Collection and Incubation Set up 8/9/24

Profile Readings:

Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)	pH
0.5	21.89	14.50	166.2	9.42
1.0	21.55	13.23	150.0	9.33
1.5	~~8/9/24 21.44~~ 21.54	12.75	144.7	9.25
2.0	21.27	11.62	131.1	9.15
2.5	21.23	11.29	127.4	9.15
3.0	21.19	10.93	123.2	9.13
3.5	21.18	10.87	122.4	9.14
4.0	21.10	10.04	113.1	9.17
4.5	20.50	5.77	63.9	8.63
5.0	20.48	5.08	56.3	8.51

Notes: surface 0.04 T 22.15°C 10:02am
DO ~~8/9/24~~ CB 14.64 mg/L
DO %. 167.5
pH 9.42

QC surface post readings: 0.05 10:33am
T 21.98°C
DO 14.2 mg/L
DO %. 162.5
pH 9.47

Lab D. Sediment Incubation Study Sediment Incubation Set up

Lab D. Sediment Incubation Study Sediment Core Collection and Incubation Set up 8/19/24

pg 20 CB 8/19/24

Profile Readings:

Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)	pH
0.5	21.89	14.50	166.2	9.42
1.0	21.55	13.23	150.0	9.33
1.5	~~CB 8/19/24 21.44~~ 21.54	12.75	144.7	9.25
2.0	21.27	11.62	131.1	9.15
2.5	21.23	11.29	127.4	9.15
3.0	21.19	10.93	123.2	9.13
3.5	21.18	10.87	122.4	9.14
4.0	21.10	10.04	113.1	9.17
4.5	20.58	5.77	63.9	8.63
5.0	20.48	5.08	56.3	8.51

Profile readings were also logged on the YSI, C.A. will send and I will add to this notebook (pg 23)

Water Quality Samples Collected*:

Fill in the Sample IDs and depths below. Check the box (X) for each sample bottle filled.

Sample ID (sample site-date)	Sample Time	Sample Depth (m)	TP* (60 mL HDPE) Collect at least 20 mL	SRP */** (10 mL HDPE) Do not collect past 10 mL line
CAM-DEEP-08192024	10:53a	~4.5	X	X

*All water quality samples must be kept on ice or refrigerated until delivered to lab.

**Soluble reactive phosphate samples must be field filtered into bottles using syringes.

Notes: Both TP and SRP samples were filtered (they were subsamples from the 20 L carboy of filtered water.

Label sample bottles with the following:

- Sample ID (sample site-date)
- Date of collection
- Time of collection
- Analytical parameters
- Initials of personnel and client

filtering carboy water 10:~~22~~ am CB 8/17/24 start time
sample depth 15ft from surface (≈ 4.5m)

Lab & Sediment Incubation Study. Sediment Core Collection and incubation set up 8/19/24

CB 8/19/24 8:21

11:22 OB 8/19/24

Lab D. Sediment Incubation Study Sediment Core Collection and Incubation Set-up 8/19/24

Sediment Cores Collected*:

Sample ID (core #)	Time Collected	Comments
1	14:02	sediment very soft / odorous, no hammering needed
2	11:40am	
3	11:54am	
4	11:59am	
5	12:10pm	
6	12:20pm	
7	12:24pm	
8	14:09	
9	14:13	
10	14:18	
11	14:25	
12	14:30	
13	14:37	
14	14:44	
15	14:50	
16	15:00	

*All sediment cores must be kept on ice until delivered to lab.

Label cores with the Sample ID (core #).

- starting location 48.437482, -122.616677.
- moving 5 ft NW for each core 2-7
- for 8-16, 1st started 50ft west from starting pt. Moving 5ft W for each core.
- #1 recollected due to sediment fell out while adjusting it.
- secchi depth 11:21am 23.5 inches
- the core sample times were written on waterproof notepad (attached) and transcribed to table above.

Lab D. Sediment Incubation Study Incubation Set-up

Lab D. Sediment Incubation Study
Incubation set-up

1 m of water bottom is 15 ft

Core times 8/19/24

1	~~11:32~~ 11:40	13	14:37
2	11:40	14	14:44
3	~~11:49~~ 11:54	15	14:50
4	11:59	16	15:00
5	12:10		
6	12:20		
7	12:24		
8	14:09		
9	14:13		
10	14:18		
11	14:25		
12	14:30		

11:21 Secchi - 23.1 cm

Rite in the Rain

Observations:

Mass flow gas system turned on 8:15 pm, post the CB 8/19/24 ~~collects~~ pre-bubbling readings. 4 tubes, ~~one~~ delivering gas to tx high CO_2/~~Air~~ N_2, ~~one to tx low CO_2/Air~~, ~~one to tx high CO_2/N_2~~, and ~~one to tx low CO_2/N_2~~ had taken in water from the core tubes rather than delivering gas to the core tubes. Troubleshooting by D.S., got mass flow working properly again and bubbling resumed.

CB 8/19/24

CB 8/19/24

Lab D. Sediment Incubation Study Sediment Core Collection and Incubation Set-up 8/19/24

1 m from bottom is 15 ft

Core times 8/19/24

1	~~11:32~~ 14:02	13	14:37
2	11:40	14	14:44
3	~~11:48~~ 11:54	15	14:50
4	11:59	16	15:00
5	12:10		
6	12:20		
7	12:24		
8	14:09		
9	14:13		
10	14:18		
11	14:25		
12	14:30		

11:21 Secchi - 23 1/2 inches

Out

Rite in the Rain

YSI logged profile readings

Date	Time	Site	°C-17L101532	mmHg-17M100762	DO %-17L103032	DO mg/L-17L103032	SPC-µ
8/19/2024	10:02:01 AM	lake campb	22.168	762.2	168.5	14.68	
8/19/2024	10:07:44 AM	lake campb	21.909	762.2	166.9	14.61	
8/19/2024	10:09:17 AM	lake campb	21.557	762.1	150.4	13.25	
8/19/2024	10:12:43 AM	lake campb	21.441	762.1	140.5	12.41	
8/19/2024	10:14:30 AM	lake campb	21.286	762.1	131.8	11.68	
8/19/2024	10:17:01 AM	lake campb	21.229	762.1	127.8	11.33	
8/19/2024	10:18:40 AM	lake campb	21.19	762.1	123.2	10.94	
8/19/2024	10:20:30 AM	lake campb	21.18	762.1	122.4	10.87	
8/19/2024	10:25:49 AM	lake campb	21.111	762.1	112.7	10.02	
8/19/2024	10:28:58 AM	lake campb	20.575	762.1	64.4	5.78	
8/19/2024	10:30:32 AM	lake campb	20.484	762	56.4	5.08	
8/19/2024	10:32:24 AM	lake campb	21.988	762	161.7	14.13	

Observations:

Mass flow gas system turned [...] bubbling readings. 4 tubes [...] ~~one to XX low CO_2/Air, one to~~ [...] ~~low CO_2/N_2~~ had taken in wa[...] than delivering gas to the core tu[...] mass flow working properly again[...]

OB 8/19/24

OB 8/19/24

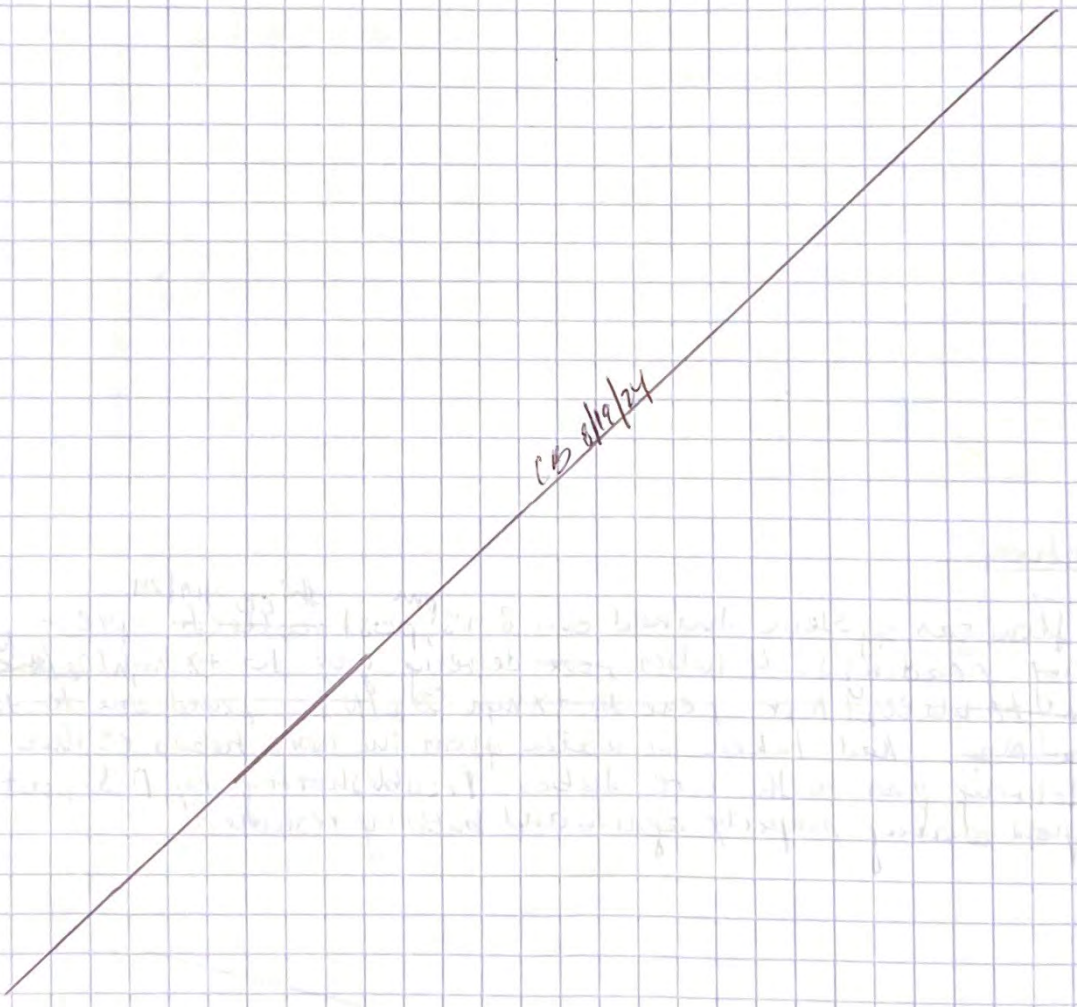
Pg. 23

OB 8/19/24

Lab D Sediment Incubation Study - Sediment Core Collection 8/19/24
→ Incubation set-up

Summary:

Collected 16 sediment cores with overlying water and filled 20L carboy with filtered water with R.Z. and C.A. Field readings at different depths are attached on pg 23. Transported cores to the lab (R.Z), arriving at 4:14pm. Cores were set up in the chilled incubation chamber, set to 20.48°C to match temp. of lake at 5.0m depth. T/DO/pH readings were taken of overlying water for each core prior to turning on bubbling. When bubbling was turned on, some (4) gas tubes took in core water, rather than delivering gas to cores. Troubleshooting done by D.S. and airstones to those tubes were removed, water removed from tubing. D.S got system working properly and bubbling ~~commenced~~ CB 8/19/24 commenced.



CB 8/19/24

PG 24 CB 8/19/24

Lab E. Core Equilibration Confirmation, Hour 0 measurements, and Alum dosing 8/20/24

Objectives: To confirm sediment core overlying water has reached the target ~~pH 7~~ 8/20/24 treatments of ~pH 7, ~pH 8.5, aerobic, and anaerobic.
To take Hour 0 measurements of T, D.O., pH and TP and SRP samples once target conditions achieved.
To dose cores with aluminum sulfate (alum) and sodium aluminate after the measurements and samples have been taken.

Methods:

Core equilibration confirmation

1. **Record** N2 and CO2 psi and mass flow readings at start of lab.
2. Measure the pH and DO in four tubes, one for each gas treatment, to check how close we are to target DO and pH (refer to Table 1 on page 14 for target pH conditions). **Note the time**. If we are off a little, adjust the flow using the flow controller: press ↵, adjust number with arrows, press ↵, then press ⊕ to set it.
3. If you need to make the pH go lower, either reduce the air/N2 flow or raise the CO2 flow. To make the pH go higher, either raise the air/N2 flow or reduce the CO2 flow. If you do adjust the flow, change the second digit by one unit. For example, if the flow is 4.000, change it to either 4.100 or 3.900. If the flow is 0.400, change it to either 0.410 or 0.390. **Record** the new readings.

Switch the N2 gas tank

1. Switch to the N2 gas tank previously used: Turn off the flow controllers using the power strip switch. Turn off the N2 tank and switch the regulator to the tank next to the CO2 tank. Turn on the gas, then turn on the flow controllers using the power strips, then start the flow by pushing the button on the right side of each flow controller. **Record** the N2 and CO2 psi. ⊕

Adjust the overlying water in the cores

1. Adjust the water level on the cores to a uniform 25cm height: Measure 25 cm from the sediment surface and make a mark on the core tubes with a piece of label tape.
2. Suck out water from each core to the level marked. Then all tubes have the same volume of overlying water. (You will need to add a longer tube to the 60-cc syringe because you'll have to reach deeper into each tube after you drop the water level.

HOUR 0 measurements and sample collection (When cores have equilibrated and before adding alum)
(Ogdahl et al., 2014; Lake Campbell Phase II Sediment Incubation Study QAPP, 2024; IWS Sampling and Handling TP and SRP Samples, 2024)

Supplies:

17 60mL TP sample bottles
18 10 mL SRP sample vials
60 mL syringe with tube of enough length to reach middle of the water column
18 0.45 µm syringe filters
Pre-made labels
Glass DO bottle labeled V1

LabE. Core Equilibration Confirmation, Hour 0 measurements, and alum dosing 8/20/24

1. Label the sample bottles and vials with pre-made labels. Place them in their racks and set them aside.
2. Turn on the DO sensor, you will be using the V1 bottle to measure T, DO, and pH. Press the back arrow for the menu, navigate to the sensor screen, select V1, press ok.
3. Turn on the pH meter, unplug the blue hole at the top of the electrode, remove the electrode from the storage solution, rinse the electrode with DI water, dab dry with a Kimwipe.
4. Use randomchoicegenerator.com to select the core from which to collect the duplicate and spike samples. Core 5 dup, core 8 spike.
5. Begin with Core 1. Rinse syringe with deionized water and discard. Rinse the syringe with 10 mL of core water and discard.
6. Remove 60 mL of core water. With the syringe pointing up, push out any air space and ensuring there aren't any air bubbles in the syringe.
7. Dispense 28 mL of water into the V1 vial (approx. 24 mL + overflow). Cap the vial and turn it over slowly to ensure you don't see any air bubbles.
8. Measure DO with the DO sensor: Press ok twice on the DO instrument. Hold the V1 vial upside down by the cap only, hold the laser to the middle of the sensor dot on the bottom of the vial. **Record** the T and DO readings on the **Incubation Data Sheet**.
9. Pour out a small amount of the sample to avoid spilling when measuring pH. Place a small stir bar into the vial and place vial on stir plate. Insert electrode into the sample vial and press the measure button on the pH meter. **Record** pH on the **Incubation Data Sheet** once the reading stabilizes.
10. Dispense 20 mL of the sample in the syringe into a 60mL sample bottle for analysis of TP. **Write** the sample time on the label.
11. Attach the 0.45 µm filter to the syringe and rinse by filtering 1 mL of the sample and disposing it. Dispense a 10 mL subsample into the 10 mL sample vial for analysis of SRP. **Write** the sample time on the label.
12. Discard any left-over sample from the syringe.
13. Place the TP and SRP samples in the freezer upright, in the holding racks.
14. Repeat for the remaining cores, including a duplicate TP and SRP from the core in step 4 and an SRP spike for the core from step 4.
15. Replace the 70 mL of water extracted from each core (60 mL for the measurements and samples + 10 mL for rinsing) with water from the carboy. After replacing the water, the water level should reach the mark you made when you previously adjusted the water height.

Aluminum sulfate (alum) and sodium aluminate buffer dosing
(Lake Campbell Phase II Sediment Incubation Study QAPP, 2024)

1. ~~Use the balance in the analytical chem lab to measure 8 aliquots of each of the two chemicals into weigh boats.~~ CB 8/21/24 Invert each jar 3 times before drawing up chemical.
2. Turn off the gas flow by turning off the power strips. You do not need to turn off the gas tanks.
3. Using a micropipette and a clean tip, add 0.5 mL Alum (500 uL) to Core 1. Discard the tip.
4. Add a new tip to the pipette and dose the same core 0.25 mL sodium aluminate (250 uL).
5. Use the pipette to stir the surface of overlying water. A floc should form and settle to the bottom.
6. After all floc settles, turn gas power strips back on. Record dose on Incubation data sheet

N2 gas tank and mass flow check

1. Check the pressure in the N2 tank. Move it to a tank that has enough pressure to make it to the next sampling time (turn off power strips, move regulator, turn on gas, turn on power strips, hit buttons on mass flow controllers to start them pumping). **Record** the N2 and CO2 psi.
2. **Record** any change in mass flow readings.

Return to the lab in 12-18 hrs for measurements and sample collection.

Lab E. Core Equilibration Confirmation, Hour 0 measurements, 8/21/24
and Alum dosing

Data:

Table 1. Reagents and Instruments

Reagents/Instruments	Serial/Lot #	Calibrated
DO sensor PreSense Fibox 4	SAAA000800000473	D.S. 8/15/24
Thermo Scientific orionStar A214 pH meter	X18241	C.A/CB. 8/21/24
N_2	W242221 24A	—
CO_2	21+33619	—
pH 7 buffer sol.	CC 788831	—
pH 10 buffer sol	CC 787687	—

Table 2. N_2 gas tracking

N_2 lot #	Time	psi
W24 222124 A	8:43a	400
~~W24222124A~~ ~~W242221248~~ 8/21/24	11:12a	900
W24222124A	6:31p	400
W24222124A	6:34p	2900

Table 3. CO_2 gas tracking

CO_2 Lot #	Time	psi
21+33619	8:47a	600
—	—	—

Table 4. Mass Flow Readings 8:44am

Treatment	CO_2 (scc/m)	N_2 (sl/m)	Air (sl/m)
High CO_2/Air	4.999 CB 8/21/24	—	0.501 CB 8/21/24
High CO_2/N_2	~~7.001~~ 7.709	~~3.700~~ 0.750	—
Low CO_2/Air	0.600	—	5.400
Low CO_2/N_2	0.300	3.701	—

Mass flow notes: N/A

CB 8/21/24

Labe. Core Equilibration, WQ measurements, Alum dosing 8/21/24

Bubbling check:

8:52 am Core 4, receiving high CO_2/N_2 tx, attached to gas tube 1, is not bubbling. adjusted knob for flow increase and bubbling restored.

~~10:43~~
CB 8/21/24

pH calibration

buffer solution	before cal.	after cal.
pH buffer 7	~~7.00~~ 7.01	cal to 7.00
pH buffer 10	~~10.03~~ 10.04	cal to 10.00

slope ~~95.4%~~ 99.9%.

Start: 10:06

DOT/pHT

	Core	Tx	DO	pH	mV
CB 8/21/24	~~1~~ 9	aerobic/neutral	~~19.6~~ 19.6/20.0 324.6	7.09	-18.8
	2		19.6 370.5	7.11	-19.5
	3	anaerobic/neutral	19.5/19.9 134.9	7.05	-15.7
	4	not bubbling @ sample	19.5/19.6 220.0	7.21	-25.3
	5	aerobic/high pH	19.5/19.9 317.5	8.41	-94.7
	6		19.4/19.7 319.2	8.47	-98.1
A CB 8/21/24	~~7~~ 15	anaerobic/high pH	19.4/19.6 206.9	8.43	-107.4
	~~8~~ 16		19.4/19.9 194.3	8.56	-105.8
CB 8/21/24	9 1	aerobic/neutral	19.4/19.7 299.8	7.26	-28.3
	10		pH 19.8/19.4/~~316.1~~ 316.1	7.16	-27.2
	11	anaerobic/neutral	19.4/20.0 191.2	7.06	-16.6
	12		19.3/19.7 155.1	7.09	-18.1
	13	aerobic/high pH	19.3/19.5 289.1	8.55	-103.1
	14		19.3/19.7 316.5	8.45	-97.1
CB 8/21/24	~~15~~ 7	anaerobic/high pH	19.3/19.9 222.7	~~8.4~~ 8.51	-100.3
CB 8/21/24	~~16~~ 8		19.3/~~19.6~~ 19.5 ~~150.3~~ 150.3	~~8.51~~ 8.57	~~-102.4~~ -103.9

End: 11:26

- used as WQ parameters

11:22 - new tank PSI 900

PS 28 CB 8/21/24

lab E. Core Equilibration, URO measurements, alum dosing 8/21/24
10:44am

12, 8, 7, 15, 16, 9, 8, 12, 3, 4, 11 not bubbling - N_2 gas tank needs to be switched.

after switching gas tank at 10:58am 1 not bubbling steel
11 not bubbling

turned knob for higher flow - steel not bubbling - turned / balanced flow for all tubes corresponding to these tx, bubbling restored.

8/21/2024 T_P / SRP sampling / Dosing

Core #	Time	Vol pull (mL)	SRP	T_P	Vol replaced (mL)		Dose time
~~9~~	13:30	10 + ~~24~~ 28	✓	✓	38	(38 mls)	4:11p
2 CB 8/21/24	13:40	10 + 30	✓	✓	40		N/A
3	13:45	10 + 30	✓	✓	40		N/A
4	13:55	10 + 30	✓	✓	40		N/A
D 5	13:57	10 + 30 + 30	✓	✓✓	70	AC 14:01	N/A
6	14:04	10 + 30	✓	✓	40		N/A
~~7~~ 15 CB 8/21/24	14:11	10 + 30	✓	✓	40		4:15p
+ ~~8~~ 16 CB 8/21/24	14:17	10 + 40	✓	✓	50		4:13p
~~9~~ 1	14:22	10 + 30	✓	✓	40		N/A
10 CB 8/21/24	14:26	10 + 30	✓	✓	40		5:05p
11	14:31	10 + 30	✓	✓	40		5:00p
12	14:34	10 + 30	✓	✓	40		4:08p
13	14:39	10 + 30	✓	✓	40		4:06p
14	14:45	10 + ~~30~~ 30	✓	✓	40		5:02p
~~15~~ 7 CB 8/21/24	14:49	9 + 30	✓	✓	39		N/A
~~16~~ 8 CB 8/21/24	14:53	10 + 30	✓	✓	40		N/A

Notes:

D = duplicate sample

+ = spike.

8/22/24 pH check

pH 7 → 6.99 -127 mV

CB 9/24/24
pg 29

LabE. Core Equilibration, HRO measurements, alum dosing 8/21/24

Aluminum sulfate/sodium aluminate dosing

3:50p gas flow was turned off

4:06p began to dose cores 13, 12, 1, 8, 7 with 500uL alum and 250 uL sodium aluminate. Realized cores 1, 8, 7 should not have recd dose. After consulting with D.S. switched labels w/the undosed duplicate tx and ~~switched~~ fixed all labels on samples + recordings. 1→9, 8→16, 7→15 CB 8/21/24

5.00p dosed the remaining cores 10, 11, 14

6:16p floc ~~CB~~ 8/21/24 on core 13 has settled to bottom ~~15~~ 12 cm of water column. Core 9 floc settled to bottom 9.5cm of water column. Core 16 to bottom 14 cm. Core 15 to bottom 6cm. Core 11 to bottom 9 cm. Core 14 to bottom 9cm. Core ~~to 10~~ 10 to bottom 8 cm. Core ~~12~~ Core 12 to bottom 12 cm. CB 8/21/24

(measurements approx)

Switched N_2 tank 6:31pm psi 400 old tank
psi 2900 new tank

7:13p gas turned back on. Disturbed floc on core 12. Turned gas off until floc settled.

7:28p gas back on. Floc in all cores undisturbed.

Summary:

Today there were a few instances of cores not bubbling, which were corrected by adjusting knobs for increased flow. pH and DO were checked to see if target tx was reached. pH was within target. Checked with D.S. - these measurements can be/will be used for HR O measurements. DO measurements not stabilizing, used first readings, informed D.S.

~~IR set error~~ 8/21/24 Water level in each core was then adjusted to a height of 25 cm above the sediment, which was marked with sharpie and tape on each core.

PJ 8/21/24

Lab E. Core Equilibration, HRO measurements, alum dosing 8/21/24

Summary cont:

TP/SRP samples were collected.

Gas flow was turned off and 8 cores were dosed with aluminum sulfate 500 uL and sodium aluminate 250 uL.:

Cores 13, 12, 1, 8, 7, 10, 11, 14. Cores 1, 8, 7 shouldn't have been dosed. This was corrected by switching labels with their undosed duplicates that should have been dosed. Core 1 was re-labled Core 9. Core 8 was relabled core 16. Core 7 was re-labeled core 15.

Corrected dosed cores: 13, 12, 9, 16, 15, 10, 11, 14. Also corrected labels on sample bottles and places where measurements were recorded in the data sheets and in this notebook. Consulted with D.S., TC, CA.

Gas restored (bubbling) once floc settled.

Per D.S. instructions, wrapped the top of cores w/ 2 layers of saran wrap. Lights are kept off when I'm not in chamber. Gas tank was switched to new tank for the night.

OB 8/21/24

OB 8/21/24
14:31

Lab F. HR 17 Measurements, sample collection, gas check 8/22/24

Objectives: gas (N_2) check, mass flow check, HR 17 measurements and sample collection

Methods: I. Switch N_2 gastank (pg 25)
II. Mass flow check (pg 26)
III. HR 17 measurements and sample collection (pg 25-26)

OBS 8/22/24

pg 32 8/22/24

Lab F. HK 17 Measurements, sample collection, gas check 8/22/24

Data:

Table 1. Reagents + Instruments

Reagents + Instruments	Serial/Lot #	Calibrated
DO Sensor PreSense Fibox4	SDDA000820000273	DS 8/15/24
Thermo Scientific Orion Star A214 pH meter	X18241	CA/CB 8/21/24
pH 7 buffer	cc 788331	—
N_2	W242221124A	—
CO_2	LH 336619	—

Table 2 N_2 gas tracking

N_2 Lot #	Time	psi	
W242221124A	8:38am	1300	will switch
W242221124A	8:46a	350	
W242221124A	10:37a	1300	
W242221124A	6:55p	350	will switch
W242221124A	7:03p	2800	

Table 3 CO_2 gas tracking

Lot #	Time	psi
LH 336619	8:38am	600

Table 4 Mass Flow Readings 8:23am

tx	CO_2 (scc/m)	N_2 (sL/m)	Air (sL/m)
low CO_2/N_2	0.300 → adjusted to 0.100 at 5:28pm	3.700	—
high CO_2/N_2	7.681	0.750	—
high CO_2/Air	5.111	—	0.500
low CO_2/Air	~~5.400~~ 8/22/24 0.600 → adjusted to 0.400 at 5:28pm	—	5.399

Core check: 8:25am

All cores are bubbling. The flock on the 8 alum dosed cores 13, 12, 9, 16, 15, 11, 14, 2 has settled to the bottom, with all of them ~4 cm ~~from~~ the bottom of the water column, except core 16, approx 6 cm ~~to~~ at bottom of water column. Inserted the gas tubes a little further in to reach approx middle of water column, as they were left closer to the surface last night to not disturb the settling floc. 8/22/24 pg 33

Lab F Lhr 17, Measurements, Sample Collection, gas check 8/22/24

pH 7 buffer 6.99 prior to measurements

8/22/24 TP/SRP Sampling

Core	Time	Vol Pull (mL)	SRP	TP	Vol replaced
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

CBS 8/22/24

— Recorded on Incubation Data Sheet

CBS 8/22/24

pg 34 CBS 8/22/24

Lab F. UR 17, Measurements, sample collection, gas check 8/22/24

Table 5. 8/22/24 parameters

Target tx	Core	Time	T (°C)	DO (umol/L)	pH	TP/SRP
aerobic/neutral pH	2	9:22a	19.4	322.3	7.12	✓
high CO_2/Air	1	9:15a	19.4	322.6	7.11	✓
NO alum						
		08/22/24				
aerobic/neutral pH	9	10~~12~~:29a	19.4	317.1	6.93	✓
high CO_2/Air	10	10:45a	19.4	318.0	6.99	✓
ALUM						
anaerobic/neutral pH	3	9:28a	19.4	191.1	7.04	✓
high CO_2/N_2	4	9:33a	19.4	153.6	7.00	✓
NO alum						
anaerobic/neutral pH	11	10:58a	19.4	189.3	6.86	✓
high CO_2/N_2	12	11:05a	19.4	260.8	6.98	✓
ALUM						
aerobic/pH~8.5	5	9:36a	19.4	314.6	8.24	✓
* low CO_2/Air	6	9:51a	19.4	315.8	7.95	✓
NO alum						
aerobic/pH~8.5	13	11:15a	19.4	320.0	7.71	✓
* low CO_2/Air	14	11:33a	19.4	322.6	8.05	✓
ALUM						
anaerobic/pH~8.5	7	9:59a	19.4	174.2	8.42	✓
* low CO_2/N_2	8	10:11a	19.4	230.2	8.07	✓
NO alum						
anaerobic/pH~8.5	15	12:01p	9.4	144.0	7.54	✓+spk
* low CO_2/N_2	16	12:15	19.4	201.2	6.98	✓+dup
ALUM	16-DUP	12:15	19.4	182.3	6.96	

The data on this table is transcribed from the Incubation Data Sheets.

* per consultation with D.S. I will drop the CO_2 flow on the low CO_2/Air tx and low CO_2/N_2 tx by ~~0.1 scc/m~~, and in the low CO_2/Air tx and low CO_2/N_2 tx by 0.2 ~~scc~~/m/ to try to increase pH.

CB 8/22/24 was unable to drop these specific tx by 0.1 due to gas flow setup, can't drop by different increments if belong to same tx group - all 4 cores CO_2 dropped by 0.2 scc/m.

CB 8/22/24

Lab F. HR17 measurements, sample collection, gas check 8/22/24

Summary

All cores were bubbling at 8:25 am upon my arrival. The alum dosed cores had floc settled to the bottom ~4 cm of the water column, except for core 16, which had floc settled to the bottom ~6 cm.

Gas flow to the 4 cores receiving the high CO_2/N_2 tx gets weak every so often and needs adjusting of knobs to get it going a little stronger again (no adjusting of numbers to mass flows is involved). This is the set of gas tubes that took in the water on 8/19/24. However, this problem seems to be improving with time.

All the high pH/CO_2 cores seem to have dropped in pH, but the alum dosed seem to have dropped ~~most~~ most. Consulted w/ D.S. and adjusted the CO_2 mass flow numbers (CB 8/22/24) in the high pH/low CO_2 txs by a 0.2 decrease. The low CO_2/N_2 was adjusted from 0.300 sccm to 0.100 sccm. The low CO_2/Air was adjusted from 0.600 sccm to 0.400 sccm.

The saran wrap top covers were not sticking well. I re-applied 2 layers of saran wrap and a layer of parafilm on top, then zipped with adjustable ties.

N_2 gas tank switched to new tank to last overnight. Lights are being kept off when I'm not in chamber.

CB 8/22/24

pg 36 CB 8/22/24

Lab G HR 46 measurements, sample collection, gas check 8/23/24

Objectives: HR 46 measurements and sample collection
check on mass flow, bubbling, and N_2 gas tank.

Methods:

I. HR 46 measurements and sample collection (pg 25)
II. Switch N_2 gas tank (pg 25). (pg 26)
III. Mass flow check (pg 26)

~~Data~~ CB 8/23/24 QA/QC: following QAPP, SOPs, duplicates, calibration checks, good lab practices

Data:

Table 1 Reagents + Instruments

Reagents/Instruments	Serial #/Lot #	Calibrated
DO Sensor PreSense Fibox 4	SAAA0008000073	D.S. 8/15/24
ThermoScientific Orion Star A214 pH meter	X18241	~~CB 8/23/24~~ ~~CA/CB 8/21/24~~ CB 8/23/24
N_2 tank	W242221244	—
CO_2 tank	2H33619	—
pH 7 buffer	CC788831	—
pH 10 buffer	CC787687	—

Table 2 N_2 gas tracking
(lot # are same on all tanks)

time	psi
1:33 pm	750
4:13 pm	650
8:20 pm	2800
—	—

ran out 4:00pm 2:43pm

Table 3. pH meter calibration

buffer sol.	before cal.	after cal
pH 7 buffer	6.97	7.00
pH 10 buffer	9.98	10.00
slope 99.4%		

pH post measurement (of buffer pH 7) = 7.00

Table ~~3~~ 4 Mass flow Readings ~~(sccm)~~ CB 8/23/24 at 1:30pm

tx	CO_2 (sccm)	N_2 (sl/m)	Air (sl/m)
low CO_2/N_2	0.100	3.700	—
high CO_2/N_2	7.700	0.750	—
high CO_2/Air	5.100	—	0.500
low CO_2/Air	~~5.400~~ CB 8/23/24 0.400	—	5.400 → 5.600 at 9:20pm

Air increased to 5.600 slm at 9:20pm
Bubbling increased on all N_2 tx at 9:20pm

CB 8/23/24 pg 37

Tabs 4. HK 46 measurements, sample collection, gas check 8/23/24 8/23/24

Core check observations:

1:15 pm arrived and checked core bubbling. All cores bubbling except for Core 1 (High CO_2/Air NO ALUM). Turned the corresponding knob on the gas flow system a little and bubbling was restored.

9:02 pm floc on ~~all~~ 8/23/24 dosed cores (alum) 9, 15, 16, 12, 13, 14, 10 had settled to height of ~2.5 cm at bottom of water column. Core 11 height of floc ~2.5-3 cm at bottom of water column

(Table 5 - Pg. 39)

~~8/23/24 Summary:~~ Summary:

Cores remained sealed throughout the night. Core 1 not bubbling upon my arrival, adjusted knob and bubbles restored (no mass flow numbers changed at this point).

Buffers pH 7 and pH 10 reading slightly below, so pH meter recalibrated. An approx middle of water column was marked with tape on all cores to ensure measurements/sampling was done at the same level going forward.

Noticed the tube attached to the syringe pulls out an extra 5 mL from the cores yesterday. This extra amt was replaced for HR 12-18 (17) and today, HK 46. The extra amt was not replaced for HR0, where a shorter syringe was used. Will check how many mL it holds.

Floc was measured at 9:02 pm, looked denser/thicker. Floc had settled to ~2.5 cm in height, at bottom of water column, with Core 11 ~2.5 cm - ~3 cm in height, at bottom of water column.

After consultation with D.S., increased bubble rate (turned knobs only) in all N_2 tx to decrease DO. Also adjusted numbers in mass flow system by increasing air by 0.2 sl/m in the low CO_2/Air tx to try to increase pH.

Gas tank (N_2) switched for the night, lights off in chamber.

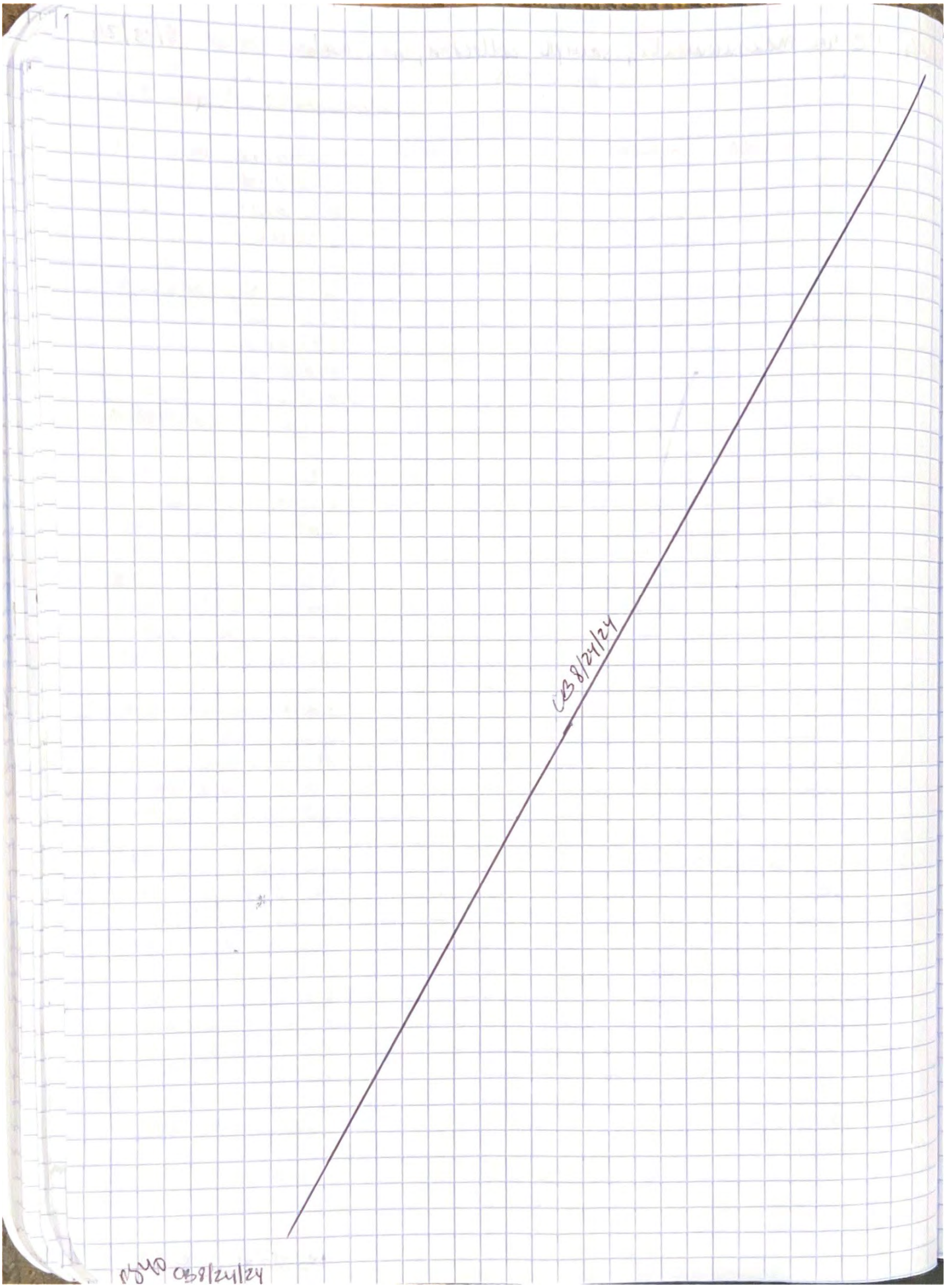
Lab 4. HR 46 measurements, sample collection, pH check

8/23/24

8/23/2024 HR46 Parameters

Target Tx	Core	Time	T (°C)	DO (umol/L)	pH	TP/SRP
aerobic/pH7-high CO2/Air-NO alum	1	2:50 PM	19.5	328.0	7.10	done
aerobic/pH7-high CO2/Air-NO alum	2	3:18 PM	19.5	324.7	7.04	done
aerobic/pH7-high CO2/Air-ALUM	9	5:20 PM	19.4	317.1	6.93	done
aerobic/pH7-high CO2/Air-ALUM	10	5:30 PM	19.4	318.1	6.97	done+dup
aerobic/pH7-high CO2/Air-ALUM	10-dup	5:30 PM	19.4	320.1	6.96	N/A
anaerobic/pH7-high CO2/N2-NO alum	3	3:33 PM	19.5	169.8	6.98	done
anaerobic/pH7-high CO2/N2-NO alum	4	3:44 PM	19.5	140.2	6.99	done
anaerobic/pH7-high CO2/N2-ALUM	11	5:43 PM	19.4	189.3	6.86	done
anaerobic/pH7-high CO2/N2-ALUM	12	5:55 PM	19.4	201.8	6.83	done
aerobic/pH8.5/low CO2/Air-NO alum	5	4:16 PM	19.5	320.2	8.30	done+ spike
aerobic/pH8.5/low CO2/Air-NO alum	6	4:30 PM	19.5	312.7	7.73	done
aerobic/pH8.5/low CO2/Air-ALUM	13	6:09 PM	19.4	317.3	8.10	done
aerobic/pH8.5/low CO2/Air-ALUM	14	6:24 PM	19.4	320.3	8.10	done
anaerobic/pH8.5-low CO2/N2-NO Alum	7	4:45 PM	19.5	203.1	8.57	done
anaerobic/pH8.5-low CO2/N2-NO Alum	8	5:00 PM	19.5	98.4	8.48	done
anaerobic/pH8.5-low CO2/N2-ALUM	15	6:38 PM	19.4	211.6	8.46	done
anaerobic/pH8.5-low CO2/N2-ALUM	16	6:46 PM	19.4	165.3	7.83	done

8/23/24 RS 3.7


08/24/24
08/24/24

Lab H. HR 70 measurements, sample collection, gas check 8/24/24

Objectives: Check mass flow, bubbling, N_2 gas tank.
HR 70 measurements and sample collection

Methods: I. Switch N_2 gas tank (pg 25)
II ~~III~~. Mass flow check (pg 26)
CB 8/24/22
III. HR 70 measurements + sample collection (pg 25-26)

QA/QC: following QAPP, SOPs, duplicates, calibration checks, good lab practices.

Data:

Table 1 Reagents + Instruments

Reagents/Instruments	Serial/Lot#	calibrated
DO Sensor PreSense Fibox 4	SMA 00080000073	DS 8/15/24
ThermoScientific Orion Star A214 pH meter	X18241	CB 8/24/24
N_2 tank	W242221D4A	—
CO_2 tank	2H 336619	—
pH 7 buffer	CC 788831	—
pH 10 buffer	CC 787687	—

Table 2 N_2 gas tracking

Time	psi
1:27p	750 *
6:30p	2700
8:18p	2500
—	—

* used gas tank w/ 450 psi used in between.

Table 3 pH meter calibration

buffer sol	before cal	after cal
pH 7 buffer	6.98	6.99
pH 10 buffer	9.99	10.00

Slope 99.4%
no calibrated - after cal pH 7 buffer = 7.00
pH 10 buffer = 10.00
pH buffer 7 before cal 7.01
buffer pH 10 before cal 10.05

Table Mass flow readings at 1.27 pm. pH 7 buffer post measurements 6.99

Tx	CO_2 (sccm)	N_2 (sl/m)	Air (sl/m)
low CO_2/N_2	0.100	3.700	—
high CO_2/N_2	7.708	0.751	—
high CO_2/Air	5.106	—	0.500
low CO_2/Air	0.401	—	5.600

8:20pm increased N_2 bubbling only.

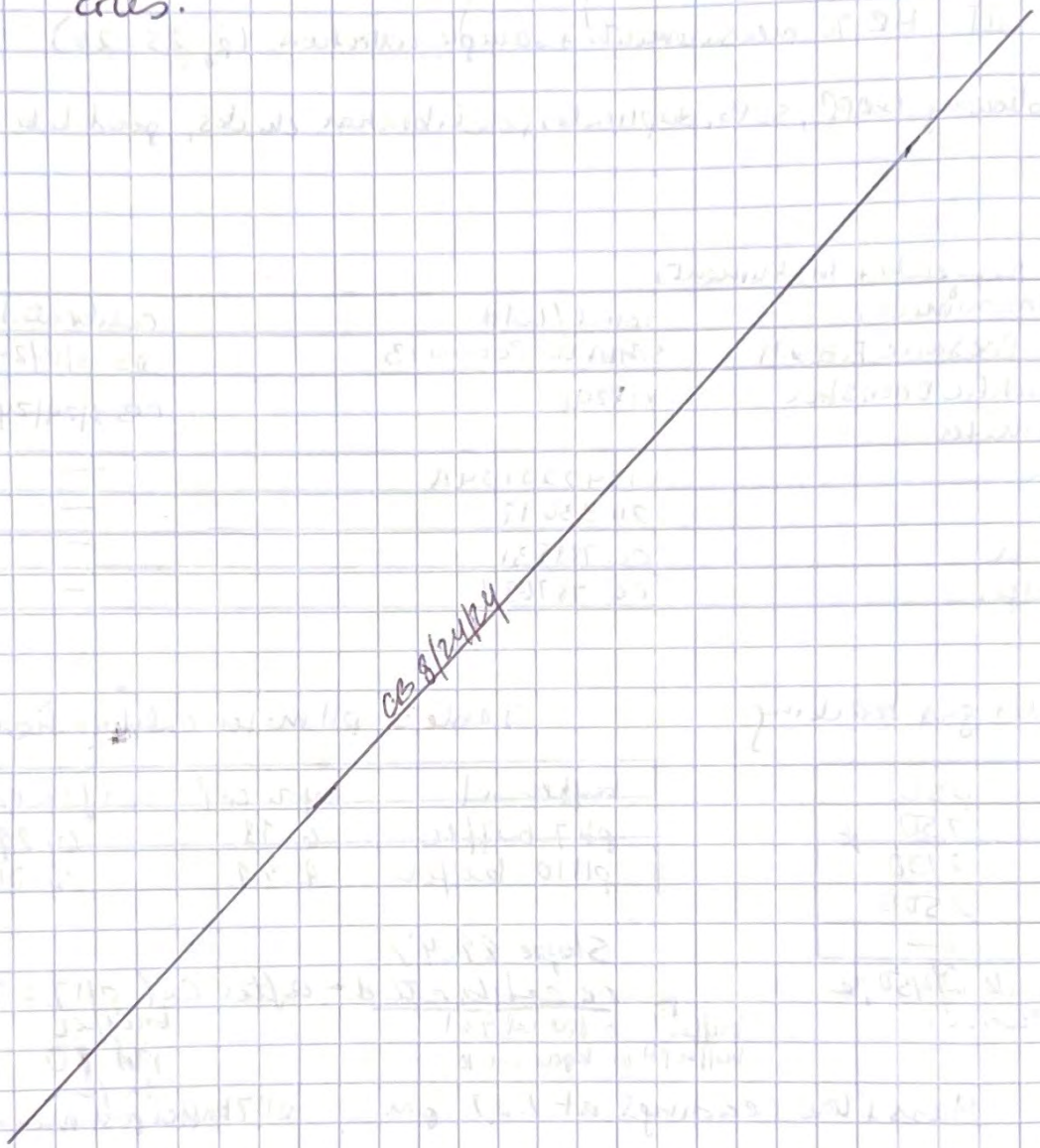
CB 8/24/24

CB 8/24/24 pg 41

Lab #. HR 70 measurements, sample collection, gas check 8/24/24

Core check observations:

1:29pm all cores bubbling.
7:55pm floc ~ 2.5cm 1in height, settled to bottom of water column in all dosed (Alum/Aluminate) cores.



RS-42, CB 8/24/24

Lab H. HR70 measurements, sample collection, gas check

6/24/24

8/24/2024 HR70 Parameters

Target Tx	Core	Time	T (°C)	DO (umol/L)	pH	TP/SRP
aerobic/pH7-high CO2/Air-NO alum	1	2:28 PM	19.5	321.7	7.05	done
aerobic/pH7-high CO2/Air-NO alum	2	2:59 PM	19.5	327.9	7.01	done
aerobic/pH7-high CO2/Air-ALUM	9	4:51 PM	19.4	324.9	6.96	done+spike
aerobic/pH7-high CO2/Air-ALUM	10	5:16 PM	19.4	326.2	6.96	done
anaerobic/pH7-high CO2/N2-NO alum	3	3:15 PM	19.5	160.7	6.99	done+dup
anaerobic/pH7-high CO2/N2-NO alum	3-dup	3:15 PM	19.5	171.4	7.12	N/A
anaerobic/pH7-high CO2/N2-NO alum	4	3:41 PM	19.4	186.3	7.01	done
anaerobic/pH7-high CO2/N2-ALUM	11	5:26 PM	19.4	194.4	6.82	done
anaerobic/pH7-high CO2/N2-ALUM	12	6:03 PM	19.4	188.9	6.97	done
aerobic/pH8.5/low CO2/Air-NO alum	5	3:53 PM	19.4	325.6	8.33	done
aerobic/pH8.5/low CO2/Air-NO alum	6	4:11 PM	19.4	323.5	7.88	done
aerobic/pH8.5/low CO2/Air-ALUM	13	6:14 PM	19.4	321	8.27	done
aerobic/pH8.5/low CO2/Air-ALUM	14	6:22 PM	19.4	324.2	8.55	done
anaerobic/pH8.5-low CO2/N2-NO Alum	7	4:24 PM	19.4	216.2	8.83	done
anaerobic/pH8.5-low CO2/N2-NO Alum	8	4:40 PM	19.4	196.2	8.65	done
anaerobic/pH8.5-low CO2/N2-ALUM	15	6:46 PM	19.4	215	8.59	done
anaerobic/pH8.5-low CO2/N2-ALUM	16	6:57 PM	19.4	184.1	8.59	done

8/24/24 OS - RS43

Lab H. HR TO measurements, sample collection, gas check 8/24/24

Summary:

All cores bubbling at arrival 1:30 pm. pH meter recalibrated. DO sensor last calibrated 8/15/24 by D.S. I have not recalibrated since - not comfortable/confident recalibrating this instrument.

pH levels have improved, closer to target since the adjustments last night, but the anaerobic DO still needs to decrease. After consulting with David, N_2 bubbling was increased on all N_2 tx by turning knob (no mass flow numbers were adjusted).

Duplicate pH/DO readings don't seem to be precise at each sampling event. It's ~~unpossible~~ CB 8/24/24 error could be introduced through sampling methods or technique. It's possible variation in measurements could be a result of instability during 1st week of incubation as reported in Jovan (~~Ogbu~~ Ogdahl et al., 2014) methods. It's also possible DO sensor needs re-calibration. DS 8/24/24

Floc checked ~7:55p on all dosed cores and height of floc is approx 2.5 cm, settled at bottom of water column. I observed and compared Core 15 (low CO_2/N_2 ALUM) and Core 7 (low CO_2/N_2 no alum) qualitatively and noticed algae still in Core 7, but none ~~could~~ CSB 8/24/24 was observed in Core 15. Unsure if Core 1 looks a little different than others not dosed around it, difficult to tell due to placement. However, no floc in Core 1. → poss less algae is noticeable

N_2 tanks switched, lights off in chamber.

DS 8/24/24

P844 ers 8/24/24

Lab I. N_2 gas / bubbling check 8/25/24

Objectives: Check N_2 gas tank and bubbling.

Methods: I. switch gas tank N_2 (pg 25)

Data:

Table 1 N_2 gas tracking

N_2 lot# W242221244A

Time	psi
2:57pm	350
3:02pm	2800

Summary: gas tank (N_2) was switched to a new tank. All cores were bubbling

CB 8/25/24

CB 8/25/24 pg 45

Lab J. N_2 gas / bubbling check, YSI DO measurements 8/26/24

Objectives: Check N_2 gas tank and bubbling.

Methods: I. switch N_2 gas tank

Data:

Table 1 N_2 gas tracking

time	psi		lot #
10:08 am	600	switched to	W242221244A
10:40 am	300	switched	W242221244A
12:10pm	450		W242221244A
3:01 pm	300	switched to	W242221244A
3:06pm	2750		W242221244A lot #

Changes to Procedures:

Per consultation with Clark, also measure DO in the anaerobic tx using DO probe to compare to DO sensor being used for the study due to high DO reading in anaerobic tx. Possibly introducing DO with syringe pulling method or error with instrument.

CB 8/25/24 pg 45

8/26/24

Lab 5. N_2 gas / bubbling check, YSI DO

YSI ProPlus DO measurements 8/26/24

Core	Time	DO mg/L	DO %	tx
3	1:34p	1.51	16.7	high CO_2/N_2
4	1:49p	0.40	4.5	high CO_2/N_2
7	1:57p	0.84	9.3	low CO_2/N_2
8	2:07p	0.67	7.3	low CO_2/N_2
15	2:05p	0.60	6.7	low CO_2/N_2 AWM
16	2:09	0.34	3.8	low CO_2/N_2 AWM
11	2:13	0.44	4.8	high CO_2/N_2 AWM
12 ~~8/26/24~~ CB	2:17	2.85	31.4	high CO_2/N_2 AWM

YSI Calibrated for DO (YSI ProPlus) per user manual calibration instructions

Summary:

Will only have enough N_2 ~~for~~ CB 8/26/24 to get through Wed 8/28/24 ~3am - ~5am. Derek will try to aquire more N_2 tanks, at least one more.

YSI confirmed lower DO measurements than DO sensor, however will re-test both methods at next sampling.

CB 8/26/24

1 pg 46 CB 8/26/24

labK N_2 gas / bubbling check 8/27/24

Objective: check N_2 gas tank / bubbling

Methods: 1. switch gas tank N_2 (pg 25)

Data:

Table 1 N_2 gas tracking

time	psi	Lot #
11:48am	400	W242229 24A
12:31pm	300	W242229 24A
12:39pm	200	W242229 24A
1:15pm	2800	W242229 24A

Observations:

all cores bubbling on arrival. Noticed water level a little lower than previously when last sampled - 0.25 - 0.50 cm lower Poss. evaporation?

Summary:

Derek aquired 2 more gas tanks. Next sampling will be thurs 8/29 ~9am (185 hrs).

CB 8/27/24

CB 8/27/24

pg 47

8/28/24

Lab L. ~~Hr 485 pressure~~ N_2 gas / bubbling check

Objective: check N_2 gas tank / bubbling

Methods: I. switch N_2 gas tank (pg 25)

Data:

Table 1 N_2 gas tracking

Time	psi	Lot #
9:25 am	450	W242212241A
11:40 am	2800	W242201241A
12:55 pm	2650	W242201241A
12:59 pm	2800	W242201241A

Observations:

All cases bubbling upon my arrival at 9:25am.

CS 8/28/24

pg 48 CS 8/28/24

Lab M. HR 185 Measurements, sample collection, gas check 8/29/24

Objectives: Check mass flow, bubbling, N_2 gas check
HR 185 measurements and sample collection

Methods: I. Switch N_2 gas tank (pg 25)
II. Mass flow check (pg 26)
III. Hr 185 measurements (pg 25-26)
IV. YSI measurements

IV. YSI Measurements
1. Calibrate YSI according to instruction manual
2. measure DO and pH for each core by inserting the probe into the core's overlying water, ensuring probe is completely submerged. Record measurement once ~~probe at~~ numbers stabilize. CB 8/29/24

QA/QC: QAPP, SOPs, duplicates, calibration checks, good lab practices

Data:

Table 1 Reagents + Instruments

Reagents + Instruments	Serial/lot #	Calibrated
DO Sensor PreSense Fibox4	SAAA00080000073	8/15/24 D.S.
Thermoscientific Orionstar A214 pH meter	x18241	8/29/24 CB
YSI ProDSS	24A106859	8/29/24 JV
N_2 tank		—
CO_2 tank	24336019	—
pH 7 buffer	CC788831	—
pH 10 buffer	CC787687	—

Table 2 N_2 gas tracking

Time	psi	lot #
2:19p	2300	W24220124A
—	—	—
—	—	—

Table 3 pH meter calibration

buffer	before cal	after cal
pH 7	7.01	7.02
pH 10	10.07	10.00
slope		

pH 7 buffer post measurements ~~6.97~~ 8/29/24 7.02

Table 4 Mass flow readings at 9:00 am

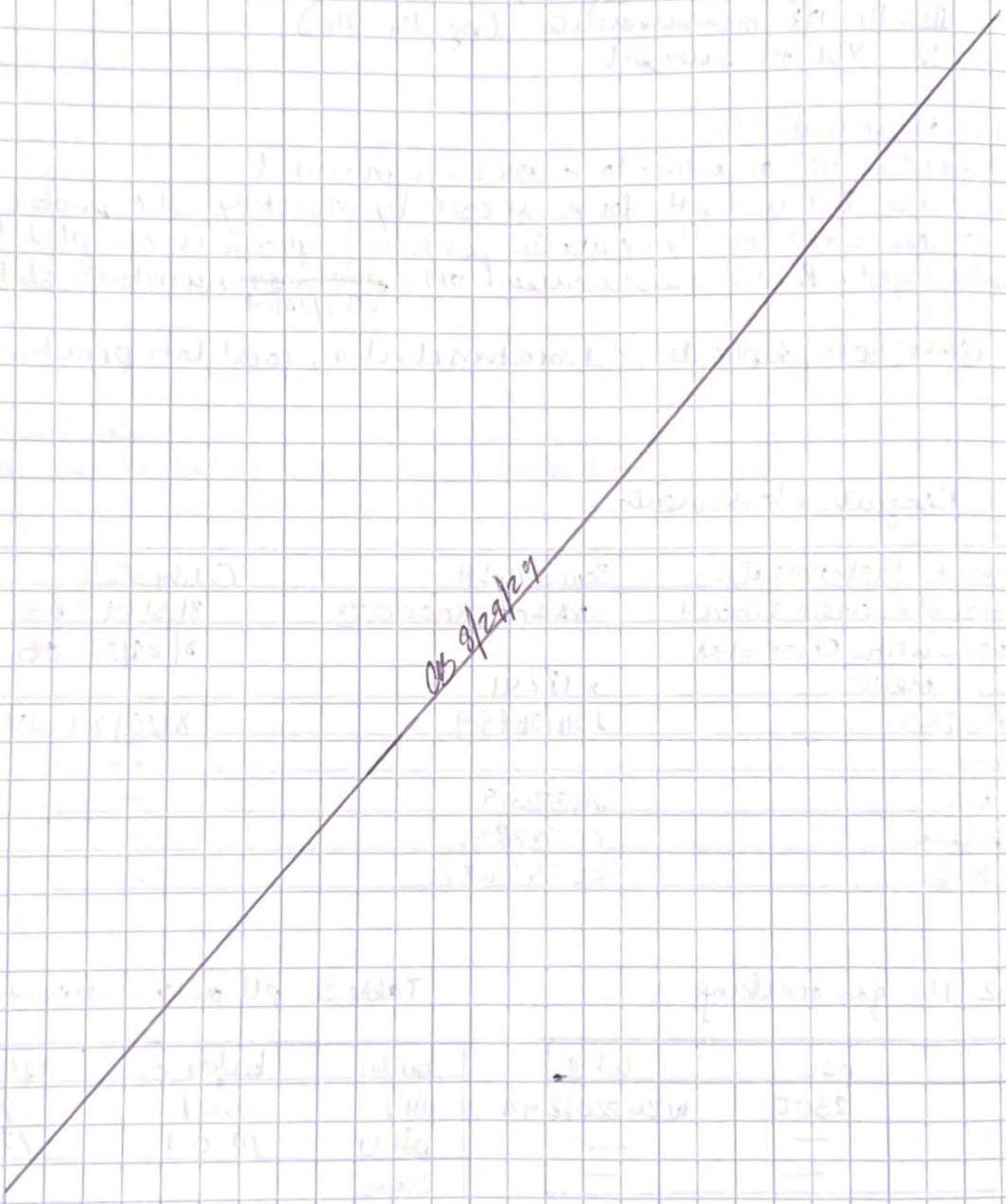
Tx	CO_2 (scc/m)	N_2 (sl/m)	Air (sl/m)
low CO_2/N_2	0.100	3.700	—
high CO_2/N_2	7.700	0.750	—
high CO_2/Air	5.106	—	0.500
low CO_2/Air	0.400	—	5.600

CB 8/29/24 pg 49

LabM. HR185 Measurements, sample collection, gas check 8/29/24

core check observations:

9:00 all cores bubbling



RJSO OBS 8/29/24

lab H HR185 Measurements, sample collection, gas check 8/29/24

Table 5.

YSI ProDDS DO measurements CB 8/29/24

Core	Time	DO mg/L mid-way	DO% midway	pH midway	DO mg/L 1" from bottom	DO% bottom	pH bottom
1	12:17p	9.53	104.9	—	9.50	104.6	—
2	12:23p	9.48	104.4	—	9.41	104.0	—
3	11:44a	1.98	21.9	~~7.10~~	1.84	20.3	~~7.09~~
4	12:25p	0.52	5.7	—	0.52	5.8	—
5	11:50a	9.41	104.3	~~8.24~~	9.42	104.2	~~8.27~~
6	11:59a	9.23	101.8	~~7.99~~	9.23	101.7	~~7.96~~
7	12:42p	0.86	9.5	—	0.81	8.9	—
8	12:45p	1.34	14.7	—	1.23	13.5	—
9	12:10p	9.58	~~105.7~~ 105.6	~~4.58~~	~~9.58~~ 9.57 ~~105.7~~	105.7	
10	12:20p	9.32	102.8	—	9.20	101.2	—
11	12:30p	0.52	5.7	—	0.46	5.1	—
12	12:34p	0.38	4.2	—	0.21	2.3	—
13	12:07p	9.57	105.9	~~8.47~~	~~9.59~~ 9.62	105.9	~~8.47~~
14	12:02p	9.59	105.9	~~8.41~~	9.60	106.0	~~8.45~~
15	12:38p	0.93	10.2	—	0.89	9.8	—
16	12:49p	0.57	6.3	—	0.56	6.1	—

initially also recorded pH, however since only DO was necessary and pH readings were taking long to stabilize between cores, continued with DO measurements only.

CB 8/29/24

CB 8/29/24 pg 51

LabM. HR185 Measurements, sample collection, gas check

NOTES

tube 7

8/29/2024 HR185 Parameters

Target Tx	Core	Time	T (°C)	DO (umol/L) DO sensor	pH	TP/SRP
aerobic/pH7-high CO2/Air-NO alum	1	9:26 AM	19.5	318	7.01	done
aerobic/pH7-high CO2/Air-NO alum	2	9:34 AM	19.5	323.7	7.11	done
aerobic/pH7-high CO2/Air-ALUM	9	10:25 AM	19.4	316.2	7.08	done
aerobic/pH7-high CO2/Air-ALUM	10	10:31 AM	19.3	316.4	7.14	done
anaerobic/pH7-high CO2/N2-NO alum	3	9:42 AM	19.5	139.6	7.02	done
anaerobic/pH7-high CO2/N2-NO alum	4	9:52 AM	19.5	186.6	7.02	done
anaerobic/pH7-high CO2/N2-ALUM	11	10:40 AM	19.3	149	6.87	done
anaerobic/pH7-high CO2/N2-ALUM	12	10:55 AM	19.3	196.6	7.02	done+dup
anaerobic/pH7-high CO2/N2-ALUM	12-dup	10:55 AM	19.3	162.7	7.04	N/A
aerobic/pH8.5/low CO2/Air-NO alum	5	9:58 AM	19.5	322.1	8.26	done
aerobic/pH8.5/low CO2/Air-NO alum	6	10:00 AM	19.4	325.3	7.99	done
aerobic/pH8.5/low CO2/Air-ALUM	13	11:02 AM	19.3	320.4	8.4	done
aerobic/pH8.5/low CO2/Air-ALUM	14	11:10 AM	19.3	323.4	8.46	done
anaerobic/pH8.5-low CO2/N2-NO Alu	7	10:15 AM	19.4	180.3	8.7	done
anaerobic/pH8.5-low CO2/N2-NO Alu	8	10:20 AM	19.4	165	8.93	done
anaerobic/pH8.5-low CO2/N2-ALUM	15	11:11 AM	19.3	149.4	9.02	done
anaerobic/pH8.5-low CO2/N2-ALUM	16	11:20 AM	19.3	118	8.84	done+spike

Time	DO (mg/L) YSI ProDSS mid-water column	DO (%) YSI ProDSS mid-water column	DO (mg/L) YSI ProDSS inch from bottor	DO (%) YSI ProDSS inch from bottor
12:17 PM	9.53	104.9	9.5	104.6
12:23 PM	9.45	104.4	9.41	104
12:10 PM	9.58	105.7	9.58	105.7
12:20 PM	9.32	102.8	9.2	101.2
11:44 AM	1.98	21.9	1.84	20.3
12:25 AM	0.52	5.7	0.52	5.8
12:30 PM	0.52	5.7	0.46	5.1
12:34 PM	0.38	4.2	0.21	2.3
N/A	N/A	N/A	N/A	N/A
11:50 AM	9.41	104.3	9.42	104.2
11:59 AM	9.23	101.8	9.23	101.7
12:07 PM	9.57	105.9	9.59	105.9
12:02 PM	9.59	105.9	9.6	106
12:42 AM	0.86	9.5	0.81	8.9
12:45 PM	1.34	14.7	1.23	13.5
12:38 PM	0.93	10.2	0.89	9.8
12:49 PM	0.57	6.3	0.56	6.1

Lab M. HR185 Measurements, sample collection, gas check 8/29/24

8/29/2024 HR185 Parameters

Target Tx	Core	Time	T (°C)	DO (umol/L) DO sensor	pH	TP/SRP	Time	DO (YSI P mid-wat
aerobic/pH7-high CO2/Air-NO alum	1	9:26 AM	19.5	318	7.01	done	12:17 PM	9.
aerobic/pH7-high CO2/Air-NO alum	2	9:34 AM	19.5	323.7	7.11	done	12:23 PM	9.
aerobic/pH7-high CO2/Air-ALUM	9	10:25 AM	19.4	316.2	7.08	done	12:10 PM	9.
aerobic/pH7-high CO2/Air-ALUM	10	10:31 AM	19.3	316.4	7.14	done	12:20 PM	9.
anaerobic/pH7-high CO2/N2-NO alun	3	9:42 AM	19.5	139.6	7.02	done	11:44 AM	1.
anaerobic/pH7-high CO2/N2-NO alun	4	9:52 AM	19.5	186.6	7.02	done	12:25 AM	0.
anaerobic/pH7-high CO2/N2-ALUM	11	10:40 AM	19.3	149	6.87	done	12:30 PM	0.
anaerobic/pH7-high CO2/N2-ALUM	12	10:55 AM	19.3	196.6	7.02	done+dup	12:34 PM	0.
anaerobic/pH7-high CO2/N2-ALUM	12-dup	10:55 AM	19.3	162.7	7.04	N/A	N/A	N
aerobic/pH8.5/low CO2/Air-NO alum	5	9:58 AM	19.5	322.1	8.26	done	11:50 AM	9.
aerobic/pH8.5/low CO2/Air-NO alum	6	10:00 AM	19.4	325.3	7.99	done	11:59 AM	9.
aerobic/pH8.5/low CO2/Air-ALUM	13	11:02 AM	19.3	320.4	8.4	done	12:07 PM	9.
aerobic/pH8.5/low CO2/Air-ALUM	14	11:10 AM	19.3	323.4	8.46	done	12:02 PM	9.
anaerobic/pH8.5-low CO2/N2-NO Alu	7	10:15 AM	19.4	180.3	8.7	done	12:42 AM	0.
anaerobic/pH8.5-low CO2/N2-NO Alu	8	10:20 AM	19.4	165	8.93	done	12:45 PM	1.
anaerobic/pH8.5-low CO2/N2-ALUM	15	11:11 AM	19.3	149.4	9.02	done	12:38 PM	0.
anaerobic/pH8.5-low CO2/N2-ALUM	16	11:20 AM	19.3	118	8.84	done+spike	12:49 PM	0.

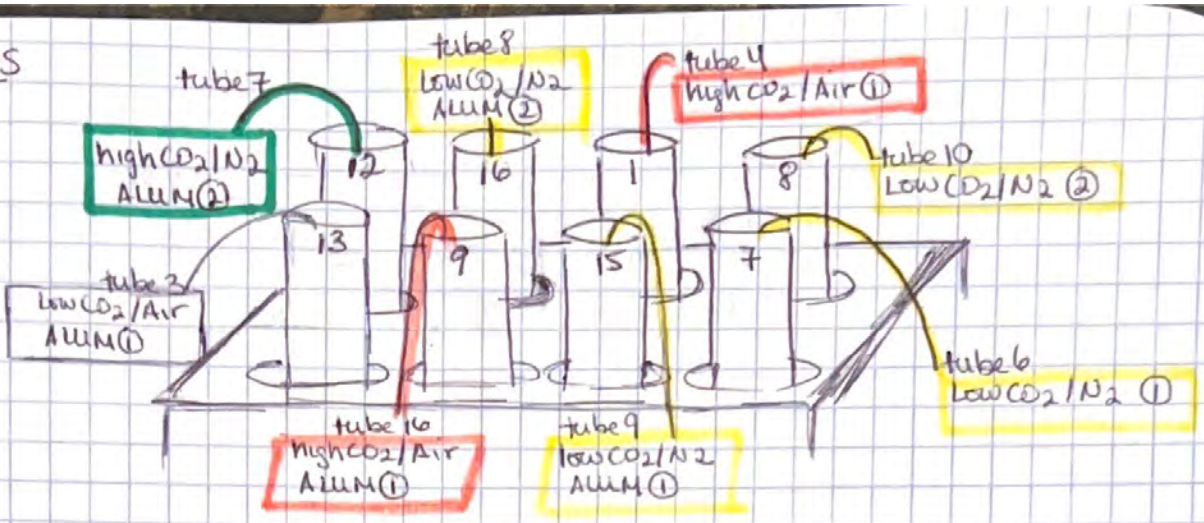
Summary:
All cores were bubbling upon my arrival at 9am. pH, DO, and sample collection were done per previous methods. Then DO was measured with YSI ProDSS.

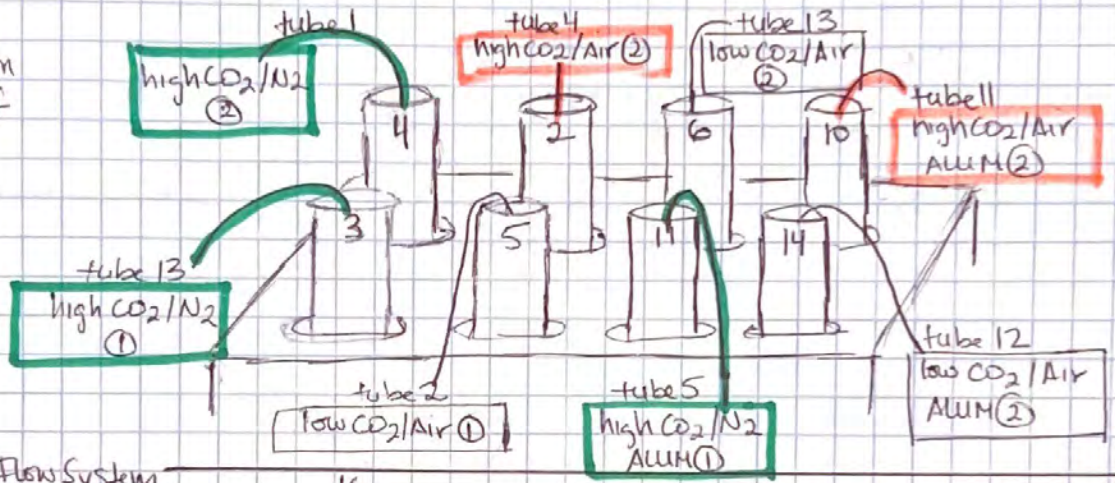
DO sensor measurements have been the initial number provided by sensor, as numbers did not seem to stabilize. At the end of the experiment, I re-tested, randomly, Cores 10 and 11 to see if there could be a possibility not enough time was allowed for DO sensor to stabilize. Initial reading for Core 10 was 319.0, went down to 318, then back up to 340.2 (after 5min) and continued to go up. Core 11 started at 179.1 and after 6min was at 71.7 and continued to slowly go down. Results reported to T.C. CB 8/29/24

CB 8/29/24

8 852 CB 8/29/24

NOTES





Mass Flow System

	16	14	4	11
red	X X high CO_2/Air ALUM ①	high CO_2/Air ②	high CO_2/Air ①	high CO_2/Air ALUM ②
	15	1	5	7
green	X X high CO_2/N_2 ①	high CO_2/N_2 ②	high CO_2/N_2 ALUM ①	high CO_2/N_2 ALUM ②
	2	13	3	12
white	X X low CO_2/Air ①	low CO_2/Air ②	low CO_2/Air ALUM ①	low CO_2/Air ALUM ②
	9	8	6	10
yellow	X X low CO_2/N_2 ALUM ①	low CO_2/N_2 ALUM ②	low CO_2/N_2 ①	low CO_2/N_2 ②

Appendix B

Lab Reports

HERRERA
Science + Planning + Design

CERTIFICATE OF ANALYSIS

Herrera
Contact:Rob Zisette
200 6th Ave
Seattle, WA 98121
Phone:206 441 9080 Fax:206 441 9108

IEH Laboratories & Consulting Group
IEH Analytical Laboratories
3927 Aurora Avenue North
Seattle, WA 98103
Phone:(206) 632-2715 Fax:(206) 632-2417
www.iehinc.com

TRADE SECRET / CONFIDENTIAL COMMERCIAL INFORMATION

WO: 1750468 Rec. Date: 9/3/2024 6:51 Report Date: 12/31/2024 Report No: IAL-67241

Lab Sample ID	Client Sample ID	Analysis Date	Aluminum (mg/L)
1750468-161194	ALUM	9/10/2024	60100
1750468-161195	LAS	9/10/2024	108000

Test Method: Aluminum = Aluminum EPA 200.8

Laboratory Director: Damien Gadomski

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

Chain of Custody Record

1750468

Project Name:	Project Number:	Client:
Lake Campbell Sediment Study	24-08365-000	Skagit County
Report To: Tim Clark, tclark@herrerainc.com		Copy To: Rob Zisette, rzisette@herrerainc.com
Sampled By: Rob Zisette		Delivery Method: Hand: Caution Hazardous Materials
Laboratory: IEH Aquatic Research	Requested Completion Date: Std	Total No. of Containers: 2

Sample ID	Date	Time	Sample Type (see codes)	Preser-vative? (Y/N)	Matrix (see codes)	Number of Containers	Analyses Requested: Total Aluminum	Lab ID No.
ALUM	9/2/2024	1030	G	N	M	1	X	-16/194
LAS	9/2/2024	1030	G	N	M	1	X	-16/195

Comments/Special Instructions:

ALUM = Aluminum sulfate (8.3% Al2O3)= strong acid

LSA = Sodium aluminate (20.1% AL2O3) = strong caustic base

Relinquished by (Name/CO/	Signature	Date/Time	Received By (Name/CO)	Signature	Date/Time
Rob Zisette, Herrera		9/2/24 1150	Aidan Winant		9-3-24 2:40
Relinquished by (Name/CO/	Signature	Date/Time	Received By (Name/CO)	Signature	Date/Time

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)

CORE 4-046-QC+SPK
CORE 3-070-DUP
CORE 5-HRO-DUP
CORE 8-HRO-QC+SPK

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Institute for Watershed Studies
Western Washington University
516 High St ES501
Bellingham, WA 98225
(360) 650-3510

CHAIN OF CUSTODY RECORD

Client Information
Name: Skagit County
Address: 1800 Continental Pl.
Mount Vernon, WA 98273
Contact: Leanne Ingman
Phone: 360-899-6758
Email: leanne@co.skagit.wa.us

Project and Billing Information
Project Name: Lake Campbell Sediment Incubation Study
Contact: Tim Clark
Email: tclark@herrerainc.com
Grant/Fast Index:
(WWU internal only)
Samples collected by: Claudia Basso

Laboratory
WWU Institute for Watershed Studies
Environmental Studies Building
Contact:
Phone:

Analysis Requested

Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Total Organic Carbon (as NPOC)	Dissolved Organic Carbon (as NPOC)	Total Nitrogen	Nitrate + Nitrite	Total Phosphous	Ammonia	*Soluble Reactive Phosphorus*	Chlorophyll a					Preservation (eg. HCl, ice, etc.)
CAM-DEEP-08192024	8/19/24	10:53a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE1-HRO	8/19/24	14:22	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE2-HRO	8/19/24	13:40	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE3-HRO	8/19/24	13:45	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE4-HRO	8/19/24	13:55	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE5-HRO	8/19/24	13:57	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE5-HRO-DUP	8/19/24	13:57	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE6-HRO	8/19/24	14:04	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE7-HRO	8/19/24	14:49	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE8-HRO SPK+QC (TP/TN)	8/19/24	14:53	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice

Comments/Special Notes:
*Keep samples refrigerated or on ice.
*Check with lab for specific holding times and sample containers.

Relinquished by: Claudia Basso	Relinquished by:
Signature:	Signature:
Company: Herrera Environmental Consultants, Inc.	Company:
Date/Time: 8/29/24 12:45p	Date/Time:
Received by:	Received by:
Signature:	Signature:
Company:	Company:
Date/Time:	Date/Time:

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Institute for Watershed Studies
Western Washington University
516 High St ES501
Bellingham, WA 98225
(360) 650-3510

CHAIN OF CUSTODY RECORD

Client Information

Name: Skagit County
Address: 1800 Continental Pl.
Mount Vernon, WA 98273
Contact: Leanne Ingman
Phone: 360-899-6758
Email: leanne@co.skagit.wa.us

Project and Billing Information

Project Name: Lake Campbell Sediment Incubation Study
Contact: Tim Clark
Email: tclark@herrerainc.com
Grant/Fast Index:
(WWU internal only)
Samples collected by: Claudia Basso

Project Name: Lake Campbell Sediment Incubation Study

Laboratory

WWU Institute for Watershed Studies
Environmental Studies Building
Contact:
Phone:

Analysis Requested

Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Total Organic Carbon (as NPOC)	Dissolved Organic Carbon (as NPOC)	Total Nitrogen	Nitrate + Nitrite	Total Phosphous	Ammonia	Soluble Reactive Phosphorus	Chlorophyll a	TP spike	SRP spike			Preservation (eg. HCl, Ice, etc.)
CORE9-HR0	8/19/24	13:30	1-60ml, 1-10ml	W					x								frozen and trasported on ice
CORE10-HR0	8/19/24	14:26	1-60ml, 1-10ml	W					x								frozen and trasported on ice
CORE11-HR0	8/19/24	14:31	1-60ml, 1-10ml	W					x								frozen and trasported on ice
CORE12-HR0	8/19/24	14:34	1-60ml, 1-10ml	W					x								frozen and trasported on ice
CORE13-HR0	8/19/24	14:39	1-60ml, 1-10ml	W					x								frozen and trasported on ice
CORE14-HR0	8/19/24	14:45	1-60ml, 1-10ml	W					x								frozen and trasported on ice
CORE15-HR0	8/19/24	14:49	1-60ml, 1-10ml	W					x								frozen and trasported on ice
CORE16-HR0	8/19/24	14:17	1-60ml, 1-10ml	W					x		x		x				frozen and trasported on ice
CORE16-HR0-SPK + QC + SPK	8/19/24	14:17	1-10ml	W										x			frozen and trasported on ice
																	frozen and trasported on ice

Comments/Special Notes:
*Keep samples refrigerated or on ice.
*Check with lab for specific holding times and sample containers.

Relinquished by: Claudia Basso	Relinquished by:
Signature:	Signature:
Company: Herrera Environmental Consultants, Inc.	Company:
Date/Time: 8/29/24 12:45p	Date/Time:
Received by:	Received by:
Signature:	Signature:
Company:	Company:
Date/Time:	Date/Time:

Project and Billing Info...

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(360) 650-3510

CHAIN OF CUSTODY RECORD

Client Information
Name: Skagit County
Address: 1800 Continental Pl.
Mount Vernon, WA 98273
Contact: Leanne Ingman
Phone: 360-899-6758
Email: leanne@co.skagit.wa.us

Laboratory
WWU Institute for Watershed Studies
Environmental Studies Building
Contact:
Phone:

Project and Billing Information
Project Name: Lake Campbell Sediment Incubation Study
Contact: Tim Clark
Email: tclark@herrerainc.com
Grant/Fast Index:
(WWU internal only)
Samples collected by: Claudia Basso

Page: 3 of 10
Project Name: Lake Campbell Sediment Incubation Study

Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Analysis Requested: Total Organic Carbon (as NPOC)	Dissolved Organic Carbon (as NPOC)	Total Nitrogen	Nitrate + Nitrite	Total Phosphous	Ammonia	Soluble Reactive Phosphorus	Chlorophyll a					Preservation (eg. HCl, ice, etc.)
CORE1-~~HR17~~ HR12-18	8/22/24	9:15a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE2-~~HR17~~ HR12-18	8/22/24	9:22a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE3-~~HR17~~ HR12-18	8/22/24	9:28a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE4-~~HR17~~ HR12-18	8/22/24	9:33a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE5-~~HR17~~ HR12-18	8/22/24	9:36a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE6-~~HR17~~ HR12-18	8/22/24	9:51a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE7-~~HR17~~ HR12-18	8/22/24	9:59a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE8-~~HR17~~ HR12-18	8/22/24	10:11a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE9-~~HR17~~ HR12-18	8/22/24	10:29a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE10-~~HR17~~ HR12-18	8/22/24	10:45a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice

Comments/Special Notes:
*Keep samples refrigerated or on ice.
*Check with lab for specific holding times and sample containers.

Relinquished by:	Claudia Basso	Relinquished by:
Signature:		Signature:
Company:	Herrera Environmental Consultants, Inc.	Company:
Date/Time:	Date/Time: 8/29/24 12:45p	Date/Time:
Received by:		Received by:
Signature:		Signature:
Company:		Company:
Date/Time:		Date/Time:

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(360) 650-3510

CHAIN OF CUSTODY RECORD

Client Information
Name: Skagit County
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Contact: Leanne Ingman
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Email: leanne@co.skagit.wa.us

Project and Billing Information
Project Name: Lake Campbell Sediment Incubation Study
Contact: Tim Clark
Email: tclark@herrerainc.com
Grant/Fast Index:
(WWU internal only)
Samples collected by: Claudia Basso

Laboratory
WWU Institute for Watershed Studies
Environmental Studies Building
Contact:
Phone:

Analysis Requested

Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Total Organic Carbon (as NPOC)	Dissolved Organic Carbon (as NPOC)	Total Nitrogen	Nitrate + Nitrite	Total Phosphous	Ammonia	Soluble Reactive Phosphorus	Chlorophyll a	TP spike	SRP spike			Preservation (eg. HCl, ice, etc.)
CORE11-~~HR17~~ HR12-18	8/22/24	10:58a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE12-~~HR17~~ HR 12-18 [redacted]	8/22/24	11:05a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE13 ~~HR17~~ HR 12-18	8/22/24	11:15a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE14-~~HR17~~ HR 12-18	8/22/24	11:33a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE15-~~HR17~~ HR 12-18	8/22/24	12:01p	1-60ml, 1-10ml	W					x		x		x				frozen and trasported on ice
CORE15-~~HR17 SPIKE~~ HR12-18-SPK + BC	8/22/24	12:01p	1-10ml	W										x			frozen and trasported on ice
CORE16-~~HR17~~ HR12-18	8/22/24	12:15p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE16-~~HR17-DUP~~ HR12-18-DUP	8/22/24	12:15p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice

Comments/Special Notes:
*Keep samples refrigerated or on ice.
*Check with lab for specific holding times and sample containers.

Relinquished by:	Claudia Basso	Relinquished by:
Signature:		Signature:
Company:	Herrera Environmental Consultants, Inc.	Company:
Date/Time:	Date/Time: 8/29/24 12:45p	Date/Time:
Received by:		Received by:
Signature:		Signature:
Company:		Company:
Date/Time:		Date/Time:

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Bellingham, WA 98225
(360) 650-3510

CHAIN OF CUSTODY RECORD

Client Information

Name: Skagit County
Address: 1800 Continental Pl.
Mount Vernon, WA 98273
Contact: Leanne Ingman
Phone: 360-899-6758
Email: leanne@co.skagit.wa.us

Project and Billing Information

Project Name: Lake Campbell Sediment Incubation Study
Contact: Tim Clark
Email: tclark@herrerainc.com
Grant/Fast Index:
(WWU internal only)
Samples collected by: Claudia Basso

Laboratory

WWU Institute for Watershed Studies
Environmental Studies Building
Contact:
Phone:

					Analysis Requested													
Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Total Organic Carbon (as NPOC)	Dissolved Organic Carbon (as NPOC)	Total Nitrogen	Nitrate + Nitrite	Total Phosphous	Ammonia	Soluble Reactive Phosphorus	Chlorophyll a	TP spike	SRP spike			Preservation (eg. HCl, ice, etc.)
CORE1-HR46	8/23/24	2:50p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE2-HR46	8/23/24	3:18p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE3 -HR46	8/23/24	3:33p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE4-HR46	8/23/24	3:44p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE4-HR46-SPK + QC	8/23/24	3:44p	1-10ml	W					x		x		x				frozen and trasported on ice
CORE5-HR46	8/23/24	4:16p	1-60ml, 1-10ml	W										x			frozen and trasported on ice
CORE6-HR46	8/23/24	4:30p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE7-HR46	8/23/24	4:45p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE8-HR46	8/23/24	5:00p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE9-HR46	8/23/24	5:20p	1-60ml, 1-10ml	W					x		x						

Comments/Special Notes:
*Keep samples refrigerated or on ice.
*Check with lab for specific holding times and sample containers.

Relinquished by:	Claudia Basso
Signature:	
Company:	Herrera Environmental Consultants, Inc.
Date/Time:	Date/Time: 8/29/24 12:45p
Received by:	
Signature:	
Company:	
Date/Time:	

Relinquished by:	
Signature:	
Company:	
Date/Time:	
Received by:	
Signature:	
Company:	
Date/Time:	

INSTITUTE FOR WATERSHED STUDIES | WESTERN WASHINGTON UNIVERSITY

Institute for Watershed Studies
Western Washington University
516 High St ES501
Bellingham, WA 98225
(360) 650-3510

CHAIN OF CUSTODY RECORD

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Email: leanne@co.skagit.wa.us

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Contact: Tim Clark
Email: tclark@herrerainc.com
Grant/Fast Index:
(WWU internal only)
Samples collected by: Claudia Basso

Laboratory
WWU Institute for Watershed Studies
Environmental Studies Building
Contact:
Phone:

Analysis Requested

Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Total Orga	Diss olve	Total Nitro	Nitra te +	Total Pho	Amm onia	Solu ble	Chlo roph	TP spik	SRP spik			Preservation (eg. HCl, ice, etc.)
CORE10-HR46	8/23/24	5:30p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE10-HR46-DUP	8/23/24	5:30p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE11-HR46	8/23/24	5:43p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE12-HR46 SPKT QC	8/23/24	5:55p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE13-HR46	8/23/24	6:09p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE14-HR46	8/23/24	6:24p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE15-HR46 SPKT QC	8/23/24	6:38p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE16-HR46	8/23/24	6:46p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
			1-60ml, 1-10ml	W					x		x						
			1-60ml, 1-10ml	W					x		x						

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Relinquished by:	Claudia Basso	Relinquished by:
Signature:		Signature:
Company:	Herrera Environmental Consultants, Inc.	Company:
Date/Time:	Date/Time: 8/29/24 12:45p	Date/Time:
Received by:		Received by:
Signature:		Signature:
Company:		Company:
Date/Time:		Date/Time:

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Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Total Orga	Diss olve	Total Nitro	Nitra te +	Total Pho	Amm onia	Solu ble	Chlo roph	TP spik	SRP spik			Preservation (eg. HCl, ice, etc.)
CORE1-HR70	8/24/24	2:48p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE2-HR70	8/24/24	2:59p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE3-HR70	8/24/24	3:15p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE3-HR70-DUP	8/24/24	3:15p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE4-HR70	8/24/24	3:41p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE5-HR70	8/24/24	3:53p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE6-HR70	8/24/24	4:11p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE7-HR70	8/24/24	4:24p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE8-HR70	8/24/24	4:40p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE9-HR70 SDKT QC	8/24/24	4:51p	1-60ml, 1-10ml	W					x		x		x				frozen and trasported on ice

Comments/Special Notes:
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Relinquished by:	Claudia Basso	Relinquished by:
Signature:		Signature:
Company:	Herrera Environmental Consultants, Inc.	Company:
Date/Time:	Date/Time: 8/29/24 12:45p	Date/Time:
Received by:		Received by:
Signature:		Signature:
Company:		Company:
Date/Time:		Date/Time:

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Email: tclark@herrerainc.com
Grant/Fast Index:
(WWU internal only)
Samples collected by: Claudia Basso

Laboratory
WWU Institute for Watershed Studies
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Contact:
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Analysis Requested

Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Total Orga	Diss olve	Total Nitro	Nitra te +	Total Pho	Amm onia	Solu ble	Chlo roph	TP spik	SRP spik			Preservation (eg. HCl, ice, etc.)
CORE9-HR70-SPK	8/24/24	4:51p	1-10ml	W										x			frozen and trasported on ice
CORE10-HR70	8/24/24	5:16p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE11-HR70	8/24/24	5:26p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE12-HR70	8/24/24	6:03p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE13-HR70	8/24/24	6:14p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE14-HR70 SPK+ RC	8/24/24	6:22p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE15-HR70	8/24/24	6:46p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE16-HR70	8/24/24	6:57p	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice

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Signature:		Signature:
Company:		Company:
Date/Time:		Date/Time:

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Laboratory
WWU Institute for Watershed Studies
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Contact:
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Analysis Requested

Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Total Organic Carbon (as NPOC)	Dissolved Organic Carbon (as NPOC)	Total Nitrogen	Nitrate + Nitrite	Total Phosphous	Ammonia	Soluble Reactive Phosphorus	Chlorophyll a	TP spike	SRP spike			Preservation (eg. HCl, ice, etc.)
CORE1-HR185	8/29/24	9:26a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE2-HR185	8/29/24	9:34a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE3-HR185	8/29/24	9:42a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE4-HR185	8/29/24	9:52a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE5-HR185	8/29/24	9:58a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE6-HR185	8/29/24	10:00a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE7-HR185	8/29/24	10:15a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE8-HR185	8/29/24	10:20a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE9-HR185	8/29/24	10:25a	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice
CORE10-HR185	8/29/24	10:31	1-60ml, 1-10ml	W					x		x						frozen and trasported on ice

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Company:	Company:
Date/Time:	Date/Time:

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Contact:
Phone:

Sample ID	Date Collected	Time Collected	# and type of containers	matrix	Analysis Requested: Total Organic Carbon	Dissolved Organic Carbon	Total Nitrogen	Nitrate + Nitrite	Total Phosphorus	Ammonia	Soluble Chlorophyll	TP spike	SRP spike			Preservation (eg. HCl, ice, etc.)
CORE11-HR185	8/29/24	10:40a	1-60ml, 1-10ml	W					x		x					frozen and trasported on ice
CORE12-HR185	8/29/24	10:55a	1-60ml, 1-10ml	W					x		x					frozen and trasported on ice
CORE12-HR185-DUP	8/29/24	10:55a	1-60ml, 1-10ml	W					x		x					frozen and trasported on ice
CORE13-HR185	8/29/24	11:02a	1-60ml, 1-10ml	W					x		x					frozen and trasported on ice
CORE14-HR185	8/29/24	11:10a	1-60ml, 1-10ml	W					x		x					frozen and trasported on ice
CORE15-HR185	8/29/24	11:11a	1-60ml, 1-10ml	W					x		x					frozen and trasported on ice
CORE16-HR185	8/29/24	11:20a	1-60ml, 1-10ml	W					x		x		x			frozen and trasported on ice
CORE16-HR185-SPK + QC	8/29/24	11:20a	1-60ml, 1-10ml	W					x		x			x		frozen and trasported on ice
			1-60ml, 1-10ml	W												
			1-60ml, 1-10ml	W												

Comments/Special Notes:
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*Check with lab for specific holding times and sample containers.

Relinquished by:	Claudia Basso	Relinquished by:
Signature:		Signature:
Company:	Herrera Environmental Consultants, Inc.	Company:
Date/Time:	Date/Time: 8/29/24 12:45p	Date/Time:
Received by:		Received by:
Signature:		Signature:
Company:		Company:
Date/Time:		Date/Time:

Project: S16-06417

	Analysis Date	Method	MDL
T Phosphorus	9/5/2024	SM 4500-P J	5 ug/L
Ortho Phosphorus	9/4/2024	SM 4500-P G	3 ug/L

Core	Batch	Date	Time	TP(ug P/L)	OrthoP(ug P/L)	notes
LC-CAM DEEP-081924	Lake	8/19/2024	10:53 AM	31.8	14.1	
1	HR0	8/21/2024	10:06 AM	54.1	<det	
1	HR12-18	8/22/2024	9:15 AM	54.1	<det	
1	HR46	8/23/2024	2:50 PM	41.5	<det	
1	HR70	8/26/2024	2:28 PM	37.0	<det	
1	HR185	8/29/2024	9:26 AM	22.1	3.5	
2	HR0	8/21/2024	10:11 AM	67.5	<det	
2	HR12-18	8/22/2024	9:22 AM	48.6	<det	
2	HR46	8/23/2024	3:18 PM	45.0	10.4	
2	HR70	8/26/2024	2:59 PM	51.9	21.8	
2	HR185	8/29/2024	9:34 AM	46.7	33.0	
3	HR0	8/21/2024	10:16 AM	79.5	3.6	
3	HR12-18	8/22/2024	9:28 AM	83.0	5.7	
3	HR46	8/23/2024	3:33 PM	93.8	10.8	
3	HR70	8/26/2024	3:15 PM	87.1	13.2	
3	HR185	8/29/2024	9:42 AM	55.0	23.7	
4	HR0	8/21/2024	10:21 AM	54.6	3.2	
4	HR12-18	8/22/2024	9:33 AM	69.2	12.3	
4	HR46	8/23/2024	3:44 PM	96.2	27.0	
4	HR70	8/26/2024	3:41 PM	101.8	32.0	
4	HR185	8/29/2024	9:52 AM	96.0	52.1	
5	HR0	8/21/2024	10:26 AM	51.8	<det	
5	HR12-18	8/22/2024	9:36 AM	46.5	<det	
5	HR46	8/23/2024	4:16 PM	35.0	<det	
5	HR70	8/26/2024	3:53 PM	27.7	<det	

5	HR185	8/29/2024	9:58 AM	31.8	7.4	
6	HR0	8/21/2024	10:31 AM	75.8	10.5	
6	HR12-18	8/22/2024	9:51AM	103.4	51.5	
6	HR46	8/23/2024	4:30 PM	217.2	185.2	
6	HR70	8/26/2024	4:11 PM	250.3	215.9	
6	HR185	8/29/2024	10:00 AM	474.0	491.4	
7	HR0	8/21/2024	10:36 AM	459.1	6.8	double-checked both values
7	HR12-18	8/22/2024	9:59 AM	87.6	10.1	
7	HR46	8/23/2024	4:45 PM	113.9	41.1	
7	HR70	8/26/2024	4:24 PM	149.4	81.6	
7	HR185	8/29/2024	10:15 AM	203.7	180.4	
8	HR0	8/21/2024	10:46 AM	48.7	<det	
8	HR12-18	8/22/2024	10:11 AM	51.7	<det	
8	HR46	8/23/2024	5:00 PM	55.1	3.1	
8	HR70	8/26/2024	4:40 PM	59.9	8.7	
8	HR185	8/29/2024	10:20 AM	95.0	67.8	
9	HR0	8/21/2024	10:51 AM	48.6	<det	
9	HR12-18	8/22/2024	10:29 AM	<det	<det	
9	HR46	8/23/2024	5:20 PM	<det	<det	
9	HR70	8/26/2024	4:51 PM	6.0	<det	
9	HR185	8/29/2024	10:25 AM	5.9	<det	
10	HR0	8/21/2024	10:56 AM	39.4	<det	
10	HR12-18	8/22/2024	10:45 AM	<det	<det	
10	HR46	8/23/2024	5:30 PM	11.1	<det	
10	HR70	8/26/2024	5:16 PM	9.1	<det	
10	HR185	8/29/2024	10:31 AM	7.8	<det	
11	HR0	8/21/2024	11:01 AM	63.7	<det	
11	HR12-18	8/22/2024	10:58 AM	<det	<det	
11	HR46	8/23/2024	5:43 PM	5.9	<det	
11	HR70	8/26/2024	5:26 PM	6.9	<det	
11	HR185	8/29/2024	10:40 AM	6.5	<det	
12	HR0	8/21/2024	11:06 AM	188.8	133.8	

12	HR12-18	8/22/2024	11:05 AM	8.1	<det
12	HR46	8/23/2024	5:55 PM	14.5	<det
12	HR70	8/26/2024	6:03 PM	19.2	22.9
12	HR185	8/29/2024	10:55 AM	20.5	8.3
13	HR0	8/21/2024	11:11 AM	20.8	<det
13	HR12-18	8/22/2024	11:15 AM	<det	<det
13	HR46	8/23/2024	6:09 PM	6.6	<det
13	HR70	8/26/2024	6:14 PM	8.9	<det
13	HR185	8/29/2024	11:02 AM	8.9	<det
14	HR0	8/21/2024	11:16 AM	84.2	11.5
14	HR12-18	8/22/2024	11:33 AM	9.5	<det
14	HR46	8/23/2024	6:24 PM	11.7	<det
14	HR70	8/26/2024	6:22 PM	11.3	<det
14	HR185	8/29/2024	11:10 AM	17.5	3.1
15	HR0	8/21/2024	11:21 AM	76.8	11.7
15	HR12-18	8/22/2024	12:01 PM	10.2	<det
15	HR46	8/23/2024	6:38 PM	9.4	<det
15	HR70	8/26/2024	6:46 PM	16.3	<det
15	HR185	8/29/2024	11:11 AM	24.6	6.7
16	HR0	8/21/2024	11:26 AM	64.9	<det
16	HR12-18	8/22/2024	12:15 PM	<det	<det
16	HR46	8/23/2024	6:46 PM	6.9	<det
16	HR70	8/26/2024	6:57 PM	7.9	<det
16	HR185	8/29/2024	11:20 AM	8.9	<det
5-DUP	HR0	8/19/2024	1:57 PM	58.1	<det
16-DUP	HR12-18	8/22/2024	12:15 PM	<det	<det
10-DUP	HR46	8/23/2024	5:30 PM	<det	<det
3-DUP	HR70	8/24/2024	2:48PM	92.3	13.8
12-DUP	HR185	8/29/2024	10:55 AM	20.7	8.2

Orthophosphate Lab Rep

Coll. Date	Run Date	Sample ID	Result	Lab Rep
8/23/2024	9/4/2024	C4 HR46	27.0	26.6
8/21/2024	9/4/2024	C8 HR0	<det	<det
8/26/2024	9/4/2024	C9 HR70	<det	<det
8/21/2024	9/4/2024	C12 HR0	133.8	130.1
8/21/2024	9/4/2024	C14 HR0	11.5	12.0
8/22/2024	9/4/2024	C15 HR12-18	<det	<det
8/21/2024	9/4/2024	C16 HR0	<det	<det
8/29/2024	9/4/2024	C16 HR185	<det	<det

Orthophosphate Spike Recovery

Coll. Date	Run Date	Sample ID	pre-spike	post-spike	spike (ug)	% Recovery
8/23/2024	9/4/2024	C4 HR46	27.0	57.7	25	123%
8/26/2024	9/4/2024	C9 HR70	0.7	24.7	25	96%
8/22/2024	9/4/2024	C15 HR12-18	0.8	24.8	25	96%
8/21/2024	9/4/2024	C16 HR0	0.6	24.2	25	94%
8/29/2024	9/4/2024	C16 HR185	0.2	21.6	25	86%

TP Lab Rep

Coll. Date	Run Date	Sample ID	Result	Lab Rep
8/23/2024	9/4/2024	C4 HR46	96.7	96.2
8/21/2024	9/4/2024	C8 HR0	48.7	48.0
8/26/2024	9/4/2024	C9 HR70	5.9	6.0
8/23/2024	9/4/2024	C12 HR46	14.1	14.5
8/26/2024	9/4/2024	C14 HR70	13.1	11.3
8/22/2024	9/4/2024	C15 HR12-18	10.0	10.2
8/23/2024	9/4/2024	C15 HR46	8.9	9.4
8/21/2024	9/4/2024	C16 HR0	63.7	64.9
8/29/2024	9/4/2024	C16 HR185	8.7	8.9

TP Spike Recovery

Coll. Date	Run Date	Sample ID	pre-spike	post-spike	spike (ug)	% Recovery
8/21/2024	9/4/2024	C4 HR0	96.7	119.4	25	91%
8/21/2024	9/4/2024	C8 HR0	48.0	92.1	25	176%
8/26/2024	9/4/2024	C9 HR70	5.9	29.2	25	93%
8/23/2024	9/4/2024	C12 HR46	14.1	33.2	25	76%
8/26/2024	9/4/2024	C14 HR70	13.1	31.1	25	72%
8/22/2024	9/4/2024	C15 HR12-18	10.0	34.1	25	96%
8/23/2024	9/4/2024	C15 HR46	8.9	31.7	25	91%
8/21/2024	9/4/2024	C16 HR0	63.7	88.7	25	100%
8/29/2024	9/4/2024	C16 HR185	8.7	32.9	25	97%

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Run Date	Analyte	Blank 1	Blank 2	Blank3	Blank4	Blank5
9/4/2024	OP	<det	<det	<det	<det	<det
9/5/2025	TP	<det	<det	<det	<det	<det