

Coeur d'Alene Lake Monitoring Program 2012–2014 Data Quality Review

Part 1: State Waters



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Prepared by
Craig Cooper, Glen Pettit, and Robert Witherow
Idaho Department of Environmental Quality
Coeur d'Alene Regional Office
2110 Ironwood Drive
Coeur d'Alene, Idaho 83814

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Executive Summary

This document evaluates data quality for Coeur d'Alene Lake monitoring data collected by Idaho Department of Environmental Quality Lake Management Plan (LMP) staff in State jurisdictional waters for CY 2012 – 2014. This document also summarizes results from additional quality assessments to evaluate specific quality issues that were completed within the 2012 – 2014 timeframe. The purpose of this report is to provide a rigorous accounting of the quality of water quality data collected during this time period, and produce a summary assessment of the effectiveness and the LMP's quality assurance efforts in State jurisdictional waters.

Many of the LMP's quality assurance procedures were developed prior to the institution of a DEQ Quality Management Program (March 2012). Additionally, the LMP is an intergovernmental collaboration between the State of Idaho (DEQ) and the Coeur d'Alene Tribe. Consequently, the LMP Quality Assurance Project Plans (QAPP's) were developed collaboratively with the Tribe using the U.S. EPA framework. As part of this collaboration, QAPP's are updated annually and quality assurance methods refined through an adaptive management process. In practice, this means that data quality objectives (DQO's) evolve and change as more information becomes available. This overall framework is consistent with the DEQ Quality Management Plan.

This report utilizes the most current data quality objectives to evaluate data collected under historic QAPP's that had different DQO's, in order to provide a uniform basis for assessing data quality.

Overall data quality for the 2012–2014 time period is high. The dataset for CY 2013-2014 is complete, comparable, and representative. The dataset for CY 2012 contains some limited QA/QC issues for one sampling event, but is solid enough to support LMP lake assessments. The LMP has experienced isolated issues associated with equipment failures, staff turnover, one-off human mistakes, and managing field variability. These issues are not unique to the LMP, and are a common challenge in field monitoring and environmental work. The LMP QA/QC process has pro-actively identified these issues and implemented effective corrective actions.

The LMP data quality process has generated improvements to overall data quality. These include improvements in phosphorus comparability between DEQ and the Tribe, and quantification of the potential impact of colloidal material on metals assessments. The QA/QC process is currently being used pro-actively to (i) enhance phosphorus data quality, and (ii) manage a laboratory transition for chlorophyll-a analyses. Data quality records are complete and comprehensive, quality is high, and quality assurance processes have been effective in sustaining high data quality while also supporting continuous improvement.

Note that this data quality review does identify some isolated data quality issues. All such issues should be considered within the context of the overall document. Observations that are taken out of context can lead to false understandings. It is especially important to understand that isolated data quality issues are common in environmental monitoring. Such occurrences are not related to staff professionalism. They simply arise from the inherent challenges of running a large monitoring program in a dynamic and complex environment. Variability is intrinsic to the system. The purpose of data quality practices is not to eliminate variability, but to rigorously account for it. This report demonstrates that LMP data is of high quality from 2012 – 2014.

Acronyms and Abbreviations

As	arsenic
Cd	cadmium
Chl <i>a</i>	chlorophyll <i>a</i>
CY	calendar year
DQO	data quality objective
DO	dissolved oxygen
DEQ	Idaho Department of Environmental Quality
Fe	iron
LMP	Coeur d'Alene Lake Management Plan
LS	laboratory spike
LSD	laboratory spike duplicate
MDL	measurement detection limit. The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, and is determined from analysis of a sample in a given matrix containing the analyte.
Mn	manganese
MRL	measurement reporting limit. The lowest amount of an analyte in a sample that can be quantitatively determined with stated, acceptable precision and accuracy under stated analytical conditions (i.e. the lower limit of quantitation).
MS	matrix spike
MSD	matrix spike duplicate
mg/L	milligrams per liter (approximately equivalent to parts per million, ppm)
Pb	lead
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SOP	standard operating procedure
SRP	soluble reactive phosphorus (predominantly dissolved ortho-phosphate)

TDP	total dissolved phosphorus
TN	total nitrogen
TP	total phosphorus
Tribe	Coeur d'Alene Tribe
µg/L	micrograms per liter (approximately equivalent to parts per billion, ppb)
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
WQS	water quality standards
WY	water year (October 1–September 30)
Zn	zinc

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1 Quality Assurance/Quality Control Methods

The QA/QC (quality assurance/quality control) program and parameters for Coeur d'Alene Lake monitoring are detailed in the Quality Assurance Project Plans (QAPP's) for each calendar year on record. This section provides a summary of what measures are used to assess data quality, and the associated data quality objectives (DQO's) that are used to assess the validity and dependability of the data. The performance of the data relative to these DQO's is presented in Section 2.

Note that the implementation of some of these DQO's may have changed over the time period covered by this report. Analytical methods have changed and improved since 2007, the LMP team has refined and improved field sampling methods, and the LMP has also improved its management of electronic data records. Any alterations to QA/QC methodology and reporting reflect these ongoing improvements.

Data quality is assessed in three general stages. The first stage is analytical laboratory data quality. These DQO's are used to assess the ability of an analytical laboratory to successfully measure a sample. The second stage is field collection data quality. These DQO's are used to assess the ability of the field team to repeatedly collect samples that are representative of the system. The final stage is an assessment of the completeness and representativeness of the overall dataset for a given year. These DQO's are used to assess how well that year's dataset represents lake conditions for each parameter and monitoring location.

Note that the State and Tribe assess data quality by “standard” approaches after each sampling event and again at the end of each year, and also conduct special QA/QC studies to assess how well current datasets compare to prior datasets for purposes of long-term trend analyses. These special studies are not conducted each year, but are stand-alone studies. This report only covers standard, quality control measures. Special data quality studies will be presented in a subsequent report.

1.1 Types of Quality Control Samples

Different types of samples are collected to assess different data quality measures. This section describes standard types of field and laboratory QC samples collected. Both method of collection and QC purpose are summarized.

Type 1/Type 2 Laboratory Water Blanks. These are samples of the DEQ systems two types of purified water, Type 1 and Type 2, collected directly from the DEQ Millipore system at the beginning of each year. These blanks are used to determine if laboratory water is contaminated. These blank samples are preserved, sealed, handled, stored, shipped, and analyzed in the same manner as regular unfiltered samples. The analysis of laboratory water blanks should yield values less than the reporting limits for each analyte. Values above the reporting limits may indicate small sources of contamination from the laboratory water system, bottles, or preservative(s). Laboratory water blanks are used to assess the *Contamination DQO*.

Equipment Blanks. This is a sample of Type 1 water collected at the beginning and end of each year to test for contamination in sampling equipment under laboratory conditions. Equipment

blanks are prepared by filling the water column sampler with Type 1 (certified contaminant-free) water and transferring it to the churn splitter. Non-filtered blank samples are placed in the proper laboratory sample bottles. Filtered blank samples are processed through the filter capsule, and then placed in the proper laboratory sample bottles. Equipment blank samples are preserved, sealed, handled, stored, shipped, and analyzed in the same manner as regular samples. The analysis of equipment blanks should yield values less than the reporting limits for each analyte. Values above the reporting limits may indicate small sources of contamination from the sampling equipment, laboratory water system, bottles, or preservative(s). Equipment water blanks are used to assess the *Contamination DQO*.

Field Blanks. This is a sample of Type 1 water collected at the end of a field run, in order to test for equipment contamination from field sampling. Type 1 water (certified contaminant free) is placed in the water column sampler, and then transferred to the churn splitter, while still in the field at the end of a field run. Non-filtered blank samples are placed in the proper laboratory sample bottles. Filtered blank samples are processed through the filter capsule and then placed in the proper laboratory sample bottles. Field blank samples are preserved, sealed, handled, stored, shipped, and analyzed in the same manner as regular samples. The analysis of field blanks should yield values less than the reporting limits for each analyte. Values above the reporting limits may indicate small sources of contamination from the laboratory water system, bottles, or preservative(s). Field blanks are used to assess the *Contamination DQO*.

Sample Replicates (concurrent samples). These are replicate sets of samples withdrawn from the same volume of water collected in the sampling equipment at a given sampling location. Replicate sets of subsamples are withdrawn from the same volume of water in the churn splitter. They are processed and analyzed separately to assess the combined precision of sample handling, laboratory sample treatment, and laboratory analyses. Sample replicates are used to assess the *Field Precision DQO*.

Field Replicates (sequential samples). These are replicate sets of samples from the same location and lake water column zone, collected in immediate succession using identical techniques. Replicate samples are preserved, sealed, handled, stored, shipped, and analyzed in the same manner as the primary sample. A field replicate provides an estimate of the combined precision of sample collection (i.e. field heterogeneity), sample handling, and laboratory analyses. Field replicates are also used to assess the *Field Precision DQO*.

Field Staff Replicates. These are replicate samples from the same location and lake water column zone, collected in immediate succession, by *either* DEQ *or* the Tribe, using each entity's standard protocols. They are used in conjunction with field replicates to determine the combined precision of inter-agency technical differences (e.g., differing field equipment, field staff, analytical laboratories), sample collection, sample handling, and laboratory analyses.

These replicates are collected by DEQ and/or the Tribe during side-by-side sampling events. If a side-by-side event is conducted in State jurisdictional waters, then State staff collects a sample and a field replicate and Tribe staff collect two field-staff replicates. The reverse occurs when side-by-side sampling events are held in Tribe jurisdictional waters. Field staff replicates are compared against the *Field Staff Precision DQO* to identify areas to improve coordination and joint methods.

Laboratory Calibration Samples. These are samples the laboratory uses to calibrate their analyses. They are provided by the laboratory as required by the analytical methods and laboratory SOPs.

Laboratory Duplicates. Laboratory duplicates are two portions of a single homogeneous sample analyzed for the same parameter. They are prepared and analyzed as the laboratory standard method requires. Laboratory duplicates are used to assess the *Laboratory Precision DQO*.

Analytical Method Blank. Analytical method (preparation) blanks are used to check for contamination and bias in the analytical laboratory. A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in the sample processing, and analyzed with each batch. The method blank is carried through the complete sample preparation and analytical procedure. QC criteria require that no contaminants be detected in the blank(s) above the method quantitative limit (reporting limit). If a chemical is detected, the action taken will follow the laboratory SOPs. Method blanks are used to assess the *Contamination DQO*.

Laboratory Matrix Spike/Matrix Spike Duplicates (MS/MSDs). MS/MSDs are used to assess sample matrix interferences and analytical errors, as well as to measure the accuracy and precision of the laboratory analysis. These QC samples are prepared in the laboratory according to laboratory SOPs. For MS or MSD samples, known concentrations of analytes are added to the environmental samples prior to digestion or preparation. The samples are then processed through the entire analytical procedure and the recovery of analytes is calculated. Ideally, the spiked concentration should be greater than 25% of the unspiked concentration in the sample – though this can be difficult to predict for environmental samples. A frequency of 1 MS/MSD in each group of 20 samples is recommended. MS/MSD samples measure the matrix interference of a specific matrix, and thus MS/MSD samples are project specific. The laboratory may not substitute a sample from another project to act as the QC for LMP samples. MS/MSDs are used to assess the *Laboratory Precision DQO* and the *Laboratory Accuracy DQO*.

Laboratory Control Samples/Laboratory Control Sample Duplicates (LCS/LCSDs). LCS is a clean matrix (e.g. purified water) spiked with known quantities of analytes. The LCS is processed with field samples through every step of preparation of analyses. LCS/LCSDs are similar to MS/MSDs, except that they do not contain matrix interferences. They are also used to measure precision and accuracy. LCS/LCSDs may also be used to assess the *Laboratory Precision DQO* and the *Laboratory Accuracy DQO*.

Standard Reference Materials. SRMs can be used to fulfill the same purpose as laboratory control samples (LCS). They are used to monitor the laboratory's performance, independent of matrix effects. The SRMs are extracted and analyzed with each batch of samples as applicable to the analysis. Results are compared on a per-batch basis to established control limits and are used to evaluate laboratory performance for precision and accuracy. Laboratory control samples may also be used to identify any background interference or contamination of the analytical system that may generate error or bias. SRM's can be used to assess the *Laboratory Accuracy DQO*.

1.2 Number of Quality Control Samples

The number of quality control samples is used to assess how well the quality control process assesses data quality. If too few QC samples are collected, then the data cannot be robustly assessed for data quality and the certainty of observed trends is consequently lower. The collection of additional QC samples, over and above the minimum, strengthens data quality and increases the certainty of observed trends.

The accepted general rule for quality control sampling is that 10% of field samples should be QC samples. The analytical laboratory will run additional samples to satisfy analytical QA/QC requirements. If QC samples are not blind to the laboratory, then the lab must report both precision and accuracy.

The 10% rule applies to the total number of samples. The 10% should be as evenly spaced as practical, but a strict rule of “one QC every 10 samples” is not necessary. It is also best to have at least one QC sample per sample collection event, though that is not strictly required so long as the 10% rule is met. QC samples can be collected to reflect just sampling and analytical variability (e.g. multiple samples from the same collection container) or the combination of sampling, analytical, and field variability (e.g., multiple sampling containers). The LMP team typically collects an equal number of field replicates and sample replicates each year, with both DEQ and the Tribe each collecting at least one field/sample replicate on every run. Field-staff replicates are collected in addition to field/sample replicates, during regular annual side-by-side sampling events.

DEQ and Tribe LMP staff also collect a series of blanks in addition to these QC samples. Laboratory water blanks are collected at the beginning of each year. Equipment and field blanks are collected at the beginning and end of each year. Additional field blanks are collected during the year.

1.3 Data Quality Objectives

This section describes the quality measures and data quality objectives (DQOs) used by the Lake Management Plan. Target values for these measures (data quality objectives) are also presented here. These data quality measures assess the data from multiple perspectives.

1. *Quality of Laboratory Analyses*—accuracy, precision, sensitivity, laboratory contamination
2. *Quality of Field Collection*—field precision, equipment and reagent contamination, field contamination, completeness of dataset for each sampling event
3. *Quality of Overall Dataset*—representativeness, completeness of the annual dataset for each sampling site and lake monitoring parameters, comparability of State and Tribe datasets.

Note again that the State and Tribe also conduct special studies to assess how comparable current datasets are to historic datasets, in order to determine whether advances in monitoring methods and analytical technology may introduce bias into the dataset. These special studies are not conducted each year, but are stand-alone studies. This report only covers standard, annual quality control measures. Special data quality studies will be presented as the studies are completed. Standard data quality measures, assessed as part of normal operations, are described below.

Sensitivity. Sensitivity is a measure of both (i) the *Quality of Laboratory Analyses*, and (ii) *Quality of Overall Dataset*. It is defined as the lowest level for which data can be reliably detected (MDL) and accurately measured (MRL) for a given combination of sample processing and quantitative analysis. Method detection limits (MDL) are established by analytical laboratories using standard methods. Method reporting limits (MRL) consider both analytical capabilities and project needs; and developed via consultation between LMP technical staff and analytical laboratory staff.

Sensitivity DQO's cannot be exceeded, but data quality assessments do factor in sensitivity limits (e.g., low-level analyses) and data records include appropriate sensitivity flags for each parameter. Sensitivity limits and the associated data flags are provided in annual data quality reports.

Accuracy. Accuracy is measure of the *Quality of Laboratory Analyses*. It is defined as the amount of agreement between a measured value and the true value. It is measured for laboratory analyses, as the percent recovery of MS/MSD (matrix spikes, matrix spike duplicates), and also from LCS/LCSDs (laboratory control samples/LCS duplicates). LCS/LCSD's measure the accuracy of instruments on standard reference materials. MS/MSD's account for matrix effects in sample solutions. Both measures (i.e., reference, matrix) are important. Accuracy is calculated as percent recovery of analytes, according to the following equation.

$$\%R_i = (Y_i \div X_i) \times 100\%$$

and:

$\%R_i$ = percent recovery for compound i

Y_i = measured analyte concentration in sample i (measured concentration minus original sample concentration)

X_i = known analyte concentration in sample i

Percent recoveries are reviewed upon receipt of laboratory data after each sampling event. During this review, laboratory percent recoveries are compared to data quality objectives (DQO's) for accuracy. If accuracy DQO's are not met, the laboratory may be requested to re-run samples to try and obtain higher quality data. Any deviations from specified limits are noted in annual data records and project data quality records. These records note the occurrence, cause, and resolution of the DQO exceedance and describe how associated data should be flagged in electronic and paper records. These records also include a laboratory report on the cause(s) and corrective actions. Percent recoveries are also reviewed again at the end of the year. Annual QA reports include a summary of whether the accuracy DQO's were met for each run and analytical parameter.

The LMP technical staff has historically established a DQO for laboratory accuracy of $\pm 20\%$ recovery of MS/MSD (e.g., % recovery range of 80 – 120%) for all chemical analytes. The LMP has not historically limited the accuracy DQO to “high-level” samples whose measured concentration is high enough to account for unavoidable inaccuracies that occur when measured concentrations approach the minimum value that can be reliably measured. The minimum-achievable accuracy of chemical analyses is a higher percentage of the measured value at lower concentrations than at higher concentrations. However, laboratory standard methods do provide

special acceptance accuracy criteria for “low-level” samples whose measured value is less than 5 * reporting limits.

Samples that do not meet a standard criteria of 5*MRL (method reporting limit) are defined as “low-level” by standard definition. Laboratories can often achieve accuracy DQO’s below this limit if special precautions are taken. The LMP has historically requested laboratories to attempt to achieve low-level accuracy and note when alternate low-level accuracy DQO’s are used.

This report will provide information on both (i) whether data met accuracy DQO’s in the absence of special considerations for low-level samples, and (ii) whether data met accuracy DQO’s when low-level analytical limitations are considered.

Precision. Precision is measured at all stages of data quality assessment. Separate measurements of precision are evaluated for (i) *Quality of Laboratory Analyses*, (ii) *Quality of Field Collection*, and (iii) *Quality of the Overall Dataset*. It is defined as the degree of agreement between independent, similar, or repeated measures. Precision is expressed in terms of analytical variability, and is expressed as the range within which the true value lies. Smaller variability leads to smaller data ranges and greater precision. Greater variability leads to larger data ranges and less precision. Note that precision does not reflect the “true value”, but rather the repeatability of multiple measurements of the same sample (or representative similar samples).

Laboratory precision is a measure of the *Quality of Laboratory Analyses*. It is calculated as the relative percent difference (%RPD) of paired laboratory duplicates, where:

$$\%RPD_i = \frac{|O_i - D_i|}{(O_i + D_i) \div 2} \times 100\%$$

and:

- $\%RPD_i$ = relative percent difference for compound i
- O_i = value of compound i in original sample
- D_i = value of compound i in laboratory duplicate samples

The laboratory %RPD’s are reviewed upon receipt of laboratory data after each sampling event. During this review, laboratory precision %RPD’s are compared to data quality objectives (DQO’s) for precision. Laboratory precision DQO’s are managed in the same manner as accuracy DQO’s.

Field precision is a measure of the *Quality of Field Collection*. It is calculated as the relative percent difference (%RPD) of paired field replicates and/or paired sample replicates. Field %RPD’s are calculated upon receipt of laboratory data after each sampling event. If field precision DQO’s are not met, then necessary corrective actions are identified and implemented. Deviations from specified DQO’s are noted in annual data records and data quality records. These records note the occurrence, cause, and resolution of the DQO exceedance and describe how associated data should be flagged in electronic and paper records. These records also include a report on the cause(s) and corrective actions.

Field-staff precision is a measure of the *Quality of Overall Dataset*. It is calculated as the relative standard deviation (%RSD) over field samples, field replicates, and field-staff replicates collected at a sampling location during a side-by-side sampling event. A sampling location is a specific combination of sampling depth and monitoring site. The Relative Standard Deviation (%RSD) is calculated according to the following equation.

$$\%RSD_i = \frac{\sigma_i}{\bar{X}_i} \times 100\%$$

where:

- $\%RSD_i$ = relative standard deviation for compound i
 σ_i = standard deviation over all replicate analyses for compound i
 \bar{X}_i = mean value over all replicate analyses for compound i

and,

$$\sigma = \sqrt{\sum_{j=1}^n \frac{(X_j - \bar{X})^2}{n-1}}$$

where:

- n = number of replicate analyses (j) for compound i
 X_j = measured value of the replicate (j) for compound i
 \bar{X} = mean value over all replicate analyses (n) for compound i

Field-staff %RSD's are calculated at the end of each calendar year as part of the annual QA review. No formal DQO's are established for field-staff precision, but this measure is evaluated and discussed with respect to how well it compares to field precision DQO's. The value of %RSD is recorded in the annual data quality report, and potential causes are identified. The State and Tribe also develop a plan to identify and improve field-staff precision as needed. This plan is also discussed in annual data quality reports and improvements noted. Annual data quality reports also discuss the potential impacts of poor %RSD's on overall data interpretation.

All precision DQO's are reviewed after each sampling event and again at the end of each year. Annual QA reports include a summary of whether the precision DQO's were met for each run and analytical parameter. The LMP technical staff has historically established a DQO for *laboratory precision* of $\pm 20\%$ RPD and a DQO for *field precision* of $\pm 25\%$ RPD. No formal DQO for *field-staff precision* has been established, though this measure is evaluated and discussed with respect to how well it compares to the DQO for field precision.

The LMP has not historically limited precision DQO's to "high-level" samples whose measured concentration is $\geq 5 \times \text{MRL}$. However, the same considerations apply for precision as for accuracy. The minimum-achievable variability of chemical analyses creates a higher %RPD at lower concentrations than at higher concentrations. This factor needs to be considered when

evaluating data quality. Laboratory standard methods do provide special precision acceptance criteria for “low-level” samples whose measured value is less than 5 * reporting limits. However, there is no standard method for evaluating data quality for field precision for low-level samples. Field precision DQO’s are established according to project-specific needs. Approaches for assessing field precision for low-level samples are discussed in Section 1.4.

Note that, as with accuracy, laboratories can often achieve laboratory precision DQO’s below the 5*MRL limit if special precautions are taken. The LMP has historically requested laboratories to attempt to achieve low-level precision and note when alternate low-level precision DQO’s are used.

This report will provide information on both (i) whether data met precision DQO’s in the absence of special considerations for low-level samples, (ii) whether data met laboratory precision DQO’s when low-level analytical limitations are considered, and (iii) what actual levels of field-staff precision were achieved during side-by-side sampling events.

Completeness. Completeness is a measure of the *Quality of the Overall Dataset*. Completeness is defined as the percentage of usable data obtained from the total amount of data generated, for each parameter. It is a measure of how well the annual field sampling campaign collected the data needed to assess water quality for that year. This measure of completeness is measured at the end of each calendar year during the annual data quality review.

Completeness is calculated from the proportion of data that meet QA/QC criteria (i.e. standard or alternate DQO’s). Data that do not meet standard or alternate DQO’s will be rejected and not considered to be valid data. Completeness will be calculated as follows:

$$\%C = \frac{A}{I} \times 100\%$$

where:

- $\%C$ = percent completeness (either annual or for a sampling run)
- A = actual number valid analyses obtained (i.e., data that met DQO’s)
- I = intended number of samples/analyses requested (i.e. samples analyzed)

If the completeness DQO is exceeded, then the cause(s) are identified and corrective actions taken as necessary. Corrective actions involve investigate the extent to which the incomplete dataset may bias data analysis. If the incomplete dataset is determined to adversely impact data analysis, then the impacts are discussed in both the annual data quality report and factored into associated analyses conducted in annual State of Lake Quality reports.

The LMP technical staff has historically established a DQO for completeness of 95% of all analyses conducted. This applies to both the field collection and overall dataset contexts.

This historic DQO does not specifically account for the impacts of low-level samples, or the differing number of samples collected for different monitoring parameters. For example, chlorophyll-a samples are only collected in the photic zone while metals samples are collected from all depths within the water column. Thus, one non-valid chlorophyll-a value in a given year could drop the annual percentage completeness for that sampling site below 90% while one non-

valid metals analysis would only drop the percent completeness to ~95% for a given sampling location. Similar challenges exist for total phosphorus and other parameters.

This report will provide information whether the historic completeness DQO of 95% was met for each parameters measured, with a focus on LMP trigger criteria. Cases where one single non-valid analysis would drop this value below 95% are highlighted. This consideration is factored into the associated data quality assessment.

Contamination. Contamination is a measure of both (i) *Quality of Laboratory Analyses*, and (ii) *Quality of Field Collection*. Contamination occurs when field or analytical laboratory personnel inadvertently introduce mass of an analytical parameter into a sample from an external source. This introduces positive bias into the analysis and leads to an inaccurate result that is not captured by analysis of other DQO's. Contamination is assessed by analysis of method blanks, laboratory water blanks (i.e. Type 1 and Type 2 water), equipment blanks, and field blanks.

Contamination is assessed after receipt of laboratory data. If the contamination DQO for method blanks is exceeded, then the laboratory is notified and corrective actions taken. Corrective actions may include re-running samples. If the contamination DQO for water, equipment, or field blanks is exceeded, then the LMP technical staff conducts investigations to determine the potential cause(s) of contamination and implement corrective actions. All incidences where a contamination DQO is exceeded are reported in the annual data quality report, and data flagged accordingly. The cause(s), impacts, and corrective actions are discussed.

The target DQO for contamination is all parameters less than MRL for all blanks. In cases where the laboratory also reports to MDL, contamination is also assessed relative to MDL. The contamination DQO is formally assessed relative to MRL, but any incidence of blank > MDL is investigated and a corrective action implemented.

Comparability. Comparability is a measure of the *Quality of Overall Dataset*. It is defined as the degree to which data from one study can be compared with data from other similar studies (e.g. comparing with USGS Coeur d'Alene Lake studies in 1990-94 and 2004 – 2006), reference values (such as background), reference materials, and screening values. This objective is assessed via professional judgement using a combination of quantitative and qualitative considerations. Comparability is enhanced by using standard techniques to collect and analyze representative samples and reporting analytical results in appropriate units. Comparability is also improved by keeping records of which methods were used to collect, process, and analyze samples. Historic experience has shown that different analytical methodologies can yield different results for sample splits that otherwise meet all DQO's. These differences are detected and their impact(s) quantified by conducting special studies to determine what values different analytical methods produce for splits of the same field and/or reference sample.

The LMP does not have formal quantitative DQO for Comparability. This objective is assessed through professional judgement and factored into data analyses.

The LMP QA process keeps records of the methods used to measure parameters, as well as known differences between methods. When different methods yield different result in a consistent and predictable manner, then data quality records also contain discussions of how to reliably compare results from different analytical methods. These cases are also flagged in data

records and estimated values for what the result would be if a different analysis were used are provided as possible. The LMP planning and analytical process pays close attention to comparability considerations, and best-comparable data are collected to the greatest extent practical.

Representativeness. Representativeness is a measure of the *Quality of Overall Dataset*. It is defined as the degree to which sample results represent the system under study. This component is a key factor considered during the design phase of a program. It is a qualitative assessment that considers all data available at the time. As additional data is collected, project design can be adapted to become more representative of the system. If long-term trend analysis is a core objective, then Comparability is also a key factor when assessing Representativeness.

The LMP does not have formal quantitative DQO for Comparability. This objective is assessed through professional judgement and factored into data analyses. One key consideration for this QA parameter in the Coeur d'Alene Basin is the impact of annual and inter-annual hydrologic variability. This consideration is factored into the 2009 LMP, annual sampling plans, and all data evaluations used to develop the annual State of Lake Water Quality reports.

1.4 Data Quality Objectives for Low-Level Samples

The Coeur d'Alene Lake Management Plan manages phosphorus and chlorophyll-a at levels less than 5*MRL. This is an uncommon situation, and there are few standard approaches to guide the development of accuracy and precision DQO's to control data quality at these low levels. Standard methods allow laboratories to accept low-level samples that fail a standard DQO, if they meet other QA/QC criteria. These procedures depend upon which combination of DQO's are passed and/or failed, and are described in the laboratory's standard methods. As needed, the laboratory flags data according to these alternate DQO's and the need to conditionally accept as an estimate. The LMP accepts/rejects low-level laboratory data analyses according to laboratory recommendations regarding accuracy and laboratory precision DQO's.

For field precision, standard practice typically defines DQO's according to project-specific requirements. There are few common practices for evaluating the field precision of low-level samples. Many QAPPs use a "blanket DQO" approach that applies a single field precision DQO across all values, and then rely upon professional judgement for assessing low-level values. Historic LMP QAPP's have taken this approach. However, this approach can suffer from inconsistency for longer-term monitoring programs. It is helpful to have a more quantitative guide. One reasonable approach is to adopt the precision guidelines used by EPA for laboratory analyses. The EPA Manchester Environmental Laboratory do not establish precision DQO's for samples where the measured value and/or the laboratory duplicate value is ≤ 5 *MRL unless the range between the two is ≥ 5 *MRL (personal communication, Jennifer Crawford, USEPA, 1/8/2016). Applying this to field precision data that exceed the standard DQO,

- Low-level data is accepted if the absolute difference of (value – replicate) $\leq 5 \times \text{MRL}$. These data may be flagged with qualifiers, depending on professional judgement.
- Low-level data may be rejected if the absolute difference of (value – replicate) $> 5 \times \text{MRL}$.

Data quality is still assessed according to standard DQO's and actions are taken to improve data quality as appropriate. However, low-level data is *not* rejected for exceeding standard DQO's established for concentrations $> 5 \times \text{MRL}$. Note that the DEQ Lake Pend Oreille monitoring program uses a similar approach to this, but defines low-level samples as those $\leq 3 \times \text{MRL}$.

For purposes of this data quality review, all data are initially evaluated according to standard, “blanket” DQO's regardless of whether or not it is a low-level value ($5 \times \text{MRL}$). Data that meet this DQO are accepted as valid. Data that exceed this DQO are then assessed again according to the method outlined above. Data that meet this alternate low-level field precision DQO are accepted and flagged as estimates. Data that exceed this alternate low-level field precision DQO are rejected, unless professional judgement that accounts for other factors indicates otherwise.

Note that this low-level criterion of $\leq 5 \times \text{MRL}$ is not derived from detailed studies reported in the technical literature, as very little information exists with regard to this issue. Lower levels such as $\leq 3 \times \text{MRL}$ or $\leq 2 \times \text{MRL}$ may potentially be more appropriate for LMP water quality data. Additional analysis and consultation between DEQ and Tribe technical staff is needed to identify the optimum criteria for assessing the precision of low-level data. Absent this, the $5 \times \text{MRL}$ EPA criterion outlined above provides a reasonable, non-biased “placeholder” approach to use until a more comprehensive analysis can be completed.

All low-level DQO determinations involve discussions between LMP technical staff, analytical laboratory technical staff, and other technical experts. QA/QC decisions are presented in this summary report, as well as the data disposition and appropriate data flags. All data which is not rejected is used for data analyses and trend evaluations. This accepted dataset includes data that is accepted as an estimate. Inclusion of estimates into trend evaluations reduces overall confidence, and conclusions from such evaluations are consequently more limited.

1.5 Data Quality Objectives for Biologic Analyses

Standard methods for chlorophyll-a analysis and phytoplankton enumeration do not use laboratory duplicates or matrix spike duplicates. The precision of biologic analyses is assessed on the basis of field and sample replicates. Laboratory data is accepted based on laboratory quality reports.

1.6 Data Quality Management

All LMP data is assessed to determine if it meets data quality objectives (DQO's). Data quality is assessed for each parameter, using the professional judgement of the LMP technical staff. Data that meet DQO's is accepted as valid data. Data that fail DQO's is rejected. Professional judgement will be used for all data quality assessments, and a number of alternate DQO's may be used to accept or reject data so long as they are fully documented and data are flagged accordingly.

DQO's for laboratory duplicate analyses are established by the analytical laboratories for each batch of samples, in accordance with the applicable standard method. These laboratory DQO results are reported with the data and reviewed by LMP technical staff upon receipt. Corrective actions are identified if necessary. Field DQO's are assessed for each sampling event, and again at the end of each calendar year. Corrective actions are identified as necessary.

All data records contain data quality summaries. All electronic data records contain data flags (and keys to flag interpretation), to the extent that electronic database software allows. Data that is rejected due to failure to meet DQO's is recorded as "rejected". In such cases, the reasons for data rejection and the corrective action plan are also recorded and summarized in the annual data quality report. If data is accepted via alternate DQO's, then such data is flagged accordingly and alternate QA methodology described in the annual data quality report. Note that historic practices have flagged all data where $MDL < \text{measured value} < MRL$ as "estimates".

For all cases where a DQO is not met, DEQ and the Tribe determine whether a corrective action plan is needed. If so, then DEQ and the Tribe attempt to identify and rectify the cause. Such activities may include examining historic data trends, examining the laboratory data record, evaluating and/or altering equipment cleaning and handling procedures, and/or conducting "isolate tests" of field equipment, including laboratory sample bottles. DEQ and Tribe technical staff regularly communicate on their reviews of field and laboratory QC results following the receipt of laboratory data reports. As necessary, there are also consultations with the Laboratory QA manager involving unsatisfactory results from the laboratory QC samples and implementation of identified measures to find a cause and rectify unsatisfactory QC results.

Information describing field and laboratory QC results and any corrective actions is documented and presented in program reports. The QA/QC and data management process assesses and records the entire sampling process, including both laboratory and environmental variability. These processes evaluate and record the relative contribution of known sources of error and/or variability to overall data accuracy, precision, and reliability.

2 Data Quality Report for CY 2012

This section provides a summary of data quality for CY 2012, relative to the DQO's summarized in Section 1. This section only provides a performance summary. Detailed data reports to support this summary are available from DEQ upon request. The LMP had 7 sampling events in 2012 (March, April, May, June, July, August, September).

2.1 Quality of Laboratory Analyses in 2012

This section summarizes results from measures used to assess the data quality of laboratory measurements in CY 2012. These are accuracy, laboratory precision, laboratory contamination, and sensitivity. Summary results are presented in tables that detail whether DQO's were met for each sampling run in CY 2012, and discussed in the narrative. Deviations and laboratory notes are noted as necessary. *All laboratory analysis DQO's were met for all parameters in CY 2012.*

Sensitivity. This sub-section summarizes DQO's for *Sensitivity* for all biologic and chemical parameters for 2012. Values are given for both MDL and MRL. LMP data records for CY 2012 flag *Sensitivity* data quality as follows.

- All values < MDL are recorded as 0.5*MDL and flagged as “below detection limit” (U-flag).
- Values < MRL are recorded in one of two ways
 - If data are reported to MDL, then all values where MDL < value < MRL as flagged as “estimates” and recorded to 1 significant figure.
 - If data are reported to MRL, then all values are recorded as 0.5*MRL and flagged as “below detection limit” (U-flag).
- All values < 5*MRL are reported to no more than 2 significant figures. Values > 5*MRL are reported to three significant figures.

Sensitivity parameters (MDL, MRL) for CY 2012 are provided in Table 1.

Table 1. Sensitivity parameters for CY 2012. Multiples of MRL are provided for reference purposes. Cases where data are only reported to MRL are noted as < MRL.

Parameter	MDL	MRL	3*MRL	5*MRL
Biologic				
Fluorescence Chla	< MRL	1.0	3.0	5.0
Spectrophotometric Chla	Not measured in 2012			
Plankton bionumber (cells/mL)				
Nutrients				
Total Phosphorus	2.0	3.0	9.0	15
Total Dissolved Phosphorus	2.0	3.0	9.0	15
Soluble Reactive Phosphorus ^a	2.0	3.0	9.0	15
Total Nitrogen	15	50	150	250
Nitrate	5	10	30	50
Nitrite	5	10	30	50
Ammonia	5	10	30	50
Metals ^b				
Dissolved, Total As	< MRL	0.20, 0.63	0.60, 1.9	1.0, 3.2
Dissolved, Total Cd	< MRL	0.10, 0.13	0.30, 0.40	0.50, 0.65
Dissolved, Total Pb	< MRL	0.10, 0.13	0.30, 0.40	0.50, 0.65
Dissolved, Total Zn	< MRL	5.0, 5.0	15, 15	25, 25
Dissolved, Total Fe ^c	< MRL	5.0, 5.0	15, 15	25, 25
Dissolved, Total Mn	< MRL	0.10, 0.13	0.30, 0.40	0.50, 0.65
Dissolved, Total Ca	< MRL	30, 30	90, 90	150, 150
Dissolved, Total Mg	< MRL	50, 50	150, 150	250, 250
Total Hardness(mg/L CaCO ₃)	< MRL	0.3	0.9	1.5

^a Sometimes reported as dissolved ortho-phosphate.

^b Dissolved and total metals are in the same cell as dissolved, total.

^c MRL is 20 µg/L for samples with high turbidity, such values are reported as estimates.

Table 2. Laboratory accuracy, precision, and contamination data quality for CY 2012.

Parameter	Blanks < MDL/MRL	LCS/LCSD ±20%	MS/MSD ±20%	%RPD ≤20%	DQO's met?	Lab QA/QC Notes ^a
Biologic						
Fluorescence Chla	7/7	7/7	n/a	n/a	All	Note #1
Spectrophotometric Chla	Not measured in 2012					
Plankton bionumber (cells/mL)	n/a	n/a	n/a	n/a	All	None
Nutrients						
Total Phosphorus	7/7	7/7	7/7	7/7	All	Note #4, 5
Total Dissolved Phosphorus	7/7	7/7	7/7	7/7	All	Note #4, 5
Soluble Reactive Phosphorus ^b	7/7	7/7	7/7	7/7	All	Note #4, 5
Total Nitrogen	7/7	7/7	7/7	7/7	All	Note #4, 5
Nitrate	7/7	7/7	7/7	7/7	All	Note #3
Nitrite	7/7	7/7	7/7	7/7	All	None
Ammonia	7/7	7/7	7/7	7/7	All	Note #2
Metals ^c						
Dissolved, Total As	7/7	7/7	7/7	7/7	All	Note #1
Dissolved, Total Cd	7/7	7/7	7/7	7/7	All	Note #1
Dissolved, Total Pb	7/7	7/7	7/7	7/7	All	Note #1
Dissolved, Total Zn	7/7	7/7	7/7	7/7	All	Note #1
Dissolved, Total Fe	7/7	7/7	7/7	7/7	All	Note #1
Dissolved, Total Mn	7/7	7/7	7/7	7/7	All	Note #1
Dissolved, Total Ca	7/7	7/7	7/7	7/7	All	Note #1
Dissolved, Total Mg	7/7	7/7	7/7	7/7	All	Note #1
Total Hardness (mg/L CaCO ₃)	7/7	7/7	7/7	7/7	All	Note #1

^a Numbers for Laboratory QA/QC notes refer to numbered list in the narrative.

^b Sometimes reported as dissolved ortho-phosphate.

^c Unless otherwise noted, table cells refer to both total and dissolved metals.

Laboratory accuracy, precision, and contamination. This sub-section summarizes laboratory performance relative to DQO's for accuracy, precision, and contamination for all biologic and chemical parameters for 2012. *All data met standard or alternate DQO's for laboratory accuracy, precision, and contamination for 7 of 7 sampling events in 2012, for all parameters.*

A summary is provided in Table 2, and presents results for all sampling runs in terms of the proportion of events where the associated laboratory DQOs were met for *all* parameters (e.g., 7/7 means that DQO's for that parameters were met for 7 out of 7 sampling events). For some cases, data may have been accepted as valid based on alternate DQO's as per laboratory standard methods, or there are non-critical data qualifiers to be noted in data records. These instances are indicated in the table and presented here. Also note that some laboratories report blanks to MRL,

while others report to MDL. Contamination is assessed based on the lowest values the laboratory reports to.

Minor laboratory qualifiers were issued in CY 2012. None of these qualifiers were critical, and they did not negatively impact data quality. All data for 2012 are accepted as valid with respect to laboratory QA/QC measures. The non-critical laboratory qualifiers are summarized below.

1. **Metals & Chl-a**— In July 2012, EPA Manchester Environmental Laboratory issued a Corrective Action Notice for improper sample transport and receipt. 58 of 63 samples had sample numbers for week 23, when samples were collected in week 29. This did not impact the quality of analyses, but corrective actions were taken for data management.
 - a. Sample numbers on the containers were corrected to reflect week 29.
 - b. DEQ staff refreshed their training in procedures for sample labeling, COC's, and shipping. Procedures for cross-checking COC's were strengthened.
2. **Ammonia**— In April 2012, TCL had an ammonia MSD $\geq 20\%$ RPD (29%). Data is low level and accepted as valid based on LCS/LCSD (lab qualifier QR-01). Valid data.
3. **Nitrate**— In May 2012, TCL had an NO₃ MS greater than $\pm 20\%$ recovery (125%). Data is accepted as valid based on LCS %recovery (lab qualifier QM-07). Valid data.
4. **Total Phosphorus in August 2012**— SVL had a total phosphorus MS greater than $\pm 20\%$ recovery (139%). Data is valid based on LCS %recovery (lab qualifier M1). Valid data.
5. **August, September 2012**— SVL received some samples at a temperature $> 6\text{ }^{\circ}\text{C}$ (7-9 $^{\circ}\text{C}$). Data were not qualified, but this temperature is outside of EPA guidelines (Q6). Valid data.
 - a. It was determined that samples most likely warmed during the process of cross-checking sample labels with COC's prior to delivery, and delivering samples to SVL.
 - b. Sample handling procedures were revised to insure that samples were maintained at the proper temperature during the warmer summer months.

Note also that many SVL data for 2012 are qualified as T6, which excludes the data for being used for regulatory actions such as permit applications. Follow-up discussions with SVL concluded that this qualifier was mistakenly applied and should be disregarded.

2.2 Quality of Field Collection in 2012

This section summarizes results from QA/QC measures used to assess the quality of field collection in CY 2012. These are contamination and field precision. Summary results are presented in tables that detail whether DQO's were met for each sampling run in CY 2012, and discussed in the narrative. Deviations and laboratory notes are noted as necessary. *Some DQO's for field and reagent contamination were exceeded in CY 2012. Some DQO's for field precision were also exceeded.*

Contamination. This sub-section summarizes QA/QC performance relative to equipment, field, and reagent contamination. Laboratory water blanks (i.e., Type 1, Type 2 water) are used to assess reagent contamination. Equipment blanks are used to assess equipment contamination. Field blanks are used to assess field contamination. Results are summarized below.

1. **Reagent contamination**— two laboratory water blanks were collected in March 2012 and one laboratory water blank was collected in April 2012. Reagent contamination DQO's were exceeded in March-2012 for the Type 2 Water Blank.
 - a. *Type 1 Water Blank*. This blank was < MRL/MDL for all parameters except total phosphorus (TP) and total dissolved phosphorus (TDP). It was within 2*MDL for TP and TDP. This DQO was met both March-2012 and April-2012.
 - b. *Type 2 Water Blank*. This blank was < MRL for all parameters except for the following. This DQO was met for some parameters but not all.
 - i. *Total phosphorus*— DQO failed (11 µg/L, > 3*MRL)
 - ii. *Total dissolved phosphorus*— DQO failed (11 µg/L, > 3*MRL)
 - iii. *Dissolved ortho-phosphate*— DQO failed (5.8 µg/L, > MRL)
 - iv. *Total Iron*— DQO failed (5.2 µg/L, > MRL)
 - v. *Total Manganese*— DQO failed (0.21 µg/L, > MRL)
2. **Equipment contamination**— No equipment blanks were collected in 2012.
3. **Field contamination**— two field blanks were collected in 2012 (March, July). All field contamination DQO's were met for 1 of 2 field blanks.
 - a. *March-2012*. This blank was < MRL/MDL for all parameters except total phosphorus (TP) and total dissolved phosphorus (TDP). This DQO was met for some parameters but not all.
 - i. *Total phosphorus*— DQO failed (6.1 µg/L, > 2*MRL)
 - ii. *Total dissolved phosphorus*— DQO failed (5.4 µg/L, > MRL)
 - b. *July-2012*. This blank was < MRL/MDL for all parameters. The DQO was met.

Based on these results, all contamination DQO's were met in 2012 for all parameters except for phosphorus, iron, and manganese during the March – June time period. With these exceptions, all other data can be accepted as valid with respect to contamination during sample collection. Phosphorus, iron, and manganese data must be rejected and/or conditionally accepted as lower quality estimates. These data have been flagged and managed as follows.

1. **March 2012 Sampling Event**—Some data rejected, others accepted as estimates.
 - a. *Total phosphorus, total dissolved phosphorus*— rejected for all sampling locations. Both the water blank and the field blank failed contamination DQO's.
 - b. *Dissolved ortho-phosphate, total iron, total manganese*— conditionally accepted as estimates for all sampling locations. The water blank failed contamination DQO's, but the field blank passed DQO's.
2. **April – June 2012 Sampling Events**—All phosphorus, iron, and manganese data are conditionally accepted as estimates for all sampling locations. This decision is based on professional judgement according to the following reasons.
 - a. Immediately upon detection of the blank problem, DEQ technical staff worked with the manufacturer of the Milli-Q water purification system to identify potential causes. The cause was identified as biofouling in the Type 2 water system due to the purification system not being kept in “Shut-Down” mode while not in use.
 - b. DEQ staff immediately implemented appropriate corrective actions and collected and additional Water Blank prior to the April-2012 sampling event.

- c. In April, DEQ Technical Staff mistakenly collected a Type 1 Water Blank (clean in March) rather than a Type 2 Water Blank (contaminated in March). No accompanying field blank was collected in April. No follow-on field blanks were collected until July-2012.
- d. This quality record indicates that DEQ technical staff took immediate action to remedy the problem and conducted QA tests to demonstrate success. However, DEQ staff mistakenly tested the wrong Water Type in April-2012.
- e. Based on the above points, it can be reasonably concluded that DEQ staff took the problem seriously and immediately implemented corrective actions.
- f. The “clean” field blank in July proves that the corrective actions were successful. However, the lack of hard evidence for the April – June time period requires that an assumption be made about performance relative to contamination DQO’s for those months. There is no clear contamination data record for April, May, and June.
- g. Based on the evidence above, it is more reasonable to assume that the problem was corrected (no contamination) than to assume that it was not (contamination).
- h. Data are conditionally accepted as lower-quality estimates due to the above points and the lack of a strong record of performance relative to contamination DQO’s.

All contamination DQO’s were met for all parameters during the July – December time period. All of these data are accepted as valid relative to equipment, field, and reagent contamination DQO’s. Note that some laboratories report blanks to MRL, while others report to MDL. Contamination is controlled based on MRL, but also assessed based on MDL as possible.

Field Precision. This sub-section summarizes results QA/QC performance relative to field precision for 2012. This section only covers precision for field replicates and sample replicates collected by DEQ technical staff. Field-staff replicates are considered to be a measure of comparability of data collected by the different agencies that are partners in the LMP, and are discussed in the sub-section that discusses *Quality of the Overall Dataset*. Eight field replicates and eight sample replicates were collected in 2012 according to the schedule below.

- *Field replicates (10)*— April (C1-NB, C3-photic), May (C4-30m, C4-30m with additional 0.1 µm filtration, Cougar Bay, Cougar bay with additional 0.1 µm filtration), June (Loffs Bay), July (Carlin Bay), August (C2-photic), September (C1-photic)
- *Sample replicates (11)*— March (C3-25m), May (C1-30m, C1-30m with additional 0.1 µm filtration), June (C1-20m, C4-NB), July (C3-NB), August (C3-20m), September (C2-20m, C2-20m 2nd sample replicate, C3-NB, C3-NB 2nd sample replicate)
- *Note #1*— C1 = Tubbs Hill site, C2 = Wolf Lodge Bay site, C3 = Driftwood Point site, C4 = University Point site, all bays refer to bay sampling locations (photic zone only).
- *Note #2*— photic = photic zone composite, 20m = 20 meters depth, 25m = 25 meters depth, 30m = 30 meters depth, 40m = 40 meters depth, NB = near bottom.

These data are summarized in Table 3 and Table 4. Virtually all samples were accepted as valid with respect to precision DQO’s. Only two were rejected. Some samples were conditionally accepted as estimates. These are noted in this report and flagged in data records.

These tables summarize results for all sampling runs in terms of the proportion of events where the associated field precision DQOs were met for each parameter (e.g., 7/7 means that DQO’s

were met for 7 out of 7 sampling events). Replicate samples where one or both of the measured values are < MRL are excluded from the analysis, as %RPD cannot be assessed. The range and average %RPD of sample replicates and field replicates is also provided for informational purposes, as is the combined average %RPD and standard deviation over all field and sample replicates collected that year.

Cases where data have been rejected or conditionally accepted as valid estimates using alternate DQO's are noted. Alternate DQO's include low-level samples and cases where one replicate for a given run meets DQO's while the other does not. There also may be non-critical data qualifiers to be noted in data records.

Table 3. Field precision data quality for biologic and nutrient data in CY 2012 for sample replicates (SR) and field replicates (FR). %RPD's are for both the range and average.

Parameter	SR %RPD	SR DQO Met? ^a	FR %RPD	FR DQO Met? ^a	Overall % RPD	Field QA/QC Notes ^b
Biologic						
Fluorescence Chla	No sample replicates		10% (2-21)	6/6	10% (± 7)	none
Spect. Chla ^c	Not measured in CY 2012					
Plankton bionumber (cells/mL)	No field precision DQO's established in the 2012 QAPP					
Nutrients						
Total Phosphorus	12% (3-25)	7/7	7% (1-25)	7/7	10% (± 7)	none
Total Dissolved Phosphorus	18% (6-26)	4/4	10% (4-29)	4/4	14% (± 9)	Note #2, 3, 5
Soluble Reactive Phosphorus ^d	No sample replicates		All were < MRL		< MRL	Note #1
Total Nitrogen	7% (2-13)	7/7	7% (2-16)	7/7	7% (± 5)	none
Nitrate	2% (0-7)	6/6	14% (9-27)	3/3	7% (± 9)	Note #4, 5
Nitrite	All values < MRL					
Ammonia	0%	1/1	8%	1/1	4% (± 4)	Note #5

^a DQO's do not apply when analytes are < MRL. This results in fewer instances where DQO's can be evaluated.

^b Numbers for field QA/QC notes refer to numbered list in the narrative.

^c Spectrophotometric method of chlorophyll-a detection.

^d Sometimes reported as dissolved ortho-phosphate.

Table 4. Field precision data quality for total and dissolved metals data in CY 2012 for sample replicates (SR) and field replicates (FR). %RPD's are for both the range and average.

Parameter	SR %RPD	SR DQO Met? ^a	FR %RPD	FR DQO Met? ^a	SR, FR Average %RPD	Field QA/QC Notes ^b
Dissolved Metals ^c						
Dissolved As	4% (0-13)	7/7	5% (2-15)	7/7	5% (± 4)	none
Dissolved Cd	5% (0-11)	7/7	5% (0-18)	7/7	4% (± 5)	none
Dissolved Pb	13% (0-42)	6/7	15% (0-37)	6/6	14% (± 15)	Note #6, 7
Dissolved Zn	1% (0-3)	7/7	1.5% (0-3)	7/7	1% (± 1)	none
Dissolved Fe	12% (0-39)	7/7	17% (5-30)	6/7	14% (± 10)	Note #7, 8
Dissolved Mn	3% (0-8)	7/7	11% (0-54)	6/7	6.5% (± 12)	Note #7, 9
Dissolved Ca	1% (0-2)	7/7	1% (0-2.5)	7/7	1% (± 1)	none
Dissolved Mg	1% (0-2)	7/7	1% (0.5-3)	7/7	1% (± 1)	none
Total Metals ^c						
Total As	1.4%	1/1	10% (3-17)	2/2	7% (± 8)	Note #10
Total Cd	5% (0-14)	7/7	6% (0-17)	7/7	6% (± 5)	none
Total Pb	2%(0-5)	7/7	4% (0-10)	7/7	3% (± 3)	none
Total Zn	1% (1-3)	7/7	2% (0-3)	7/7	2% (± 1)	none
Total Fe	5% (0-13)	7/7	4% (0-19)	7/7	5% (± 5)	none
Total Mn	1% (0-2.4)	7/7	6% (0-26)	6/7	3.2% (± 7)	Note #11
Total Ca	Not collected in 2012					
Total Mg	Not collected in 2012					
Total Hardness (mg/L CaCO ₃)	0.6% (0-2)	7/7	1% (0-2)	7/7	0.7% (± 0.7)	none

^a DQO's do not apply when analytes are < MRL. This results in fewer instances where DQO's can be evaluated.

^b Numbers for field QA/QC notes refer to numbered list in the narrative.

^c % RPD values are reported as "range", "average%". The values in the range are minimum and maximum %RPD's observed for that parameter over all replicates.

Cases where data have been rejected or conditionally accepted as valid estimates using alternate DQO's are discussed below. Note that alternate DQO's include low-level samples and cases where one replicate for a given run meets DQO's while the other does not. There also may be non-critical data qualifiers, such as COC errors, to be noted in data records. All such instances that are indicated in the tables are discussed here.

1. **Soluble Reactive Phosphorus (Dissolved ortho-phosphate)**— All field and sample replicates had results < MRL and a %RPD cannot be calculated. Precision DQO does not apply. All data accepted as valid unless otherwise noted.
2. **Total Dissolved Phosphorus (TDP)**— All samples were low-level values (<5*MRL) and precision DQO's do not apply. All data accepted as valid unless otherwise noted.
3. **Total Dissolved Phosphorus (TDP) in May**— In May, TDP exceeded the field precision DQO of 25% RPD, but is a low-level sample where the DQO does not apply. TDP data for May-2012 is conditionally accepted as an estimate.

4. ***Nitrate in May***— In May, nitrate exceeded the field precision DQO of 25% RPD, but was a low-level sample. DQO does not apply. Data conditionally accepted as an estimate.
5. ***Ammonia, nitrate, and total dissolved phosphorus***— Measured values are commonly below MRL in summer and %RPD cannot be calculated. QA is based on samples > MRL. Samples < MRL are excluded from the assessment.
6. ***Dissolved Lead (Pb)***— Dissolved Pb had several QA issues in 2012, one of which required data to be rejected. These qualifications are discussed below, all other data are valid.
 - a. *June-2012*: Observed %RPD for the *sample* replicate at site C1 (20 m) of 42%, but the *sample* replicate at site C4 (near bottom) and the *field* replicate at Loffs Bay was 15%. Measured concentrations were > 5*MRL, and *not low-level*. Dissolved Pb data for June-2012 is managed as follows.
 - i. Dissolved Pb for the 20m sample at C1 (Tubbs Hill) is rejected for failing the field precision DQO (sample replicate > 25% RPD).
 - ii. Dissolved Pb data for Loffs Bay and site C4 is accepted as valid (field replicate < 25% RPD).
 - iii. All other dissolved Pb data is conditionally accepted as a valid estimate because two of the three field/sample replicates were ≤ 25% RPD
 - b. *July-2012*: Observed %RPD for the *field* replicate of 37%, but the *sample replicate* was 3.9%. Measured concentrations were < 5*MRL. %RPD DQO's for field precision do not apply. All dissolved Pb data is conditionally accepted as an estimate because it is low-level and one of the two field/sample replicates was ≤ 25% RPD.
 - c. *Aug-2012*: Observed %RPD for the *field* replicate of 33%, but the *sample replicate* was 4.1%. Measured concentrations were < 5*MRL. %RPD DQO's for field precision do not apply. All dissolved Pb data is conditionally accepted as an estimate because it is low-level and one of the two field/sample replicates was ≤ 25% RPD.
 - d. *Sept-2012*: Observed %RPD's for both *sample* replicates were > 25% (30%. 36%), and the *field replicate* was < MRL. All measured concentrations were < 5*MRL. %RPD DQO's for field precision do not apply. Dissolved Pb data for Sept-2012 is managed as follows. All dissolved Pb data is conditionally accepted as an estimate because it is low-level.
 - e. Note that the flags for dissolved lead described above only apply to cases where the value is above MRL. All cases where value < MRL are flagged as below detect.
7. ***August 2012 Sample at Driftwood Point Site (C3), 40 m depth***— Reported values for dissolved Pb, Fe, and Mn are abnormally high and well outside the range of typical values for the lake at this time of year. The pattern suggests that the sample may have been contaminated with a small sediment particle (< 0.45 μm dia.). Dissolved Pb, Fe, and Mn data are rejected for this sampling location for reasons of being an unreliable outlier. This qualifier applies to single samples and not overall field precision.
8. ***Dissolved Fe***— Dissolved Fe exceeded one of two field precision DQO's in May (Field Rep 29% RPD), July (Field Rep 30% RPD), and September (Sample Rep 39% RPD). All dissolved Fe data for these sampling events is conditionally accepted as an estimate. One replicate exceeded DQO's while the other passed. Note also that most are low-level values (< 5*MRL) where precision DQO's do not apply.

9. **Dissolved Mn**— In July 2012, dissolved Mn exceeded one of two field precision DQO's in July (Carlin Bay Field Rep, 54% RPD). Dissolved Mn data for the Carlin Bay sample is *rejected* based on the field rep $\geq 25\%$ RPD. All other dissolved Mn data for this sampling event is conditionally accepted as an estimate. One replicate exceeded DQO's while the other passed. Note also that most samples are low-level values ($< 5 \times \text{MRL}$), where precision DQO's do not apply.
10. **Total As**— Six of seven sample replicates and five of seven field replicates were $< \text{MRL}$.
11. **August 2012 Field Replicate for Total Mn**— Total Mn had a field replicate %RPD of 26%, and a *sample* replicate %RPD 0%. All samples had measured values $> 5 \times \text{MRL}$. All data are accepted as a valid due to close proximity to the 25% RPD DQO, and one of two replicates meeting the precision DQO. Data is valid. Not an estimate.

Note that all data that is conditionally accepted as an estimate is flagged as an estimate in data records, *only if* the value is $> \text{MDL}$ (or MRL, if lab does not report to MDL). Data that are below sensitivity limits are flagged as below detect.

2.3 Quality of Overall Dataset in 2012

This section summarizes results from measures used to assess the quality of the overall dataset in CY 2012. These are completeness, field-staff precision, comparability, and representativeness. The completeness measure considers the cumulative quality over all *Laboratory Analysis* and *Field Collection* DQO's. The other measures are more qualitative, and evaluate the integrity of the overall dataset with respect to the needs of the LMP.

Most DQO's for overall dataset quality were met in CY 2012. Some DQO's were not met for phosphorus and lead. The dataset is not complete for total phosphorus and total dissolved phosphorus. This needs to be taken into consideration when comparing CY 2012 to prior years as a single year's annual average. However, only one month's worth of data was rejected. Long-term trend analyses that compare across many years should not be impacted. No side-by-sides were conducted in CY 2012, and inter-agency comparability cannot be assessed. The available data from laboratory splits for phosphorus (see Field-Staff Precision) indicates that the different analytical laboratories may generate different results for laboratory splits for phosphorus parameters. CY 2012 phosphorus data should be treated with caution.

Completeness. This sub-section summarizes results for the assessment of dataset completeness for 2012. Completeness assessments are given for all data collected across all sampling dates and locations, as well as for subsets that focus on LMP trigger criteria. Note that completeness DQO's from historic QAPP's apply to the overall dataset and are not specific to LMP trigger criteria. *Completeness DQO's were not met in 2012 for total phosphorus and total dissolved phosphorus. Completeness DQO's were met for all other analytes.*

Completeness was 100% for all parameters except chlorophyll-a, total phosphorus, total dissolved phosphorus, dissolved lead (Pb), dissolved iron (Fe), and dissolved manganese (Mn). Completeness values for these parameters are as follows. .

- *Total Phosphorus*— 129 valid analyses out of 149 samples (87 %complete)
- *Total Dissolved Phosphorus*— 129 valid analyses out of 149 samples (87%complete)

- *Dissolved Lead*— 147 valid analyses out of 149 samples (99 %complete)
- *Dissolved Iron*— 148 valid analyses out of 149 samples (99 %complete)
- *Dissolved Manganese*— 148 valid analyses out of 149 samples (99 %complete)

The incomplete dataset for total phosphorous and total dissolved phosphorus occurred because the blank contamination in March forced all March-2012 data to be rejected. March typically has some of the highest annual phosphorus concentrations, and thus exclusion of this data may bias analysis of the total phosphorus LMP trigger downward. Excluding this data may also bias the long-term analysis downward somewhat. However, the Mann-Kendall used to assess long-term trends analysis is designed to account for data gaps and any effect of excluded data should be minor.

Field-Staff Precision. This sub-section summarizes results for the assessment of field-staff precision for 2012. Note that there are no formal DQO's for field-staff precision, and these studies are used for informational purposes to help assess the comparability and representativeness of joint, inter-agency sampling. No DEQ-Tribe side-by-side sampling events were conducted in 2012, but a lab-sample split study was conducted using samples collected in April-2012 from the photic zone of site C4-University Point (11-April, 2012). Results from this laboratory split study, for samples collected by DEQ, are as follows.

- *Total phosphorus*— Poor comparability (70% RPD)
 - SVL Laboratories (DEQ) = 25 µg/L
 - TCL/STL Laboratories (Tribe) = 12 µg/L
- *Total dissolved phosphorus*— Good comparability (1.7% RPD)
 - SVL Laboratories (DEQ) = 6.1 µg/L
 - TCL/STL Laboratories (Tribe) = 6.0 µg/L
- *Soluble reactive phosphorus (aka., ortho-phosphate)*— Poor comparability (57% RPD)
 - SVL Laboratories (DEQ) = < 3 µg/L
 - TCL/STL Laboratories (Tribe) = 5.2 µg/L

This sample-split study was only conducted for phosphorus samples. The comparability results are generally poor. In 2013, DEQ initiated an extensive study to document phosphorus inter-comparability across a range of sampling conditions. This is further discussed in Section 5.

Comparability. This sub-section summarizes results for the assessment of dataset comparability for 2012. The high data quality for all parameters except total phosphorus and total dissolved phosphorus means that the data is comparable for those parameters. However, the poor completeness of the phosphorus dataset combined with the poor field-staff precision of this same dataset indicates that phosphorus data is not as comparable in CY 2012 as for other data, both (i) across the lake, and (ii) across years for purposes of trend assessment. *Phosphorus data from CY 2012 should be treated cautiously. Long-term analyses that include and exclude CY 2012 data should be conducted to assess the impact of this lower-quality year on phosphorus trends.*

Representativeness. This sub-section summarizes results for the assessment of dataset representativeness for 2012. The data for CY 2012 is representative for all parameters except total phosphorus and total dissolved phosphorus. Data for these parameters are not fully representative, due to the exclusion of samples from the March sample run due to issues with the

field, water, and equipment blanks. Long-term trend analyses that both include and exclude low-quality data from CY 2012 have been completed. Comparison of these analyses show that long-term trend analyses that exclude the rejected total phosphorus data are statistically indistinguishable from long-term trend analyses that include this data. Therefore, CY 2012 data for total phosphorus can reliably be included into long-term trend analyses.

3 Data Quality Report for CY 2013

This section provides a summary of data quality for CY 2013, relative to the DQO's summarized in Section 1. This section only provides a performance summary. Detailed data reports to support this summary are available from DEQ upon request. The LMP had 6 complete sampling events in 2013 (April, May, June, July, August, Sept/Oct) and one partial sampling event (December).

3.1 Quality of Laboratory Analyses in 2013

This section summarizes results from measures used to assess the data quality of laboratory measurements in CY 2013. These are accuracy, laboratory precision, laboratory contamination, and sensitivity. Summary results are presented in tables that detail whether DQO's were met for each sampling run in CY 2013. Deviations and laboratory notes are noted as necessary and summarized in the text. *All laboratory DQO's were met for all parameters in CY 2013.*

Sensitivity. This sub-section summarizes DQO's for Sensitivity for all biologic and chemical parameters for 2013. Values are given for both MDL and MRL. LMP data records for CY 2013 flag *Sensitivity* data quality as follows.

- All values < MDL are recorded as 0.5*MDL and flagged as “below detection limit” (U-flag).
- Values < MRL are recorded in one of two ways
 - If data are reported to MDL, then all values where MDL < value < MRL as flagged as “estimates” and recorded to 1 significant figure.
 - If data are reported to MRL, then all values are recorded as 0.5*MRL and flagged as “below detection limit” (U-flag).
- All values < 5*MRL are reported to no more than 2 significant figures. Values > 5*MRL are reported to three significant figures.

Sensitivity parameters (MDL, MRL) for CY 2013 are the same as for CY 2012.

Table 5. Laboratory accuracy, precision, and contamination data quality for CY 2013.

Parameter	Blanks < MDL/MRL	LCS/LCSD ±20%	MS/MSD ±20%	%RPD ≤20%	DQO's met?	Lab QA/QC Notes ^a
Biologic						
Fluorescence Chla	6/6	6/6	n/a	n/a	All	Note #1
Spectrophotometric Chla	Laboratory data quality not recorded in 2013.					
Plankton bionumber (cells/mL)	n/a	n/a	n/a	n/a	All	None
Nutrients						
Total Phosphorus	6/6	6/6	6/6	6/6	All	Note #2
Total Dissolved Phosphorus	6/6	6/6	6/6	6/6	All	Note #3
Soluble Reactive Phosphorus ^b	6/6	6/6	6/6	6/6	All	Note #4
Total Nitrogen	6/6	6/6	6/6	6/6	All	None
Nitrate	6/6	6/6	6/6	6/6	All	Note #5
Nitrite	6/6	6/6	6/6	6/6	All	None
Ammonia	6/6	6/6	6/6	6/6	All	None
Metals^c						
Dissolved, Total As	6/6	6/6	6/6	6/6	All	Note #1
Dissolved, Total Cd	6/6	6/6	6/6	6/6	All	Note #1
Dissolved, Total Pb	6/6	6/6	6/6	6/6	All	Note #1
Dissolved, Total Zn	6/6	6/6	6/6	6/6	All	Note #1
Dissolved, Total Fe	6/6	6/6	6/6	6/6	All	Note #1
Dissolved, Total Mn	6/6	6/6	6/6	6/6	All	Note #1
Dissolved, Total Ca	6/6	6/6	6/6	6/6	All	Note #1
Dissolved, Total Mg	6/6	6/6	6/6	6/6	All	Note #1
Total Hardness (mg/L CaCO ₃)	6/6	6/6	6/6	6/6	All	Note #1

^a Numbers for Laboratory QA/QC notes refer to numbered list in the narrative.

^b Sometimes reported as dissolved ortho-phosphate.

^c Unless otherwise noted, table cells refer to both total and dissolved metals.

Laboratory accuracy, precision, and contamination. This sub-section summarizes laboratory performance relative to DQO's for accuracy, precision, and contamination for all biologic and chemical parameters for 2013. *All data met standard or alternate DQO's for laboratory accuracy, precision, and contamination for 7 of 7 sampling events in 2013, for all parameters.*

A summary is provided in Table 5 and presents results for all sampling runs in terms of the proportion of events where the associated laboratory DQOs were met for *all* parameters (e.g., 7/7 means that DQO's for that parameters were met for 7 out of 7 sampling events). For some cases, data may have been accepted as valid based on alternate DQO's as per laboratory standard methods, or there are non-critical data qualifiers to be noted in data records. These instances are indicated in the table and presented here. Also note that some laboratories report blanks to MRL, while others report to MDL. Contamination is assessed based on the lowest values the laboratory reports to.

Minor laboratory qualifiers were issued in CY 2013. None of these qualifiers were critical, and they did not negatively impact data quality. All data for 2013 are accepted as valid with respect to laboratory QA/QC measures. The non-critical laboratory qualifiers are summarized below.

1. **Metals & Chl-a**—EPA Manchester Environmental Laboratory issued Corrective Action Notices for improper sample transport and receipt of samples in April-2013, Sept-2013, and Oct-2013. These errors did not impact the quality of analyses, but corrective actions were taken for data management and sample handling procedures.
 - a. Sample numbers and dates on the containers were corrected.
 - b. DEQ staff refreshed their training in procedures for sample labeling, COC's, and shipping. Procedures for cross-checking COC's were strengthened. Note that these mistakes occurred while new staff were being trained.
 - c. Note that some EPA records (WTR-171H) have DEQ samples collected at the same time as the Tribe (19-Nov), when DEQ actually collected samples in December.
2. **Total Phosphorus (TP)**— TP analyses by TCL laboratories (laboratory splits) exceeded the MS/MSD target of $\pm 20\%$ RPD in Aug-2013 (40% RPD) and Sep-2013 (44% RPD). Measured values $< 5^*$ MRL and accepted on the basis of LCS/LCSD (lab note QR-01). Valid data.
3. **Total Dissolved Phosphorus (TDP)**— TDP analyses by TCL laboratories (laboratory splits) exceeded the MS/MSD target of $\pm 20\%$ RPD in July-2013 (48% RPD). Measured values $< 5^*$ MRL and accepted on the basis of LCS/LCSD (lab note QR-01). Valid data.
4. **Soluble Reactive Phosphorus (SRP)**— SRP analyses by TCL laboratories (laboratory splits) exceeded the MS/MSD target of $\pm 20\%$ RPD in May-2013 (40% RPD) and Jun-2013 (43% RPD). Measured values $< 5^*$ MRL and accepted on the basis of LCS/LCSD (QR-01). Valid data.
5. **Nitrate**— Nitrate analyses by TCL laboratories e exceeded the LCS target of $\pm 20\%$ accuracy in April-2013 (130% recovery). Measured values $< 5^*$ MRL and accepted on the basis of good recovery of the matrix spike (88% recovery). Valid data.

3.2 Quality of Field Collection in 2013

This section summarizes results from QA/QC measures used to assess the quality of field collection in CY 2013. These are contamination and field precision. Summary results are presented in tables that detail whether DQO's were met for each sampling run in CY 2013, and discussed in the narrative. Deviations and laboratory notes are noted as necessary. *All DQO's for field and reagent contamination were met in CY 2013. Some DQO's for field precision were exceeded.*

Contamination. This sub-section summarizes QA/QC performance relative to equipment, field, and reagent contamination. Laboratory water blanks (i.e., Type 1, Type 2 water) are used to assess reagent contamination. Equipment blanks are used to assess equipment contamination. Field blanks are used to assess field contamination. Results are summarized below.

1. **Reagent contamination**— two laboratory water blanks were collected in March 2013. Both water blanks met all contamination DQO's.

2. **Equipment contamination**—equipment blanks were collected in April 2013 and December 2013. Both equipment blanks met all contamination DQO's.
3. **Field contamination**— three field blanks were collected in 2013 (April, June, November). All contamination DQO's were met for all field blanks.

Note that some laboratories report blanks to MRL, while others report to MDL. Contamination is controlled based on MRL, but also assessed based on MDL as possible.

Field Precision. This sub-section summarizes results QA/QC performance relative to field precision for 2013. This section only covers precision for field replicates and sample replicates collected by DEQ technical staff. Field-staff replicates are considered to be a measure of comparability of data collected by the different agencies that are partners in the LMP, and are discussed in the sub-section that discusses *Quality of the Overall Dataset*. Five field replicates and six sample replicates were collected in 2013 according to the schedule below.

- *Field replicates (5)*— April (C1-NB), May (C3-photic), August (Echo Bay), two in Sept/Oct (C1-photic, Bennett Bay). *Only 3 field replicates had metals analyses.*
- *Sample replicates (6)*— June (C3-25m), two in July (C3-NB, C4-NB), two in August (C4-20m, C2- photic), Sept/Oct (C2-20m). *Only 4 sample replicates had metals analyses.*
- *Note #1*— C1 = Tubbs Hill site, C2 = Wolf Lodge Bay site, C3 = Driftwood Point site, C4 = University Point site, all bays refer to bay sampling locations (photic zone only).
- *Note #2*— photic = photic zone composite, 20m = 20 meters depth, 25m = 25 meters depth, 30m = 30 meters depth, 40m = 40 meters depth, NB = near bottom.

These data are summarized in Table 6 and Table 7. *All samples were accepted as valid with respect to precision DQO's. None were rejected. Some samples were conditionally accepted as estimates, and are flagged in data records.*

As in Section 2, these tables summarize results for all sampling runs in terms of the proportion of events where the associated field precision DQOs were met for each parameter (e.g., 7/7 means that DQO's were met for 7 out of 7 sampling events). Replicate samples where one or both of the measured values are < MRL are excluded from the analysis, as %RPD cannot be assessed. The range and average %RPD of sample replicates and field replicates is also provided for informational purposes, as is the combined average %RPD and standard deviation over all field and sample replicates collected that year.

Table 6. Field precision data quality for biologic and nutrient data in CY 2013 for sample replicates (SR) and field replicates (FR). %RPD's are for both the range and average.

Parameter	SR %RPD	SR DQO Met? ^a	FR %RPD	FR DQO Met? ^a	Overall %RPD	Field QA/QC Notes ^b
Biologic						
Fluorescence Chla	18%	1/1	23% (8-37)	2/2	21% (±15)	Note #1
Spect. Chla ^c	40%	1/1	0%	1/1	20% (±28)	Note #1
Plankton bionumber (cells/mL)	No field precision DQO's established in the 2013 QAPP.					
Nutrients						
Total Phosphorus	10% (5-22)	6/6	16% (0-45)	5/5	13% (±13)	Note #2
Total Dissolved Phosphorus	0%	2/2	27% (22-32)	2/2	13% (±16)	Note #3
Soluble Reactive Phosphorus ^d	All values < MRL. DQO's cannot be evaluated					
Total Nitrogen	11% (2-20)	6/6	12% (5-21)	5/5	11% (±7)	none
Nitrate	2% (0-6)	3/3	0%	1/1	2% (±3)	Note #4
Nitrite	Not measured in CY 2013					
Ammonia	No sample replicates		All values < MRL. DQO's cannot be evaluated			

^a DQO's do not apply when analytes are < MRL. This results in fewer instances where DQO's can be evaluated.

^b Numbers field QA/QC notes refer to numbered list in the narrative.

^c Spectrophotometric method of chlorophyll-a detection.

^d Sometimes reported as dissolved ortho-phosphate.

Table 7. Field precision data quality for total and dissolved metals data in CY 2013 for sample replicates (SR) and field replicates (FR). %RPD's are for both the range and average.

Parameter	SR %RPD	SR DQO Met? ^a	FR %RPD	FR DQO Met? ^a	SR, FR Average %RPD	Field QA/QC Notes ^b
Dissolved Metals ^c						
Dissolved As	4% (3-6)	4/4	9% (3-18)	3/3	6% (±6)	none
Dissolved Cd	4% (0-12)	4/4	9% (0-27)	3/3	6% (±10)	Note #5
Dissolved Pb	4% (0-8)	4/4	14% (11-17)	3/3	9% (±7)	none
Dissolved Zn	6% (1-16)	4/4	3% (1-4)	3/3	4% (±6)	none
Dissolved Fe	32% (21-44)	4/4	7% (0-15)	3/3	20% (±19)	Note #6
Dissolved Mn	10% (3-31)	4/4	10% (0-26)	3/3	10% (±13)	Note #7
Dissolved Ca	1% (0.4-2)	4/4	2% (1.5-2)	3/3	1.2% (±1)	none
Dissolved Mg	1% (1-2)	4/4	0.2% (0-0.6)	3/3	1% (±1)	none
Total Metals ^c						
Total As	All values < MRL. DQO's cannot be evaluated.					
Total Cd	11% (0-25)	4/4	9% (0-18)	3/3	10% (±9)	none
Total Pb	2% (0-5)	4/4	0%	3/3	1% (±2)	none
Total Zn	5% (1-16)	4/4	3% (2-4)	3/3	4% (±5)	none
Total Fe	15% (6-26)	4/4	7% (2-16)	3/3	12% (±10)	Note #8
Total Mn	2% (0-5)	4/4	2% (0.2-4)	3/3	2% (±2)	none
Total Ca	Not collected in 2013					
Total Mg	Not collected in 2013					
Total Hardness (mg/L CaCO ₃)	1% (0-2)	4/4	1% (0-2)	3/3	1% (±1)	none

^a DQO's do not apply when analytes are < MRL. This results in fewer instances where DQO's can be evaluated.

^b Numbers for field QA/QC notes refer to numbered list in the narrative.

^c % RPD values are reported as "range", "average%". The values in the range are minimum and maximum %RPD's observed for that parameter over all replicates.

Cases where data have been rejected conditionally accepted as valid estimates using alternate DQO's are discussed below. Note that alternate DQO's include low-level samples and cases where one replicate for a given run meets DQO's while the other does not. There also may be non-critical data qualifiers, such as COC errors, to be noted in data records. All such instances that are indicated in the tables are discussed here.

1. **Chlorophyll-a**— The sample replicate from August (TCL) and the field replicate from September/October (EPA) had > 25% RPD, but were low-level samples (< 5*MRL). Field precision DQO's do not apply. These data are accepted as valid estimates. All other chlorophyll-a data is valid. Note that the August field replicate collected at Echo Bay had values < MRL for both the fluorescence and spectrophotometric method.
2. **Total Phosphorus (TP)**— The August field replicate had a > 25% RPD (45%), but was a low-level sample (< 5*MRL). Field precision DQO's do not apply. The August-2013 TP data are conditionally accepted as valid estimates. All other TP data are valid.

3. **Total Dissolved Phosphorus (TDP)**— All TDP replicates are $< 5 \times \text{MRL}$ (low-level), with most measured values for field and sample replicates being $< \text{MRL}$. Field precision DQO's do not apply. The Augsut field replicate was $\geq 25\%$ RPD (32% RPD), but is a low-level sample. All other values were within the 25% RPD precision DQO. Data are valid, and not flagged as an estimate.
4. **Nitrate**— Note that many replicates were $< \text{MRL}$ and DQO's cannot be quantitatively assessed. All cases where DQO's can be assessed were within the 25% RPD precision DQO. All data are valid.
5. **Dissolved Cadmium**— The April-2013 field replicate exceeded the 25% RPD precision DQO (27% RPD). Data is low-level ($< 5 \times \text{MRL}$) and DQO's do not apply. Data accepted as valid due to close proximity to DQO target. *Not* flagged as an estimate.
6. **Dissolved Iron**— The July-2013 sample replicate exceeded the 25% RPD precision DQO (44% RPD). Data is low-level ($< 5 \times \text{MRL}$) and DQO's do not apply. All data for July-2013 are conditionally accepted as valid estimates. All other dissolved iron data are valid.
7. **Dissolved Manganese**— The April-2013 field replicate (26% RPD) exceeded the 25% RPD precision DQO. Data is not low-level ($> 5 \times \text{MRL}$), but is accepted as valid due to close proximity to DQO target. An August-2013 sample replicate (30% RPD) that exceeded the 25% RPD precision DQO, but a 2nd sample replicate in August met the DQO (4%). Data is not low-level ($> 5 \times \text{MRL}$), but is accepted as valid due to close proximity to DQO target and an average value $< 25\%$ RPD. *Not* flagged as an estimate.
8. **Total Iron**— The August-2013 sample replicate exceeded the 25% RPD precision DQO (26% RPD). Data is low-level ($< 5 \times \text{MRL}$) and DQO's do not apply. Data accepted as valid due to close proximity to DQO target. *Not* flagged as an estimate.

Note that all data that is conditionally accepted as an estimate is flagged as an estimate in data records, *only if* the value is $> \text{MDL}$ (or MRL , if lab does not report to MDL). Data that are below sensitivity limits are flagged as below detect.

3.3 Quality of Overall Dataset in 2013

This section summarizes results from measures used to assess the quality of the overall dataset in CY 2013. These are completeness, field-staff precision, comparability, and representativeness. The completeness measure considers the cumulative quality over all *Laboratory Analysis* and *Field Collection* DQO's. The other measures are more qualitative, and evaluate the integrity of the overall dataset with respect to the needs of the LMP.

Most DQO's for overall dataset quality were met in CY 2013. Some DQO's were not met for metals in the bays. The dataset is complete for all parameters collected at main lake locations, but the metals dataset is not representative for the northern bays. Metals data was only collected during spring for the bays, and cannot be compared with other years as an annual average. However, the metals data is representative of the spring season, and can be used for analyses that specifically account for seasonal effects. The overall data quality is high for all other measures.

Completeness. This sub-section summarizes results for the assessment of dataset completeness for 2013. Completeness assessments are given for all data collected across all sampling dates and locations, as well as for subsets that focus on LMP trigger criteria. Note that completeness DQO's from historic QAPP's apply to the overall dataset and are not specific to LMP trigger criteria. *No data were rejected in 2013. Completeness DQO's were met in 2013 for all parameters.*

Table 8. Field-staff precision for biologic and nutrient data in CY 2013 for the photic zone samples, near bottom samples, and overall average.

Parameter	Photic %RPD	Near Bottom %RPD	Overall %RPD	QA/QC Notes ^a
Biologic				
Fluorescence Chla	13%	n/a	13%	none
Spect. Chla ^b	79%	n/a	79%	Values < 5*MRL
Plankton bionumber (cells/mL)	The total bionumber of cells in photic zone agreed to within 45%. The %RPD of the ratios of major species groupings to total bionumber ranged from 6% to 65%, with an average of 25% (±27).			
Nutrients				
Total Phosphorus	9%	53%	31%	potential for sediment influence, <5*MRL
Total Dissolved Phosphorus	All data below Tribe Lab's MRL. Data agree.			Different MRL's for DEQ and Tribe Labs
Soluble Reactive Phosphorus ^c	Only photic zone data, all < MRL. Data agree.			Photic zone only
Total Nitrogen	65%	50%	58%	Different lab methods
Nitrate	2 of 2 < MRL	indeterminate	n/a	Near bottom sample had a split of < MRL, > MRL
Nitrite	Not measured in 2013			
Ammonia	2 of 2 < MRL	indeterminate	n/a	Near bottom sample had a split of < MRL, > MRL

^a QA/QC notes are discussed in the narrative. There are no formal DQO's, and data are not flagged or data records managed according to field-staff precision.

^b Spectrophotometric method of chlorophyll-a detection.

^c Sometimes reported as dissolved ortho-phosphate.

Field-Staff Precision. This sub-section summarizes results for the assessment of field-staff precision for 2013. Note that there are no formal DQO's for field-staff precision, and these studies are used for informational purposes to help assess the comparability and representativeness of joint, inter-agency sampling. One DEQ-Tribe side-by-side sampling event was conducted in CY 2013, at Blue/Chippy Pt (site C5) in October. During this event, DEQ and the Tribe each collected one photic zone sample and one near bottom sample. Results from this study are summarized in Table 8 and Table 9.

The data agreed to within 25% RPD for all chemical analytes (nutrients and metals) except for total nitrogen, near bottom total phosphorus, and the chlorophyll-a samples measured using the

spectrophotometric method (e.g., TCL Laboratories). All field-staff replicates were low-level samples with values < 5*MRL, and fluorescence-method chlorophyll-a values compared well. It is unclear why total nitrogen values had high %RPD's. DEQ and the Tribe utilize different laboratories, that employ different methods for extraction and analysis of total nitrogen and total phosphorus. In CY 2014, DEQ and the Tribe normalized total nitrogen analyses.

Measured values for total dissolved phosphorus, soluble reactive phosphorus, ammonia, and nitrate were predominantly below MRL and precision cannot be quantified. Measured values for these replicates agreed to within the limits of analytical capability.

With respect to phytoplankton data, the LMP has not established quantitative criteria for assessing phytoplankton community composition. Current criteria are qualitative, and data quality relative to those criteria can only be assessed qualitatively. Total bionumber for two replicate photic zone samples only agreed to within $\pm 50\%$, but the community composition as estimated by the ratio of major phytoplankton groups to total bionumber was much more consistent across the field-staff replicates. Biologic communities are inherently variable and these data are considered to be comparable and representative of the system.

With respect to metals, all data except iron, lead, and manganese agreed to within 25% RPD. These metals can be heavily influenced by sediment disturbance. Sediment disturbance could cause Tribe samples to be elevated relative to DEQ samples, resulting in higher %RPD's. Another possible factor is that the lake had recently reverted to near-isothermal conditions after a long stratified period. Hydrodynamics and wind mixing during this period of lake mixing could also account for some of the observed variability. These effects could also elevate total phosphorus values. Note that all samples with >25% RPD were low-level (< 5*MRL).

Table 9. Field-staff precision for dissolved and total metals data in CY 2013 for the photic zone samples, near bottom samples, and overall average.

Parameter	Photic %RPD	Near Bottom %RPD	Overall %RPD	QA/QC Notes ^a
Dissolved Metals				
Dissolved As	0%	2%	1%	None
Dissolved Cd	0%	indeterminate	0%	Near bottom sample had a split of < MRL, > MRL
Dissolved Pb	8%	38%	23%	potential sediment influence for near bottom, < 5*MRL
Dissolved Zn	1%	14%	8%	none
Dissolved Fe	5%	67%	36%	potential sediment influence for near bottom, < 5*MRL
Dissolved Mn	6%	184%	95%	potential sediment influence for near bottom, < 5*MRL
Dissolved Ca	2%	0.5%	1.2%	none
Dissolved Mg	1%	2%	2%	none
Total Metals				
Total As	All values < MRL. DQO's cannot be evaluated.			
Total Cd	All values < MRL. DQO's cannot be evaluated.			
Total Pb	5%	55%	30%	potential sediment influence for near bottom, < 5*MRL
Total Zn	21%	8%	14%	none
Total Fe	22%	72%	47%	potential sediment influence for near bottom, < 5*MRL
Total Mn	2%	173%	88%	potential sediment influence for near bottom, < 5*MRL
Total Ca	Not measured in 2013.			
Total Mg	Not measured in 2013.			
Total Hardness (mg/L CaCO3)	0%	2%	1%	none

^a QA/QC notes are discussed in the narrative. There are no formal DQO's, and data are not flagged or data records managed according to field-staff precision.

Comparability. This sub-section summarizes results for the assessment of dataset comparability for 2013. The high data quality for all parameters means that the data is comparable with historic datasets for all parameters. DEQ and Tribe data were comparable for all parameters except low-level metals that can be heavily influenced by sediment disturbance. The potential impact of sediment disturbance is a quality concern for these metals. However, all high %RPD's were observed only in the near bottom for low-level samples where analytical constraints inherently limit accuracy and precision. These data are valid estimates.

The phosphorus data for CY 2013 side-by-side was more comparable than in the CY 2012. Laboratory splits. All values were low-level, where field precision DQO's are not consistently reliable measures of data quality. The photic zone replicate was < 25% RPD, and near-bottom

replicate may have also been influenced by bottom sediment. The phosphorus data for CY 2013 are considered to be comparable between DEQ and the Tribe.

Representativeness. This sub-section summarizes results for the assessment of dataset representativeness for 2013. The data for CY 2013 is a complete, high-quality dataset for all parameters. However, the standard LMP sampling plan was not utilized for metals analyses in the northern bays. Unforeseen constraints from the USEPA forced cut-backs in metals analyses, and a full dataset was not collected for the bays. Metals data was only collected in the bays for the early spring months, as follows.

- *Echo Bay*—April, May, June
- *Cave Bay*—April, June
- *Bennett Bay*—April, June

This lack of samples means that metals data for the northern bays in CY2013 is not representative of the entire year. These data cannot be compared on an annual basis, but are comparable for analyses that specifically account for seasonality. Metals data are representative for main lake locations.

CY 2013 data is representative for all parameters except metals in the northern bays.

4 Data Quality Report for CY 2014

This section provides a summary of data quality for CY 2014, relative to the DQO's summarized in Section 1. This section only provides a performance summary. Detailed data reports to support this summary are available from DEQ upon request. The LMP had 8 sampling events in 2014 (March, April, May, June, July, August, September, December).

4.1 Quality of Laboratory Analyses in 2014

This section summarizes results from measures used to assess the data quality of laboratory measurements in CY 2014. These are accuracy, laboratory precision, laboratory contamination, and sensitivity. Summary results are presented in tables that detail whether DQO's were met for each sampling run in CY 2014. Deviations and laboratory notes are noted as necessary and summarized in the text. *All laboratory DQO's were met for all parameters in CY 2014.*

Sensitivity. This sub-section summarizes DQO's for *Sensitivity* for all biologic and chemical parameters for 2014. Values are given for both MDL and MRL. LMP data records for CY 2014 flag *Sensitivity* data quality as follows.

- All values < MDL are recorded as 0.5*MDL and flagged as “below detection limit” (U).
- Values < MRL are recorded in one of two ways
 - If data are reported to MDL, then all values where MDL < value < MRL as flagged as “estimates” and recorded to 1 significant figure.
 - If data are reported to MRL, then all values are recorded as 0.5*MRL and flagged as “below detection limit” (U-flag).

- All values < 5*MRL are reported to no more than 2 significant figures. Values > 5*MRL are reported to three significant figures.

Sensitivity parameters (MDL, MRL) for CY 2014 are the same as for CY 2013.

Table 10. Laboratory accuracy, precision, and contamination data quality for CY 2014.

Parameter	Blanks < MDL/MRL	LCS/LCSD ±20%	MS/MSD ±20%	%RPD ≤20%	DQOs met?	Lab QA/QC Notes ^a
Biologic						
Fluorescence Chla	4/4	4/4	n/a	n/a	All	none
Spectrophotometric Chla	Laboratory data quality not recorded in 2014.					
Plankton bionumber (cells/mL)	n/a	n/a	n/a	n/a	All	none
Nutrients						
Total Phosphorus	8/8	8/8	8/8	8/8	All	Note #1
Total Dissolved Phosphorus	8/8	8/8	8/8	8/8	All	none
Soluble Reactive Phosphorus ^b	8/8	8/8	8/8	8/8	All	Note #2
Total Nitrogen	8/8	8/8	8/8	8/8	All	none
Nitrate	8/8	8/8	8/8	8/8	All	Note #3
Nitrite	Not measured in CY 2014.					
Ammonia	8/8	8/8	8/8	8/8	All	none
Metals^c						
Dissolved, Total As	8/8	8/8	8/8	8/8	All	none
Dissolved, Total Cd	8/8	8/8	8/8	8/8	All	none
Dissolved, Total Pb	8/8	8/8	8/8	8/8	All	none
Dissolved, Total Zn	8/8	8/8	8/8	8/8	All	none
Dissolved, Total Fe	8/8	8/8	8/8	8/8	All	Note #4
Dissolved, Total Mn	8/8	8/8	8/8	8/8	All	none
Dissolved, Total Ca	8/8	8/8	8/8	8/8	All	none
Dissolved, Total Mg	8/8	8/8	8/8	8/8	All	none
Total Hardness (mg/L CaCO ₃)	8/8	8/8	8/8	8/8	All	none

^a Numbers for Laboratory QA/QC notes refer to numbered list in the narrative.

^b Sometimes reported as dissolved ortho-phosphate.

^c Unless otherwise noted, table cells refer to both total and dissolved metals.

Laboratory accuracy, precision, and contamination. This sub-section summarizes laboratory performance relative to DQO's for accuracy, precision, and contamination for all biologic and chemical parameters for 2014. *All data met standard or alternate DQO's for laboratory accuracy, precision, and contamination for 8 of 8 sampling events in 2014, for all parameters.*

A summary is provided in Table 10, and presents results for all sampling runs in terms of the proportion of events where the associated laboratory DQOs were met for all parameters (e.g., 8/8 means that DQO's for that parameters were met for 8 out of 8 sampling events). For some cases, data may have been accepted as valid based on alternate DQO's as per laboratory standard methods, or there are non-critical data qualifiers to be noted in data records. These instances are indicated in the table and presented here. Also note that some laboratories report blanks to MRL, while others report to MDL. Contamination is assessed based on the lowest values the laboratory reports to.

Minor laboratory qualifiers were issued in CY 2014. None of these qualifiers were critical, and they did not negatively impact data quality. All data for 2014 are accepted as valid with respect to laboratory QA/QC measures. The non-critical laboratory qualifiers are summarized below.

1. **Total Phosphorus (TP)**— two separate lab qualifiers issued by TCL, in March and May. These apply only to TCL data, which were part of a lab inter-comparison study and are *not* used for trend monitoring in the northern lake. SVL data are used for trend monitoring.
 - a. *March 2014*— The MS recovery was outside the range of 80 – 120%, data accepted based on acceptable LCS recovery (QM-07).
 - b. *May 2014*— The MS/MSD precision was > 20% RPD. Data accepted based on acceptable LCS/LCSD precision (QR-01).
2. **Soluble Reactive Phosphorus (SRP)**— TCL issued a lab qualifier in March-2014. The SRP MS/MSD precision was > 20% RPD. Data accepted based on LCS /LCSD (QR-01).
3. **Nitrate**— TCL issued a lab qualifier in August-2014. The MS/MSD precision was > 20% RPD. Data accepted based on LCS /LCSD (QR-01).
4. **Total and Dissolved Iron**— USEPA could not meet the MRL of 5 µg/L for total and dissolved iron for 7 of 8 sampling runs, though values could be detected with reduced precision. All iron data < 20 µg/L in CY 2014 is conditionally accepted as an estimate.
5. **Description of Lab Qualifiers**— the lab qualifier notes issued in 2014 are as follows.
 - a. *QM-07 (TCL)*— The MS/MSD spike recovery is outside acceptable limits. Batch is accepted based on LCS recovery.
 - b. *QR-01 (TCL)*— Analyses not controlled on RPD for values with concentrations < 10*MRL. QC batch accepted based on LCS or LCSD QC results.

4.2 Quality of Field Collection in 2014

This section summarizes results from QA/QC measures used to assess the quality of field collection in CY 2014. These are contamination and field precision. Summary results are presented in tables that detail whether DQO's were met for each sampling run in CY 2014, and discussed in the narrative. Deviations and laboratory notes are noted as necessary. *All DQO's for field and reagent contamination were met in CY 2014. Some DQO's for field precision were exceeded.*

Contamination. This sub-section summarizes QA/QC performance relative to equipment, field, and reagent contamination. Laboratory water blanks (i.e., Type 1, Type 2 water) are used to assess reagent contamination. Equipment blanks are used to assess equipment contamination. Field blanks are used to assess field contamination. Results are summarized below.

1. ***Reagent contamination***— two laboratory water blanks were collected in March 2014. Both water blanks met all contamination DQO's.
2. ***Equipment contamination***—equipment blanks were collected in March 2014 and December 2014. Both equipment blanks met all contamination DQO's.
3. ***Field contamination***— four field blanks were collected in 2013 (March, July, September, December). All contamination DQO's were met for all field blanks.
 - *Note*— The July field blank met the DQO with respect to MRL, but slightly exceeded the MDL for total phosphorus. Field cleaning procedures were strengthened, and the follow-on field blank in September was < MDL.

Note that some laboratories report blanks to MRL, while others report to MDL. Contamination is controlled based on MRL, but also assessed based on MDL as possible.

Field Precision. This sub-section summarizes results QA/QC performance relative to field precision for 2014. This section only covers precision for field replicates and sample replicates collected by DEQ technical staff. Field-staff replicates are considered to be a measure of comparability of data collected by the different agencies that are partners in the LMP, and are discussed in the sub-section that discusses *Quality of the Overall Dataset*. Four field replicates and six sample replicates were collected in 2014 according to the schedule below.

- *Field replicates (4)*—two in June (Gasser-photoc, Gasser-NB), two in September (C5-photoc, C5-NB). *All 4 field replicates had metals analyses.*
- *Sample replicates (6)*—April (C4-NB), May (C1-20m), 2* July (C1-photoc, Beauty Bay photoc), 2* September (Beauty Bay NB, C4-20m). *Only 5 sample replicates had metals analyses.*
- *Note #1*—C1 = Tubbs Hill site, C4 = University Point site, C5 = Blue/Chippy Point site, Gasser = Gasser Point Site, all bays refer to bay sampling locations.
- *Note #2*—photoc = photic zone composite, 20m = 20 meters depth, 25m = 25 meters depth, 30m = 30 meters depth, 40m = 40 meters depth, NB = near bottom.

These data are summarized in Table 11 and Table 12. *All samples were accepted as valid with respect to precision DQO's. None were rejected. Some samples were conditionally accepted as estimates, and are flagged in data records.*

As in prior sections, these tables summarize results for all sampling runs in terms of the proportion of events where the associated field precision DQOs were met for each parameter (e.g., 7/7 means that DQO's were met for 7 out of 7 sampling events). Replicate samples where one or both of the measured values are < MRL are excluded from the analysis, as %RPD cannot be assessed. The range and average %RPD of sample replicates and field replicates is also provided for informational purposes, as is the combined average %RPD and standard deviation over all field and sample replicates collected that year.

Table 11. Field precision data quality for biologic and nutrient data in CY 2014 for sample replicates (SR) and field replicates (FR). %RPD's are for both the range and average.

Parameter	SR %RPD	SR DQO Met? ^a	FR %RPD	FR DQO Met? ^a	Overall %RPD	Field QA/QC Notes ^b
Biologic						
Fluorescence Chla	No sample replicates		6% (4-8)	2/2	6% (±3)	none
Spect. Chla ^c	9%	1/1	5% (4-7)	2/2	6% (±3)	none
Plankton bionumber (cells/mL)	No field precision DQO's established in the 2014 QAPP.					
Nutrients						
Total Phosphorus	12% (4-21)	6/6	18% (11-33)	4/4	15% (± 9)	Note #1
Total Dissolved Phosphorus	12% (0-44)	6/6	7% (3-13)	4/4	10% (±13)	Note #2
Soluble Reactive Phosphorus ^d	All values < MRL. DQO's cannot be evaluated					
Total Nitrogen	8% (3-11)	6/6	7% (2-18)	6/6	7% (± 5)	none
Nitrate	12% (0-31)	3/3	2% (0-4)	2/2	8% (± 13)	Note #3
Nitrite	Not measured in CY 2014					
Ammonia	8%	1/1	4/4 < MRL	< MRL	~8%	Note #3

^a DQO's do not apply when analytes are < MRL, yielding fewer instances that can be evaluated.

^b Numbers field QA/QC notes refer to numbered list in the narrative.

^c Spectrophotometric method of chlorophyll-a detection.

^d Sometimes reported as dissolved ortho-phosphate.

Table 12. Field precision data quality for total and dissolved metals data in CY 2014 for sample replicates (SR) and field replicates (FR). %RPD's are for both the range and average.

Parameter	SR %RPD	SR DQO Met? ^a	FR %RPD	FR DQO Met? ^a	SR, FR Average %RPD	Field QA/QC Notes ^b
Dissolved Metals ^c						
Dissolved As	2.5% (0-3.5)	5/5	4% (2-7)	4/4	3% (± 2)	none
Dissolved Cd	4% (0-11)	5/5	5% (0-9)	4/4	4% (± 4)	none
Dissolved Pb	3.0%	1/1	12% (11-13)	4/4	9% (± 5)	none
Dissolved Zn	2.2% (0.5-9)	5/5	3% (0-5)	4/4	3% (± 3)	none
Dissolved Fe	4.4%	1/1	27% (0-64)	4/4	23% (± 27)	Note #4
Dissolved Mn	4% (2-8)	5/5	28% (5-82)	3/4	15% (± 26)	Note #5
Dissolved Ca	0.5% (0-1)	5/5	0.7% (0-2)	4/4	1% (± 1)	none
Dissolved Mg	0.5% (0-1)	5/5	0.5% (0-1.5)	4/4	1% (± 1)	none
Total Metals ^c						
Total As	All values < MRL. DQO's cannot be evaluated.					
Total Cd	1/5 < MRL	4/4	5% (0-10)	4/4	3% (± 4)	none
Total Pb	0.5% (0-2)	5/5	10% (0-28)	3/4	5% (± 10)	Note #6
Total Zn	1.3% (0.5-2)	5/5	4% (0-8)	4/4	3% (± 3)	none
Total Fe	14% (0-40)	5/5	8% (2-15)	4/4	12% (± 13)	Note #7
Total Mn	2% (1-3.5)	5/5	9% (4-20)	4/4	5% (± 6)	none
Total Ca	Not collected in 2014.					
Total Mg	Not collected in 2014.					
Total Hardness (mg/L CaCO ₃)	1% (0-1.6)	5/5	1% (0-1.6)	4/4	1% (± 1)	none

^a DQO's do not apply when analytes are < MRL, yielding fewer instances that can be evaluated.

^b Numbers for field QA/QC notes refer to numbered list in the narrative.

^c % RPD values are reported as "range", "average%". The values in the range are minimum and maximum %RPD's observed for that parameter over all replicates.

Cases where data have been rejected conditionally accepted as valid estimates using alternate DQO's are discussed below. Note that alternate DQO's include low-level samples and cases where one replicate for a given run meets DQO's while the other does not. There also may be non-critical data qualifiers, such as COC errors, to be noted in data records. All such instances that are indicated in the tables are discussed here.

- 1. Total Phosphorus (TP)**— One of the two June-2014 field replicates at Gasser Point exceeded the 25% precision DQO (33%). The other field replicate met DQO's. All values were low-level (< 5*MRL). The June-2014 TP data are accepted as estimates.
- 2. Total Dissolved Phosphorus (TDP)**— The Sep-2014 sample replicate at Beauty Bay exceeded the 25% precision DQO (44%). The two field replicates at C5 met DQO's. All values were low-level (< 5*MRL). The Sep-2014 TDP data are accepted as estimates.
- 3. Ammonia and Nitrate**— The May-2014 nitrate sample (31% RPD) exceeded the 25% precision DQO. Values were low-level (< 5*MRL) and DQO's don't apply. For ammonia, only one field precision QA sample was above MRL.

4. ***Dissolved Iron (Fe)***— One of two field replicates in Sep-2014 exceeded the 25% precision DQO (64%). Values were low-level (< 5*MRL). September data are accepted as estimates based on being low-level and having one of two samples < 25% RPD.
5. ***Dissolved Manganese (Mn)***— One of two field replicates in Sep-2014 exceeded the 25% precision DQO (88%). This sample was not low level. September field data are accepted as estimates because one of two field replicates met precision DQO's.
6. ***Total Lead (Pb)***— One of two field replicates in Sep-2014 exceeded the 25% precision DQO (28%). September field data are accepted as estimates because one of two field replicates met precision DQO's.
7. ***Total Iron (Fe)***— One sample replicates in Sep-2014 exceeded the 25% precision DQO (40%), but was below the EPA lab control level of 20 µg/L reported in the laboratory QA section. This sample is low-level (< 5*MRL). September data are accepted as estimates.

Note that all data that is conditionally accepted as an estimate is flagged as an estimate in data records, *only if* the value is > MDL (or MRL, if lab does not report to MDL). Data that are below sensitivity limits are flagged as below detect.

4.3 Quality of Overall Dataset in 2014

This section summarizes results from measures used to assess the quality of the overall dataset in CY 2014. These are completeness, field-staff precision, comparability, and representativeness. The completeness measure considers the cumulative quality over all *Laboratory Analysis* and *Field Collection* DQO's. The other measures are more qualitative, and evaluate the integrity of the overall dataset with respect to the needs of the LMP.

All DQO's for overall dataset quality were met in CY 2014. The dataset is complete for all parameters. Note that metals data was only collected in Beauty Bay, in the eastern end of the northern pool. Beauty Bay is one of the lake's most pristine bays, and may be the least impacted by metals contamination and phosphorus loading. This data can be considered to be representative of the lightly developed bays adjacent to the northern pool, but may not be representative of the bays in the central pool that are closer to the Coeur d'Alene River – or the more heavily developed bays.

Completeness. This sub-section summarizes results for the assessment of dataset completeness for 2014. Completeness assessments are given for all data collected across all sampling dates and locations, as well as for subsets that focus on LMP trigger criteria. Note that completeness DQO's from historic QAPP's apply to the overall dataset and are not specific to LMP trigger criteria. *No data were rejected in 2014. Completeness DQO's were met in 2014 for all parameters.*

Field-Staff Precision. This sub-section summarizes results for the assessment of field-staff precision for 2014. Note that there are no formal DQO's for field-staff precision, and these studies are used for informational purposes to help assess the comparability and representativeness of joint, inter-agency sampling. Two DEQ-Tribe side-by-side sampling events were conducted in CY 2014, at University Point (C4) in June and Blue/Chippy Pt (site C5) in September. During these events, DEQ and the Tribe each collected one photic zone sample and one near bottom sample. Results from this study are summarized in Table 13 and Table 14.

The data agreed to within 25% RSD for all photic zone chemical analytes (nutrients and metals) except for dissolved lead, dissolved manganese, and dissolved iron. Iron and lead replicates were low-level samples with values < 5*MRL, but manganese was not. The pattern of differences suggests that one replicate (Sept-2014 at C5-Chiipy/Blue Point) may have been influenced by suspended colloids. The data also agreed to within 25% RSD for all near bottom samples except for dissolved manganese. The reduced precision occurred for near bottom samples that had abnormally high dissolved manganese levels that may be associated with sediment anoxia.

Table 13. Field-staff precision for biologic and nutrient data in CY 2014 for the photic zone samples, near-bottom samples, and overall average.

Parameter	Photic %RSD	Near Bottom %RSD	Overall %RSD	QA/QC Notes ^a
Biologic				
Fluorescence Chla	9% (± 6)	n/a	9% (± 6)	none
Spect. Chla ^b	19% (± 7)	n/a	19% (± 7)	none
Plankton bionumber (cells/mL)	For Sep-2014, the total bionumber of cells in photic zone agreed to within 9%. The %RSD of the ratios of major species groupings to total bionumber ranged from 12% to 70%, with an average of 38% (± 26).			
Nutrients				
Total Phosphorus	13% (± 9)	12% (± 2)	13% (± 6)	Low-level
Total Dissolved Phosphorus	18% (± 3)	19% (± 12)	18% (± 7)	Low-level
Soluble Reactive Phosphorus ^c	All data < MRL. Data agree.		none	
Total Nitrogen	15% (± 1)	21% (± 1)	18% (± 4)	none
Nitrate	2 of 2 < MRL	12% (± 2)	12% (± 2)	none
Nitrite	Not measured in 2013			
Ammonia	All data < MRL. Data agree		none	

^a QA/QC notes are discussed in the narrative. There are no formal DQO's, and data are not flagged or data records managed according to field-staff precision.

^b Spectrophotometric method of chlorophyll-a detection.

^c Sometimes reported as dissolved ortho-phosphate.

Table 14. Field-staff precision for total and dissolved metals data in CY 2014 for the photic zone samples, near-bottom samples, and overall average.

Parameter	Photic %RSD	Near Bottom %RSD	Overall %RSD	QA/QC Notes ^a
Dissolved Metals				
Dissolved As	3% (± 2)	4% (± 3)	3% (± 2)	none
Dissolved Cd	6%	5% (± 4)	5% (± 3)	September photic < MRL
Dissolved Pb	40% (± 6)	13% (± 11)	26% (± 17)	potential colloid influence
Dissolved Zn	7% (± 3)	4% (± 4)	6% (± 3)	none
Dissolved Fe	24% (± 6)	22% (± 19)	23% (± 12)	potential colloid influence
Dissolved Mn	35% (± 14)	26% (± 21)	30% (± 15)	potential colloid influence
Dissolved Ca	1% (± 0.1)	1% (± 0.3)	1% (± 0.3)	none
Dissolved Mg	1% (± 0.6)	1% (± 1)	1% (± 1)	none
Total Metals				
Total As	All values < MRL. DQO's cannot be evaluated.			
Total Cd	5%	3% (± 1)	4% (± 1)	September photic < MRL
Total Pb	16% (± 12)	4% (± 3)	10% (± 10)	none
Total Zn	7% (± 7)	4% (± 0.1)	5% (± 4)	none
Total Fe	5% (± 4)	5% (± 1)	5% (± 3)	none
Total Mn	7% (± 2)	6% (± 2)	7% (± 2)	none
Total Ca	Not measured in 2014.			
Total Mg	Not measured in 2014.			
Total Hardness (mg/L CaCO ₃)	1% (± 0)	1% (± 0.2)	1% (± 0.2)	none

^a QA/QC notes are discussed in the narrative. There are no formal DQO's, and data are not flagged or data records managed according to field-staff precision.

Comparability. This sub-section summarizes results for the assessment of dataset comparability for 2014. The high data quality for all parameters means that the data is comparable with historic datasets for all parameters. DEQ and Tribe data were comparable for all parameters except low-level metals that are heavily influenced by sediment disturbance. The potential impact of sediment disturbance is a quality concern for these metals. However, all high %RPD's were observed only in the near bottom for low-level samples where analytical constraints inherently limit accuracy and precision. These data are valid estimates.

The phosphorus data for CY 2014 side-by-side was comparable to within 25% RPD, which is better performance than in both CY 2012 and CY 2013. Phosphorus data are comparable.

Representativeness. This sub-section summarizes results for the assessment of dataset representativeness for 2014. The data for CY 2014 is a complete, high-quality dataset for all parameters. Note that metals data was only collected in one bay site, Beauty Bay. Beauty Bay is

in the eastern end of the northern pool, and one of the least developed bays in Coeur d'Alene Lake. It is isolated from the mouth of the Coeur d'Alene River, and may not be representative of conditions in bay locations closer to the river mouth. Lake geography should be taken into account when using CY 2014 data to assess metal trends for the northern bays.

5 Additional Quality Assessments

This section provides a summary of additional quality assessments that were conducted and completed in the 2012 – 2014 timeframe. Some of these studies are ongoing, and only studies that were completed by the end of CY 2014 will be reported here. These studies involve phosphorus data quality, the comparability of different methods for chlorophyll-a analysis, and the potential influence of colloidal material on measurements of dissolved/filtered parameters.

Colloidal Influences. In CY 2011 and prior years, LMP staff had noticed that water filtered through the standard 0.45 micron filters used for water quality analyses were sometimes cloudy with small suspended particles –likely colloids. EPA Laboratory quality reports confirmed presence of colloids when present, and noted potential impacts on data quality. LMP stakeholders also expressed concern about the potential influence of colloids.

In CY 2012, DEQ staff conducted studies to assess the potential impact of colloidal material. This study was conducted by sequentially filtering samples through 0.45 micron filters, and then post-filtered with 0.1 micron filters. Dissolved metals were measured at each step. Dissolved phosphorus was not measured; as it is typically below reporting limits and analytical methods most likely will not be able to measure the differences. The results of this study are as follows.

- *Dissolved calcium (Ca) and magnesium (Mg)*—virtually no difference.
- *Dissolved zinc (Zn)*—post-filtering removed an average of 2% ($\pm 2.5\%$). This is less than 5% for all samples, and not consistent across all samples.
- *Dissolved arsenic (As), cadmium (Cd), and manganese (Mn)*—post-filtering removed an average of 12% ($\pm 16\%$). On isolated occasions, up to 50 – 70% was removed. This impact is consistent across most samples, but is less than the target field precision of 25% RPD.
- *Dissolved iron (Fe), and lead (Pb)*—post-filtering removed an average of 40% ($\pm 25\%$). On isolated occasions, up to 70 – 90% was removed. This is a significant impact whose magnitude is generally greater than the target field precision of 25% RPD.

Results from this study indicate that colloidal materials do consistently impact results for dissolved metals other than calcium, magnesium, and zinc. The impact is greatest for iron and lead and least for calcium, magnesium, and zinc. Post-filtering removed less than 25% for all metals except iron and lead, suggesting that colloids may not exert a significant bias on results for these metals (e.g. measurable within the limits of field precision). Colloidal material does consistently bias dissolved lead and iron upward.

These results do indicate that the “dissolved” fraction of metals, which is defined as the proportion of metals that pass through a 0.45 micron filter, does not truly reflect the “aqueous” species of metals for arsenic, cadmium, iron, manganese, and lead. The truly “aqueous” fraction, which is used in most geochemical and toxicity models, will be less than the “dissolved/filtered” fraction measured in LMP monitoring efforts. However, this is not a unique problem to the LMP

and does not impact interpretation of water quality standards that are built around the 0.45 micron –filtered definition for dissolved material. This is a known issue for many waters around the U.S., and the impact of colloidal material on water quality standards is factored into the assessment process.

The standard methodology for accounting for colloidal influences involves broad assumptions about how colloidal material impacts water quality from both an ecologic and health perspective. These assumptions may or may not be accurate, and thus best practices should take reasonable actions to limit potential biases associated with colloids. The LMP is taking two actions to specifically address this issue. These are outlined below.

- *The potential impact of colloids is acknowledged.* Management assessments and technical analyses attempt to account for colloidal impacts to the extent practical and feasible.
- *Field collection methods attempt to reduce the influence of colloids on measurements of “dissolved” metals.* This is done by the following modifications to field sampling.
 - LMP staff utilizes improved filters that are more durable and less susceptible to colloidal breakthrough during field sampling.
 - LMP staff first filters sufficient water for the metals container, collect the sample, and then filters for the remainder of “dissolved” samples that are less sensitive to colloids. This reduces the mass of colloids in the “dissolved” sample.

These actions cannot perfectly account for colloidal impact. However, they are best practices that effectively mitigate colloidal influence and improve the quality and comparability of LMP data. USEPA has not issued a colloid-related notice of violation in their data quality reports since this procedure was implemented.

Chlorophyll-*a*. USEPA has historically conducted chlorophyll-*a* analyses for the LMP, using a fluorescence detection method. However, EPA has reduced analytical support to the LMP. EPA ramped down chlorophyll-*a* analyses over a 2 year period (CY 2013 – 2014), and no longer provides chlorophyll-*a* analyses for the LMP. Local providers at this time used a different analytical method (spectrophotometric detection). Literature studies report that these different methods can yield a different value for sample splits. This difference arises from the different sensitivity of the spectrophotometric method relative to the fluorescence method, and differences in how the methods respond to other organic compounds that can interfere with the analysis.

In response, LMP staff conducted a sample-split study where identical samples were sent to both EPA and a local provider (TCL Laboratories) in CY 2013 and CY 2014. Results from these studies indicated that the different methods do produce consistently different results. The magnitude and consistency of the differences are not the same across the lake, but instead change from site-to-site and season-to-season. This generates a comparability problem. Data from the spectrophotometric method are not directly comparable to historic data from the fluorescence method. This difference needs to be accounted for in trend analysis and data quality management.

For the oligotrophic regions of the northern lake, the results from the spectrophotometric method are consistently ~0.5 – 1.0 µg/L *lower* than those from the fluorescence method. Results from the two methods correlate, and one can be predicted from the other with acceptable accuracy. However, the correlation is much weaker for the more mesotrophic regions in the southern lake

and far northwestern corner (i.e., adjacent to Cougar Bay and Blackwell Isl. Marina, near the outlet to the Spokane River). The different chlorophyll-*a* analyses do not compare well in these regions.

DEQ and the Tribe are continuing to conduct sample-split studies to improve comparability between the different methods. These will be reported as results become available. Additionally, DEQ has identified a local vendor who can provide fluorescence method analyses of chlorophyll-*a*. DEQ will use the fluorescence method again beginning in CY 2016 (CY 2015 is spectrophotometric method). The Tribe is also considering the utility of conducting additional fluorescence analyses.

Phosphorus. LMP stakeholders have raised two issues relative to phosphorus data quality, (i) concern over poor reproducibility for some DEQ field samples collected in CY 2011, and (ii) poor reproducibility for some DEQ-Tribe field-staff replicates collected at annual side-by-side sampling events prior to CY 2012. The LMP staff has taken three actions to address these concerns in the CY 2012 – 2014 timeframe. These actions are enumerated below.

1. *Poor reproducibility for select DEQ field samples in CY 2011*—DEQ has conducted an audit of internal QA/QC records.
2. *Poor reproducibility for some DEQ-Tribe field-staff replicates collected prior to CY 2012*—DEQ and the Tribe have taken two actions, enumerated below.
 - DEQ and the Tribe have initiated an inter-laboratory study to determine the reproducibility of phosphorus analyses for sample-splits collected at the same location. This will help determine whether the different methods employed by the different laboratories yield consistently different analytical results on the same sample.
 - DEQ and the Tribe have increased the number of side-by-side samples collected. This will help determine whether differences are consistent biases, or one-off differences associated with inherent field variability.

With respect to point #1, a set of laboratory inter-comparison sample splits collected from the photic zone at Tubbs Hill (May-2011) did not meet data quality objectives of $\leq 25\%$ RPD (2011 LMP annual report, Table 25). The %RPD's for these splits were 26% for total phosphorus (TP), 89% for total dissolved phosphorus (TDP), and $>135\%$ for dissolved ortho-phosphate (DOP). Follow-on investigations were conducted in CY 2011. These investigations compared dissolved ortho-phosphate results from SVL to those from TCL for samples collected from other locations on the lake. Note that all samples sent to SVL were managed according to proper chain of custody requirements for dissolved ortho-phosphate. The samples sent to TCL were not managed according to chain of custody protocols for dissolved ortho-phosphate. These follow-on samples demonstrated additional large discrepancies between the different laboratories. DEQ conducted an internal audit of QA/QC records in CY 2012 and found the following.

1. For laboratory sample splits on lake waters collected from the photic zone at station C1 (Tubbs Hill), field staff likely acidified the wrong Tshimakin Creek Laboratories sample bottle(s). The reasons for this conclusion are as follows.
 - a. TDP bottles are acidified in the field, DOP bottles are not.
 - b. DOP was greater than TDP. This is physically impossible, as DOP is a subset of TDP.

- c. The TCL-TDP value was comparable with SVL-DOP, and the TCL-DOP value was comparable with the SVL-TDP
 - d. Both total phosphorus values were comparable for low-level analytes.
2. For all other laboratory splits for dissolved ortho-phosphate (DOP) for samples collected in May-2011 from other sampling sites, chain of custody requirements were not followed. This yielded faulty data that should be rejected and not used for analysis.
 - a. Billing records and chain of custody documents do not report dissolved ortho-phosphate samples from the May-2011 sampling event being sent to Tshimakin Creek Laboratories for any other sample than the photic zone at Tubbs Hill.
 - b. TCL reports that DOP analyses were conducted on nitrate samples for May-2011. These samples were not managed according to QAPP protocols for DOP.
 - c. TCL reports that results from ion chromatography analyses for DOP in those samples were all < 10 µg/L (detection limit), while the results from the spectrophotometric DOP method ranged from 12 – 13 µg/L.
3. The May-2011 laboratory sample splits are faulty for all data except total phosphorus. The data for TDP and DOP are invalid. These samples cannot be compared for QA/QC purposes.

With respect to the first phosphorus data quality concern (poor reproducibility for one set of field samples collected in CY 2011), this follow-on assessment concludes that two single-incident staff mistakes in May-2011 produced a set of inter-laboratory duplicate samples that exceeded data quality objectives (DQO's) of 25% RPD for replicate samples. These mistakes were (i) field staff accidentally reversing field preservation and sample handling protocols for total dissolved phosphorus and dissolved ortho-phosphate samples collected from the photic zone at Tubbs Hill in May-2011, and (ii) field staff mistakenly reported results for other dissolved ortho-phosphate samples from the May-2011 run that were analyzed by Tshimakin Creek Laboratories but not managed according to chain of custody requirements

With respect to point #2 (poor comparability between DEQ and Tribe phosphorus data collected during side-by-side events prior to CY 2012), DEQ and the Tribe acknowledge poor comparability in some phosphorus samples collected during side-by-side sampling events. However, these issues are intermittent. Reproducibility is good for some samples, but not others. QA/QC results from CY 2014 indicate that part of the problem is field variability. The average over many comparisons is better than for single comparisons. Comparability should be judged on a larger batch of samples rather than single events. DEQ and the Tribe will continue to use the expanded side-by-side sampling approach. The inter-laboratory sampling comparison is ongoing, and will be reported on in subsequent reports. Preliminary data from this inter-laboratory analytical method comparison suggest that there may be a consistent bias between different total phosphorus analytical methods used by different laboratories for samples collected from the northern lake. Additional, follow-on analyses are on-going. This analysis includes comparison for samples currently being collected from the southern lake.

6 Summary of QA/QC Performance, 2012–2014

This section summarizes the overall performance of LMP data relative to their associated DQO's for CY 2012 – 2014. The QA/QC summaries are presented in order of descending level of detail. Detailed QA/QC breakdowns for all data collected on 2012 – 2014 are presented in the prior sections. Detailed QA/QC breakdowns for 2007 – 2011 are provided in prior annual reports. Note that data quality assessments for prior studies conducted by agencies other than DEQ and the Tribe are discussed in their associated reports. Their data quality is not discussed in this report

6.1 Data Quality Summary for 2012

Data from CY 2012 met all requirements for *Quality of Laboratory Analyses* and are all quality data from a laboratory perspective. All data except for phosphorus parameters met DQO's for *Quality of Field Collection* for $\geq 99\%$ of all samples collected. With the exception of phosphorus, samples collected in 2012 are also quality data from a field collection perspective.

There are data quality issues associated with the phosphorus data collected in CY 2012. Contamination in water blanks and field blanks require that all the total phosphorus and total dissolved phosphorus data from the March-2012 sampling event be rejected. The lack of proper confirmatory field, water, or equipment blanks between March-2012 and July-2012 consequently requires that all phosphorus data collected in those months be only conditionally accepted as lower-quality estimates. Additionally, the lab-sample split data collected in 2012 indicate that total phosphorus and soluble reactive phosphorus sample analyses did not compare well between DEQ and Tribe laboratories. *This combination of data quality issues requires that all phosphorus data collected in 2012 be treated with caution. Most of the data is valid, and long-term trend analyses are not significantly impacted by the rejection of phosphorus data from the March-2012 sampling event. However, there is a potential for bias if CY 2012 is compared to other years on a single-year, one-on-one basis.*

DEQ and the Tribe have developed and implemented response plans to the phosphorus issues identified in CY 2012. Standard methods for operating the Milli-Q water system were modified to mitigate that source of contamination. Procedures for responding to contaminated blanks have been strengthened, and follow-on investigations of blank issues are now more comprehensive. DEQ and the Tribe have initiated special investigations to identify and mitigate potential causes of inter-laboratory phosphorus discrepancies, and have expanded the scope of side-by-side sampling events. Results from these studies are discussed in subsequent sections.

Electronic data records have been updated to reflect these quality issues, and improved electronic data management capabilities are actively being developed. Field and laboratory methods for lake water quality analyses have been modified to account for these data quality issues. Water quality reporting and data management incorporates data quality assessments to specifically assess the potential for a repeat of these issues.

6.2 Data Quality Summary for 2013

Data from CY 2013 met all requirements for *Quality of Laboratory Analyses* and are all quality data from a laboratory perspective. All data met DQO's for *Quality of Field Collection* for all samples collected (i.e., 100% completeness). All samples collected in 2013 are quality data from a field collection perspective.

Data from CY 2013 met all requirements for *Quality of Overall Dataset* except for the representativeness of metals samples in the northern bays. All collected data were high quality, but an insufficient dataset was collected. Metals data from the northern bays is only representative of early spring conditions, and not representative of the year at-large.

6.3 Data Quality Summary for 2014

Data from CY 2014 met all requirements for *Quality of Laboratory Analyses* and are all quality data from a laboratory perspective. All data met DQO's for *Quality of Field Collection* for all samples collected (i.e., 100% completeness). All samples collected in 2014 are quality data from a field collection perspective.

Data from CY 2014 met all requirements for *Quality of Overall Dataset* except for the representativeness of metals samples in the northern bays. All collected data were high quality with representative datasets. However, it should be noted that the metals dataset for the northern bays has geographic limitations and may not be fully representative of bays closer to the mouth of the Coeur d'Alene River.

6.4 Overall Data Quality 2012–2014

Overall data quality for the 2012–2014 time period is strong. The dataset for CY 2013-2014 is complete, comparable, and representative. The dataset for CY 2012 contains QA/QC issues for one sampling event, but is still solid enough to support LMP lake assessments. The LMP has experienced isolated issues associated with equipment failures, staff turnover, one-off staff mistakes, and managing field variability. These issues are not unique to the LMP, and are a common challenge in field monitoring and environmental work. The LMP QA/QC process has pro-actively identified these issues and implemented effective corrective actions.

The LMP data quality process has generated improvements to overall data quality. These include improvements in phosphorus comparability between DEQ and the Tribe, and quantification of the potential impact of colloidal material on metals assessments. The QA/QC process is currently being used pro-actively to (i) enhance phosphorus data quality, and (ii) manage a laboratory transition for chlorophyll-*a* analyses. Data quality records are complete and comprehensive, quality is strong, and quality assurance processes have been effective in sustaining high data quality while also supporting continuous improvement.

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