

Lake Whatcom Water & Sewer District Board Meeting Access Information

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Public



Regular Meetings of the Board of Commissioners are held on the second Wednesday of each month at 6:30 pm and the last Wednesday of each month at 8:00 am.

Our Meetings



LAKE WHATCOM WATER AND SEWER DISTRICT 1220 Lakeway Drive Bellingham, WA 98229

WORK SESSION OF THE BOARD OF COMMISSIONERS

AGENDA

January 10, 2024 5:30 p.m. – Work Session

- 1. CALL TO ORDER
- SPECIFIC ITEMS OF WORK
 A. On-site Sewage System Policy Review
- 3. ADJOURNMENT



On-site Sewage System Policy Review

DATE SUBMITTED: December 19, 2023		MEETING DATE: January 10, 202				2024		
TO: BOARD OF COMMISSIONERS			FROM: Justin Clary, General Manager					
GENERAL MANAGER APPROVAL			Sotolly					
ATTACHED DOCUMENTS			 2017 Lake Whatcom North Shore On-site Sewage System Leachate Detection Report 2020 Lake Whatcom On-site Sewage System Impact Assessment Report Drainage 485 Sewage Collection System Inspection letter dated Nov. 12, 2020 Email from J. Clary dated Jan. 27, 2021 					
TYPE OF ACTION RE	QUESTED	RES		FOF	RMAL ACTION/ MOTION	INFORMATIONA L/OTHER		

BACKGROUND / EXPLANATION OF IMPACT

WORK

SESSION

Together with the city of Bellingham (City) and Whatcom County (County), the Lake Whatcom Water and Sewer District formed a partnership in 1992 to develop a joint management strategy for the Lake Whatcom watershed. The resulting Lake Whatcom Management Program guides actions by the three entities to protect the quality of Lake Whatcom water. The prior 2015-2019 and current 2020-2024 work plans for the Lake Whatcom Management Program include as an objective under the Monitoring & Data program area "collect and manage data to increase our understanding of water quality and pollution sources, and to guide management decisions."

In the winter/spring of 2017, Herrera Environmental Consultants, Inc. (Herrera) under contract with the District, conducted a series of monitoring events along the north shore of Lake Whatcom to assess the impact of existing on-site sewage systems (OSS; commonly referred to as septic systems) on the water quality of the lake. The findings of the assessment, which were published in a report in July 2017 (attached), indicated that OSS are likely adversely impacting water quality. However, City and County staff raised several concerns regarding the monitoring approach of the assessment. To address the data gaps of the 2017 assessment identified by City and County staff, and to collect additional data to better understand the impact of OSS, a scope of work for a

second round of monitoring was jointly developed by City, County, and District staff, and an interlocal agreement between the District and County was executed in November 2019 to share funding of the assessment.

Herrera was again selected to conduct a second round of monitoring, with the scope expanded to address City/County comments on the 2017 study. Herrera completed the monitoring effort during winter/spring 2020 and issued a findings report in September 2020 (attached). Herrera provided a presentation to the Board on the results and conclusions of the 2020 monitoring effort during the Board's September 9, 2020 meeting, as well as to the Lake Whatcom Management Program Policy Group during its September 23, 2020 meeting. In summary, the 2020 assessment indicated that results were consistent with the 2017 study relative to the presence of target analytes in OSS-served drainages; however, the presence of human DNA biomarkers did not correlate with loadings of phosphorus or live fecal coliform bacteria (Lake Whatcom TMDL-specific contaminants). As a result, Herrera concluded phosphorus and fecal coliform bacteria are effectively removed from OSS effluent by soils before entering the lake. The study did note the presence of human DNA biomarkers in District sewer-served drainage No. 485, indicating a possible leaking sewer pipe. The District subsequently performed inspection of sewer mains in the drainage, which confirmed the integrity of the sewer system (November 12, 2020 letter summarizing the inspection findings is attached).

The Board discussed the assessment findings and the District's policy/direction regarding existing OSS during its January 27, 2021 meeting. The Board ultimately determined it infeasible to pursue sewer system expansion to remove OSS and rather to focus on OSS compliance. Attached is an email that was issued to the Board summarizing action items identified during the January 27, 2021 meeting. Following is a summary of the identified actions, and District efforts undertaken to implement each:

- Request Whatcom County Health Department provide annual presentation to the Board on the status of OSS maintenance inspection and enforcement program within the watershed.
 - Multiple requests were made throughout 2021; however, County staff were assigned to the COVID pandemic response team and unavailable to provide a presentation. OSS inspection metrics were, however, added to all subsequent annual Lake Whatcom Management Program progress reports.
- Ensure Whatcom County Public Works Department completes source tracing of Drainage Nos. 440 and 520.
 - See attached email dated June 21, 2021 from Gary Stoyka regarding the County's monitoring plan. The County has not completed the investigation todate (dry conditions prohibited sampling during the summer of 2021, followed by a mis-communication between Public Works and Health Department staff on who would conduct). Recent communication with Gary Stoyka has resulted in the County re-scheduling this work for this winter.

- Recommend amendment of Whatcom County Code Section 24.05.160(B) to prohibit the allowance of self-evaluation in the watershed.
 - A District request for County Council consideration of the prohibition was declined due to Health Department workload and a desire to maintain program consistency throughout the county.
- Encourage the City of Bellingham to pursue acquisition of 25 undeveloped parcels located along the north shore of the lake to prevent future development.
 - A map identifying the 25 parcels was provided to City staff involved in the watershed property acquisition program via email in July 2021.
- Research legality of District assuming ownership or management of a group of OSS in District boundaries.
 - Subsequent discussion with the Board concluded that the District does not have the internal expertise or resources to take on such an enterprise.

FISCAL IMPACT

No fiscal impact is anticipated associated with the Board's policy discussion. Should the Board wish to proceed with additional actions, fiscal impacts would be dependent upon the action(s).

APPLICABLE EFFECTIVE UTILITY MANAGEMENT ATTRIBUTE(S)

Water Resource Sustainability

RECOMMENDED BOARD ACTION

No action is recommended.

PROPOSED MOTION

Not applicable.

WATER QUALITY MONITORING REPORT

LAKE WHATCOM NORTH SHORE ON-SITE SEWAGE SYSTEM LEACHATE DETECTION PROJECT



Prepared for Lake Whatcom Water & Sewer District

Prepared by Herrera Environmental Consultants, Inc.



WATER QUALITY MONITORING REPORT

LAKE WHATCOM NORTH SHORE ON-SITE SEWAGE SYSTEM LEACHATE DETECTION PROJECT

Prepared for Lake Whatcom Water & Sewer District 1220 Lakeway Drive Bellingham, Washington 98229

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

July 10, 2017

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LAKE WHATCOM WATER & SEWER DISTRICT



1220 Lakeway Drive Bellingham, WA, 98229 (360) 734-9224 Fax 738-8250

PREFACE

Lake Whatcom Water and Sewer District (District) was formed in the 1960's for the primary purpose of reducing pollution entering Lake Whatcom from individual onsite sewage septic systems in the urbanized and growing Sudden Valley and Geneva communities. The District's public sewer system now serves the equivalent of 4,308 single family residences located in the Lake Whatcom watershed. By means of a network of sewer mains and pump stations an average of 0.78 million gallons of wastewater is collected and sent to the City of Bellingham's wastewater treatment plant every day. For nearly 50-years the District has worked with the State of Washington and other local governments to protect and improve Lake Whatcom water quality, which is the drinking water source for a population of nearly 100,000 people. The District's mission statement has long included the protection of Lake Whatcom water quality.

In furtherance of the District's mission to protect lake water quality, the District commissioned this study to investigate potential impacts from onsite septic systems at the end of Northshore Road where there is currently no public sewer system. The District contracted with Herrera Environmental Consultants to test lake water quality over a period of time using various state of the art scientific methods along 2.5 miles of shoreline starting at Agate Bay and ending at Whatcom County's Lake Whatcom Park. On this stretch there are 97 existing homes with the potential for development of around 30 more. Wastewater from these lots could result in as much as 22,000 gallons per day (8 million gallons annually) that is treated and dispersed by individual onsite sewage septic system drain fields located close to the lakeshore.

The District was concerned that wastewater percolating through soils from individual drain fields near the lakeshore may be carrying fecal coliform, phosphorus, and other chemicals to ground water that flows into the lake. The results of this study give credence to these concerns. DNA testing of the water samples positively identified fecal coliform entering the lake came from not just animals but also humans. The study made no attempt to quantify or perform a loading analysis, but proves that human feces are entering Lake Whatcom from several sources along Northshore Road.

The results of this study may support extending public sewer and eliminating septic systems near the lake. The District plans to coordinate with various Whatcom County departments and Washington State Department of Ecology to review all potential solutions to this problem, including the potential for extending public sewer to the end of Northshore Road.

Lake Whatcom Water and Sewer District Board of Commissioners

EXECUTIVE SUMMARY

To protect the high quality water supply from Lake Whatcom, the Lake Whatcom Water and Sewer District investigated the area along approximately 2.3 miles of North Shore Road that includes approximately 97 homes currently served by on-site septic systems . A water quality monitoring study was developed to determine if septic systems along North Shore Road are contaminating Lake Whatcom, either by soil seepage or surfacing failure.

Herrera Environmental Consultants prepared a plan that considered various microbiological, chemical, biochemical, and molecular techniques for detecting septic system effluent in drainage from the study area and in the lake. The study design included monitoring of select field and laboratory parameters during three wet weather events in the winter of 2017, when septic system contamination would most likely be observed due to saturated soils and a high water table. Water quality monitoring was conducted in the lake near the shoreline and in discharges to the lake that drain only properties in the study area. Therefore, any discharge shown to be contaminated by septic system effluent is contaminating the lake from septic systems located within the study area.

The study was conducted, as planned, by boat during a large rain event on January 19 (2.20 inches in 48 hours), a moderate rain event on March 15 (0.87 inch in 48 hours), and a large rain event on March 29 (1.86 inches in 48 hours), 2017. The lake level rose 1.9 feet between January 19 and March 15, and another 0.7 foot by March 29, 2017.

For each rain event, field measurements were taken continuously in the lake and in all the observed surface water discharges to the lake, proceeding in a northwest direction along the shoreline from the control site (undeveloped forest) and then through the study area. Water samples were collected from select lake and surface water discharge locations where optical brighteners from laundry detergent were detected at greater than approximately 50 percent above the background measured at the lake control stations. During each event, a total of up to 18 samples were collected at lake control stations (undeveloped shoreline to southeast for background), lake impact stations (distant from drainage discharges in study area), discharge stations (draining only the study area), and one on-site sewage station (source confirmation). The samples were analyzed for microbiological parameters (fecal coliform bacteria and E. coli) for all three events, and for two different DNA biomarkers of human-specific fecal bacteria and chemistry parameters (total phosphorus, chloride, and bromide) for the second and third events only.

Study results showed that many septic systems in the study area are a likely source of contamination to Lake Whatcom. The DNA biomarkers of human-specific bacteria were found at moderate to high concentrations at 6 of the 13 sampled discharge stations and at 1 of the 4 sampled lake stations located along the 2.3-mile-long shoreline. At one discharge station,



human biomarker concentrations were high for both wet weather sampling events and were present at levels similar to those measured in septic tank samples.

Discharge and lake samples contaminated by human biomarkers from septic system effluent also contained elevated levels of optical brighteners, fecal coliform bacteria, and total phosphorus. The elevated concentrations of optical brighteners indicate the presence of laundry detergents from septic system effluent. Fecal coliform bacteria and total phosphorus concentrations in the contaminated samples exceeded Washington State surface water quality standards, indicating impacts on public health and the lake environment, respectively. Both fecal coliform bacteria and total phosphorus positively correlated with optical brighteners, providing additional evidence that septic systems are a significant source of the observed contamination.

Fecal coliform bacteria and total phosphorus concentrations were several orders of magnitude higher in septic tank samples than in lake samples, indicating that the lake was contaminated by diffuse seepage from septic system drain fields rather than overland flow from failed systems. The numerous and diffuse septic system sources present in the study area would be difficult to locate and control for protection of public health and the environment. Connecting homes in the study area to a sanitary sewer would prevent the ongoing contamination of Lake Whatcom from septic systems in the area.



1. INTRODUCTION

Lake Whatcom is the surface water supply for the Lake Whatcom Water and Sewer District (LWWSD) that currently serves a population of nearly 10,000 people from a water treatment plant located in Sudden Valley. Lake Whatcom is also the drinking water source for a number of residences that draw directly from the lake as well as the City of Bellingham, which serves a population of nearly 100,000.

The US Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) determined that the water quality of Lake Whatcom has become polluted to the point where action must be taken. The Lake Whatcom Watershed Total Phosphorus and Bacteria TMDL (total maximum daily load) Water Quality Improvement Plan (Ecology 2016) addresses elevated amounts of fecal coliform bacteria and phosphorus, which causes excessive growth of algae and low dissolved oxygen levels. Sources contributing to the high phosphorus and bacteria levels may include failed on-site septic systems (OSS). The TMDL Water Quality Improvement Plan primarily relies on stormwater treatment to reduce phosphorus loadings to the lake, and only addresses OSS inputs through existing OSS regulations and permitting.

The City of Bellingham and Whatcom County each have a program to sample and analyze water quality of certain areas of Lake Whatcom and incoming streams. The LWWSD is a partner with the City of Bellingham and Whatcom County through inter-local agreements. However, there currently are no known efforts to sample and analyze the North Shore area of Lake Whatcom to investigate possible impacts from OSS leaching into the lake.

The LWWSD has concerns that OSS along the North Shore of Lake Whatcom may be contributing to phosphorus and fecal coliform bacteria pollution problems, as well as adding pharmaceutical and other manmade compounds to the lake. The leachate of OSS drain fields contain high levels of phosphorus and fecal bacteria. Leachate also contains man-made compounds found in most detergents called optical brighteners. These compounds may be detectible and useful as an indicator of leachate entering the lake.

The LWWSD evaluated OSS maintenance records showing recent OSS problems and a lack of regulatory compliance, and recommended conducting a water quality study to document impacts to Lake Whatcom by OSS in the North Shore Road area (Wilson 2015). Subsequent to a concentrated effort by the Whatcom County Health Department; 90 properties became current on their OSS inspections as of August 2016.

A water quality monitoring study was developed to determine if septic systems along North Shore are contaminating Lake Whatcom, either by soil seepage or surfacing failure. A quality assurance project plan (QAPP) was prepared that considered various microbiological, chemical, biochemical, and molecular techniques for detecting septic system effluent in drainage from the study area and in the lake (Herrera 2016). The study design included monitoring of select field



and laboratory parameters during three wet weather events in the winter of 2017, when septic system contamination would be most likely observed due to saturated soils and a high water table. Water quality monitoring was conducted in the lake near the shoreline and in discharges to the lake. All 20 discharges in the study area drained only properties in the study area. Thus, any discharge shown to be contaminated by septic system effluent is contaminating the lake from a septic system located within the study area.

This report is organized into the following sections:

- Methods
- Results and Discussion
- Conclusions



2. METHODS

Field and analytical methods used are discussed below. Additional information regarding project background, experimental design, and sampling methods can be found in the *Lake Whatcom North Shore OSS Quality Assurance Project Plan* (QAPP) (Herrera 2016).

Water quality monitoring was conducted from a motorized inflatable boat during three wet weather events that included continuous field measurements along the lake shore within a control site and the project site (Figure 1), and the collection of water samples from four different types of sample stations:

- 1. **Lake Control Station**: Lake water adjacent to an undeveloped lake shoreline located southeast of the project site in the control site
- 2. **Lake Impact Station**: Lake water adjacent to the lake shoreline in the project site that is distant from and not directly affected by discharge of local drainages
- 3. **Discharge Station**: Drainage water discharging to the lake from local pipes and ditches in the project site
- 4. **OSS Station**: OSS source water collected from one septic tank located in the project site

The wet weather events analyzed 48-hour rainfall totals (for sampling date and previous day) with 2.20 inches of rainfall on January 19 (Event 1), 0.87 inches on March 15 (Event 2), and 1.86 inches on March 29 (Event 3), 2017, as shown in Table 1. These rainfall amounts are for a rain gauge located at a lake shore residence in the project site and are slightly higher than those measured at a nearby rain gauge operated by the City of Bellingham. Thus, samples were collected during two large storm events (Events 1 and 3) and one moderate storm event (Event 2). The QAPP objective of sampling after a minimum of 0.5 inches of rain in 24 hours was not quite met for Event 2.

Table 1. Rainfall Amounts and Lake Levels for Sampling Events.									
	Sampling Event 1 1/19/2017	Sampling Event 1 Sampling Event 2 1/19/2017 3/15/2017							
City 24-hour rainfall previous day (inches) ^a	0.98	0.33	0.59						
City 24-hour rainfall sampling day (inches) ^a	1.05	0.42	1.10						
City Total 48-hour rainfall (inches) ^a	2.03	0.75	1.69						
Lake Shore 48-hour rainfall (inches) ^b	2.20	0.87	1.86						
Daily Average Lake Elevation (feet MSL)	312.0	313.9	314.6						

^a Rainfall data from the City of Bellingham's North Shore MET rain gage.

July 2017

^b Rainfall data from Weather Underground station SWABELL105 located at a lake shore residence in the project site.

The lake level rose 1.9 feet between sampling on January 19 (Event 1) and March 15 (Event 2), and another 0.7 feet on March 29 (Event 3) (see Table 1). The shallow water table adjacent to the lake likely rose a similar amount and may have increased the potential for OSS contamination of the lake with each event.

For each event, field measurements were measured continuously in the lake and all of the observed surface water discharges to the lake, proceeding in a northwest direction along the shoreline from the control site (undeveloped forest) and then through the project site (see Figure 1). Photographic documentation is included in Appendix A.

A calibrated YSI ProDSS multimeter was used to measure and log positon, temperature, dissolved oxygen (DO), pH, and conductivity. A Turner Cyclops-7 fluorometer, configured at a wavelength for optical brighteners (OB) and calibrated for a low detection limit (0.6 μ g/L), was used to log data in relative fluorescence units (RFU). The meter probes were zip tied together and deployed at a depth of about 6 inches in the lake while the boat was slowly maneuvered as close to shore as possible; the boat was typically beached for deployment of the probes directly in discharges.

The OB fluorometer method has the advantage of detecting human wastewater inputs in realtime and by logging data continuously, which is particularly useful for pinpointing OSS inputs. However, other studies have reported no correlation between fluorometer and fecal coliform bacteria results. High concentrations of naturally-produced humic acids and contamination by petroleum hydrocarbons may interfere with OB analyses, but those interferences are not expected to be a substantial in Lake Whatcom. The Cyclops 7 probe with the DataBank display/logger, stainless steel sensor, and 5 meter cable was recommended for this OSS detection study because of its high sensitivity, low detection limit, low interference, and ease of use for measuring OB concentrations at an unlimited number of locations along the lake shore (Herrera 2016).

Water samples were collected from select lake and surface water discharge locations exhibiting fluorescence greater than approximately 50 percent above background measured at the lake control stations. During each event, a total of up to 18 samples were collected from up to 3 lake control stations, 3 lake impact stations, 14 discharge stations, and 1 on-site sewage (OSS) station (see Figure 1). All of the lake impact stations were located beyond the influence of a discharge and represent impacts from groundwater seepage or other non-point sources. Nearly all of the 20 discharges located along the 2.3 mile shoreline exceeded the fluorescence criterion for sampling and some discharges were not sampled because they were not observed or had previously exhibited low fecal coliform concentrations. Table 2 summarizes the sample analyses performed for each event.





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Table 2. Sample Analyses Performed for Each Sampling Event.									
		Sample Analyses							
Station ID	Station Description	Event 1	Event 2	Event 3					
Lake Control	· · · · · · · · · · · · · · · · · · ·		·						
C1	Next to undeveloped shoreline SE of site	F, B	F, B, L	F, B, L					
C2	Next to undeveloped shoreline SE of site	F, B	-	_					
C3	Next to undeveloped shoreline SE of site	F, B	F, B, L	F, B					
Lake Impact									
1L	Next to shoreline S of Discharge 525	_	-	F, B, L					
2L	Next to shoreline at Discharge 517	_	F, B, L	-					
3L	Next to shoreline NW of Discharge 517	F, B	-	_					
4L	Next to shoreline SE of Discharge 440	_	F, B, L	_					
5L	Next to shoreline at Discharge 440	_	F, B, L	-					
Discharge			·						
429	8-inch corrugated HDPE	_	-	F, B					
430	Twin 12- and 8-inch corrugated HDPE	F ^a , B	F, B, L	F, B, L					
437	Open channel	F ^a , B	F, B, L	F, B, L					
440	Open channel	F ^a , B	-	F, B, L					
449	Open channel	F ^a , B	F, B	F, B, L					
453	24-inch corrugated HDPE	_	F, B	F, B, L					
462	36-inch corrugated HDPE	F ^a , B	F, B, L	F, B, L					
466	36-inch concrete	F ^a , B	F, B, L	F, B, L					
481	36-inch concrete	F, B	F	F					
488	36-inch corrugated HDPE	F, B	F	F					
492	Open channel	F, B	F, B, L	F, B					
495	36-inch concrete	F, B	F	-					
509	36-inch concrete	F, B	F, B	F, B, L					
518	36-inch concrete	_	F, B, L	F, B, L					
520	Open channel	-	F, B, L	F, B, L					
521	36-inch concrete	F, B	F	F, B, L					
525	24-inch concrete	_	F, B, L	F, B, L					
525A	Open channel	F, B	-	_					
Septic Tank									
OSS	3201 North_ <mark>sS</mark> hore Road	_	F, B, L	F, B, L					

^a Optical brighteners not measured with field parameters due to fluorometer malfunction.

F = Field parameters (temperature, dissolved oxygen, pH, conductivity, turbidity, optical brighteners).

B = Bacteria parameters (fecal coliform bacteria and E. coli).

July 2017

L = Laboratory analysis of chemistry (total phosphorus, chloride, and bromide) and Bacteroidetes (B. dorei and EPA developed assay).

Water samples were collected by pumping water with a peristaltic pump from 0.25-inch tubing attached to the instrument probe assembly. New tubing was used for each event and purged for several minutes prior to the collection of each sample. Sterile technique was employed, the



control samples were collected first, and the OSS sample was collected last. Sample containers provided by the laboratories were filled as designed for the following laboratory analyses:

- Microbiological: fecal coliform bacteria and *E. coli* by LabCor, Inc. using Standard Method 9222D (membrane filtration).
- Chemistry: total phosphorus, chloride, and bromide by Analytical Resources, Inc. using Standard Method 4500-P E (persulfate/ascorbic acid) and EPA Method 300.0 (ion chromatography).
- Microbial Source Tracking (MST): Bacteroidetes human gene biomarkers 1 (*B. dorei*) and 2 (EPA developed assay) by Source Molecular Corporation using digital quantitative polymerase chain reaction (digital qPCR).

Analysis of water samples for fecal coliform bacteria was recommended for this OSS detection study to assess potential effects of OSS on fecal coliform bacteria loading to Lake Whatcom and assist with TMDL implementation. Although fecal coliform bacteria concentrations in the lake may not be directly related to OSS inputs, due to an abundance of non-human fecal sources, unusually high concentrations may be used as one line of evidence for OSS impacts to human health.

Total dissolved phosphorus analysis of water samples was originally recommended for this OSS study because of the importance of phosphorus loading from OSS to the lake, and because measuring only dissolved fractions of phosphorus would reduce variation in concentrations of total phosphorus caused by wave suspension of near shore sediment (Herrera 2016). However, total phosphorus was analyzed because it directly relates to the TMDL (Ecology 2016) and ongoing monitoring at Lake Whatcom. In addition, suspension of lake sediment along the shoreline appeared to be minor and analysis of only soluble phosphorus would have excluded phosphorus from OSS contamination that had precipitated or adsorbed to particles in discharge waters.

Chloride and bromide analyses were recommended for this OSS study as an additional indicator of possible OSS contamination of the lake. Chloride concentrations are elevated in sewage due to large amounts of salt in human waste and chloride moves conservatively (no adsorption or degradation) in ground and surface waters. Chloride (Cl) to bromide (Br) ratios have been used successfully to detect OSS contamination of ground waters because this ratio accounts for natural variation of these constituents in the salt content of rainfall and groundwater. The USGS (Katz et al. 2011) conducted a nationwide study of 1,848 wells and found that the Cl/Br ratio was useful as a screening tool for identifying potential impacts of OSS on shallow wells. However, bromide analysis may not be necessary because background salt concentrations are not likely to vary in the lake or shallow groundwater within the study area.

The *B. dorei* and EPA Developed Assay methods are designed around the principle that fecal Bacteroidales-like bacteria are found in large quantities in feces of warm-blooded animals. Furthermore, certain strains have been shown to be associated only with humans. False positives from non-human sources have never been observed for the *B. dorei* method and have been

observed only on rare occasions for the EPA method (Source Molecular, personal communication). As such, these bacterial strains can be used as indicators of human fecal contamination. MST results were weighted based on the following criteria with respect to the extent of human fecal contamination (Cao et. al. 2013):

- The frequency of samples that are positive for human MST markers was of primary importance
- The magnitude of and consistency between human-associated markers was of secondary importance
- General fecal indicator bacteria received the least weight.

For each event, all 17 or 18 samples were analyzed for the microbiological parameters and results were reported within 48 hours. For Events 2 and 3, 15 of the lake control and other samples exhibiting elevated fecal coliform concentrations were analyzed for the chemistry and MST parameters.



3. RESULTS AND DISCUSSION

Summary statistics for samples are presented in Table 3. Laboratory reports and data quality review worksheets and are presented in Appendix B. The sample results database is included in Appendix C.

Data quality review results are summarized first in this section. Monitoring results are then presented and discussed separately for field parameters (temperature, DO, pH, conductivity, and OB), chemistry (total phosphorus, chloride, and bromide), bacteria (fecal coliform and *E. coli*), and Bacteroidetes. This section concludes with results and discussion of the correlation analysis performed on the collected data.

3.1. DATA QUALITY REVIEW

Field and laboratory procedures followed the project QAPP (Herrera 2016) with the following exceptions:

- Optical brightener data are missing for approximately half of the site during Event 1 due to water damage to the fluorometer.
- Chemistry analyses were performed by Analytical Resources, Inc. instead of the Institute for Environmental Health that was specified in the QAPP.
- Total phosphorus was analyzed instead of total dissolved phosphorus.
- Reported laboratory detection limits for total phosphorus (0.008 milligrams per liter [mg/L]) and bromide (0.100 mg/L) were slightly elevated from the QAPP objectives (0.005 mg/L and 0.05 mg/L, respectively).

All continuous field parameter data were reviewed to remove data logged while probes were out of the water. Identified data were deleted from the database

Laboratory data were verified and validated to ensure that all data were consistent, correct, and complete, and that all required quality control information was provided. Values associated with minor quality control problems were considered estimates and assigned *J* qualifiers. Estimated values were used for evaluation purposes. The following laboratory quality control elements were reviewed for each sampling event:

- Completeness
- Methodology



Table 3. Summary Statistics for Samples Collected.												
	Disc	harge Stat	ions	Lake	Lake Impact Stations Lake Control Stat			ations OSS Station				
Parameter	Min.	Max.	Median	Min.	Max.	Median	Min.	Max.	Median	Min.	Max.	Median
Temperature (°C)	5.2	8.9	7.4	6.8	7.7	7.2	6.3	6.7	6.7	7.8	9.1	8.5
Dissolved oxygen (mg/L)	10.5	12.2	11.7	11.1	11.7	11.3	10.4	11.8	11.4	0.30	0.61	0.46
pH (std. units)	6.3	7.4	7.1	6.9	7.4	7.1	7.2	7.5	7.3	6.9	7.0	6.9
Conductivity (µS/cm)	0.2	115.6	59.0	56.6	64.8	60.9	50.7	58.1	57.3	944	963	660
Turbidity (FNU)	0.9	67.2	8.2	0.4	3.0	1.7	0.2	0.6	0.3	26.8	32.3	29.6
Optical brighteners (RFUB)	51.0	297	189	61.7	227.7	81.2	8.2	45.5	43.4	632	686	660
Total phosphorus (mg/L)	0.014	0.218	0.054	0.012	0.030	0.021	<0.008	<0.008	<0.008	10.2	10.3	10.3
Chloride (mg/L)	1.15	3.47	2.08	2.56	3.05	2.61	2.59	2.68	2.68	46.8	48.1	47.5
Bromide (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.001
Fecal coliform (CFU/100 mL)	2	800	36/ 192 ª	<5	46	10/31ª	<2	<5	3/5ª	1,500,000	4,080,000	2,470,000/ 3,820,000 ^a
<i>E. coli</i> (CFU/100 mL)	2	342	28/ 156 ª	<5	42	10/29ª	<2	<5	3/5ª	1,500,000	4,080,000	2,470,000/ 3,820,000 ^a
Fecal coliform/ <i>E. coli</i> ratio	0.1	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
B. dorei (copies/100 mL)	0	21,700	8.4 ^b	0	60	3.7 ^b	0	<3	1.4 ^b	1,030	1,460	1,230 ^b
B. EPA (copies/100 mL)	0	9,960	4.6 ^b	0	0	0	0	0	0	55,000	141,000	88,100 ^b

^a Geometric mean/90th percentile calculated for coliform bacteria.

^b Geometric mean calculated for Bacteroidetes DNA.

Bold values exceed following surface water standards (WAC 173-201A): Temperature >16°C, DO <9.5 mg/L, pH <6.5, >8.5, Total phosphorus >0.020 mg/L, Bacteria geometric mean >0 cfu/100 mL or 90th percentile >100 cfu/100 mL.

°C = degrees Celsius

mg/L = milligrams per liter

 μ S/cm = microsiemens per centimeter

FNU = formazin nephelometric units

RFUB = relative fluorescence units, blank corrected

CFU/100 mL = colony forming units per 100 milliliters; Copies/100 mL = copies per 100 milliliters

< = not detected above the associated reporting limit



- Holding times
- Blanks
- Control Standards
- Matrix spikes
- Laboratory duplicates
- Fecal coliform bacteria enumeration

Based on the data validation, all reported results were considered acceptable for use as reported with the following exceptions:

- Several fecal coliform bacteria and *E. coli* results were qualified as estimated due to plate counts outside the ideal range of 20 to 60.
- The total phosphorus result for the sample collected from Station 4L during the second event was qualified as estimated (flagged *J*) due to method blank contamination.

3.2. FIELD PARAMETERS

Sample summary statistics for temperature, DO, pH, conductivity, and OB are presented in Table 3. Continuous field parameter data are presented on Figures 2 through 7.

As shown on Figure 2, continuous temperature measurements for Events 2 and 3 indicate a general increase in lake temperature along the shoreline moving away (northwest) from the control site, and the discharge points exhibited higher water temperature than the lake. For Event 1, however, temperature was generally consistent along the lake shoreline and discharge water temperatures were lower than the lake. This was due to snow and ice being present in the area during sampling for Event 1 in January. Temperature measurements ranged from 5.2 to 8.9 degrees Celsius (°C) at the discharge stations, 6.8 to 7.7°C at the lake impact stations, 6.3 to 6.7°C at the lake control stations, and 7.8 to 9.1°C at the OSS station (Table 3). Thus, the OSS samples were only a couple of degrees warmer than the lake and discharge waters. All temperature measurements met the surface water standard of less than 16°C (WAC 173-201A).

DO levels in the lake increased with each of the sampling events (Figure 3), likely due to increasing algae productivity. DO levels also slightly increased with distance along the shoreline from the control area for all three events. The DO results ranged from 10.5 to 12.2 mg/L at the discharge stations, 11.1 to 11.7 mg/L at the lake impact stations, 10.4 to 11.8 mg/L at the lake control stations, and 0.3 to 0.6 mg/L at the OSS station (Table 3). The lake and discharge samples were essentially saturated with oxygen, while essentially no oxygen was present in the OSS samples.





Figure 2. Water Temperature (°C) Along Lake Whatcom Shoreline Extending from Control Area.





Figure 3. Dissolved Oxygen (mg/L) Along Lake Whatcom Shoreline Extending from Control Area.





Figure 4. Conductivity (µS/cm) Along Lake Whatcom Shoreline Extending from Control Area.





Figure 5. Continuous pH Along Lake Whatcom Shoreline Extending from Control Area.





Figure 6. Turbidity (FNU) Along Lake Whatcom Shoreline Extending from Control Area.





Figure 7. Optical Brightener (RFUB) Along Lake Whatcom Shoreline Extending from Control Area.



In general, conductivity was similar between all three sampling events and remained consistent in the lake with distance along the shoreline (Figure 4). Conductivity often decreased briefly in the lake at and between discharges, while some discharges exhibited high conductivity compared to the lake. As shown in Table 3, conductivity ranged from 0.2 to 115.6 microsiemens per centimeter (μ S/cm) at the discharge stations, 56.6 to 64.8 μ S/cm at the lake impact stations, 50.7 to 58.1 μ S/cm at the lake control stations, and 944 to 963 μ S/cm at the OSS stations. Discharge station 429 had the unusually low conductivity value of 0.2 μ S/cm. The median conductivity was approximately 11 times higher in the OSS samples than the lake impact or discharge samples.

Continuous pH measurements were generally consistent with distance along the shoreline from the control area for all three events (Figure 5). The pH of discharge water was lower than the lake water at all discharge points for all three events. The pH results ranged from 6.3 to 7.4 at the discharge stations, 6.9 to 7.4 at the lake impact stations, 7.2 to 7.5 at the lake control stations, and 6.9 to 7.0 at the OSS station. The low pH results at discharge sample locations 429 (6.27) and 453 (6.43) during the third sampling event did not meet the surface water standard of greater than 6.5 and less than 8.5.

Continuous turbidity was consistently low in the lake except in the vicinity of some turbid discharges (Figure 6). Turbidity results ranged from 0.9 to 67 formazin nephelometric units (FNU) at the discharge stations, 0.4 to 3.0 FNU at the lake impact stations, 0.2 to 0.6 FNU at the lake control stations, and 27 to 32 FNU at the OSS station.

OB values in the lake frequently increased from baseline either in the vicinity of or distant from discharges, and slightly increased with distance along the shoreline from the control area for Event 3 (Figure 7). The OB values ranged from 51 to 297 relative fluorescence units—blank corrected (RFUB) at the discharge stations, 62 to 228 RFUB at the lake impact stations, 8.2 to 46 RFUB at the lake control stations, and 632 to 686 RFUB at the OSS station. Median OB values increased from the lake control stations (43 RFUB) by a factor of 2 at the lake impact stations (81 RFUB), a factor of 4 at the discharge stations (189 RFUB), and a factor of 15 at the OSS station (660 RFUB).

3.3. CHEMISTRY

Sample summary statistics for total phosphorus, chloride, and bromide are presented in Table 3. Results for all sample locations are presented in Appendix C.

Total phosphorus was not detected above the laboratory reporting limit (0.008 mg/L) in any of the lake control samples. Median total phosphorus concentrations increased from the lake impact stations (0.021 mg/L), to the discharge stations (0.054 mg/L), and to a very high concentration at the OSS station (10.3 mg/L). High concentrations, defined as exceeding the Washington State action value of 0.020 mg/L for Puget Sound lowland lakes (WAC 173-201A), were observed at 12 of the 13 discharge stations and at 2 of the 4 lake impact stations.



The median chloride concentration was similar for lake impact stations (2.61 mg/L) and lake control station (2.68 mg/L), and slightly lower for the discharge stations (2.08 mg/L). The median chloride concentration at the OSS station (47.5 mg/L) was 18 times higher than the lake stations.

Bromide was not detected above the reporting limit in any sample. Therefore, chloride/bromide ratios were not calculated.

3.4. BACTERIA INDICATORS

Sample summary statistics for fecal coliform and *E. coli* are presented in Table 3. Results for all sample locations are presented in Appendix C.

Geometric mean concentrations of fecal coliform bacteria increased from the lake control stations (<3 CFU/100 mL), to the lake impact stations (10 CFU/100 mL), to the discharge stations (36 CFU/100 mL), and to a very high concentration at the OSS station (2.5 million CFU/100 mL) (see Table 2).

Fecal coliform bacteria results are summarized for each station location in Figure 8. High concentrations, defined as exceeding the Washington State surface water standard of 100 CFU/100 mL for a single sample, were observed on one or more occasion at eight discharge stations and no lake stations. Thus, primary contact recreation in the vicinity of these discharges should be avoided to protect public health. Furthermore, consumption of untreated lake waters containing any detectable concentrations of fecal coliform bacteria should be avoided to protect public health.

Fecal coliform bacteria concentrations were typically equivalent to E. coli concentrations, suggesting that the samples did not include many positive testing organisms that are not of fecal origin. Considering the high levels observed at the OSS station and that fecal coliform concentrations commonly exceed 1,000 CFU/100 mL in stormwater runoff (e.g., event mean concentration of 7,750 most probable number [MPN]/100 mL for stormwater draining residential development; Shaver et al. 2007), none of the observed lake or discharge results exhibited high enough fecal coliform bacteria concentrations to strongly indicate contamination from septic system effluent.

3.5. BACTEROIDETES

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Geometric mean concentrations of Bacteroidetes human biomarkers (including both *B. dorei* and EPA methods) did not exceed the limit of quantitation at the lake control and impact stations (<3 copies/100 mL for both methods), increased at the discharge stations (8.4 and 4.6 copies/100 mL, respectively), and were much higher at the OSS station (1,230 and 88,100 copies/100 mL, respectively) (see Table 3).


Bacteroidetes human biomarker results are summarized for each station in Figure 9. High concentrations, defined as greater than 100 times the quantitation limit of 3 copies/100 mL, were observed on one or more occasion at two discharge locations and no lake locations.

Moderate concentrations (3 to 300 copies/100 mL) were observed at four discharge stations and one lake station (located near a discharge with a moderate concentration). Moderate to high concentrations of human biomarkers are considered proof that the samples were contaminated by septic system effluent. False positives from non-human sources have never been observed for the *B. dorei* method and have been observed only on rare occasions for the EPA method (Source Molecular personal communication). Thus, septic system contamination was definitely observed at seven locations in the 2.3-mile study area.

Discharge 520 (see Figure 9) exhibited the most conclusive evidence of septic system contamination because both samples collected at this discharge contained high concentrations of both biomarkers that were similar to concentrations observed in the OSS sample. Interestingly, fecal coliform bacteria concentrations were not exceptionally high (62 and 100 CFU/100 mL) in either sample from Discharge 520. Higher fecal coliform bacteria concentrations would be expected if this discharge was contaminated by a septic system that was undergoing a surfacing failure and draining directly into the discharge drainage. The moderate to high concentrations of human Bacteroidetes DNA without exceptionally high fecal coliform bacteria concentrations at this and the other sampled stations suggest that those drainage and lake waters were contaminated by seepage of septic system effluent through soils, which may have retained fecal coliform bacteria cells and passed Bacteroidetes DNA.

3.6. CORRELATION ANALYSIS

Non-parametric correlation analysis (Spearman's rho) was performed on the results to determine which monitoring parameters were good predictors of fecal and phosphorus contamination. The lake and discharge sample data were tested both separately and combined for significant parameter correlations. Results of this analysis are presented in Table 4.

None of the field, chemical, or microbiological parameters analyzed for this study were good predictors of human fecal contamination in the lake or discharge samples. Neither human biomarker correlated to fecal coliform or *E. coli*, suggesting that fecal coliform bacteria also originate from animals and are not good indicators of human fecal contamination within the project area. The two human biomarkers were significantly ($\alpha = 0.05$) correlated with each other among the discharge samples, but not strongly (rho = 0.46). Significant but rather weak correlations (rho < 0.6) were observed in the discharge samples for *B. dorei* with temperature (positive) and for the EPA method with dissolved oxygen (negative), pH (negative), and chloride (positive).





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Table 4. Spearman Rank Order Correlation Coefficients for the Lake Whatcom North Shore Road OSS Detection Project.												
	Temp.	DO	pH (std.	Sp. Cond	OB	Total P	Chloride	Fecal coliform	E. coli	B. dorei	B. EPA	B. dorei+B. EPA
Variable	(°C)	(mg/L)	units)	(uS/cm)	(RFUB)	(mg/L)	(mg/L)	(CFU/100mL)	(CFU/100mL)	(copies/100mL)	(copies/100mL)	(copies/100 ml)
All Sites except OSS												
Temperature (°C)	1.00	-0.31	0.00	-0.03	0.41	0.70	-0.29	0.12	0.09	0.50	0.19	0.43
Dissolved Oxygen (mg/L)	-0.31	1.00	0.37	-0.30	0.26	0.10	-0.45	-0.04	-0.05	-0.20	-0.51	-0.32
pH (standard units)	0.00	0.37	1.00	-0.14	-0.16	-0.14	-0.18	-0.52	-0.55	-0.12	-0.47	-0.25
Specific Conductance (uS/cm)	-0.03	-0.30	-0.14	1.00	0.02	-0.15	0.62	0.12	0.06	0.28	0.25	0.26
Optical Brighteners (RFUB)	0.41	0.26	-0.16	0.02	1.00	0.70	-0.53	0.38	0.38	0.30	-0.05	0.23
Total Phosphorus (mg/L)	0.70	0.10	-0.14	-0.15	0.70	1.00	-0.59	0.61	0.57	0.36	0.05	0.30
Chloride (mg/L)	-0.29	-0.45	-0.18	0.62	-0.53	-0.59	1.00	-0.20	-0.29	0.22	0.42	0.27
Fecal coliform (CFU/100mL)	0.12	-0.04	-0.52	0.12	0.38	0.61	-0.20	1.00	0.97	0.31	0.31	0.35
E. coli (CFU/100mL)	0.09	-0.05	-0.55	0.06	0.38	0.57	-0.29	0.97	1.00	0.17	0.18	0.22
B. dorei (copies/100mL)	0.50	-0.20	-0.12	0.28	0.30	0.36	0.22	0.31	0.17	1.00	0.43	0.96
B. EPA (copies/100mL)	0.19	-0.51	-0.47	0.25	-0.05	0.05	0.42	0.31	0.18	0.43	1.00	0.64
B. dorei + B. EPA (copies/100 ml)	0.43	-0.32	-0.25	0.26	0.23	0.30	0.27	0.35	0.22	0.96	0.64	1.00
Discharge Sites Only												
Temperature (°C)	1.00	-0.48	0.15	-0.07	0.19	0.46	-0.14	0.06	-0.01	0.54	0.10	0.41
Dissolved Oxygen (mg/L)	-0.48	1.00	0.51	-0.37	0.15	0.20	-0.53	-0.29	-0.31	-0.22	-0.53	-0.36
pH (standard units)	0.15	0.51	1.00	-0.12	0.16	0.18	-0.43	-0.48	-0.53	-0.05	-0.49	-0.22
Specific Conductance (uS/cm)	-0.07	-0.37	-0.12	1.00	-0.08	-0.24	0.72	0.06	-0.03	0.36	0.31	0.35
Optical Brighteners (RFUB)	0.19	0.15	0.16	-0.08	1.00	0.47	-0.58	-0.04	-0.05	0.16	-0.28	0.02
Total Phosphorus (mg/L)	0.46	0.20	0.18	-0.24	0.47	1.00	-0.53	0.31	0.27	0.34	-0.14	0.21
Chloride (mg/L)	-0.14	-0.53	-0.43	0.72	-0.58	-0.53	1.00	0.13	0.00	0.25	0.55	0.36
Fecal coliform (CFU/100mL)	0.06	-0.29	-0.48	0.06	-0.04	0.31	0.13	1.00	0.94	0.32	0.20	0.33
E. coli (CFU/100mL)	-0.01	-0.31	-0.53	-0.03	-0.05	0.27	0.00	0.94	1.00	0.11	0.06	0.13
B. dorei (copies/100mL)	0.54	-0.22	-0.05	0.36	0.16	0.34	0.25	0.32	0.11	1.00	0.46	0.94
B. EPA (copies/100mL)	0.10	-0.53	-0.49	0.31	-0.28	-0.14	0.55	0.20	0.06	0.46	1.00	0.71
B. dorei + B. EPA (copies/100 ml)	0.41	-0.36	-0.22	0.35	0.02	0.21	0.36	0.33	0.13	0.94	0.71	1.00
Lake Sites Only												
Temperature (°C)	1.00	-0.14	-0.83	0.56	0.74	0.96	0.03	0.49	0.49	0.43	0.00	0.43
Dissolved Oxygen (mg/L)	-0.14	1.00	0.45	-0.06	0.19	-0.48	-0.05	0.11	0.11	0.00	0.00	0.00
pH (standard units)	-0.83	0.45	1.00	-0.25	-0.46	-0.67	0.36	-0.29	-0.29	0.09	0.00	0.09
Specific Conductance (uS/cm)	0.56	-0.06	-0.25	1.00	0.71	0.63	0.44	0.49	0.49	0.36	0.00	0.36
Optical Brighteners (RFUB)	0.74	0.19	-0.46	0.71	1.00	0.93	0.22	0.77	0.77	0.42	0.00	0.42
Total Phosphorus (mg/L)	0.96	-0.48	-0.67	0.63	0.93	1.00	0.17	0.58	0.58	0.56	0.00	0.56
Chloride (mg/L)	0.03	-0.05	0.36	0.44	0.22	0.17	1.00	0.15	0.15	0.73	0.00	0.73
Fecal coliform (CFU/100mL)	0.49	0.11	-0.29	0.49	0.77	0.58	0.15	1.00	1.00	0.37	0.00	0.37
E. coli (CFU/100mL)	0.49	0.11	-0.29	0.49	0.77	0.58	0.15	1.00	1.00	0.37	0.00	0.37
B. dorei (copies/100mL)	0.43	0.00	0.09	0.36	0.42	0.56	0.73	0.37	0.37	1.00	0.00	1.00
B. EPA (copies/100mL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
B. dorei + B. EPA (copies/100 ml)	0.43	0.00	0.09	0.36	0.42	0.56	0.73	0.37	0.37	1.00	0.00	1.00

Red values are significant correlations at p<0.05

Fecal coliform and *E. coli* were significantly and strongly correlated (rho = 0.77) with optical brighteners in the lake samples (see Table 4). Optical brighteners did not correlate with fecal bacteria in the discharge samples, likely due to false positive fluorescence from varied amounts and types of dissolved organic carbon in the discharge samples. Relationships of fecal coliform bacteria with optical brighteners are shown separately for the lake and discharge samples in Figure 10.

Fecal coliform and *E. coli* were significantly correlated with pH (weakly negative at rho = -0.47) in the discharge samples, but not in the lake samples. Combining the lake and discharge data showed a significant correlation of both fecal indicators with total phosphorus (rho = 0.6)

Total phosphorus was significantly correlated with optical brighteners and temperature with much higher coefficients in the lake samples (rho = 0.93 and 0.96, respectively) than the discharge samples (rho = 0.47 and 0.46). Relationships of total phosphorus with optical brighteners are shown separately for the lake and discharge samples in Figure 11. The discharge samples also exhibited a significant but weakly negative relationship between total phosphorus and chloride (rho = -0.53).





Figure 10. Fecal Coliform Bacteria Versus Optical Brighteners.

Herrera



Figure 11. Total Phosphorus Versus Optical Brighteners.



4. CONCLUSIONS

Study results showed that many septic systems in the study area are a likely source of contamination to Lake Whatcom. The two molecular DNA biomarkers of human-specific bacteria were found at moderate to high concentrations of either biomarker at 6 of the 13 sampled discharge stations and at 1 of the 4 sampled lake stations located along the 2.3-mile-long shoreline. At one discharge station, biomarker concentrations were high for both wet weather sampling events and were present at levels similar to those measured in septic tank samples.

Discharge and lake samples contaminated by human biomarkers from septic system effluent also contained elevated levels of optical brighteners, fecal coliform bacteria, and total phosphorus. The elevated concentrations of optical brighteners indicate the presence of laundry detergents from septic system effluent. Fecal coliform bacteria and total phosphorus concentrations exceeded Washington State surface water quality standards, indicating impacts on public health and the lake environment, respectively. Both fecal coliform bacteria and total phosphorus positively correlated with optical brighteners, providing additional evidence that septic systems are a significant source of the observed contamination.

Fecal coliform bacteria and total phosphorus concentrations were several orders of magnitude higher in septic tank samples, indicating that the lake was contaminated by diffuse seepage from septic system drain fields rather than overland flow from failed systems. The numerous and diffuse septic system sources present in the study area would be difficult to locate and control for protection of public health and the environment. Connecting homes in the study area to a sanitary sewer would prevent the ongoing contamination of Lake Whatcom from septic systems in the area.



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APPENDIX A

Photographic Documentation



WATER QUALITY MONITORING REPORT— LAKE WHATCOM NORTH SHORE OSS LEACHATE DETECTION PROJECT PHOTOGRAPHIC LOG



LAKE CONTROL STATION





LAKE IMPACT STATIONS



💩 Herrera





LAKE DISCHARGE STATIONS

























🚸 HERRERA







💩 Herrera











Water Quality Monitoring Report—Lake Whatcom North Shore OSS Leachate Detection Project

APPENDIX B

Laboratory Data Reports





Analysis Report Cover

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

Final Report

A Professional Service Corporation in the Northwest

Job Number: 170	0061 SEA		Report Number: 170061R02			
Client: Her Address: 220 Suit Sea	rera Environmental Consultants, Inc 0 Sixth Avenue te 1100 tttle, WA 98121	•	Report Date: 1/23/2017			
Project Name: What Project No.: PO Number: PWS ID:	atcom OSS Detection					
Reference No.:						
Enclosed please find	results for samples submitted to our la	boratory. A list of samples a	nd analyses follows:			
Lab/Cor Sample #	Client Sample # and Description	Analysis	Analysis Notes	Date Received:		
170061 - S1	C1 - Lake; Aliquots 50ml & 5ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S2	C2 - Lake; Aliquots 50ml & 5ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S3	C3 - Lake; Aliquots 50ml & 5ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S4	1D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S5	2D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S6	3L - Lake; Aliquots 50ml & 5ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S7	4D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S8	5D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S9	6D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S10	7D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S11	8D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S12	9D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S13	10D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S14	11D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S15	12D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S16	13D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S17	14D - Stormwater; Aliquots 20ml & 2ml	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S18	MB1 - Method Blank #1	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S19	MB2 - Method Blank #2	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S20	MB3 - Method Blank #3	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
170061 - S21	MB4 - Method Blank #4	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		1/20/2017		
				Page 1 of 7		
L/L Lab/Cor, Inc. 7619 6th Ave NW

Seattle, WA 98117

Final Report

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

A Professional Service Corporation in the Northwest

Job Number: 170 Client: Her Project Name: Wh	0061 SEA rrera Environmental Consultant accom OSS Detection	s, Inc	Report Number: 170061R02 Report Date: 1/23/2017
170061 - S22	Neg - Negative Control	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU	1/20/2017
170061 - S23	Pos - Positive Control	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU	1/20/2017

SM 9222D G1c1- The presence of Fecal Coliform and E. coli from waters and/or environmental sources are tested using the following standard Fecal Coliform/ methods:

E.coli - CFU

SM9222 D&G1c1:

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

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

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

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

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

Sincerely,

Derk Wipprecht

Laboratory Supervisor



A Professional Service Corporation in the Northwest

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

Job Number: 170061 SEA

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom OSS Detection

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S1	C1 - Lake; Aliquots 50ml & 5ml	FECAL COLIFORM	<2	CFU/ 100ml	0 - 7.4	1/19/2017	9:26 AM	DW 1/21/2017
S1	C1 - Lake; Aliquots 50ml & 5ml	E. COLI	<2	CFU/ 100ml	0 - 7.4	1/19/2017	9:26 AM	DW 1/21/2017
S1	C1 - Lake; Aliquots 50ml & 5ml	FECAL COLIFORM	<20	CFU/ 100ml	0 - 74	1/19/2017	9:26 AM	DW 1/21/2017
S1	C1 - Lake; Aliquots 50ml & 5ml	E. COLI	<20	CFU/ 100ml	0 - 74	1/19/2017	9:26 AM	DW 1/21/2017
S2	C2 - Lake; Aliquots 50ml & 5ml	FECAL COLIFORM	<2	CFU/ 100ml	0 - 7.4	1/19/2017	9:32 AM	DW 1/21/2017
S2	C2 - Lake; Aliquots 50ml & 5ml	E. COLI	<2	CFU/ 100ml	0 - 7.4	1/19/2017	9:32 AM	DW 1/21/2017
S2	C2 - Lake; Aliquots 50ml & 5ml	FECAL COLIFORM	<20	CFU/ 100ml	0 - 74	1/19/2017	9:32 AM	DW 1/21/2017
S2	C2 - Lake; Aliquots 50ml & 5ml	E. COLI	<20	CFU/ 100ml	0 - 74	1/19/2017	9:32 AM	DW 1/21/2017
S3	C3 - Lake; Aliquots 50ml & 5ml	FECAL COLIFORM	4	CFU/ 100ml	0.4 - 14.4	1/19/2017	9:40 AM	DW 1/21/2017
S3	C3 - Lake; Aliquots 50ml & 5ml	E. COLI	4	CFU/ 100ml	0.4 - 14.4	1/19/2017	9:40 AM	DW 1/21/2017
S3	C3 - Lake; Aliquots 50ml & 5ml	FECAL COLIFORM	<20	CFU/ 100ml	0 - 74	1/19/2017	9:40 AM	DW 1/21/2017
S3	C3 - Lake; Aliquots 50ml & 5ml	E. COLI	<20	CFU/ 100ml	0 - 74	1/19/2017	9:40 AM	DW 1/21/2017
S4	1D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	150	CFU/ 100ml	122.6 - 177.4	1/19/2017	11:00 AM	DW 1/21/2017
S4	1D - Stormwater; Aliquots 20ml & 2ml	E. COLI	145	CFU/ 100ml	118.1 - 171.9	1/19/2017	11:00 AM	DW 1/21/2017
S4	1D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	350	CFU/ 100ml	140 - 720	1/19/2017	11:00 AM	DW 1/21/2017
S4	1D - Stormwater; Aliquots 20ml & 2ml	E. COLI	300	CFU/ 100ml	110 - 655	1/19/2017	11:00 AM	DW 1/21/2017

Report Number: 170061R02 Date Received: 1/20/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170061 SEA

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom OSS Detection

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S5	2D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	135	CFU/ 100ml	109 - 161	1/19/2017	11:32 AM	DW 1/21/2017
S5	2D - Stormwater; Aliquots 20ml & 2ml	E. COLI	105	CFU/ 100ml	82.1 - 127.9	1/19/2017	11:32 AM	DW 1/21/2017
S5	2D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	100	CFU/ 100ml	10 - 360	1/19/2017	11:32 AM	DW 1/21/2017
S5	2D - Stormwater; Aliquots 20ml & 2ml	E. COLI	100	CFU/ 100ml	10 - 360	1/19/2017	11:32 AM	DW 1/21/2017
S6	3L - Lake; Aliquots 50ml & 5ml	FECAL COLIFORM	46	CFU/ 100ml	36.4 - 55.6	1/19/2017	11:44 AM	DW 1/21/2017
S6	3L - Lake; Aliquots 50ml & 5ml	E. COLI	42	CFU/ 100ml	32.8 - 51.2	1/19/2017	11:44 AM	DW 1/21/2017
S6	3L - Lake; Aliquots 50ml & 5ml	FECAL COLIFORM	100	CFU/ 100ml	32 - 234	1/19/2017	11:44 AM	DW 1/21/2017
S6	3L - Lake; Aliquots 50ml & 5ml	E. COLI	60	CFU/ 100ml	12 - 176	1/19/2017	11:44 AM	DW 1/21/2017
S7	4D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	50	CFU/ 100ml	23.5 - 92	1/19/2017	11:58 AM	DW 1/21/2017
S7	4D - Stormwater; Aliquots 20ml & 2ml	E. COLI	25	CFU/ 100ml	8 - 58.5	1/19/2017	11:58 AM	DW 1/21/2017
S7	4D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	100	CFU/ 100ml	10 - 360	1/19/2017	11:58 AM	DW 1/21/2017
S7	4D - Stormwater; Aliquots 20ml & 2ml	E. COLI	50	CFU/ 100ml	5 - 280	1/19/2017	11:58 AM	DW 1/21/2017
S8	5D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<5	CFU/ 100ml	0 - 18.5	1/19/2017	12:17 PM	DW 1/21/2017
S8	5D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<5	CFU/ 100ml	0 - 18.5	1/19/2017	12:17 PM	DW 1/21/2017
S8	5D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<50	CFU/ 100ml	0 - 185	1/19/2017	12:17 PM	DW 1/21/2017
S8	5D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<50	CFU/ 100ml	0 - 185	1/19/2017	12:17 PM	DW 1/21/2017

Report Number: 170061R02 **Date Received:** 1/20/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170061 SEA

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom OSS Detection

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S9	6D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	75	CFU/ 100ml	42 - 124	1/19/2017	12:27 PM	DW 1/21/2017
S9	6D - Stormwater; Aliquots 20ml & 2ml	E. COLI	60	CFU/ 100ml	31 - 105	1/19/2017	12:27 PM	DW 1/21/2017
S9	6D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<50	CFU/ 100ml	0 - 185	1/19/2017	12:27 PM	DW 1/21/2017
S9	6D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<50	CFU/ 100ml	0 - 185	1/19/2017	12:27 PM	DW 1/21/2017
S10	7D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<5	CFU/ 100ml	0 - 18.5	1/19/2017	12:34 PM	DW 1/21/2017
S10	7D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<5	CFU/ 100ml	0 - 18.5	1/19/2017	12:34 PM	DW 1/21/2017
S10	7D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<50	CFU/ 100ml	0 - 185	1/19/2017	12:34 PM	DW 1/21/2017
S10	7D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<50	CFU/ 100ml	0 - 185	1/19/2017	12:34 PM	DW 1/21/2017
S11	8D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	5	CFU/ 100ml	0.5 - 28	1/19/2017	12:45 PM	DW 1/21/2017
S11	8D - Stormwater; Aliquots 20ml & 2ml	E. COLI	5	CFU/ 100ml	0.5 - 28	1/19/2017	12:45 PM	DW 1/21/2017
S11	8D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<50	CFU/ 100ml	0 - 185	1/19/2017	12:45 PM	DW 1/21/2017
S11	8D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<50	CFU/ 100ml	0 - 185	1/19/2017	12:45 PM	DW 1/21/2017
S12	9D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	80	CFU/ 100ml	46 - 130	1/19/2017	1:07 PM	DW 1/21/2017
S12	9D - Stormwater; Aliquots 20ml & 2ml	E. COLI	75	CFU/ 100ml	42 - 124	1/19/2017	1:07 PM	DW 1/21/2017
S12	9D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<50	CFU/ 100ml	0 - 185	1/19/2017	1:07 PM	DW 1/21/2017
S12	9D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<50	CFU/ 100ml	0 - 185	1/19/2017	1:07 PM	DW 1/21/2017

Report Number: 170061R02 Date Received: 1/20/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170061 SEA

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom OSS Detection

Lab/Cor Sample	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
No.								
S13	10D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	90	CFU/ 100ml	53.5 - 142	1/19/2017	1:16 PM	DW 1/21/2017
S13	10D - Stormwater; Aliquots 20ml & 2ml	E. COLI	70	CFU/ 100ml	38.5 - 117.5	1/19/2017	1:16 PM	DW 1/21/2017
S13	10D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<50	CFU/ 100ml	0 - 185	1/19/2017	1:16 PM	DW 1/21/2017
S13	10D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<50	CFU/ 100ml	0 - 185	1/19/2017	1:16 PM	DW 1/21/2017
S14	11D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	210	CFU/ 100ml	177.6 - 242.4	1/19/2017	1:29 PM	DW 1/21/2017
S14	11D - Stormwater; Aliquots 20ml & 2ml	E. COLI	180	CFU/ 100ml	150 - 210	1/19/2017	1:29 PM	DW 1/21/2017
S14	11D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<50	CFU/ 100ml	0 - 185	1/19/2017	1:29 PM	DW 1/21/2017
S14	11D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<50	CFU/ 100ml	0 - 185	1/19/2017	1:29 PM	DW 1/21/2017
S15	12D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	45	CFU/ 100ml	20 - 85.5	1/19/2017	1:39 PM	DW 1/21/2017
S15	12D - Stormwater; Aliquots 20ml & 2ml	E. COLI	25	CFU/ 100ml	8 - 58.5	1/19/2017	1:39 PM	DW 1/21/2017
S15	12D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	100	CFU/ 100ml	10 - 360	1/19/2017	1:39 PM	DW 1/21/2017
S15	12D - Stormwater; Aliquots 20ml & 2ml	E. COLI	100	CFU/ 100ml	10 - 360	1/19/2017	1:39 PM	DW 1/21/2017
S16	13D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	20	CFU/ 100ml	5 - 51	1/19/2017	1:44 PM	DW 1/21/2017
S16	13D - Stormwater; Aliquots 20ml & 2ml	E. COLI	15	CFU/ 100ml	3 - 44	1/19/2017	1:44 PM	DW 1/21/2017
S16	13D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	<50	CFU/ 100ml	0 - 185	1/19/2017	1:44 PM	DW 1/21/2017
S16	13D - Stormwater; Aliquots 20ml & 2ml	E. COLI	<50	CFU/ 100ml	0 - 185	1/19/2017	1:44 PM	DW 1/21/2017

Report Number: 170061R02 Date Received: 1/20/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170061 SEA

Report Number: 170061R02 **Date Received:** 1/20/2017

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom OSS Detection

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S17	14D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	125	CFU/ 100ml	100 - 150	1/19/2017	1:53 PM	DW 1/21/2017
S17	14D - Stormwater; Aliquots 20ml & 2ml	E. COLI	100	CFU/ 100ml	77.6 - 122.4	1/19/2017	1:53 PM	DW 1/21/2017
S17	14D - Stormwater; Aliquots 20ml & 2ml	FECAL COLIFORM	50	CFU/ 100ml	5 - 280	1/19/2017	1:53 PM	DW 1/21/2017
S17	14D - Stormwater; Aliquots 20ml & 2ml	E. COLI	50	CFU/ 100ml	5 - 280	1/19/2017	1:53 PM	DW 1/21/2017

Reviewed by:



Laboratory Supervisor

FECAL COUNTS

77 1 82

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100 mL)	Herrera Check	Start Date/Time:	End Date/Time:
$\label{eq:states} \begin{array}{c} \mathbf{u}_{1} = \left(\mathbf{u}_{1} \right) \\ \mathbf{u}_{1} = \left(\mathbf{u}_{1} \right) \\ \mathbf{u}_{2} = \left(\mathbf{u}_{1} \right) \\ \mathbf{u}_{1} = \left(\mathbf{u}_{1} \right) \\ \mathbf{u}_{2} = \left(\mathbf{u}_{1} \right) \\ \mathbf{u}_{2} = \left(\mathbf{u}_{2} \right) \\ \mathbf{u}_$	50	ø	12	1	1/20/17	1/21/17
170061-01	5	ø	< 20	1. A	11:00	11:00
	50	ø	5.202		1	1
- 02	5	ø	520		i	
	50	2.00	4 5	AJ	認識が良い。	
- 03	5	6	< 20			
	20	30	150	~		
-04	2	7	350			
and the second second	20	27	135		市市都市 いたいな	
-05	2	2	100			and the second
	50	23	46	V		
-06	5	5	100	1	1	
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- 07	2	2	100 -			
-	20	ø	< 5	-		
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	2	ø	< 50	1213 196 2 21		S. Sec. Sak
	20	ø	< 5	1	1211	
-10	2	ø	< 50	1	1.15	
	20	The second	5	55	Della state	
-11	2	ø	50			
	20	16	80	73 J	·	
-12	2	ø	< 50		E.	
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Negative Control						
Positive Control	The States	Aller Start	THE NEW YORK			新聞 調子物語

Calculation of Results

Density: use if only one count is within Ideal range (20-60 colonies)

 $\frac{Colonies}{100 \, mL} = \frac{Colonies \, counted}{mL \, SampleFiltered} \times 100$

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100\,mL} = \frac{\sum Colonies \, counted}{\sum mL \, sample \, filtered} \times 100$

FECAL COURTS

2 2 3 2

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100 mL)	Herrera Check	Start Date/Time:	End Date/Time:
	20	18	.90	82 J	,/20/17	1/21/17
170061-13	2	ø	< 50		11:00	11:00
	20	42	1 210	1905	1	1
- 14	2	ø	5 50	and the second		
	20	9	45	50J		
-15	2	2	100			
	20	4	.20	187		
- 14	2	ø	550		1	
No. The state of	20	25	125	-	CAR STOR	
-17	2	S I S	50			
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	100	ø	<1		2011 2 3	
M8 4 2	120 States	Ø	CLOWER D. L. S	Mar I the fight		
MB # 3	100	ø	* 1			
MAR #4	100	0	<1			
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and the second sec						
Lab Duplicate	1. N. 1. 2. 1.	Contraction of the		Sec. Marson	E. 1.5.27	Castle Street
Negative Control	100	ø	< 1			
Positive Control	100	231	231	12		Y

Calculation of Results

Density: use if only one count is within ideal range (20-60 colonies)

 $\frac{Colonies}{100 \, mL} = \frac{Colonies \, counted}{mL \, SampleFiltered} \times 100$

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

$$\frac{Colonies}{100\,mL} = \frac{\sum Colonies\,counted}{\sum mL\,sample\,filtered} \times 100$$

E. COLI COUNTS

10 8 2

Sample ID	Volume (mL)	Colonies counted	Result Herrera Ch (CPN/100 mL)		Start Date/Time:	End Date/Time:
	50	ø	12		1/21/17	1/2/17
170061-01	5	ø	520		11:00	12.00
	50	B	122	/		-
- 02	5	ø	< 20			
	50	2	4	AJ	4	
-03	5	ø	< 20			
	20	29	145	-		
- 04	2	6	300			
	20	21	105			
- 05	2	2	100	Marcon (499) 		
	50	21	42			
-06	5	3	60			
Sec. S. A. S.	20	5	25	275	1990 A. 1997	
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-08	2	Ø	5 50			
	20	12	60	55 5	5 - 47 - 149C	
-09	2	ø	< 50			推拔 起
	20	25	55	1		
-10	2	ø	< 50			
	20	1	5	57		
-11	2	ø	550			
	20	15	75	685	E.	
-12	2	ø	< 50			
Lab Duplicate	1. ST.		de la seconda			
Negative Control				-		
Positive Control	1- 1- 1- 1- F	A Harry Supple -	1. 16.	12 CT 11 CT		

Calculation of Results

Density: use if only one count is within ideal range (20-60 colonies)

 $\frac{Colonies}{100 \, mL} = \frac{Colonies \, counted}{mL \, Sample Filtered} \times 100$

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100\,mL} = \frac{\sum Colonies \, counted}{\sum mL \, sample \, filtered} \times 100$

E. COLI COUNTS

Pg 282

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100 mL)	Herrera Check	Start Date/Time:	End Date/Time:
	20	14	70	645	1/21/17	1/21/17
170061-13	2	ø	< 50		11:00	12:00
	20	36	180	-		
- 14	2	ø	< 50			
	20	5	- 25	325	Not the	
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	20	.3	15	145		
-14	2	ø	< 50			
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-17	2	1215	50		and the second	
MB # 1	100	25	* 1			
MB # 2	100	ø	< 1			
MB # 3	00	ø	*1			
MB # 4	100	ø	4 4			
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Lab Duplicate	and a star	1 March	The lat	17 - W - 14	138	
Negative Control	100	ø	< 1_			
Positive Control	100	231	28/	1 1 2 2 2	1992 1993 19	NY STATISTICS

Calculation of Results

Density: use if only one count is within ideal range (20-60 colonies)

 $\frac{Colonies}{100 \, mL} = \frac{Colonies \, counted}{mL \, Sample Filtered} \times 100$

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100\,mL} = \frac{\sum Colonies\,counted}{\sum mL\,sample\,filtered} \times 100$

		(2)	Bacte	rial Ch	ain oj	f Cust	ody Recor	d			170 Pag	006	1	
Lab/(7619 6 th Seattle, v Office (206) Fax (206) mail@la www.la	Cor, Inc ^a Ave NW WA 98117 781-0155 789-8424 abcor.net bcor.net	Client: <u>Herrera Environmental Consultants</u> Address: <u>Z200 Sixth Ave Suite 1100</u> City, State, Zip: <u>Seattle</u> , <u>WA 98/21</u> Contact: <u>Rob Zisette</u> Phone: <u>206-787-8262</u> Fax: Email: <u>rzisette</u> <u>herrerainc</u> , com Other Info:						Analytical Protocol: Tur E. coli P/A					Turn Ti 5 c 3 d 48 24 SLaw (Not all availab) analysi	around me: lays lays lays hours hours hours* lare lare le for all s types)
Sample	me: <u>UNat</u>	mole Description	tion	Project	Num	ber:		1	_	P.	O. Num	ber:		
Number	* See	filtervolume note	Water	Sumple	Type	Other	Sample Date	S	ample T	ime	Flo	w Rate (lpm)	Total
CI	Lake		X	Swab	All	Other	1/10/-	On	Off	Total	Start	End	Avg	volume
C2	Lake		1			-	1/19/17	09	26		_			100mc
C3	Lake				1	-		09	32		-			
10	Stormwa	ter			-			09	40					
20	Stormi	uater-		-	-			_4_	00			_		
34	Lake			1221	-			11	32			_		
40	Storm	ater						_11	44	1.1				
5A	1					-	1		58	1				
6D			1-1			-		12	17					20-
70	V		5					12	27				2	2
lo be com	pleted by Jahi	Doodint /P.	*				*	12	34		-			
Iternal Lab I	se Only.	Kecenpi Tem	peratu	re_4_		_°C	Receipt	Con	dition_	- 1	ing			
elim Released	I. Phone E-1	Final Resul naîl 🔲 Verbal — By . 🛄 Fa	ts Release x D Pho	d: me	-mail		Hardco	py / Inv R	oice Mai eviewed	iled: By:				
signing below linquished by	you are agreeing to	Decomply with Lab/Cor's Requests, T Date: 1/20/16 17 4/2 Date: 1/20/17	Fenders and Fime: Fime:	830 830	F	Relinquis Received	shed by:			Da	* <i>Call al</i> ate:	head for	TATs of 2. Time:	Ahrs or less

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Lab/Ca 7619 6 th Seattle, W office (206) Fax (206) mail@la www.la	Lab/Cor, Inc 7619 6th Ave NW Seattle, WA 98117 fice (206) 781-0155 Fax (206) 789-8424 mail@labcor.net www.labcor.net						sultan		Analytical Pro E. coli P/A E. coli / Colifo E. coli / Fecal Heterotrophic Bacterial ID MPA Analysis Cryptosporidi Giardia Turbidity Microbial Lin			Analytical Protocol: I _E. coli / Coliform MPN		
roject Na	me: Whate	com OSS Detectio	m	Project	Num	ber:				P.0	O. Num	ber:		
Sample	5	Sample Description		Sample	Туре	21	Sample	Sa	mple T	ime	Floy	v Rate ((lpm)	Total
Number	X See S	filter volume note	Water	Swab	Air	Other	Date	Qn	Off	Total	Start	End	Avg	voranc
80	Stor	musater	X	1			1/19/17	12	45			-		100m
9D				-				13	07					
10 D				_		A		13	16				1	
ID							1-17	13	29	1				
12 D	1-2-11							13	39		1.6		12.4	
130					1.11			13	44	1.1				
14D	4		V			-	V	13	53					V
*	Filler L	ake at 50mL	and	5	nL									
	Filter .	Stormwater at 20	mL	and	21	mL			1	100	1 -		1.1	
(To be co	mpleted by I	ab). Receipt Te	mperat	ure	4°	°C	Rec	eipt Co	nditio	1 90	d_			
Internal La Prélim Rele By : 🗖 Fai	b Use Only: ased: x □ Phone □	Final Re] E-mail 🔲 Verbal — By 🔲	sults Reica Fax 🔲 1	sed: None 🗖	E-mai	1	H	irdeopy / I	nvoice M Review	dailed: ed By:				
By signing be Relinquishe	elow you are agree	ing to comply with Lab/Cor's Reques	ts, Tenders ; Time:	and Contra 0830	icts.	Relin	quished by:				* Call Date:	l ahead j	for TATs of Time:	f 24hrs or le

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Data Quality Assurance Worksheet

		By	G. Catarra	
Project Name/No./Client:	Lake Whatcom / 16-06326-000 / LWWSD.	Date	1/26/2017	Page <u>1</u> of <u>1</u>
Laboratory/Parameters:	LabCor, Inc. / fecal bacteria and E. coli	Checked:	initials	
Sample Date/Sample ID:	1/19/2017 / 17 samples		date	

		Pre-preser Holding 7 (hour	vation Fimes s)	Total Ho Times (c	lding lays)	Method	Matrix Sp Surroga Recovery	vikes/ ate (%)	Lab Con Samples Re (%)	trol covery	Lab Dupl RPD (1	icates %)	Field Dup RPD (licates %)	
Parameter	Completeness/ Methodology	Reported	Goal	Reported	Goal	Reporting Limit	Reported	Goa 1	Reported	Goal	Reported	Goal ¹	Reported	Goal ¹	ACTION
Fecal coliform	OK/ SM9222D	NA	NA	1	≤1	≤2 2	NA	NA	NA	NA	NA	≤35	NA	NA	C3, 4D,6D,8D-13D "J" DUE TO PLATE COUNTS. RESULTS CALCULATED PER METHOD.
E. coli	OK/ SM9222D	NA	NA	1	≤1	≤2 2	NA	NA	NA	NA	NA	≤35	NA	NA	C3, 4D, 6D, 8D-10D, 12D, 13D "J" due to plate counts. Results calculated per method.
						3									

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

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

PJJ https://herrerainc.sharepoint.com/16-06326-000/shared documents/report/apxb/b04 event 1 qa worksheet.docx



Analysis Report Cover

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

Final Report

A Professional Service Corporation in the Northwest

Job Number: 170242 SEA		Report Numb	per: 170242R02
Client: Herrera Environmental Consultants, In	nc	Report D	ate: 3/17/2017
Address: 2200 Sixth Avenue Suite 1100 Seattle, WA 98121			
Project Name: Whatcom Septic Detection			
Project No.: 16-06326-000			
PO Number: 16-06326 R2			
PWS ID:			
Reference No.:			
Enclosed please find results for samples submitted to our I	aboratory. A list of sar	nples and analyses follows:	
Lab/Cor Sample # Client Sample # and Description	Analysis	Analysis Notes	Date
			0/10

Lab/Cor Sample	# Client Sample # and Description	Analysis	Analysis Notes	Date Received:
170242 - S1	C1 - Control - Lake	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S2	C2 - Control - Lake	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S3	1D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S4	2D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S5	3D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S6	4L - Lake Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S7	5D (DUP) - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S8	6D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S9	7D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S10	8D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S11	9D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S12	10D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S13	11L - Lake Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S14	12L - Lake Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S15	13D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S16	14D - Discharge Water	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S17	OSS - Raw Sewage (High Level)	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S18	18 - Method Blank 1	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S19	19 - Method Blank 2	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S20	20 - Negative Control	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017
170242 - S21	21 - Positive Control	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		3/16/2017

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

Final Report

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

A Professional Service Corporation in the Northwest

Job Number: 170242

Client: Herrera Environmental Consultants, Inc Project Name: Whatcom Septic Detection

SEA

Report Number: 170242R02 Report Date: 3/17/2017

SM 9222D G1c1- The presence of Fecal Coliform and E. coli from waters and/or environmental sources are tested using the following standard Fecal Coliform/ methods:

E.coli - CFU

SM9222 D&G1c1:

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

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

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

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

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

Sincerely,

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A Professional Service Corporation in the Northwest

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

Job Number: 170242 SEA

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom Septic Detection

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S1	C1 - Control - Lake	FECAL COLIFORM	<50	CFU/ 100ml (2ml)	0 - 185	3/15/2017	9:41 AM	AT 3/17/2017
S1	C1 - Control - Lake	E. COLI	<50	CFU/ 100ml (2ml)	0 - 185	3/15/2017	9:41 AM	AT 3/17/2017
S1	C1 - Control - Lake	FECAL COLIFORM	<5	CFU/ 100ml (20ml)	0 - 18.5	3/15/2017	9:41 AM	AT 3/17/2017
S1	C1 - Control - Lake	E. COLI	<5	CFU/ 100ml (20ml)	0 - 18.5	3/15/2017	9:41 AM	AT 3/17/2017
S2	C2 - Control - Lake	FECAL COLIFORM	<50	CFU/ 100ml (2ml)	0 - 185	3/15/2017	9:50 AM	AT 3/17/2017
S2	C2 - Control - Lake	E. COLI	<50	CFU/ 100ml (2mL)	0 - 185	3/15/2017	9:50 AM	AT 3/17/2017
S2	C2 - Control - Lake	FECAL COLIFORM	<5	CFU/ 100ml (20ml)	0 - 18.5	3/15/2017	9:50 AM	AT 3/17/2017
S2	C2 - Control - Lake	E. COLI	<5	CFU/ 100ml (20ml)	0 - 18.5	3/15/2017	9:50 AM	AT 3/17/2017
S3	1D - Discharge Water	FECAL COLIFORM	80	CFU/ 100ml (5ml)	20 - 204	3/15/2017	10:50 AM	AT 3/17/2017
S3	1D - Discharge Water	E. COLI	80	CFU/ 100ml (5ml)	20 - 204	3/15/2017	10:50 AM	AT 3/17/2017
S3	1D - Discharge Water	FECAL COLIFORM	114	CFU/ 100ml (50ml)	98.9 - 129.1	3/15/2017	10:50 AM	AT 3/17/2017
S3	1D - Discharge Water	E. COLI	114	CFU/ 100ml (50ml)	98.9 - 129.1	3/15/2017	10:50 AM	AT 3/17/2017
S4	2D - Discharge Water	FECAL COLIFORM	120	CFU/ 100ml (5ml)	44 - 262	3/15/2017	11:05 AM	AT 3/17/2017
S4	2D - Discharge Water	E. COLI	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	11:05 AM	AT 3/17/2017
S4	2D - Discharge Water	FECAL COLIFORM	100	CFU/ 100ml (50ml)	85.9 - 114.1	3/15/2017	11:05 AM	AT 3/17/2017
S4	2D - Discharge Water	E. COLI	8	CFU/ 100ml (50ml)	2 - 20.4	3/15/2017	11:05 AM	AT 3/17/2017

Report Number: 170242R02 Date Received: 3/16/2017

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Report Number: 170242R02

Date Received: 3/16/2017

A Professional Service Corporation in the Northwest

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

Job Number: 170242 SEA

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom Septic Detection

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S5	3D - Discharge Water	FECAL COLIFORM	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	11:20 AM	AT 3/17/2017
S5	3D - Discharge Water	E. COLI	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	11:20 AM	AT 3/17/2017
S5	3D - Discharge Water	FECAL COLIFORM	44	CFU/ 100ml (50ml)	34.6 - 53.4	3/15/2017	11:20 AM	AT 3/17/2017
S5	3D - Discharge Water	E. COLI	14	CFU/ 100ml (50ml)	5.6 - 28.8	3/15/2017	11:20 AM	AT 3/17/2017
S6	4L - Lake Water	FECAL COLIFORM	<50	CFU/ 100ml (2ml)	0 - 185	3/15/2017	11:35 AM	AT 3/17/2017
S6	4L - Lake Water	E. COLI	<50	CFU/ 100ml (2ml)	0 - 185	3/15/2017	11:35 AM	AT 3/17/2017
S6	4L - Lake Water	FECAL COLIFORM	<5	CFU/ 100ml (20ml)	0 - 18.5	3/15/2017	11:35 AM	AT 3/17/2017
S6	4L - Lake Water	E. COLI	<5	CFU/ 100ml (20ml)	0 - 18.5	3/15/2017	11:35 AM	AT 3/17/2017
S7	5D (DUP) - Discharge Water	FECAL COLIFORM	20	CFU/ 100ml (5ml)	2 - 112	3/15/2017	12:15 PM	AT 3/17/2017
S7	5D (DUP) - Discharge Water	E. COLI	20	CFU/ 100ml (5ml)	2 - 112	3/15/2017	12:15 PM	AT 3/17/2017
S7	5D (DUP) - Discharge Water	FECAL COLIFORM	<4	CFU/ 100ml (25ml)	0 - 14.8	3/15/2017	12:15 PM	AT 3/17/2017
S7	5D (DUP) - Discharge Water	E. COLI	<4	CFU/ 100ml (25ml)	0 - 14.8	3/15/2017	12:15 PM	AT 3/17/2017
S7	5D (DUP) - Discharge Water	FECAL COLIFORM	2	CFU/ 100ml (50ml)	0.2 - 11.2	3/15/2017	12:15 PM	AT 3/17/2017
S7	5D (DUP) - Discharge Water	E. COLI	2	CFU/ 100ml (50ml)	0.2 - 11.2	3/15/2017	12:15 PM	AT 3/17/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170242 SEA

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom Septic Detection

Lab/Cor Sample	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S8	6D - Discharge Water	FECAL COLIFORM	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	12:26 PM	AT 3/17/2017
S8	6D - Discharge Water	E. COLI	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	12:26 PM	AT 3/17/2017
S8	6D - Discharge Water	FECAL COLIFORM	8	CFU/ 100ml (50ml)	2 - 20.4	3/15/2017	12:26 PM	AT 3/17/2017
S8	6D - Discharge Water	E. COLI	8	CFU/ 100ml (50ml)	2 - 20.4	3/15/2017	12:26 PM	AT 3/17/2017
S9	7D - Discharge Water	FECAL COLIFORM	340	CFU/ 100ml (5ml)	198 - 544	3/15/2017	12:51 PM	AT 3/17/2017
S9	7D - Discharge Water	E. COLI	320	CFU/ 100ml (5ml)	184 - 520	3/15/2017	12:51 PM	AT 3/17/2017
S9	7D - Discharge Water	FECAL COLIFORM	184	CFU/ 100ml (50ml)	164.8 - 203.2	3/15/2017	12:51 PM	AT 3/17/2017
S9	7D - Discharge Water	E. COLI	178	CFU/ 100ml (50ml)	159.1 - 196.9	3/15/2017	12:51 PM	AT 3/17/2017
S10	8D - Discharge Water	FECAL COLIFORM	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	1:03 PM	AT 3/17/2017
S10	8D - Discharge Water	E. COLI	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	1:03 PM	AT 3/17/2017
S10	8D - Discharge Water	FECAL COLIFORM	4	CFU/ 100ml (50ml)	0.4 - 14.4	3/15/2017	1:03 PM	AT 3/17/2017
S10	8D - Discharge Water	E. COLI	4	CFU/ 100ml (50ml)	0.4 - 14.4	3/15/2017	1:03 PM	AT 3/17/2017
S11	9D - Discharge Water	FECAL COLIFORM	40	CFU/ 100ml (5ml)	4 - 144	3/15/2017	1:18 PM	AT 3/17/2017
S11	9D - Discharge Water	E. COLI	40	CFU/ 100ml (5ml)	4 - 144	3/15/2017	1:18 PM	AT 3/17/2017
S11	9D - Discharge Water	FECAL COLIFORM	38	CFU/ 100ml (50ml)	23 - 59.2	3/15/2017	1:18 PM	AT 3/17/2017
S11	9D - Discharge Water	E. COLI	38	CFU/ 100ml (50ml)	23 - 59.2	3/15/2017	1:18 PM	AT 3/17/2017

Report Number: 170242R02 **Date Received:** 3/16/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170242 SEA

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom Septic Detection

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S12	10D - Discharge Water	FECAL COLIFORM	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	1:35 PM	AT 3/17/2017
S12	10D - Discharge Water	E. COLI	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	1:35 PM	AT 3/17/2017
S12	10D - Discharge Water	FECAL COLIFORM	2	CFU/ 100ml (50ml)	0.2 - 11.2	3/15/2017	1:35 PM	AT 3/17/2017
S12	10D - Discharge Water	E. COLI	2	CFU/ 100ml (50ml)	0.2 - 11.2	3/15/2017	1:35 PM	AT 3/17/2017
S13	11L - Lake Water	FECAL COLIFORM	<50	CFU/ 100ml (2ml)	0 - 185	3/15/2017	1:56 PM	AT 3/17/2017
S13	11L - Lake Water	E. COLI	<50	CFU/ 100ml (2ml)	0 - 185	3/15/2017	1:56 PM	AT 3/17/2017
S13	11L - Lake Water	FECAL COLIFORM	5	CFU/ 100ml (20ml)	0.5 - 28	3/15/2017	1:56 PM	AT 3/17/2017
S13	11L - Lake Water	E. COLI	5	CFU/ 100ml (20ml)	0.5 - 28	3/15/2017	1:56 PM	AT 3/17/2017
S14	12L - Lake Water	FECAL COLIFORM	<50	CFU/ 100ml (2ml)	0 - 185	3/15/2017	2:09 PM	AT 3/17/2017
S14	12L - Lake Water	E. COLI	<50	CFU/ 100ml (2ml)	0 - 185	3/15/2017	2:09 PM	AT 3/17/2017
S14	12L - Lake Water	FECAL COLIFORM	10	CFU/ 100ml (20ml)	1 - 36	3/15/2017	2:09 PM	AT 3/17/2017
S14	12L - Lake Water	E. COLI	10	CFU/ 100ml (20ml)	1 - 36	3/15/2017	2:09 PM	AT 3/17/2017
S15	13D - Discharge Water	FECAL COLIFORM	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	2:20 PM	AT 3/17/2017
S15	13D - Discharge Water	E. COLI	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	2:20 PM	AT 3/17/2017
S15	13D - Discharge Water	FECAL COLIFORM	10	CFU/ 100ml (50ml)	3.2 - 23.4	3/15/2017	2:20 PM	AT 3/17/2017
S15	13D - Discharge Water	E. COLI	10	CFU/ 100ml (50ml)	3.2 - 23.4	3/15/2017	2:20 PM	AT 3/17/2017

Report Number: 170242R02 **Date Received:** 3/16/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170242 SEA

Client: Herrera Environmental Consultants, Inc

Project Name: Whatcom Septic Detection

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S16	14D - Discharge Water	FECAL COLIFORM	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	2:40 PM	AT 3/17/2017
S16	14D - Discharge Water	E. COLI	<20	CFU/ 100ml (5ml)	0 - 74	3/15/2017	2:40 PM	AT 3/17/2017
S16	14D - Discharge Water	FECAL COLIFORM	8	CFU/ 100ml (50ml)	2 - 20.4	3/15/2017	2:40 PM	AT 3/17/2017
S16	14D - Discharge Water	E. COLI	8	CFU/ 100ml (50ml)	2 - 20.4	3/15/2017	2:40 PM	AT 3/17/2017
S17	OSS - Raw Sewage (High Level)	FECAL COLIFORM	1500000	CFU/ 100ml (0.01ml)	1377525.5 - 1622474.5	3/15/2017	3:50 PM	AT 3/17/2017
S17	OSS - Raw Sewage (High Level)	E. COLI	1500000	CFU/ 100ml (0.01ml)	1377525.5 - 1622474.5	3/15/2017	3:50 PM	AT 3/17/2017
S17	OSS - Raw Sewage (High Level)	FECAL COLIFORM	880000	CFU/ 100ml (0.1ml)	850335.2 - 909664.8	3/15/2017	3:50 PM	AT 3/17/2017
S17	OSS - Raw Sewage (High Level)	E. COLI	880000	CFU/ 100ml (0.1ml)	850335.2 - 909664.8	3/15/2017	3:50 PM	AT 3/17/2017
S17	OSS - Raw Sewage (High Level)	FECAL COLIFORM	TNTC	CFU/ 100ml (1.0ml)		3/15/2017	3:50 PM	AT 3/17/2017
S17	OSS - Raw Sewage (High Level)	E. COLI	TNTC	CFU/ 100ml (1.0ml		3/15/2017	3:50 PM	AT 3/17/2017
S18	18 - Method Blank 1	FECAL COLIFORM	<1	CFU/ 100ml	0 - 3.7	3/15/2017	10:00 AM	AT 3/17/2017
S18	18 - Method Blank 1	E. COLI	<1	CFU/ 100ml	0 - 3.7	3/15/2017	10:00 AM	AT 3/17/2017
S19	19 - Method Blank 2	FECAL COLIFORM	<1	CFU/ 100ml	0 - 3.7	3/15/2017	10:00 AM	AT 3/17/2017
S19	19 - Method Blank 2	E. COLI	<1	CFU/ 100ml	0 - 3.7	3/15/2017	10:00 AM	AT 3/17/2017
S20	20 - Negative Control	FECAL COLIFORM	<1	CFU/ 100ml	0 - 3.7	3/15/2017	10:00 AM	AT 3/17/2017
S20	20 - Negative Control	E. COLI	<1	CFU/ 100ml	0 - 3.7	3/15/2017	10:00 AM	AT 3/17/2017

Report Number: 170242R02 **Date Received:** 3/16/2017

Page 7 of 8



A Professional Service Corporation in the Northwest

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

Job Number: 170242 SEA

Client: Herrera Environmental Consultants, Inc

Report Number: 170242R02 **Date Received:** 3/16/2017

Project Name: Whatcom Septic Detection

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S21	21 - Positive Control	FECAL COLIFORM	27	CFU/ 100ml	21.8 - 32.2	3/15/2017	10:00 AM	AT 3/17/2017
S21	21 - Positive Control	E. COLI	27	CFU/ 100ml	21.8 - 32.2	3/15/2017	10:00 AM	AT 3/17/2017

Reviewed by:

Page 8 of 8

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100 mL)	Herrera Check	Start Date/Time:	End Date/Time:
1700/0 01	2	0	0 /	45	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
170242-01	20	0	0		1.000	
1700 110 40	2	0	0 /	125		
140292-02	20	6	0	1		
10	5	4	80	1	201	1.11
170242-03	50	57	114/	in an A		
Mondon al	5	6	120			
140242-04	50	50	100/			
-	5	D	0	157 . 1984 . A	1.	The second
170242-05	-50	22	44	North States		South and Strategy
Inter La al	2	0	0/	45		
170242-06	20	0	0	- Alla		
1200 1/2 07	5	1 Same	20 >	410 31	1.2.2.1	10 - 1 - NS - 1
170242-07	50	ØI	0			1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1
100001000	5	0	0	ITANIZI	r	
170242-08	50	4	8	100410		
ITAD 110 00	5	AND THE	340	198 00 12	17	State and the second
170292-07	50	92	184	11 0 310	12 20 31	1000
lando la	-5	0	0	15 - 113		
170242-10	50	2	4	4 8 3124		
Intra dia 11	5	2	40	185 ~	x	10 8 18
170242-11	50	19	38	0 0 3120	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	10 1 10 10 10 10 10 10 10 10 10 10 10 10
1	-5	0	0	1 m 11	Y	
70242-12	50		2 /	08320		
Lab Duplicate	10(25)	0	0	1 State of the	1- 1-6-54° S.	1.18
Negative Control	100	0	0		-	
Positive Control	100	27	27	A CONTRACTOR	1	1.

Calculation of Results

 $\frac{Colonies}{100 \, mL} = \frac{Colonies \, counted}{mL \, SampleFiltered} \times 100$

Density: use if only one count is within ideal range (20-60 colonies)

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100 \, mL} = \frac{\sum Colonies \, counted}{\sum mL \, sample \, filtered} \times 100$

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100 mL)	Herrera Check	Start Date/Time:	End Date/Time:
120242-13	2	0	0	55 8 1245	2	1
1061610	20	N 241 1973	5	71	84 D. 2010	A Carlos Andrews
170242-14	2	0	$ 0\rangle$	9J 5 5021		
	20	4	10			
170242-15	5	0	0 >	9 J 92 12/13		Contraction of
	50	5	10		Las Land	1.22
170242-16	5	0	0)	75 8	17	
	50	4	8	310	-	
170242.17	0.01	150	1500000	Jan	x	
110214	0.1	880	880000	3120		
170242-17	1.0	TNTC	TNTC		J.	V
	Constraints	1 St. 1	States Sec.	Te inte		
		A. A.				135 A.
	1955 E 1					51-
	30		1961 Ng 1798	1997 - 1997 - 1994 1997 -		10000000000000000000000000000000000000
10 - Marcine - 10 - 10				and the second		A. The Sol
Lab Duplicate	2			New cost		10-5-30
Negative Control						
Positive Control					1.12-0-11	

Calculation of Results

 $\frac{Colonies}{100 \, mL} = \frac{Colonies \, counted}{mL \, Sample Filtered} \times 100$

Density: use if only one count is within ideal range (20-60 colonies)

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100\,mL} = \frac{\sum Colonies \ counted}{\sum mL \ sample \ filtered} \times 100$

E. coli Analysis Bench Sheet

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100 mL)	Herrera Check	Start Date/Time:	End Date/Time:
170242-01	2	0	<50	1	3 14 17 11 30 AM	3/17/17 11:3014
	20	0	<5			1. 1. 1. 1. 1.
170242-02	2	0	<50			
	20	0	<5 /			
170242-03	5	4	80	1 January	1.1.1	1.11
	50	57	114	1		1.00
170242-04	5	0	<20			
	50	4	8	75 8		5.4. C
170242-05	5	0	<20	a company	1. 1. 1. 1. 1.	
	50	7	14	135 8		1.2
170242-06	2	0	<50			
	20	0	<5 /			
170242-07	5	and the second s	20	1		1 - N - A
	50	1	2	45 0		
170242-08	5	0	<20		1.1	
	50	4	8	75 8		
170242-09	5	16	320	V		1.
	50	89	178	19138		
170242-10	5	0	<20	N		
	50	2	4	458		
170242-11	5	2	40	1		
	50	19	38	3858	and the second	
170242-12	5	0	<20	1		
	50		2	258	L V	V.
Lab Duplicate	Sec. and	1. S.	Call In			S. Carling
Negative Control						
Positive Control	1		1		1	

Calculation of Results

 $\frac{Colonies}{100\,mL} = \frac{Colonies\,counted}{mL\,SampleFiltered} \times 100$

Density: use if only one count is within ideal range (20-60 colonies)

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100 \, mL} = \frac{\sum Colonies \, counted}{\sum mL \, sample \, filtered} \times 100$

E. coli Analysis Bench Sheet

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100 mL)	Herrera Check	irrera Check Start Date/Time:	
170242-13	2	0	<50		3/10/17 11-3044	3 17 17 11 30 AM
110242 15	20		5	55 8	1	1
170242-14	2	0	<50	1		
1/0292 29	20	2	10	95 4		
170242-15	5	0	<20	100		
	50	5	10	958		
170242-16	5	0	<20			
	50	4	8	73 4		
170242-17	0.01	150	1500000	T sac		
	0.1	880	880000	- G	1	1.1.1.1
170242-17	1.0	TNTC			V	V
	8					
		-				
		-				
				-	1000	
1						
Lab Duplicate-57	25	0				1
Negative Control	100	0				1
Positive Control	100	27				

Calculation of Results

 $\frac{Colonies}{100 \, mL} = \frac{Colonies \, counted}{mL \, SampleFiltered} \times 100$

Density: use if only one count is within ideal range (20-60 colonies)

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100\,mL} = \frac{\sum Colonies\,counted}{\sum mL\,sample\,filtered} \times 100$

Lab/Co 7619 6 th Seattle, W Office (206) Fax (206) mail@la www.lab	<i>or, Inc</i> Ave NW VA 98117 781-0155 789-8424 bcor.net <i>bcor.net</i>	^h AVE le, WA 98121 iseHe 62 Fax: ettecherreratric.com							Analytical Protocol: E. coli P/A E. coli / Coliform MPN E. coli / Fecal Coliform Heterotrophic Bacteria Bacterial ID MPA Analysis Cryptosporidium Giardia Turbidity Microbial Limit Test Other					Turnaround Time: 7 days 5 days 3 days 48 hours 224 hours* (Not all TATs are available for all analysis types)		
roject Nan Sample	ne: <u>What</u>	ample Description	ction	Projec	t Nun	iber:	16-	06	326-	000	P.0	O. Num	ber:	16-06	326 RZ	-
Number		Las woor thorner .	Water	Swab	Air	Other	Dat	e e	On Sa	mple Ti Off	Total	Flov	W Rate (lpm)	Volume	* * · · · · · · · · · · · · · · · · · ·
CI	Cont	rol - lake	X			-	3/15/	57	0941			Juli		nvg	3,20m	
22	Cont	vol -lake	1	·		1	1		0950						2,20mL	2
ID.	Disc	charge water							1050						5 canil	3
2D	- 19 - 1944								1105							4
D	1 2 3	¥							1120							5
+L	Lake	water							N 35			2			2,20 mL	
5D	Disch	large Water							1215						5 50 ml	77
60		1		-					1226						1	8
7D				· ·	t.				1251					· · · · ·		9
80		✓	Y				V.		1303							- 1
be com	pleted by Jub Use Only: d Phone: I F w you are agreeing y: MAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	$\frac{1}{2} \frac{1}{2} \frac{1}$	Its Release Its Release Its Release Tenders and Time:	re <u>2</u> . dr dr d Contract <u>0825</u> 330	Lo E-mail Is.	Relinqu	Re I	ceip lardo	t Com 3py / Inv R	lition oice Ma eviewed	CIDO. iled: By: D	* Call a Date:	head for	TATs of Time:	24hrs or less	

	Bacterial Chain of Custody Record	170242	Page Zof 2
Lab/Cor, Inc 7619 6 th Ave NW Seattle, WA 98117 Office (206) 781-0155 Fax (206) 789-8424 mail@labcor.net www.labcor.net	Client: Herrera Address:	Analytical Protocol: E. coli P/A E. coli / Coliform MPN E. coli / Fecal Coliform Heterotrophic Bacteria Bacterial ID MPA Analysis Cryptosporidium Giardia Turbidity Microbial Limit Test Other	Turnaround Time: 7 days 5 days 3 days 48 hours 24 hours* (Not all TATs are available for all analysis types)

Project Na	me:		Project	t Num	ber:					P.0	O. Num	ber:		
Sample	Sample Description		Sample	Туре		Sam	ple	Sa	mple Ti	me	Flov	w Rate (l	pm)	Delution
Number		Water	Swab	Air	Other	Da	te	On	Off	Total	Start	End	Avg	Volume S
90	Discharge Water	X				3/15	ー	1318						5,50 ml
100	L .	1				Ì		1335	•					550 ml
IIL	Lake Water							1409	1356					3,30m
12L	L							1420	1409					2,20ml
130	Discharge Water							1420	*					5,50 mL
14D	k						• •	1440)					5,50 ml
oss	Row Sewage (high level)	1				¥	• 	1550						Ool J m
														· · · · · · · · · · · · · · · · · · ·
(To be co	mpleted by lab). Receipt Ter	uperati	ure <u>2</u> .	6	_°C	R	ecei	ot Con	dition	GIOL	bd			
Internal La	b Use Only:													
Prelim Relea	Ised: Final Rest	uts Relea	sed: hone \square	P-mail			Hard	copy / In	voice M. Reviewe	nled: { By:				
By signing he	low you are agreeing to comply with Lab/Cor's Requests	, Tenders a	and Contra	cts.							* Call	ahead fo	r TATs of	f 24hrs or less
Relinquished	1 by: 117216 Date: 3/16/17	Time:	0825	-	Relinq	uished b	y:				Date:		Time:	
Received by:	Cetonge Date: 3/16/13	Time: (0830)	Receiv	ed by: _					Date:		Tip	
/ / /. *								<u> </u>				· · ·	Pag	je 101 of 3



01 April 2017

Rob Zisette Herrera Environmental Consultants 2200 6th Avenue, Suite 1100 Seattle, WA 98121

RE: Lake Whatcom North Shore Testing

Please find enclosed sample receipt documentation and analytical results for samples from the project referenced above.

Sample analyses were performed according to ARI's Quality Assurance Plan and any provided project specific Quality Assurance Plan. Each analytical section of this report has been approved and reviewed by an analytical peer, the appropriate Laboratory Supervisor or qualified substitute, and a technical reviewer.

Should you have any questions or problems, please feel free to contact us at your convenience.

Associated Work Order(s) 17C0308

Associated SDG ID(s) N/A



I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed in the enclose Narrative. ARI, an accredited laboratory, certifies that the report results for which ARI is accredited meets all the reqirements of the accrediting body. A list of certified analyses, accreditations, and expiration dates is included in this report.

Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his/her designee, as verified by the following signature.

Analytical Resources, Inc.

Mark Harris, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.



4611 S. 134th Place, Suite 100 • Tukwila, WA 98168 • Ph: (206) 695-6200 • Fax: (206) 695-6202

Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number:	Turn-around	Requested:	Page:	1	of	2			Analytical Resources, Incorporated Analytical Chemists and Consultan 4611 South 134th Place, Suite 100					
Herreva		Phone:	441 9	080	Date:	16/17	Prese	nt?			Tukwila 206-69	i, WA 98168 5-6200_206-695-6201 (fax)		
Client Contact: Rob Zisc	ette				No. of Coolers:	1	Coole Temp	r s:			www.a	rilabs.com		
Client Project Name:	tcow	\						Analysis Requested			Notes/Comments			
Client Project #: 16-0326326-000	Samplers: (3C/RT	2		de/ licp	TL-J	Total	mus				until we receive		
Sample ID	Date	Time	Matrix	No. Containers	EVIUNI Brov	total Arissol	phor					bacteria resulti 02 of the 17 samples will not		
CI	3/15/17	13180	941 W	1	X	X						be analyzed,		
CA		1335	0950		X	X								
ID		1356	1050		×	X								
20		1409	1105		X	X								
30		1420	1120		X	X								
4L		1440	1135		X	X								
5D		1550	1215		X	X								
60		1226			X	X								
70		1251			X	X								
80	Y	1303	\checkmark	V	X	X								
Comments/Special Instructions	Relinquished by: (Signature)	ANC	at	Received by: (Signature)	Dave	Mak		Relinquished (Signature)	by:		Received by (Signature)			
Phosphones pol	Printed Name:	a Cata	arra	Printed Name:	Daul	Mark	4	Printed Name	91		Printed Nam	e:		
Cittereprise to	Company:	ivera		Company:	ARI	-		Company:			Company:			
digestion	Date & Time: 31161	17	1505	Date & Time:	116/20	017 15	05	Date & Time:	8		Date & Time			

Limits of Liability: ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for sald services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.

Sample Retention Policy: All samples submitted to ARI will be appropriately discarded no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer, unless alternate retention schedules have been established by work-order or contract.

Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number:	Turn-around	Requested:	Std		Page:	Page: 2 of 2					Analytical Resources, Incorporated Analytical Chemists and Consultan 4611 South 134th Place, Suite 100				
ARI Client Company: Herven	va	Phone:			Date:		Ice Prese	ent?		7	Tukwila 206-69	a, WA 98168 5-6200_206-695-6201 (fax)			
Client Contact: Rob Z	isett	e			No. of Cooler Coolers: Temps:						www.a	rilabs.com			
Client Project Name:	uma	toon)			1 p	Br	Analysis	Requested		1	Notes/Comments			
Client Project #: 116-0163210-000	Samplers: (GCIR	2_		ice	ditte	Foral)	form				Hold analysis until bacteria			
Sample ID	Date	Time	Matrix	No. Containers	Chilevic brown	tetat Diso	broza					vesults vectived 3 15 of the 17 samples will			
90	3115/17	1318	W	1	X	×						be analyzed.			
IOD	1	1335	1	1	×	X									
11 L		1356			X	X									
122		1409			X	×									
13D		1420			X	×		1			1				
14D		1440	V		X	X									
OSS	\checkmark	1550	*		X	×									
						0	0		17						
					D	Ca	~	3/161							
Comments/Special Instructions	Relinquished by: (Signature)	NC	t	Received by: (Signature)	Dark	Ma	k	Relinquished (Signature)	l by:		Received by (Signature)	d.			
* Sample	Printed Name:	Cata	Ma	Printed Name:	Daul	Mar	k	Printed Nam	e:		Printed Nan	ie:			
Total dissolved &	Stat dissolved & Company:		Company:	AD	T	~	Company:			Company:					
Filtered prior to:	Date & Time: 31611	7 15	505	Date & Time:	116/20	17 (5	05	Date & Time	1		Date & Time	И			

Ligits of Liability: ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for sald services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.

Sample Retention Policy: All samples submitted to ARI will be appropriately discarded no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer, unless alternate retention schedules have been established by work-order or contract.



Analytical Resources, Incorporated Analytical Chemists and Consultants

Cooler Receipt Form

ARI Client: Harrara		Project Name	Lake	Matco	0	
COC No(s):	NA	Delivered by I		· The con		
Assigned ARI Job No: 1700308			-eu-ex UPS Co	urier Hand Deliv	vered Other	
Preliminary Examination Phase:		I racking No: _				(NA)
Were intact, properly signed and dated custody seals	attached to th	a outsido of to poo	le-O		and the second se	\sim
Were custody papers included with the cooler?			ner?		YES	(NO)
Were custody papers properly filled out (ink sizes of a	······			9	(YES)	NO
Temperature of Cooler(s) (°C) (recommended 2.0-6.0 ° Time:	°C for chemis	stry) 4	 7		YES	NO
If cooler temperature is out of compliance fill out form (00070F		=	Temp Gup ID	- h005	71
Cooler Accepted by: PM		Data: 3/16	12017 -			-16
Complete custo	dv forms an	d attach all shipp		le: 151	13	S
Log-In Phase:	-y renne un	d ditaon an shippi	ng uocuments			
Was a temperature black included in the easter?						
What kind of packing material uses use 10	·····				YES	NO
Was sufficient issued (for several is as	ibble Wrap	Vet Ice) Gel Packs	Baggies Foan	n Block Paper (Other:	
Was sufficient ice used (if appropriate)?				NA	YES	NO
Did all bottles sealed in individual plastic bags?			•••••		YES	NO
Did all bottles arrive in good condition (unbroken)?					(YES)	NO
Were all bottle labels complete and legible?					(YES)	NO
Did the number of containers listed on COC match with	the number	of containers recei	ived?		YES	NO
Did all bottle labels and tags agree with custody papers	\$?				YES	(NO
Were all bottles used correct for the requested analyses	s?				VEC	NO
Do any of the analyses (bottles) require preservation? (attach prese	rvation sheet exclu	uding VOCe)	(NIA)	VEO	NO
Were all VOC vials free of air bubbles?			uung voos)	ANA A	YES	NO
Was sufficient amount of sample sent in each bottle?			••	NA	YES	NO
Date VOC Trip Blank was made at ARI	•••••••	•••••••••••••••••••••••••••••••••••••••		-	YES	NO
Was Sample Solit by ARI : (NA) YES DetaT	 Imai		·····	NA	-	
TEO Date/1	inte	Equi	oment:		Split by:	
Samples Logged by: MR.H.	Date:	3/21/1-	7	9.20	1	
B-H- ** Notify Project	t Manager o	fdicoronanalas	Time: _	1.01	2	
3/21/17	cinanager o	r discrepancies o	r concerns **			
Sample ID on Bottle Sample ID on	000	Semple ID	D.UI			
IID II/		Gample ID (οη βοπιέ	Samp	ole ID on C	00
Additional Notes Discremencies & Decelution						
For sample leD the samp	ling d	late on h	attle wa	15 3/15	114 0	or
date was 3/15/17	0		onde to.	-11-	, C	50
BURH DU ZIOIL						
Small Air Pubbles		nell A time to a				
=2mm 2-4 mm	bbies Br	man ~ "sm" (<2	mm)			
· · · · · · · · · · · · · · · · · · ·		abubbles → "pb"	(2 to < 4 mm)			
0 0 0 0 0		$arge \rightarrow "lg" (4 to <$	6 mm)			
······································	H	eadspace \rightarrow "hs" (>6 mm)			

Revision 014 Page⁴P67 of 393 Herrera Environmental Consultants 2200 6th Avenue, Suite 1100 Seattle, WA 98121 Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000

Reported: 01-Apr-2017 09:12

ANALYTICAL REPORT FOR SAMPLES

Project Manager: Rob Zisette

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
C1	17C0308-01	Water	15-Mar-2017 09:41	16-Mar-2017 15:05
C2	17C0308-02	Water	15-Mar-2017 09:50	16-Mar-2017 15:05
1D	17C0308-03	Water	15-Mar-2017 10:50	16-Mar-2017 15:05
2D	17C0308-04	Water	15-Mar-2017 11:05	16-Mar-2017 15:05
3D	17C0308-05	Water	15-Mar-2017 11:20	16-Mar-2017 15:05
4L	17C0308-06	Water	15-Mar-2017 11:35	16-Mar-2017 15:05
6D	17C0308-07	Water	15-Mar-2017 12:26	16-Mar-2017 15:05
7D	17C0308-08	Water	15-Mar-2017 12:51	16-Mar-2017 15:05
8D	17C0308-09	Water	15-Mar-2017 13:03	16-Mar-2017 15:05
9D	17C0308-10	Water	15-Mar-2017 13:18	16-Mar-2017 15:05
11L	17C0308-11	Water	15-Mar-2017 13:56	16-Mar-2017 15:05
12L	17C0308-12	Water	15-Mar-2017 14:09	16-Mar-2017 15:05
13D	17C0308-13	Water	15-Mar-2017 14:20	16-Mar-2017 15:05
14D	17C0308-14	Water	15-Mar-2017 14:40	16-Mar-2017 15:05
OSS	17C0308-15	Water	15-Mar-2017 15:50	16-Mar-2017 15:05
5D	17C0308-16	Water	15-Mar-2017 12:15	16-Mar-2017 15:05
10D	17C0308-17	Water	15-Mar-2017 13:35	16-Mar-2017 15:05

Analytical Resources, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

4611 S. 134th Place, Suite 100 • Tukwila, WA 98168 • Ph: (206) 695-6200 • Fax: (206) 695-6202



Herrera Environmental Consultants 2200 6th Avenue, Suite 1100 Seattle, WA 98121 Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported:

Analytical Report

01-Apr-2017 09:12

Case Narrative

Client: Herrera Environmental Consultants **Project:** Lake Whatcom North Shore Testing **Workorder:** 17C0308

Sample receipt

17 samples were received 16-Mar-2017 15:05 under ARI work order 17C0308. For details regarding sample receipt, please refer to the Cooler Receipt Form. 15 samples were analyzed for anions and total phosphorous as requested.

Wet Chemistry

These samples were prepared and analyzed within the recommended holding times.

All initial and continuing calibrations were within method requirements.

A small amount of phosphorous was detected in the method blank (MB) associated with the 3/30/17 analyses of samples '11L' and 'OSS'. Since the concentration of total phosphorous measured in sample 'OSS' was substantially greater than the amount found in the MB, the contribution to the result from laboratory contamination should be considered negligible. The concentration of total phosphorous measured in sample '11L' was comparable to that found in the MB. Since the source of the contamination is uncertain, and repeated analyses have yielded similar results, no corrective actions were taken. This sample can be re-prepared and re-analyzed upon request. No other target compounds were detected in the MBs.

The percent recoveries for all compounds were within acceptable QC limits for the LCSs.

Matrix spikes (MSs) were prepared and analyzed in conjunction with sample 'C1'. The percent recoveries were within acceptable QC limits for the MSs.

Matrix duplicates (MDs) were prepared and analyzed in conjunction with sample 'C1'. The RPD for total phosphorous was high following the analysis of the MD. Since the percent recovery for total phosphorous was within acceptable QC limits for the the corresponding LCS, it was concluded that a lack of sample homogeneity was the cause of the high RPD. No corrective actions were taken. The RPDs for both anions were within acceptable QC limits for the MD.

Analytical Resources, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.



Herrera Environmental Consultants 2200 6th Avenue, Suite 1100 Seattle, WA 98121 Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

C1 17C0308-01 (Water)

Sampled: 03/15/2017 09:41

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume: 5	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	21/2017 20:10
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte Chloride		CAS Number 16887-00-6	Dilution 1	Reporting Limit 0.100	Result 2.68	Units mg/L	Notes
Sample Preparation:	Preparation Method: SM 4500-P B-5 Per Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	sulfate Sample Size: 2. Final Volume: 3	5 mL 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV1	800-2		А	nalyzed: 03/	27/2017 13:31
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	ND	mg-P/L	U


Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

C2

17C0308-02 (Water)

Sampled: 03/15/2017 09:50

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Cherr Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	n Sample Size: 5 Final Volume: :	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	21/2017 21:53
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte Chloride		CAS Number 16887-00-6	Dilution 1	Reporting Limit 0.100	Result 2.68	Units mg/L	Notes
Sample Preparation:	Preparation Method: SM 4500-P B-5 Pe Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	rsulfate Sample Size: 2 Final Volume: :	5 mL 50 mL			-	
Analytical Method: SM	4500-P E-99	Instrument: UV	800-2		А	nalyzed: 03/	27/2017 13:33
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	ND	mg-P/L	U



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

1D

17C0308-03 (Water) Sampled: 03/15/2017 10:50

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume: 5	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	21/2017 22:13
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	2.63	mg/L	
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persul	lfate					
	Preparation Batch: BFC0652	Sample Size: 2:	5 mL				
	Prepared: 03/25/2017 10:38	Final Volume: 5	50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV1	800-2		A	nalyzed: 03/	27/2017 13:33
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0360	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

2D

17C0308-04 (Water) Sampled: 03/15/2017 11:05

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	21/2017 22:34
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	3.47	mg/L	
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persulf Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	ate Sample Size: 2 Final Volume: 1	5 mL 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV	1800-2		A	nalyzed: 03/	27/2017 13:33
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7/23-14-0	I	0.00800	0.0520	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

3D

17C0308-05 (Water) Sampled: 03/15/2017 11:20

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume: :	mL 5 mL				
Analytical Method: EPA 300.0		Instrument: DX	2100		A	nalyzed: 03/	21/2017 22:55
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	2.16	mg/L	
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persulf Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	ate Sample Size: 2 Final Volume: :	5 mL 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV	800-2		A	nalyzed: 03/	27/2017 13:34
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0480	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

4L 17C0308-06 (Water)

Sampled: 03/15/2017 11:35

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume: 5	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		А	nalyzed: 03/	21/2017 23:14
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	2.59	mg/L	
Sample Preparation:	Preparation Method: SM 4500-P B-5 Per Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	sulfate Sample Size: 2. Final Volume: 5	5 mL 50 mL				
Analytical Method: SM	4500-Р Е-99	Instrument: UV1	800-2		A	nalyzed: 03/	27/2017 13:34
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0180	mg-P/L	



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

6D

17C0308-07 (Water) Sampled: 03/15/2017 12:26

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume: 5	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	21/2017 23:34
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	1.15	mg/L	
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persulfa Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	ate Sample Size: 2 Final Volume: 5	5 mL 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV1	800-2		A	nalyzed: 03/	27/2017 13:34
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0240	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

7D 17C0308-08 (Water) Sampled: 03/15/2017 12:51

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	21/2017 23:53
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	2.41	mg/L	
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persulf Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	ate Sample Size: 2 Final Volume: 3	5 mL 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV	800-2		A	nalyzed: 03/	/27/2017 13:35
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0500	mg-P/L	



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

8D

17C0308-09 (Water) Sampled: 03/15/2017 13:03

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	22/2017 00:13
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte		CAS Number 16887-00-6	Dilution	Reporting Limit	Result	Units	Notes
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persulf Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	ate Sample Size: 2 Final Volume:	5 mL 50 mL	0.100	2.00	ing/L	
Analytical Method: SM	4500-P E-99	Instrument: UV	1800-2		A	nalyzed: 03/	27/2017 13:36
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		//23-14-0	1	0.00800	0.0560	mg-P/L	



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

9D

17C0308-10 (Water) Sampled: 03/15/2017 13:18

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume: :	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	22/2017 01:14
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	2.82	mg/L	
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persult Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	ate Sample Size: 2 Final Volume: :	5 mL 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV	800-2		A	nalyzed: 03/	27/2017 13:37
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0140	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

11L 17C0308-11 (Water) Sampled: 03/15/2017 13:56

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume: :	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	22/2017 01:34
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte Chloride		CAS Number 16887-00-6	Dilution 1	Reporting Limit 0.100	Result	Units mg/L	Notes
Sample Preparation:	Preparation Method: SM 4500-P B-4 Strong Preparation Batch: BFC0762 Prepared: 03/29/2017 18:21	Acid Sample Size: 2 Final Volume: :	5 mL 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV	800-2		A	nalyzed: 03/	30/2017 15:57
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0240	mg-P/L	В



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

12L 17C0308-12 (Water) Sampled: 03/15/2017 14:09

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	22/2017 01:54
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte		CAS Number 16887-00-6	Dilution	Reporting Limit	Result	Units	Notes
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persulf Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	ate Sample Size: 2 Final Volume:	5 mL 50 mL	0.100	0.00	ing D	
Analytical Method: SM	4500-P E-99	Instrument: UV	800-2		A	nalyzed: 03/	27/2017 13:37
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0300	mg-P/L	



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

13D

17C0308-13 (Water) Sampled: 03/15/2017 14:20

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	22/2017 02:14
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	1.96	mg/L	
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persulf	ate					
* *	Preparation Batch: BFC0652	Sample Size: 2	5 mL				
	Prepared: 03/25/2017 10:38	Final Volume:	50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV	800-2		A	nalyzed: 03/	27/2017 13:38
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0320	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

14D

17C0308-14 (Water) Sampled: 03/15/2017 14:40

Wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume: :	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		A	nalyzed: 03/	/22/2017 02:34
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	2.70	mg/L	
Sample Preparation:	Preparation Method: SM 4500-P B-5 Persulf Preparation Batch: BFC0652 Prepared: 03/25/2017 10:38	ate Sample Size: 2 Final Volume: :	5 mL 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV	800-2		A	nalyzed: 03/	27/2017 13:38
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0160	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

OSS

17C0308-15 (Water)

Sampled: 03/15/2017 15:50

Wet Chemistry						
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 mL Final Volume: 5 mL				
Analytical Method: EPA	. 300.0	Instrument: DX2100		А	nalyzed: 03/	22/2017 02:55
Analyte		CAS Number Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9 1	0.100	ND	mg/L	U
Sample Preparation:	Preparation Method: SM 4500-P B-4 Stron	ng Acid				
1 1	Preparation Batch: BFC0762	Sample Size: 25 mL				
	Prepared: 03/29/2017 18:21	Final Volume: 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV1800-2		А	nalyzed: 03/	30/2017 16:00
			Reporting			
Analyte		CAS Number Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0 50	0.400	10.3	mg-P/L	D, B



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

OSS

17C0308-15RE1 (Water) Sampled: 03/15/2017 15:50

Wet	Chemist	ry
		-

wet Chemistry							
Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFC0546 Prepared: 03/21/2017 13:21	Sample Size: 5 Final Volume: :	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	2100		Aı	nalyzed: 03/	22/2017 12:17
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	10	1.00	46.8	mg/L	D



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

Wet Chemistry - Quality Control

Batch BFC0546 - No Prep Wet Chem

Instrument: DX2100

QC Sample/Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Blank (BFC0546-BLK1)			Prep	ared: 21-Ma	r-2017 An	alyzed: 21-	Mar-2017 1	9:30		
Bromide	ND	0.100	mg/L							U
Chloride	ND	0.100	mg/L							U
LCS (BFC0546-BS1)			Prep	ared: 21-Ma	r-2017 An	alyzed: 21-	Mar-2017 1	9:50		
Bromide	2.97	0.100	mg/L	3.00		98.8 %	75-125			
Chloride	3.02	0.100	mg/L	3.00		101 %	75-125			
Duplicate (BFC0546-DUP1)	Source:	17C0308-01	Prep	ared: 21-Ma	r-2017 An	alyzed: 21-	Mar-2017 2	1:12		
Bromide	ND	0.100	mg/L		ND					U
Chloride	2.67	0.100	mg/L		2.68			0.23	20	
Matrix Spike (BFC0546-MS1)	Source: 1	17C0308-01	Prep	ared: 21-Ma	r-2017 An	alyzed: 21-	Mar-2017 2	1:32		
Bromide	1.89	0.100	mg/L	2.00	ND	94.4 %	75-125			
Chloride	4.70	0.100	mg/L	2.00	2.68	101 %	75-125			

Recovery limits for target analytes in MS/MSD QC samples are advisory only.

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

Wet Chemistry - Quality Control

Batch BFC0652 - SM 4500-P B-5 Persulfate

Instrument: UV1800-2

QC Sample/Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Blank (BFC0652-BLK1)			Prepa	ared: 25-Ma	ur-2017 An	alvzed: 27-	Mar-2017 1	3:30		
Total Phosphorus	ND	0.00800	mg-P/L	-		<u> </u>				U
DL (BFC0652-BLK2)			Prepa	ared: 25-Ma	ur-2017 An	alyzed: 27-	Mar-2017 1	3:35		
Total Phosphorus	ND	0.00800	mg-P/L							U
DL (BFC0652-BLK3)			Prepa	ared: 25-Ma	ur-2017 An	alyzed: 27-	Mar-2017 1	3:39		
Total Phosphorus	ND	0.00800	mg-P/L							U
LCS (BFC0652-BS1)			Prepa	ared: 25-Ma	ur-2017 An	alyzed: 27-	Mar-2017 1	3:30		
Total Phosphorus	0.298	0.00800	mg-P/L	0.300		99.3 %	90-110			
DL (BFC0652-BS2)			Prepa	ared: 25-Ma	ur-2017 An	alyzed: 27-	Mar-2017 1	3:35		
Total Phosphorus	0.298	0.00800	mg-P/L	0.300		99.3 %	90-110			
DL (BFC0652-BS3)			Prepa	ared: 25-Ma	ur-2017 An	alyzed: 27-	Mar-2017 1	3:39		
Total Phosphorus	0.298	0.00800	mg-P/L	0.300		99.3 %	90-110			
Duplicate (BFC0652-DUP1)	Source:	17C0308-01	Prepa	ared: 25-Ma	ur-2017 An	alyzed: 27-	Mar-2017 1	3:32		
Total Phosphorus	ND	0.00800	mg-P/L		ND					U
Matrix Spike (BFC0652-MS1)	Source:	17C0308-01	Prepa	ared: 25-Ma	ur-2017 An	alyzed: 27-	Mar-2017 1	3:32		
Total Phosphorus	0.198	0.00800	mg-P/L	0.200	ND	96.1 %	75-125			

Recovery limits for target analytes in MS/MSD QC samples are advisory only.

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

Wet Chemistry - Quality Control

Batch BFC0762 - SM 4500-P B-4 Strong Acid

Instrument: UV1800-2

QC Sample/Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Blank (BFC0762-BLK1)			Prepa	ared: 29-Ma	r-2017 An	alyzed: 30-	Mar-2017 1	5:52		
Total Phosphorus	ND	0.00800	mg-P/L							U
DL (BFC0762-BLK2)			Prepa	ared: 29-Ma	r-2017 An	alyzed: 30-	Mar-2017 1	6:02		
Total Phosphorus	0.0100	0.00800	mg-P/L							*
LCS (BFC0762-BS1)			Prepa	ared: 29-Ma	r-2017 An	alyzed: 30-	Mar-2017 1	5:53		
Total Phosphorus	0.320	0.00800	mg-P/L	0.300		107 %	90-110			В
DL (BFC0762-BS2)			Prepa	ared: 29-Ma	r-2017 An	alyzed: 30-	Mar-2017 1	6:02		
Total Phosphorus	0.328	0.00800	mg-P/L	0.300		109 %	90-110			В
Duplicate (BFC0762-DUP1)	Source:	17C0308-11	Prepa	ared: 29-Ma	r-2017 An	alyzed: 30-	Mar-2017 1	5:59		
Total Phosphorus	0.0300	0.00800	mg-P/L		0.0240			22.20	20	L, B
Matrix Spike (BFC0762-MS1)	Source:	17C0308-11	Prepa	ared: 29-Ma	r-2017 An	alyzed: 30-	Mar-2017 1	5:59		
Total Phosphorus	1.93	0.0400	mg-P/L	2.00	0.0240	95.4 %	75-125			D, B

Recovery limits for target analytes in MS/MSD QC samples are advisory only.

Analytical Resources, Inc.



WA-DW

Herrera Environmental Consultants	Project: Lake Whatcom North Shore Testing	
2200 6th Avenue, Suite 1100	Project Number: 16-06326-000	Reported:
Seattle, WA 98121	Project Manager: Rob Zisette	01-Apr-2017 09:12

Certified Analyses included in this Report

Ecology - Drinking Water

Analyte	Certifications						
EPA 300.0 in V	Vater						
Bromide	DoD-ELAP,WADOE,NELAP	•					
Chloride	DoD-ELAP,WADOE,WA-DV	V,NELAP					
SM 4500-P E-9	9 in Water						
Total Phosph	orus WADOE,NELAP	WADOE,NELAP					
·							
Code	Description	Number	Expires				
ADEC	Alaska Dept of Environmental Conservation	UST-033	05/06/2017				
CALAP	California Department of Public Health CAELAP	2748	02/28/2018				
DoD-ELAP	DoD-Environmental Laboratory Accreditation Program	66169	03/30/2017				
NELAP	ORELAP - Oregon Laboratory Accreditation Program	WA100006	05/11/2017				
WADOE	WA Dept of Ecology	C558	06/30/2017				

Analytical Resources, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

C558

06/30/2017



Analytical Report

Herrera Environmental Consultants 2200 6th Avenue, Suite 1100 Seattle, WA 98121 Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 01-Apr-2017 09:12

Notes and Definitions

B This analyte was detected in the method blank.

- D The reported value is from a dilution
- L Analyte concentration is <=5 times the reporting limit and the replicate control limit defaults to +/- RL instead of 20% RPD
- U This analyte is not detected above the applicable reporting or detection limit.
- DET Analyte DETECTED
- ND Analyte NOT DETECTED at or above the reporting limit
- NR Not Reported
- dry Sample results reported on a dry weight basis
- RPD Relative Percent Difference
- [2C] Indicates this result was quantified on the second column on a dual column analysis.



4985 SW 74th Court, Miami, FL 33155 USA Tel: (1) 786-220-0379, Fax: (1) 786-513-2733, Email: info@sourcemolecular.com

Preliminary Interpretation of Human Fecal Pollution ID™ Results

Detection and quantification of the fecal Human gene biomarker for Human fecal contamination by Droplet Digital Polymerase Chain Reaction (ddPCR) DNA analytical technology

> Submitter: Herrera Environmental Consultants Date Received: March 17, 2017 Report Generated: March 22, 2017

SM #	Client #	Approximate Contribution of Human Fecal Pollution in Water Sample	Comment
SM-7C17001	C1	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C17002	C2	Not Detected	2 Human fecal biomarkers not detected
SM-7C17003	1D	Not Detected	2 Human fecal biomarkers not detected
SM-7C17004	2D	Moderate Concentration	Moderate levels of human fecal biomarker(s)
SM-7C17005	3D	Not Detected	2 Human fecal biomarkers not detected
SM-7C17006	4L	Not Detected	2 Human fecal biomarkers not detected
SM-7C17008	6D	Not Detected	2 Human fecal biomarkers not detected
SM-7C17009	7D	Not Detected	2 Human fecal biomarkers not detected
SM-7C17010	8D	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C17011	9D	Low Concentration	Low levels of 2 Human fecal biomarkers
SM-7C17013	11L	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C17014	12L	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C17015	13D	Not Detected	2 Human fecal biomarkers not detected
SM-7C17016	14D	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C17017	OSS	Moderate Concentration	Moderate levels of human fecal biomarker(s)

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The client must contact Source Molecular in writing within 10 days from the date of this report if he/she does not wish for their submitted sample(s) to be used for any type of future research.



4985 SW 74th Court, Miami, FL 33155 USA Tel: (1) 786-220-0379, Fax: (1) 786-513-2733, Email: info@sourcemolecular.com

Human Fecal Pollution ID[™] Quantification

Detection and quantification of the fecal Human gene biomarker for Human fecal contamination by Droplet Digital Polymerase Chain Reaction (ddPCR) DNA analytical technology

Submitter: Herrera Environmental Consultants Date Received: March 17, 2017 Report Generated: March 22, 2017

SM #	Client #	Analysis Requested	Target	Marker Quantified (copies/100 ml)	DNA Analytical Results
SM-7C17001	C1	Human Bacteroidetes ID 1	Dorei	<loq< td=""><td>Present</td></loq<>	Present
SM-7C17002	C2	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C17003	1D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C17004	2D	Human Bacteroidetes ID 1	Dorei	1.74E+04	Present
SM-7C17005	3D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C17006	4L	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C17008	6D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C17009	7D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C17010	8D	Human Bacteroidetes ID 1	Dorei	<loq< td=""><td>Present</td></loq<>	Present
SM-7C17011	9D	Human Bacteroidetes ID 1	Dorei	<loq< td=""><td>Present</td></loq<>	Present
SM-7C17013	11L	Human Bacteroidetes ID 1	Dorei	<loq< td=""><td>Present</td></loq<>	Present
SM-7C17014	12L	Human Bacteroidetes ID 1	Dorei	6.00E+01	Present
SM-7C17015	13D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C17016	14D	Human Bacteroidetes ID 1	Dorei	<loq< td=""><td>Present</td></loq<>	Present
SM-7C17017	OSS	Human Bacteroidetes ID 1	Dorei	1.03E+03	Present
SM-7C17018	C1	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17019	C2	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17020	1D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17021	2D	Human Bacteroidetes ID 2	EPA	1.45E+03	Present
SM-7C17022	3D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17023	4L	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17025	6D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17026	7D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17027	8D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17028	9D	Human Bacteroidetes ID 2	EPA	4.05E+03	Present
SM-7C17030	11L	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17031	12L	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17032	13D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17033	14D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C17034	OSS	Human Bacteroidetes ID 2	EPA	5.50E+04	Present

ND: Not Detected

<LOQ: Detected below level of quantification

Laboratory Comments Submitter: Herrera Environmental Consultants Report Generated: March 22, 2017

Negative Results

In sample(s) classified as negative, the human-associated Bacteroidetes gene biomarker(s) was either not detected in test replicates, one replicate was detected at a concentration below 3 copies/copies/20µL and the other was not, or one replicate was detected at a concentration above 3 copies/copies/20µL and the other was not after repeated analysis. It is important to note that a negative result does not mean that the sample does not definitely have human fecal contamination. Only repeated sampling (both during wet and dry sampling events) will enable you to draw more definitive conclusions as to the contributor(s) of fecal pollution.

In order to strengthen the result, a negative sample should be analyzed further for human fecal contamination with other DNA analytical tests. A list of human fecal ID tests can be found at **www.sourcemolecular.com/human**.

Positive Results

In sample(s) classified as positive, the human-associated Bacteroidetes gene biomarker(s) was detected in both test replicates suggesting that human fecal contamination is present in the water sample(s). The biomarker(s) serve as an indicator of the targeted fecal pollution, but the presence of the biomarker does not signify conclusively the presence of that form of fecal pollution. Only repeated sampling (both during wet and dry sampling events) will enable you to draw more definitive conclusions as to the contributor(s) of fecal pollution.

Detected Not Quantified (DNQ) Results

In sample(s) classified as detected not quantified (DNQ), the human-associated Bacteroidetes biomarker was detected in both test replicates but in low, non-quantifiable quantities. This result indicates that fecal indicators associated with human were present in the sample(s) but in low concentrations.

Human Fecal Reference Samples

The client is encouraged to submit samples from the surrounding wastewater facilities and/or septic systems in order to gain a better understanding of the concentration of the human-associated fecal Bacteroidetes genetic marker as well as the concentration of the general fecal Bacteroidetes genetic marker in the geographic region of interest. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

Quantitative results are reported along with interpretations. Interpretations are given as "negative", "trace", "low concentration", "moderate concentration", or "high concentration" based on the concentration of the genetic markers found in the water samples.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination. A list of available tests can be found at www.sourcemolecular.com/tests

DNA Analytical Method Explanation

All reagents, chemicals, and apparatuses were verified and inspected beforehand to ensure that no false negatives or positives could be generated. In that regard, positive and negative controls were run to attest the integrity of the analysis. All inspections and controls tested negative for possible extraneous contaminants.

Each submitted water sample was filtered through 0.45-micron membrane filters. Each filter was placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample was homogenized and the DNA extracted and purified.

Sample DNA was amplified and analyzed with a Bio-Rad QX200 Droplet Digital PCR System (Bio-Rad Laboratories, Inc.). Samples were processed in duplicate in a 20µL reaction containing DNA extract, forward primer, reverse primer, probe (as appropriate) and an optimized buffer solution. Absolute quantification was achieved by software Poisson Distribution Analysis.

For quality control purposes, a positive control consisting of genomic or synthetic DNA, and three negative controls consisting of PCR-grade water were run alongside the sample(s) to monitor for any false negatives or false positives.

Human Bacteroidetes ID[™] Species: B. dorei

The Human Bacteroidetes ID[™] Species: B. dorei service targets the species Bacteroides dorei. B. dorei is an anaerobe that is frequently shed from the gastrointestinal tract and isolated from human feces worldwide. It is a newly discovered species that is widely distributed in the USA.^{1,2} The human-associated marker DNA sequence is located on the 16S rRNA gene of *B. dorei.*³ The marker is the microbial source tracking (MST) marker of choice for detecting human fecal pollution due to its exceptional sensitivity and specificity. Internal validations have been conducted on hundreds of sewage, septage, human and animal host fecal samples collected from throughout the U.S and archived in the Source Molecular fecal bank. The marker has also been evaluated in both inland and coastal waters. A recent, comprehensive, multilaboratory MST method evaluation study, exploring the performance of current MST methods, concluded the B. dorei PCR assay to be the top performing human-associated assay amongst those tested. The success and consistency of this marker in numerous studies around the world^{1,3,4} makes the **Human** Bacteroidetes ID[™] Species: B. dorei service the primary service for identifying human fecal pollution at Source Molecular.

Fecal Bacteroidetes are considered for several reasons an interesting alternative to more traditional indicator organisms such as E. coli and Enterococci.⁵ Since they are strict anaerobes, they are indicative of recent fecal contamination when found in water systems. This is a particularly strong reference point when trying to determine recent outbreaks in fecal pollution. They are also more abundant in feces of warmblooded animals than E. coli and Enterococci.

The Human Bacteroidetes ID[™] service is designed around the principle that fecal Bacteroidetes are found in large quantities in feces of warm-blooded animals.^{3,5,6,7,8} Furthermore, certain strains of Bacteroidetes have been found to be associated with humans.^{3,6} As such, these bacterial strains can be used as indicators of human fecal contamination.

Accuracy of the results is possible because the method amplifies DNA into a large number of small copies of the gene biomarker of interest. This is accomplished with small pieces of DNA called primers that are complementary and specific to the unique B. dorei DNA sequence. Through a heating process called thermal cycling, the double stranded DNA is denatured, hybridized to the complementary primers and amplified to create many copies of the DNA fragment desired. If the primers are successful in finding a site on the DNA fragment that is specific to the B. dorei DNA sequence, then billions of copies of the DNA fragment will be available, detected and quantified.

To strengthen the validity of the results, additional tests targeting other high-ranking, human-associated Bacteroidetes species should be performed, such as

Human Bacteroidetes ID[™] Species: B. stercoris,

Human Bacteroidetes ID[™] Species: B. fragilis, and

Human Bacteroidetes ID[™] Species: B. thetaiotaomicron.

²Bakir, M., Sakamoto, M., Kitahara, M., Matsumoto, M., Benno, Y. Bacteroides dorei sp. nov., isolated from human faeces. Int. J. Syst. Evol. Microbiol. 2006 56: 1639-1641.

³ Bernhard, A., Field, K. A PCR assay to discriminate human and ruminant feces on the basis of host differences in Bacteroides-Prevotella genes encoding 16S rRNA. Appl. Environ. Microbiol. 2000b 66: 4571-4574.

⁴Ahmed, w., Masters, N., Toze, S. Consistency in the host specificity and host sensitivity of the Bacteroides HF183 marker for sewage pollution tracking. Lett. Appl. Microbiol. 2012 55: 283-289.

⁵ Scott, T., Rose, J., Jenkins, T., Farrah, S., Lukasik, J. Microbial Source Tracking: Current Methodology and Future Directions. Appl. Environ. Microbiol. 2002 68: 5796-5803.

⁶ Bernhard, A., Field, K. Identification of nonpoint sources of fecal pollution in coastal waters by using host-specific 16S ribosomal DNA genetic markers from fecal anaerobes. Appl. Environ. Microbiol. 2000a 66: 1587-1594. ⁷ Eccentry L. Voytek M. A Comparison of Bacteroides-Prevetella 16S rPNA Constic Markers for Fecal Samples from Different Animal

¹Boehm, A., Fuhrman, J., Mrse, R., Grant, S. Tiered approach for identification of a human fecal pollution source at a recreational beach: case study at Avalon Bay, Catalina Island, California. Environ Sci Technol. 2003 37: 673-680.

Human Bacteroidetes ID[™]: EPA Developed Assay

The Human Bacteroidetes IDTM: EPA Developed Assay service targets a functional gene biomarker in Bacteroidales-like anaerobic bacteria that is present in high concentrations in the human gut. The U.S. Environmental Protection Agency (U.S. EPA) was the first to target the biomarker using Polymerase Chain Reaction (PCR) technology in order to detect ground and surface waters impacted by human fecal pollution.¹ Since it's development, the assay has been used succesfully around the U.S to identify fecal pollution originating from human sources, such as sewage and septage wastewaters.

The U.S. EPA Developed assay has been shown to be highly associated with human fecal pollution. It has successfully been validated in multiple nationwide studies using at least 300 individual reference fecal material from 22 different animal species known to commonly contaminate environmental waters.^{1,2} A reported 99.2% specificity to human fecal material makes this one of the leading assays to confirm the presence of fecal contamination that is of human origin.¹ The *Bacteroidales*-like bacteria is widely distributed. It was detected in 100% of hundreds of sewage and human reference fecal samples collected from more than 20 human populations, making it highly sensitive. Internal validations have also been conducted on hundreds of wastewater, human and animal host fecal samples archived in the Source Molecular fecal bank.

Fecal anaerobic bacteria are considered for several reasons an interesting alternative to more traditional fecal indicator organisms such as E. coli and Enterococci.³ Since they are strict anaerobes, they are indicative of recent fecal contamination when found in water systems.³ This is a particularly strong reference point when trying to determine recent outbreaks in fecal pollution. They are also more abundant in feces of warm-blooded animals than E. coli and Enterococci.

The Human Bacteroidetes ID[™]: EPA Developed Assay service is designed around the principle that fecal Bacteroidales-like bacteria are found in large quantities in feces of warm-blooded animals.^{4,5} Furthermore, certain strains have been shown to be associated with humans.^{4,5} As such, these bacterial strains can be used as indicators of human fecal contamination. An advantage of the Human Bacteroidetes ID[™] service is that the entire portion of water sampled is filtered to concentrate bacteria. As such, this method avoids the randomness effect of culturing and selecting bacterial isolates. This is an advantage for highly contaminated water systems with potential multiple sources of fecal contamination.

Accuracy of the results is possible because the method amplifies DNA into a large number of small copies of the gene biomarker of interest. This is accomplished with small pieces of DNA called primers that are complementary and specific to the unique B. dorei DNA sequence. Through a heating process called thermal cycling, the double stranded DNA is denatured, hybridized to the complementary primers and amplified to create many copies of the DNA fragment desired. If the primers are successful in finding a site on the DNA fragment that is specific to the B. dorei DNA sequence, then billions of copies of the DNA fragment will be available, detected and quantified.

To strengthen the validity of the results, additional tests targeting other high-ranking, human-associated Bacteroidetes species should be performed, such as Human Bacteroidetes ID[™] Species: *B. dorei*, Human Bacteroidetes ID[™] Species: *B. fragilis*, and Human Bacteroidetes ID[™] Species: *B. stercoris*

¹ Shanks, O., Kelty, C., Sivaganesan, M., Varma, M. and Haugland, R. **Quantitative PCR for Genetic Markers of Human Fecal Pollution**. Appl. Environ. Microbiol. 2009 75: 5507-5513.

² Layton, B., Cao, Y., Ebentier, D., Hanley, K., Ballesté, E., Brandão, J., et al. Performance of Human Fecal Anaerobe-Associated PCR-Based Assays in a Multi-Laboratory Method Evaluation Study. Water Research. 2013 In Press. ³Scott, T., Rose, J., Jenkins, T., Farrah, S. and Lukasik, J. Microbial Source Tracking: Current Methodology and Future Directions. Appl. Environ. Microbiol. 2002 68: 5796-5803.

Scott, T., Rose, J. Jenkins, T., Farrah, S. and Lukasik, J. Microbial Source Tracking: Current Methodology and Future Directions. Appl. Environ. Microbiol. 2002 68: 5796-5803.
Bernhard, A., Field, K. Identification of nonpoint sources of fecal pollution in coastal waters by using host-specific 16S ribosomal DNA genetic markers from fecal anaerobes. Appl. Environ. Microbiol. 2000a 66: 1587-1594.
Bernhard, A., Field, K. A PCR assay to discriminate human and ruminant feces on the basis of host differences in Bacteroides-Prevotella genes encoding 16S rRNA. Appl. Environ. Microbiol. 2000b 66: 4571-4574.



Data Quality Assurance Worksheet

		Ву	G. Catarra	
Project Name/No./Client:	Lake Whatcom / 16-06326-000 / LWWSD.	Date	1/26/2017	Page <u>1</u> of <u>1</u>
Laboratory/Parameters:	LabCor, Inc. / fecal bacteria and E. coli; ARI / TP, Cl/Br; Source Molecular / MST	Checked:	initials	
Sample Date/Sample ID:	3/15/2017 / 17 samples		date	

		Pre-preser Holding 7 (hours	vation Fimes s)	Total Hol Times (d	lding lays)	Method <u>Blanks</u>	Matrix Sp Surroga Recovery	ikes/ ate (%)	Lab Con Samples Re (%)	trol covery	Lab Dupl RPD (icates %)	Field Dup RPD (licates %)	
Parameter	Methodology	Reported	Goal	Reported	Goal	Reporting Limit	Reported	Goal	Reported	Goal	Reported	Goal	Reported	Goal ¹	ACTION
Fecal coliform	OK / SM9222D	NA	NA	1	≤1	≤1.0 2 CFU /100ML	NA	NA	NA	NA	5D NC	≤35	NA	NA	STATIONS 5-14, OSS "J" DUE TO PLATE COUNTS. RESULTS CALCULATED PER METHOD.
						≤1.0									STATION 2-3, 5-14, OSS "J"
E. coli	OK/ SM9222D	NA	NA	1	≤1	2	NA	NA	NA	NA	5D NC	≤35	NA	NA	DUE TO PLATE COUNTS. RESULTS CALCULATED PER METHOD.
Total Phosphorus	OK / EPA 365.1	NA	NA	12	≤28	$\frac{\leq 8.0 - 10}{8.0 \mu\text{g/L}}$	95-96	±20	99-109	±10	NC, D = 6	≤20	NA	NA	11L "J" DUE TO MB CONTAMINATION.
Chloride	OK / EPA 300.0	NA	≤12	6	≤28	≤0.1 0.1 mg/L	101	±20	101	±10	2.7	≤20	NA	NA	None
Duomida	OK/	NA	NA	6	~29	≤0.1	04	+20	00	+10	NC	< 20	NA	NA	NONE
bronnide	EPA 300.0	NA	INA	0	520	0.1 mg/L	94	±20	22	±10	INC.	≤ 20	NA		
B. Dorei	OK/		≤48		NA	≤0.01	NA	NA	NA	NA	NA	≤ 30	NA	NA	None
	Digital qPCR					3						cov			
EPA Assay	OK / Digital qPCR		≤48		NA	≤0.05 3	NA	NA	NA	NA	NA	≤ 30 cov	NA	NA	None

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

PJJ https://herrerainc.sharepoint.com/16-06326-000/shared documents/report/apxb/b10 event 2 qa worksheet.docx



170293 - S20

170293 - S21

POSCTRL - , WA Water ID#:

Blank - Run #1, WA Water ID#:

11919838

11919839

Analysis Report Cover

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

Final Report

Soottle N		T mai neport		
	A Profe	ssional Service Corporati	on in the Northwest	
Job Number: 170	0293 SEA		Report Number: 17	'0293R01
Client: Her	rera Environmental Consultants, In	c	Report Date: 3/3	31/2017
Address: 220	0 Sixth Avenue			
Sui	te 1100 Http://www.asi21			
Project Name: Lake	e Whatcom North Shore Water Testin	a		
Project No.: 16-0	06326-000	9		
PO Number:				
PWS ID:				
Reference No.:				
inclosed please find	results for samples submitted to our la	aboratory. A list of samples a	and analyses follows:	
Lab/Cor Sample #	Client Sample # and Description	Analysis	Analysis Notes	Dat
170293 - S1	C1 - Control - Lake, WA Water ID#:	SM 9222D G1c1- Fecal		3/30
/=	11919819	Coliform/ E.coli - CFU		
170293 - S2	C2 - Control - Lake, WA Water ID#:	SM 9222D G1c1- Fecal Coliform/ E coli - CEU		3/30
170293 - S3	1L - Lake Water, WA Water ID#:	SM 9222D G1c1- Fecal		3/3(
	11919821	Coliform/ E.coli - CFU		
170293 - S4	2D - Discharge Water, WA Water	SM 9222D G1c1- Fecal		3/30
170202 85	1D#: 11919822	SM 9222D G1o1 Eccal		2/2
170293 - 33	ID#: 11919823	Coliform/ E.coli - CFU		5/51
170293 - S6	4D - Discharge Water, WA Water	SM 9222D G1c1- Fecal		3/30
	ID#: 11919824	Coliform/ E.coli - CFU		
170293 - S7	5D - Discharge Water, WA Water	SM 9222D G1c1- Fecal Coliform/ E coli - CEU		3/30
170293 - S8	6D - Discharge Water, WA Water	SM 9222D G1c1- Fecal		3/3(
	ID#: 11919826	Coliform/ E.coli - CFU		
170293 - S9	7D - Discharge Water, WA Water	SM 9222D G1c1- Fecal		3/30
170203 - \$10	ID#: 11919827 8D - Discharge Water, WA Water	SM 9222D G1c1- Eecal		3/3
170293 - 310	ID#: 11919828	Coliform/ E.coli - CFU		5/50
170293 - S11	9D - Discharge Water, WA Water	SM 9222D G1c1- Fecal		3/3/
	ID#: 11919829	Coliform/ E.coli - CFU		
170293 - S12	10D - Discharge Water, WA Water	SM 9222D G1c1- Fecal Coliform/ E coli - CEU		3/30
170293 - S13	11D - Discharge Water, WA Water	SM 9222D G1c1- Fecal		3/30
	ID#: 11919831	Coliform/ E.coli - CFU		
170293 - S14	12D - Discharge Water, WA Water	SM 9222D G1c1- Fecal		3/30
170202 815	12D Dispharap Water, WA Water	Coliform/ E.coli - CFU		2/2
170293 - 315	ID#: 11919833	Coliform/ E.coli - CFU		3/31
170293 - S16	14D - Discharge Water, WA Water	SM 9222D G1c1- Fecal	High Confluent Growth Present	3/3/
	ID#: 11919834	Coliform/ E.coli - CFU		
1/0293 - S17	0SS - (Raw Sewage), WA Water	SM 9222D G1c1- Fecal Coliform/ E coli - CEU		3/30
170293 - S18	15D - Discharge Water, WA Water	SM 9222D G1c1- Fecal		3/30
	ID#: 11919836	Coliform/ E.coli - CFU		
170293 - S19	NEGCTRL - , WA Water ID#:	SM 9222D G1c1- Fecal		3/30
170293 - S18 170293 - S19	15D - Discharge Water, WA Water ID#: 11919836 NEGCTRL - , WA Water ID#: 11919837	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU SM 9222D G1c1- Fecal Coliform/ E.coli - CFU		

SM 9222D G1c1- Fecal

SM 9222D G1c1- Fecal

Coliform/ E.coli - CFU

Coliform/ E.coli - CFU

Date Received: 3/30/2017

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

Final Report

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

A Professional Service Corporation in the Northwest

Job Number: 170 Client: Her	0293 SEA rrera Environmental Consultants, Inc		Report Number: 170293R01 Report Date: 3/31/2017
Project Name: Lak	e Whatcom North Shore Water Testing		
170293 - S22	Blank - After Run #10, WA Water ID#: 11919840	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU	3/30/2017
170293 - S23	Blank - Final Run, WA Water ID#: 11919841	SM 9222D G1c1- Fecal Coliform/ E.coli - CFU	3/30/2017

SM 9222D G1c1- The presence of Fecal Coliform and E. coli from waters and/or environmental sources are tested using the following standard Fecal Coliform/ methods:

E.coli - CFU

SM9222 D&G1c1:

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

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

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

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

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

Sincerely,

long

Ashley Tonge Technician/Analyst

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A Professional Service Corporation in the Northwest

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

Job Number: 170293 SEA

Report Number: 170293R01 Date Received: 3/30/2017

Client: Herrera Environmental Consultants, Inc

Project Name: Lake Whatcom North Shore Water Testing

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S1	C1 - Control - Lake, WA Water ID#: 11919819	FECAL COLIFORM	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	10:01 AM	AT 3/31/2017
S1	C1 - Control - Lake, WA Water ID#: 11919819	E. COLI	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	10:01 AM	AT 3/31/2017
S1	C1 - Control - Lake, WA Water ID#: 11919819	FECAL COLIFORM	<2	CFU/ 100ml (50mL)	0 - 7.4	3/29/2017	10:01 AM	AT 3/31/2017
S1	C1 - Control - Lake, WA Water ID#: 11919819	E. COLI	<2	CFU/ 100ml (50mL)	0 - 7.4	3/29/2017	10:01 AM	AT 3/31/2017
S2	C2 - Control - Lake, WA Water ID#: 11919820	FECAL COLIFORM	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	10:12 AM	AT 3/31/2017
S2	C2 - Control - Lake, WA Water ID#: 11919820	E. COLI	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	10:12 AM	AT 3/31/2017
S2	C2 - Control - Lake, WA Water ID#: 11919820	FECAL COLIFORM	<2	CFU/ 100ml (50mL)	0 - 7.4	3/29/2017	10:12 AM	AT 3/31/2017
S2	C2 - Control - Lake, WA Water ID#: 11919820	E. COLI	<2	CFU/ 100ml (50mL)	0 - 7.4	3/29/2017	10:12 AM	AT 3/31/2017
S3	1L - Lake Water, WA Water ID#: 11919821	FECAL COLIFORM	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	10:56 AM	AT 3/31/2017
S3	1L - Lake Water, WA Water ID#: 11919821	E. COLI	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	10:56 AM	AT 3/31/2017
S3	1L - Lake Water, WA Water ID#: 11919821	FECAL COLIFORM	10	CFU/ 100ml (50mL)	3.2 - 23.4	3/29/2017	10:56 AM	AT 3/31/2017
S3	1L - Lake Water, WA Water ID#: 11919821	E. COLI	10	CFU/ 100ml (50mL)	3.2 - 23.4	3/29/2017	10:56 AM	AT 3/31/2017
S4	2D - Discharge Water, WA Water ID#: 11919822	FECAL COLIFORM	80	CFU/ 100ml (5mL)	20 - 204	3/29/2017	11:08 AM	AT 3/31/2017
S4	2D - Discharge Water, WA Water ID#: 11919822	E. COLI	80	CFU/ 100ml (5mL)	20 - 204	3/29/2017	11:08 AM	AT 3/31/2017
S4	2D - Discharge Water, WA Water ID#: 11919822	FECAL COLIFORM	112	CFU/ 100ml (50mL)	97 - 127	3/29/2017	11:08 AM	AT 3/31/2017
S4	2D - Discharge Water, WA Water ID#: 11919822	E. COLI	112	CFU/ 100ml (50mL)	97 - 127	3/29/2017	11:08 AM	AT 3/31/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170293 SEA

Report Number: 170293R01 **Date Received:** 3/30/2017

Client: Herrera Environmental Consultants, Inc

Project Name: Lake Whatcom North Shore Water Testing

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S5	3D - Discharge Water, WA Water ID#: 11919823	FECAL COLIFORM	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	11:21 AM	AT 3/31/2017
S5	3D - Discharge Water, WA Water ID#: 11919823	E. COLI	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	11:21 AM	AT 3/31/2017
S5	3D - Discharge Water, WA Water ID#: 11919823	FECAL COLIFORM	18	CFU/ 100ml (50mL)	8 - 34.2	3/29/2017	11:21 AM	AT 3/31/2017
S5	3D - Discharge Water, WA Water ID#: 11919823	E. COLI	18	CFU/ 100ml (50mL)	8 - 34.2	3/29/2017	11:21 AM	AT 3/31/2017
S6	4D - Discharge Water, WA Water ID#: 11919824	FECAL COLIFORM	160	CFU/ 100ml (5mL)	68 - 316	3/29/2017	11:36 AM	AT 3/31/2017
S6	4D - Discharge Water, WA Water ID#: 11919824	E. COLI	160	CFU/ 100ml (5mL)	68 - 316	3/29/2017	11:36 AM	AT 3/31/2017
S6	4D - Discharge Water, WA Water ID#: 11919824	FECAL COLIFORM	62	CFU/ 100ml (50mL)	50.9 - 73.1	3/29/2017	11:36 AM	AT 3/31/2017
S6	4D - Discharge Water, WA Water ID#: 11919824	E. COLI	62	CFU/ 100ml (50mL)	50.9 - 73.1	3/29/2017	11:36 AM	AT 3/31/2017
S7	5D - Discharge Water, WA Water ID#: 11919825	FECAL COLIFORM	40	CFU/ 100ml (5mL)	4 - 144	3/29/2017	11:50 AM	AT 3/31/2017
S7	5D - Discharge Water, WA Water ID#: 11919825	E. COLI	40	CFU/ 100ml (5mL)	4 - 144	3/29/2017	11:50 AM	AT 3/31/2017
S7	5D - Discharge Water, WA Water ID#: 11919825	FECAL COLIFORM	28	CFU/ 100ml (50mL)	15.4 - 47	3/29/2017	11:50 AM	AT 3/31/2017
S7	5D - Discharge Water, WA Water ID#: 11919825	E. COLI	28	CFU/ 100ml (50mL)	15.4 - 47	3/29/2017	11:50 AM	AT 3/31/2017
S8	6D - Discharge Water, WA Water ID#: 11919826	FECAL COLIFORM	360	CFU/ 100ml (5mL)	214 - 568	3/29/2017	12:10 PM	AT 3/31/2017
S8	6D - Discharge Water, WA Water ID#: 11919826	E. COLI	360	CFU/ 100ml (5mL)	214 - 568	3/29/2017	12:10 PM	AT 3/31/2017
S8	6D - Discharge Water, WA Water ID#: 11919826	FECAL COLIFORM	340	CFU/ 100ml (50mL)	313.9 - 366.1	3/29/2017	12:10 PM	AT 3/31/2017
S8	6D - Discharge Water, WA Water ID#: 11919826	E. COLI	340	CFU/ 100ml (50mL)	313.9 - 366.1	3/29/2017	12:10 PM	AT 3/31/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170293 SEA

Report Number: 170293R01 Date Received: 3/30/2017

Client: Herrera Environmental Consultants, Inc

Project Name: Lake Whatcom North Shore Water Testing

Lab/Cor	Client Sample	Analyte Type	Analysis Besult	UOM	95% Confidence	Sample	Sample	Analyst
Sample No.			nesut		interval	Dule	Time	
S9	7D - Discharge Water, WA Water ID#: 11919827	FECAL COLIFORM	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	12:33 PM	AT 3/31/2017
S9	7D - Discharge Water, WA Water ID#: 11919827	E. COLI	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	12:33 PM	AT 3/31/2017
S9	7D - Discharge Water, WA Water ID#: 11919827	FECAL COLIFORM	2	CFU/ 100ml (50mL)	0.2 - 11.2	3/29/2017	12:33 PM	AT 3/31/2017
S9	7D - Discharge Water, WA Water ID#: 11919827	E. COLI	2	CFU/ 100ml (50mL)	0.2 - 11.2	3/29/2017	12:33 PM	AT 3/31/2017
S10	8D - Discharge Water, WA Water ID#: 11919828	FECAL COLIFORM	120	CFU/ 100ml (5mL)	44 - 262	3/29/2017	12:55 PM	AT 3/31/2017
S10	8D - Discharge Water, WA Water ID#: 11919828	E. COLI	120	CFU/ 100ml (5mL)	44 - 262	3/29/2017	12:55 PM	AT 3/31/2017
S10	8D - Discharge Water, WA Water ID#: 11919828	FECAL COLIFORM	128	CFU/ 100ml (50mL)	112 - 144	3/29/2017	12:55 PM	AT 3/31/2017
S10	8D - Discharge Water, WA Water ID#: 11919828	E. COLI	122	CFU/ 100ml (50mL)	106.4 - 137.6	3/29/2017	12:55 PM	AT 3/31/2017
S11	9D - Discharge Water, WA Water ID#: 11919829	FECAL COLIFORM	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	1:05 PM	AT 3/31/2017
S11	9D - Discharge Water, WA Water ID#: 11919829	E. COLI	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	1:05 PM	AT 3/31/2017
S11	9D - Discharge Water, WA Water ID#: 11919829	FECAL COLIFORM	16	CFU/ 100ml (50mL)	6.8 - 31.6	3/29/2017	1:05 PM	AT 3/31/2017
S11	9D - Discharge Water, WA Water ID#: 11919829	E. COLI	12	CFU/ 100ml (50mL)	4.4 - 26.2	3/29/2017	1:05 PM	AT 3/31/2017
S12	10D - Discharge Water, WA Water ID#: 11919830	FECAL COLIFORM	140	CFU/ 100ml (5mL)	56 - 288	3/29/2017	1:25 PM	AT 3/31/2017
S12	10D - Discharge Water, WA Water ID#: 11919830	E. COLI	140	CFU/ 100ml (5mL)	56 - 288	3/29/2017	1:25 PM	AT 3/31/2017
S12	10D - Discharge Water, WA Water ID#: 11919830	FECAL COLIFORM	122	CFU/ 100ml (50mL)	106.4 - 137.6	3/29/2017	1:25 PM	AT 3/31/2017
S12	10D - Discharge Water, WA Water ID#: 11919830	E. COLI	110	CFU/ 100ml (50mL)	95.2 - 124.8	3/29/2017	1:25 PM	AT 3/31/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170293 SEA

Report Number: 170293R01 **Date Received:** 3/30/2017

Client: Herrera Environmental Consultants, Inc

Project Name: Lake Whatcom North Shore Water Testing

Lab/Cor Sample No.	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
S13	11D - Discharge Water, WA Water ID#: 11919831	FECAL COLIFORM	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	1:39 PM	AT 3/31/2017
S13	11D - Discharge Water, WA Water ID#: 11919831	E. COLI	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	1:39 PM	AT 3/31/2017
S13	11D - Discharge Water, WA Water ID#: 11919831	FECAL COLIFORM	22	CFU/ 100ml (50mL)	10.8 - 39.4	3/29/2017	1:39 PM	AT 3/31/2017
S13	11D - Discharge Water, WA Water ID#: 11919831	E. COLI	20	CFU/ 100ml (50mL)	9.4 - 36.8	3/29/2017	1:39 PM	AT 3/31/2017
S14	12D - Discharge Water, WA Water ID#: 11919832	FECAL COLIFORM	40	CFU/ 100ml (5mL)	4 - 144	3/29/2017	1:57 PM	AT 3/31/2017
S14	12D - Discharge Water, WA Water ID#: 11919832	E. COLI	40	CFU/ 100ml (5mL)	4 - 144	3/29/2017	1:57 PM	AT 3/31/2017
S14	12D - Discharge Water, WA Water ID#: 11919832	FECAL COLIFORM	44	CFU/ 100ml (50mL)	34.6 - 53.4	3/29/2017	1:57 PM	AT 3/31/2017
S14	12D - Discharge Water, WA Water ID#: 11919832	E. COLI	44	CFU/ 100ml (50mL)	34.6 - 53.4	3/29/2017	1:57 PM	AT 3/31/2017
S15	13D - Discharge Water, WA Water ID#: 11919833	FECAL COLIFORM	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	2:12 PM	AT 3/31/2017
S15	13D - Discharge Water, WA Water ID#: 11919833	E. COLI	<20	CFU/ 100ml (5mL)	0 - 74	3/29/2017	2:12 PM	AT 3/31/2017
S15	13D - Discharge Water, WA Water ID#: 11919833	FECAL COLIFORM	22	CFU/ 100ml (50mL)	10.8 - 39.4	3/29/2017	2:12 PM	AT 3/31/2017
S15	13D - Discharge Water, WA Water ID#: 11919833	E. COLI	22	CFU/ 100ml (50mL)	10.8 - 39.4	3/29/2017	2:12 PM	AT 3/31/2017
S16	14D - Discharge Water, WA Water ID#: 11919834	FECAL COLIFORM	800	CFU/ 100ml (5mL)	673.5 - 926.5	3/29/2017	2:28 PM	AT 3/31/2017
S16	14D - Discharge Water, WA Water ID#: 11919834	E. COLI	200	CFU/ 100ml (5mL)	94 - 368	3/29/2017	2:28 PM	AT 3/31/2017
S16	14D - Discharge Water, WA Water ID#: 11919834	FECAL COLIFORM	164	CFU/ 100ml (50mL)	145.9 - 182.1	3/29/2017	2:28 PM	AT 3/31/2017
S16	14D - Discharge Water, WA Water ID#: 11919834	E. COLI	82	CFU/ 100ml (50mL)	69.2 - 94.8	3/29/2017	2:28 PM	AT 3/31/2017

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A Professional Service Corporation in the Northwest

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

Job Number: 170293 SEA

Report Number: 170293R01 **Date Received:** 3/30/2017

Client: Herrera Environmental Consultants, Inc

Project Name: Lake Whatcom North Shore Water Testing

Lab/Cor Sample	Client Sample	Analyte Type	Analysis Result	UOM	95% Confidence Interval	Sample Date	Sample Time	Analyst
No.								
S17	0SS - (Raw Sewage), WA Water ID#: 11919835	FECAL COLIFORM	4080000	CFU/ 100ml (0.01mL)	3878009.9 - 4281990.1	3/29/2017	3:41 PM	AT 3/31/2017
S17	0SS - (Raw Sewage), WA Water ID#: 11919835	E. COLI	4080000	CFU/ 100ml (0.01mL)	3878009.9 - 4281990.1	3/29/2017	3:41 PM	AT 3/31/2017
S18	15D - Discharge Water, WA Water ID#: 11919836	FECAL COLIFORM	280	CFU/ 100ml (5mL)	154 - 470	3/29/2017	2:47 PM	AT 3/31/2017
S18	15D - Discharge Water, WA Water ID#: 11919836	E. COLI	280	CFU/ 100ml (5mL)	154 - 470	3/29/2017	2:47 PM	AT 3/31/2017
S18	15D - Discharge Water, WA Water ID#: 11919836	FECAL COLIFORM	260	CFU/ 100ml (50mL)	237.2 - 282.8	3/29/2017	2:47 PM	AT 3/31/2017
S18	15D - Discharge Water, WA Water ID#: 11919836	E. COLI	258	CFU/ 100ml (50mL)	235.3 - 280.7	3/29/2017	2:47 PM	AT 3/31/2017
S19	NEGCTRL - , WA Water ID#: 11919837	FECAL COLIFORM	<1	CFU/ 100ml	0 - 3.7	3/30/2017	8:00 AM	AT 3/31/2017
S19	NEGCTRL - , WA Water ID#: 11919837	E. COLI	<1	CFU/ 100ml	0 - 3.7	3/30/2017	8:00 AM	AT 3/31/2017
S20	POSCTRL - , WA Water ID#: 11919838	FECAL COLIFORM	25	CFU/ 100ml	20 - 30	3/30/2017	8:00 AM	AT 3/31/2017
S20	POSCTRL - , WA Water ID#: 11919838	E. COLI	25	CFU/ 100ml	20 - 30	3/30/2017	8:00 AM	AT 3/31/2017
S21	Blank - Run #1, WA Water ID#: 11919839	FECAL COLIFORM	<1	CFU/ 100ml	0 - 3.7	3/30/2017	8:00 AM	AT 3/31/2017
S21	Blank - Run #1, WA Water ID#: 11919839	E. COLI	<1	CFU/ 100ml	0 - 3.7	3/30/2017	8:00 AM	AT 3/31/2017
S22	Blank - After Run #10, WA Water ID#: 11919840	FECAL COLIFORM	<1	CFU/ 100ml	0 - 3.7	3/30/2017	8:00 AM	AT 3/31/2017
S22	Blank - After Run #10, WA Water ID#: 11919840	E. COLI	<1	CFU/ 100ml	0 - 3.7	3/30/2017	8:00 AM	AT 3/31/2017
S23	Blank - Final Run, WA Water ID#: 11919841	FECAL COLIFORM	<1	CFU/ 100ml	0 - 3.7	3/30/2017	8:00 AM	AT 3/31/2017
S23	Blank - Final Run, WA Water ID#: 11919841	E. COLI	<1	CFU/ 100ml	0 - 3.7	3/30/2017	8:00 AM	AT 3/31/2017

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Final Report

A Professional Service Corporation in the Northwest

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

Job Number: 170293 SEA

Report Number: 170293R01 Date Received: 3/30/2017

Client: Herrera Environmental Consultants, Inc

Project Name: Lake Whatcom North Shore Water Testing

		5						
Lab/Cor	Client Sample	Analyte Type	Analysis	UOM	95% Confidence	Sample	Sample	Analyst
Sample			Result		Interval	Date	Time	
No.								

Reviewed by:

Ashley Tonge Technician/Analyst

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Sample ID	Volume (mL)	Colonies counted	Result (CPN/100	Herrera Check	Start Date/Time:	End Date/Time:
			mL)			
170293-01	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	0	<2 /		3/30 10:00AM	3/31 10:00AM
170293-02	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	0	<2 /	()	3/30 10:00AM	3/31 10:00AM
170293-03	5	0	<20	-	3/30 10:00AM	3/31 10:00AM
	50	5	10	958	3/30 10:00AM	3/31 10:00AM
170293-04	5	4	80		3/30 10:00AM	3/31 10:00AM
	50	56	112 /		3/30 10:00AM	3/31 10:00AM
170293-05	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	9	18	1058	3/30 10:00AM	3/31 10:00AM
170293-06	5	8	160		3/30 10:00AM	3/31 10:00AM
	50	31	62 /	•	3/30 10:00AM	3/31 10:00AM
170293-07	-5	2	40	1	3/30 10:00AM	3/31 10:00AM
	50	14	28	2958	3/30 10:00AM	3/31 10:00ÅM
170293-08	-5	18	360		3/30 10:00AM	3/31 10:00AM
	50	170	340	3425800	3/30 10:00AM	3/31 10:00AM
170293-09	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	1	2	258	3/30 10:00AM	3/31 10:00AM
170293-10	5	6	120		3/30 10:00AM	3/31 10:00AM
	50	64	128	12758	3/30 10:00AM	3/31 10:00AM
170293-11	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	8	16	157 4	3/30 10:00AM	3/31 10:00AM
170293-12	5	7	140		3/30 10:00AM	3/31 10:00AM
	-50	61	122	124 38	3/30 10:00AM	3/31 10:00AM
Lab Duplicate						
Negative Control					5	
Positive Control						

 $\frac{Colonies}{100\,mL} = \frac{Colonies\,counted}{mL\,SampleFiltered} \times 100$

Density: use if only one count is within ideal range (20-60 colonies)

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100\,mL} = \frac{\sum Colonies \ counted}{\sum mL \ sample \ filtered} \times 100$

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100 mL)	Herrera Check	Start Date/Time:	End Date/Time:
170293-13	-5	0	<20		3/30 10:00AM	3/31 10:00AM
4		- 11	22	2058	3/30 10:00AM	3/31 10:00AM
170293-14	5	2	40		3/30 10:00AM	3/31 10:00AM
	50	22	44	L.	3/30 10:00AM	3/31 10:00AM
170293-15	_5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	11	22	2058	3/30 10:00AM	3/31 10:00AM
170293-16	5	40	800	a	3/30 10:00AM	3/31 10:00AM
	50	82	164		3/30 10:00AM	3/31 10:00AM
170293-17	.01	408	> 4080000	gre	3/30 10:00AM	3/31 10:00AM
		-1-27 m			3/30 10:00AM	3/31 10:00AM
170293-18	-5	14	280		3/30 10:00AM	3/31 10:00AM
	50	130	260	202 8	3/30 10:00AM	3/31 10:00AM
		1				
Lab Duplicate						
Negative Control	100	0	0			
Positive Control	100	25	25			

 $\frac{Colonies}{100 \, mL} = \frac{Colonies \, counted}{mL \, Sample Filtered} \times 100$

Density: use if only one count is within ideal range (20-60 colonies)

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100\,mL} = \frac{\sum Colonies\,counted}{\sum mL\,sample\,filtered} \times 100$

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100	Herrera Check	Start Date/Time:	End Date/Time:
170293-13	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	10	20	185 820	3/30 10:00AM	3/31 10:00AM
170293-14	5	2	40	1000	3/30 10:00AM	3/31 10:00AM
	50	22	44 /		3/30 10:00AM	3/31 10:00AM
170293-15	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	11	22	205 82	3/30 10:00AM	3/31 10:00AM
170293-16	5	10	200	1	3/30 10:00AM	3/31 10:00AM
	50	41	82		3/30 10:00AM	3/31 10:00AM
170293-17	.01	408	>4080000	Sol	3/30 10:00AM	3/31 10:00AM
				0	3/30 10:00AM	3/31 10:00AM
170293-18	5	14	280		3/30 10:00AM	3/31 10:00AM
	50	129	258	26058	3/30 10:00AM	3/31 10:00AM
ALMONT OF						
		H				
		arres Tes				
		1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-				
	-					
Lab Duplicate						
Negative Control	100	0	0			1
Positive Control	100	25	25			

 $\frac{Colonies}{100\,mL} = \frac{Colonies\,counted}{mL\,SampleFiltered} \times 100$

Density: use if only one count is within ideal range (20-60 colonies)

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100\,mL} = \frac{\sum Colonies\,counted}{\sum mL\,sample\,filtered} \times 100$

Sample ID	Volume (mL)	Colonies counted	Result (CPN/100 mL)	Herrera Check	Start Date/Time:	End Date/Time:
170293-01	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	0	<2 /		3/30 10:00AM	3/31 10:00AM
170293-02	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	0	<2 /		3/30 10:00AM	3/31 10:00AM
170293-03	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	5	10	95 8	3/30 10:00AM	3/31 10:00AM
170293-04	5	4	80		3/30 10:00AM	3/31 10:00AM
	50	56	112 🖊		3/30 10:00AM	3/31 10:00AM
170293-05	- 5	0	<20	2	3/30 10:00AM	3/31 10:00AM
	50	9	18	1658	3/30 10:00AM	3/31 10:00AM
170293-06	5	8	160		3/30 10:00AM	3/31 10:00AM
	50	31	62 /		3/30 10:00AM	3/31 10:00AM
170293-07	- 5	2	40		3/30 10:00AM	3/31 10:00AM
	50	14	28	29380	3/30 10:00AM	3/31 10:00AM
170293-08	5	18	360		3/30 10:00AM	3/31 10:00AM
	50	170	340	342 3 80-	3/30 10:00AM	3/31 10:00AM
170293-09	- 5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	1	2	25 82	3/30 10:00AM	3/31 10:00AM
170293-10	5	6	120		3/30 10:00AM	3/31 10:00AM
	50	61	122	1225 82	3/30 10:00AM	3/31 10:00AM
170293-11	5	0	<20		3/30 10:00AM	3/31 10:00AM
	50	6	12	1158	3/30 10:00AM	3/31 10:00AM
170293-12	5	7	140		3/30 10:00AM	3/31 10:00AM
	50	55	110 /	2	3/30 10:00AM	3/31 10:00AM
Lab Duplicate						
Negative Control						
Positive Control						

 $\frac{Colonies}{100\,mL} = \frac{Colonies\,counted}{mL\,SampleFiltered} \times 100$

Density: use if only one count is within ideal range (20-60 colonies)

Average Density: use if all counts are outside of ideal range (20-60 colonies) excluding counts greater than 200 or if more than one count is within ideal range

 $\frac{Colonies}{100\,mL} = \frac{\sum Colonies\,counted}{\sum mL\,sample\,filtered} \times 100$

HERRERA

2200 Sixth Avenue | Suite 1100 Seattle, Washington | 98121 p 206 441 9080 | f 206 441 9108 PORTLAND, OR | MISSOULA, MT | OLYMPIA, WA WINTHROP, WA | GUANGZHOU, CHINA

Chain of Custody Record



Project Name:	Project N	Number:	Client:						<u></u>		A	nalvses	Reque	sted				T
Lake Whatcom North Shore Water Testing	16-063	26-000	LWWD	n		· · ·												land g
Report To:	<u>, 73</u> 1 - 11 -		Сору То:					5 		· · :	1997 - 1997 1997 - 1997							
Rob Zisette									. :									
Sampled By:			Delivery Method	1:							. :		1				1	n te i
R. Zisette, G. Catarra			Hand deliver	ed	· · · · · · · · · · · · · · · · · · ·		ι Σ	teria		-				· ·	1: -			
Laboratory:	F	Requested Cor	mpletion Date:	Total No.	of Contai	ners:	aine	pac										
LabCorp		24	hrs	1 11.	18		out	E			1		1 .		, te d	. :	11.2	
Lab Use:	······································			1		<u> </u>	of	olifo									* .	ó
Private and the Private Privat	tron :	n an		Sample	Preserv-	Matrix	nbei	<u>0</u>	10	:		:			1 · .			.⊒
Sample ID / DCSCripti	on	Date	Time	codes)	(Y/N)	codes)	Nur -	. Ч.	<u>ш</u>				1.1					Lab
ci / control-lake 5,	50 ml	3/29/17	1001	G	N	SW	1	X	X							· ·		
$[\mathbf{C}_{2}]$		3/29/17	1012	G	N N	SW	1	X	X									1
1L / Lake Water		3/29/17	1056	G	N	SW	1.1	X	X		· · · · · · · · · · · · · · · · · · ·			1				
2D / Dischargewater		3/29/17	1108	G	Ň.	SW	1	X	X	· · · ·								
3 🗅		3/29/17	1121	G	N	SW	1	X ¹	X									
4 D		3/29/17	1136	G	N	SW	1	X	X						·			
5 D		3/29/17	1150	G	N	SW	1	X	X									
6 D		3/29/17	1210	G	N _e e:	SW	1	X :	X									1
7 Ď		3/29/17	1233	G	N	SW	1.	X	X		· · · · ·			:				
8 D		3/29/17	1255	G	N	SW	1	. : X	X	• :								
90	χ .	3/29/17	/305	G	N	SW	1	X	X									
Comments/Special Instructions:							· .: ·				· · ·	· · · ·					! :::	
							<u></u>	Arto		7000	1 7	Marki	41	æ			i di	
Relinguished by (Name/CO/ / Signature	·····		Date/Time	Re	ceived By	(Name/CC	$(\underline{v},\underline{v})$	ann		ienatri	- FC			,		Date/T	ime 4	2.4.4.4
Rob Zieotta/llama	n	1. Al	3/2/17	0500 10	Pshi	011 Ti	Sna	•		(0	2 -	1_	- 11 - 1 - 1 6 - 1			3/2=	line	AM
Relinquished by (Name/CO/ Signature	· /	Juno	Date/Time	Re	ceived By	(Name/CC				ignatu	re	02	y			ノ <u>(30</u> Date/I	<u>117</u> ime	<u></u>

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)

Signature

gc. Lake Whatcom COC.docx

HERRERA

Date/Time

HERRERA

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Project Name:	Project	Number:	Client:	<u></u>							Δ	nalvses	Reque	sted	<u> </u>		<u></u>	<u> </u>
Lake Whatcom North Shore Water Testing	16-06	326-000							[·····			liaryses	Incque		1			t in
Report To:	10 00	320 000	Copy To:		· · · ·													. ⁶¹ 1 -
Rob Zisette							· · :		· ·								-	1111 - 1 1 1 - 1
Sampled By:	inter p	· · · · ·	Delivery Method	in i		<u> </u>		, . 	·		• • • • •						· · · · · ·	
R. Zisette, G. Catarra			Hand deliver	ed			S	teria							· · · ·			
Laboratory:		Requested Cor	npletion Date:	Total No.	of Contair	iers:	aine	bac						•	: · · · · · · · · · · · ·			
LabCorp	-11 	27	hours		18		Cont	E E					·····					
Lab Use:	V512			Sample Type (see	Preserv- ative?	Matrix (see	imber of	cal colife	Coli		· · ·		· . ·					o ID No.
Sample ID / DC C		Date	Time	codes)	(Y/N)	codes)	ž	<u>ः</u> स्	<u>сыі</u>	: : 		• • • •		: <u>.</u>				- a
10 b / Discharge Water 5, 4	50 mL	, 3/29/17	1325	G	N	SW	1	X .	X		11 1 7.0				· · · · · · · · · · · · · · · · · · ·			
11 D	· 	3/29/17	1339	G	N.	SW	1	X :	X :		:	:		·				· .
12 Ď		3/29/17	1357	G	N	SW .	1	X	X							: :		
13)		3/29/17	1412	G	N	SW	1	X	X									
		3/29/17	1428	G	N	SW	1	X	X									· · · ·
OSS (Raw sewage) 0.01 r	nL	3/29/17	1541	G	N	0	1	X	X	1.77.								
150 / Discharge water 5,5	omb	3/29/13	7 1447	G	N	SW	j	X	X	. :			-	-				
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la de la composición de la composición La composición de la c	····			· · · · ·		:			··· : · ·		· · · · · · · · · · · ·	:				::		
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Comments/Special Instructions:		· · · · ·			······			م ا	L	L		· ·						ببنا ·
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gc Lake Whatcom COC.docx Project Name HERRERA



24 April 2017

Rob Zisette Herrera Environmental Consultants 2200 6th Avenue, Suite 1100 Seattle, WA 98121

RE: Lake Whatcom North Shore Testing

Please find enclosed sample receipt documentation and analytical results for samples from the project referenced above.

Sample analyses were performed according to ARI's Quality Assurance Plan and any provided project specific Quality Assurance Plan. Each analytical section of this report has been approved and reviewed by an analytical peer, the appropriate Laboratory Supervisor or qualified substitute, and a technical reviewer.

Should you have any questions or problems, please feel free to contact us at your convenience.

Associated Work Order(s) 17C0454

Associated SDG ID(s) N/A



I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed in the enclose Narrative. ARI, an accredited laboratory, certifies that the report results for which ARI is accredited meets all the reqirements of the accrediting body. A list of certified analyses, accreditations, and expiration dates is included in this report.

Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his/her designee, as verified by the following signature.

Analytical Resources, Inc.

Mark Harris, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.



Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number:	Turn-around	Turn-around Requested:				Page: / of 2					Analytical Resources, Incorporated Analytical Chemists and Consultan			
ARI Client Company: HENYUVA	2	Phone:	7826	-2	Date:	Date: 3/29/17 Present?					4611 S Tukwili	outh 134th Place, Suite 100 a, WA 98168		
Client Contact: Rob ZiseHe					No. of Coolers:	No. of Cooler Coolers: Cooler Temps:					206-695-6200 206-695-6201 (fax) www.arilabs.com			
Client Project Name: Lake Whatcom	North SI	rove Wa	iter To	sting		1		Analysis	Requested	1	1	Notes/Comments		
Client Project #: 14 - 06326-000	Samplers: R.2	selte,	G. Cat	arva	al Sph.	wide,						anulyses		
Sample ID	Date	Time	Matrix	No. Containers	Pho.	Brow						bacteria results.		
CI	3/29/17	- 100)	W	2×spe	\otimes	\otimes								
C2	1	1012		1	1)								
12		1056												
20		1108												
3D		1121												
45		1136												
50		1150							1					
6D		1210						-						
70		1233						1						
80	V	1255	4	Y	+	Y								
Comments/Special Instructions	Relinquished by: (Signature)	THEG	tarra	Received by: (Signature)	with	y the	20	Relinquished (Signature)	by:		Received by (Signature)			
	Printed Name:	Cata	INA	Printed Name:	ittre	S Ha	11	Printed Name	9:		Printed Nam	e:		
	Company:	vera		Company:	T	1		Company:			Company:			
	Date & Time:	133	1	Date & Time: 31301	17	13:	31	Date & Time:			Date & Time			

Lignits of Liability: ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program recets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for signed services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or cosigned agreement between ARI and the Client.

Sample Retention Policy: All samples submitted to ARI will be appropriately discarded no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer, unless alternate retention schedules have been established by work-order or contract.

Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number:	Number: Turn-around Requested: 454					Page: 2 of 2					Analytical Resources, Incorporated Analytical Chemists and Consultant			
ARI Client Company: Herver	a	Phone: 206	7878	262	Date 3/2	9/17	lce Pres	ent?		7	4611 S Tukwila	outh 134th Place, Suite 100 a, WA 98168		
Client Contact: Rob ZiseHe					No. of Cooler Coolers: Temps:						www.arilabs.com			
Client Project Name:	orth Sh	ove wa	ter te	sting		1		Analysis I	Requested		-	Notes/Comments		
Client Project #: 16-06-326-006	Samplers: R-Z	isette,	G,C4	tarva	Shua	vide			E. 61			D-hold analyse		
Sample ID	Date	Time	Matrix	No. Containers	Phosph	Brain						results.		
90	3/29/17	1305	W	2	Ø	\otimes								
IDD	1	1325	1	1	1	1								
ND		1339												
12Þ		1357												
13D		1412												
14D		1428												
DSS	$\overline{\mathbf{A}}$	1541	X	¥	1	4		1						
Comments/Special Instructions	Relinquished by: (Signature)	10 Ca	t	Received by: (Signature)	enth	in the	.00	Relinquished (Signature)	by:		Received by (Signature)			
	Printed Name:	Cata	wa	Printed Name:	itte a	J.H.	11	Printed Name	t.		Printed Nam	a;		
	Company:	veva		Company:	T	4 110		Company:			Company:			
	Date & Time:	7 13	31	Date & Time: 3/301	17	13:	31	Date & Time:			Date & Time:			

Lignits of Liability: ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program neets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or cosigned agreement between ARI and the Client.

Sample Retention Policy: All samples submitted to ARI will be appropriately discarded no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer, unless alternate retention schedules have been established by work-order or contract.

Analytical Resources,	Incorporated
Analytical Chemists ar	nd Consultants

Cooler Receipt Form

ARI Client: Herrera		Project Name: Lake	Iberte	200	
COC No(s):	NA	Delivered by: Fed-Fy LIPS Cou	riar Hand Da		
Assigned ARI Job No: 1700454	-	Tracking No:	her hand De	ivered Other	~
Preliminary Examination Phase:					NA
Were intact, properly signed and dated custod	ly seals attached t	o the outside of to poplar?		11-10-00	~
Were custody papers included with the cooler	?	a the outside of to cooler?		YES	NO
Were custody papers properly filled out (ink s	ioned etc.)		(YES	NO
Temperature of Cooler(s) (°C) (recommended	2.0-6.0 °C for che	mistry)	(YES	NO
	alexa San San	3.6			
in cooler temperature is out of compliance fill c	ut form 00070F		Temp Gun I	D#: 17009	5276
cooler Accepted by:3_+	1-	_Date: 3/30/17_Time	_ 13	31	
og-In Phase:	e custody forms	and attach all shipping documents			
log in i nase.					
Was a temperature blank included in the coole	ır?			VEC	~
What kind of packing material was used?	Bubble Wrag	Weilce Gel Packs Baggies Form	Block Paner	Other:	UNU
Was sufficient ice used (if appropriate)?			NA	YES	NO
Were all bottles sealed in individual plastic bag	ıs?			YES	NO
Did all bottles arrive in good condition (unbroke	∍n)?			YES	NO
Were all bottle labels complete and legible?				YES	NO
Did the number of containers listed on COC m	atch with the numb	per of containers received?		YES	NO
Did all bottle labels and tags agree with custod	y papers?			YES	NO
Were all bottles used correct for the requested	analyses?			YES	NO
Do any of the analyses (bottles) require preser	vation? (attach pre	servation sheet, excluding VOCs)	NA	YES	NO
Were all VOC vials free of air bubbles?			NA	YES	NO
Was sufficient amount of sample sent in each t	ottle?			YES	NO
Was Sample Salish ADL	•••••••••••••••••••••••••••••••••••••••		(NA)	_	
YES	Date/Time:	Equipment:		Split by:	
amples Logged by: 13 - H.	Date	3/31/17	b' FI		
** Notify	Project Manage	of discrepancies or concernent	4.56	0	
		er diser epancies of concerns **			
Sample ID on Bottle Sampl	e ID on COC	Sample ID on Pottle			
A			Sam	ple ID on CO	00
	ь. х				
	. ••				
Additional Notes, Discrepancies, & Resolution	ons:				
hose samples by the	pletely 31	meared and illegib	le.I.i	dentif	ied
in the plane	nomper h	stillen on their li	ds.		
PII	1				
Date: 3/31	40				
Small Air Bubbles Pesbubbles' LARC	E Air Buteles	Small → "sm" (<2 mm)			
	24 mm	Peabubbles \rightarrow "pb" (2 to < 4 mm)			<i>a</i>
000	• •	Large \rightarrow "lg" (4 to < 6 mm)			
		Headspace → "hs" (>6 mm)			

Cooler Receipt Form

Revision 014

Analytical Resources, Incorporated

Printed: 3/31/2017 7:08:59AM

Analytical Chemists and Consultants

WORK ORDER

17C0454

Client: Herrera Environmental Consultants

Project Manager: Mark Harris Project Number: [none]

Project: Lake Whatcom North Shore Testing

Preservation Confirmation

Container ID	Container Type	pH
17C0454-01 A	Small OJ, 500 mL	
17C0454-01 B	Small OJ, 500 mL, 9N H2SO4	L2 Pass
17C0454-02 A	Small OJ, 500 mL	
17C0454-02 B	Small OJ, 500 mL, 9N H2SO4	LZ Pass
17C0454-03 A	Small OJ, 500 mL	
17C0454-03 B	Small OJ, 500 mL, 9N H2SO4	12 Pass
17C0454-04 A	Small OJ, 500 mL	
17C0454-04 B	Small OJ, 500 mL, 9N H2SO4	62 Parc
17C0454-05 A	Small OJ, 500 mL	
17C0454-05 B	Small OJ, 500 mL, 9N H2SO4	L2 PALS
17C0454-06 A	Small OJ, 500 mL	
17C0454-06 B	Small OJ, 500 mL, 9N H2SO4	L2 Pars
17C0454-07 A	Small OJ, 500 mL	
17C0454-07 B	Small OJ, 500 mL, 9N H2SO4	12 Pass
17C0454-08 A	Small OJ, 500 mL	
17C0454-08 B	Small OJ, 500 mL, 9N H2SO4	12 Pars
17C0454-09 A	Small OJ, 500 mL	
17C0454-09 B	Small OJ, 500 mL, 9N H2SO4	12 Pace
17C0454-10 A	Small OJ, 500 mL	
17C0454-10 B	Small OJ, 500 mL, 9N H2SO4	22 Pass
17C0454-11 A	Small OJ, 500 mL	
17C0454-11 B	Small OJ, 500 mL, 9N H2SO4	L2 PARS
17C0454-12 A	Small OJ, 500 mL	
17C0454-12 B	Small OJ, 500 mL, 9N H2SO4	LA Pars
17C0454-13 A	Small OJ, 500 mL	
17C0454-13 B	Small OJ, 500 mL, 9N H2SO4	22 Para
17C0454-14 A	Small OJ, 500 mL	
17C0454-14 B	Small OJ, 500 mL, 9N H2SO4	L2 PALE
17C0454-15 A	Small OJ, 500 mL	
17C0454-15 B	Small OJ, 500 mL, 9N H2SO4	12 Pass
17C0454-16 A	Small OJ, 500 mL	

B.H Reviewed By

3/31/17 Date



WORK ORDER

17C0454	

Client: Herrera Environmental Consultants Project: Lake Whatcom North Shore Testing		Project Manager: Mark Harris
17C0454-16 B	Small OJ, 500 mL, 9N H2SO4	2 Parts
17C0454-17 A	Small OJ, 500 mL	-0 1055
17C0454-17 B	Small OJ, 500 mL, 9N H2SO4	1.2 Pass

Preservation Confirmed By

<u>3/3///7</u> Date

Reviewed By

B.H.

<u>3/3//17</u> Date

Page⁶75% 06 393

Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000

Reported: 24-Apr-2017 12:15

ANALYTICAL REPORT FOR SAMPLES

Project Manager: Rob Zisette

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
C1	17C0454-01	Water	29-Mar-2017 10:01	30-Mar-2017 13:31
C2	17C0454-02	Water	29-Mar-2017 10:12	30-Mar-2017 13:31
1L	17C0454-03	Water	29-Mar-2017 10:56	30-Mar-2017 13:31
2D	17C0454-04	Water	29-Mar-2017 11:08	30-Mar-2017 13:31
3D	17C0454-05	Water	29-Mar-2017 11:21	30-Mar-2017 13:31
4D	17C0454-06	Water	29-Mar-2017 11:36	30-Mar-2017 13:31
5D	17C0454-07	Water	29-Mar-2017 11:50	30-Mar-2017 13:31
6D	17C0454-08	Water	29-Mar-2017 12:10	30-Mar-2017 13:31
7D	17C0454-09	Water	29-Mar-2017 12:33	30-Mar-2017 13:31
8D	17C0454-10	Water	29-Mar-2017 12:55	30-Mar-2017 13:31
9D	17C0454-11	Water	29-Mar-2017 13:05	30-Mar-2017 13:31
10D	17C0454-12	Water	29-Mar-2017 13:25	30-Mar-2017 13:31
11D	17C0454-13	Water	29-Mar-2017 13:39	30-Mar-2017 13:31
12D	17C0454-14	Water	29-Mar-2017 13:57	30-Mar-2017 13:31
13D	17C0454-15	Water	29-Mar-2017 14:12	30-Mar-2017 13:31
14D	17C0454-16	Water	29-Mar-2017 14:28	30-Mar-2017 13:31
OSS	17C0454-17	Water	29-Mar-2017 15:41	30-Mar-2017 13:31

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Analytical Report

Reported: 24-Apr-2017 12:15

Case Narrative

Client: Herrera Environmental Consultants **Project:** Lake Whatcom North Shore Testing **Workorder:** 17C0454

Sample receipt

The samples listed on the preceding page were received 30-Mar-2017 13:31 under ARI work order 17C0454. For details regarding sample receipt, please refer to the Cooler Receipt Form.

Wet Chemistry

These samples were prepared and analyzed within the recommended holding times.

All initial and continuing calibrations were within method requirements.

A small amount of chloride was detected in the method blank (MB) associated with these samples. Choride was detected in all samples associated with this MB. Since the concentrations of chloride measured in the samples were significantly greater than the amount found in the blank, no corrective actions were taken.

A small amount of total phosphorous was detected in the MB associated with these samples. Total phosphorous was detected in all samples associated with this MB. All samples that contained total phosphorous at concentrations that were less than 10x the amount found in the MB were re-prepared and re-analyzed. Total phosphorous was not detected in the re-analyses of the MBs. The results for the re-analyses only have been submitted for these samples. No other target compounds were detected in the MBs above the LOQs.

The percent recoveries for all compounds were within acceptable QC limits for the LCSs.

A matrix spike (MS) was prepared and analyzed for bromide and chloride in conjunction with sample 'C1'. The percent recoveries for both anions were within acceptable QC limits for the MS.

A matrix duplicate (MD) was prepared and analyzed for bromide and chloride in conjunction with sample 'C1'. The RPDs for both anions were within acceptable QC limits for the MD.



Chloride

	~ .			_ ·			
Herrera Environmental	Consultants	Project: Lake W	re Testing				
2200 6th Avenue, Suite	1100	Project Number: 16-0632		Reported:			
Seattle, WA 98121		Project Manager: Rob Zis	ette			24-Apr-20	017 12:15
		C1					
		17C0454-01 (Wat Sampled: 03/29/2017	er) 10:01				
		1					
Wet Chemistry					2.00		
Sample Preparation:	Preparation Method: No Prep Wet Che	em					
* *	Preparation Batch: BFD0124	Sample Size: 5	mL				
	Prepared: 04/06/2017 08:52	Final Volume:	5 mL				
Analytical Method: EPA	300.0	Instrument: D2	X500		Aı	nalyzed: 04/	/13/2017 14:09
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
[Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes

16887-00-6

1

0.100

2.59

mg/L

В

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

C1

17C0454-01RE1 (Water) Sampled: 03/29/2017 10:01

Preparation Method: SM 4500-P B-5 Persulfate Sample Preparation: Preparation Batch: BFD0538 Sample Size: 25 mL Prepared: 04/21/2017 13:02 Final Volume: 50 mL Analytical Method: SM 4500-P E-99 Instrument: UV1800-2 Analyzed: 04/22/2017 15:00 Reporting CAS Number Limit Dilution Units Analyte Result Notes 7723-14-0 0.00800 Total Phosphorus ND mg-P/L U 1

Analytical Resources, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

1L 17C0454-03 (Water) Sampled: 03/29/2017 10:56

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 Final Volume: 5	mL 5 mL				
Analytical Method: EPA 300.0		Instrument: DY	K500		Aı	nalyzed: 04	/13/2017 15:16
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	2.56	mg/L	В

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Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

1L 17C0454-03RE1 (Water) Sampled: 03/29/2017 10:56

Sample Preparation:	Preparation Method: SM 4500-P B-5 Preparation Batch: BFD0538 Prepared: 04/21/2017 13:02	B-5 Persulfate Sample Size: 25 mL Final Volume: 50 mL					
Analytical Method: SM 4500-P E-99		Instrument: UV1	300-2		A	nalyzed: 04	/22/2017 15:00
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0120	mg-P/L	

Analytical Resources, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

2D

17C0454-04 (Water) Sampled: 03/29/2017 11:08

Preparation Method: No Prep Wet Chem Sample Preparation: Preparation Batch: BFD0124 Sample Size: 5 mL Prepared: 04/06/2017 08:52 Final Volume: 5 mL Instrument: DX500 Analytical Method: EPA 300.0 Analyzed: 04/13/2017 15:33 Reporting Limit CAS Number Dilution Units Analyte Result Notes 24959-67-9 0.100 Bromide ND U 1 mg/L Reporting Limit CAS Number Dilution Analyte Result Units Notes Chloride 16887-00-6 0.100 2.30 В 1 mg/L



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

2D

17C0454-04RE1 (Water)

Sampled: 03/29/2017 11:08

Sample Preparation:	Preparation Method: SM 4500-P B-5 Preparation Batch: BFD0422 Prepared: 04/18/2017 10:45	Persulfate Sample Size: 2: Final Volume: 5	5 mL 50 mL				
Analytical Method: SM 4500-P E-99		Instrument: UV1	800-2		А	nalyzed: 04	/19/2017 13:47
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0460	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

3D

17C0454-05 (Water) Sampled: 03/29/2017 11:21

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 Final Volume:					
Analytical Method: EPA 300.0		Instrument: D2	X500		Aı	nalyzed: 04/	/13/2017 15:50
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	2.66	mg/L	В



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

3D

17C0454-05RE1 (Water)

Sampled: 03/29/2017 11:21

Sample Preparation:	Preparation Method: SM 4500-P B-5 I Preparation Batch: BFD0538 Prepared: 04/21/2017 13:02	Persulfate Sample Size: 2 Final Volume:	5 mL 50 mL				
Analytical Method: SM 4500-P E-99		Instrument: UV	1800-2		A	nalyzed: 04	/22/2017 15:01
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0140	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

4D

17C0454-06 (Water) Sampled: 03/29/2017 11:36

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA 300.0		Instrument: D2	X500		A	nalyzed: 04	/13/2017 17:00
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	3.10	mg/L	В



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

4D

17C0454-06RE1 (Water)

Sampled: 03/29/2017 11:36

Sample Preparation:	Preparation Method: SM 4500-P B-5 I Preparation Batch: BFD0422 Prepared: 04/18/2017 10:45	Persulfate Sample Size: 2 Final Volume:	5 mL 50 mL				
Analytical Method: SM 4500-P E-99		Instrument: UV	1800-2		А	nalyzed: 04	/19/2017 13:48
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0640	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

5D

17C0454-07 (Water) Sampled: 03/29/2017 11:50

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA 300.0		Instrument: D2	X500		Aı	nalyzed: 04	/13/2017 17:16
Australia		CAC Number	Dilution	Reporting	Denult	TT:: ite	Nutra
Analyte		CAS Number	Dilution	Liinit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	1.77	mg/L	В



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

5D

17C0454-07RE1 (Water)

Sampled: 03/29/2017 11:50

Sample Preparation:	Preparation Method: SM 4500-P B-5 Persulf Preparation Batch: BFD0422 Prepared: 04/18/2017 10:45	ate Sample Size: 2 Final Volume:	5 mL 50 mL				
Analytical Method: SM 45	Instrument: UV	1800-2		А	nalyzed: 04	/19/2017 13:48	
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0660	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

6D 454 08 (W

17C0454-08 (Water) Sampled: 03/29/2017 12:10

Sample Preparation:	Preparation Method: No Prep Wet Chem						
1 1	Preparation Batch: BFD0124	Sample Size: 5	mL				
	Prepared: 04/06/2017 08:52	Final Volume:	5 mL				
Analytical Method: EPA	300.0	Instrument: D2	X500		A	nalyzed: 04/	/13/2017 17:33
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	1.42	mg/L	В
Wet Chemistry					6.00		
Sample Preparation:	Preparation Method: SM 4500-P B-4 Strong	g Acid					
1 1	Preparation Batch: BFD0198	Sample Size: 2	5 mL				
	Prepared: 04/15/2017 12:20	Final Volume:	Final Volume: 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV	1800-2		A	nalyzed: 04/	/17/2017 16:37
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0860	mg-P/L	В



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

8D

17C0454-10 (Water) Sampled: 03/29/2017 12:55

Sample Preparation:	Preparation Method: No Prep Wet Chem						
1 1	Preparation Batch: BFD0124	Sample Size: 5	mL				
	Prepared: 04/06/2017 08:52	Final Volume:	5 mL				
Analytical Method: EPA	300.0	Instrument: D2	X500		A	nalyzed: 04/	/13/2017 17:50
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	1.87	mg/L	В
Wet Chemistry					6.00		
Sample Preparation:	Preparation Method: SM 4500-P B-4 Strong	g Acid					
1 1	Preparation Batch: BFD0198	Sample Size: 2	5 mL				
	Prepared: 04/15/2017 12:20	Final Volume:	50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV	1800-2		A	nalyzed: 04/	/17/2017 16:38
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0880	mg-P/L	В



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

9D

17C0454-11 (Water)

Sampled: 03/29/2017 13:05

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 Final Volume: :	mL 5 mL						
Analytical Method: EPA	300.0	Instrument: D2	X500		A	nalyzed: 04/	4/13/2017 18:07		
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes		
Bromide		24959-67-9	1	0.100	ND	mg/L	U		
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes		
Chloride		16887-00-6	1	0.100	1.46	mg/L	В		
Wet Chemistry					6.00				
Sample Preparation:	Preparation Method: SM 4500-P B-4 Strong Preparation Batch: BFD0198 Prepared: 04/15/2017 12:20	Acid Sample Size: 2 Final Volume: :	5 mL 50 mL						
Analytical Method: SM	4500-P E-99	Instrument: UV	1800-2		A	nalyzed: 04/	/17/2017 16:39		
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes		
Total Phosphorus		7723-14-0	1	0.00800	0.218	mg-P/L	В		

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

10D

17C0454-12 (Water)

Sampled: 03/29/2017 13:25

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: D2	Instrument: DX500				/13/2017 18:23
Analyte Bromide		CAS Number 24959-67-9	Dilution 1	Reporting Limit 0.100	Result ND	Units mg/L	Notes U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	2.17	mg/L	В

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

10D

17C0454-12RE1 (Water)

Sampled: 03/29/2017 13:25

Sample Preparation:	Preparation Method: SM 4500-P B-5 Preparation Batch: BFD0422 Prepared: 04/18/2017 10:45	Persulfate Sample Size: 2 Final Volume: :	5 mL 50 mL				
Analytical Method: SM 4500-P E-99		Instrument: UV1800-2			A	nalyzed: 04	/19/2017 13:49
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0540	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

11D

17C0454-13 (Water)

Sampled: 03/29/2017 13:39

Sample Preparation:	Preparation Method: No Prep Wet Cherr Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	n Sample Size: 5 Final Volume: 5	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: DX	\$500		A	nalyzed: 04/	13/2017 18:40
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	1.71	mg/L	В
Wet Chemistry					6.00		
Sample Preparation:	Preparation Method: SM 4500-P B-4 Str	ong Acid					
	Preparation Batch: BFD0198	Sample Size: 2	5 mL				
	Prepared: 04/15/2017 12:20	Final Volume:	Final Volume: 50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV1	800-2		A	nalyzed: 04/	17/2017 16:40
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0980	mg-P/L	В



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

12D

17C0454-14 (Water)

Sampled: 03/29/2017 13:57

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: D2	X500		Aı	nalyzed: 04	/13/2017 18:57
Analyte Bromide		CAS Number 24959-67-9	Dilution 1	Reporting Limit 0.100	Result ND	Units mg/L	Notes U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	1.80	mg/L	В

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

12D

17C0454-14RE1 (Water)

Sampled: 03/29/2017 13:57

Sample Preparation:	Preparation Method: SM 4500-P B-5 I Preparation Batch: BFD0422 Prepared: 04/18/2017 10:45	Persulfate Sample Size: 2 Final Volume: :	5 mL 50 mL				
Analytical Method: SM 4500-P E-99		Instrument: UV	1800-2		А	nalyzed: 04	/19/2017 13:50
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0620	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

13D

17C0454-15 (Water)

Sampled: 03/29/2017 14:12

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 Final Volume:	mL 5 mL				
Analytical Method: EPA	. 300.0	Instrument: D2	X500		Aı	nalyzed: 04/	/13/2017 19:14
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Bromide		24959-67-9	1	0.100	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	1.38	mg/L	В

Analytical Resources, Inc.

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Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

13D

17C0454-15RE1 (Water)

Sampled: 03/29/2017 14:12

Sample Preparation:	Preparation Method: SM 4500-P B-5 Preparation Batch: BFD0422 Prepared: 04/18/2017 10:45	Persulfate Sample Size: 2 Final Volume:	5 mL 50 mL				
Analytical Method: SM 4	500-P E-99	Instrument: UV	1800-2		A	nalyzed: 04	/19/2017 13:50
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0600	mg-P/L	

Analytical Resources, Inc.

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Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

14D

17C0454-16 (Water)

Sampled: 03/29/2017 14:28

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 mL Final Volume: 5 mL					
Analytical Method: EPA	300.0	Instrument: D2	X500		Aı	nalyzed: 04	/13/2017 19:31
Analyte Bromide		CAS Number 24959-67-9	Dilution 1	Reporting Limit 0.100	Result ND	Units mg/L	Notes U
Analyte		CAS Number	Dilution	Reporting Limit	Result	Units	Notes
Chloride		16887-00-6	1	0.100	1.78	mg/L	В



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

14D

17C0454-16RE1 (Water)

Sampled: 03/29/2017 14:28

Sample Preparation:	Preparation Method: SM 4500-P B-5 F Preparation Batch: BFD0422 Prepared: 04/18/2017 10:45	Persulfate Sample Size: 2. Final Volume: 5	5 mL 50 mL				
Analytical Method: SM 4	500-P E-99	Instrument: UV1	800-2		А	nalyzed: 04	/19/2017 13:50
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	1	0.00800	0.0880	mg-P/L	

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

OSS

17C0454-17 (Water)

Sampled: 03/29/2017 15:41

Sample Preparation:	Preparation Method: No Prep Wet Chem Preparation Batch: BFD0124 Prepared: 04/06/2017 08:52	Sample Size: 5 Final Volume: 5	mL 5 mL				
Analytical Method: EPA	300.0	Instrument: D2	K500		A	nalyzed: 04/	/13/2017 20:21
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Bromide		24959-67-9	10	1.00	ND	mg/L	U
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Chloride		16887-00-6	10	1.00	48.1	mg/L	B, D
Wet Chemistry					6.00		
Sample Preparation:	Preparation Method: SM 4500-P B-4 Stron	ng Acid					
1 1	Preparation Batch: BFD0198	Sample Size: 2	5 mL				
	Prepared: 04/15/2017 12:20	Final Volume:	50 mL				
Analytical Method: SM	4500-P E-99	Instrument: UV1	800-2		At	nalyzed: 04/	/17/2017 16:43
				Reporting			
Analyte		CAS Number	Dilution	Limit	Result	Units	Notes
Total Phosphorus		7723-14-0	20	0.160	10.2	mg-P/L	B, D



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

Wet Chemistry - Quality Control

Batch BFD0124 - No Prep Wet Chem

Instrument: DX500

QC Sample/Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Blank (BFD0124-BLK1)			Prep	ared: 06-Apr	-2017 Ana	alyzed: 13-	Apr-2017 13	3:32		
Bromide	ND	0.100	mg/L							U
Chloride	0.103	0.100	mg/L							*
Blank (BFD0124-BLK2)			Prep	ared: 06-Apr	-2017 Ana	alyzed: 13-	Apr-2017 14	4:26		
Bromide	ND	0.100	mg/L							U
Chloride	ND	0.100	mg/L							U
LCS (BFD0124-BS1)			Prep	ared: 06-Apr	-2017 Ana	alyzed: 13-	Apr-2017 13	3:49		
Bromide	3.03	0.100	mg/L	3.00		101 %	75-125			
Chloride	2.94	0.100	mg/L	3.00		97.8 %	75-125			В
Duplicate (BFD0124-DUP1)	Source:	17C0454-01	Prep	ared: 06-Apr	-2017 Ana	alyzed: 13-	Apr-2017 14	4:43		
Bromide	ND	0.100	mg/L		ND					U
Chloride	2.59	0.100	mg/L		2.59			0.23	20	В
Matrix Spike (BFD0124-MS1)	Source:	17C0454-01	Prep	ared: 06-Apr	-2017 Ana	alyzed: 13-	Apr-2017 15	5:00		
Bromide	1.94	0.100	mg/L	2.00	ND	96.8 %	75-125			
Chloride	4.76	0.100	mg/L	2.00	2.59	109 %	75-125			В

Recovery limits for target analytes in MS/MSD QC samples are advisory only.

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

Wet Chemistry - Quality Control

Batch BFD0198 - SM 4500-P B-4 Strong Acid

Instrument: UV1800-2

QC Sample/Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Blank (BFD0198-BLK1)			Prepa	ared: 15-Ap	-2017 An	alyzed: 17-	Apr-2017 16	5:11		
Total Phosphorus	0.0100	0.00800	mg-P/L							*
Blank (BFD0198-BLK2)			Prepa	ared: 15-Ap	-2017 An	alyzed: 17-	Apr-2017 16	5:36		
Total Phosphorus	0.0100	0.00800	mg-P/L							*
DL (BFD0198-BLK3)			Prepa	ared: 15-Ap	-2017 An	alyzed: 17-	Apr-2017 16	5:44		
Total Phosphorus	0.00800	0.00800	mg-P/L							*
Blank (BFD0198-BLK4)			Prepa	ared: 15-Ap	-2017 An	alyzed: 17-	Apr-2017 16	5:47		
Total Phosphorus	0.0100	0.00800	mg-P/L							*
LCS (BFD0198-BS1)			Prepa	ared: 15-Api	-2017 An	alyzed: 17-	Apr-2017 16	5:11		
Total Phosphorus	0.304	0.00800	mg-P/L	0.300		101 %	90-110			В
DL (BFD0198-BS2)			Prepa	ared: 15-Ap	-2017 An	alyzed: 17-	Apr-2017 16	5:37		
Total Phosphorus	0.300	0.00800	mg-P/L	0.300		100 %	90-110			В
DL (BFD0198-BS3)			Prepa	ared: 15-Api	:-2017 An	alyzed: 17-	Apr-2017 16	5:45		
Total Phosphorus	0.304	0.00800	mg-P/L	0.300		101 %	90-110			В
LCS (BFD0198-BS4)			Prepa	ared: 15-Api	-2017 An	alyzed: 17-	Apr-2017 16	5:48		
Total Phosphorus	0.304	0.00800	mg-P/L	0.300		101 %	90-110			В

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

Wet Chemistry - Quality Control

Batch BFD0422 - SM 4500-P B-5 Persulfate

Instrument: UV1800-2

QC Sample/Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Blank (BFD0422-BLK1)			Prepa	ared: 18-Ap	r-2017 An	alyzed: 19-	Apr-2017 13	:33		
Total Phosphorus	ND	0.00800	mg-P/L							U
Blank (BFD0422-BLK2)			Prepa	ared: 18-Ap	r-2017 An	alyzed: 19-	Apr-2017 13	:52		
Total Phosphorus	ND	0.00800	mg-P/L							U
DL (BFD0422-BLK3)			Prepa	ared: 18-Ap	r-2017 An	alyzed: 19-	Apr-2017 14	:00		
Total Phosphorus	ND	0.00800	mg-P/L							U
Blank (BFD0422-BLK4)			Prepa	ared: 18-Ap	r-2017 An	alyzed: 19-	Apr-2017 14	:01		
Total Phosphorus	ND	0.00800	mg-P/L							U
LCS (BFD0422-BS1)			Prepa	ared: 18-Ap	r-2017 An	alyzed: 19-	Apr-2017 13	:33		
Total Phosphorus	0.294	0.00800	mg-P/L	0.300		98.0 %	90-110			
DL (BFD0422-BS2)			Prepa	ared: 18-Ap	r-2017 An	alyzed: 19-	Apr-2017 13	:52		
Total Phosphorus	0.296	0.00800	mg-P/L	0.300		98.7 %	90-110			
DL (BFD0422-BS3)			Prepa	ared: 18-Ap	r-2017 An	alyzed: 19-	Apr-2017 14	:00		
Total Phosphorus	0.294	0.00800	mg-P/L	0.300		98.0 %	90-110			
LCS (BFD0422-BS4)			Prepa	ared: 18-Ap	r-2017 An	alyzed: 19-	Apr-2017 14	:02		
Total Phosphorus	0.296	0.00800	mg-P/L	0.300		98.7 %	90-110			

Analytical Resources, Inc.



Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

Wet Chemistry - Quality Control

Batch BFD0538 - SM 4500-P B-5 Persulfate

Instrument: UV1800-2

QC Sample/Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Blank (BFD0538-BLK1)			Prepa	ared: 21-Apr	r-2017 An	alyzed: 22-	Apr-2017 14	:30		
Total Phosphorus	ND	0.00800	mg-P/L							U
Blank (BFD0538-BLK2)			Prepa	ared: 21-Apr	r-2017 An	alyzed: 22-	Apr-2017 15	:04		
Total Phosphorus	ND	0.00800	mg-P/L							U
DL (BFD0538-BLK3)			Prepa	ared: 21-Apr	r-2017 An	alyzed: 22-	Apr-2017 15	:12		
Total Phosphorus	ND	0.00800	mg-P/L							U
Blank (BFD0538-BLK4)			Prepa	ared: 21-Apr	r-2017 An	alyzed: 22-	Apr-2017 15	:14		
Total Phosphorus	ND	0.00800	mg-P/L							U
LCS (BFD0538-BS1)			Prepa	ared: 21-Apr	r-2017 An	alyzed: 22-	Apr-2017 14	:31		
Total Phosphorus	0.296	0.00800	mg-P/L	0.300		98.7 %	90-110			
DL (BFD0538-BS2)			Prepa	ared: 21-Apr	r-2017 An	alyzed: 22-	Apr-2017 15	:05		
Total Phosphorus	0.296	0.00800	mg-P/L	0.300		98.7 %	90-110			
DL (BFD0538-BS3)			Prepa	ared: 21-Apr	r-2017 An	alyzed: 22-	Apr-2017 15	:13		
Total Phosphorus	0.298	0.00800	mg-P/L	0.300		99.3 %	90-110			
LCS (BFD0538-BS4)			Prepa	ared: 21-Apr	r-2017 An	alyzed: 22-	Apr-2017 15	:15		
Total Phosphorus	0.296	0.00800	mg-P/L	0.300		98.7 %	90-110			

Analytical Resources, Inc.



WA-DW

Herrera Environmental Consultants	Project: Lake Whatcom North Shore Testing	
2200 6th Avenue, Suite 1100	Project Number: 16-06326-000	Reported:
Seattle, WA 98121	Project Manager: Rob Zisette	24-Apr-2017 12:15

Certified Analyses included in this Report

Ecology - Drinking Water

Analyte	Certifications						
EPA 300.0 in V	Vater						
Bromide	DoD-ELAP,WADOE,NELAP	DoD-ELAP,WADOE,NELAP					
Chloride	DoD-ELAP,WADOE,WA-DV	DoD-ELAP,WADOE,WA-DW,NELAP					
SM 4500-P E-9	9 in Water						
Total Phosph	orus WADOE,NELAP						
Code	Description	Number	Expires				
ADEC	Alaska Dept of Environmental Conservation	UST-033	05/06/2017				
CALAP	California Department of Public Health CAELAP	2748	02/28/2018				
DoD-ELAP	DoD-Environmental Laboratory Accreditation Program	66169	03/30/2017				
NELAP	ORELAP - Oregon Laboratory Accreditation Program	WA100006	05/11/2017				
WADOE	WA Dept of Ecology	C558	06/30/2017				

Analytical Resources, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

C558

06/30/2017



Analytical Report

Herrera Environmental Consultants 2200 6th Avenue, Suite 1100 Seattle, WA 98121 Project: Lake Whatcom North Shore Testing Project Number: 16-06326-000 Project Manager: Rob Zisette

Reported: 24-Apr-2017 12:15

Notes and Definitions

*	Flagged value is not within established con	ntrol limits.

- B This analyte was detected in the method blank.
- D The reported value is from a dilution
- U This analyte is not detected above the applicable reporting or detection limit.
- DET Analyte DETECTED
- ND Analyte NOT DETECTED at or above the reporting limit
- NR Not Reported
- dry Sample results reported on a dry weight basis
- RPD Relative Percent Difference
- [2C] Indicates this result was quantified on the second column on a dual column analysis.

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4985 SW 74th Court, Miami, FL 33155 USA Tel: (1) 786-220-0379, Fax: (1) 786-513-2733, Email: info@sourcemolecular.com

Preliminary Interpretation of Human Fecal Pollution ID[™] Results

Detection and quantification of the fecal Human gene biomarker for Human fecal contamination by Droplet Digital Polymerase Chain Reaction (ddPCR) DNA analytical technology

> Submitter: Herrera Environmental Consultants Date Received: March 31, 2017 Report Generated: April 7, 2017

SM #	Client #	Approximate Contribution of Human Fecal Pollution in Water Sample	Comment
SM-7C31005	C1	Not Detected	Human fecal biomarkers not detected
SM-7C31007	1L	Not Detected	Human fecal biomarkers not detected
SM-7C31008	2D	Not Detected	Human fecal biomarkers not detected
SM-7C31009	3D	Not Detected	Human fecal biomarkers not detected
SM-7C31010	4D	Moderate Concentration	Moderate levels of Human fecal biomarker(s)
SM-7C31011	5D	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C31012	6D	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C31014	8D	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C31015	9D	Not Detected	Human fecal biomarkers not detected
SM-7C31016	10D	Low Concentration	Low levels of 2 Human fecal biomarkers
SM-7C31017	11D	Not Detected	Human fecal biomarkers not detected
SM-7C31018	12D	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C31019	13D	Not Detected	Human fecal biomarkers not detected
SM-7C31020	14D	Low Concentration	Low levels of 1 Human fecal biomarker
SM-7C31021	OSS (Raw Sewage)	High Concentration	High levels of Human fecal biomarker(s)

Limitation of Damages – Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The client must contact Source Molecular in writing within 10 days from the date of this report if he/she does not wish for their submitted sample(s) to be used for any type of future research.



4985 SW 74th Court, Miami, FL 33155 USA Tel: (1) 786-220-0379, Fax: (1) 786-513-2733, Email: info@sourcemolecular.com

Human Fecal Pollution ID[™] Quantification

Detection and quantification of the fecal Human gene biomarker for Human fecal contamination by Droplet Digital Polymerase Chain Reaction (ddPCR) DNA analytical technology

Submitter: Herrera Environmental Consultants Date Received: March 31, 2017 Report Generated: April 7, 2017

SM #	Client #	Analysis Requested	Target	Marker Quantified (copies/100 ml)	DNA Analytical Results
SM-7C31005	C1	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C31007	1L	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C31008	2D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C31009	3D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C31010	4D	Human Bacteroidetes ID 1	Dorei	2.17E+04	Present
SM-7C31011	5D	Human Bacteroidetes ID 1	Dorei	1.12E+02	Present
SM-7C31012	6D	Human Bacteroidetes ID 1	Dorei	<loq< td=""><td>Present</td></loq<>	Present
SM-7C31014	8D	Human Bacteroidetes ID 1	Dorei	8.70E+01	Present
SM-7C31015	9D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C31016	10D	Human Bacteroidetes ID 1	Dorei	<loq< td=""><td>Present</td></loq<>	Present
SM-7C31017	11D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C31018	12D	Human Bacteroidetes ID 1	Dorei	1.07E+02	Present
SM-7C31019	13D	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-7C31020	14D	Human Bacteroidetes ID 1	Dorei	2.78E+02	Present
SM-7C31021	OSS (Raw Sewage)	Human Bacteroidetes ID 1	Dorei	1.46E+03	Present
SM-7C31022	C1	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31024	1L	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31025	2D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31026	3D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31027	4D	Human Bacteroidetes ID 2	EPA	1.61E+03	Present
SM-7C31028	5D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31029	6D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31031	8D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31032	9D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31033	10D	Human Bacteroidetes ID 2	EPA	9.96E+03	Present
SM-7C31034	11D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31035	12D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31036	13D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31037	14D	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-7C31038	OSS (Raw Sewage)	Human Bacteroidetes ID 2	EPA	1.41E+05	Present

ND: Not Detected

<LOQ: Detected below level of quantification

Laboratory Comments Submitter: Herrera Environmental Consultants Report Generated: April 7, 2017

Negative Results

In sample(s) classified as negative, the human-associated Bacteroidetes gene biomarker(s) was either not detected in test replicates, one replicate was detected at a concentration below 3 copies/copies/20µL and the other was not, or one replicate was detected at a concentration above 3 copies/copies/20µL and the other was not after repeated analysis. It is important to note that a negative result does not mean that the sample does not definitely have human fecal contamination. Only repeated sampling (both during wet and dry sampling events) will enable you to draw more definitive conclusions as to the contributor(s) of fecal pollution.

In order to strengthen the result, a negative sample should be analyzed further for human fecal contamination with other DNA analytical tests. A list of human fecal ID tests can be found at **www.sourcemolecular.com/human**.

Positive Results

In sample(s) classified as positive, the human-associated Bacteroidetes gene biomarker(s) was detected in both test replicates suggesting that human fecal contamination is present in the water sample(s). The biomarker(s) serve as an indicator of the targeted fecal pollution, but the presence of the biomarker does not signify conclusively the presence of that form of fecal pollution. Only repeated sampling (both during wet and dry sampling events) will enable you to draw more definitive conclusions as to the contributor(s) of fecal pollution.

Detected Not Quantified (DNQ) Results

In sample(s) classified as detected not quantified (DNQ), the human-associated Bacteroidetes biomarker was detected in both test replicates but in low, non-quantifiable quantities. This result indicates that fecal indicators associated with human were present in the sample(s) but in low concentrations.

Human Fecal Reference Samples

The client is encouraged to submit samples from the surrounding wastewater facilities and/or septic systems in order to gain a better understanding of the concentration of the human-associated fecal Bacteroidetes genetic marker as well as the concentration of the general fecal Bacteroidetes genetic marker in the geographic region of interest. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

Quantitative results are reported along with interpretations. Interpretations are given as "negative", "trace", "low concentration", "moderate concentration", or "high concentration" based on the concentration of the genetic markers found in the water samples.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination. A list of available tests can be found at www.sourcemolecular.com/tests

DNA Analytical Method Explanation

All reagents, chemicals, and apparatuses were verified and inspected beforehand to ensure that no false negatives or positives could be generated. In that regard, positive and negative controls were run to attest the integrity of the analysis. All inspections and controls tested negative for possible extraneous contaminants.

Each submitted water sample was filtered through 0.45-micron membrane filters. Each filter was placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample was homogenized and the DNA extracted and purified.

Sample DNA was amplified and analyzed with a Bio-Rad QX200 Droplet Digital PCR System (Bio-Rad Laboratories, Inc.). Samples were processed in duplicate in a 20µL reaction containing DNA extract, forward primer, reverse primer, probe (as appropriate) and an optimized buffer solution. Absolute quantification was achieved by software Poisson Distribution Analysis.

For quality control purposes, a positive control consisting of genomic or synthetic DNA, and three negative controls consisting of PCR-grade water were run alongside the sample(s) to monitor for any false negatives or false positives.

Human Bacteroidetes ID[™] Species: B. dorei

The Human Bacteroidetes ID[™] Species: B. dorei service targets the species Bacteroides dorei. B. dorei is an anaerobe that is frequently shed from the gastrointestinal tract and isolated from human feces worldwide. It is a newly discovered species that is widely distributed in the USA.^{1,2} The human-associated marker DNA sequence is located on the 16S rRNA gene of *B. dorei.*³ The marker is the microbial source tracking (MST) marker of choice for detecting human fecal pollution due to its exceptional sensitivity and specificity. Internal validations have been conducted on hundreds of sewage, septage, human and animal host fecal samples collected from throughout the U.S and archived in the Source Molecular fecal bank. The marker has also been evaluated in both inland and coastal waters. A recent, comprehensive, multilaboratory MST method evaluation study, exploring the performance of current MST methods, concluded the B. dorei PCR assay to be the top performing human-associated assay amongst those tested. The success and consistency of this marker in numerous studies around the world^{1,3,4} makes the **Human** Bacteroidetes IDTM Species: B. dorei service the primary service for identifying human fecal pollution at Source Molecular.

Fecal Bacteroidetes are considered for several reasons an interesting alternative to more traditional indicator organisms such as E. coli and Enterococci.⁵ Since they are strict anaerobes, they are indicative of recent fecal contamination when found in water systems. This is a particularly strong reference point when trying to determine recent outbreaks in fecal pollution. They are also more abundant in feces of warmblooded animals than E. coli and Enterococci.

The Human Bacteroidetes ID[™] service is designed around the principle that fecal Bacteroidetes are found in large quantities in feces of warm-blooded animals.^{3,5,6,7,8} Furthermore, certain strains of Bacteroidetes have been found to be associated with humans.^{3,6} As such, these bacterial strains can be used as indicators of human fecal contamination.

Accuracy of the results is possible because the method amplifies DNA into a large number of small copies of the gene biomarker of interest. This is accomplished with small pieces of DNA called primers that are complementary and specific to the unique B. dorei DNA sequence. Through a heating process called thermal cycling, the double stranded DNA is denatured, hybridized to the complementary primers and amplified to create many copies of the DNA fragment desired. If the primers are successful in finding a site on the DNA fragment that is specific to the B. dorei DNA sequence, then billions of copies of the DNA fragment will be available, detected and quantified.

To strengthen the validity of the results, additional tests targeting other high-ranking, human-associated Bacteroidetes species should be performed, such as

Human Bacteroidetes ID[™] Species: B. stercoris,

Human Bacteroidetes ID[™] Species: B. fragilis, and

Human Bacteroidetes ID[™] Species: B. thetaiotaomicron.

²Bakir, M., Sakamoto, M., Kitahara, M., Matsumoto, M., Benno, Y. Bacteroides dorei sp. nov., isolated from human faeces. Int. J. Syst. Evol. Microbiol. 2006 56: 1639-1641.

³ Bernhard, A., Field, K. A PCR assay to discriminate human and ruminant feces on the basis of host differences in Bacteroides-Prevotella genes encoding 16S rRNA. Appl. Environ. Microbiol. 2000b 66: 4571-4574.

¹Boehm, A., Fuhrman, J., Mrse, R., Grant, S. Tiered approach for identification of a human fecal pollution source at a recreational beach: case study at Avalon Bay, Catalina Island, California. Environ Sci Technol. 2003 37: 673-680.

⁴Ahmed, w., Masters, N., Toze, S. Consistency in the host specificity and host sensitivity of the Bacteroides HF183 marker for sewage pollution tracking. Lett. Appl. Microbiol. 2012 55: 283-289.

⁵ Scott, T., Rose, J., Jenkins, T., Farrah, S., Lukasik, J. Microbial Source Tracking: Current Methodology and Future Directions. Appl. Environ. Microbiol. 2002 68: 5796-5803.

⁶ Bernhard, A., Field, K. Identification of nonpoint sources of fecal pollution in coastal waters by using host-specific 16S ribosomal DNA genetic markers from fecal anaerobes. Appl. Environ. Microbiol. 2000a 66: 1587-1594. ⁷ Eccentry L. Voytek M. A Comparison of Bacteroides-Prevetella 16S rPNA Constic Markers for Fecal Samples from Different Animal

Human Bacteroidetes ID[™]: EPA Developed Assay

The Human Bacteroidetes IDTM: EPA Developed Assay service targets a functional gene biomarker in Bacteroidales-like anaerobic bacteria that is present in high concentrations in the human gut. The U.S. Environmental Protection Agency (U.S. EPA) was the first to target the biomarker using Polymerase Chain Reaction (PCR) technology in order to detect ground and surface waters impacted by human fecal pollution.¹ Since it's development, the assay has been used succesfully around the U.S to identify fecal pollution originating from human sources, such as sewage and septage wastewaters.

The U.S. EPA Developed assay has been shown to be highly associated with human fecal pollution. It has successfully been validated in multiple nationwide studies using at least 300 individual reference fecal material from 22 different animal species known to commonly contaminate environmental waters.^{1,2} A reported 99.2% specificity to human fecal material makes this one of the leading assays to confirm the presence of fecal contamination that is of human origin.¹ The *Bacteroidales*-like bacteria is widely distributed. It was detected in 100% of hundreds of sewage and human reference fecal samples collected from more than 20 human populations, making it highly sensitive. Internal validations have also been conducted on hundreds of wastewater, human and animal host fecal samples archived in the Source Molecular fecal bank.

Fecal anaerobic bacteria are considered for several reasons an interesting alternative to more traditional fecal indicator organisms such as E. coli and Enterococci.³ Since they are strict anaerobes, they are indicative of recent fecal contamination when found in water systems.³ This is a particularly strong reference point when trying to determine recent outbreaks in fecal pollution. They are also more abundant in feces of warm-blooded animals than E. coli and Enterococci.

The Human Bacteroidetes ID[™]: EPA Developed Assay service is designed around the principle that fecal Bacteroidales-like bacteria are found in large quantities in feces of warm-blooded animals.^{4,5} Furthermore, certain strains have been shown to be associated with humans.^{4,5} As such, these bacterial strains can be used as indicators of human fecal contamination. An advantage of the Human Bacteroidetes ID[™] service is that the entire portion of water sampled is filtered to concentrate bacteria. As such, this method avoids the randomness effect of culturing and selecting bacterial isolates. This is an advantage for highly contaminated water systems with potential multiple sources of fecal contamination.

Accuracy of the results is possible because the method amplifies DNA into a large number of small copies of the gene biomarker of interest. This is accomplished with small pieces of DNA called primers that are complementary and specific to the unique B. dorei DNA sequence. Through a heating process called thermal cycling, the double stranded DNA is denatured, hybridized to the complementary primers and amplified to create many copies of the DNA fragment desired. If the primers are successful in finding a site on the DNA fragment that is specific to the B. dorei DNA sequence, then billions of copies of the DNA fragment will be available, detected and quantified.

To strengthen the validity of the results, additional tests targeting other high-ranking, human-associated Bacteroidetes species should be performed, such as Human Bacteroidetes ID[™] Species: *B. dorei*, Human Bacteroidetes ID[™] Species: *B. fragilis*, and Human Bacteroidetes ID[™] Species: *B. stercoris*

¹ Shanks, O., Kelty, C., Sivaganesan, M., Varma, M. and Haugland, R. **Quantitative PCR for Genetic Markers of Human Fecal Pollution**. Appl. Environ. Microbiol. 2009 75: 5507-5513.

² Layton, B., Cao, Y., Ebentier, D., Hanley, K., Ballesté, E., Brandão, J., et al. Performance of Human Fecal Anaerobe-Associated PCR-Based Assays in a Multi-Laboratory Method Evaluation Study. Water Research. 2013 In Press. ³Scott, T., Rose, J., Jenkins, T., Farrah, S. and Lukasik, J. Microbial Source Tracking: Current Methodology and Future Directions. Appl. Environ. Microbiol. 2002 68: 5796-5803.

Scott, T., Rose, J. Jenkins, T., Farrah, S. and Lukasik, J. Microbial Source Tracking: Current Methodology and Future Directions. Appl. Environ. Microbiol. 2002 68: 5796-5803.
Bernhard, A., Field, K. Identification of nonpoint sources of fecal pollution in coastal waters by using host-specific 16S ribosomal DNA genetic markers from fecal anaerobes. Appl. Environ. Microbiol. 2000a 66: 1587-1594.
Bernhard, A., Field, K. A PCR assay to discriminate human and ruminant feces on the basis of host differences in Bacteroides-Prevotella genes encoding 16S rRNA. Appl. Environ. Microbiol. 2000b 66: 4571-4574



Data Quality Assurance Worksheet

		By	G. Catarra	
Project Name/No./Client:	Lake Whatcom / 16-06326-000 / LWWSD.	Date	4/3/2017	Page <u>1</u> of <u>1</u>
Laboratory/Parameters:	LabCor, Inc. / fecal bacteria and E. coli; ARI / TP, Cl/Br; Source Molecular / MST	Checked:	initials	
Sample Date/Sample ID:	3/29/2017 / 18 samples		date	

		Pre-preser Holding 7 (hour	vation Fimes s)	Total Ho Times (d	lding lays)	Method <u>Blanks</u>	Matrix Sp Surroga Recovery	Matrix Spikes/ Surrogate Recovery (%)		trol covery	Lab Dupl RPD (9	icates %)	Field Dup RPD (licates %)		
Parameter	Completeness/ Methodology	Reported	Goal	Reported	Goal	Reporting Limit	Reported Goal		Reported Goal I		Reported	Goal	Reported	Goal ¹	ACTION	
Fecal coliform	OK / SM9222D	NA	NA	1	≤1	≤1.0 2 CFU /100ML	NA	NA	NA	NA	NA	≤35	NA	NA	STATIONS 1, 3, 5-11, 13, 15 "J" due to plate counts. Results calculated per Method.	
E. coli	OK / SM9222D	NA	NA	1	≤1	≤1.0 2	NA	NA	NA	NA	NA	≤35	NA	NA	STATIONS 1, 3, 5-9, 11, 13, 15 "J" due to plate counts. Results calculated per method.	
Total Phosphorus	OK / EPA 365.1	NA	NA	19-24	≤28	≤8.0 – <mark>10</mark> 8.0 µg/L	NA	±20	98-101	±10	NA	≤20	NA	NA	NO FLAG FOR MB, SAMPLES <10X MB WERE REPREPPED AND REANALYZED.	
Chloride	OK / EPA 300.0	NA	≤12	16	≤28	0.103 0.1 mg/L	109	±20	98	±10	0.23	≤20	NA	NA	NO FLAG FOR MB, ALL SAMPLES >10X MB.	
Bromide	OK / EPA 300.0	NA	NA	16	≤28	≤0.1 0.1 mg/L	97	±20	101	±10	NC	≤20	NA	NA	None	
B. Dorei	OK / Digital qPCR	<48	≤48	NA	NA	≤0.01 3	NA	NA	NA	NA	NA	≤ 30 cov	NA	NA	None	
EPA Assay	OK / Digital qPCR	<48	≤48	NA	NA	≤0.05 3	NA	NA	NA	NA	NA	≤ 30 cov	NA	NA	None	

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

PJJ https://herrerainc.sharepoint.com/16-06326-000/shared documents/report/apxb/b16 event 3 qa worksheet.docx

APPENDIX C

Sample Results Database



		Sample						Temp			Sp Cond	Turbidity		Fecal colifo	orm	E coli	EC/FC	B dorei	B EP	A	Bacteroidetes	Total P	Chloride	Brom	nide	Sample Analysis
Station	Station Type	ID	Event	Date	Time	Lat (°)	Long (°)	(°C)	DO (mg/L)	рН	(uS/cm)	(FNU)	OB (RFUB)	(CFU/100r	mL)	(CFU/100mL)	Ratio	(copies/100mL)	(copies/1	.00mL)	Lab Category	(mg/L)	(mg/L)	(mg	/L)	Code
OSS	Septage	OSS	2	3/15/2017	15:50	48.73255	-122.31705	7.8	0.30	6.96	963	26.81	632.9	1500000	Ĺ	1500000 J	1.0	1030	55000	,	Moderate	10.3	46.8	0.10	οU	All parameters
055	Sentage	055	3	3/29/2017	15:41	48 73254	-122 31709	9.1	0.61	6.91	943.8	32.3	686.0	4080000	>	4080000 >	1.00	1460	141000		High	10.2	48.1	0.100		All parameters
11	Lake	11	3	3/29/2017	10:56	48 73429	-122 31767	6.9	11 31	6.92	56.6	0.58	61.7	9	Í	91	1.00	0 ND	0	ND	Not detected	0.012	2 56	0.10		All parameters
21	Lake	41	2	3/15/2017	11.35	48 73649	-122.321707	7.2	11.31	7.08	64.8	2.95	90.51	5	11	511	1.00		0	ND	Not detected	0.012	2.50	0.10		All narameters
31	Lake	31	1	1/19/2017	11:35	48.7369	-122.32124	6.8	11.14	7.00	60.9	2.55	81 17	46	Ŭ	12	0.9	0 110			Not detected	0.010	2.55	0.10		Field + Fecals
41	Lake	111	2	3/15/2017	13:56	48.74635	-122.32150	7.2	11.55	7.55	59.7	0.43	73.0	5	1	51	1.0	3 <	0	ND	Low	0.024.1	2.63	0.10	211	All narameters
51	Lake	121	2	3/15/2017	14:09	48.74695	-122.33763	7.2	11.07	7.10	61.4	1 71	227.7	9	ı,	91	1.0	60	0	ND	Low	0.0245	3.05	0.10		All parameters
 	Lake	 	1	1/19/2017	9.26	48.74085	-122.33832	67	10.42	7.08	50.7	03	8 16	2	, ,	2 II	1.0	00	0	ND	2000	0.030	3.05	0.100	50	Field + Fecals
C1	Lake	C1	2	2/15/2017	0.41	48.72230	-122.30223	6.3	11.55	7.20	57.3	0.5	13.64	5		511	1.0	3 /	0	ND	Low	0.008.11	2.68	0.10	211	All parameters
C1	Lake	C1	2	3/13/2017	10:01	48.72372	-122.30255	6.6	11.55	7.40	56.7	0.41	43.04	2		211	1.0		0		Not detected	0.008 U	2.00	0.10		All parameters
	Lake		1	1/10/2017	0.22	48.72373	122.30237	6.7	10.60	7.41	50.7	0.0	41.1	2		20	1.00	0 110	0	ND	Not detected	0.008 0	2.55	0.100	50	Field + Focals
C2	Lake	C2	1	1/19/2017	9.32	40.72400	-122.30264	6.7	10.00	7.21	57.7	0.2	45.45	2	1	20	1.0							-	-	Field + Fecals
	Lake		2	2/15/2017	9.40	46.72506	-122.50415	6.2	10.60	7.20	50.1	0.2	42.4	4 5	J 11	4 J	1.0		0		Not detected	0.009.11	2.69	0.10		All parameters
	Lake	C2	2	3/13/2017	9.30	48.72304	122.30418	6.7	11.45	7.35	57.0	0.44	44.05			30	1.0		0	ND	Not detected	0.008 0	2.00	0.100	50	
420	Lake	150	2	3/29/2017	10.12	40.72500	-122.50406	0.7	11.07	7.51	57.1	0.25	45.5	2	0	20	1.00						、	-	_	Field + Fecals
429	Discharge	140	5	5/29/2017	14.47	40.74005	-122.54024	0.9 F F	11.47	0.27	0.2	25.0	297	202	J	200 J	0.99							-	_	Field + Fecals
430	Discharge	14D		1/19/2017	13:53	48.74805	-122.34364	5.5	11.85	0.94	61.3	9.1	100.1	125	l. –	100	0.8	2 4	0		1	0.010	2 70	0.10		Field + Fecals
430	Discharge	14D	2	3/15/2017	14:40	48.74866	-122.34368	7.2	11.99	7.33	60.3	1.26	106.1	/	J	/ J	1.0	3 <	0		LOW	0.016	2.70	0.100		All parameters
430	Discharge	14D	3	3/29/2017	14:28	48.74871	-122.34364	8.4	11.47	7.00	57.0	11.4	229	800		82	0.10	278	0	ND	LOW	0.088	1.78 J	0.100	00	All parameters
437	Discharge	13D	1	1/19/2017	13:44	48.74736	-122.33991	5.2	12.17	7.05	41.4	6.4	264.4	18	J	14 J	0.8	0.110	0		Net detected	0.022	1.00	0.40		Fleid + Fecais
437	Discharge	13D	2	3/15/2017	14:20	48.74743	-122.3399	7.6	11.82	7.29	45.6	5.68	264.1	9	J	9 J	1.0	0 ND	0	ND	Not detected	0.032	1.96	0.100		All parameters
437	Discharge	13D	3	3/29/2017	14:12	48.74738	-122.33993	8.0	11.64	7.18	37.7	1.1	270.7	20	J	20 J	1.00	0 ND	0	ND	Not detected	0.060	1.38	0.100	0 0	All parameters
440	Discharge	12D	1	1/19/2017	13:39	48.7469	-122.3386	5.3	11.88	6.85	53.5	3.6	270.0	50	J	32 J	0.6	407	-			0.000	1.00	0.40		Field + Fecals
440	Discharge	12D	3	3/29/2017	13:57	48.7469	-122.33854	8.4	11.14	7.04	49.1	5.11	270.8	44		44	1.00	107	0	ND	Low	0.062	1.80	0.100	0 0	All parameters
449	Discharge	11D	1	1/19/2017	13:29	48.74545	-122.33574	6.6	11.97	7.17	58.8	34.7	106.5	190	J	180	0.9							_	_	Field + Fecals
449	Discharge	10D	2	3/15/2017	13:35	48.74546	-122.33574	7.9	11.87	7.37	59.2	6.63	196.5	2	J	2 J	1.0									Field + Fecals
449	Discharge	11D	3	3/29/2017	13:39	48.74547	-122.33577	7.6	11.89	7.20	48.6	67.15	148.7	20	J	18 J	0.90	0 ND	0	ND	Not detected	0.098	1.71	0.100	U U	All parameters
453	Discharge	9D	2	3/15/2017	13:18	48.74528	-122.33444	6.9	10.48	6.60	59.3	1.38	111.2	38	J	38 J	1.0	3 <	4050		Low	0.014	2.82	0.100	D U	All parameters
453	Discharge	10D	3	3/29/2017	13:25	48.7453	-122.33442	7.6	10.75	6.43	51.4	6.52	157.2	124	J	110	0.89	3 <	9960		Low	0.054	2.17	0.100	D U	All parameters
462	Discharge	10D	1	1/19/2017	13:16	48.74376	-122.33084	5.4	12.21	7.13	57.7	29.7		82	J	64 J	0.8							_	_	Field + Fecals
462	Discharge	8D	2	3/15/2017	13:03	48.74375	-122.33079	7.2	11.94	7.33	59.2	10.17	225.1	4	J	4 J	1.0	3 <	0	ND	Low	0.056	2.08	0.100	υ	All parameters
462	Discharge	9D	3	3/29/2017	13:05	48.74385	-122.33078	7.6	11.77	7.26	49.4	39.41	207.1	15	J	11 J	0.73	0 ND	0	ND	Not detected	0.218	1.46	0.10	0 U	All parameters
466	Discharge	9D	1	1/19/2017	13:07	48.74336	-122.33008	5.4	11.91	6.84	58.1	6.8		73	J	68 J	0.9							_		Field + Fecals
466	Discharge	7D	2	3/15/2017	12:51	48.74335	-122.33005	6.8	11.47	6.96	58.6	14.41	146.8	198	J	191 J	1.0	0 ND	0	ND	Not detected	0.050	2.41	0.100	υ	All parameters
466	Discharge	8D	3	3/29/2017	12:55	48.74333	-122.33004	7.7	11.39	6.94	50.7	17.83	163.2	127	J	122 J	0.96	87	0	ND	Low	0.088	1.87	0.100	U C	All parameters
481	Discharge	8D	1	1/19/2017	12:45	48.74184	-122.32775	6.0	11.88	6.90	67.2	10.9	188.03	5	J	5 J	1.0							_		Field + Fecals
481	Discharge	1-8D	2	3/15/2017	12:43	48.74184	-122.32772	7.3	11.72	7.02	65.8	3.7	154													Field only
481	Discharge	1-8D	3	3/29/2017	12:45	48.74184	-122.32774	7.4	11.85	7.11	57.7	17.0	160													Field only
488	Discharge	7D	1	1/19/2017	12:34	48.74094	-122.32648	6.4	11.92	7.09	52.5	18.6	212.8	5	U	5 U	1.0							_		Field + Fecals
488	Discharge	1-7D	2	3/15/2017	12:35	48.74089	-122.32634	7.5	11.88	7.21	49.1	8.1	177											_		Field only
488	Discharge	1-7D	3	3/29/2017	12:41	48.74098	-122.32636	7.4	11.87	7.25	48.6	15.4	140													Field only
492	Discharge	6D	1	1/19/2017	12:27	48.74084	-122.32623	6.5	11.92	7.18	41.3	14.1	194.52	68	J	55 J	0.8		ļ				+			Field + Fecals
492	Discharge	6D	2	3/15/2017	12:26	48.74082	-122.32623	7.6	11.89	7.22	40.3	2.31	174.6	7	J	7 J	1.0	0 ND	0	ND	Not detected	0.024	1.15	0.100	υU	All parameters
492	Discharge	7D	3	3/29/2017	12:33	48.74081	-122.32622	7.8	11.74	7.20	38.9	13.81	163.2	2	J	2 J	1.00		ļ				+			Field + Fecals
495	Discharge	5D	1	1/19/2017	12:17	48.74035	-122.3254	6.5	11.07	7.00	115.6	3.6	254.56	5	U	5 U	1.0		ļ				+			Field + Fecals
495	Discharge	1-5D	2	3/15/2017	12:07	48.74028	-122.32543	7.4	11.28	7.12	102.0	2.1	212		<u> </u>				ļ				+		4	Field only
509	Discharge	4D	1	1/19/2017	11:58	48.73824	-122.32341	6.6	11.84	7.21	65.1	15.8	219.16	55	J	27 J	0.5									Field + Fecals
509	Discharge	5D	2	3/15/2017	12:15	48.73822	-122.32336	7.8	11.75	7.38	61.8	7.58	191.9	4	J	4 J	1.0									Field + Fecals
509	Discharge	6D	3	3/29/2017	12:10	48.73803	-122.32349	8.1	11.59	7.27	59.1	22.21	187.1	342	J	342 J	1.00	3 <	0	ND	Low	0.086	1.42	0.10	U C	All parameters
518	Discharge	3D	2	3/15/2017	11:20	48.73634	-122.32094	8.2	11.64	7.24	71.8	8.5	192.5	44		13 J	0.3	0 ND	0	ND	Not detected	0.048	2.16	0.100	U C	All parameters
518	Discharge	5D	3	3/29/2017	11:50	48.73637	-122.32088	8.2	11.51	7.25	66.7	15.3	223.4	29	J	29 J	1.00	112	0	ND	Low	0.066	1.77	0.100	υu	All parameters
520	Discharge	2D	2	3/15/2017	11:05	48.73556	-122.31964	8.7	11.09	7.05	81.9	4.36	147.2	100		7 J	0.1	17400	1450		Moderate	0.052	3.47	0.100	U 0	All parameters
520	Discharge	4D	3	3/29/2017	11:36	48.73561	-122.31953	8.9	10.92	6.87	75.3	8.26	196.8	62		62	1.00	21700	1610		Moderate	0.064	3.10	0.10	0 U	All parameters
521	Discharge	2D	1	1/19/2017	11:32	48.73633	-122.32094	6.2	11.91	7.24	67.4	10.8	248.34	135		105	0.8									Field + Fecals
521	Discharge	1-2D	2	3/15/2017	11:02	48.73558	-122.31968	6.9	11.35	7.19	61.4	0.9	51.0													Field only
521	Discharge	3D	3	3/29/2017	11:21	48.73546	-122.31934	7.6	10.83	6.80	66.2	1.57	94.2	16	J	16 J	1.00	0 ND	0	ND	Not detected	0.014	2.66	0.10	υu	All parameters
525	Discharge	1D	2	3/15/2017	10:50	48.73466	-122.31799	7.4	10.74	6.62	64.4	3.84	150.8	114		114	1.0	0 ND	0	ND	Not detected	0.036	2.63	0.100	υu	All parameters
525	Discharge	2D	3	3/29/2017	11:08	48.73478	-122.31793	7.9	10.62	6.56	64.9	5.06	174.5	112		112	1.00	0 ND	0	ND	Not detected	0.046	2.30	0.100	υu	All parameters
525A	Discharge	1D	1	1/19/2017	11:00	48.73471	-122.31801	6.1	10.59	6.55	70.4	5.8	190.63	150		145	1.0									Field + Fecals

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WATER QUALITY MONITORING REPORT

LAKE WHATCOM ON-SITE SEWAGE SYSTEM IMPACT ASSESSMENT



Prepared for Lake Whatcom Water & Sewer District Whatcom County City of Bellingham







Prepared by Herrera Environmental Consultants, Inc.



Note:

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WATER QUALITY MONITORING REPORT

LAKE WHATCOM ON-SITE SEWAGE SYSTEM IMPACT ASSESSMENT

Prepared for Lake Whatcom Water & Sewer District 1220 Lakeway Drive Bellingham, Washington 98229

Whatcom County 311 Grand Avenue Bellingham, Washington 98225

City of Bellingham 210 Lottie Street Bellingham, Washington 98225

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

September 30, 2020

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1. INTRODUCTION

The Lake Whatcom watershed is located in Whatcom County in the northwest corner of Washington State. Lake Whatcom is the drinking water source for City of Bellingham (City) and Lake Whatcom Water and Sewer District (District) customers (over 100,000 people), as well as a number of residents in unincorporated Whatcom County residing in homes located along the lake that directly draw their water from the lake.

In response to the deterioration of the lake's water quality, a joint resolution was passed by the City, Whatcom County (County), and District in 1992 to organize efforts to address the most serious threats to the watershed. This resolution served as the basis for the creation of the Lake Whatcom Management Program (LWMP) in 1998. The LWMP partners have since coordinated on the implementation of a number of programs and actions aimed at protecting and improving the health of the lake and its watershed. One of the main concerns of the LWMP program is water quality impacts related to low dissolved oxygen and excess fecal coliform bacteria concentrations. Subsequent investigations identified excess phosphorus entering the lake as the primary cause of low oxygen levels.

In 2016, the United States Environmental Protection Agency (EPA) approved a Total Maximum Daily Load (TMDL) for phosphorus in the lake and fecal coliform bacteria in 11 tributaries to the lake. To meet the TMDL requirements, efforts are underway to protect and improve lake water quality by reducing the amount of phosphorus entering the lake system, and reducing fecal bacteria concentrations in several tributaries entering the lake. Sources contributing to the elevated phosphorus and bacteria concentrations may include failed on-site sewage systems (OSS, also referred to as septic systems). However, the TMDL Water Quality Improvement Plan (Ecology 2016) primarily relies on stormwater treatment to reduce phosphorus loadings to the lake, and only addresses OSS inputs through existing OSS regulations and permitting.

In 2017, the District contracted Herrera Environmental Consultants (Herrera) to conduct a study of potential impacts of 97 OSS on lake water quality along North Shore Road that identified human waste sources in some drainages within the study area (Herrera 2017). The Whatcom County Health Department then inspected 68 of those OSS in November 2017 through June 2018, resulting in repair of three identified OSS failures (Cierebeij 2018). Additional sites have been evaluated since this inspection period as part of the ongoing Whatcom County OSS Operations and Maintenance Program.

Based upon the results of the 2017 study, the LWMP partners contracted Herrera to conduct a second phase of the OSS impact assessment in 2020 to expand the study area to include three shoreline types (i.e., undeveloped, OSS-served, and sewer-served areas), while providing consistent sample sites and modifying methods from the previous study based upon lessons learned and recent method developments.

Herrera prepared a water quality monitoring and quality assurance project plan (QAPP) documenting procedures used for sample collection, field analysis, laboratory analysis, and data analysis to ensure high quality, scientifically defensible results would be obtained for the 2020 study (Herrera 2020a). The QAPP also includes background information on Lake Whatcom and OSS. Herrera implemented the QAPP from February through June 2020 that included some procedural modifications specified in the QAPP amendment (Herrera 2020b). This report presents the 2020 water quality study methods, results, conclusions, and recommendations.



2. METHODS

The project goals were to obtain supplemental data to that collected in 2017, expand the study area to include shoreline areas served by sewer, and characterize phosphorus, fecal bacteria, and human biomarker inputs to the lake from OSS- and sewer-served drainage areas. Water quality monitoring was conducted in three project areas representing undeveloped, OSS-served, and sewer-served shoreline drainages (Figure 1). The undeveloped area is located immediately east of the OSS area in a small northern portion of the Blue Canyon basin along the Hertz Trail in Lake Whatcom Park. The OSS area is located within the North Shore basin between Smith and Olsen Creeks except for 13 OSS located up to 1,000 feet east of Smith Creek in the Blue Canyon basin. The sewered area is located across the lake from the OSS area in the Sudden Valley basin and the eastern portion of the Strawberry basin.

Monitoring stations in the undeveloped and OSS areas are shown in Figure 2. Monitoring stations in the sewer area are shown in Figure 3. Detailed maps of the drainage station locations and catchment areas are presented in Appendix A. These maps include approximate drainage basin boundaries for each monitoring station that were delineated for the QAPP (Herrera 2020a) using light detection and ranging (LiDAR) and available drainage (pipe and ditch) data to identify flow paths.

All three areas are predominantly forested and have similar topography and geology (sandstone and shale in the Chuckanut Formation). Forest is the predominant land use in all three areas at 95 percent for the undeveloped area (Blue Canyon basin), 83 percent for the OSS area (North Shore basin), and 75 to 83 percent in the sewer area (75 percent for Sudden Valley and 83 percent for Strawberry basins). Developed land use in the study area basins is 0 percent in the undeveloped area, 6 percent for the OSS area, and 15 to 24 percent in the sewer area (24 percent for Sudden Valley and 15 percent for Strawberry basins) (Ecology 2016).

2.1. MONITORING STATIONS

Monitoring was conducted at the following 17 stations described in Table 1:

- Two drainages at lake outfalls in the undeveloped area (stations UN-1 and UN-2) located along the Hertz Trail southeast of the OSS area.
- Five drainages at lake outfalls in the OSS area along North Shore Road (outfall stations 430, 440, 453, 466, 520) where indicators of human sewage were detected at moderate to high levels during the 2017 study.

September 2020

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- Two drainages upstream of lake outfall 440 in the OSS area (station 440-U1 and 440-U4) for source tracking of potential septic system impacts during only one event.
- Five drainages at lake outfalls in the sewer area along Lake Whatcom Boulevard (outfall stations 485, 504, 482, 516, and 531), located across the lake from the OSS area between Sudden Valley and west of Strawberry Point. These stations were selected to determine if drainages with sanitary sewers also contain human sources of contamination.
- Two septic tanks located in the OSS area (stations Septage-1 and Septage-2) for source characterization.
- One sanitary sewer manhole (station Sewage-1) located where a small sewer collector serving the Strawberry Point neighborhood connects to the main trunk sewer on Lake Whatcom Boulevard for source characterization.

2.2. SAMPLING EVENTS

In accordance with the QAPP, three storm sampling events were conducted in March through April 2020 during the tail end of storm hydrographs for storm events totaling at least 0.5 inches of rain in 24 hours. In accordance with the QAPP addendum, two base flow events were sampled in May and June 2020 to evaluate differences in drainage pollutant concentrations between storm and base flow conditions. Sampling conducted during base flow conditions was initiated at least 24 hours after a storm event to ensure drainage samples were all base flow and did not contain any stormwater runoff.

Herrera collected one grab sample from each location during the following five events:

- Storm Event 1 on March 3, 2020
- Base Event 1 on May 11, 2020
- Storm Event 2 on March 24, 2020
- Base Event 2 on June 2, 2020
- Storm Event 3 on April 27, 2020

Sampling locations and hydrology data for each sampling event are presented in Tables 1 and 2, respectively. Daily total rainfall totals and mean lake surface elevations are presented in Figure 4.






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Table 1. Monitoring Station Locations and Descriptions.												
Station ID	Catchment Area (acres)	Pipe Type	Pipe Diameter (in)	Latitude	Longitude	Location Description						
Undevelope	d Area Drainag	e										
UN-1	2.0	СМР	12	48.7274	-122.3074	Trail culvert outfall at 500 from parking area, measure flow up from notch in outfall						
UN-2	36.0	Concrete	24	48.7262	-122.3045	Trail culvert inflow across from island						
OSS Area Drainage												
430	69.3	Concrete	24	48.7490	-122.3437	Road culvert inflow from ditch combined from 3 directions: 80-100% W, 0-10% E, 0-15% N. Outfall in pair of black plastic pipes under dock						
440	107	Concrete	24	48.7471	-122.3384	Road culvert inflow from ditch. Flow 50-100% from north pond into ditch, 0-40% from east ditch, and 0-10% from west ditch						
440-U1	unknown	Ditch	None	48.7471	-122.3381	Upstream drainage from north pond into ditch with 50% of 440 flow; sampled for Storm 3 only						
440-U4	unknown	Ditch	None	48.7469	-122.3380	Upstream drainage from east ditch upstream of inflow from north pond with 40% of 440 flow; sampled for Storm 3 only						
453	8.0	Black Plastic	24	48.7452	-122.3346	Road culvert inflow from square catch basin grate. Flow 60-100% from east 0-40% from west, both 1-foot concrete pipes						
466	47.9	Concrete	36	48.7434	-122.3300	Road culvert outfall. Flow 95-100% from north side of Holmstead Rd and 0-5% from east ditch						
520	4.6	Concrete	18	48.7357	-122.3198	Road culvert outfall at 3138 N Shore Rd. Flow into upstream catch basin from both directions, 3 inches of sediment in outfall						
Sewer Area	Drainage											
485	158	Black HDPE	24	48.7404	-122.3835	Road culvert inflow from stream (with staff gauge) on east side of Grand Blvd.						
504	32.3	Concrete	12	48.7383	-122.3715	Road culvert outfall in corrugated half pipe next to pump station						
482	5.6	Concrete	12	48.7408	-122.3704	Road culvert inflow from ditch						
516	15.0	Concrete	36	48.7362	-122.3573	Road culvert inflow from ditch to east						
531	11.2	Concrete	18	48.7319	-122.3472	Road culvert outfall. Inflow to culvert from locked catch basin grate south of road						

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	Table 1 (continued). Monitoring Station Locations and Descriptions.												
Station ID	Catchment Area (acres)	Pipe Type	Pipe Diameter (in)	Latitude	Longitude	Location Description							
Human Sources													
Septage-1	One house	Septic Tank	NA	48.7326	-122.3168	Carlson residence at 3201 Northshore Rd. Green lid on left looking at house entryway							
Septage-2	One house	Septic Tank	NA	48.7321	-122.3167	Park Department house rental at 3211 Northshore Rd. Access lid on lake side							
Sewage-1	Strawberry Point	Steel	8	48.7387	-122.3715	MH G5-1 sewer lid over plastic cover in grass next to lake. Access through pump house gate down to right							



Table 2. Sampling Event Locations and Hydrologic Characteristics.											
	Storm Event 1 3/3/20	Storm Event 2 3/24/20	Storm Event 3 4/27/20	Base Event 2 5/11/20	Base Event 2 6/2/20						
Locations											
Outfall stations not sampled due to no flow	none	none	none	UN-1, 520	UN-1, 520, 533						
Upstream stations sampled	none	none	430-U1, 430- U4	none	none						
Septage station sampled	Septage-1	Septage-2	Septage-2	Septage-1	Septage-2						
Field duplicate station	430	482	453	UN-2	430						
Hydrology											
City 24-hour rainfall previous day (inches) ^a	0.40	0.85	0.08	0.00	0.00						
City 24-hour rainfall sampling day (inches) ^a	0.10	0.22	0.49	0.00	0.14						
City total 48-hour rainfall (inches) ^a	0.50	1.07	0.57	0.00	0.14						
Station KWABELLI91 48-hour rainfall (inches) ^b	0.51	1.30	0.60	0.06	0.13						
Station KWABELLI05 48-hour rainfall (inches) ^c	0.83	2.09	1.00	0.15	0.24						
Daily average lake elevation (feet MSL)	313.47	314.24	314.46	314.37	314.42						

^a Rainfall data from the City of Bellingham's North Shore MET rain gauge.

^b Rainfall data from Weather Underground station KWABELLI191 located at a lake shore residence in the project site.

^c Rainfall data from Weather Underground station KWABELLI105 located at a lake shore residence in the project site.

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Figure 4. Daily Total Rainfall and Mean Lake Elevation During Study Period.

2.3. SAMPLE COLLECTION AND ANALYSIS

All sampling stations were accessed by land from the Hertz Trail for the undeveloped area, North Shore Road for the OSS area, and Lake Whatcom Boulevard for the sewer area. Septic tank and sanitary sewer stations were accessed by land with permissions granted by property owners. One grab sample was collected from each station during each sampling event with the following exceptions:

- Only one of two septic tanks were sampled for each event by design; permission to sample a third septic tank could not be obtained as originally planned.
- Two upstream stations from OSS area outfall 440 were only sampled during storm event 3 to track sources to that outfall as per the QAPP addendum.
- Samples were not collected due to a lack of flow at undeveloped area station UN-1 and OSS area station 520 during either of the two base events, or at OSS area station 533 during base event 2 (see Table 2).

One field duplicate sample was collected separately at one of the drainage stations for each of the five sampling events. Following sample collection, discharge rate was measured at each drainage station with a current meter or estimated if water depth was too shallow for velocity measurement. Observations were recorded in field notes and the sampling stations were occasionally photographed. Representative photographs are presented in Appendix B.



The collected samples were stored with ice in coolers and submitted to the following laboratories for the specified analyses:

- Exact Scientific Services (Exact) in Ferndale, Washington: hand delivered on the sampling date for analysis of fecal coliform and *E. coli* bacteria (membrane filtration by Standard Method 9222-D and -G) and shipment to Anatek Labs in Moscow, Idaho for analysis of total phosphorus (EPA Method 365.1).
- Herrera's Seattle laboratory: shipped overnight for analysis of conductivity (by field meter) and optical brighteners, which included correction of natural background fluorescence by exposing the samples to ultraviolet (UV) light (Dubber and Gill 2017).
- Source Molecular in Miami, Florida: overnight shipment for analysis of two human biomarkers by quantitative polymerase chain reaction (qPCR) including biomarker HF183 by EPA Method 1696 (which is equivalent to the *Bacteroidetes dorei* biomarker method used in the 2017 study) and biomarker BacV4V5-1 by an analytical method recently developed by scientists at the University of Wisconsin-Milwaukee School of Freshwater Sciences (Feng and McLellan 2019).

2.4. DATA ANALYSIS

2.4.1. Data Quality Review

Laboratory data were verified and validated to ensure that all data were consistent, correct, complete and that all required quality control information was provided. Values associated with minor quality control problems were considered estimates and assigned *J* qualifiers. Estimated values were used for evaluation purposes. The following laboratory quality control elements were reviewed for each sampling event:

- Completeness
- Methodology
- Holding times
- Blanks

- Control Standards
- Matrix spikes
- Laboratory duplicates
- Field duplicates



2.4.2. Parameter Thresholds

For general characterization, thresholds were developed for total phosphorus, indicator bacteria, and human biomarker concentrations to designate the drainage stations into categories of low, moderate, or high. These thresholds were developed by Herrera for the draft report and accepted by the project team to help guide interpretation.

Rating thresholds for total phosphorus concentrations cannot be based on the TMDL goal or associated stormwater treatment goal because those goals are based on percent reduction in loadings rather than concentration criteria. Total phosphorus thresholds are based on a combination of lake trophic state criteria and lake tributary monitoring data. A value of 20 micrograms per liter (μ g/L) is used for an action limit for Puget Sound lowland lakes by Washington State surface water standards (WAC 173-201A, Ecology 2019) and as a limit for comparison to median monthly total phosphorus concentrations in lake tributaries (Matthews et al. 2020). The Lake Whatcom watershed contains both "nonresidential" streams located primarily in undeveloped watersheds and "residential" streams located primarily in developed watersheds. Typical total phosphorus concentrations in lake tributary streams have been described as ranging from 5 to 15 μ g/L in nonresidential streams and less than 50 μ g/L in residential streams (Matthews et al. 2001). The following total phosphorus thresholds were selected:

- Low arithmetic mean less than 20 µg/L, which is the action limit for Puget Sound lowland lakes in the Washington State surface water quality standards (WAC 173-201A; Ecology 2019)
- Moderate arithmetic mean from 20 to 50 µg/L, which is the typical maximum concentration observed in residential streams in the watershed
- High arithmetic mean greater than 50 µg/L, which is greater than the typical maximum concentration observed in residential streams in the watershed

Fecal coliform and *E. coli* bacteria thresholds are based on Washington State surface water quality standards (WAC-173-201A; Ecology 2019) for the geometric mean and 90th percentile concentrations. Currently, these standards include water contact recreation criteria for both fecal coliform bacteria and *E. coli*, but the criteria for fecal coliform will expire on January 1, 2021 (WAC-201A-200 [2] [g]). In accordance with these standards, the maximum sample value was used rather than the 90th percentile because less than 10 samples were collected at each station. The following fecal coliform bacteria thresholds were selected:

• Low – geometric mean less than 100 colony forming units per 100 milliliters (CFU/100 mL) and maximum value less than 200 CFU/100 mL, which is the surface water quality standard



- Moderate geometric mean from 100 to 500 CFU/100 mL or maximum value from 200 to 1,000 CFU/100 mL, which is up to 5 times the surface water quality standard
- High geometric mean greater than 500 CFU/100 mL or maximum value greater than 1,000 CFU/100 mL, which is greater than 5 times the surface water quality standard

The following *E. coli* bacteria thresholds were selected:

- Low geometric mean less than 100 CFU/100 mL and maximum value less than 320 CFU/100 mL, which is the surface water quality standard
- Moderate geometric mean from 100 to 500 CFU/100 mL or maximum value from 320 to 1,600 CFU/100 mL, which is up to 5 times the surface water quality standard
- High geometric mean greater than 500 CFU/100 mL or maximum value greater than 1,600 CFU/100 mL, which is greater than 5 times the surface water quality standard

The human biomarker rating threshold approach used in 2017 was used for the 2020 effort, which included comparison of human biomarker concentrations to the detection limit on an order of magnitude basis. An alternative rating threshold for human biomarker concentrations was considered for this effort by comparing results to those observed in the human source (septage and sewage) samples, but this method was not selected because of the wide range of human biomarker concentrations observed in individual septic tanks and municipal sewage. The following human biomarker thresholds were selected:

- Low geometric mean less than 250 copies/100 mL and maximum value less than 500 copies/100 mL, which is the limit of quantitation
- Moderate geometric mean from 250 to 2,500 copies/100 mL or maximum value from 500 to 5,000 copies/100 mL, which is up to 10 times the limit of quantitation
- High geometric mean greater than 2,500 copies/100 mL or maximum value greater than 5,000 copies/100 mL, which is greater than 10 times the limit of quantitation

2.4.3. Statistical and Correlation Analyses

The results were tested for statistically significant differences between the three monitoring areas and two event types using a two-factor analysis of variance (AVOVA) that accounts for differences between each of these two factors (Helsel and Hirsch 1992). The two factors considered were the drainage area (undeveloped, OSS, and sewer) and the observed flow types (storm and base). Parameters tested include total phosphorus, *E. coli* bacteria, and the two human biomarkers (BacV4V5-1 and HF183). The resulting p-value of the test statistic was compared to an error rate (significance level) of $\alpha = 0.05$ and 0.10. The significance level of 0.05 is commonly used to identify significance (Helsel and Hirsch 1992) and was used as the basis for study conclusions of statistical significance. As environmental parameters such as the ones

analyzed here commonly display high variance, p-values between 0.05 and 0.10 were considered nearly significant but not used as the basis of study conclusions. If p-values were less than 0.10 within a given factor, a post hoc Tukey test was then conducted to further identify the specific variables that differ significantly.

Correlation analysis among the parameters was performed following the method used for the 2017 study (Herrera 2017). Scatter plots were prepared for total phosphorus and *E. coli* as a function of conductivity, optical brighteners, and the log of both human biomarkers. Relationships between parameters were evaluated based on the Spearman rank-order correlation analysis with the correlation coefficient and associated p-value displayed on the scatter plots. The same p-value significance levels of 0.05 and 0.10 used for the ANOVA analysis were also used for the Spearman rank-order correlation analysis.

2.4.4. Parameter Loading Analysis

Loading rates for total phosphorus, *E. coli*, and both human biomarkers were estimated for each monitoring station using a simple approach of applying the measured loading rates over an entire year, and then divided by the respective drainage basin area to yield annual areal loading rates for comparison among stations and study areas. Flow-weighted average parameter concentrations were calculated for each area by summing the product of each station's concentration and flow rate for each event and dividing that sum by the average flow rate for all stations and events, as follows:

 $Flow - weighted Average Concentration (FWA) per Study Area = \frac{\sum (Concentration \times Flow)}{\sum Flow}$

Flow-weighted average parameter concentrations were multiplied by the average flow rate estimated for all stations and sampling events to obtain the average loading rate for each area, and the average loading rate was then divided by the total monitored drainage basin area to obtain annual areal loading rates in units of pounds/acre-year for total phosphorus, billion CFU/acre-year for *E. coli*, and billion copies/acre-year for BacV4V5-1, as follows:

 $\label{eq:Annual Areal Load per Study Area} = \frac{FWA \times Average \ Annual \ Flow}{Drainage \ Area}$

The annual areal loading rates were compared among the three areas for each parameter to evaluate relative rates for the OSS area versus the undeveloped and sewer areas. Annual areal loading rates calculated for total phosphorus also were compared to those estimated by the TMDL for the North Shore basin, which is 400 pounds/year from 1,167 acres or 0.34 pounds/acre-year (Ecology 2016).



3. RESULTS AND DISCUSSION

Table 3 presents a summary of the study results that includes the mean (or geomean) and maximum of results for each station and area group of stations for storm, base, and all events combined.

Figures 5 and 6 present box plots of the study results for all events at each station showing the following statistics for each of eight parameters: overall range excluding outliers (whiskers), interquartile range (box), median (line) arithmetic mean or geometric mean (red dot showing arithmetic mean in Figure 5 and geometric mean in Figure 6 for human biomarkers and indicator bacteria), and outliers (diamonds) for each group of stations. Values are considered outliers if they are outside of 1.5 times the interquartile range (Helsel and Hirsch 1992).

Figure 7 presents box plots of the study results separately for storm and base events for all stations in each study area (undeveloped, OSS, and sewer). These study area box plots are only presented for parameters included in the ANOVA (*E. coli*, total phosphorus, and both human biomarkers).

The ANOVA of the area-wide results are not presented in a table because it showed that the only statistically significant difference was between the OSS and sewer areas for human biomarker BacV4V5-1 with a p-value of 0.036. Human biomarker BacV4V5-1 was also higher in the OSS area than the undeveloped area, but the difference was not significant with a p-value of 0.18. Thus, the OSS stations produced higher levels of BacV4V5-1 but not human biomarker HF183, *E. coli*, or total phosphorus. The difference between storm and base flows is not consistent across the data but is specific to each location and parameter.

Figures 8 and 9 present scatter plots of total phosphorus and *E. coli*, respectively, as a function of key parameters to evaluate potential relationships with conductivity, optical brighteners, and the log of human biomarkers. Table 4 presents the Spearman rank order correlation coefficients for columnar comparisons of all parameters with correlations shown in yellow and red for statistically significant correlations with p-values less than 0.10 and 0.05, respectively. The resulting Spearman rank order correlation coefficient and p-value are also included on each scatter plot.

Laboratory reports and data quality review worksheets and are presented in Appendix C. The sample results database is included in Appendix D.

Data quality review results are summarized first in this section. Monitoring results are then presented and discussed separately for hydrology, conductivity, total phosphorus, indicator bacteria (fecal coliform and *E. coli*), and human biomarkers. This section concludes with results of the pollutant loading analysis and a brief assessment of the OSS inspections conducted between study phases.

3.1. DATA QUALITY REVIEW

Field and laboratory procedures followed the project QAPP (Herrera 2020a, 2020b) with the following exceptions resulting in missing data:

- Optical brightener and specific conductance data are missing for storm event 2 on 3/24/20 because an analyst was not available.
- Optical brightener and specific conductance data are missing for storm event 3 on 4/27/20 for Septage-2 and Sewage-1 because the samples were not collected.
- Optical brightener and specific conductance data are missing for base event 1 on 5/11/20 for station 430 because the sample jar broke in transit.

All reported results were considered acceptable for use as reported with the following data qualifications:

- Total phosphorus results were flagged as estimated (J) for field duplicate samples collected at station UN-2 for base event 1 on 5/11/20 and at station 430 for base event 2 on 6/2/20 because precision criteria were not met.
- Fecal coliform bacteria and E coli results were flagged as estimated (J) for field duplicate samples collected at station 482 for storm event 2 on 3/24/20 and station 453 for storm event 3 on 4/27/20 because precision criteria were not met.
- Human biomarker HF183 results were flagged as estimated (J) for field duplicate samples values reported as not detected (ND) and detected but not quantified (DNQ) for samples collected at station 430 for storm event 1 on 3/3/20, and station 430 for base event 2 on 6/2/20.
- Several fecal coliform bacteria and *E. coli* results for sewage samples were too numerous to count for storm events on 3/3/20 and 3/24/20 (which were assigned a value of greater than 6,000 CFU/100 mL based on the greater than 60 colonies in the 1 milliliter dilution volume) and on 4/27/20 (which were assigned a value of greater than 600,000 CFU/100 mL based on the greater than 60 colonies in the 0.01 milliliter dilution volume). Dilution volumes were decreased for the 4/27/20 and remaining events to obtain a higher detection limit for sewage samples.

The optical brightener sample bottles were reduced in size from 1 liter to 12 ounces for the two base events to reduce shipping costs. The smaller bottle size did not appear to affect optical brightener degradation by UV light exposure because the 1 liter samples exhibited complete degradation of a Tide detergent standard after 1 minute of exposure (see standards test at the end of Appendix C) and, therefore, significant additional UV light degradation would not be expected for the smaller sample bottle.



	Table 3. Summary of Results by Sample Group																		
		Event	Event Flow		Conductivity		C	Optical Brig	hteners	Total Phos	phorus - P	Fecal Co	liform	Е. с	oli	HF183 Huma	an Biomarker	BacV	4V5-1
Sampla		Type (Samplo	(gp	om)	(μS/	/cm)	(RF	UB)	(Percent Pos)	(µg	/L)	(CFU/10	0 mL)	(CFU/10)0 mL)	(copies/	/100 mL)	(copies,	/100 mL)
Group	Station	No.)	Mean	Max.	Mean	Max.	Mean	Max.	Total	Mean	Max.	Geomean	Max.	Geomean	Max.	Geomean	Max.	Geomean	Max.
Mean/G	Geomean	Low	-	-	-	-	-	-	-	<20	-	<100	<200	<100	<320	<250	<500	<250	<500
Threshold		Moderate	-	-	-	-	-	-	-	20-50	-	100-500	200-1,000	100-500	320-1,600	250-2,500	500-5,000	250-2,500	500-5,000
		High	-	-	-	-	-	-	-	>50	-	>500	> 1,000	>500	>1,600	>2,500	> 5,000	>2,500	> 5,000
Undev.	UN-1	All (3)	20	36	67	75	167	193	50	73	99	90	220	90	220	215	1,850	25	25
Area	UN-2	All (5)	7	22	75	85	188	224	75	56	91	81	480	79	480	125	766	25	25
	All	All (8)	12	36	72	85	181	224	66	62	99	85	480	83	480	146	1,850	25	25
		Storm (6)	16	36	67	75	187	224	50	60	99	101	290	99	290	149	1,850	25	25
		Base (2)	0	0	83	85	170	193	100	71	91	49	480	49	480	138	766	25	25
OSS Area	430	All (5)	115	287	95	111	270	303	100	47	64	114	410	114	410	127	860	1,186	15,300
	440	All (5)	57	148	98	115	186	235	25	64	122	163	2,000	162	2,000	25	25	4,370	62,900
	453	All (4)	1	1	67	69	117	160	33	76	103	5	36	5	36	25	25	79	250
	466	All (5)	11	27	83	99	114	135	100	40	53	35	1,300	35	1,300	60	1,920	76	640
	520	All (3)	9	22	107	116	138	157	100	368	950	8	34	8	34	2,495	75,700	1,204	11,700
	All	All (22)	43	287	89	116	165	303	69	98	950	36	2,000	36	2,000	83	75,700	523	62,900
		Storm (15)	60	287	87	116	172	261	80	118	950	27	2,000	27	2,000	114	75,700	1,055	62,900
		Base (7)	6	14	93	115	153	303	50	56	122	67	1,300	67	1,300	41	860	116	11,700
Sewer	482	All (5)	6	15	203	229	182	230	100	122	226	131	260	131	260	25	25	25	25
Area	485	All (5)	49	94	134	162	131	145	75	44	67	316	3,600	316	3,600	79	250	44	250
	504	All (5)	40	135	48	54	125	185	75	67	210	12	96	12	92	25	25	25	25
	516	All (5)	255	359	83	93	257	311	75	69	81	29	118	29	118	389	2,280	116	546
	531	All (5)	4	9	98	105	135	173	75	42	54	100	1,100	100	1,100	25	25	25	25
	All	All (25)	69	359	114	229	164	311	80	69	226	64	3,600	64	3,600	57	2,280	41	546
		Storm (15)	93	359	102	183	183	311	90	55	226	72	900	72	900	54	250	42	546
		Base (10)	33	157	126	229	144	254	70	92	210	54	3,600	54	3,600	62	2,280	40	250
Septage	Septage-1	All (2)	-	-	817	822	453	455	50	9,550	11,100	57,446	550,000	57,446	550,000	3,311	3,570	117,942,359	224,000,000
	Septage-2	All (3)	-	-	1,030	1,030	1,628	1,628	100	15,333	16,200	28,965	270,000	28,965	270,000	116	250	258,699,024	615,000,000
Sewage	Sewage	All (5)	-	-	593	683	2,606	5,946	66	8,334	17,000	202,331	>600,000	202,331	>600,000	300,814,415	1,300,000,000	14,003,402	56,200,000
2017 Resu	lts													·					
OSS Area	430	Storm (3)	220	224	60	61	168	229	-	52	88	89	800	39	100	29	278	-	-
	440	Storm (2)	1,346	1,346	51	54	271	271	_	62	62	47	50	38	44	107	107	-	-
	453	Storm (2)	314	359	55	59	134	157	-	34	54	69	124	65	110	3	3	-	-
	466	Storm (3)	1,302	1,481	56	59	155	163	-	69	88	122	198	117	191	9	87	-	-
	520	Storm (2)	117	168	79	82	172	197	-	58	64	79	100	21	62	19,431	21,700	-	-
	All	Storm (12)	680	1,481	60	82	170	271	_	54	88	81	800	50	191	67	21,700	-	-
Septage	Septage-1	Storm (2)	-	-	953	963	659	686	-	10,250	10300	2,473.863	4,080.000	2,473.863	4,080.000	1,226	1,460	-	-

Bold values exceed listed thresholds; μ S/cm = microsiemens per centimeter RFUB = relative fluorescence units blank corrected; μ g/L = milligrams per liter; CFU/100 mL = colony forming units per 100 milliliters; copies/100 mL = copies per 100 milliliters. * B dorei human biomarker, nearly equivalent to HF183.



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Red \mathbf{X} = arithmetic mean, black \mathbf{X} = flow-weighted mean, diamond = outlier.



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Red \mathbf{X} = geometric mean, black \mathbf{X} = flow-weighted mean, diamond = outlier.







Figure 7. Box Plots by Study Area and Event Type for Human Biomarkers HF183 and BacV4V5, E. coli, and Total Phosphorus.





Figure 8. Scatter Plots of Total Phosphorus as a Function of Other Key Parameters.





Figure 9. Scatter Plots of *E. coli* as a Function of Other Key Parameters.



Table 4. Spearman Rank-Order Correlation Coefficients.													
Parameter	HF183	BacV4V5-1	E. coli	Total Phosphorus	Specific Conductance	Optical Brighteners	Flow						
HF183	-	0.243	0.044	0.215	-0.058	0.324	0.303						
BacV4V5-1	0.243	-	-0.136	0.08	0.124	0.259	0.370						
E. Coli	0.044	-0.136	-	-0.045	0.39	0.199	0.239						
Total Phosphorus	0.215	0.08	-0.045	-	0.124	0.026	-0.227						
Specific Conductance	-0.058	0.124	0.39	0.124	-	0.028	-0.054						
Optical Brighteners	0.324	0.259	0.199	0.026	0.028	-	0.548						
Flow	0.303	0.370	0.239	-0.227	-0.054	0.548	-						

Red shaded values are significant at p < 0.05

Yellow shaded values are nearly significant at p > 0.05 and p < 0.10

Fecal coliform, *E. coli*, and human biomarker values reported as ND were assigned a value equivalent to one-half the reporting limit as a best estimate of the actual value. Similarly, human biomarker values reported as DNQ were assigned a value equivalent to one-half the limit of quantification (LOQ). Reporting limits met objectives in the QAPP at 2 CFU/100 mL for fecal coliform and *E. coli* and 25 copies/100 mL for human biomarkers. The human biomarker LOQ was 500 copies/100 mL.

3.2. HYDROLOGY

All storm events had 48-hour rainfall amounts over 0.5 inches, with values of 0.51, 1.30, 0.60 inches of precipitation recorded for storm events 1, 2, and 3, respectively, for the City's rain gauge located in the North Shore basin (see Figure 2 and Table 2). Rainfall amounts were higher for two Weather Underground rain gauges located nearby on the lake shore. Rainfall amounts were questionably much higher for Weather Underground rain gauge KWABELLI05 The low 48-hour rainfall amounts for base event 1 and base event 2 (0.06 and 0.13 inches, respectively) occurred after sampling was completed.

The lake level rose nearly 1 foot between storm event 1 and storm event 3, and then varied little through the base events (see Figure 4).

Estimated flows varied across the different drainage areas ranging from no flow to 359 gallons per minute (gpm), which is equivalent to 0.8 cubic feet per second. The stations with the highest mean discharge rates were 430 and 516 at 115 and 250 gpm, respectively. Sites with the lowest mean discharge rates were 453, 482, and 531 at 1, 6, and 4 gpm, respectively.



There was a clear difference in flow rates between storm and base events, especially in the undeveloped area where discharge was nearly zero during the base events. In the OSS area, storm flows were roughly seven times the base flows. In the sewer area, the storm flows were only twice the base flows. Undeveloped, OSS, and sewer area flows averaged 12, 43, and 69 gpm per station, respectively (see Table 3).

The average total storm flow observed at the five monitoring stations in the OSS area during 2017 was over 10 times higher at 680 gpm than the 60 gpm measured during 2020 storm events because much larger storm events were sampled during 2017.

3.3. CONDUCTIVITY

Specific conductance (conductivity at 25 degrees Celsius) is representative of the ion content of an aqueous solution. It is used to represent dissolved solids or salinity and includes common cations (calcium, magnesium, sodium, and potassium) and anions (carbonate, sulfate, and chloride). As conductivity increases, the concentration of these ions increases (Wetzel 2001).

Specific conductance of sampled stations ranged from 40 to 229 microsiemens per centimeter (μ S/cm). For each station the range of values was relatively small when compared to the mean. Sewer area station 482 reported the highest specific conductance for every sampling event throughout the study period with a mean value of 203 μ S/cm. Conversely, sewer area station 504 had the lowest specific conductance for every sampling event with a mean of 48 μ S/cm. Specific conductance was higher in septage (means of 817 μ S/cm at Septage-1 and 1,030 μ S/cm at Septage-2) than municipal sewage (593 μ S/cm at Sewage-1) (see Table 3).

Specific conductance increased during base flow events by an average increase of 18 percent relative to storm events, across the three drainage areas. Conductivity was highest at the sewer area stations and the lowest at the undeveloped area stations. The average conductivity observed during storm flow at the five OSS area stations in 2017 was 60 μ S/cm compared to 87 μ S/cm in 2020. The higher conductivity observed in 2020 is likely due to the lower flows measured later in the year during this monitoring effort.

Among all drainage samples, conductivity exhibited positive relationships that were not significant with total phosphorus (p=0.441, see Figure 8) but were significant with *E. coli* (p=0.011, see Figure 9).

3.4. OPTICAL BRIGHTENERS

Optical brighteners can originate from OSS or sewage effluent containing laundry detergents. They were analyzed in the field with an optical brightener fluorometer for the 2017 study to help identify hot spots for human biomarker sampling. Optical brighteners were measured in the laboratory for 2020 study using a modified fluorometer method that uses ultraviolet (UV) light exposure to correct for positive background fluorescence from natural substances in order to



determine if background correction improves its ability to detect OSS or sewage effluent in site drainages.

Across all samples collected during the study period, raw optical brightener (OB) values (without background correction) ranged from 87 to 311 relative fluorescence units blank corrected (RFUB). OSS area station 430 and sewer area station 516 had the highest mean values of 270 and 257 RFUB, respectively, compared to a range of 114 to 188 RFUB for the remaining stations. Mean OB was much higher at the Sewer station (2,606 RFUB) than either Septage-1 (453 RFUB) or Septage 2 (1,628 RFUB) (see Table 3).

Overall, raw OB was 17 percent higher during storm events than base flow events among all stations. Raw OB also had a significant positive correlation with flow (Table 4). No substantial differences were observed between the three study areas in either the raw or background corrected OB. Percent positive OB among all background corrected results was similarly high at 66 percent for the undeveloped area, 69 percent for the OSS area, and 80 percent for the sewer area (see Table 3). Considering the higher human biomarker results observed in the OSS area discussed below, the background corrected OB results were not reliable indicators of septage contamination.

The average raw OB value for the five OSS area stations was very similar during 2017 storm flow (170 RFUB) compared to the 2020 storm flows (172 RFUB). In 2017, raw OB significantly positively correlated with total phosphorus in the OSS area drainage samples (Herrera 2017). However, raw OB did not correlate with total phosphorus or *E. coli* (see Table 4) in 2020 for drainage samples collected from all three study areas. OB did show a significant positive correlation with human biomarkers HF183 (p=0.036) and a nearly significant correlation with BacV4V5-1 (p=0.098; see Table 4). These results suggest that OB is not a good predictor of total phosphorus or *E. coli*, but may be a useful indicator of human biomarkers in surface waters draining to Lake Whatcom.

3.5. TOTAL PHOSPHORUS

Total phosphorus (TP) concentrations ranged from 21 to 950 micrograms per liter (μ g/L) as phosphorus across all of the samples collected at stations discharging to Lake Whatcom. TP concentrations were typically less than 100 ug/L with exceptions of highly variable values for OSS area station 520 and sewer area stations 482 and 504 (see Figure 5). High concentrations of TP, where the mean exceeds 50 μ g/L, were observed at both undeveloped area stations (UN-1 and UN-2), three OSS area stations (440, 453, and 520), and three sewer area stations (482, 504, and 516) (see Table 3). The mean TP concentration was particularly high at OSS area station 520 (368 μ g/L), which is the only station to also exhibit high concentrations of both human biomarkers.

A high TP concentration of 347 μ g/L was also measured in the one upstream sample collected at station 440-U4 during storm event 3 (see Appendix D). This upstream source flowed at a low rate (4 gpm) along the roadside ditch before it joined the primary basin drainage at station 440-

U1 (21 gpm) from a pond located above the road. Because of the low ditch flow at 440-U4, the TP concentration at this site did not appear to impact outfall site 440, resulting in similar TP concentrations at stations 440-U1 and 440 (81 and 76 ug/L, respectively).

TP concentrations were higher during base events than storm events in the undeveloped and sewer areas, but not in the OSS area (see Table 3 and Figure 7). TP concentrations did not increase during base flow events in the OSS area because OSS area station 520, which had the highest TP concentrations during storm flow events, dried up and was not sampled during the two base flow events. The ANOVA test results showed no significant differences between storm and base events in total phosphorus concentrations for any area, regardless of whether station 520 was excluded in the analysis. Total phosphorus loads are presented and discussed below in Section 3.8 Pollutant Loading Analysis.

TP concentrations were higher at both septage stations (mean of 10,000 and 15,000 μ g/L at Septage-1 and Septage-2, respectively) than the sewer station (mean of 8,000 μ g/L). TP concentrations in septage and sewage samples were similar to the 10,000 μ g/L typically observed is sewage (Welch and Jacoby 2004).

The average TP concentration observed during storm flow in the OSS drainage area in 2017 was 54 μ g/L compared to the storm event average of 118 μ g/L for 2020. The higher TP is likely due to relatively lower flows sampled during 2020 because TP is diluted by forest runoff as evident by the higher TP concentrations observed during base than storm events, which is commonly observed in forest streams. Total phosphorus did show a nearly significant negative correlation with flow, supporting this claim further (see Table 4). TP did not correlate with human biomarkers for OSS area stations in 2017, and similarly did not correlate with any parameter besides flow among all stations in 2020 (see Figure 8 and Table 4).

For comparison, all 14 stream sites sampled by Herrera over the past few years (18 to 32 samples/station) for the Redmond Paired Watershed Study of stormwater BMP performance showed negative correlations between TP and flow, with significant correlations (p < 0.05) observed at all three stations in undeveloped basins and in 9 of 11 stations in residential developed basins (J. Lenth, Herrera, personal communication). However, monthly monitoring data collected in the past four years for Smith Creek did not show a significant correlation between TP and flow (J, Pickens, Western Washington University, personal communication).

3.6. INDICATOR BACTERIA

Fecal coliform and *E. coli* were found to be nearly identical in value with only a few minor deviations suggesting that the positively testing organisms in the sampled water were largely of fecal origin. This was the case for drainage samples as well as the septage and sewage samples. Therefore, only *E. coli* results are discussed as the representative indicator bacteria parameter.

E. coli concentrations ranged across the stations from less than the detection limit of 2 CFU/ 100 mL to 3,600 CFU/100 mL. The indicator bacteria within sites displayed high variability within



each station with large ranges relative to the corresponding geometric mean. OSS area station 440 and sewer area station 485 had the highest geometric mean values of 163 and 316 CFU/100 mL, respectively, and both stations were ranked high due to maximum values exceeding 1,600 CFU/100 mL (see Table 3). OSS area stations 453 and 520 and sewer area station 504 exhibited the lowest geometric mean values for *E. coli* of 5, 8, and 12 CFU/100 mL, respectively.

High *E. coli* concentrations were measured during storm event 3 at OSS area station 440 and the primary upstream station 440-U1 (2,000 and 2,300 CFU/100 mL, respectively), but not at the low flowing upstream station 440-U4 (11 CFU/100 mL) where a high TP concentration was observed.

No significant differences in *E. coli* were observed between storm and base events, or between the three study areas (see Figure 7). However, *E. coli* did show a nearly significant (p < 0.10) positive correlation with flow (Table 4). Maximum values exceeded 1,000 CFU/100 mL at two stations in each of the OSS and sewer areas, but not in either station in the undeveloped area (see Figure 6).

E. coli concentrations were higher in sanitary sewage than septage, ranging up to greater than 600,000 CFU/100 mL in a sewage sample. Maximum values in Table 3 are underestimates because many values were reported as greater than a value due to insufficient sample dilution. Quantified *E. coli* values were similar for the sewer station (280,000 to 580,000 CFU/100 mL) and Septage-1 station (550,000 CFU/100 mL), but substantially lower for the Septage-2 station (15,000 to 270,000 CFU/100 mL).

The geometric mean *E. coli* concentration observed during storm flow for OSS area stations in 2017 was 50 CFU/100 mL compared 27 CFU/100 mL for 2020. Unlike total phosphorus, indicator bacteria concentrations were lower with the lower flows in 2020 due to less wash off of fecal deposits on land. Additionally, rainfall has commonly been found to promote bacterial transport through soils (Bitton and Harvey 1992), further supporting this difference between studies. *E. coli* exhibited a significantly (p = 0.011) positive correlation with conductivity during 2020 (see Figure 8 and Table 4), and did not correlate with other parameters (besides fecal coliform bacteria and pH) for drainage samples collected during 2017 (Herrera 2017).

3.7. HUMAN BIOMARKERS

Human biomarkers HF183 and BacV4V5-1 exhibited a wide range in concentrations in drainage samples. Results for HF183 ranged from not detected (detection limit of 50 copies/100 mL) to a maximum of 75,700 copies/100 mL at OSS area station 520. Results for BacV4V5-1 ranged from not detected to a maximum of 62,900 copies/100 mL at OSS area station 440 (see Figure 6 and Table 3). OSS area station 520 had the highest geometric mean value for HF183 of 2,495 copies/100 mL and it also exhibited a moderately high geometric mean value for BacV4V5-1 of 1,204 copies/100 mL. OSS area stations 430 and 440 exhibited moderate to high geometric means for BacV4V5-1 at 1,186 and 4,370 copies/100 mL, respectively, but HF183



concentrations were low (geometric mean less than 250 copies/100 mL) at these two stations. These results show the high value of analyzing the drainage samples for both biomarkers.

In comparison to the EPA-approved biomarker HF183, the experimental biomarker BACV4V5-1 was detected more often in the OSS area drainages. Also, the septic tank samples had much higher geometric mean concentrations of BACV4V5-1 (118 to 259 x 10⁶ copies/100 mL) than biomarker HF183 (0.1 to 3 x 10³ copies/100 mL). The higher abundance of BACV4V5-1 in both the drainage and septic tank samples provides additional evidence that septage was the primary source of human biomarkers observed in drainage from the OSS area. Biomarker BACV4V5-1 was recently developed for detecting municipal sewage discharges where its higher abundance than HF183 was more related to the persistence of anaerobic Bacteroidetes in sewer pipe biofilm than in human feces (Feng and McLellan 2019). The high abundance of biomarker BACV4V5-1 in the septage and drainage samples from the OSS area suggests there is an abundance of anaerobic Bacteroidetes in biofilms present within septic tanks and drain fields.

As noted for *E. coli*, high concentrations of human biomarker BACV4V5-1 were measured during storm event 3 at OSS area station 440 and the primary upstream station 440-U1 (8,190 and 7,310 copies/100 mL, respectively), but not at the low flowing upstream 440-U4 (250 copies/ 100 mL) where a high TP concentration was observed. These results indicate that elevated levels of biomarkers at station 440 originated in the drainage from the western portion of outfall basin 440 draining to the pond located above North Shore Road and west of Lazer Lane, rather than in drainage from the eastern portion of the basin draining to the road ditch east of Lazer Lane (see Figure A2).

Human biomarker HF183 was detected at a moderate level above the LOQ of 500 copies/ 100 mL on one occasion at both undeveloped area stations (1,820 copies/100 mL at UN-1 for storm event 1 and 766 copies/100 mL at UN-2 for base event 1) and on one occasion at sewer area station 516 (2,280 copies/100 mL for base event 2). Human biomarker BACV4V5-1 was never detected at the undeveloped area stations and was detected on one occasion at sewer area station 516 (546 copies/100 mL for storm event 2). The low to moderate levels of HF183 and undetected levels of BACV4V5-1 observed at the undeveloped stations suggest that biomarker BACV4V5-1 is more a selective biomarker and reliable indicator of septage, regardless of its origin, than biomarker HF183. Additional biomarker validation research would be needed to confirm these preliminary observations and indications.

The moderate levels of HF183 detected in the undeveloped area may have originated from human fecal deposits from unsanitary practices by visitors of the popular Hertz Trail, but also may have been false positive results originating from animal feces. For example, Feng and McLellan (2019) detected biomarker HF183 in 3 of 11 (27 percent) deer fecal samples while biomarker BACV4V5-1 was not detected in any deer fecal samples. The low to moderate levels of both biomarkers observed at sewer area station 516 suggest that human waste was commonly present in this drainage, either from a sewer system release or unsanitary practices (direct deposit), in amounts similar to those observed at OSS area stations 453 and 466, but much lower than those observed at OSS area stations 430, 440, and 520.



Comparison of human biomarker geometric means for storm and base events suggest that human sources were more abundant during storm events in the OSS area. A positive significant correlation between both biomarkers and flow was also identified (see Table 4). The base event geomean is lower in part because station 520 was not sampled for either base event due to lack of water flow, further supporting this difference. High levels of human biomarker HF183 were observed during both types of events at OSS area station 430 but only during storm events at OSS area station 440. Low to moderate levels of human biomarker HF183 were observed during storm and base events at OSS area station 430, undeveloped area station UN-2, and sewer area station 516. Thus, human biomarker results overall were not substantially different between storm and base events.

The geometric mean concentration for the human biomarker *B. dorei* (which is nearly equivalent to HF183) during storm flow observed in the five OSS drainage area in 2017 was 67 copies/100 mL compared to the HF183 geometric mean of 114 copies/100 mL in 2020. The lower concentration during 2017 was primarily due to a lower detection limit of 3 copies/100 mL reported for 2017 than 50 copies/100 mL reported for 2020. A better comparison of human biomarker results between the 2017 and 2020 efforts is made for OSS station 520 where concentrations were high with *B. dorei* at 17,400 and 21,700 copies/100 mL with a geometric mean concentration of 19,000 copies/100 mL for two storm events in 2017. Whereas, HF183 widely ranged from less than 50 to 75,700 copies/100 mL with a lower geometric mean concentration of 2,495 copies/100 mL for three storm events in 2020 (see Table 3). During both studies, human biomarker concentrations were highest at OSS area station 520, and higher at OSS area stations 430 and 440 than OSS area stations 453 and 466. Therefore, human biomarker patterns among the five OSS area stations of concern did not appreciably change from 2017 to 2020, as discussed further below in Section 3.9 OSS Area Maintenance Assessment.

The high concentrations of human biomarkers observed at OSS area stations 430, 440, and 520 compared to all other stations clearly indicate that these drainages receive OSS effluent. However, they did not exhibit particularly high concentrations of *E. coli* or total phosphorus. These contrasting observations suggest that human biomarkers are more readily transported through soils to the drainages than E. coli or total phosphorus. Human biomarkers are extracted from filtered particulate matter, which may include dead bacteria cells or DNA fragments that transport more readily than contaminants such as E. coli and phosphorus. Bacteria (E. coli) are more susceptible to being strained by soil, allowing for smaller particles such as viruses and DNA to transport further (Bitton and Harvey 1992). In addition, bacteria survival is lower for the slower transport through soils than in overland flow. DNA also does not adsorb to soil minerals or particles as quickly as negatively charged dissolved orthophosphate, which is commonly not a concern in groundwater due to its high soil adsorption (Lusk et al 2017). Thus, the contrasting results for the measured effluent parameters can be explained by differences in their soil transport characteristics and suggest that the drainages are not being contaminated by overland flow of surfacing OSS failures. The results also suggest that other contaminants in OSS effluent that were not analyzed for and that are not readily filtered or adsorbed by soil, such as viruses, nitrate, and hydrophilic (polar and attracted to water) compounds (Lusk et al. 2017), may be present in drainage to stations 430, 440, and 520.

3.8. POLLUTANT LOADING ANALYSIS

As described in Section 2.4.4, annual pollutant loadings and areal pollutant loadings were estimated for total phosphorus and *E. coli*. In addition, loadings were calculated for human biomarkers HF183 and BACV4V5-1 as indicators of human fecal sources. Technically, biomarkers HF183 and BacV4V5-1 are not considered pollutants because they are not a direct risk to human or environmental health. Table 5 presents the results along with hydraulic loading rates for each drainage monitoring station. These loadings are gross estimates for comparative purposes only because they are based on inaccurate estimates of average annual flow rate and drainage basin area.

It is apparent from the total and areal loading rates of BacV4V5-1 in Table 5 that OSS area stations 430, 440, and 520 are contributing much more human biomarkers to Lake Whatcom than the undeveloped or sewer area stations. HF183 loading also shows that stations 520 and 516 had relatively high loading rates of human biomarkers. *E. coli* loading rates were particularly high at OSS stations 430 and 440 as well as sewer stations 485 and 516. However, total phosphorus loadings from these OSS area stations are generally within the range estimated for the undeveloped and sewer area stations. Areal TP loading rates were highest for UN-1 (1.2 kg/acre/year) and sewer area station 516 (2.2 kg/acre-year) that also exhibited the highest areal hydraulic loading rates. On an average basis by study area, the sewer area had over twice the areal TP loading rate at 0.18 kg/acre-year than the undeveloped and OSS areas, each at 0.08 kg/acre-year. The low total phosphorus loading rate estimated for the OSS area compared to the sewer area indicates that OSS are not a significant source of phosphorus loading the lake.

The Lake Whatcom TMDL estimated a stormwater TP loading rate for the North Shore basin under the existing conditions in 2013 at 400 pounds/year from 1,167 acres, which is equivalent to 0.16 kg/acre-year (Ecology 2016). Thus, the average areal TP loading rate estimated for the five OSS area stations sampled during 2020 (0.08 kg/acre-year) is half the areal stormwater TP loading rate estimated for the OSS area by the Lake Whatcom TMDL.

Phosphorus loading analysis of the 2017 results was performed by comparing differences in flow-weighted mean concentrations in OSS area drainages where human biomarkers were positively detected versus those drainages without a positive detection of human biomarkers (Herrera 2018). The mean total phosphorus concentrations were nearly significantly different (p=0.069) but were only 10 percent higher in the OSS drainages with human biomarkers detected. The resulting total phosphorus loading from OSS was estimated at 50 pounds/year (10 percent of 400 pounds/year plus 10 pounds/year for seepage of OSS contamination directly to the lake). The 2017 study estimate is similar to the annual total phosphorus loading of 55 pounds/year from OSS in the North Shore basin that was estimated for a cost-benefit analysis of phosphorus reducing activities in the watershed using a gross average per person loading rate obtained from the literature (Carlson 2011). The relatively small contribution of OSS to phosphorus loading from the basin (14 percent of the TMDL estimate) generally agrees with the 2020 study finding that this contribution is not significant.



	Table 5. Summary of Loading Analysis.													
				Hydrolog	jic	Total Phosphorus		E. coli		HF	183	BacV4V5-1		
9	itation	Area (acres)	Mean Flow (gpm)	Annual Load (MG/yr)	Areal Annual Load (MG/yr/ac)	Annual Load (kg/yr)	Areal Annual Load (kg/yr/ac)	Annual Load (10 ⁹ CFU/ yr)	Areal Annual Load (10 ⁹ CFU/yr /ac)	Annual Load (10 ⁹ copies/ yr)	Areal Annual Load (10 ⁹ copies/ yr/ac)	Annual Load (10 ⁹ copies/ yr)	Areal Annual Load (10 ⁹ copies/ yr/ac)	
Undev.	UN-1	2.0	20.4	10.7	5.37	2.5	1.23	33	16	955	477	102	51	
	UN-2	36.0	7.0	3.7	0.10	0.7	0.02	29	1	269	7	35	1	
	All	38.0	13.7	14.4	0.38	3.2	0.08	62	2	1,224	32	136	4	
	430	69.3	114.6	60.2	0.87	11.0	0.16	274	4	4,023	58	185,847	2,682	
	440	107.0	56.9	29.9	0.28	5.9	0.06	557	5	283	3	526,959	4,925	
SS	453	8.0	0.7	0.4	0.04	0.1	0.01	0	0	3	0	23	3	
Ö	466	47.9	11.5	6.0	0.13	0.9	0.02	44	1	2,088	44	306	6	
	520	4.6	9.0	4.7	1.03	1.7	0.36	1	0	115,103	25,022	19,186	4,171	
	All	236.8	38.5	101.3	0.43	19.6	0.08	875	4	121,500	513	732,321	3,093	
	482	5.6	6.5	3.4	0.61	1.3	0.23	26	5	32	6	32	6	
	485	158.0	49.0	25.8	0.16	4.0	0.03	891	6	932	6	1,306	8	
ver	504	42.7	39.7	20.9	0.49	1.9	0.05	65	2	197	5	197	5	
Sev	516	15.0	254.9	134.0	8.93	33.8	2.25	220	15	23,193	1,546	12,288	819	
	531	11.2	3.6	1.9	0.17	0.3	0.03	30	3	18	2	18	2	
	All	232.5	70.7	185.9	0.80	41.3	0.18	1,232	5	24,373	105	13,842	60	

kg = kilograms; MG = million gallons; mL = milliliters; µg = micrograms; ac = acre; yr = year

3.9. OSS MAINTENANCE ASSESSMENT

In response to the 2017 findings of OSS impact assessment, the Whatcom County Health Department inspected 68 of the 97 OSS in the OSS area from November 2017 through June 2018 (Cierebeij 2018, see Appendix B in QAPP). At the time of evaluation, the Reports of System Status (ROSS) for 64 of these systems showed that they met the functionality requirements of state and local regulations. They identified three OSS failures and one OSS in need of maintenance. Two of these four OSS are in the drainage basins sampled during 2020. One OSS failure was located at a parcel in the station 466 basin, and was observed discharging to a ditch and subsequently repaired. The OSS in need of maintenance was located at a parcel in the station 430 basin, and required clearing of the drain field.

OSS repairs in the basins draining to stations 466 and 430 apparently did not eliminate OSS effluent from reaching surface water in those drainages based on the moderate levels of human biomarker HF183 observed at both stations and the high levels of human biomarker BACV4V5-1 observed at station 430 during 2020. These results suggest that OSS repairs in the station 466 and 430 basins did not reduce OSS inputs of human biomarkers.

From 2017 to 2020 at station 466, the TP mean concentration decreased slightly from 69 to 43 μ g/L and the fecal coliform geometric mean decreased slightly from 122 to 90 CFU/100 mL. At station 430, the TP mean concentration did not appreciably change from 52 to 49 μ g/L and the fecal coliform geometric mean increased from 89 to 129 CFU/100 mL. The 2017 and 2020 results for stations 466 and 430 are similar to those observed in undeveloped drainages in 2020 where the TP mean concentration was 62 ug/L and the fecal coliform geometric mean concentration was 85 CFU/100 mL (see Table 3). These comparisons suggest that OSS inputs to stations 466 and 430 were not significantly contributing TP or fecal coliform bacteria to Lake Whatcom before or after the OSS maintenance assessment. It is possible that OSS contamination of these and other basins is occurring from systems that appeared to be in good working order during an inspection, but their drain fields are not effectively removing some effluent contaminants other than TP and fecal coliform bacteria that are more readily transported through soils.



4. CONCLUSIONS

Water quality monitoring was conducted as planned in three project areas representing undeveloped, OSS-served, and sewer-served shorelines of Lake Whatcom during the 2020 OSS impact assessment. Monitoring was conducted at the two drainages in the undeveloped area, five drainages in the OSS area, and five drainages in the sewer area, and included septic tank and sanitary sewer samples for source characterization. Flow rates were measured, and one grab sample was collected at each monitoring station during three storm flow sampling events in March through April 2020 and two base flow events in May through June 2020. The samples were analyzed for conductivity, optical brighteners, total phosphorus, fecal coliform bacteria, *E. coli* bacteria, human biomarker HF183, and human biomarker BACV4V5-1. The results generally met data quality objectives with minor exceptions for missing data due to lack of flow or omitted sample analysis, and data qualifications due to low precision of field duplicate analyses or indicator bacteria reported as too numerous to count.

The 2020 study results were consistent with the 2017 study relative to presence of target analytes in OSS-served drainages in the North Shore basin of Lake Whatcom. High concentrations of human biomarkers from OSS were observed in some of the drainages. However, the presence of human biomarkers did not correlate with loadings of phosphorus or live fecal coliform bacteria, which indicates that these contaminants appear to be effectively removed from OSS effluent by soils. It is possible that other unmonitored OSS contaminants such as viruses and polar chemicals, which are more readily transported through soils like human biomarkers, may be discharged to the lake. Key study findings are listed for each of the following analyses.

4.1. FLOW

- Drainage flows averaged 12 gpm in the undeveloped area, 43 gpm in the OSS area, and 69 gpm in the sewer area, and were substantially higher during storm flow than base flow.
- Storm flows in the OSS area were less than 10 percent of the storm flows measured at the same five stations in 2017 due to unusually large storms sampled during that assessment effort.



4.2. OPTICAL BRIGHTENERS

- The fluorescence of optical brighteners correlated with both human biomarkers HF183 and BacV4V5-1 but not with total phosphorus or *E. coli*, suggesting that field measurement of this laundry detergent additive is potentially useful for detecting the presence sewage effluent in drainages, but not as an indicator of total phosphorus or *E. coli* contamination.
- Exposure of samples to UV light to correct background fluorescence of natural organic matter did not accurately predict samples as either positive or negative for optical brighteners based on comparison to the human biomarker results.

4.3. TOTAL PHOSPHORUS

- High concentrations of total phosphorus (mean greater than 50 μg/L) were observed at both undeveloped area stations, three OSS area stations (440, 453, and 520), and three sewer area stations (482, 504, and 516). Total phosphorus concentrations were particularly high at OSS station 520 (mean of 368 μg/L) and in one grab sample collected at the primary upstream source of water draining to OSS area station 440 (347 μg/L).
- Total phosphorus concentrations were typically higher during base events than storm events, and during the lower flows sampled in 2020 than 2017, likely because drainage from the highly forested basins is primarily fed by shallow groundwater where dissolved phosphorus is diluted by infiltrated rainfall and not contaminated by runoff of particulate phosphorus. Total phosphorus analytical results did not correlate with any other parameters in the drainage samples.
- Total phosphorus concentrations were somewhat higher in samples from septic tanks (means of 10,000 and 15,000 μg/L) than the sanitary sewer samples (mean of 8,000 μg/L), but similar to the typical concentration reported in the literature for municipal sewage (10,000 μg/L).

4.4. INDICATOR BACTERIA

- Fecal coliform and *E. coli* concentrations were found to be nearly identical in value, suggesting that the positively testing indicator bacteria in the sampled water were largely of fecal origin.
- High concentrations of *E. coli* were observed at OSS area station 440 and sewer area station 485 (geometric means of 163 and 316 CFU/100 mL, respectively).



- No significant differences in *E. coli* concentrations were observed between the three study areas or the storm and base events.
- *E. coli* concentrations were higher in sanitary sewage than septic tank, ranging up to greater than 600,000 CFU/100 mL in a sewage sample.
- Unlike total phosphorus, indicator bacteria concentrations were typically lower with the lower flows in 2020, likely due to less wash off of fecal deposits on land.

4.5. HUMAN BIOMARKERS

- High human biomarker concentrations were observed at OSS area station 520 (geometric means of 2,495 copies/100 mL for HF183 and 1,204 copies/100 mL for BacV4V5-1) and OSS area stations 430 and 440 (geometric means at 1,186 and 4,370 copies/100 mL for BacV4V5-1, respectively, but low HF183 concentrations).
- Analysis of both human biomarkers proved to be very valuable and the experimental biomarker BACV4V5-1 was found more frequently than the EPA-approved biomarker HF183 in the OSS area.
- Sampling of two stations upstream of OSS area station 440 during one storm event was useful for identifying which area of the basin was likely impacted by OSS.
- The low to moderate levels of HF183 and undetected levels of BACV4V5-1 observed at the undeveloped stations suggest that biomarker BACV4V5-1 is a more selective biomarker and reliable indicator of human waste, regardless of its origin, than biomarker HF183.
- The low to moderate levels of both biomarkers observed at sewer area station 516 suggest that human waste was commonly present in this drainage, either from a sewer system release or unsanitary practice (direct deposit), in amounts similar to those observed at OSS area stations 453 and 466, but much lower than those observed at OSS area stations 430, 440, and 520.
- Human biomarker results were not substantially different between storm and base events.
- Human biomarker patterns among the five OSS area stations of concern did not appreciably change from 2017 to 2020.
- OSS area drainages appear to not be impacted by overland flow of surfacing OSS failures and the observed human biomarkers are more readily transported through soils to the drainages than living *E. coli* cells filtered by soils or phosphorus adsorbed to soil particles.


4.6. LOADING ANALYSIS

- OSS area stations 430, 440, and 520 are contributing much more human biomarkers to Lake Whatcom than the undeveloped or sewer area stations.
- The estimated annual areal total phosphorus loading rate was higher for the sewer area (0.18 kg/acre-year) than the undeveloped and OSS areas (0.08 kg/acre-year), and similar to the stormwater loading rate estimated for the OSS area (0.16 kg/acre/year) by the Lake Whatcom TMDL.
- The low total phosphorus loading rate estimated for the OSS area indicates that OSS are not a significant source of phosphorus loading to the lake, which agrees with previous estimates from the 2017 study and a previous estimate for the basin based on human population (CH2M Hill 2011), indicating that OSS represent less than 15 percent of the annual loading from the North Shore basin.

4.7. OSS MAINTENANCE ASSESSMENT

- OSS repairs performed in response to inspections in basins draining to OSS area stations 466 and 430 basins did not reduce inputs of human biomarkers, total phosphorus, or fecal coliform bacteria from this basin to Lake Whatcom. However, OSS did not appear to contaminate either drainage with total phosphorus or fecal coliform bacteria in 2017 or 2020 based on similar concentrations observed in the undeveloped area drainages.
- Further investigation would need to be conducted to determine if OSS are not effectively removing effluent contaminants of concern other than total phosphorus and fecal coliform bacteria.



5. RECOMMENDATIONS

It is recommended that the sources of high concentrations of human biomarkers, total phosphorus, and *E. coli* observed at OSS area stations 520 and 440 be located and controlled if possible. High concentrations of human biomarkers were also observed at OSS area station 430, but high concentrations of total phosphorus and *E. coli* were not observed in this drainage.

OSS contamination source tracking should be performed by sampling multiple locations upstream of stations 520 and 440 during at least two storm events and analyzing the samples for human biomarkers HF183 and BACV4V5-1, total phosphorus, and fecal coliform and *E. coli* bacteria. Potential OSS sources identified by the source tracking should be further investigated for proper OSS function and maintenance, and dye tested during wet weather conditions to confirm effluent transport from the OSS to surface drainage.



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APPENDIX A

Monitoring Station Maps





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APPENDIX B

Photographic Documentation



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Herrera Herrera





















APPENDIX C

Laboratory Data Reports





Laboratory Report Case Narrative

Client:	Herrera Seattle	Invoice Number:	20-03016
	2200 Sixth Ave #1100	PO Number:	-
	Seattle, WA 98121	Project Name:	-
Contact:	Rob Zisette	Date Received:	03/03/2020
Phone:	(206) 787-8262	Date Reported:	03/20/2020
Fax: Email:	- rzisette@herrerainc.com		

Overview

This report contains the analytical results for 15 samples. The samples were received on 03/03/2020 with a complete chain of custody. The samples arrived in good condition, in the appropriate sample containers for the analytes requested. All samples were received and analyzed within their established hold times.

The analytical results included in this report meet all applicable quality control procedure requirements except as noted in the QC remarks section below.

QC Remarks and Comments

The results contained in the following report have been reviewed and approved by the personnel listed below.

____ 03/20/2020 Date Name

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Fecal Coliform

290

CFU/100mL

03/03/2020

Stormwater Analysis Report

Lab #: 11716	Locatio	n: UN-	1		Collected:	03/03/2020) 8:45AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0599	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	34	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	34	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Lab #: 11717	Locatio	n: UN-	2		Collected:	03/03/2020) 9:00AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0575	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	290	CFU/100mL	2	-	SM9222D	ER	03/03/2020

Lab #: 11718	Locatio	n: Sep	Septage-1 Sewage		Collected:	03/03/2020 9:20AM	
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	8.00	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	>6,000	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	>6,000	CFU/100mL	2	-	SM9222D	ER	03/03/2020

-

SM9222D

ER

2

Lab #: 11719	Locatio	n: 520		Collected:	03/03/2020) 9:45AM	
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.102	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	7	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	7	CFU/100mL	2	-	SM9222D	ER	03/03/2020

Lab #: 11720	Location: 466					03/03/2020) 10:05AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0363	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	164	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	164	CFU/100mL	2	-	SM9222D	ER	03/03/2020



Stormwater Analysis Report

Lab #: 11721	Locatio	n: 453			Collected:	03/03/2020) 10:35AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.103	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	<2	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	<2	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Lab #: 11722	Locatio	n: 440			Collected:	03/03/2020) 10:50AM
Analyte	Results	Unite	POI	мы	Method	Analyst	Date Analyzed

Analyte	Results	Units	FQL	MDL	Method	Analysi	Date Analyzeu
Phosphorus, Total	0.0473	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	38	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	38	CFU/100mL	2	-	SM9222D	ER	03/03/2020

Lab #: 11723	Locatio	n: 430			Collected:	03/03/2020) 11:15AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0455	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	72	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	72	CFU/100mL	2	-	SM9222D	ER	03/03/2020

Lab #: 11724	Locatio	n: DUP			Collected:	03/03/2020) 11:35AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0431	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	78	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	78	CFU/100mL	2	-	SM9222D	ER	03/03/2020

Lab #: 11725	Locatio	n: 485			Collected:	03/03/2020) 12:20PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0316	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	30	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	30	CFU/100mL	2	-	SM9222D	ER	03/03/2020



Fecal Coliform

>6,000

CFU/100mL

03/03/2020

Stormwater Analysis Report

Lab #: 11726	Locatio	n: 504			Collected:	03/03/2020	12:50PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0206	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	92	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	96	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Lab #: 11727	Locatio	n: Sew	age-1		Collected:	03/03/2020	1:15PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	4.08	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	>6,000	CFU/100mL	2	-	SM9222D	ER	03/03/2020

Lab #: 11728	Locatio	n: 516			Collected:	03/03/2020	1:50PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0695	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	18	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	18	CFU/100mL	2	-	SM9222D	ER	03/03/2020

2

-

SM9222D

ER

Lab #: 11729	Locatio	n: 531		Collected:	03/03/2020) 2:10PM	
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0399	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	800	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	800	CFU/100mL	2	-	SM9222D	ER	03/03/2020

Lab #: 11730	Locatio	n: 482			Collected:	03/03/2020) 1:30PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0528	mg/L	0.0100	0.0300	SM4500PF	OS	03/11/2020
E. Coli	82	CFU/100mL	2	-	SM9222D	ER	03/03/2020
Fecal Coliform	82	CFU/100mL	2	-	SM9222D	ER	03/03/2020



Quality Control Analysis Report

Client:	Herrera Seattle	Invoice Number:	20-03016
	2200 Sixth Ave #1100	PO Number:	-
	Seattle, WA 98121	Project Name:	-

Independent Quality Control - Inorganics													
Analyte Date Sample Result True Value Units Rec. (%) Limits (%)													
Phosphorus	03/11/20	MB	<0.0100	-	mg/L	N/A	< PQL						
	LFB 0.959 0.100 mg/L 96 80 – 120												

Dependent Quality Control - Inorganics													
Analyte	Date	Sample	Result	Dup.	Units	DD (%)	Limits (%)	MS	Rec. (%)	Limits (%)			
Phos.	Phos. 03/11/20 0036MS 2.23 2.22 mg/L <1												

Definitions

DD (Percent Duplicate Difference): The calculated percent difference between laboratory duplicates.

MDL (Minimum Detection Level): The minimum level of target analyte that can be determined with 99% confidence.

MS (Matrix Spike): A sample that has been spiked with a known concentration of analyte. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results.

Laboratory Fortified Blank (LFB): An aliquot of laboratory reagent blank spiked with a known concentration of analyte. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Method Blank (MB): An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples.

PQL (Practical Quantitation Limit): The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Rec: Percent recovery. Result/True Value * 100

N/A: Not Applicable

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20-03016	11716	Herrera Seattle					
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20-03016	11717	Herrera Seattle					
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Received Date:03/03/2020

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Method Id: SM Invoice 20-03016 Method Id: SM Incubator: 44.5C Incubator: 35C Es Page 6 of 24	Lab.# 11725 J_9222D_confit J_9222D_confit ESS 2.2.1.020 SS 2.2.1.021	Client Herrera Seattle m* Media Code: Membrane Lot:	Dilution 10 10 50 10 10 1	Method Name: Confirmation Description Method Name: Confirmation	Fecal Coliform with Analyte Con Coli E. coli 39 9 1 5 5 5 6 1 1 5 6 1 1 5 6 1 1 5 6 1 1 5 6 1 1 5 6 1 1 5 6 1 1 5 6 1 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 6 1 5 7 7 6 1 5 7 7 7 7 7 7 7 7 7 7 7 7 7	h E. coli co Int Fecal 3q 5 l l h E. coli co Int Fecal (4 3 (d l) Appro- Com	onfirm MF	Results E. coli 78 Results E. coli 3/9 3/5 3/4 Py/5%01	Fecal Fecal 78 Fecal 70 30 30 30 30 30 30 30 30 30 3				

Received Date:03/03/2020

Invoice	Lab #	Client		Descriptio	n	N. Function					
20-03016	11726	Herrera Seattle									
Method Id: SM	1_9222D_confi	m*		Method Name:	: Fecal Coliform with E. coli	i confirm M	F				
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Invoice	Lab #	Client		Descriptio	n	in an the					
20-03016	11727	Herrera Seattle									
Method Id: SM	1_9222D_confi	m *		Method Name:	: Fecal Coliform with E. coli	i confirm M	F				
					Analyte Count		Results				
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Invoico	Lah #	Client									
20-03016	11728	Herrera Seattle		Descriptio	מ	Participation of the					
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Method Id: SM	4 9222D Contil	m *	Method Name: Fecal Coliform with E. coli confirm MF								
method 10: SM	1_9222D_confil	m *		Method Name:	Fecal Coliform with E. coli	i confirm Mi	F				
Method Id: SM	1_9222D_confil	m*	Dilution	Method Name:	Fecal Coliform with E. coli	i confirm Mi	F <u>Results</u>				
method 10: Sr	1_9222D_contil	m*	Dilution	Method Name;	Fecal Coliform with E. coli <u>Analyte Count</u> Coli E. coli Fecal	Coli	F <u>Results</u> E. coli	Fecal			
Method 10: SM	1_9222D_contil	m*	Dilution	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal	Coli	Results E. coli	Fecal			
Method 10: SM	1_9222D_contil	m*	Dilution 60 10	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal	Coli 0423/4/	Results E. coli	Fecal			
Method 10: SM	1_9222D_contil	m*	Dilution 60 10 1	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal	Coli 0423/4/ 14/20	F Results E. coli	Fecal			
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Invoice 20-03016 Method Id: SM	Lab # 11729 1_9222D_confi	Client Herrera Seattle m *	Dilution 60 10 1	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal Coli E. coli Fecal Coli Coli Coli Coliform with E. coli	Coli <i>QP</i> -3/4/ <i>DP</i> -3/4/20 Confirm Mi	F Results E. coli 20	Fecal			
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Invoice 20-03016 Method Id: SM	Lab # 11729 1_9222D_confi	<mark>Client</mark> Herrera Seattle m*	Dilution	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal	Coli	F Results E. coli 20 (§ (§ Results E. coli	Fecal			
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Invoice 20-03016 Method Id: SM	Lab # 11729 1_9222D_confit	<mark>Client</mark> Herrera Seattle m*	Dilution 60 10 1 0 1 0 10 1 0 10 1 0 10 1 0 10 1 0 10 10 10 10 10 10	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal Coli E. coli Fecal Coli Cult Cu	Coli	Results E. coli	Fecal			
Invoice 20-03016 Method Id: SM	Lab # 11729 1_9222D_confit	Client Herrera Seattle m*	Dilution 60 10 1 0 1 0 10 1 0 10 1 0 10 1 0 10 1 0 10 10 10 10 1	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal Coli E. coli Fecal Coli Cult Cult Cult Cult Cult Cult Analyte Count Coli E. coli Fecal TNTC TNTC TNTC TNTC S S	confirm Mi	Results E. coli	Fecal			
Invoice 20-03016 Method Id: SM	Lab # 11729 1_9222D_confit	<mark>Client</mark> Herrera Seattle m*	Dilution 60 10 1 0 1 0 10 1	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal Coli E. coli Fecal Coli Cult C	Coli Confirm Mi Coli Coli Coli Coli	F Results E. coli () () () Results E. coli	Fecal			
Invoice 20-03016 Method Id: SM	Lab # 11729 1_9222D_confi 1_9222D_confi	<u>Client</u> Herrera Seattle m*	Dilution 60 10 1 0 1 0 10 1 0 10 1 0 10 1 0 10 1 0 10 10 10 10 10 1	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal Coli E. coli Fecal Coli C.	Coli	Results E. coli	Fecal			
Invoice 20-03016 Method Id: SM	Lab # 11729 1_9222D_confit 1_9222D_confit	Client Herrera Seattle m*	Dilution 60 10 1 0 1 0 10 1 0 10 1 0 10 1 0 10 10 10 10 1	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal Coli E. coli Fecal Coli Cult	Coli	Results E. coli	Fecal			
Invoice 20-03016 Method Id: SM Incubator: 44.5C Incubator: 35C Es	Lab # 11729 1_9222D_confi 1_9222D_confi ESS 2.2.1.020 SS 2.2.1.021	Client Herrera Seattle m* Media Code:	Dilution 10 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 10 10 10 10 10 10 1	Pre pst Date/Time	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal Coli E. coli Fecal Coli Coli Coli Analyte Count Coli E. coli Fecal Coli E. coli Fecal	confirm Mi	Results E. coli 20 (5) Results E. coli E. coli SUD 5,17 3/4	Fecal			
Invoice 20-03016 Method Id: SM Incubator: 44.5C Incubator: 35C E: Page 7 of 24	Lab # 11729 1_9222D_confit 1_9222D_confit ESS 2.2.1.020 SS 2.2.1.021	Client Herrera Seattle m* Media Code: Membrane Lot:	Dilution 60 10 1 0 1 0 10 1 0 10 1 0 10 1 0 10 10 10 10 10 10 10 1	Method Name:	Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal Coli E. coli Fecal Coli Call Call Fecal Coliform with E. coli Analyte Count Coli E. coli Fecal TNTC TNTC TNTC TNTC S 8	confirm Mi	Results E. coli 20 (§ Results E. coli 800 800	Fecal			

Received Date:03/03/2020

Invoice	Lab #	Client	Description
20-03016	11730	Herrera Seattle	
Method Id: SM	_9222D_confin	m*	Method Name: Fecal Coliform with E. coli confirm MF

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Client NARAYA ENVIRONMENTALXOONSUNTANTS

Description

Incubator: 44.5C ESS 2.2.1.020 Incubator: 35C ESS 2.2.1.021





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Date/Time Out:

Approve:



Water Chemistry Chain of Custody

1355 Pacific Place Suite 101 Ferndale, WA 98248 phone: 360-733-1205 fax: 888-818-2978 email: lab@exactscientific.com

Report To Information		Public Wa	ter System Information Only:			AT SALE				
Client Name: Herrera Environmenta	1 Consultants	Public S	ystem ID:			System N	lame:			
Address: 2200 6th Ave, St	re 1100	County:								
County: U	hatom	Source	# :			Composi	tion:	Grab	Composi	te
City: Seattle State: WA	Zip: 98121	Compos	ite Sampling: List Sourc	e #'s						
Phone: Fax:		Sample	Type: Pre-Treatm	ent (RA	w)	Post-Tre	atment (Finished)		
Email: vziszette@herrerainc.co	DM	Sample	Purpose: Routine	Compliar	nce	_ Investiga	tive	_Building F	Permit	Other
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Temperature at receipt°C	Chain of custody and labels age	ree: 🔀 Yes	No No				Check	with lab fo	r specific h	olding times.

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Water Chemistry Chain of Custody

1355 Pacific Place Suite 101 Ferndale, WA 98248 phone: 360-733-1205 fax: 888-818-2978 email: lab@exactscientific.com

Report To Information				Public Wa	ter System Information Only:		in SA	all and			-				
				Public S	System ID:				System N	ame:					
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Email:				Sample	Purpose: Routine	Compl	iance		Investigat	ive	Buil	ding P	ermit _	Other	<u> </u>
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Human Fecal Quantification ID Test Results Report

Detection and quantification of the fecal associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

> Submitter: Herrera Environmental Date Received/Processed: March 5, 2020 Report Generated: March 12, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Analysis Requested	Marker Quantified (copies/100 ml)	Sample Type
SM20C05006	UN-1	Human_HF183	ND	Water
SM20C05007	UN-2	Human_HF183	DNQ	Water
SM20C05008	Septage-1	Human_HF183	3.57E+03	Water
SM20C05009	520	Human_HF183	7.57E+04	Water
SM20C05010	466	Human_HF183	1.92E+03	Water
SM20C05013	453	Human_HF183	ND	Water
SM20C05014	440	Human_HF183	ND	Water
SM20C05015	430	Human_HF183	ND	Water
SM20C05017	DUP	Human_HF183	DNQ	Water
SM20C05018	485	Human_HF183	ND	Water
SM20C05019	504	Human_HF183	ND	Water
SM20C05020	516	Human_HF183	DNQ	Water
SM20C05021	531	Human_HF183	ND	Water
SM20C05023	Sewage-1	Human_HF183	4.69E+08	Water
SM20C05024	482	Human_HF183	ND	Water

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





Human Fecal Quantification ID Test Results Report

Detection and quantification of the fecal associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: March 5, 2020 Report Generated: March 12, 2020

SM #	Sample ID	Extraction Date	Analysis Date	Amount Processed (ml)	Analytical Volume (ul)
SM20C05006	UN-1	3/9/2020	3/9/2020	100	2
SM20C05007	UN-2	3/9/2020	3/9/2020	100	2
SM20C05008	Septage-1	3/9/2020	3/9/2020	50	2
SM20C05009	520	3/9/2020	3/9/2020	100	2
SM20C05010	466	3/9/2020	3/9/2020	100	2
SM20C05013	453	3/9/2020	3/9/2020	100	2
SM20C05014	440	3/9/2020	3/9/2020	100	2
SM20C05015	430	3/9/2020	3/9/2020	100	2
SM20C05017	DUP	3/9/2020	3/9/2020	100	2
SM20C05018	485	3/9/2020	3/9/2020	100	2
SM20C05019	504	3/9/2020	3/9/2020	100	2
SM20C05020	516	3/9/2020	3/9/2020	100	2
SM20C05021	531	3/9/2020	3/9/2020	100	2
SM20C05023	Sewage-1	3/9/2020	3/10/2020	50	0.02
SM20C05024	482	3/9/2020	3/9/2020	100	2

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received.

Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

Non-Detect Results

In sample(s) classified as non-detect, the host-associated fecal gene biomarker(s) was either not detected in test replicates, one replicate was detected at a cycle threshold greater than 35 and the other was not, or one replicate was detected at a cycle threshold less than 35 and the other was not after repeated analysis.

Detected Results

In sample(s) classified as detected, the host-associated fecal gene biomarker(s) was detected in both test replicates suggesting that the host's fecal contamination is present in the sample(s). Copy number measurements reported are relative, not absolute, quantification.

Detected Not Quantified (DNQ) Results

In sample(s) classified as Detected Not Quantified (DNQ), the host-associated fecal biomarker was detected in both test replicates but in quantities below the limit of quantification. This result indicates that fecal indicators associated with the respective host was present in the sample(s) but in low concentrations.

Fecal Reference Samples

The client is encouraged to submit fecal samples from suspected sources in the surrounding area in order to gain a better understanding of the concentration of the host-associated biomarker with the regional population. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

The presence of the biomarker does not signify the presence or absence of that form of fecal pollution conclusively. The most reliable way to accurately test for contamination is to combine genetic testing with scientifically sound and adequate study design appropriate for the water quality questions to be answered or issues to be resolved.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination.

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The client must contact Source Molecular in writing within 10 days from the date of this report if he/she does not wish for their submitted sample(s) to be used for any type of future research.

DNA Analytical Method Explanation

Water Samples: Each submitted water sample is filtered through 0.45 micron membrane filter(s). Each filter is placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample is homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol. Devitations to these procedures may occur at the client's request.

Non-Water Samples: Each non-water sample submitted by the client is processed as per internal laboratory extraction procedures. An extracted DNA sample is proceed directly to PCR analysis. Details available upon request.

Amplifications to detect the target gene biomarker were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul sample extract, forward primer, reverse primer, probe and an optimized buffer. All assays are run in duplicate. Quantification is achieved by extrapolating target gene copy numbers from a standard curve generated from serial dilutions of known gene copy numbers.

For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.





Human Fecal Quantification ID Test Results Report

Detection and quantification of the fecal associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

> Submitter: Herrera Environmental Date Received/Processed: March 5, 2020 Report Generated: March 12, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Analysis Requested	Marker Quantified (copies/100 ml)	Sample Type
SM20C05025	UN-1	Sewage Marker BacV4V5-1	ND	Water
SM20C05026	UN-2	Sewage Marker BacV4V5-1	ND	Water
SM20C05027	Septage-1	Sewage Marker BacV4V5-1	6.21E+07	Water
SM20C05028	520	Sewage Marker BacV4V5-1	1.17E+04	Water
SM20C05029	466	Sewage Marker BacV4V5-1	ND	Water
SM20C05030	453	Sewage Marker BacV4V5-1	DNQ	Water
SM20C05031	440	Sewage Marker BacV4V5-1	4.95E+04	Water
SM20C05032	430	Sewage Marker BacV4V5-1	DNQ	Water
SM20C05033	DUP	Sewage Marker BacV4V5-1	DNQ	Water
SM20C05034	485	Sewage Marker BacV4V5-1	DNQ	Water
SM20C05035	504	Sewage Marker BacV4V5-1	ND	Water
SM20C05036	516	Sewage Marker BacV4V5-1	ND	Water
SM20C05037	531	Sewage Marker BacV4V5-1	ND	Water
SM20C05038	Sewage-1	Sewage Marker BacV4V5-1	5.00E+06	Water
SM20C05040	482	Sewage Marker BacV4V5-1	ND	Water

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





Human Fecal Quantification ID Test Results Report

Detection and quantification of the fecal associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: March 5, 2020 Report Generated: March 12, 2020

SM #	Sample ID	Extraction Date	Analysis Date	Amount Processed (ml)	Analytical Volume (ul)
SM20C05025	UN-1	3/9/2020	3/9/2020	100	2
SM20C05026	UN-2	3/9/2020	3/9/2020	100	2
SM20C05027	Septage-1	3/9/2020	3/9/2020	50	0.2
SM20C05028	520	3/9/2020	3/9/2020	100	2
SM20C05029	466	3/9/2020	3/9/2020	100	2
SM20C05030	453	3/9/2020	3/9/2020	100	2
SM20C05031	440	3/9/2020	3/9/2020	100	2
SM20C05032	430	3/9/2020	3/9/2020	100	2
SM20C05033	DUP	3/9/2020	3/9/2020	100	2
SM20C05034	485	3/9/2020	3/9/2020	100	2
SM20C05035	504	3/9/2020	3/9/2020	100	2
SM20C05036	516	3/9/2020	3/9/2020	100	2
SM20C05037	531	3/9/2020	3/9/2020	100	2
SM20C05038	Sewage-1	3/9/2020	3/9/2020	50	2
SM20C05040	482	3/9/2020	3/9/2020	100	2

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received.

Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

Non-Detect Results

In sample(s) classified as non-detect, the host-associated fecal gene biomarker(s) was either not detected in test replicates, one replicate was detected at a cycle threshold greater than 35 and the other was not, or one replicate was detected at a cycle threshold less than 35 and the other was not after repeated analysis.

Detected Results

In sample(s) classified as detected, the host-associated fecal gene biomarker(s) was detected in both test replicates suggesting that the host's fecal contamination is present in the sample(s). Copy number measurements reported are relative, not absolute, quantification.

Detected Not Quantified (DNQ) Results

In sample(s) classified as Detected Not Quantified (DNQ), the host-associated fecal biomarker was detected in both test replicates but in quantities below the limit of quantification. This result indicates that fecal indicators associated with the respective host was present in the sample(s) but in low concentrations.

Fecal Reference Samples

The client is encouraged to submit fecal samples from suspected sources in the surrounding area in order to gain a better understanding of the concentration of the host-associated biomarker with the regional population. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

The presence of the biomarker does not signify the presence or absence of that form of fecal pollution conclusively. The most reliable way to accurately test for contamination is to combine genetic testing with scientifically sound and adequate study design appropriate for the water quality questions to be answered or issues to be resolved.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination.

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The client must contact Source Molecular in writing within 10 days from the date of this report if he/she does not wish for their submitted sample(s) to be used for any type of future research.

DNA Analytical Method Explanation

Water Samples: Each submitted water sample is filtered through 0.45 micron membrane filter(s). Each filter is placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample is homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol. Devitations to these procedures may occur at the client's request.

Non-Water Samples: Each non-water sample submitted by the client is processed as per internal laboratory extraction procedures. An extracted DNA sample is proceed directly to PCR analysis. Details available upon request.

Amplifications to detect the target gene biomarker were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul sample extract, forward primer, reverse primer, probe and an optimized buffer. All assays are run in duplicate. Quantification is achieved by extrapolating target gene copy numbers from a standard curve generated from serial dilutions of known gene copy numbers.

For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.

Chain Of Custody Record

Revision 1.2

Effective Date 8/20/2018



Source Molecular Corporation 15280 NW 79th CT Suite 107 Miami Lakes, FL 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733 Email: info@sourcemolecular.com

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Completed by Client:

Signature

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To protect confidentiality, confirmation and results will only be sent to email address provided or authorized by contact provided. Signed form indicates agreement with the test limitations on the back of this form and the company's terms of use found here: sourcemolecular.com/aboutsourcemolecular/privacy_statement/.

Completed by Source Molecular: las Gran neejo Received/Filtered 64 Temperature Signature Thermometer 94 Buro/S 20 San Cooler Number Date/Time Page 306 of 393



Data Quality Assurance Worksheet

		By	R. Zisette				
Project Name/No./Client:	Lake Whatcom OSS-2/ 19-07208-000 / LWWSD.	Date	7/24/2020	Page	1	of	1
Laboratory/Parameters:	Herrera (OB); Exact (TP, FC, EC); Source Molecular (HF183, Bac/V4V5-1)	Checked:	initials				
Sample Date/Sample ID:	3/3/2020 Storm Event 1 / 15 samples (DUP = field duplicate of 430)		date				

		Holdin (d	ng Time lay)	Reporting	Matrix Surro Recove	Spike/ ogate ery (%)	Lab C Sample I (9	Control Recovery %)	Lab Dı RPE	uplicate	Field D RPD	uplicate (%)	
Parameter	Completeness/ Methodology	Goal	Actual	Limit Goal / Method Blank	Goal	Actual	Goal	Actual	Goal	Actual	Goal	Actual	ACTION/Notes
Conductivity	OK / meter	≤28		2 uS/cm / NA	NA	NA	NA	NA	≤20	NA	≤20	2	None
Optical Brighteners	OK / QAPP	≤2	2	NA	NA	NA	NA	NA	≤20	NA	≤20	0.3	None
Total Phosphorus	OK / EPA 365.1	≤28	8	10 ug/L/ <10	80-120	106	90-110	96	≤20	<1	≤20	7	None
Fecal coliform	OK / SM9222D	≤1	0	2 CFU /100mL / neg	NA	NA	Pos/neg	NA	≤35	NA	≤35	8	None. Checked worksheet calculations of 50, 10, and 1 mL dilutions – all correct. Used >6,000 for TNTC with 1 mL dilution - OK
E. coli	OK / SM9222D	≤1	0	2 CFU /100mL / NA	NA	NA	Pos/neg	NA	≤35	NA	≤35	8	None. Checked worksheet calculations of 50, 10, and 1 mL dilutions – all correct. Used >6,000 for TNTC with 1 mL dilution - OK
Human HF 183	OK / qPCR	≤2	2	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	ND/ DNQ	Flag J value of ND for Sample 430 due to field dup = DNQ
Sewage BacV4V5-1	OK / qPCR	≤2	2	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	DNQ /DNQ	None

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



Laboratory Report Case Narrative

Client:	Herrera Seattle 2200 Sixth Ave #1100 Seattle, WA 98121	Invoice Number: PO Number: Project Name:	20-04066 - -
Contact: Phone: Fax:	Rob Zisette (206) 787-8262	Date Received: Date Reported:	03/24/2020 04/15/2020
Email:	rzisette@herrerainc.com		

Overview

This report contains the analytical results for 15 samples. The samples were received on 03/24/2020 with a complete chain of custody. The samples arrived in good condition, in the appropriate sample containers for the analytes requested. All samples were received and analyzed within their established hold times.

The analytical results included in this report meet all applicable quality control procedure requirements except as noted in the QC remarks section below.

QC Remarks and Comments

The results contained in the following report have been reviewed and approved by the personnel listed below.

____ 04/15/2020 Date Name

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98

Fecal Coliform

CFU/100mL

03/24/2020

Stormwater Analysis Report

Lab #: 16176	Locatio	n: UN-	2		Collected:	03/24/2020 8:20AM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	
Phosphorus, Total	0.0327	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020	
E. Coli	25	CFU/100mL	2	-	SM9222D	ER	03/24/2020	
Fecal Coliform	28	CFU/100mL	2	-	SM9222D	ER	03/24/2020	
Lab #: 16177	Locatio	n: UN-	1		Collected:	03/24/2020 8:30AM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	
Phosphorus, Total	0.0583	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020	
E. Coli	98	CFU/100mL	2	-	SM9222D	ER	03/24/2020	

Lab #: 16178	Location: Septage-2		tage-2		Collected:	03/24/2020	9:00AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	13.9	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	>6,000	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	>6,000	CFU/100mL	2	-	SM9222D	ER	03/24/2020

2

-

SM9222D

ER

Lab #: 16179	Locatio	n: 520			Collected:	03/24/2020) 9:25AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0525	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	<2	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	<2	CFU/100mL	2	-	SM9222D	ER	03/24/2020

Lab #: 16180	#: 16180 Location: 466) 9:45AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0394	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	3	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	3	CFU/100mL	2	-	SM9222D	ER	03/24/2020



Stormwater Analysis Report

Lab #: 16181	Locatio	n: 453			Collected: 03/24/2020 10:05AM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0294	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	<2	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	<2	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Lab #: 16182	Locatio	n: 440			Collected:	03/24/2020) 10:15AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed

Phosphorus, Total	0.0467	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	310	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	320	CFU/100mL	2	-	SM9222D	ER	03/24/2020

Lab #: 16183	Locatio	n: 430			Collected:	03/24/2020) 10:25AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0493	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	74	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	74	CFU/100mL	2	-	SM9222D	ER	03/24/2020

Lab #: 16184	Locatio	n: 531			Collected:	03/24/2020) 12:00PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0386	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	16	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	16	CFU/100mL	2	-	SM9222D	ER	03/24/2020

Lab #: 16185	Locatio	n: 516			Collected:	03/24/2020) 12:20PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0569	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	16	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	16	CFU/100mL	2	-	SM9222D	ER	03/24/2020



Stormwater Analysis Report

Lab #: 16186	Locatio	n: 482			Collected: 03/24/2020 12:30PM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0445	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	260	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	260	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Lab #: 16187	Locatio	n: DUP)		Collected:	03/24/2020) 12:35PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed

Phosphorus, Total	0.0519	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	28	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	28	CFU/100mL	2	-	SM9222D	ER	03/24/2020

Lab #: 16188	Location: Sewage-1		age-1		Collected: 03/24/2020 12:50) 12:50PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	5.66	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	280,000	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	280,000	CFU/100mL	2	-	SM9222D	ER	03/24/2020

Lab #: 16189	Locatio	n: 504			Collected:	03/24/2020) 12:05PM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0248	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	82	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	88	CFU/100mL	2	-	SM9222D	ER	03/24/2020

Lab #: 16190	Locatio	n: 485			Collected: 03/24/2020 1:15PM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0303	mg/L	0.0100	0.0030	SM4500PF	OS	04/02/2020
E. Coli	102	CFU/100mL	2	-	SM9222D	ER	03/24/2020
Fecal Coliform	102	CFU/100mL	2	-	SM9222D	ER	03/24/2020



Quality Control Analysis Report

Client:	Herrera Seattle	Invoice Number:	20-04066
	2200 Sixth Ave #1100	PO Number:	-
	Seattle, WA 98121	Project Name:	-

Independent Quality Control - Inorganics										
Analyte	Analyte Date Sample Result True Value Units Rec. (%) Limits (%)									
Phosphorus	04/02/20	MB	<0.0100	-	mg/L	N/A	< PQL			
		LFB	1.04	1.00	mg/L	104	80 – 120			

Dependent Quality Control - Inorganics										
Analyte	Date	Sample	Result	Dup.	Units	DD (%)	Limits (%)	MS	Rec. (%)	Limits (%)
Phos.	04/02/20	0008MS	1.02	1.01	mg/L	1.1	0 – 10	1.02	99	80 – 120

Definitions

DD (Percent Duplicate Difference): The calculated percent difference between laboratory duplicates.

MDL (Minimum Detection Level): The minimum level of target analyte that can be determined with 99% confidence.

MS (Matrix Spike): A sample that has been spiked with a known concentration of analyte. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results.

Laboratory Fortified Blank (LFB): An aliquot of laboratory reagent blank spiked with a known concentration of analyte. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Method Blank (MB): An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples.

PQL (Practical Quantitation Limit): The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Rec: Percent recovery. Result/True Value * 100

N/A: Not Applicable

Page 5 of 5

Received Date:03/24/2020

Invoice	Lab #	Client		Descriptio	n			h the state
****** **	X 1618X XXXX	XVANATOON XOONERVALION X	DENCK X					
Method Id: SI	4_9222D_confir	m*		Method Name:	Fecal Coliform with E. co	oli confirm MF	•	
		•			Analyte Count		<u>Results</u>	
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			XXXXXXX		XXXXXXXXX	XXXX		
			XXXXXXX		XXXXXXX	XXXXXXX	X GOOS	\$800
Invoice	Lah #	Client		Descriptio				
20-04066	16176	Herrera Seattle		Maschiptio				
Method Id: Si	4_9222D_confir	m*		Method Name:	Fecal Coliform with E. c	oli confirm MF		
					Analyte Count		Results	
			Dilution	Confirmation	Coli E. coli Fec	al Coli	E. coli	Fecal
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20-04066	16177	Herrera Seattle		Descriptio				
Method Id: SN	4_9222D_confir	m*		Method Name:	Fecal Coliform with E. co	oli confirm MF	:	
					Analyte Count		Results	
			Dilution	Confirmation	Coli E. coli Fec	al Coli	E. coli	Fecal
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			0.6					
Invoice	Lah #	Client	0.01	Description	C			
20-04066	16178	Herrera Seattle		Descriptio				
Method Id: SI	4_9222D_confir	m*		Method Name:	Fecal Coliform with E. co	oli confirm MF		
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			Dilution	Confirmation	Coli E. coli Fec	al Coli	<u>Kesuits</u>	Fecal
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Incubator: 35C E	SS 2.2.1.021	Media Code:	10000000000000000000000000000000000000	Data	10: 304 11-	Approve [.] Г	3125	4
Page 1 of 26		Membrane Lot:	10822102	Date/Time	Out: 3125 10	Computer.9e	31395	393

Received Date:03/24/2020

Invoice	Lab #	Client		Descriptio	n	and a state			
20-04066	16179	Herrera Seattle							
Method Id: SN	4_9222D_confi	m*		Method Name:	Fecal Coliform wit	th E. coli c	onfirm M	F	
					Analyte Co	unt		Results	
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Invoice	Lab #	Client		Descriptio	n	Mark Strail	N. CAR		
20-04066	16180	Herrera Seattle							
Method Id: SM	1_9222D_confi	rm*		Method Name:	Fecal Coliform wi	th E. coli c	onfirm M	F	
					<u>Analyte Co</u>	unt		Results	
			Dilution	Confirmation	Coli E. coli	Fecal	Coli	E. coli	Fecal
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Method Id: SN	1_9222D_confi	m*		Method Name:	Fecal Coliform wi	th E. coli c	onfirm Mi	F	
Method Id: SN	4_9222D_confi	m*		Method Name:	Fecal Coliform wit	th E. coli c unt	onfirm M	F <u>Results</u>	
Method Id: SM	4_9222D_confi	m*	Dilution	Method Name: <u>Confirmation</u>	Fecal Coliform with <u>Analyte Co</u> Coli E. coli	th E. coli c unt Fecal	onfirm Mi Coli	F <u>Results</u> E. coli	Fecal
Method Id: SM	1_9222D_confi	m*	<u>Dilution</u>	Method Name: Confirmation	Fecal Coliform with Analyte Co Coli E. coli	th E. coli c unt Fecal	onfirm Mi Coli	F <u>Results</u> E. coli	Fecal
Method Id: SM	4_9222D_confi	m*	Dilution 50 10	Method Name: Confirmation	Fecal Coliform with Analyte Co Coli E. coli	th E. coli o unt Fecal	Coli	F <u>Results</u> E. coli	Fecal
Method Id: SM	1_9222D_confi	m*	Dilution 50 10	Method Name:	Fecal Coliform with Analyte Co Coli E. coli	th E. coli o unt Fecal	Coli	F <u>Results</u> E. coli	Fecal
Method Id: SM	4_9222D_confi	m*	Dilution 50 10	Method Name:	Fecal Coliform with Analyte Co Coli E. coli	th E. coli of unt Fecal Ø Ø	Coli	F Results E. coli	Fecal
Method Id: SN	4_9222D_confi	m*	Dilution 50 10 1	Method Name:	Fecal Coliform with Analyte Co Coli E. coli	th E. coli of unt Fecal	Coli	F Results E. coli	Fecal
Method Id: SM	4_9222D_confi 4_9222D_confi 16182	Client Herrera Seattle	Dilution 50 10 1	Method Name: Confirmation	Fecal Coliform with Analyte Co Coli E. coli	th E. coli of unt Fecal	Coli	F Results E. coli	Fecal
Method Id: SM Invoice 20-04066 Method Id: SM	Lab # 16182 4_9222D_confi	Client Herrera Seattle	Dilution 50 10	Method Name:	Fecal Coliform with Analyte Co Coli E. coli Ø Ø Ø Ø Ø Paral Coliform with	th E. coli o unt Fecal Ø Ø	onfirm MI	F Results E. coli	Fecal
Method Id: SM Invoice 20-04066 Method Id: SM	Lab # 16182 M_9222D_confi	Client Herrera Seattle	Dilution	Method Name:	Fecal Coliform with Analyte Co Coli E. coli Ø Ø Ø Ø Fecal Coliform with Analyte Co	th E. coli of unt Fecal	onfirm Mi	F Results E. coli	Fecal
Method Id: SM Invoice 20-04066 Method Id: SM	Lab # 16182 4_9222D_confi	Client Herrera Seattle	Dilution	Method Name:	Fecal Coliform with Analyte Co Coli E. coli	th E. coli of unt Fecal Ø Ø Ø b th E. coli of unt Fecal	onfirm Mi	F Results E. coli	Fecal
Method Id: SM Invoice 20-04066 Method Id: SM	Lab # 16182 4_9222D_confi	Client Herrera Seattle	Dilution	Method Name:	Fecal Coliform with Analyte Co Coli E. coli Coli E. coli Coli Coliform with Analyte Co Coli E. coli	th E. coli of unt Fecal Ø Ø Ø b th E. coli of unt Fecal	onfirm Mi	F Results E. coli	Fecal
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Method Id: SM Invoice 20-04066 Method Id: SM	Lab # 16182 4_9222D_confi	Client Herrera Seattle	Dilution Do 10 10 1 Dilution 60 10 1	Method Name:	Fecal Coliform with Analyte Co Coli E. coli	th E. coli of unt Fecal Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø	onfirm Mi	F Results E. coli	Fecal
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Method Id: SM Invoice 20-04066 Method Id: SM	Lab # 16182 4_9222D_confi	Client Herrera Seattle rm*	Dilution 10 10 1 0 1 0 1 0 1 1	Method Name:	Fecal Coliform with Analyte Co Coli E. coli Ø Ø Ø Ø O O O Coli E. coli T Z 1 Ø	th E. coli of Unt Fecal Ø Ø Ø Ø C O th E. coli of Unt Fecal T 32 O I	onfirm Mi	F Results E. coli	Fecal
Method Id: SM Invoice 20-04066 Method Id: SM	4_9222D_confi 16182 4_9222D_confi 4_9222D_confi	rm* Client Herrera Seattle rm*	Dilution 10 10 1 Dilution 60 10 1	Method Name:	Fecal Coliform with Analyte Co Coli E. coli	th E. coli of unt Fecal Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø Ø	onfirm Mi	F Results E. coli LL F Results E. coli	Fecal

Page 2 of 26

Membrane Lot:

Date/Time Out:

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Date/Time In:

Received Date:03/24/2020

Invoice	Lab #	Client		Description	n		Sec. 3-3	12/7-5	2015
20-04066	16183	Herrera Seattle							
Method Id: SM	l_9222D_confii	m *		Method Name:	Fecal Coliform v	/ith E. coli c	onfirm M	F	
					Analyte (ount		Results	
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			<u>\</u>			3			
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Invoice	Lab #	Client	WP She had	Description	D	La Cillara			
20-04066	16184	Herrera Seattle							
Method Id: SM	I_9222D_confi	m*		Method Name:	Fecal Coliform v	rith E. coli c	onfirm M	F	
					Analyte (ount		Results	
			Dilution	Confirmation	Coli E. co	i Fecal	Coli	E. coli	Fecal
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Invoice	Lab #	Client		Description	n			And San	
20-04066	16185	Herrera Seattle							
Method Id: SM	1_9222D_confi	rm*		Method Name:	Fecal Coliform v	/ith E. coli c	onfirm M	F	
					Analyte (ount		<u>Results</u>	
			Dilution	Confirmation	Coli E. co	i Fecal	Coli	E. coli	Fecal
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Invoice	Lab #	Client	<u>60</u> 10	Descriptio		8 2 0 ; (AIC		16	16
Invoice 20-04066	Lab # 16186	Client Herrera Seattle	<u>60</u> 10	Descriptio		8 2 0 . ((())()		16	10
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Invoice 20-04066 Method Id: SM	Lab # 16186 1_9222D_confi t	Client Herrera Seattle m *	<u>60</u> 10	Description	Fecal Coliform v	8 2 0 ((()()) (()) (()) ()) ()) ()) ()) ())	confirm M	16 Results	10
Involce 20-04066 Method Id: SM	Lab # 16186 1_9222D_confi t	Client Herrera Seattle m *	<u>60</u> 10 1	Description Method Name: Confirmation	Fecal Coliform v Analyte (Coli E. co	8 2 0 (A(C) rith E. coli c Count	coli	f Results E. coli	Fecal
Invoice 20-04066 Method Id: SM	<mark>Lab #</mark> 16186 1_9222D_confi t	Client Herrera Seattle rm*	<u>BO</u> 10 1 Dilution	Description Method Name: Confirmation	Fecal Coliform v Analyte (Coli E. co	8 2 0 (AlC)	Coli	Results E. coli	Fecal
Involce 20-04066 Method Id: SM	<mark>Lab #</mark> 16186 1_9222D_confi	Client Herrera Seattle rm*	<u>60</u> 10 1 Dilution	Description Method Name: Confirmation	Fecal Coliform v Analyte (Coli E. co	8 2 0 (AIC with E. coli c count li Fecal	Coli	F Results E. coli	Fecal
Invoice 20-04066 Method Id: SM	<mark>Lab #</mark> 16186 1_9222D_confi t	Client Herrera Seattle rm*	<u>60</u> 10 1 Dilution	Description Method Name: Confirmation	Fecal Coliform v Analyte (Coli E. co	$\frac{8}{2}$ $\frac{2}{0}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	Coli	Results E. coli	Fecal
Involce 20-04066 Method Id: SM	<mark>Lab #</mark> 16186 1_9222D_confi	Client Herrera Seattle rm*	<u>50</u> 10 1 <u>Dilution</u>	Description Method Name: Confirmation	Fecal Coliform v Analyte (Coli E. co	8 2 0 ((()()) (()())) (()())(()) (())) (()()) (()()) (()))) (()))(()))(())) (())))(()))(()))(()))(()))(()))(()))(()))(()))(()))(()))	Coli	(6 F Results E. coli Z{0()	Fecal
Invoice 20-04066 Method Id: SM	<mark>Lab #</mark> 16186 1_9222D_confi t	Client Herrera Seattle rm*	<u>50</u> 10 1 <u>50</u> 10	Description Method Name: Confirmation	Fecal Coliform v Analyte (Coli E. co	$\frac{8}{2}$ $\frac{2}{0}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	Coli	Results E. coli	Fecal
Invoice 20-04066 Method Id: SM	Lab # 16186 1_9222D_confi	Client Herrera Seattle m*	<u>50</u> 10 1 	Description	Fecal Coliform v Analyte (Coli E. co	8 2 0 (((())) ((())) (()))) (())) (()))) (()))) (()))) (()))) (()))) (())))(()))(())))(())	Coli	(6 Results E. coli	Fecal
Invoice 20-04066 Method Id: SM	Lab # 16186 1_9222D_confit	Client Herrera Seattle rm*	<u>50</u> 10 1 1 20 1 20 10 1	Description Method Name: Confirmation	Fecal Coliform v Analyte (Coli E. co	$\frac{8}{2}$ $\frac{2}{0}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	Coli	Results E. coli	Fecal
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Membrane Lot:

Date/Time Out:

Approve: 3/25Computer: 3/25

Received Date:03/24/2020

Invoice	Lab #	Client		Descriptio	n			the lot
20-04066	16187	Herrera Seattle	¥(
Method Id: SM	1_9222D_confi	rm*		Method Name:	Fecal Coliform with	E. coli confirm MI	F	
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20-04066	16188	Herrera Seattle		Descriptio				
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meuloa Ia: Sr	1_9222Dconin			method Name:	recai Conform with		r	
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Invoice	Lab #	Client	0.01	Descriptio	m 28	28 2	280000	28000
20-04066	16189	Herrera Seattle						
Method Id: SM	1_9222D_confi	rm*		Method Name:	Fecal Coliform with	E. coli confirm M	F	
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Invoice	Lab #	Client		Descriptio	n			
20-04066	16190	Herrera Seattle						
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Incubator: 44.5C	ESS 2.2.1.020	Г		Pro ost				
Incubator: 35C E	SS 2.2.1.021	Media Code:		ria par		Approve	3/15	
Page 4 of 26		Membrane Lot:		Date/Time	e In:	Compleade	31600	393
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Received Date:03/24/2020

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20-04072	16225	N3 Consulting - David Ha	ggith							
Method Id: SM	_9222D_confii	m *		Method Name:	Fecal Coli	form with	n E. coli o	onfirm M	F	
					An	alyte Cou	Int		Results	
			Dilution	Confirmation	Coli	E. coli	Fecal	Coli	E. coli	Fecai
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Invoice	Lab #	Client		Descriptio	n					1.V9-6.5
20-04072	16226	N3 Consulting - David Ha	ggith							
Method Id: SM	_9222D_confi	m*		Method Name:	Fecal Coli	form witi	h E. coli c	onfirm M	F	
					An	alyte Cou	int		Results	
			Dilution	Confirmation	Coli	E. coli	Fecal	Coli	E. coli	Fecal
										
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nvoice	Lab #	<u>Client</u>		Descriptio	n					
20-04072	16227	N3 Consulting - David Ha	ggith							
Method Id: SM	9222D_confi	rm*		Method Name:	Fecal Coli	form wit	h E. coli c	onfirm M	F	
					An	alyte Cou	int		Results	
			Dilution	<u>Confirmation</u>	Coli	E. coli	Fecal	Coli	E. coli	Fecal
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			16			4	9			
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	Lab #	<u>Client</u>		Descriptio	n			100 Page 1	u neen	
20-04072	16228	N3 Consulting - David Ha	ggith							
Method Id: SM	I_9222D_confi	rm*		Method Name:	Fecal Coli	form with	h E. coli c	onfirm M	F	
					An	alyte Cou	Int		<u>Results</u>	
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Page 5 of 26

Membrane Lot:

Date/Time Out:







Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: March 25, 2020 Report Generated: April 2, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Analysis Requested	Marker Quantified (copies/100 ml)	Sample Type
SM20C25001	UN-2	Human_HF183	ND	Water
SM20C25002	UN-1	Human_HF183	DNQ	Water
SM20C25003	Septage-2	Human_HF183	ND	Water
SM20C25004	520	Human_HF183	8.21E+03	Water
SM20C25005	466	Human_HF183	ND	Water
SM20C25006	453	Human_HF183	ND	Water
SM20C25009	440	Human_HF183	ND	Water
SM20C25010	430	Human_HF183	DNQ	Water
SM20C25011	531	Human_HF183	ND	Water
SM20C25013	516	Human_HF183	DNQ	Water
SM20C25014	482	Human_HF183	ND	Water
SM20C25015	DUP	Human_HF183	ND	Water
SM20C25016	Sewage-1	Human_HF183	2.46E+08	Water
SM20C25018	504	Human_HF183	ND	Water
SM20C25019	485	Human_HF183	DNQ	Water

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: March 25, 2020 Report Generated: April 2, 2020

SM #	Sample ID	Extraction Date	Analysis Date	Amount Processed (ml)	Analytical Volume (ul)
SM20C25001	UN-2	3/30/2020	3/30/2020	100	2
SM20C25002	UN-1	3/30/2020	3/30/2020	100	2
SM20C25003	Septage-2	3/30/2020	3/30/2020	20	2
SM20C25004	520	3/30/2020	3/30/2020	100	2
SM20C25005	466	3/30/2020	3/31/2020	100	2
SM20C25006	453	3/30/2020	3/30/2020	100	2
SM20C25009	440	3/30/2020	3/30/2020	100	2
SM20C25010	430	3/30/2020	3/30/2020	100	2
SM20C25011	531	3/30/2020	3/30/2020	100	2
SM20C25013	516	3/30/2020	3/30/2020	100	2
SM20C25014	482	3/30/2020	3/30/2020	100	2
SM20C25015	DUP	3/30/2020	3/30/2020	100	2
SM20C25016	Sewage-1	3/30/2020	3/31/2020	50	0.02
SM20C25018	504	3/30/2020	3/30/2020	100	2
SM20C25019	485	3/30/2020	3/30/2020	100	2

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received.

Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

Non-Detect Results

In sample(s) classified as non-detect, the host-associated fecal gene biomarker(s) was either not detected in test replicates, one replicate was detected at a cycle threshold greater than 35 and the other was not, or one replicate was detected at a cycle threshold less than 35 and the other was not after repeated analysis.

Detected Results

In sample(s) classified as detected, the host-associated fecal gene biomarker(s) was detected in both test replicates suggesting that the host's fecal contamination is present in the sample(s). Copy number measurements reported are relative, not absolute, quantification.

Detected Not Quantified (DNQ) Results

In sample(s) classified as Detected Not Quantified (DNQ), the host-associated fecal biomarker was detected in both test replicates but in quantities below the limit of quantification. This result indicates that fecal indicators associated with the respective host was present in the sample(s) but in low concentrations.

Fecal Reference Samples

The client is encouraged to submit fecal samples from suspected sources in the surrounding area in order to gain a better understanding of the concentration of the host-associated biomarker with the regional population. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

The presence of the biomarker does not signify the presence or absence of that form of fecal pollution conclusively. The most reliable way to accurately test for contamination is to combine genetic testing with scientifically sound and adequate study design appropriate for the water quality questions to be answered or issues to be resolved.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination.

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The cultar the sample(s) to be used for any type of future research.

DNA Analytical Method Explanation

Water Samples: Each submitted water sample is filtered through 0.45 micron membrane filter(s). Each filter is placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample is homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol. Devitations to these procedures may occur at the client's request.

Non-Water Samples: Each non-water sample submitted by the client is processed as per internal laboratory extraction procedures. An extracted DNA sample is proceed directly to PCR analysis. Details available upon request.

Amplifications to detect the target gene biomarker were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul sample extract, forward primer, reverse primer, probe and an optimized buffer. All assays are run in duplicate. Quantification is achieved by extrapolating target gene copy numbers from a standard curve generated from serial dilutions of known gene copy numbers.

For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: March 25, 2020 Report Generated: April 2, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Analysis Requested	Marker Quantified (copies/100 ml)	Sample Type
SM20C25020	UN-2	Sewage Marker BacV4V5-1	ND	Water
SM20C25021	UN-1	Sewage Marker BacV4V5-1	ND	Water
SM20C25022	Septage-2	Sewage Marker BacV4V5-1	9.20E+07	Water
SM20C25023	520	Sewage Marker BacV4V5-1	5.96E+03	Water
SM20C25024	466	Sewage Marker BacV4V5-1	DNQ	Water
SM20C25025	453	Sewage Marker BacV4V5-1	DNQ	Water
SM20C25026	440	Sewage Marker BacV4V5-1	6.29E+04	Water
SM20C25027	430	Sewage Marker BacV4V5-1	1.53E+03	Water
SM20C25028	531	Sewage Marker BacV4V5-1	ND	Water
SM20C25029	516	Sewage Marker BacV4V5-1	5.46E+02	Water
SM20C25030	482	Sewage Marker BacV4V5-1	ND	Water
SM20C25031	DUP	Sewage Marker BacV4V5-1	ND	Water
SM20C25032	Sewage-1	Sewage Marker BacV4V5-1	4.93E+06	Water
SM20C25033	504	Sewage Marker BacV4V5-1	ND	Water
SM20C25034	485	Sewage Marker BacV4V5-1	ND	Water

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: March 25, 2020 Report Generated: April 2, 2020

SM #	Sample ID	Extraction Date	Analysis Date	Amount Processed (ml)	Analytical Volume (ul)
SM20C25020	UN-2	3/30/2020	3/30/2020	100	2
SM20C25021	UN-1	3/30/2020	3/30/2020	100	2
SM20C25022	Septage-2	3/30/2020	3/31/2020	20	0.2
SM20C25023	520	3/30/2020	3/30/2020	100	2
SM20C25024	466	3/30/2020	3/30/2020	100	2
SM20C25025	453	3/30/2020	3/30/2020	100	2
SM20C25026	440	3/30/2020	3/30/2020	100	2
SM20C25027	430	3/30/2020	3/30/2020	100	2
SM20C25028	531	3/30/2020	3/30/2020	100	2
SM20C25029	516	3/30/2020	3/30/2020	100	2
SM20C25030	482	3/30/2020	3/30/2020	100	2
SM20C25031	DUP	3/30/2020	3/30/2020	100	2
SM20C25032	Sewage-1	3/30/2020	3/30/2020	50	2
SM20C25033	504	3/30/2020	3/30/2020	100	2
SM20C25034	485	3/30/2020	3/30/2020	100	2

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received.

Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

Non-Detect Results

In sample(s) classified as non-detect, the host-associated fecal gene biomarker(s) was either not detected in test replicates, one replicate was detected at a cycle threshold greater than 35 and the other was not, or one replicate was detected at a cycle threshold less than 35 and the other was not after repeated analysis.

Detected Results

In sample(s) classified as detected, the host-associated fecal gene biomarker(s) was detected in both test replicates suggesting that the host's fecal contamination is present in the sample(s). Copy number measurements reported are relative, not absolute, quantification.

Detected Not Quantified (DNQ) Results

In sample(s) classified as Detected Not Quantified (DNQ), the host-associated fecal biomarker was detected in both test replicates but in quantities below the limit of quantification. This result indicates that fecal indicators associated with the respective host was present in the sample(s) but in low concentrations.

Fecal Reference Samples

The client is encouraged to submit fecal samples from suspected sources in the surrounding area in order to gain a better understanding of the concentration of the host-associated biomarker with the regional population. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

The presence of the biomarker does not signify the presence or absence of that form of fecal pollution conclusively. The most reliable way to accurately test for contamination is to combine genetic testing with scientifically sound and adequate study design appropriate for the water quality questions to be answered or issues to be resolved.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination.

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The client must contact Source Molecular in writing within 10 days from the date of this report if he/she does not wish for their submitted sample(s) to be used for any type of future research.

DNA Analytical Method Explanation

Water Samples: Each submitted water sample is filtered through 0.45 micron membrane filter(s). Each filter is placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample is homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol. Devitations to these procedures may occur at the client's request.

Non-Water Samples: Each non-water sample submitted by the client is processed as per internal laboratory extraction procedures. An extracted DNA sample is proceed directly to PCR analysis. Details available upon request.

Amplifications to detect the target gene biomarker were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul sample extract, forward primer, reverse primer, probe and an optimized buffer. All assays are run in duplicate. Quantification is achieved by extrapolating target gene copy numbers from a standard curve generated from serial dilutions of known gene copy numbers.

For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.

Chain Of Custody Record

Revision 1.2



Source Molecular Corporation 15280 NW 79th CT Suite 107 Miami Lakes, FL 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733 Email: info@sourcemolecular.com

Effective Date 8/20/2018								Email: Info@sourcemoi	ecular.co	om	
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UN-1	TT								1	1	8:30
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520	11										9:25
400	11										9:45
453	11										10:05
440	11		21 2			14					10:15
430	11										10-25
53	11										12:00
5110	1										12:20
482	11								1		12:30
DUP	11				-						12:35
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504										V	13:15
485	V	V									
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Completed by Client: Relinquished By Danielle Rapoza Signature Danielle Rapoza Date/Time 3/24/20 13:50

To protect confidentiality, confirmation and results will only be sent to email address provided or authorized by contact provided. Signed form indicates agreement with the test limitations on the back of this form and the company's terms of use found here: sourcemolecular.com/aboutsourcemolecular/privacy_statement/.

Completed by S Temperature	ource Molecular:	_ Received/Filtered Douglas Gramaju
Thermometer	201	Signature
Cooler Number_	13/11021	_ Date/Time

Page 324 of 393


Data Quality Assurance Worksheet

		By	R. Zisette				
Project Name/No./Client:	Lake Whatcom OSS-2/ 19-07208-000 / LWWSD.	Date	7/24/2020	Page	1	of	1
Laboratory/Parameters:	Herrera (OB); Exact (TP, FC, EC); Source Molecular (HF183, Bac/V4V5-1)	Checked:	initials				
Sample Date/Sample ID:	3/24/2020 Storm Event 2 / 15 samples (DUP = field duplicate of 482)		date				

		Holdir (d	ng Time ay)	Reporting	Matrix Surro Recove	Spike/ ogate ery (%)	Lab C Sample I (9	Control Recovery %)	Lab Du RPD	uplicate (%)	Field D RPD	uplicate (%)	
Parameter	Completeness/ Methodology	Goal	Actual	Limit Goal / Method Blank	Goal	Actual	Goal	Actual	Goal	Actual	Goal	Actual	ACTION/Notes
Conductivity	NA	≤28		2 uS/cm / NA	NA	NA	NA	NA	≤20	NA	≤20	2	Not analyzed due to analyst unavailability
Optical Brighteners	NA	≤2	2	NA	NA	NA	NA	NA	≤20	NA	≤20	0.3	Not analyzed due to analyst unavailability
Total Phosphorus	OK / EPA 365.1	≤28	9	10 ug/L/ <10	80-120	99	90-110	104	≤20	1	≤20	14	None
Fecal coliform	OK / SM9222D	≤1	0	2 CFU /100mL / neg	NA	NA	Pos/neg	NA	≤35	NA	≤35	<mark>160</mark>	Flag J value for Sample 482 due to field dup. Checked worksheet calculations of 50, 10, and 1 mL dilutions – all correct. Used >6,000 for TNTC with 1 mL dilution - OK
E. coli	OK / SM9222D	≤1	0	2 CFU /100mL / NA	NA	NA	Pos/neg	NA	≤35	NA	≤35	<mark>160</mark>	Flag J value for Sample 482 due to field dup. Checked worksheet calculations of 50, 10, and 1 mL dilutions – all correct. Used >6,000 for TNTC with 1 mL dilution - OK
Human HF 183	OK / qPCR	≤2	1	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	ND/ND	None
Sewage BacV4V5-1	OK / qPCR	≤2	1	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	ND/ND	None

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



Laboratory Report Case Narrative

Client:	Herrera Seattle 2200 Sixth Ave #1100 Seattle, WA 98121	Invoice Number: PO Number: Project Name:	20-05658 - -
Contact:	Rob Zisette	Date Received:	04/27/2020
Fax: Email:	rzisette@herrerainc.com	Date Reported:	05/15/2020

Overview

This report contains the analytical results for 18 samples. The samples were received on 04/27/2020 with a complete chain of custody. The samples arrived in good condition, in the appropriate sample containers for the analytes requested. All samples were received and analyzed within their established hold times.

The analytical results included in this report meet all applicable quality control procedure requirements except as noted in the QC remarks section below.

QC Remarks and Comments

The results contained in the following report have been reviewed and approved by the personnel listed below.

____ 05/14/2020 Date Name

Page 1 of 6



Lab #: 22323	Locatio	n: UN-	2		Collected: 04/27/2020 7:30AM			
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	
Phosphorus, Total	0.0495	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020	
E. Coli	182	CFU/100mL	2	-	SM9222D	ER	04/27/2020	
Fecal Coliform	182	CFU/100mL	2	-	SM9222D	ER	04/27/2020	
Lab #: 22324	Locatio	n: UN-	1		Collected:	04/27/2020) 7:45AM	
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	

Phosphorus, Total	0.0994	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	220	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	220	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22325	Location: Septage-2		tage-2		Collected:) 8:00AM	
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	15.9	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	15,000	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	15,000	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22326	Locatio	n: 520			Collected:	04/27/2020) 8:20AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.950	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	34	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	34	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22327	Location	: 520-U1	(Missing	Sample)	Collected:	: 04/27/2020 8:25AM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	
Phosphorus, Total	Not Tested	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020	
E. Coli	Not Tested	CFU/100mL	2	-	SM9222D	ER	04/27/2020	
Fecal Coliform	Not Tested	CFU/100mL	2	-	SM9222D	ER	04/27/2020	



Lab #: 22328	Locatio	n: 466			Collected:	04/27/2020) 8:35AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0527	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	<2	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	<2	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Lab #: 22329	Locatio	n: 453			Collected:	04/27/2020) 8:50AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed

Phosphorus, Total	0.0855	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	36	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	36	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22330	n: DUF		Collected:	04/27/2020) 8:55AM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0901	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	<2	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	<2	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22331	Locatio	n: 440			Collected:	04/27/2020) 9:15AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0759	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	2,000	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	2,000	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22332	Location: 440-U1			Collected: 04/27/2020 9:25AM) 9:25AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0812	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	2,300	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	2,300	CFU/100mL	2	-	SM9222D	ER	04/27/2020



Lab #: 22333	Location: 440-U4				Collected: 04/27/2020 9:35AM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.347	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	11	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	11	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22334	Locatio	n: 430			Collected: 04/27/2020 9:45AM				
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed		
Phosphorus, Total	0.0534	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020		
E. Coli	410	CFU/100mL	2	-	SM9222D	ER	04/27/2020		
Fecal Coliform	410	CFU/100mL	2	-	SM9222D	ER	04/27/2020		

Lab #: 22335	Locatio	n: 531			Collected:	04/27/2020) 11:15AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0389	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	21	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	21	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22336	Locatio	n: 516			Collected:	04/27/2020) 11:30AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0676	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	118	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	118	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22337	Locatio	n: 482			Collected: 04/27/2020 11:45AI		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.226	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	210	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	210	CFU/100mL	2	-	SM9222D	ER	04/27/2020



Lab #: 22338	Locatio	n: Sew	Sewage-1		Collected:	04/27/2020	12:15AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	17.0	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	>600,000	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	>600,000	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Lab #: 22339	Locatio	n: 504			Collected:	04/27/2020	11:55AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0415	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	8	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	8	CFU/100mL	2	-	SM9222D	ER	04/27/2020

Lab #: 22340	Locatio	n: 485			Collected:	04/27/2020) 12:20AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0451	mg/L	0.0100	0.0030	SM4500PF	OS	05/01/2020
E. Coli	900	CFU/100mL	2	-	SM9222D	ER	04/27/2020
Fecal Coliform	900	CFU/100mL	2	-	SM9222D	ER	04/27/2020



Quality Control Analysis Report

Client:	Herrera Seattle	Invoice Number:	20-05658
	2200 Sixth Ave #1100	PO Number:	-
	Seattle, WA 98121	Project Name:	-

Independent Quality Control - Inorganics								
Analyte Date Sample Result True Value Units Rec. (%) Limits (%)								
Phosphorus	05/01/20	MB	<0.0100	-	mg/L	N/A	< PQL	
LFB 1.03 1.00 mg/L 103 80 – 120								

Dependent Quality Control - Inorganics										
Analyte	Date	Sample	Result	Dup.	Units	DD (%)	Limits (%)	MS	Rec. (%)	Limits (%)
Phos.	05/01/20	0774MS	1.08	1.08	mg/L	<1	0 – 10	1.08	103	80 – 120

Definitions

DD (Percent Duplicate Difference): The calculated percent difference between laboratory duplicates.

MDL (Minimum Detection Level): The minimum level of target analyte that can be determined with 99% confidence.

MS (Matrix Spike): A sample that has been spiked with a known concentration of analyte. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results.

Laboratory Fortified Blank (LFB): An aliquot of laboratory reagent blank spiked with a known concentration of analyte. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Method Blank (MB): An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples.

PQL (Practical Quantitation Limit): The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Rec: Percent recovery. Result/True Value * 100

N/A: Not Applicable

Page **6** of **6**





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter:	Herrera Environmental
Date Received/Processed:	April 28, 2020
Report Generated:	May 5, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Date Collected	Time Analysis Requested		Marker Quantified	Result Unit
SM20D28001	UN-2	4/27/2020	7:30 AM	Human_HF183	DNQ	copies per 100ml
SM20D28002	UN-1	4/27/2020	7:45 AM	Human_HF183	1.85E+03	copies per 100ml
SM20D28003	Septage-2	4/27/2020	8:00 AM	Human_HF183	DNQ	copies per 100ml
SM20D28006	520	4/27/2020	8:20 AM	Human_HF183	ND	copies per 100ml
SM20D28007	466	4/27/2020	8:35 AM	Human_HF183	ND	copies per 100ml
SM20D28008	453	4/27/2020	8:50 AM	Human_HF183	ND	copies per 100ml
SM20D28009	440	4/27/2020	9:15 AM	Human_HF183	ND	copies per 100ml
SM20D28010	440-U1	4/27/2020	9:25 AM	Human_HF183	ND	copies per 100ml
SM20D28011	440-U4	4/27/2020	9:35 AM	Human_HF183	ND	copies per 100ml
SM20D28013	430	4/27/2020	9:45 AM	Human_HF183	DNQ	copies per 100ml
SM20D28014	531	4/27/2020	11:15 AM	Human_HF183	ND	copies per 100ml
SM20D28015	516	4/27/2020	11:30 AM	Human_HF183	DNQ	copies per 100ml
SM20D28016	482	4/27/2020	11:45 AM	Human_HF183	ND	copies per 100ml
SM20D28017	Sewage-1	4/27/2020	12:15 PM	Human_HF183	1.30E+09	copies per 100ml
SM20D28018	504	4/27/2020	11:55 AM	Human_HF183	ND	copies per 100ml
SM20D28019	485	4/27/2020	12:20 PM	Human_HF183	DNQ	copies per 100ml
SM20D28021	DUP	4/27/2020	8:55 AM	Human_HF183	ND	copies per 100ml

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

> Submitter: Herrera Environmental Date Received/Processed: April 28, 2020 Report Generated: May 5, 2020

SM #	Sample ID	Sample Type	Extraction Date	Analysis Date	Amount Processed	Amount Processed Unit	Analytical Volume (ul)
SM20D28001	UN-2	Water	5/4/2020	5/5/2020	100	ml	2
SM20D28002	UN-1	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28003	Septage-2	Water	5/4/2020	5/4/2020	20	ml	2
SM20D28006	520	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28007	466	Water	5/4/2020	5/5/2020	100	ml	2
SM20D28008	453	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28009	440	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28010	440-U1	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28011	440-U4	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28013	430	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28014	531	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28015	516	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28016	482	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28017	Sewage-1	Water	5/4/2020	5/5/2020	10	ml	0.02
SM20D28018	504	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28019	485	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28021	DUP	Water	5/4/2020	5/4/2020	100	ml	2

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date



15280 NW 79th Court, Suite 107 Miami Lakes, Florida 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733



Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: April 28, 2020 Report Generated: May 5, 2020

SM #	Sample ID	Comments
SM20D28001	UN-2	
SM20D28002	UN-1	
SM20D28003	Septage-2	
SM20D28006	520	
SM20D28007	466	
SM20D28008	453	
SM20D28009	440	
SM20D28010	440-U1	
SM20D28011	440-U4	
SM20D28013	430	
SM20D28014	531	
SM20D28015	516	
SM20D28016	482	
SM20D28017	Sewage-1	
SM20D28018	504	Underestimation, sample volume lost during extraction
SM20D28019	485	
SM20D28021	DUP	

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19

Non-Detect Results

In sample(s) classified as non-detect, the host-associated fecal gene biomarker(s) was either not detected in test replicates, one replicate was detected at a cycle threshold greater than 35 and the other was not, or one replicate was detected at a cycle threshold less than 35 and the other was not after repeated analysis.

Detected Results

In sample(s) classified as detected, the host-associated fecal gene biomarker(s) was detected in both test replicates suggesting that the host's fecal contamination is present in the sample(s). Copy number measurements reported are relative, not absolute, quantification.

Detected Not Quantified (DNQ) Results

In sample(s) classified as Detected Not Quantified (DNQ), the host-associated fecal biomarker was detected in both test replicates but in quantities below the limit of quantification. This result indicates that fecal indicators associated with the respective host was present in the sample(s) but in low concentrations.

Fecal Reference Samples

The client is encouraged to submit fecal samples from suspected sources in the surrounding area in order to gain a better understanding of the concentration of the host-associated biomarker with the regional population. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

The presence of the biomarker does not signify the presence or absence of that form of fecal pollution conclusively. The most reliable way to accurately test for contamination is to combine genetic testing with scientifically sound and adequate study design appropriate for the water quality questions to be answered or issues to be resolved.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination.

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The cultar the sample(s) to be used for any type of future research.

DNA Analytical Method Explanation

Water Samples: Each submitted water sample is filtered through 0.45 micron membrane filter(s). Each filter is placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample is homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol. Devitations to these procedures may occur at the client's request.

Non-Water Samples: Each non-water sample submitted by the client is processed as per internal laboratory extraction procedures. An extracted DNA sample is proceed directly to PCR analysis. Details available upon request.

Amplifications to detect the target gene biomarker were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul sample extract, forward primer, reverse primer, probe and an optimized buffer. All assays are run in duplicate. Quantification is achieved by extrapolating target gene copy numbers from a standard curve generated from serial dilutions of known gene copy numbers.

For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: April 28, 2020 Report Generated: May 5, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Date Collected	Time Collected	Analysis Requested	Marker Quantified	Result Unit
SM20D28020	UN-2	4/27/2020	7:30 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20D28021	UN-1	4/27/2020	7:45 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20D28022	Septage-2	4/27/2020	8:00 AM	Sewage Marker BacV4V5-1	3.06E+08	copies per 100ml
SM20D28023	520	4/27/2020	8:20 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20D28024	466	4/27/2020	8:35 AM	Sewage Marker BacV4V5-1	6.40E+02	copies per 100ml
SM20D28025	453	4/27/2020	8:50 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20D28026	440	4/27/2020	9:15 AM	Sewage Marker BacV4V5-1	8.19E+03	copies per 100ml
SM20D28027	440-U1	4/27/2020	9:25 AM	Sewage Marker BacV4V5-1	7.31E+03	copies per 100ml
SM20D28028	440-U4	4/27/2020	9:35 AM	Sewage Marker BacV4V5-1	DNQ	copies per 100ml
SM20D28029	430	4/27/2020	9:45 AM	Sewage Marker BacV4V5-1	2.10E+03	copies per 100ml
SM20D28030	531	4/27/2020	11:15 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20D28031	516	4/27/2020	11:30 AM	Sewage Marker BacV4V5-1	DNQ	copies per 100ml
SM20D28032	482	4/27/2020	11:45 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20D28033	Sewage-1	4/27/2020	12:15 PM	Sewage Marker BacV4V5-1	2.99E+07	copies per 100ml
SM20D28034	504	4/27/2020	11:55 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20D28035	485	4/27/2020	12:20 PM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20D28036	DUP	4/27/2020	8:55 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

> Submitter: Herrera Environmental Date Received/Processed: April 28, 2020 Report Generated: May 5, 2020

SM #	Sample ID	Sample Type	Extraction Date	Analysis Date	Amount Processed	Amount Processed Unit	Analytical Volume (ul)
SM20D28020	UN-2	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28021	UN-1	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28022	Septage-2	Water	5/4/2020	5/5/2020	20	ml	0.02
SM20D28023	520	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28024	466	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28025	453	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28026	440	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28027	440-U1	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28028	440-U4	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28029	430	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28030	531	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28031	516	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28032	482	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28033	Sewage-1	Water	5/4/2020	5/4/2020	10	ml	2
SM20D28034	504	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28035	485	Water	5/4/2020	5/4/2020	100	ml	2
SM20D28036	DUP	Water	5/4/2020	5/4/2020	100	ml	2

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date



15280 NW 79th Court, Suite 107 Miami Lakes, Florida 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733



Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: April 28, 2020 Report Generated: May 5, 2020

SM #	Sample ID	Comments
SM20D28020	UN-2	
SM20D28021	UN-1	
SM20D28022	Septage-2	
SM20D28023	520	
SM20D28024	466	
SM20D28025	453	
SM20D28026	440	
SM20D28027	440-U1	
SM20D28028	440-U4	
SM20D28029	430	
SM20D28030	531	
SM20D28031	516	
SM20D28032	482	
SM20D28033	Sewage-1	
SM20D28034	504	Underestimation, sample volume lost during extraction
SM20D28035	485	
SM20D28036	DUP	

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19

Non-Detect Results

In sample(s) classified as non-detect, the host-associated fecal gene biomarker(s) was either not detected in test replicates, one replicate was detected at a cycle threshold greater than 35 and the other was not, or one replicate was detected at a cycle threshold less than 35 and the other was not after repeated analysis.

Detected Results

In sample(s) classified as detected, the host-associated fecal gene biomarker(s) was detected in both test replicates suggesting that the host's fecal contamination is present in the sample(s). Copy number measurements reported are relative, not absolute, quantification.

Detected Not Quantified (DNQ) Results

In sample(s) classified as Detected Not Quantified (DNQ), the host-associated fecal biomarker was detected in both test replicates but in quantities below the limit of quantification. This result indicates that fecal indicators associated with the respective host was present in the sample(s) but in low concentrations.

Fecal Reference Samples

The client is encouraged to submit fecal samples from suspected sources in the surrounding area in order to gain a better understanding of the concentration of the host-associated biomarker with the regional population. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

The presence of the biomarker does not signify the presence or absence of that form of fecal pollution conclusively. The most reliable way to accurately test for contamination is to combine genetic testing with scientifically sound and adequate study design appropriate for the water quality questions to be answered or issues to be resolved.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination.

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The client must contact Source Molecular in writing within 10 days from the date of this report if he/she does not wish for their submitted sample(s) to be used for any type of future research.

DNA Analytical Method Explanation

Water Samples: Each submitted water sample is filtered through 0.45 micron membrane filter(s). Each filter is placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample is homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol. Devitations to these procedures may occur at the client's request.

Non-Water Samples: Each non-water sample submitted by the client is processed as per internal laboratory extraction procedures. An extracted DNA sample is proceed directly to PCR analysis. Details available upon request.

Amplifications to detect the target gene biomarker were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul sample extract, forward primer, reverse primer, probe and an optimized buffer. All assays are run in duplicate. Quantification is achieved by extrapolating target gene copy numbers from a standard curve generated from serial dilutions of known gene copy numbers.

For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.

Chain Of Custody Record Revision 1.2 Effective Date 8/20/2018 X Z COOLERS X



Source Molecular Corporation 15280 NW 79th CT Suite 107 Miami Lakes, FL 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733 Email: info@sourcemolecular.com

	Analysis	11	1111	Company Name	Hervera Environment	al Consulta	nts
on the man star of the part of the second	(see pg. 2)	1	////	Contact Name(s)	Rob Zisette	iserie	
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A CONTRACTOR OF A CONTRACTOR O	15051	11	//	Billing Info	PO# 19-07208-000	Mill coll w	déb anadit and
Sample ID	Har I	11	/	Comm	ents	Collection	Collection
UN-2			All all and a second second	(i.e. special requests	s. # of containers)	Date	Time
UN-1		-		6		19/20/20	7:30
Septage-2				1 - 4 - 4			7.45
520							7:00
520-UI ->> Missing	all -						8.20
466							0.63
453							0.55
440							8.50
440-02 01							9.15
440-1008 04							9:05
430							9:35
531							9:45
510							11-15
482							11-30
Sewage -1							11:45
504							12:15
485							11:55
DUP							12:20
						V	8:55
		++					

Completed by Client:

Relinquished By Rapora Danielle Signature 0000 Kapona Date/Time 4/27/20

To protect confidentiality, confirmation and results will only be sent to email address provided or authorized by contact provided. Signed form indicates agreement with the test limitations on the back of this form and the company's terms of use found here: sourcemolecular.com/aboutsourcemolecular/privacy_statement/.

Completed by Source Molecular: **Temperature** 4 Received/Filtered pra 001 Thermometer Signature BM626 Cooler Number 10:30an Date/Time Page 340 of 393



Data Quality Assurance Worksheet

		By	R. Zisette	
Project Name/No./Client:	Lake Whatcom OSS-2/ 19-07208-000 / LWWSD.	Date	7/24/2020	Page <u>1</u> of <u>1</u>
Laboratory/Parameters:	Herrera (OB); Exact (TP, FC, EC); Source Molecular (HF183, Bac/V4V5-1)	Checked:	initials	
Sample Date/Sample ID:	4/27/2020 Storm Event 3 / 17 samples (extras: 440-U1 and 440-U4) (DUP = field duplicate of 453)		date	

		Holdiı (d	ng Time lay)	Reporting	Matrix Surro Recove	Spike/ ogate ery (%)	Lab C Sample I (9	Control Recovery %)	Lab Du RPD	plicate (%)	Field D RPE	uplicate (%)	
Parameter	Completeness/ Methodology	Goal	Actual	Limit Goal / Method Blank	Goal	Actual	Goal	Actual	Goal	Actual	Goal	Actual	ACTION/Notes
Conductivity	OK / meter	≤28	2	2 uS/cm / NA	NA	NA	NA	NA	≤20	NA	≤20	0	None. Septage and sewage samples not analyzed
Optical Brighteners	OK / meter	≤2	2	5 RFUB / 0.4	NA	NA	NA	NA	≤20	NA	≤20	18	None. Septage and sewage samples not analyzed
Total Phosphorus	OK / EPA 365.1	≤28	4	10 ug/L/ <10	80-120	103	90-110	103	≤20	1	≤20	5	None
Fecal coliform	OK / SM9222D	≤1	0	2 CFU /100mL / neg	NA	NA	Pos/neg	NA	≤35	NA	≤35	36/<2	Flag J value for Sample 453 due to field dup. Worksheet not provided to check calculations of dilutions. Reported >600,000 for TNTC assuming for 0.01 mL dilution - OK
E. coli	OK / SM9222D	≤1	0	2 CFU /100mL / NA	NA	NA	Pos/neg	NA	≤35	NA	≤35	36/<2	Flag J value for Sample 453 due to field dup. Worksheet not provided to check calculations of dilutions. Reported >600,000 for TNTC assuming for 0.01 mL dilution - OK
Human HF 183	OK / qPCR	≤2	1	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	ND/ND	None
Sewage BacV4V5-1	OK / qPCR	≤2	1	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	ND/ND	None

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



Laboratory Report Case Narrative

Client:	Herrera Seattle 2200 Sixth Ave #1100 Seattle, WA 98121	Invoice Number: PO Number: Project Name:	20-06384 - -
Contact: Phone: Fax:	Rob Zisette (206) 787-8262	Date Received: Date Reported:	05/11/2020 06/02/2020
Email:	rzisette@herrerainc.com		

Overview

This report contains the analytical results for 13 samples. The samples were received on 05/11/2020 with a complete chain of custody. The samples arrived in good condition, in the appropriate sample containers for the analytes requested. All samples were received and analyzed within their established hold times.

The analytical results included in this report meet all applicable quality control procedure requirements except as noted in the QC remarks section below.

QC Remarks and Comments

The results contained in the following report have been reviewed and approved by the personnel listed below.

___ 06/02/2020 Date Name

Page 1 of 5

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Lab #: 25109	Locatio	n: UN-:	2	Collected: 05/11/2020 8:05AM			
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0910	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020
E. Coli	5	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	5	CFU/100mL	2	-	SM9222D	ER	05/11/2020
Lab #: 25110 Location: DUP					Collected:	05/11/2020) 8:10AM

Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0128	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020
E. Coli	7	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	7	CFU/100mL	2	-	SM9222D	ER	05/11/2020

Lab #: 25111	Location: Septage-1			Collected: 05/11/2020 8:40AM) 8:40AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	11.1	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020
E. Coli	550,000	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	550,000	CFU/100mL	2	-	SM9222D	ER	05/11/2020

Lab #: 25112	Locatio	n: 466			Collected:	05/11/2020) 9:00AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0357	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020
E. Coli	1,300	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	1,300	CFU/100mL	2	-	SM9222D	ER	05/11/2020

Lab #: 25113	Locatio	n: 453			Collected: 05/11/2020 9:10AM			
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	
Phosphorus, Total	0.0876	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020	
E. Coli	3	CFU/100mL	2	-	SM9222D	MM	05/11/2020	
Fecal Coliform	3	CFU/100mL	2	-	SM9222D	ER	05/11/2020	



Lab #: 25114	Location: 440 Collected: 05/11/2020 9:30A						9:30AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.122	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020
E. Coli	54	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	54	CFU/100mL	2	-	SM9222D	ER	05/11/2020
Lab #: 25115	Locatio	n: 430			Collected:	05/11/2020	9:40AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0644	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020
E. Coli	106	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	106	CFU/100mL	2	-	SM9222D	ER	05/11/2020

Lab #: 25116	Locatio	n: 531			Collected: 05/11/2020 10:15AM			
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	
Phosphorus, Total	0.0364	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020	
E. Coli	34	CFU/100mL	2	-	SM9222D	MM	05/11/2020	
Fecal Coliform	34	CFU/100mL	2	-	SM9222D	ER	05/11/2020	

Lab #: 25117	Location	n: 516			Collected:	05/11/2020) 10:25AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	Not Tested	mg/L	-	-	-	-	-
E. Coli	8	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	8	CFU/100mL	2	-	SM9222D	ER	05/11/2020

Lab #: 25118	Locatio	n: 482			Collected:	05/11/2020) 11:15AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.193	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020
E. Coli	56	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	56	CFU/100mL	2	-	SM9222D	ER	05/11/2020



Lab #: 25119	Locatio	n: 504			Collected:	05/11/2020) 11:45AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0400	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020
E. Coli	<2	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	<2	CFU/100mL	2	-	SM9222D	ER	05/11/2020
Lab #: 25120	Locatio	n: Sew	vage-1		Collected:	05/11/2020) 12:00AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	7.20	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020
E. Coli	580,000	CFU/100mL	2	-	SM9222D	MM	05/11/2020
Fecal Coliform	580 000	CEU/100ml	2	_	SM9222D	FR	05/11/2020

Lab #: 25121	Locatio	n: 485			Collected: 05/11/2020 12:15AM			
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	
Phosphorus, Total	0.0672	mg/L	0.0100	0.0030	SM4500PF	OS	05/20/2020	
E. Coli	3,600	CFU/100mL	2	-	SM9222D	MM	05/11/2020	
Fecal Coliform	3,600	CFU/100mL	2	-	SM9222D	ER	05/11/2020	



Quality Control Analysis Report

Client:	Herrera Seattle	Invoice Number:	20-06384
	2200 Sixth Ave #1100	PO Number:	-
	Seattle, WA 98121	Project Name:	-

Independent Quality Control - Inorganics											
Analyte	Analyte Date Sample Result True Value Units Rec. (%) Limits (%)										
Phosphorus	05/20/20	MB	<0.0100	-	mg/L	N/A	< PQL				
		LFB	1.00	1.00	mg/L	100	80 – 120				

	Dependent Quality Control - Inorganics											
Analyte Date Sample Result Dup. Units DD Limits (%) MS Rec. Limit										Limits (%)		
Phos.	05/20/20	0521MS	1.05	1.12	mg/L	6.8	0 – 10	1.05	96	80 – 120		

Definitions

DD (Percent Duplicate Difference): The calculated percent difference between laboratory duplicates.

MDL (Minimum Detection Level): The minimum level of target analyte that can be determined with 99% confidence.

MS (Matrix Spike): A sample that has been spiked with a known concentration of analyte. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results.

Laboratory Fortified Blank (LFB): An aliquot of laboratory reagent blank spiked with a known concentration of analyte. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Method Blank (MB): An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples.

PQL (Practical Quantitation Limit): The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Rec: Percent recovery. Result/True Value * 100

N/A: Not Applicable

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Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter:	Herrera Environmental
Date Received/Processed:	May 12, 2020
Report Generated:	May 26, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Date Collected	Time Collected	Analysis Requested	ested Marker Quantified		
SM20E12001	UN-2	5/11/2020	8:05 AM	Human_HF183	7.66E+02	copies per 100ml	
SM20E12005	DUP	5/11/2020	8:10 AM	Human_HF183	6.56E+02	copies per 100ml	
SM20E12006	Septage-1	5/11/2020	8:40 AM	Human_HF183	3.07E+03	copies per 100ml	
SM20E12007	466	5/11/2020	9:00 AM	Human_HF183	ND	copies per 100ml	
SM20E12008	453	5/11/2020	9:10 AM	Human_HF183	ND	copies per 100ml	
SM20E12009	440	5/11/2020	9:30 AM	Human_HF183	ND	copies per 100ml	
SM20E12010	430	5/11/2020	9:40 AM	Human_HF183	8.60E+02	copies per 100ml	
SM20E12011	531	5/11/2020	10:15 AM	Human_HF183	ND	copies per 100ml	
SM20E12012	516	5/11/2020	10:25 AM	Human_HF183	DNQ	copies per 100ml	
SM20E12013	482	5/11/2020	11:15 AM	Human_HF183	ND	copies per 100ml	
SM20E12014	504	5/11/2020	11:45 AM	Human_HF183	ND	copies per 100ml	
SM20E12015	Sewage-1	5/11/2020	12:00 PM	Human_HF183	6.06E+07	copies per 100ml	
SM20E12016	485	5/11/2020	12:15 PM	Human_HF183	ND	copies per 100ml	

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

> Submitter: Herrera Environmental Date Received/Processed: May 12, 2020 Report Generated: May 26, 2020

SM #	Sample ID	Sample Type	Extraction Date	Analysis Date	Amount Processed	Amount Processed Unit	Analytical Volume (ul)
SM20E12001	UN-2	Water	5/20/2020	5/21/2020	100	ml	2
SM20E12005	DUP	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12006	Septage-1	Water	5/20/2020	5/20/2020	20	ml	2
SM20E12007	466	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12008	453	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12009	440	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12010	430	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12011	531	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12012	516	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12013	482	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12014	504	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12015	Sewage-1	Water	5/20/2020	5/21/2020	20	ml	0.2
SM20E12016	485	Water	5/20/2020	5/20/2020	100	ml	2

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date

Non-Detect Results

In sample(s) classified as non-detect, the host-associated fecal gene biomarker(s) was either not detected in test replicates, one replicate was detected at a cycle threshold greater than 35 and the other was not, or one replicate was detected at a cycle threshold less than 35 and the other was not after repeated analysis.

Detected Results

In sample(s) classified as detected, the host-associated fecal gene biomarker(s) was detected in both test replicates suggesting that the host's fecal contamination is present in the sample(s). Copy number measurements reported are relative, not absolute, quantification.

Detected Not Quantified (DNQ) Results

In sample(s) classified as Detected Not Quantified (DNQ), the host-associated fecal biomarker was detected in both test replicates but in quantities below the limit of quantification. This result indicates that fecal indicators associated with the respective host was present in the sample(s) but in low concentrations.

Fecal Reference Samples

The client is encouraged to submit fecal samples from suspected sources in the surrounding area in order to gain a better understanding of the concentration of the host-associated biomarker with the regional population. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

The presence of the biomarker does not signify the presence or absence of that form of fecal pollution conclusively. The most reliable way to accurately test for contamination is to combine genetic testing with scientifically sound and adequate study design appropriate for the water quality questions to be answered or issues to be resolved.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination.

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The client must contact Source Molecular in writing within 10 days from the date of this report if he/she does not wish for their submitted sample(s) to be used for any type of future research.

DNA Analytical Method Explanation

Water Samples: Each submitted water sample is filtered through 0.45 micron membrane filter(s). Each filter is placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample is homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol. Devitations to these procedures may occur at the client's request.

Non-Water Samples: Each non-water sample submitted by the client is processed as per internal laboratory extraction procedures. An extracted DNA sample is proceed directly to PCR analysis. Details available upon request.

Amplifications to detect the target gene biomarker were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul sample extract, forward primer, reverse primer, probe and an optimized buffer. All assays are run in duplicate. Quantification is achieved by extrapolating target gene copy numbers from a standard curve generated from serial dilutions of known gene copy numbers.

For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter:	Herrera Environmental
Date Received/Processed:	May 12, 2020
Report Generated:	May 26, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Date Collected	Time Collected	Analysis Requested	Marker Quantified	Result Unit
SM20E12017	UN-2	5/11/2020	8:05 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20E12018	DUP	5/11/2020	8:10 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20E12019	Septage-1	5/11/2020	8:40 AM	Sewage Marker BacV4V5-1	2.24E+08	copies per 100ml
SM20E12020	466	5/11/2020	9:00 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20E12024	453	5/11/2020	9:10 AM	Sewage Marker BacV4V5-1	DNQ	copies per 100ml
SM20E12025	440	5/11/2020	9:30 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20E12026	430	5/11/2020	9:40 AM	Sewage Marker BacV4V5-1	1.17E+04	copies per 100ml
SM20E12027	531	5/11/2020	10:15 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20E12028	516	5/11/2020	10:25 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20E12029	482	5/11/2020	11:15 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20E12030	504	5/11/2020	11:45 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20E12031	Sewage-1	5/11/2020	12:00 PM	Sewage Marker BacV4V5-1	1.30E+07	copies per 100ml
SM20E12032	485	5/11/2020	12:15 PM	Sewage Marker BacV4V5-1	ND	copies per 100ml

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

> Submitter: Herrera Environmental Date Received/Processed: May 12, 2020 Report Generated: May 26, 2020

SM #	Sample ID	Sample Type	Extraction Date	Analysis Date	Amount Processed	Amount Processed Unit	Analytical Volume (ul)
SM20E12017	UN-2	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12018	DUP	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12019	Septage-1	Water	5/20/2020	5/21/2020	20	ml	0.2
SM20E12020	466	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12024	453	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12025	440	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12026	430	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12027	531	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12028	516	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12029	482	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12030	504	Water	5/20/2020	5/20/2020	100	ml	2
SM20E12031	Sewage-1	Water	5/20/2020	5/20/2020	20	ml	2
SM20E12032	485	Water	5/20/2020	5/20/2020	100	ml	2

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date

Non-Detect Results

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The presence of the biomarker does not signify the presence or absence of that form of fecal pollution conclusively. The most reliable way to accurately test for contamination is to combine genetic testing with scientifically sound and adequate study design appropriate for the water quality questions to be answered or issues to be resolved.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination.

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The client must contact Source Molecular in writing within 10 days from the date of this report if he/she does not wish for their submitted sample(s) to be used for any type of future research.

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Water Samples: Each submitted water sample is filtered through 0.45 micron membrane filter(s). Each filter is placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample is homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol. Devitations to these procedures may occur at the client's request.

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Amplifications to detect the target gene biomarker were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul sample extract, forward primer, reverse primer, probe and an optimized buffer. All assays are run in duplicate. Quantification is achieved by extrapolating target gene copy numbers from a standard curve generated from serial dilutions of known gene copy numbers.

For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.

Chain Of Custody Record

Revision 1.2

Effective Date 8/20/2018



Source Molecular Corporation 15280 NW 79th CT Suite 107 Miami Lakes, FL 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733 Email: info@sourcemolecular.com

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		City/State/Zip Seattle,	WA, 98121	
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440				9:30
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Completed by Client:

Relinquished By Danielle Rapora Signature Danielle Rapora Date/Time 5/11/20

To protect confidentiality, confirmation and results will only be sent to email address provided or authorized by contact provided. Signed form indicates agreement with the test limitations on the back of this form and the company's terms of use found here: sourcemolecular.com/aboutsourcemolecular/privacy_statement/.

Completed by Source Molecular: Received/Filtered Temperature Signature Thermometer 00 Cooler Number Date/Time . aler Page 353 of 393



Data Quality Assurance Worksheet

		By	R. Zisette				
Project Name/No./Client:	Lake Whatcom OSS-2/ 19-07208-000 / LWWSD.	Date	8/5/2020	Page	1	of	1
Laboratory/Parameters:	Herrera (OB); Exact (TP, FC, EC); Source Molecular (HF183, Bac/V4V5-1)	Checked:	initials				
Sample Date/Sample ID:	5-11-2020 Base Event $1/13$ samples (DUP = field duplicate of UN-2)		date				

		Holdir (d	ng Time lay)	Reporting	Matrix Surro Recove	Spike/ ogate ery (%)	Lab C Sample I (9	ontrol Recovery 6)	Lab Dı RPD	plicate	Field Duplicate RPD (%)		
Parameter	Completeness/ Methodology	Goal	Actual	Limit Goal / Method Blank	Goal	Actual	Goal	Actual	Goal	Actual	Goal	Actual	ACTION/Notes
Conductivity	Ok / meter	≤28	1	2 uS/cm / <mark>4</mark>	NA	NA	NA	NA	≤20	NA	≤20	2	None
Optical Brighteners	Ok / meter	≤2	1	5 RFUB / 0.4	NA	NA	NA	NA	≤20	NA	≤20	3	None
Total Phosphorus	OK / EPA 365.1	≤28	9	10 ug/L/ <10	80-120	96	90-110	100	≤20	7	≤20	<mark>150</mark>	Flag UN-2 as estimate due to very high field duplicate RPD
Fecal coliform	OK / SM9222D	≤1	0	2 CFU /100mL / neg	NA	NA	Pos/neg	NA	≤35	NA	≤35	±RL	None. Worksheet not provided, no > values for sewage
E. coli	OK / SM9222D	≤1	0	2 CFU /100mL / NA	NA	NA	Pos/neg	NA	≤35	NA	≤35	±RL	None. Worksheet not provided, no > values for sewage
Human HF 183	OK / qPCR	≤2	1	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	15	None
Sewage BacV4V5-1	OK / qPCR	≤2	1	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	ND/ND	None

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



Laboratory Report Case Narrative

Client:	Herrera Seattle 2200 Sixth Ave #1100 Seattle, WA 98121	Invoice Number: PO Number: Project Name:	20-07421 - -
Contact:	Rob Zisette	Date Received:	06/02/2020
Phone:	(206) 787-8262	Date Reported:	06/23/2020
Fax:	-		
Email:	rzisette@herrerainc.com		

Overview

This report contains the analytical results for 12 samples. The samples were received on 06/02/2020 with a complete chain of custody. The samples arrived in good condition, in the appropriate sample containers for the analytes requested. All samples were received and analyzed within their established hold times.

The analytical results included in this report meet all applicable quality control procedure requirements except as noted in the QC remarks section below.

QC Remarks and Comments

The results contained in the following report have been reviewed and approved by the personnel listed below.

____ 06/23/2020 Date Name

Page 1 of 5



Lab #: 29001	Location: UN-2				Collected:	06/02/2020	/2020 6:45AM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed		
Phosphorus, Total	0.0508	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020		
E. Coli	480	CFU/100mL	2	-	SM9222D	ER	06/02/2020		
Fecal Coliform	480	CFU/100mL	2	-	SM9222D	MM	06/02/2020		
Lab #: 29002	Locatio	n: 440			Collected:	06/02/2020	7:35AM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed		
Phosphorus, Total	0.0289	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020		
E. Coli	88	CFU/100mL	2	-	SM9222D	ER	06/02/2020		
Fecal Coliform	88	CFU/100mL	2	-	SM9222D	MM	06/02/2020		

Lab #: 29003	Locatio	n: 430		Collected:	06/02/2020) 7:45AM	
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0200	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020
E. Coli	82	CFU/100mL	2	-	SM9222D	ER	06/02/2020
Fecal Coliform	82	CFU/100mL	2	-	SM9222D	MM	06/02/2020

Lab #: 29004	Location: DUP Collected: 06/02/2020 7:5						7:50AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0417	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020
E. Coli	88	CFU/100mL	2	-	SM9222D	ER	06/02/2020
Fecal Coliform	88	CFU/100mL	2	-	SM9222D	MM	06/02/2020

Lab #: 29005	Locatio	n: 531			Collected: 06/02/2020 8:15AM			
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	
Phosphorus, Total	0.0544	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020	
E. Coli	1,100	CFU/100mL	2	-	SM9222D	ER	06/02/2020	
Fecal Coliform	1,100	CFU/100mL	2	-	SM9222D	MM	06/02/2020	



Fecal Coliform

155

CFU/100mL

Stormwater Analysis Report

Lab #: 29006	Locatio	n: 516			Collected:	06/02/2020	8:25AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0813	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020
E. Coli	78	CFU/100mL	2	-	SM9222D	ER	06/02/2020
Fecal Coliform	78	CFU/100mL	2	-	SM9222D	MM	06/02/2020
Lab #: 29007	Locatio	n: 482			Collected:	06/02/2020	8:35AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0958	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020
E. Coli	155	CFU/100mL	2	-	SM9222D	ER	06/02/2020

Lab #: 29008	Locatio	n: 485		Collected: 06/02/2020 8:45AM			
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0537	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020
E. Coli	74	CFU/100mL	2	-	SM9222D	ER	06/02/2020
Fecal Coliform	74	CFU/100mL	2	-	SM9222D	MM	06/02/2020

2

-

SM9222D

MM

06/02/2020

Lab #: 29009	Locatio	n: 504	Collected: 06/02/2020 8:55AM				
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.210	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020
E. Coli	<2	CFU/100mL	2	-	SM9222D	ER	06/02/2020
Fecal Coliform	<2	CFU/100mL	2	-	SM9222D	MM	06/02/2020

Lab #: 29010	Locatio	n: Sew	age-1		Collected:	06/02/2020 9:15AM		
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed	
Phosphorus, Total	7.73	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020	
E. Coli	580,000	CFU/100mL	2	-	SM9222D	ER	06/02/2020	
Fecal Coliform	580,000	CFU/100mL	2	-	SM9222D	MM	06/02/2020	



1355 Pacific Place Suite 101 Ferndale, WA 98248 phone: 360.733.1205 fax: 888-818-2978 email: lab@exactscientific.com

Lab #: 29011	Locatio	n: Sep	tage-1		Collected:	06/02/2020) 10:20AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	16.2	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020
E. Coli	270,000	CFU/100mL	2	-	SM9222D	ER	06/02/2020
Fecal Coliform	270,000	CFU/100mL	2	-	SM9222D	MM	06/02/2020
Lab #: 29012	Locatio	n: 466			Collected:	06/02/2020) 7:15AM
Analyte	Results	Units	PQL	MDL	Method	Analyst	Date Analyzed
Phosphorus, Total	0.0364	mg/L	0.0100	0.0030	SM4500PF	OS	06/10/2020
E. Coli	39	CFU/100mL	2	-	SM9222D	ER	06/02/2020
Fecal Coliform	39	CFU/100mL	2	-	SM9222D	MM	06/02/2020



Quality Control Analysis Report

Client:	Herrera Seattle	Invoice Number:	20-07421
	2200 Sixth Ave #1100	PO Number:	-
	Seattle, WA 98121	Project Name:	-

Independent Quality Control - Inorganics										
Analyte Date Sample Result True Value Units Rec. (%) Limits (%)										
Phosphorus										
		LFB	1.06	1.00	mg/L	106	80 – 120			

	Dependent Quality Control - Inorganics										
Analyte Date Sample Result Dup. Units DD Limits (%) MS Rec. Limits										Limits (%)	
Phos. 06/10/20 0233MS 1.06 1.09 mg/L 3.4 0-10 1.06 102 80-1										80 – 120	

Definitions

DD (Percent Duplicate Difference): The calculated percent difference between laboratory duplicates.

MDL (Minimum Detection Level): The minimum level of target analyte that can be determined with 99% confidence.

MS (Matrix Spike): A sample that has been spiked with a known concentration of analyte. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results.

Laboratory Fortified Blank (LFB): An aliquot of laboratory reagent blank spiked with a known concentration of analyte. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Method Blank (MB): An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples.

PQL (Practical Quantitation Limit): The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Rec: Percent recovery. Result/True Value * 100

N/A: Not Applicable

Page 5 of 5




15280 NW 79th Court, Suite 107 Miami Lakes, Florida 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733 Email: info@sourcemolecular.com

Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: June 3, 2020 Report Generated: June 12, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Date Collected	Time Collected	Analysis Requested	Marker Quantified	Result Unit
SM20F03022	UN-2	6/2/2020	6:45 AM	Human_HF183	ND	copies per 100ml
SM20F03023	440	6/2/2020	7:35 AM	Human_HF183	ND	copies per 100ml
SM20F03024	430	6/2/2020	7:45 AM	Human_HF183	ND	copies per 100ml
SM20F03026	DUP	6/2/2020	7:50 AM	Human_HF183	DNQ	copies per 100ml
SM20F03028	531	6/2/2020	8:15 AM	Human_HF183	ND	copies per 100ml
SM20F03028	516	6/2/2020	8:25 AM	Human_HF183	2.28E+03	copies per 100ml
SM20F03029	482	6/2/2020	8:35 AM	Human_HF183	ND	copies per 100ml
SM20F03032	485	6/2/2020	8:45 AM	Human_HF183	DNQ	copies per 100ml
SM20F03033	504	6/2/2020	8:55 AM	Human_HF183	ND	copies per 100ml
SM20F03033	Sewage-1	6/2/2020	9:15 AM	Human_HF183	2.71E+08	copies per 100ml
SM20F03034	Septage-2	6/2/2020	10:20 AM	Human_HF183	DNQ	copies per 100ml
SM20F03035	466	6/2/2020	7:15 AM	Human_HF183	ND	copies per 100ml

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





15280 NW 79th Court, Suite 107 Miami Lakes, Florida 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733 Email: info@sourcemolecular.com

Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

> Submitter: Herrera Environmental Date Received/Processed: June 3, 2020 Report Generated: June 12, 2020

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SM20F03022	UN-2	Water	6/9/2020	6/9/2020	100	ml	2
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SM20F03024	430	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03026	DUP	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03028	531	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03028	516	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03029	482	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03032	485	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03033	504	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03033	Sewage-1	Water	6/9/2020	6/9/2020	20	ml	0.02
SM20F03034	Septage-2	Water	6/9/2020	6/9/2020	20	ml	2
SM20F03035	466	Water	6/9/2020	6/9/2020	100	ml	2

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date

Non-Detect Results

In sample(s) classified as non-detect, the host-associated fecal gene biomarker(s) was either not detected in test replicates, one replicate was detected at a cycle threshold greater than 35 and the other was not, or one replicate was detected at a cycle threshold less than 35 and the other was not after repeated analysis.

Detected Results

In sample(s) classified as detected, the host-associated fecal gene biomarker(s) was detected in both test replicates suggesting that the host's fecal contamination is present in the sample(s). Copy number measurements reported are relative, not absolute, quantification.

Detected Not Quantified (DNQ) Results

In sample(s) classified as Detected Not Quantified (DNQ), the host-associated fecal biomarker was detected in both test replicates but in quantities below the limit of quantification. This result indicates that fecal indicators associated with the respective host was present in the sample(s) but in low concentrations.

Fecal Reference Samples

The client is encouraged to submit fecal samples from suspected sources in the surrounding area in order to gain a better understanding of the concentration of the host-associated biomarker with the regional population. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations

The presence of the biomarker does not signify the presence or absence of that form of fecal pollution conclusively. The most reliable way to accurately test for contamination is to combine genetic testing with scientifically sound and adequate study design appropriate for the water quality questions to be answered or issues to be resolved.

Additional Testing

A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination.

Limitation of Damages - Repayment of Service Price

It is agreed that in the event of breach of any warranty or breach of contract, or negligence of Source Molecular Corporation, as well as its agents or representatives, the liability of the company shall be limited to the repayment, to the purchaser (submitter), of the individual analysis price paid by him/her to Source Molecular Corp. The company shall not be liable for any damages, either direct or consequential. Source Molecular Corp. provides analytical services on a PRIME CONTRACT BASIS ONLY. Terms are available upon request. The sample(s) cited in this report may be used for research purposes after an archiving period of 3 months from the date of this report. Research includes, but is not limited to internal validation studies and peer-reviewed research publications. Anonymity of the sample(s), including the exact geographic location will be maintained by assigning an arbitrary internal reference. These anonymous samples will only be grouped by state / province of origin for research purposes. The client must contact Source Molecular in writing within 10 days from the date of this report if he/she does not wish for their submitted sample(s) to be used for any type of future research.

DNA Analytical Method Explanation

Water Samples: Each submitted water sample is filtered through 0.45 micron membrane filter(s). Each filter is placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample is homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol. Devitations to these procedures may occur at the client's request.

Non-Water Samples: Each non-water sample submitted by the client is processed as per internal laboratory extraction procedures. An extracted DNA sample is proceed directly to PCR analysis. Details available upon request.

Amplifications to detect the target gene biomarker were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul sample extract, forward primer, reverse primer, probe and an optimized buffer. All assays are run in duplicate. Quantification is achieved by extrapolating target gene copy numbers from a standard curve generated from serial dilutions of known gene copy numbers.

For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.





15280 NW 79th Court, Suite 107 Miami Lakes, Florida 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733 Email: info@sourcemolecular.com

Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: Herrera Environmental Date Received/Processed: June 3, 2020 Report Generated: June 12, 2020

ND: Not Detected DNQ: Detected Not Quantified

SM #	Sample ID	Date Collected	Time Collected	Analysis Requested	Marker Quantified	Result Unit
SM20F03036	UN-2	6/2/2020	6:45 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20F03037	440	6/2/2020	7:35 AM	Sewage Marker BacV4V5-1	DNQ	copies per 100ml
SM20F03038	430	6/2/2020	7:45 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20F03039	DUP	6/2/2020	7:50 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20F03040	531	6/2/2020	8:15 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20F03041	516	6/2/2020	8:25 AM	Sewage Marker BacV4V5-1	DNQ	copies per 100ml
SM20F03042	482	6/2/2020	8:35 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20F03043	485	6/2/2020	8:45 AM	Sewage Marker BacV4V5-1	DNQ	copies per 100ml
SM20F03044	504	6/2/2020	8:55 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml
SM20F03045	Sewage-1	6/2/2020	9:15 AM	Sewage Marker BacV4V5-1	5.62E+07	copies per 100ml
SM20F03046	Septage-2	6/2/2020	10:20 AM	Sewage Marker BacV4V5-1	6.15E+08	copies per 100ml
SM20F03047	466	6/2/2020	7:15 AM	Sewage Marker BacV4V5-1	ND	copies per 100ml

Reported Results Authorized By: Anda Quintero, Quality Manager

Results reported herein apply only to the sample matrices as received. Results reported herein relate to the genetic material extracted from the sample matrix processed and included in the analysis.

> Revision 1.4 Effective Date 12/12/19





15280 NW 79th Court, Suite 107 Miami Lakes, Florida 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733 Email: info@sourcemolecular.com

Fecal Host Quantification ID Test Results Report

Detection and quantification of the fecal host associated gene biomarker by quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

> Submitter: Herrera Environmental Date Received/Processed: June 3, 2020 Report Generated: June 12, 2020

SM #	Sample ID	Sample Type	Extraction Date	Analysis Date	Amount Processed	Amount Processed Unit	Analytical Volume (ul)
SM20F03036	UN-2	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03037	440	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03038	430	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03039	DUP	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03040	531	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03041	516	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03042	482	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03043	485	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03044	504	Water	6/9/2020	6/9/2020	100	ml	2
SM20F03045	Sewage-1	Water	6/9/2020	6/9/2020	20	ml	0.2
SM20F03046	Septage-2	Water	6/9/2020	6/9/2020	20	ml	0.02
SM20F03047	466	Water	6/9/2020	6/9/2020	100	ml	2

Reported Results Authorized By: Anda Quintero, Quality Manager

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> Revision 1.4 Effective Date

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For quality control purposes, a positive control and a negative control, were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.

Chain Of Custody Record



Source Molecular Corporation 15280 NW 79th CT Suite 107 Miami Lakes, FL 33016 Tel: (1) 786-220-0379 Fax: (1) 786-513-2733 Email: info@sourcemolecular.com

Revision 1.2 Effective Date 8/20/2018		Molec	uiar	Email: info@sourcemolecular.com					
	Analysis	1111	Company Name	HEFFEFA					
	Requested (see pg. 2)	////	Contact Name(s)	Rob Zisette					
	Mark boxes	///	Send Results To	(email) rzisette Chevr	erainc.con	2			
	with ^ / 5/ /	///	Phone	2010-1034-21100					
	1 ASI	///	Address	2200 6th Ave #1100					
	MEL	11	City/State/Zip	Seattle IWA 98	15121				
	173///	//	Billing Info	PO#: 19-07208-000	Will call w	ith credit card			
Sample ID	1400///	/	Comm	ents s. # of containers)	Collection Date	Collection Time			
UN-2					6/2/20	6:45			
Live to		The same	sle						
440						7:35			
430						7:45			
DUP						7:50			
531						8:15			
516						8:25			
482						8:35			
682 485						8:45			
504		(8:55			
Seiniage-1					4	9:15			
Septage -7-	VV				62/20	10:20			
466	XX				6/2/20	7:15			
1.0.0									

Completed by Client:	
Relinquished By	Danielle Kapoza
Signature	Danielle Kapenza
Date/Time	612/20 11:300

To protect confidentiality, confirmation and results will only be sent to email address provided or authorized by contact provided. Signed form indicates agreement with the test limitations on the back of this form and the company's terms of use found here: sourcemolecular.com/aboutsourcemolecular/privacy_statement/.

Completed by S	Source M	olecular:	1 () () () () () () () () () (٨	
Temperature	•	4.40	_ Received/Filt	ered Anu	sha
Thermometer	001		Signature	Alle	And an and a second second second
Cooler Number_	RM	027	_ Date/Time _	6/3/20,	11:40 AM
				11 1	· · ·



Data Quality Assurance Worksheet

		By	R. Zisette			
Project Name/No./Client:	Lake Whatcom OSS-2/ 19-07208-000 / LWWSD.	Date	8/5/2020	Page 1	of	1
Laboratory/Parameters:	Herrera (OB); Exact (TP, FC, EC); Source Molecular (HF183, Bac/V4V5-1)	Checked:	initials			
Sample Date/Sample ID:	6-2-2020 Base Event 2 / 12 samples (DUP = field duplicate of 430)		date			

		Holdiı (d	ng Time lay)	Reporting	Matrix Surro Recove	Spike/ ogate ery (%)	Lab C Sample I (9	ontrol Recovery 6)	Lab Du RPD	plicate	Field D RPD	uplicate (%)	
Parameter	Completeness/ Methodology	Goal	Actual	Limit Goal / Method Blank	Goal	Actual	Goal	Actual	Goal	Actual	Goal	Actual	ACTION/Notes
Conductivity	Ok / meter	≤28	2	2 uS/cm / 4.8	NA	NA	NA	NA	≤20	NA	≤20	2	None
Optical Brighteners	Ok / meter	≤2	2	5 RFUB / 0.5	NA	NA	NA	NA	≤20	NA	≤20	2	None
Total Phosphorus	OK / EPA 365.1	≤28	8	10 ug/L/ <10	80-120	102	90-110	106	≤20	3	≤20	<mark>70</mark>	Flag 430 as estimate due to very high field duplicate RPD
Fecal coliform	OK / SM9222D	≤1	0	2 CFU /100mL / neg	NA	NA	Pos/neg	NA	≤35	NA	≤35	7	None. Worksheet not provided, no > values for sewage
E. coli	OK / SM9222D	≤1	0	2 CFU /100mL / NA	NA	NA	Pos/neg	NA	≤35	NA	≤35	7	None. Worksheet not provided, no > values for sewage
Human HF 183	OK / qPCR	≤2	1	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	ND /DNQ	Flag J value of ND for Sample 430 due to field dup = DNQ
Sewage BacV4V5-1	OK / qPCR	≤2	1	50 copies/100 mL / NA	NA	NA	Pos/neg	NA	≤30 CV	NA	≤35	ND/ND	None

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

						U						
Sample ID	Sample Date	Specific Conductan ce (uS/cm)	OBF-0 (RFUB)	OBF-1 (RFUB)	OBF-10 (RFUB)	OBF-1R (%)	OBF-1R Result	OBF-10R (%)	OBF-1R/ OBF-10R	OBF-1R/ OBF-10R Result	OBF-BC (RFUB)	Final Result
UN-1	3/3/2020	59.4	141	160	122	-13.5	Negative				ND	Negative
UN-2	3/3/2020	62.2	191	191	184	0.0	Negative				ND	Negative
482	3/3/2020	173.5	230	224	214	2.6	None	7.0	0.38	Positive	16	Positive
485	3/3/2020	113.2	140	138	134	1.4	None	4.3	0.33	Positive	6	Positive
504	3/3/2020	40.3	185	182	175	1.6	None	5.4	0.30	Positive	10	Positive
516	3/3/2020	72.4	255	240	240	5.9	None	5.9	1.00	Positive	15	Positive
531	3/3/2020	93.8	110	102	100	7.3	None	9.1	0.80	Positive	10	Positive
520	3/3/2020	98.5	157	152	143	3.2	None	8.9	0.36	Positive	14	Positive
466	3/3/2020	75.8	135	131	125	3.0	None	7.4	0.40	Positive	10	Positive
453	3/3/2020	67.1	160	142	139	11.3	None	13.1	0.86	Positive	21	Positive
430	3/3/2020	80.4	245	234	227	4.5	None	7.3	0.61	Positive	18	Positive
440	3/3/2020	72.2	235	228	219	3.0	None	6.8	0.44	Positive	16	Positive
DUP	3/3/2020	82.1	247	238	225	3.6	None	8.9	0.41	Positive	22	Positive
Septage-1	3/3/2020	811	455	433	402	4.8	None	11.6	0.42	Positive	53	Positive
Sewage-1	3/3/2020	450	1280	1230	1215	3.9	None	5.1	0.77	Positive	65	Positive

Whatcom OSS Optical Brightener Background Correction Data Sheet

Analyzed 3/4/20 at Herrera lab with UV lamp missing 1 of 2 bulbs

OBF-0 = RFUB before UV exposure for time 0

OBF-1 = RFUB after 1 minute UV exposure

OBF-10 = RFUB after additional 9 minute for a total 10 minute UV exposure

OBF-1R = Percent reduction in RFUB from time 0 to time 1 minute

OB-1R Result = Positive if OB-1R > 13%

OB-1R Result = Negative if OB-1R < 1.4% or OB-0 <30 RFUB (=3xMDL)

OB-1R Result = None if OB-1R = 1.4 - 13% and then test 10 minute reduction

OBF-10R = Percent reduction in RFUB from time 0 to time 10 minute, which applies only to None result for 0 to 1 minute.

OBF-1R/OBF-10R = OBF-1R divided by OBF-10R

OBF-1R/OBF-10R Result = Positive if OB-1R%/OB-10R% >/= 0.25

OBF-1R/OBF-10R Result = Negative if OB-1R%/OB-10R% < 0.25

OBF-BC = RFUB background corrected = OBF-0 minus OBF-10

Enter result	I
Copy Formula	I

NA=not applicable ND=Not detected

	Whatcom OSS Optical Brightener Background Correction Data Sheet												
Sample ID	Sample Date	Specific Conductan ce (uS/cm)	OBF-0 (RFUB)	OBF-1 (RFUB)	OBF-10 (RFUB)	OBF-1R (%)	OBF-1R Result	OBF-10R (%)	OBF-1R/ OBF-10R	OBF-1R/ OBF-10R Result	OBF-BC (RFUB)	Final Result	
Blank	4/29/2020	NA	0.38	NA	NA								
UN-1	4/27/2020	74.9	193.3	184.4	170.9	4.6	None	11.6	0.40	Positive	22.4	Positive	
UN-2	4/27/2020	71.5	223.7	213.2	198	4.7	None	11.5	0.41	Positive	25.7	Positive	
430	4/27/2020	110.5	260.8	250.3	233.8	4.0	None	10.4	0.39	Positive	27	Positive	
440	4/27/2020	101.8	176.4	184.3	152.5	-4.5	Negative				ND	Negative	
440-04	4/27/2020	97.4	177.3	146.4	133.2	17.4	Positive				44.1	Positive	
440-UI	4/27/2020	102.9	146.8	162.8	139.3	-10.9	Negative				ND	Negative	
453	4/27/2020	68.9	103.4	98.55	82.73	4.7	None	20.0	0.23	Negative	20.67	Negative	
466	4/27/2020	76.2	124.6	118.3	105.7	5.1	None	15.2	0.33	Positive	18.9	Positive	
482	4/27/2020	183.4	180.3	112.8	107.4	37.4	Positive				72.9	Positive	
485	4/27/2020	127.8	145.1	127.6	94.66	12.1	None	34.8	0.35	Positive	50.44	Positive	
504	4/27/2020	49.2	104.7	104.1	90.38	0.6	Negative				ND	Negative	
516	4/27/2020	76.1	311.4	299.6	281.9	3.8	None	9.5	0.40	Positive	29.5	Positive	
520	4/27/2020	115.8	119.6	48.62	44.6	59.3	Positive				75	Positive	
531	4/27/2020	93.1	172.7	108.9	97.51	36.9	Positive				75.19	Positive	
DUP	4/27/2020	68.6	86.36	63.93	58.82	26.0	Positive				27.54	Positive	
Analyzed 4/2	9/20 at Herre	ra Lab	-	-		-		-	-	-			

OBF-0 = RFUB before UV exposure for time 0

OBF-1 = RFUB after 1 minute UV exposure

OBF-10 = RFUB after additional 9 minute for a total 10 minute UV exposure

OBF-1R = Percent reduction in RFUB from time 0 to time 1 minute

OB-1R Result = Positive if OB-1R > 13%

OB-1R Result = Negative if OB-1R < 1.4% or OB-0 <30 RFUB (=3xMDL)

OB-1R Result = None if OB-1R = 1.4 - 13% and then test 10 minute reduction

OBF-10R = Percent reduction in RFUB from time 0 to time 10 minute, which applies only to None result for 0 to 1 minute.

OBF-1R/OBF-10R = OBF-1R divided by OBF-10R

OBF-1R/OBF-10R Result = Positive if OB-1R%/OB-10R% >/= 0.25

OBF-1R/OBF-10R Result = Negative if OB-1R%/OB-10R% < 0.25

OBF-BC = RFUB background corrected = OBF-0 minus OBF-10

Enter result		

Copy Formula

NA=not applicable ND=Not detected

	Whatcom OSS Optical Brightener Background Correction Data Sheet												
Sample ID	Sample Date	Specific Conductan ce (uS/cm)	OBF-0 (RFUB)	OBF-1 (RFUB)	OBF-10 (RFUB)	OBF-1R (%)	OBF-1R Result	OBF-10R (%)	OBF-1R/ OBF-10R	OBF-1R/ OBF-10R Result	OBF-BC (RFUB)	Final Result	
UN-2	5/11/2020	80.6	146.3	132.1	122.0	9.7	None	16.6	0.6	Positive	24.3	Positive	
440	5/11/2020	103.2	167.1	185.6	141.6	-11.1	Negative				ND	Negative	
453	5/11/2020	65.4	86.6	85.4	89.6	1.4	None	-3.4	-0.4	Negative	-3.0	Negative	
466	5/11/2020	79.8	107.6	64.4	61.8	40.1	Positive				45.8	Positive	
482	5/11/2020	228.8	166.4	154.2	131.4	7.3	None	21.0	0.3	Positive	35.0	Positive	
485	5/11/2020	162.3	106.5	97.6	89.5	8.3	None	16.0	0.5	Positive	17.0	Positive	
504	5/11/2020	48.8	89.6	85.5	84.2	4.6	None	6.0	0.8	Positive	5.4	Positive	
516	5/11/2020	89.1	254.3	235.1	195.8	7.6	None	23.0	0.3	Positive	58.5	Positive	
531	5/11/2020	98.9	141.5	132.7	91.5	6.2	None	35.4	0.2	Negative	50.0	Negative	
DUP	5/11/2020	78.8	142.3	104.7	113.6	26.4	Positive				28.7	Positive	
Sewage 1	5/11/2020	645	5946	5572	4597	6.3	None	22.7	0.3	Positive	1349	Positive	
Septic 1	5/11/2020	822	452	444	398	1.7	None	11.9	0.1	Negative	53.7	Negative	
TS	5/12/2020	63.7	86.2	52.4	32.9	39.3	Positive				53.3	Positive	
TS Control	5/12/2020	64.7	84.9	80.7	81.2	5.0	None	4.4	1.1	Positive	3.8	Positive	
Blank	5/12/2020	4.0	0.4	NA	NA	ľ		1					

Analyzed on 5/12/20 at Herrera Lab; TS=Tide 50ppb standard; TS Control = TS with no UV exposure; Blank = Deionized water

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OBF-BC = RFUB background corrected = OBF-0 minus OBF-10

Enter result	NA=not applicable
Copy Formula	ND=Not detected

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Sample ID	Sample Date	Specific Conductan ce (uS/cm)	OBF-0 (RFUB)	OBF-1 (RFUB)	OBF-10 (RFUB)	OBF-1R (%)	OBF-1R Result	OBF-10R (%)	OBF-1R/ OBF-10R	OBF-1R/ OBF-10R Result	OBF-BC (RFUB)	Final Result
UN-2	6/2/2020	84.8	192.8	134.3	133.7	30.3	Positive				59.1	Positive
430	6/2/2020	93.2	302.7	202.1	185.4	33.2	Positive				117.3	Positive
440	6/2/2020	114.7	164.6	169.8	165	-3.2	Negative				ND	Negative
466	6/2/2020	98.9	88.95	76.63	68.11	13.9	Positive				20.84	Positive
482	6/2/2020	228.2	150.6	139.9	141.2	7.1	None	6.2	1.14	Positive	9.4	Positive
485	6/2/2020	156.1	95.14	101.2	93.46	-6.4	Negative				ND	Negative
504	6/2/2020	53.6	119.8	78.32	60.42	34.6	Positive				59.38	Positive
516	6/2/2020	92.5	205.7	198.2	150.2	3.6	None	27.0	0.14	Negative	55.5	Negative
531	6/2/2020	104.9	114.2	88.13	86.23	22.8	Positive				27.97	Positive
DUP	6/2/2020	91.7	308.4	217.7	193.2	29.4	Positive				115.2	Positive
Sewage 1	6/2/2020	683	592.4	726.8	563.8	-22.7	Negative				ND	Negative
Septage 1	6/2/2020	1030	1628	1465	1287	10.0	None	20.9	0.48	Positive	341	Positive
Blank	6/4/2020	4.8	0.52	NA	NA							
TS Control	6/4/2020	64.2	62.74	62.24	62.63	0.8	Negative				ND	Negative
TS	6/4/2020	63.7	67.3	35.36	31.63	47.5	Positive				35.67	Positive

Analyzed on 6/4/20 at Herrera Labe; Blank = deionized water; TS = Tide 50 uL/L standard, TS Control = TS without UV exposure

OBF-0 = RFUB before UV exposure for time 0

OBF-1 = RFUB after 1 minute UV exposure

OBF-10 = RFUB after additional 9 minute for a total 10 minute UV exposure

OBF-1R = Percent reduction in RFUB from time 0 to time 1 minute

OB-1R Result = Positive if OB-1R > 13%

OB-1R Result = Negative if OB-1R < 1.4% or OB-0 <30 RFUB (=3xMDL)

OB-1R Result = None if OB-1R = 1.4 - 13% and then test 10 minute reduction

OBF-10R = Percent reduction in RFUB from time 0 to time 10 minute, which applies only to None result for 0 to 1 minute.

OBF-1R/OBF-10R = OBF-1R divided by OBF-10R

OBF-1R/OBF-10R Result = Positive if OB-1R%/OB-10R% >/= 0.25

OBF-1R/OBF-10R Result = Negative if OB-1R%/OB-10R% < 0.25

OBF-BC = RFUB background corrected = OBF-0 minus OBF-10

Enter result	NA=not applicable
Copy Formula	ND=Not detected

	Optica	l Brightene	er Triplicat	e Standard	s Test Data	a Sheet		
		OBF-0	OBF-1	OBF-5	OBF-10	OBF-15	OBF-30	OBF-60
Sample ID	Test Date	(RFUB)	(RFUB)	(RFUB)	(RFUB)	(RFUB)	(RFUB)	(RFUB)
		before UV	1 min UV	+4 min UV	+5 min UV	+5 min UV	+15 min UV	+30 min UV
Lake-1	4/24/2020	40.32	40.28	38.64	35.9	36.95	34.5	32.3
Lake-2	4/24/2020	39.64	39.41	38.41	36.2	35.26	33.9	30.9
Lake-3	4/24/2020	40.19	40.19	39.54	37.3	36.17	34.1	31.5
Tide-1	4/24/2020	425.6	117.2	113.9	111.5	107.6	102.1	92.9
Tide-2	4/24/2020	390.2	116.7	114.6	109.7	106.5	100.5	91.7
Tide-3	4/24/2020	274	118.4	113.1	109.1	105.3	97.5	88.6
PTSA-1	4/24/2020	82.6	86.23	84.8	82.7	81.95	77.8	73.1
PTSA-2	4/24/2020	86.23	86.1	85.71	82.3	82.6	79.8	76.1
PTSA-3	4/24/2020	85.56	85.71	85.58	83.3	83.77	80.7	77.4
DI	4/24/2020	-2.84	-2.46	-2.72	-2.9	-2.07	-1.9	-2.1
Percent Red	uction from	time 0						
Lake-1	4/24/2020	0%	0%	4%	11%	8%	14%	20%
Lake-2	4/24/2020	0%	1%	3%	9%	11%	14%	22%
Lake-3	4/24/2020	0%	0%	2%	7%	10%	15%	22%
Tide-1	4/24/2020	0%	72%	73%	74%	75%	76%	78%
Tide-2	4/24/2020	0%	70%	71%	72%	73%	74%	77%
Tide-3	4/24/2020	0%	57%	59%	60%	62%	64%	68%
PTSA-1	4/24/2020	0%	-4%	-3%	0%	1%	6%	11%
PTSA-2	4/24/2020	0%	0%	1%	5%	4%	8%	12%
PTSA-3	4/24/2020	0%	0%	0%	3%	2%	6%	10%
DI	4/24/2020	0%	13%	4%	0%	27%	34%	27%

Ontical Brightoner Triplicate Standards Test Data Sheet

OBF-5 = Optical brightener fluoresence after a total of 5 minutes (1+4 minutes) exposure to UV light

DI = deionoized water from Herrera lab

Lake = Lake Union water collected from beach S of Kenmore Air on 4/23/20

Tide = Tide original detergent made fresh at 50 uL/L (50 ppb) in triplicate

PTSA = PTSA optical brightener standard from Turner at 10 ug/L (10 ppb) from 400 ppb standard expired March 2017



APPENDIX D

Project Database



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Area	Sample ID	Station	Event	Sample Date	Human HF 183 (copies/100 mL)	Q	Sewage BacV4V5-1 (copies/100 mL)	Q	Fecal Coliform (CFU/100 mL)	Q	E. coli (CFU/100 mL)	Q	Total Phospho rus (mg/L)	Q	Specific Conduct ance (uS/cm)	Q	Optical Brighten ers (RFUB)	Q	Optical Brighten ers Pos/Neg	Q	Flow (gpm)	Q
Undev	UN-1	UN-1	Storm 1	3/3/20	, 25	ND	, 25	ND	, 34	-	, 34		0.060		59		141	-	Negative		22	_
Undev	UN-1	UN-1	Storm 2	3/24/20	250	DNQ	25	ND	98		98		0.058		NA		NA		NA		36	
Undev	UN-1	UN-1	Storm 3	4/27/20	1,850		25	ND	220		220		0.099		75		193		Positive		2.9	
Undev	UN-2	UN-2	Storm 1	3/3/20	250	DNQ	25	ND	290		290		0.058		62		191		Negative		22	
Undev	UN-2	UN-2	Storm 2	3/24/20	25	ND	25	ND	28		25		0.033		NA		NA		NA		9.4	
Undev	UN-2	UN-2	Storm 3	4/27/20	250	DNQ	25	ND	182		182		0.050		72		224		Positive		2.2	_
Undev	UN-2	UN-2	Base 1	5/11/20	766		25	ND	5		5		0.091	J	81		146		Positive		0.4	J
Undev	DUP	UN-2-DUP	Base 1	5/11/20	656		25	ND	7		7		0.013	J	79		142		Positive		NA	
Undev	UN-2	UN-2	Base 2	6/2/20	25	ND	25	ND	480		480		0.051		85		193		Positive		0.4	
OSS	430	430	Storm 1	3/3/20	25	NDJ	250	DNQ	72		72		0.046		80		245		Positive		193	
OSS	DUP	430-DUP	Storm 1	3/3/20	250	DNQJ	250	DNQ	78		78		0.043		82		247		Positive		193	
OSS	430	430	Storm 2	3/24/20	250	DNQ	15,300		74		74		0.049		NA		NA		NA		287	
OSS	430	430	Storm 3	4/27/20	250	DNQ	2,100		410		410		0.053		111		261		Positive		79	
OSS	430	430	Base 1	5/11/20	860		11,700		106		106	i	0.064		NA		NA		NA		5.3	
OSS	430	430	Base 2	6/2/20	25	NDJ	25	ND	82		82		0.020	J	93		303		Positive		8.5	
OSS	DUP	430-DUP	Base 2	6/2/20	250	DNQJ	25	ND	88		88		0.042	J	92		308		Positive		NA	
OSS	440	440	Storm 1	3/3/20	25	ND	49,500		38		38		0.047		72		235		Positive		72	
OSS	440	440	Storm 2	3/24/20	25	ND	62,900		320		310		0.047		NA		NA		NA		148	
OSS	440	440	Storm 3	4/27/20	25	ND	8,190		2,000		2,000		0.076		102		176		Negative		45	
OSS	440	440	Base 1	5/11/20	25	ND	250	DNQ	54		54		0.122		103		167		Negative		5.4	
OSS	440	440	Base 2	6/2/20	25	ND	250	DNQ	88		88		0.029		115		165		Negative		14	
OSS	440-U1	440-U1	Storm 3	4/27/20	25	ND	7,310		2,300		2,300		0.081		103		147		Negative		21	
OSS	440-U4	440-U4	Storm 3	4/27/20	25	ND	250	DNQ	11		11		0.347		97		177		Positive		3.6	
OSS	453	453	Storm 1	3/3/20	25	ND	250	DNQ	2	U	2	U	0.103		67		160		Positive		1.3	
OSS	453	453	Storm 2	3/24/20	25	ND	250	DNQ	2	U	2	U	0.029		NA		NA		NA		0.4 、	J
OSS	453	453	Storm 3	4/27/20	25	ND	25	ND	36	J	36	J	0.086		69		103		Negative		0.4	J
OSS	DUP	453-DUP	Storm 3	4/27/20	25	ND	25	ND	2	U	2	U	0.090		69		86		Positive		NA	
OSS	453	453	Base 1	5/11/20	25	ND	25	ND	3		3		0.088		65		87		Negative		0.4 、	J
OSS	466	466	Storm 1	3/3/20	1,920		25	ND	164		164		0.036		76		135		Positive		27	
OSS	466	466	Storm 2	3/24/20	25	ND	250	DNQ	3		3		0.039		NA		NA		NA		23	
OSS	466	466	Storm 3	4/27/20	25	ND	640		2	U	2	U	0.053		76		125		Positive		1.8	
OSS	466	466	Base 1	5/11/20	25	ND	25	ND	1,300		1,300		0.036		80		108		Positive		4.9	
OSS	466	466	Base 2	6/2/20	25	ND	25	ND	39		39		0.036		99		89		Positive		0.9、	J
OSS	520	520	Storm 1	3/3/20	75,700		11,700		7		7		0.102		99		157		Positive		22	
OSS	520	520	Storm 2	3/24/20	8,210		5,960		2	U	2	U	0.053		NA		NA		NA		4.5	
OSS	520	520	Storm 3	4/27/20	25	ND	25	ND	34		34		0.950		116		120		Positive		0	
Sewer	482-DG	482	Storm 1	3/3/20	25	ND	25	ND	82		82		0.053		174		230		Positive		7.2	
Sewer	482	482	Storm 2	3/24/20	25	ND	25	ND	260	J	260	J	0.045		NA		NA		NA		15	
Sewer	DUP	482-DUP	Storm 2	3/24/20	25	ND	25	ND	28	J	28	J	0.052		NA		NA		NA		NA	
Sewer	482	482	Storm 3	4/27/20	25	ND	25	ND	210		210		0.226		183		180		Positive		10	<u> </u>
Sewer	482	482	Base 1	5/11/20	25	ND	25	ND	56		56		0.193		229		166		Positive		0.02	J
Sewer	482	482	Base 2	6/2/20	25	ND	25	ND	155		155		0.096		228		151		Positive		0.01	<u> </u>
Sewer	485	485	Storm 1	3/3/20	25	ND	250	DNQ	30		30		0.032		113		140		Positive		94	
Sewer	485	485	Storm 2	3/24/20	250	DNQ	25	ND	102		102		0.030		NA 100		NA		NA D		32	
Sewer	485	485	Storm 3	4/27/20	250	UNQ	25	ND	900		900	-	0.045	<u> </u>	128		145		Positive		28	
Sewer	485	485	Base 1	5/11/20	25		25		3,600		3,600	-	0.067	<u> </u>	162		107		Positive		41	
Sewer	485	485	Base 2	6/2/20	250	UNQ	250	UNQ	74		74		0.054	<u> </u>	156		95		Negative		1.3	
Sewer	504	504	Storm 1	3/3/20	25		25	ND	96		92		0.021		40		185		Positive		55	
Sewer	504	504	Storm 2	3/24/20	25	UND	25	UИ	88		82		0.025		NA		NA		NA		135	

Lake Whatcom On-Site Sewage System Impact Assessment Database

Area	Sample ID	Station	Event	Sample Date	Human HF 183 (copies/100 mL)	Q	Sewage BacV4V5-1 (copies/100 mL)	Q	Fecal Coliform (CFU/100 mL)	o	E. coli (CFU/100 mL)	Q	Total Phospho rus (mg/L)	0	Specific Conduct ance (uS/cm)	0	Optical Brighten ers (RFUB)	o	Optical Brighten ers Pos/Neg	0	Flow (gpm) Q
Sewer	504	504	Storm 3	4/27/20	25		25		, 	~	8	~	0.042	_	/0.0.011)	_	105	~	Negative	_	(3 p,) ~
Sewer	504	504	Base 1	5/11/20	25		25		2	U	2		0.040		49		90		Positive		0.1
Sewer	504	504	Base 2	6/2/20	25	ND	25	ND	2	U	2	U	0.210		54		120		Positive		0.02 J
Sewer	516	516	Storm 1	3/3/20	250	DNQ	25	ND	18	-	18	<u> </u>	0.070		72		255		Positive		359
Sewer	516	516	Storm 2	3/24/20	250	DNQ	546		16		16		0.057		NA		NA		NA		359
Sewer	516	516	Storm 3	4/27/20	250	DNQ	250	DNQ	118		118		0.068		76		311		Positive		269
Sewer	516	516	Base 1	5/11/20	250	DNQ	25	ND	8		8		NA		89		254		Positive		157
Sewer	516	516	Base 2	6/2/20	2,280		250	DNQ	78		78		0.081		93		206		Negative		130
Sewer	531	531	Storm 1	3/3/20	25	ND	25	ND	800		800		0.040		94		110		Positive		9.0
Sewer	531	531	Storm 2	3/24/20	25	ND	25	ND	16		16		0.039		NA		NA		NA		4.5
Sewer	531	531	Storm 3	4/27/20	25	ND	25	ND	21		21		0.039		93		173		Positive		4.5
Sewer	531	531	Base 1	5/11/20	25	ND	25	ND	34		34		0.036		99		142		Negative		0.02 J
Sewer	531	531	Base 2	6/2/20	25	ND	25	ND	1,100		1,100		0.054		105		114		Positive		0.1 J
OSS	Septage-1	Septage-1	Storm 1	3/3/20	3,570		62,100,000		6,000	>	6,000	>	8.000		811		455		Positive		NA
OSS	Septage 1	Septage-1	Base 1	5/11/20	3,070		224,000,000		550,000		550,000		11.100		822		452		Negative		NA
OSS	Septage-2	Septage-2	Storm 2	3/24/20	25	ND	92,000,000		6,000	>	6,000	>	13.900		NA		NA		NA		NA
OSS	Septage-2	Septage-2	Storm 3	4/27/20	250	DNQ	306,000,000		15,000		15,000		15.900		NA		NA		NA		NA
OSS	Septage 2	Septage-2	Base 2	6/2/20	250	DNQ	615,000,000		270,000		270,000		16.200		1,030		1,628		Positive		NA
Sewer	Sewage-1	Sewage-1	Storm 1	3/3/20	469,000,000		5,000,000		6,000	>	6,000	>	4.080		450		1,280		Positive		NA
Sewer	Sewage-1	Sewage-1	Storm 2	3/24/20	246,000,000		4,930,000		280,000		280,000		5.660		NA		NA		NA		NA
Sewer	Sewage-1	Sewage-1	Storm 3	4/27/20	1,300,000,000		29,900,000		600,000	>	600,000	>	17.000		NA		NA		NA		NA
Sewer	Sewage 1	Sewage 1	Base 1	5/11/20	60,600,000		13,000,000		580,000		580,000		7.200		645		5,946		Positive		NA
Sewer	Sewage 1	Sewage 1	Base 2	6/2/20	271,000,000		56,200,000		580,000		580,000		7.730		683		592		Negative		NA

Lake Whatcom On-Site Sewage System Impact Assessment Database

NA = Not analyzed

ND = Not detected, value = 1/2 detection limit

DNQ = Detected but not quantifiable, value = 1/2 limit of quantification

> = Greater than specified upper limit of quantification

J = Estimated value

U = Undetected at specified detection limit



1220 Lakeway Drive Bellingham, WA 98229 (360) 734-9224

November 12, 2020

Gary Stoyka Public Works Department Whatcom County 322 Commercial Street, Suite 210 Bellingham, WA 98225 Peg Wendling Public Works Department City of Bellingham 2221 Pacific Street Bellingham, WA 98229

Re: On-site Sewage System Assessment Drainage 485 Sewage Collection System Inspection

Dear Mr. Stoyka and Ms. Wendling:

The Lake Whatcom Water and Sewer District (District), in partnership with the City of Bellingham (City) and Whatcom County (County), recently completed an assessment of the impacts of on-site sewage systems (OSS) on the water quality of Lake Whatcom (Herrera 2020). Data generated through completion of the assessment identified low levels of human DNA biomarkers and high concentrations of fecal coliform and E. coli within a drainage located in a shoreline served by the District's sewage collection system (Drainage 485, see attached Figure A5 from the OSS Assessment Report). While the consultant performing the assessment (Herrera Environmental) attributed the presence of human DNA biomarkers (reported in four of five sample events, all at concentrations not quantifiable due to the concentrations being near the laboratory reporting limit) as likely the result of a single, direct human deposit, the District concluded that additional assessment is warranted to determine if the source may be from a leak in the District's sewage collection system. The purpose of this memorandum is to document actions taken and conclusions made by the District in inspecting its sewage collection system.

During the 2020 OSS assessment, samples were collected from Drainage 485 during five separate monitoring events (three storm and two base). Following summarizes the analytical results associated with human DNA biomarkers and bacteria of samples collected from Drainage 485:

Event	Date	HF 183 (copies/100 mL)	BacV4V5-1 (copies/100 mL)	Fecal Coliform (CFU/100 mL)	E. coli (CFU/100 mL)
Storm 1	03/03/2020	ND	250 DNQ	30	30
Storm 2	03/24/2020	250 DNQ	ND	102	102
Storm 3	04/27/2020	250 DNQ	ND	900	900
Base 1	05/11/2020	ND	ND	3,600	3,600
Base 2	06/02/2020	250 DNQ	250 DNQ	74	74

CFU/100 mL – colony forming units per 100 milliliters

DNQ - detected but not quantified

ND – not detected

Gary Stoyka & Peg Wendling November 12, 2020 Page 2

During the four monitoring events in which human DNA biomarkers were detected but not quantified, three events indicated that the corresponding fecal coliform and E. coli concentrations were at values ranging between 30 and 102 colony forming units per 100 milliliters (CFU/100 mL), which were in the project-assigned parameter thresholds of *low* (up to 100 CFU/100 mL) to *moderate* (between 100 and 500 CFU/100 mL). The fourth event indicated levels in the *high* parameter threshold (greater than 500 CFU/100 mL). Interestingly, the fifth event (Base 1) that did not report detections of human DNA biomarkers, reported by far the highest bacteria concentrations (3,600 CFU/100 mL for both fecal coliform and E. coli).

Regardless of correlations between bacteria concentrations and human DNA biomarker concentrations, the slight presence of human DNA biomarkers in a drainage served by the District's sewage collection and conveyance system warranted follow up to identify if any issues with the system exist.

A routine function of the District is the visual inspection of its sewage collection and conveyance system to ensure the timely repair of any leaks. The District completes this through use of a camera system that can be extended through sewer piping and inspected by District staff certified by the National Association of Sewer Service Companies (NASSCO) in assessment of sewer pipelines, laterals, and manholes. Upon being made aware of the potential of a leak in vicinity of Drainage 485 District staff reviewed the status of the inspection of its sewage collection system in this area. Many of the pipeline segments within this area had recently (2019-2020) been inspected, with no significant issues identified. However, a number of segments had not been inspected for a number of years. As a result, the District subsequently inspected those pipeline segments to ensure recent inspection of the collection system within the subject drainage, as well as neighboring drainages. Attached is a figure identifying each sewer pipeline segment.

Based upon a NASSCO-certified inspector's inspection of the District's sewage collection and conveyance system within the vicinity of the Drainage 485, all systems were found to be in good working order, with no leaks or breaks identified that could be the source of the low detections of human DNA biomarkers. Therefore, the District concludes that the minimal presence of human DNA biomarkers reported during the monitoring events were likely as the environmental consultant concluded—a direct human deposit(s) within the drainage.

The District greatly appreciates its partnership with the City and County in collaboration of the protection of Lake Whatcom. Should you have any questions regarding this letter, or any other questions regarding District operations, please do not hesitate to contact me.

Gary Stoyka & Peg Wendling November 12, 2020 Page 3

Sincerely,

Lake Whatcom Water and Sewer District

Justin L. Clary General Manager

Attachments: Table, Gravity Sewage Collection System Inspection Summary Figure A5, Drainage Monitoring Stations, 2020 On-site Sewage System Impact Assessment Figure 1, District Sewage Collection System—Strawberry Point Vicinity Figure 2, District Sewage Collection System—Lake Whatcom Blvd Vicinity

cc: District Board of Commissioners District Project No. A1919 File

TABLES

Gravity Sewage Collection System Inspection Summary

	Diameter		Inspection	
Main ID	(inches)	Material	Date	Condition
G5-001	8	Polyvinyl Chloride	11/3/2020	Pipe intact-no leaks observed
G5-002	8	Ductile Iron	11/3/2020	Pipe intact-no leaks observed
G5-003	8	Polyvinyl Chloride	11/3/2020	Pipe intact-no leaks observed
G5-004	8	Ductile Iron	10/29/2020	Pipe intact-no leaks observed; sediment buildup
G5-005	8	Polyvinyl Chloride	10/15/2020	Pipe intact-no leaks observed; sediment buildup
G5-006	8	Ductile Iron	10/15/2020	Pipe intact-no leaks observed; sediment buildup
G5-007	8	Ductile Iron	10/15/2020	Pipe intact-no leaks observed; sediment buildup
G5-008	8	Polyvinyl Chloride	10/15/2020	Pipe intact-no leaks observed; minor sediment buildup
G5-009	8	Ductile Iron	7/29/2020	Pipe intact-no leaks observed; minor sediment buildup
G5-010	8	Ductile Iron	7/29/2020	Pipe intact-no leaks observed
G5-011	8	Polyvinyl Chloride	10/29/2020	Pipe intact-no leaks observed
G5-012	8	Polyvinyl Chloride	7/29/2020	Pipe intact-no leaks observed
G5-013	8	Polyvinyl Chloride	7/29/2020	Pipe intact-no leaks observed
G5-014	8	Polyvinyl Chloride	10/19/2020	Pipe intact-no leaks observed; sediment buildup
G5-015	8	Polyvinyl Chloride	11/3/2020	Pipe intact-no leaks observed
G5-016	8	Polyvinyl Chloride	5/8/2019	Pipe intact-no leaks observed
G5-019	8	Polyvinyl Chloride	11/2/2020	Pipe intact-no leaks observed
G5-020	8	Ductile Iron	7/29/2020	Pipe intact-no leaks observed
G5-021	8	Polyvinyl Chloride	7/23/2020	Pipe intact-no leaks observed
G5-022	8	Polyvinyl Chloride	7/29/2020	Pipe intact-no leaks observed
G7-002	8	Polyvinyl Chloride	2/19/2020	Pipe intact-no leaks observed
G7-003	8	Polyvinyl Chloride	1/23/2020	Pipe intact-no leaks observed
G7-004	8	Polyvinyl Chloride	1/23/2020	Pipe intact-no leaks observed
G7-005	8	Polyvinyl Chloride	1/23/2020	Pipe intact-no leaks observed
G7-006	8	Polyvinyl Chloride	1/23/2020	Pipe intact-no leaks observed
G7-007	8	Polyvinyl Chloride	1/23/2020	Pipe intact-no leaks observed
G7-008	8	Polyvinyl Chloride	1/23/2020	Pipe intact-no leaks observed
G7-015	8	Polyvinyl Chloride	1/23/2020	Pipe intact-no leaks observed
G7-016	8	Polyvinyl Chloride	1/23/2020	Pipe intact-no leaks observed
G7-017	8	Polyvinyl Chloride	5/1/2019	Pipe intact-no leaks observed
G7-018	8	Polyvinyl Chloride	5/1/2019	Pipe intact-no leaks observed
G7-019	8	Polyvinyl Chloride	5/1/2019	Pipe intact-no leaks observed
GRD-01	8	Polyvinyl Chloride	5/1/2019	Pipe intact-no leaks observed
GRD-02	8	Polyvinyl Chloride	5/1/2019	Pipe intact-no leaks observed
GRD-03	8	Polyvinyl Chloride	2/11/2020	Pipe intact-no leaks observed
GRD-04	8	Polyvinyl Chloride	5/1/2019	Pipe intact-no leaks observed

Lake Whatcom Water and Sewer District

	Diameter		Inspection	
Main ID	(inches)	Material	Date	Condition
GRD-05	6	Ductile Iron	5/1/2019	Pipe intact-no leaks observed
GRD-06	6	Ductile Iron	5/1/2019	Pipe intact-no leaks observed
GT-011	14	Ductile Iron	12/11/2019	Pipe intact-no leaks observed; sig. struvite buildup
GT-012	14	Ductile Iron	12/11/2019	Pipe intact-no leaks observed; sig. struvite buildup
GT-013	14	Ductile Iron	12/11/2019	Pipe intact-no leaks observed; sig. struvite buildup
GT-014	14	Ductile Iron	12/12/2019	Pipe intact-no leaks observed; sig. struvite buildup
GT-015	14	Ductile Iron	12/10/2019	Pipe intact-no leaks observed; sig. struvite buildup
GT-016	10	Ductile Iron	6/25/2020	Pipe intact-no leaks observed; sig. struvite buildup
GT-017	10	Ductile Iron	6/25/2020	Pipe intact-no leaks observed; sig. struvite buildup
GT-018	10	Ductile Iron	6/25/2020	Pipe intact-no leaks observed; sig. struvite buildup
GT-019	10	Ductile Iron	6/25/2020	Pipe intact-no leaks observed; sig. struvite buildup
GT-020	10	Ductile Iron	6/25/2020	Pipe intact-no leaks observed; sig. struvite buildup
GT-021	10	Polyvinyl Chloride	6/9/2010	Not inspected due to Lake Whatcom Blvd traffic conditions
GT-023	10	Polyvinyl Chloride	6/9/2010	Not inspected due to Lake Whatcom Blvd traffic conditions
GT-024	10	Polyvinyl Chloride	12/31/2019	Pipe intact-no leaks observed; struvite buildup

FIGURES



Figure 1 - Gravity Sewer Main - TV Inspection Summary Strawberry Point Vicinity



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Figure 2 - Gravity Sewer Main - TV Inspection Summary Lake Whatcom Blvd Vicinity



Date Saved: 11/10/2020 8:56 AM

Justin Clary

From:	Justin Clary
Sent:	Wednesday, January 27, 2021 9:24 AM
То:	Laura Abele; Todd Citron; Bruce Ford; Leslie McRoberts; John Carter
Cc:	Rachael Hope; Bill Hunter; Debi Denton; Brent Winters; Robert Carmichael; Melanie
	Mankamyer
Subject:	OSS Impact Mitigation Action Items

Board of Commissioners – following is the list of action items that Melanie, Bruce and I developed that were discussed during this morning's meeting. As always, please do not hesitate to contact me with any questions or concerns.

On-site Sewage System Impact Mitigation Lake Whatcom Watershed

Objective

To protect the water quality of Lake Whatcom through ensuring the effective management of existing on-site sewage systems and mitigating potential impacts to the Lake by future development.

Applicable Effective Utility Management Attribute(s)

Water Resource Sustainability

Lake Whatcom Water and Sewer District Actions

Whatcom County:

- Request that the Whatcom County Health Department provide an annual presentation to the Board of Commissioners on the status of the on-site sewage system maintenance inspection and enforcement program specific to systems within the Lake Whatcom Watershed.
- Ensure that Whatcom County Public Works Department completes the source tracing in Drainages 440 and 520, as recommended in the 2020 OSS Impact Assessment report.
- Recommend that Whatcom County amend County Code Section 24.05.160(B) to prohibit allowance of selfevaluation of on-site sewage systems within the Lake Whatcom Watershed.

City of Bellingham:

- Encourage the City of Bellingham to pursue acquisition (using Lake Whatcom Reservoir Property Acquisition Program funds) of approximately 25 undeveloped parcels located along the north shore of Lake Whatcom that have the potential to develop with on-site sewage system service.

Lake Whatcom Water and Sewer District:

- Research the legality of the District assuming ownership or management of group on-site sewage systems (community drainfields) located in District boundaries.

Justin L. Clary, PE | General Manager



LAKE WHATCOM WATER & SEWER DISTRICT 1220 Lakeway Drive Bellingham, WA 98229

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Justin Clary

Gary Stoyka <gstoyka@co.whatcom.wa.us></gstoyka@co.whatcom.wa.us>
Monday, June 21, 2021 1:10 PM
Justin Clary
FW: Lake Whatcom OSS Follow Up

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Hi Justin:

Hope you had a nice weekend. Just wanted to let you know the status of the follow-up OSS work in the watershed. Let me know if you have any questions.

-Gary

From: Erika Douglas
Sent: Thursday, June 10, 2021 9:39 AM
To: Gary Stoyka <GStoyka@co.whatcom.wa.us>
Cc: Leah Robison <LRobison@co.whatcom.wa.us>
Subject: Lake Whatcom OSS Follow Up

Gary,

With the completion of the second phase of the Lake Whatcom OSS study, Whatcom County agreed to conduct follow up work on the sites along North Shore Drive with moderate to high levels of human biomarker detections (430, 440, and 520).

- The Whatcom County Health Department is gearing up to start sending OSS O&M letters again in the summer of 2021 as more staff are available to work in the OSS Programs. (Health staff capacity for OSS programs has been extremely limited due to reassignments to Covid response and position vacancies).
- Online OSS records were reviewed for parcels in these three drainages to identify sites with out-of-date evaluations, maintenance needs that may not have been resolved, or community drainfields. Identified sites were forwarded to the Health Department. OSS records will be reviewed and O&M letters will be sent to these landowners during the first mailing. The letters will require an evaluation of the OSS. There were approximately 10 sites identified.
- A reconnaissance study was conducted to review opportunities for bracket monitoring. As noted in the phase 2 study, upstream monitoring sites are limited in these area due to private property and private roads. Public Works may reach out to these landowners to request access to collect samples at upstream sites.
- During the recon study, maintenance needs were identified to assist with follow up sampling in fall 2021 (currently these sites are not flowing or flow is too low to collect a clean sample).
 - At site 520, the mapped catch basin could not be found in the driveway. There was a significant buildup of debris in the lower driveway area that will need to be removed to locate the catch basin. The catch basin will likely be the best location to sample. There are two stormwater drainages mapped in this location.
 - At site 440, the road cross-culvert could not be located in the ditch. Maintenance work may be needed to identify and provide access to this culvert for sampling.
- Water quality sampling will be conducted in the fall when flows return for analysis of a suite of fecal bacteria indicators. We will target both baseflow and storm conditions. It may be possible to do additional eDNA

analysis for human biomarkers tied in to another Whatcom County project or independently through Source Molecular (lab in Florida).

Please let me know if there are additional questions. I will look to the Lake Whatcom Management Team for guidance on level of priority and how much additional eDNA work is desired.

Thanks, Erika



Erika Douglas (she/her/hers) | Senior Water Quality Planner Whatcom County Public Works- Natural Resources 322 N. Commercial Street, Suite 110 | Bellingham, WA 98225 360.303.4090 (cell) / 360.778.6294 http://www.co.whatcom.wa.us/1072/Water-Quality

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