Quality Assurance Project Plan

Characterization of Groundwater Discharge to Lake Whatcom

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October 2002

303(d) listings addressed in this study:
Lake Whatcom (WA-01-9170) - Dissolved Oxygen

Ecology EIM number: CHPI002

Approvals

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Will Kendra, Section Manager, Watershed Ecology Section	Date
Approved by:	October 23, 2002
Stuart Magoon, Director, Manchester Environmental Laboratory	Date
Approved by:	October 23, 2002
Cliff Kirchmer, Ecology Quality Assurance Officer	Date

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Abstract

Lake Whatcom, located in western Whatcom County, is currently listed on the Washington State 303(d) list of waterbodies not attaining water quality criterion for dissolved oxygen. In response, the Washington State Department of Ecology's Environmental Assessment Program is undertaking a comprehensive water quality sampling program for the lake throughout 2002 and 2003.

To support this evaluation, a study is proposed to improve the understanding of the role of groundwater inflow in the water quality of the lake. The primary goal of the study described in this plan is to document the phosphorus and nitrogen content of the groundwater that is directly discharging into Lake Whatcom from the adjacent aquifer system. A secondary goal is to evaluate the possible sources for any nutrients observed. Characterization of the quality of groundwater entering Lake Whatcom will assist in the development of an up-to-date, lake-wide nutrient budget, and in construction of a water-quality model.

To provide sufficient data for this purpose, a network of approximately 12-15 lake-bed piezometers will be installed and sampled in the littoral zone sediments at points distributed around the perimeter of the lake. Piezometers will be sampled quarterly for a one-year period, for a total of four sampling rounds.

Water quality samples will be analyzed for target nutrients (total dissolved phosphorus, orthophosphate, nitrate+nitrite as nitrogen, ammonia as nitrogen), as well as several diagnostic analytes that help to characterize geochemical controls on nutrient transport (dissolved oxygen, iron, manganese) or serve as source indicator parameters (total dissolved solids, chloride, dissolved organic carbon, boron, methylene blue active substances).

Background/Problem Statement

The federal Clean Water Act (1972), Section 303(d), requires that states report waterbodies that do not meet ambient water quality standards. The resulting inventory of impaired waterbodies is called the 303(d) list. Waterbodies on the list are scheduled for Total Maximum Daily Load (TMDL) studies, which are assessments of the pollutant loading capacity of a waterbody that still allows the waterbody to meet the assigned water quality criteria and support beneficial use.

Lake Whatcom, located in Whatcom County (Figure 1), is currently listed on the Washington State 303(d) list of waterbodies not attaining water quality criterion for dissolved oxygen. The lake is an important resource to the local community, serving as the drinking water supply for the city of Bellingham, as well as for a number of residents living adjacent to the lake.

The oxygen depletion, a seasonal condition observed in the lake at water depths below the thermocline (8-10 meters), has been significantly increasing over the past two decades. This change is interpreted to be the result of several factors, including the direct loading of organic matter from the surrounding watershed, and eutrophication processes driven by the availability of phosphorus and nitrogen-based nutrients (Cusimano et al., 2002). The depletion of oxygen can ultimately lead to the reduction in the water quality for drinking purposes, and limit the available habitat for oxygen-dependent organisms such as fish.

The Northwest Regional Office (NWRO) and the Bellingham Field Office (BFO) of the Washington State Department of Ecology (Ecology) are concerned about ongoing pollutant loading adversely affecting the beneficial uses and water quality of Lake Whatcom. The NWRO/BFO concerns, combined with the listing of the lake as an impaired waterbody, have prompted a TMDL study. As part of this study, Ecology's Environmental Assessment (EA) Program is undertaking a comprehensive water quality sampling program for the lake throughout 2002 and 2003. The ultimate goal of this sampling program is the development of a water quality model, and recommendations for reduction and allocation of pollutant loads.

Project Goals and Summary Description

To ensure a comprehensive characterization of the magnitude and origin of nutrient loading to Lake Whatcom, a better understanding of the role of groundwater-derived nutrient inflow to the lake is required. The primary goal of the study described in this plan is to document the phosphorus and nitrogen content of the groundwater that is directly discharging into Lake Whatcom from the adjacent aquifer system. A secondary goal of this work will be to evaluate the possible sources for any nutrients observed. Characterization of the quality of the groundwater entering Lake Whatcom will assist in the development of an up-to-date, lake-wide nutrient budget, and construction of a water-quality model.

To provide sufficient data for this purpose, a network of approximately 12-15 lake-bed piezometers will be installed and sampled in the littoral zone sediments at points distributed

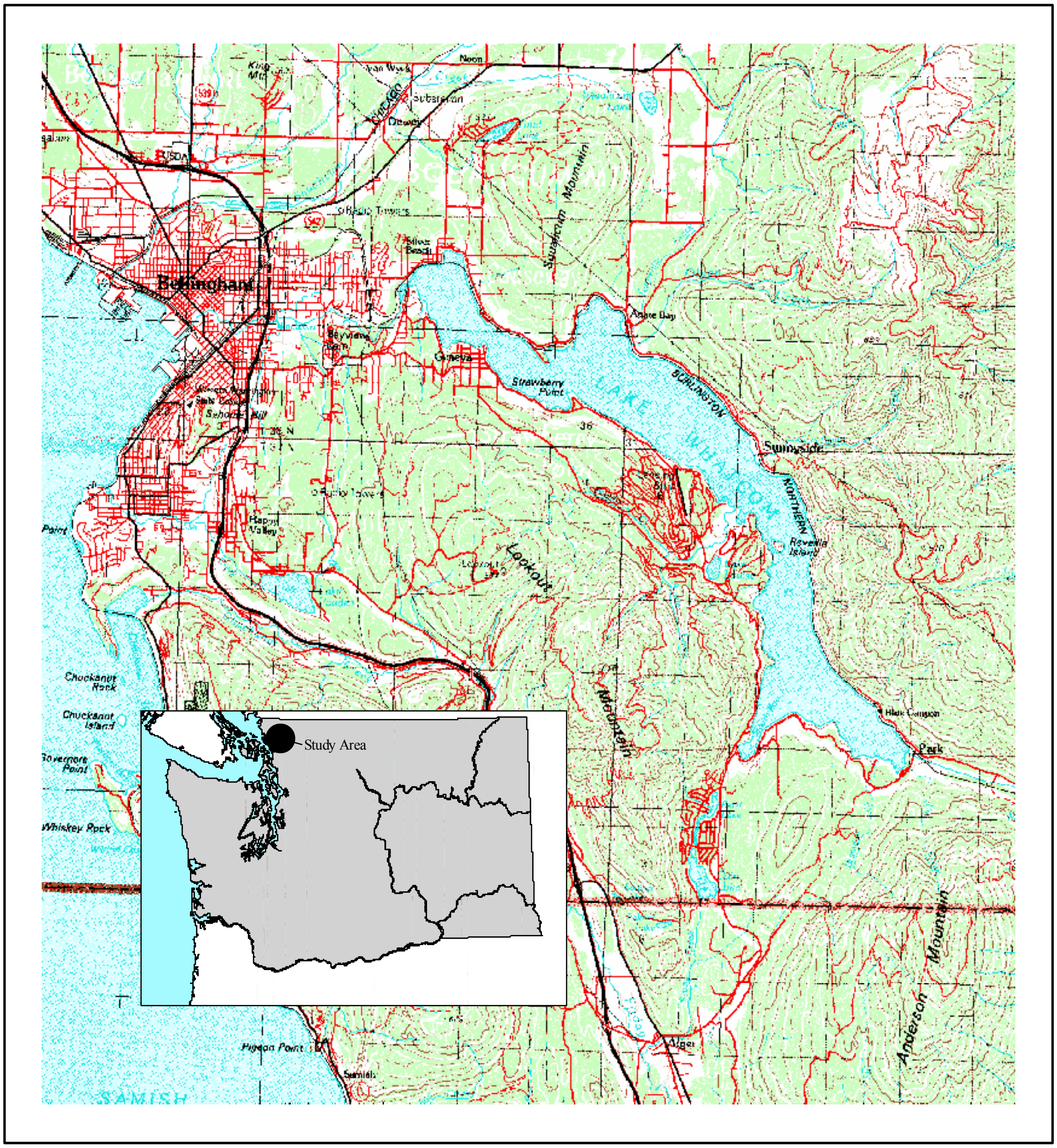

Figure 1 - Study Area Map
Lake Whatcom,
Whatcom County, Washington

around the perimeter of the lake. Piezometers will be sampled quarterly for a one-year period, for a total of four sampling rounds. Water quality samples will be analyzed for target nutrients [total dissolved phosphorus (TDP), orthophosphate (OP), nitrate+nitrite as nitrogen (referred to as nitrate-N; nitrite is infrequently detected in shallow groundwater), and ammonia as nitrogen (ammonia-N)], as well as several diagnostic analytes that help to characterize geochemical controls on nutrient transport [dissolved oxygen (DO), iron, manganese], or serve as source indicator parameters [total dissolved solids (TDS), chloride, dissolved organic carbon (DOC), boron, methylene blue active substances (MBAS)].

Responsibilities

The following individuals will be involved in this project:

Richard Grout, Water Quality Program of the BFO, is the client. Richard is responsible for approving the QA project plan and final report, and interacting with stakeholders and other interested public (360-738-6255).

Bob Cusimano, Watershed Ecology Section of the EA Program, is the project manager for the Lake Whatcom TMDL study. Bob is responsible for overseeing all elements of the EA Program TMDL project. He will provide technical input on the groundwater sampling needs for the larger study (360-407-6688).

Steve Hood, BFO, is the assistant project manager for the TMDL study. Steve will be responsible for reviewing drafts of the QA project plan and final report, and for developing the detailed implementation plans for the TMDL. Steve will also help to arrange permission for access to sampling sites (360-738-6254).

Jing Liu, Watershed Ecology Section, is the principal investigator for the Lake Whatcom TMDL study. Jing will manage sampling of surface water for the study and will serve as an additional point of contact for field sampling efforts (360-407-7451).

Will Kendra, section supervisor of the Watershed Ecology Section, is responsible for approving the QA project plan, project budget, and project reports (360-407-6698).

Darrel Anderson (360-407-6453) and *Karol Erickson* (360-407-6694), unit supervisors in the Watershed Ecology Section, are responsible for internal review of the QA project plan and project reports.

Charles Pitz, Watershed Ecology Section, is the project lead for the groundwater portion of the Lake Whatcom TMDL and will have primary responsibility for project planning, data collection and evaluation, and reporting for the groundwater study (360-407-6775).

Cliff Kirchmer, Ecology Quality Assurance Officer, will assist in providing technical guidance for QA/QC issues or problems that arise during the project, and will review and approve the QA project plan (360-407-6455).

Manchester Environmental Laboratory (MEL) will conduct the analysis of all field samples collected during this study, other than field-measured parameters. Pam Covey is responsible for coordinating requests for analysis and providing access to project data. Karin Feddersen is the primary contact for lab coordination on sample management and data quality issues. Phone numbers are MEL, (360) 871-8800; Pam, (360) 871-8827; and Karin, (360) 871-8829.

Schedule

The anticipated project schedule is presented below.

Task	2002					2003												2004				
	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
Project planning and background research	•	•	•																			
QAPP preparation, review, finalization	•	•	•																			
Field Preparations – -Equipment construction -Field surveys -Access arrangements - Piezometer installations		•	•																			
Project setup in EIM				•																		
Sampling events			•			•			•			•										
LIMS data migration to EIM					•			•			•			•								
Compile and evaluate project data					•			•			•			•	•	•	•					
Prepare draft report															•	•	•	•	•			
Incorporate review comments and finalize report																				•	•	•

October 2002	Complete final QA project plan
October 2002	Begin sampling
July 2003	End sampling
February 28, 2004	Complete draft report
May 31, 2004	Complete final report

The final report will summarize the study methods, quality assurance evaluation results, and study findings. The report will be submitted in draft form to internal reviewers in the EA Program and to NWRO/BFO staff, prior to final publication.

Data Quality Objectives

The primary objective of this study is to provide data that are representative of field conditions for input into a water quality model.

Table 1 describes the data quality (measurement) objectives for this project, including the target accuracy for results, and the precision, bias, and required reporting limit for analysis.

Table 1. Measurement Quality Objectives for Project Analytes

Analyte	Accuracy % deviation from true value (2*precision + bias)	Precision % relative standard deviation	Bias % deviation from true value	Required Reporting Limit concentration units
Field				
pH*	0.15 s.u.			
Temperature*	0.2°C			
Specific conductance*	10 µhmo/cm			
Dissolved oxygen* (#)	±0.015 mg/L @ 0.005 - 0.140 mg/L ±0.02 mg/L @ 0.140 – 0.180 mg/L			0.005 mg/L
MBAS*	±0.25 mg/L@ 0.025 – 1 mg/L ±0.5 mg/L @ 1-3 mg/L			0.025 mg/L
Laboratory				
Total dissolved phosphorus (TDP)	<25	<10	<5	0.010 mg/L
Orthophosphate (OP)	<25	<10	<5	0.010 mg/L
Nitrate-N, dissolved	<25	<10	<5	0.010 mg/L
Ammonia-N, dissolved	<25	<10	<5	0.010 mg/L
TDS	<30	<10	<10	1 mg/L
Chloride	<30	<10	<10	0.1 mg/L
Dissolved organic carbon (DOC)	<30	<10	<10	1 mg/L
Boron, dissolved	<30	<10	<10	0.050 mg/L
Iron, dissolved	<30	<10	<10	0.020 mg/L
Manganese, dissolved	<30	<10	<10	0.010 mg/L

* Accuracy as units of measurement, not percentages.

(#) Field test kit for confirmation of field meter values below 0.2 mg/L.

Field and Laboratory Methods

A summary of the field and laboratory methods that will be used for analysis of selected parameters is presented in Table 2. Past studies have indicated that, relative to the natural heterogeneity, concentration ranges, and temporal variations in groundwater quality, the precision and bias routinely obtained by the analytical and field methods selected are considered adequate for the purposes of this project (Pitz, 2002). Standard EA Program protocols will be followed when measuring water quality field parameters, and standard methods will be used for sample collection, handling, preservation, and storage (WAS, 1993; Ward, 2001).

Table 2. Summary of Project Analysis Methods

Analyte(A)	Analytical Method(B)	MEL Reporting Limit
Field		
pH	Field meter	NA
Specific conductivity	Field meter	NA
Temperature	Field meter	NA
Dissolved oxygen	Field meter/CHEMetrics® colorimetric	~0.2 mg/L / 0.005 mg/L(C)
MBAS	CHEMetrics® colorimetric	0.025 mg/L(C)
Laboratory		
TDP	SM 4500-P I	0.010 mg/L
OP	SM 4500-P G	0.010 mg/L
Nitrate-N	SM 4500-NO3 I	0.010 mg/L
Ammonia-N	SM 4500-NH3 H	0.010 mg/L
TDS	SM 2540C	1 mg/L
Chloride	SM 4110C	0.1 mg/L
DOC	SM 5310B	1 mg/L
Boron	EPA 6010 ICP	0.050 mg/L
Iron	EPA 6010 ICP	0.020 mg/L
Manganese	EPA 6010 ICP	0.010 mg/L

(A)All samples water matrix.

(B) SM indicates method from Standard Methods for the Examination of Water and Wastewater, 20th Edition.

(C) CHEMetrics® field kit lower detection limit.

Study Design and Methods

The objectives of this study will be accomplished by sampling groundwater as close to the point of discharge into Lake Whatcom as possible, using lake-bed piezometers. Samplers installed near the groundwater/surface water interface are considered one of the most representative methods of characterizing direct groundwater discharge to a surface water body (Harvey et al., 2000; USEPA, 1991; Lee, 1976; Lee, 2000; Belanger and Mikutel, 1985).

The interchange between groundwater and surface water is a complex phenomenon. Lakes may both receive groundwater discharge and recharge the adjacent aquifer system, according the distribution of local hydraulic gradients. Groundwater discharge to lakes typically occurs in the near-shore area, decreasing exponentially with distance from shore (Winter, 1978; Winter, 2000). However groundwater inflow is often a highly localized and transient process; identifying a specific area of groundwater inflow in a lake bed can be difficult even under ideal conditions. No water-level monitoring network is available in the lake vicinity that provides a current, detailed picture of (1) the groundwater flow regime and (2) interactions between the lake and the adjacent aquifer system.

These factors make it difficult to determine exactly what portions of the lake bottom are receiving groundwater discharge. All available groundwater data will be examined in order to identify those areas of the lake where groundwater discharge is the *most probable*. Field surveys and remote sensing image analysis may also be used to help identify discharge areas. Sampling locations will be focused in the areas thought most likely to be receiving groundwater discharge, as access allows.

Approximately 12 distinct locations will be sampled, depending on access considerations, groundwater flow patterns, and difficulty of piezometer installation. Although final locations will be dictated by access, Figure 2 shows a map of the proposed piezometer locations. Piezometers will be installed approximately 1 to 2 meters below the sediment/water interface in the lake's littoral zone. The piezometers are typically installed within 50-100 feet of the shoreline. Water depth and the lake bottom profile dictate the distance from shore that personnel can safely deploy the piezometers. If substrate conditions allow, vertical profiling of groundwater quality will also be conducted at several locations. This will be accomplished by driving two to three separate piezometers to various depths below the sediment/water interface.

Figure 3 illustrates the construction and deployment of the piezometers that will be used for this study. The piezometers are constructed of 1/4" I.D. rigid, translucent polyethylene tubing. The tubing is attached to a hardened steel drive point (1" at its widest diameter) via a barbed fitting. The lowermost 6-12" of the tubing is perforated, and then tightly wrapped with an inert polyester mesh filter fabric (50 micron openings). The filter fabric is attached to the tubing using hot glue and miniature rubber bands. The tubing is long enough to be driven approximately 5-6 feet into the bottom sediments of the lake, with enough extra tubing to extend several feet above the water surface of the lake for sampling access.

The piezometers are installed by slipping a temporary 1" O.D. steel drive pipe over the tubing and seating the pipe against the shoulder of the drive point. The piezometer is driven using a drop hammer and tripod assembly, or a sledge hammer. Upon installation to the desired depth, the drive pipe is withdrawn over the tubing, leaving the tubing and drive point in place in the lake. Water-saturated sediments typically quickly collapse around the tubing during withdrawal of the drive pipe; the annular space adjacent to the tubing at the sediment/water interface is also manually compacted with adjacent sediment. After installation, a peristaltic pump is attached to the tubing, and the piezometer is developed using a surged pumping action until no sediment

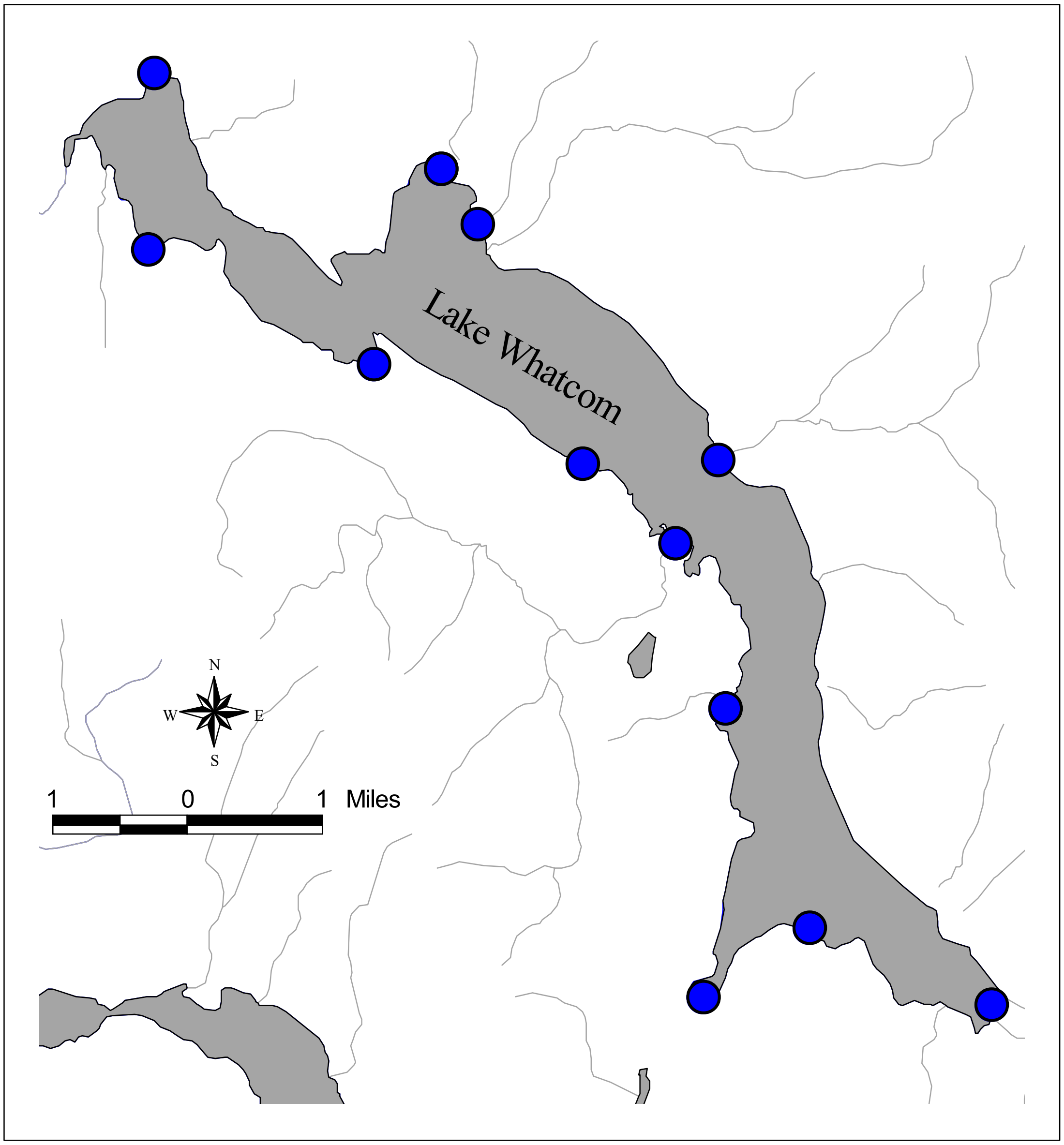

Figure 2 -
Proposed Piezometer Locations
Lake Whatcom Groundwater Study

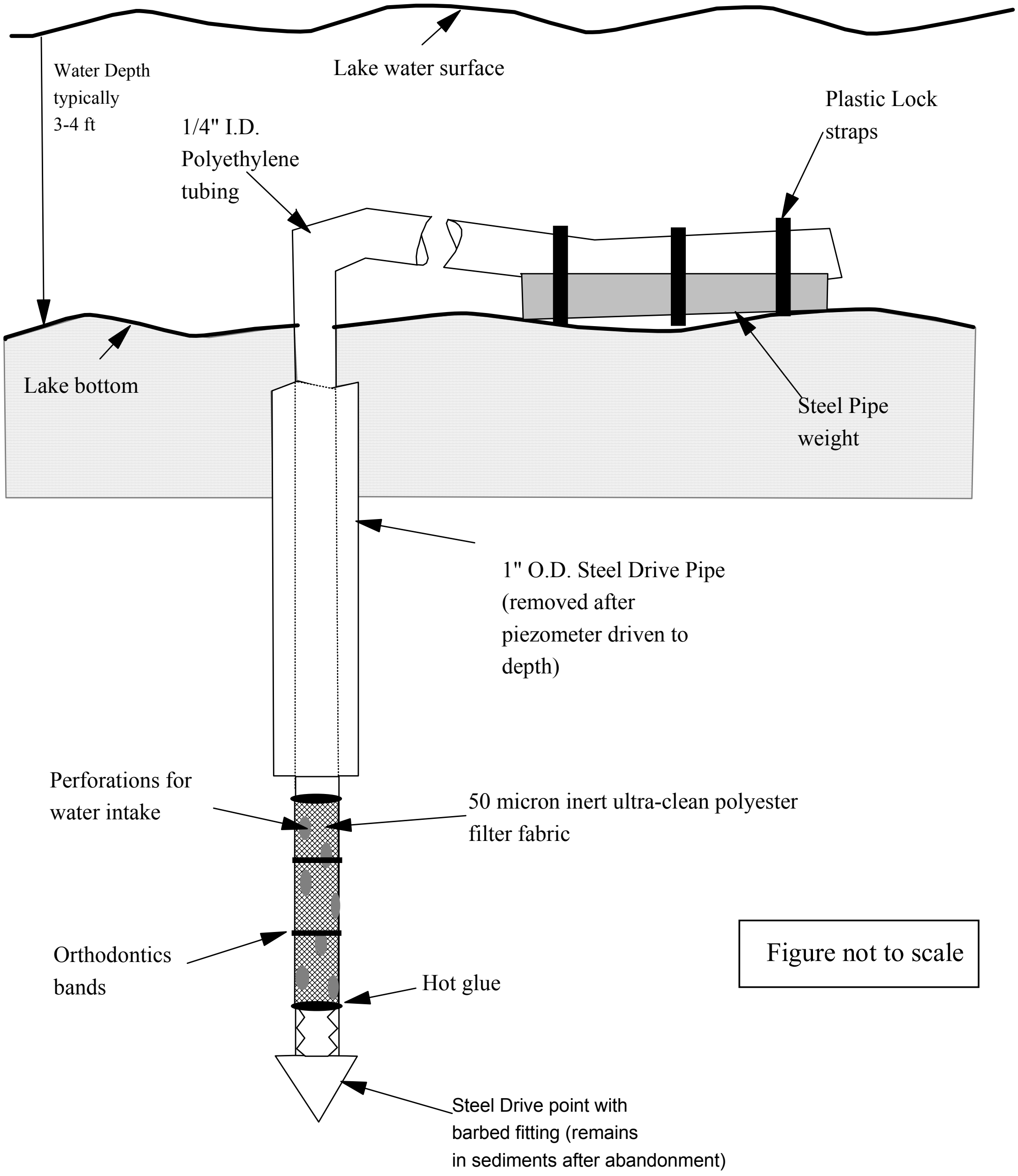

Figure 3 - Construction Diagram
for Lake-bed Piezometers

appears in the discharge water. This development procedure helps to further collapse the formation around the tubing. The piezometers are allowed to equilibrate for a minimum of one week prior to sampling.

Lake-bed piezometers allow the measurement of the relative hydraulic gradient between the lake and the underlying sediments. Water levels in the piezometers that equilibrate above the lake water surface indicate a positive (upward) groundwater flow direction (a groundwater discharge condition)(Figure 4). A water level in a piezometer that equilibrates below the lake water surface indicates a downward hydraulic gradient, pointing to loss of lake water to the underlying aquifer. Groundwater quality samples will only be collected for chemical analysis from piezometers indicating a positive (upward) hydraulic gradient.

Piezometers are sampled using a peristaltic pump. Pumping rates throughout the purge and sample procedures are maintained at all times at <1 L/min. Prior to pumping the piezometer, the hydraulic head within the tubing is measured against the lake level, and field parameters such as pH, temperature, dissolved oxygen, and specific conductance are recorded for the lake water immediately adjacent to the annular space of the piezometer. The pump is then attached to the tubing, and purging is initiated. Field parameters are monitored at five-minute intervals during purging inside of a flow cell closed to the atmosphere.

When field parameters are stabilized (less than 10% change in measurement in three consecutive measurements), a field test kit will be used to measure MBAS concentrations. Dissolved oxygen concentrations near or below the effective detection limit of the field meter (0.2 mg/L) will also be confirmed using a field test kit. Samples for lab analysis are then collected into the proper sample container, with filtration, and preservation as appropriate. All samples will be collected in pre-cleaned bottles supplied by MEL and stored on ice pending their arrival at the laboratory. Samples requiring filtration will be filtered using a clean, dedicated in-line 0.45 micron filter. Filters will be soaked with distilled water prior to use, and the first 50-100 ml of filtrate will be discarded prior to sample collection. Table 3 summarizes the container type, sample volume, field handling, preservation requirements, and holding times for the project parameters.

When not in use, the portion of the piezometer tubing above the lake bottom is "capped" with filter fabric at the upper end. A 1-1.5' length of steel pipe (1" O.D.) is securely attached to the upper end of the tubing (using plastic lock straps) to serve as a weight to weigh the tubing down to the bottom of the lake. The tubing lies flat on the bottom sediments, so it does not pose a safety hazard.

Piezometers will be abandoned after sampling is completed during the final sampling round. Piezometers are abandoned by cutting the tubing off several inches below the lake sediment surface.

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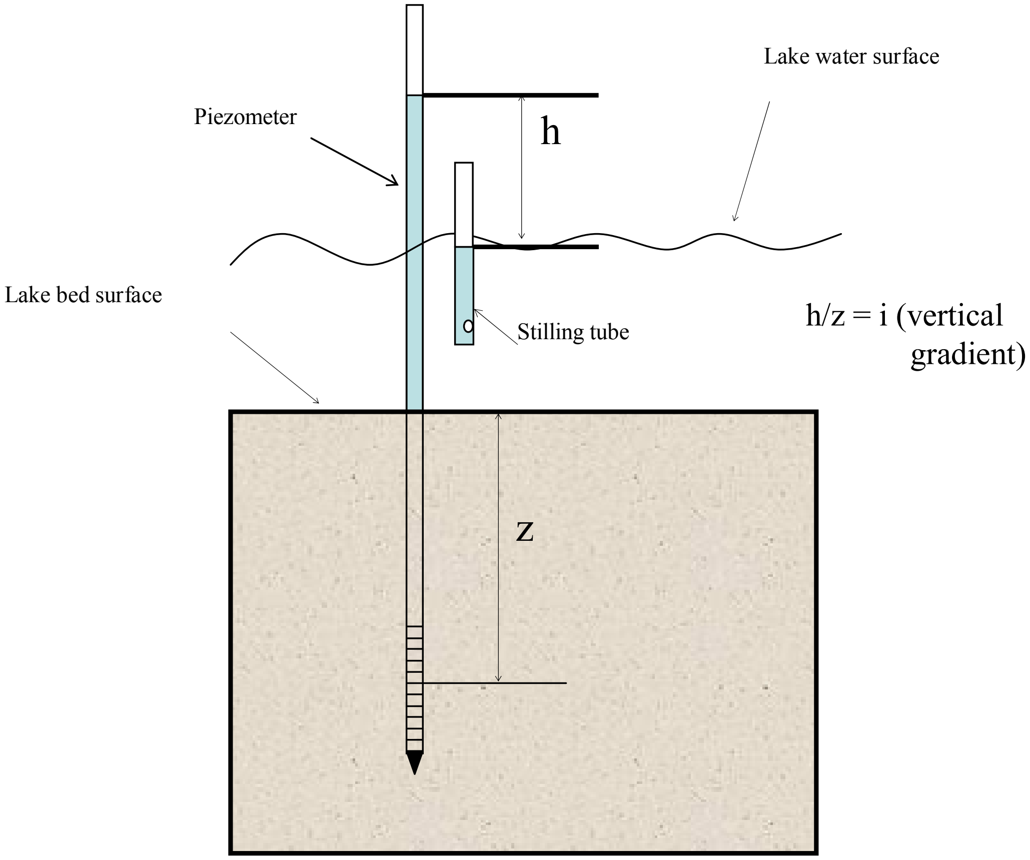

Figure 4– Measurement Method to Estimate Vertical Hydraulic Gradient In Study Piezometers

Table 3. Container, Sample Volume, Handling, Preservation, and Holding Time Requirements

Analyte	Container Type	Container (mL)	Sample Handling	Preservation	Holding Time
TDP	w/m clear Nalgene (pre-acidified)	125^A	Filter @ 0.45 micron	Adjust pH <2 w/H_2SO_4 and cool to <4°C	28 days
OP	amber w/m poly	125	Filter @ 0.45 micron	Cool to <4°C	48 hrs
Nitrate-N	w/m clear Nalgene (pre-acidified)	125^A	Filter @ 0.45 micron	Adjust pH <2 w/H_2SO_4 and cool to <4°C	28 days
Ammonia-N	w/m clear Nalgene (pre-acidified)	125^A	Filter @ 0.45 micron	Adjust pH <2 w/H_2SO_4 and cool to <4°C	28 days
TDS	w/m poly	1000^B	Filter @ 0.45 micron	Cool to <4°C	7 days
Chloride	w/m poly	1000^B	Filter @ 0.45 micron	Cool to <4°C	28 days
DOC	n/m poly (pre-acidified)	60	Filter @ 0.45 micron	Adjust pH <2 w/HCl and cool to <4°C	28 days
Boron	w/m clear Nalgene	125^C	Filter @ 0.45 micron	Adjust pH <2 w/HNO_3 and cool to <4°C	6 months
Iron	w/m clear Nalgene	125^C	Filter @ 0.45 micron	Adjust pH <2 w/HNO_3 and cool to <4°C	6 months
Manganese	w/m clear Nalgene	125^C	Filter @0.45 micron	Adjust pH <2 w/HNO_3 and cool to <4°C	6 months

[A] - Total dissolved phosphorus, ammonia-N, and nitrate-N sample collected in a common 125 ml nutrients bottle.

[B] - TDS and chloride sample collected in a common 1000 ml bottle.

[C] - Boron, iron, and manganese collected in a common 125 ml bottle.

If the installation of a piezometer is not possible for any reason along a select section of the lake shoreline, groundwater may alternatively be sampled from near-shore domestic drinking water wells screened or open within the uppermost aquifer (depending on availability of wells). This second approach is a more indirect method of sampling groundwater discharge and will be used only if piezometer installation is not practical.

Wells will be selected according to the following criteria:

- A well driller's report (well log) must be available for the well, describing the depth of completion and formation materials encountered during drilling.
- The well must have a state well tag ID number to confirm the construction details of the well.
- The well must be easily accessed for water quality sampling.

- The well must be completed in the uppermost aquifer. Wells completed in the uppermost aquifer are preferred for this study since they are the wells most likely to reflect the water quality of the groundwater discharging to the lake.
- The current well owner must grant access to the well for sampling.
- The well must have a dedicated pump.
- The well cannot have a water treatment device, such as a water softener or iron treatment system, or a large storage tank that cannot be bypassed during well purging and sampling.
- The well must be located within one-half mile of the lake shoreline.

Prior to sampling, the well will be purged through a flow-cell until temperature, conductivity, pH, and dissolved oxygen have stabilized within 10% of a consecutive measurement. Sample collection, filtration, and handling will then proceed as described above.

Estimated Laboratory Costs

Table 4 summarizes the anticipated analytical costs for the project.

Table 4. Estimated Laboratory Cost by Parameter

Parameter	Predicted Number of Samples	Cost Per Sample(1)	Cost per Parameter
TDP	80	$16	$1280
OP	80	$12	$960
Nitrate-N	80	$12	$960
Ammonia-N	80	$12	$960
TDS	80	$10	$800
Chloride	80	$12	$960
DOC	80	$29	$2320
Boron	80	$68(2)	$5440
Iron			
Manganese			
Estimate Total Lab Cost			$13680

(1) Assumes MEL "planned" price.

(2) $10 credit on MEL price (3 elements) due to field filtration.

Quality Control Procedures

Field Quality Control

A variety of field quality assurance tests, including replicate and equipment blank testing, will be conducted during this study to assist in determining the error introduced by the sample acquisition methods.

All field meters will be calibrated in accordance with the manufacturer's instructions at the start of each sampling day. Blind field replicate samples, comprising at least 10% of total samples, will be submitted to the laboratory during each sampling event to assess random error. Replicate locations will be selected on the basis of existing information for the first sampling round and on the initial analytical results for later rounds. Equipment blanks, filter blanks, and reference standard transfer samples may all be used to evaluate the influence of the sampling equipment and sample containers on the results for the project parameters. Quality control testing and analyses conducted during earlier studies have confirmed that, if properly maintained, the sampling equipment materials will not bias the results for the parameters selected for this study (Pitz, 2002).

Representativeness

An important concern regarding the use of piezometers for sampling the pore water beneath a lake bed is downward annular leakage of lake water into the openings at the base of the sampler tubing. To minimize this problem, all piezometers will be driven a minimum of 1 meter into the lake-bed sediments in order to improve the annular seal around the tubing. Additionally, pumping from piezometers will be maintained at very low flow rates to minimize reversal of the hydraulic gradient and resultant drawdown within the piezometer tubing.

Sampling only piezometers that exhibit an upward vertical hydraulic potential will also minimize the chances for downward leakage, due to the fact that annular leakage under these conditions will be upward from the sediments to the lake. The hydraulic potential at the end of sampling will be rechecked and recorded to determine if drawdown of the piezometer potential occurred during pumping.

To assist in evaluating the likelihood of the annular leakage of surface water into the screened portion of the piezometer, the pH, temperature, conductivity, and dissolved oxygen levels of the lake water will be collected and recorded immediately prior to the initiation of purging. These values will be compared to the values collected during purging.

Finally, a visual test for leakage will be conducted for at least two of the piezometers during each sampling round. To conduct this test, a water-soluble, biodegradable fluorescein dye tablet will be released immediately adjacent to the tubing at the sediment/water interface, and observations of discoloration of the purge water will be recorded.

Completeness

To maximize the amount of usable data collected during this study, Ecology will follow accepted WAS protocols for water-quality data acquisition (WAS, 1993; Ward, 2001). Only appropriately calibrated and maintained field equipment will be used. All attempts will be made to ensure that samples are packaged in a manner to prevent loss in transit and arrive at MEL within the appropriate holding time.

Comparability

An important concern for this project is the comparability of the groundwater data collected for this study to the surface water data collected by other EA Program investigators as part of the TMDL lake characterization. To ensure data comparability, the sampling, handling, and analysis techniques for the target analytes (TDP, OP, nitrate-N, ammonia-N) will follow standardized procedures to match those being employed by the other investigators.

Lab Quality Control

Routine laboratory quality control procedures will be used to estimate the accuracy, precision, and bias introduced by laboratory procedures and will be reported to the project lead for data analysis (MEL, 2000). Manchester Laboratory's quality control samples and procedures are discussed in detail in the Quality Assurance Manual, Manchester Environmental Laboratory (MEL, 2001).

Data Management Procedures

Field data will be recorded at the time of sampling in a field notebook and, if appropriate, input into the Environmental Information Management (EIM) data repository.

Data generated by MEL will be managed by the Laboratory Information Management System (LIMS) and sent to the project lead in both electronic and printed format. After evaluation of the analytical data against the project data quality objectives, the reported results will be input into the EIM system.

Data Review and Validation

Prior to distribution to the project lead, analytical data generated by MEL will be reviewed and verified against acceptance criteria according to the data review procedures outlined in the Lab Users Manual (MEL, 2002).

Upon receipt of the verified data from MEL, the project lead will compare the quality assurance and analysis performance information against the project data quality objectives. Data will be assessed for completeness and for indications of bias introduced by field procedures. If appropriate, sampling approach, quality control steps, or analytical procedures will be modified for future sampling rounds to address identified problems.

Precision

The relative percent standard deviation (%RSD) between results will be calculated for duplicate pairs in order to provide an indication of the degree of random variability introduced by sampling and analytical procedures. These values will be compared to the mean duplicate concentration (over the entire concentration range reported during the project) to assess the ability of the data to meet the project data quality objectives. The %RSD for duplicate pairs at or near the reporting limit are typically higher than the allowed error described by the data quality objectives, and will not automatically disqualify data from use.

Bias

The analysis performance for spike recoveries, blanks, instrument calibration, and control samples provided by MEL to the project lead will be evaluated to determine the analytical bias in the sampling results. These evaluations will be compared to the project data quality objectives.

Completeness

The precision and bias assessments will be used to identify those analytical results that fail to meet the data quality objectives of the project. In addition, the required versus actual holding times prior to analysis for each sample will be evaluated to confirm that the reported values are valid.

Data Quality Assessment

Upon receipt of the last round of analytical results from the laboratory, the overall data set will be evaluated for representativeness and completeness, as described above. Data error will be assessed against the project goals and the project manager will determine the applicability of the data to future water quality modeling efforts.

References

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