New Jersey Department of Environmental Protection

Site Remediation Program

DATA QUALITY ASSESSMENT AND DATA USABILITY EVALUATION TECHNICAL GUIDANCE

Version 1.0

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Preamble

The results of analyses performed on environmental matrices are used to determine if remediation is needed. Because of the nature of environmental matrices, limitations of analytical methods, characteristics of analytes, and inherent error associated with any sampling and analysis procedure, the results of environmental analysis may contain an element of uncertainty and in some cases may be significantly biased, and therefore may not be representative of the actual concentrations of the analytes in the environmental matrices. Thus, an evaluation of the quality of the analytical data in relation to the intended use is important in order for the investigator to make decisions which are supported by data of known and sufficient quality.

There are many ways to evaluate the quality of analytical data in terms of precision, accuracy, representativeness, comparability, completeness and sensitivity in relation to the intended use of the data. Precision, accuracy, representativeness, comparability, completeness and sensitivity are collectively referred to as the PARCCS parameters. This guidance document describes a NJDEP-accepted, two-step process for data evaluation. The first step in the process consists of an assessment of data quality. The second step is an evaluation to determine whether the data can be used to support the decisions that will be made using that data. Use of this guidance provides consistency in evaluation and presentation of data quality information that will facilitate review. If an alternative process is used, such a process should be documented in order to explain the thought process and may involve a commitment of significant resources to demonstrate that the data is of known and sufficient quality and is usable relative to its intended purpose.

To assist the investigator in obtaining analytical data of known quality, the Work Group developed the Data of Known Quality Protocols (DKQPs). The DKQPs include specific laboratory Quality Assurance and Quality Control (QA/QC) criteria that produce analytical data of known and documented quality for analytical methods. When Data of Known Quality are achieved for a particular data set, the investigator will have confidence that the laboratory has followed the DKQPs, has described nonconformances, if any, and the investigator has adequate information to make judgments regarding data quality.

The Data of Known Quality performance standards are given in Appendix B of the *NJDEP Site Remediation Program, Data of Known Quality Protocols Technical Guidance, April 2014*. These protocols will enhance the ability of the investigator to readily obtain from the laboratory the necessary information to identify and document the precision, accuracy and sensitivity of data.

1. Intended Use of Guidance Document

This guidance is designed to help the person responsible for conducting remediation to comply with the Department's requirements established by the Technical Requirements for Site Remediation (Technical Rules), N.J.A.C. 7:26E. Because this guidance will be used by many different people that are involved in the remediation of a contaminated site such as Licensed Site Remediation Professionals (LSRPs), Non-LSRP environmental consultants and other environmental professionals, the generic term “investigator” will be used to refer to any person that uses this guidance to remediate a contaminated site on behalf of a remediating party, including the remediating party itself.

The procedures for a person to vary from the technical requirements in regulation are outlined in the Technical Rules at N.J.A.C. 7:26E-1.7. Variances from a technical requirement or guidance must be documented and be adequately supported with data or other information. In applying technical guidance, the Department recognizes that professional judgment may result in a range of interpretations on the application of the guidance to site conditions.

This guidance supersedes previous Department guidance issued on this topic. Technical guidance may be used immediately upon issuance. However, the NJDEP recognizes the challenge of using newly issued technical guidance when a remediation affected by the guidance may have already been conducted or is currently in progress. To provide for the reasonable implementation of new technical guidance, the NJDEP will allow a 6-month “phase-in” period between the date the technical guidance is issued final (or the revision date) and the time it should be used.

This guidance was prepared with stakeholder input. The following people were on the committee who prepared this document:

- Greg Toffoli, Chair (Department), Office of Data Quality
- Nancy Rothman, Ph.D., New Environmental Horizons, Inc.
- Rodger Ferguson, CHMM LSRP, Pennjersey Environmental Consulting
- Stuart Nagourney (Department), Office of Quality Assurance
- David Robinson, LSRP, Synergy Environmental, Inc.
- Joseph Sanguiliano (Department), Office of Data Quality
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2. Purpose

The purpose of this document is to provide guidance on how to review and subsequently use analytical data generated pursuant to the remediation of a discharge of a contaminant(s).

Laboratory Quality Assurance and Quality Control (QA/QC) is a comprehensive program used to enhance and document the quality of analytical data. QA involves planning, implementation, assessment, reporting, and quality improvement to establish the reliability of laboratory data. QC procedures are the specific tools that are used to achieve this reliability.

Evaluating the quality of analytical data to determine whether the data are of sufficient quality for the intended purpose is a two-step process. The first step of the process is a data quality assessment (DQA) to identify and summarize any quality control problems that occurred during laboratory analysis (QC nonconformances). The results of the DQA are used to perform the second step, which is a data usability evaluation (DUE) to determine whether or not the quality of the analytical data is sufficient for the intended purpose.

To assist the investigator in obtaining usable, "good' analytical data, the *NJDEP Analytical Technical Guidance Work Group developed the Data of Known Quality Protocols (DKQPs)*. The DKQPs are a collection of analytical methods that contain specific performance criteria and are based on the conventional analytical methods published by the U.S. Environmental Protection Agency (EPA). DKQPs have been developed for the most commonly used analytical methods. DKQPs may be developed for other methods in the future. Analytical data generated from the DKQPs are termed Data of Known Quality (DKQ).

When the DKQPs are followed the investigator can have confidence that the data are of known and documented quality. This will enable the investigator to evaluate whether the quality of the data is usable. (When the performance criteria in the DKQPs are met, it is likely that the data will be usable for project decisions.) Information regarding the DKQPs and laboratory QA/QC is presented in the NJDEP guidance document titled *NJDEP Site Remediation Program, Data of Known Quality Protocols Technical Guidance, April 2014* (DKQ Guidance). The DKQ Guidance and DKQPs are published on the NJDEP web site at: http://www.nj.gov/dep/srp/guidance/index.html#analytic_methods.

The DKQP Guidance includes the "**Data of Known Quality Conformance/Nonconformance Summary Questionnaire**" that the investigator may request the laboratory to use to indicate whether the data meet the guidelines for DKQ. The guidance also describes the narrative (that must be included as a laboratory deliverable pursuant to N.J.A.C. 7:26E Appendix A) that describes QA/QC nonconformances. When DKQ criteria are achieved for a particular data set, the investigator will have confidence that the laboratory has followed the DKQPs, has described nonconformances, if any, and has adequate information to make judgments regarding data quality.

A basic premise of the DKQPs is that good communication and the exchange of information between the investigator and the laboratory will increase the likelihood that the quality of the analytical data will meet project-specific Data Quality Objectives (DQOs), and therefore, will be suitable for the intended purpose. To this end, the "**Example: Project Communication Form**" has been included with the DKQP Guidance (Appendix A) to provide an outline of the information that a laboratory should have prior to analyzing the associated samples.

The process of obtaining analytical data that are of sufficient quality for the intended purpose and evaluating the quality of analytical data in relation to project-specific DQOs occurs throughout the course of a project. It is the investigator's responsibility to perform the DQA/DUE process; therefore, the investigator's contact with the laboratory should be limited to explaining any issues that were not adequately addressed in the narrative (nonconformance summary) and, if provided, a **Data of Known Quality Conformance/Nonconformance Summary Questionnaire** (DKQP Guidance). It should be noted that the investigator, not the laboratory, is responsible for the usability of data.

It is not unusual for laboratory reports to contain QC nonconformances, especially for those analyses that have extensive analyte lists such as Method 8260B (Volatile Organics) and 8270C (Semivolatile Organics). The chances of every analyte passing all the QC criteria are remote and not expected. In many cases, the DQA and DUE will reveal QC nonconformances that do not affect the usability of the analytical data for the intended purpose. In these cases, the investigator and others who will be relying on the data may have confidence that the quality of the data is appropriate for the intended purpose.

In other cases, the DQA and DUE will reveal QC nonconformances that will affect the usability of the analytical data for the intended purpose. In these cases, the investigator has developed

an understanding of the limitations of the analytical data (e.g., through a conceptual site model (CSM)) and can avoid making decisions that are not technically supported and may not be fully protective of human health and the environment.

It is important to note that uncertainty introduced through the collection of non-representative samples or an inadequate number of samples will, in many cases, exceed the uncertainty caused by laboratory analysis of the samples. It is imperative that the investigator follow the appropriate regulations and guidance documents to ensure that the number and location of samples collected and analyzed are sufficient to provide adequate characterization of site conditions.

This guidance does not suggest formal data validation (such as that outlined in the NJDEP Site Remediation Program Standard Operating Procedure (SOP) for Analytical Data Validation of Target Analyte List (TAL) – Inorganics, Revision No. 5, SOP No. 5.A.2) is to be performed in all instances. Specifically, such documents describe formal, systematic processes for reviewing analytical data. These processes involve, for example, verifying derived results, inspection of raw data, review of chromatograms, mass spectra, inter-element correction factors to ascertain that the data set meets the data validation criteria, and the DQOs specified in the quality assurance project plan (QAPP). In most cases, use of the DKQPs will allow the investigator to perform a DQA without conducting formal data validation. In cases where formal data validation will be necessary, the investigator will have to evaluate the data in accordance with applicable NJDEP and/or EPA Guidance/SOPs. Please note that if data validation is necessary, then a full data deliverable package is required. (An example where full validation may be required could be where site conditions have made it difficult for the laboratory to meet the quality control requirements of a DKQP and the issuance of a RAO is in the balance.)

3. Document Overview

The DQA and DUE constitutes a two-step process that is designed to evaluate the quality of analytical data to determine if the data are of sufficient quality for the intended purpose. The DQA is an assessment of the laboratory quality control data, the laboratory report, and laboratory narrative by the investigator to identify and summarize QC nonconformances. The DUE is an evaluation by the investigator to determine if the analytical data (that may include nonconformances) are of sufficient quality for the intended purpose. The DUE uses the results of the DQA and evaluates the quality of the analytical data in relation to the project-specific DQOs and the intended use of the data. The DQA should be performed in real-time when the data are received throughout the course of a project. If issues with the data are found, an adjustment to the project may be made in real-time, so that enough data with sufficient quality may be gathered prior to beginning the DUE. The DUE is performed whenever the data are used to make decisions.

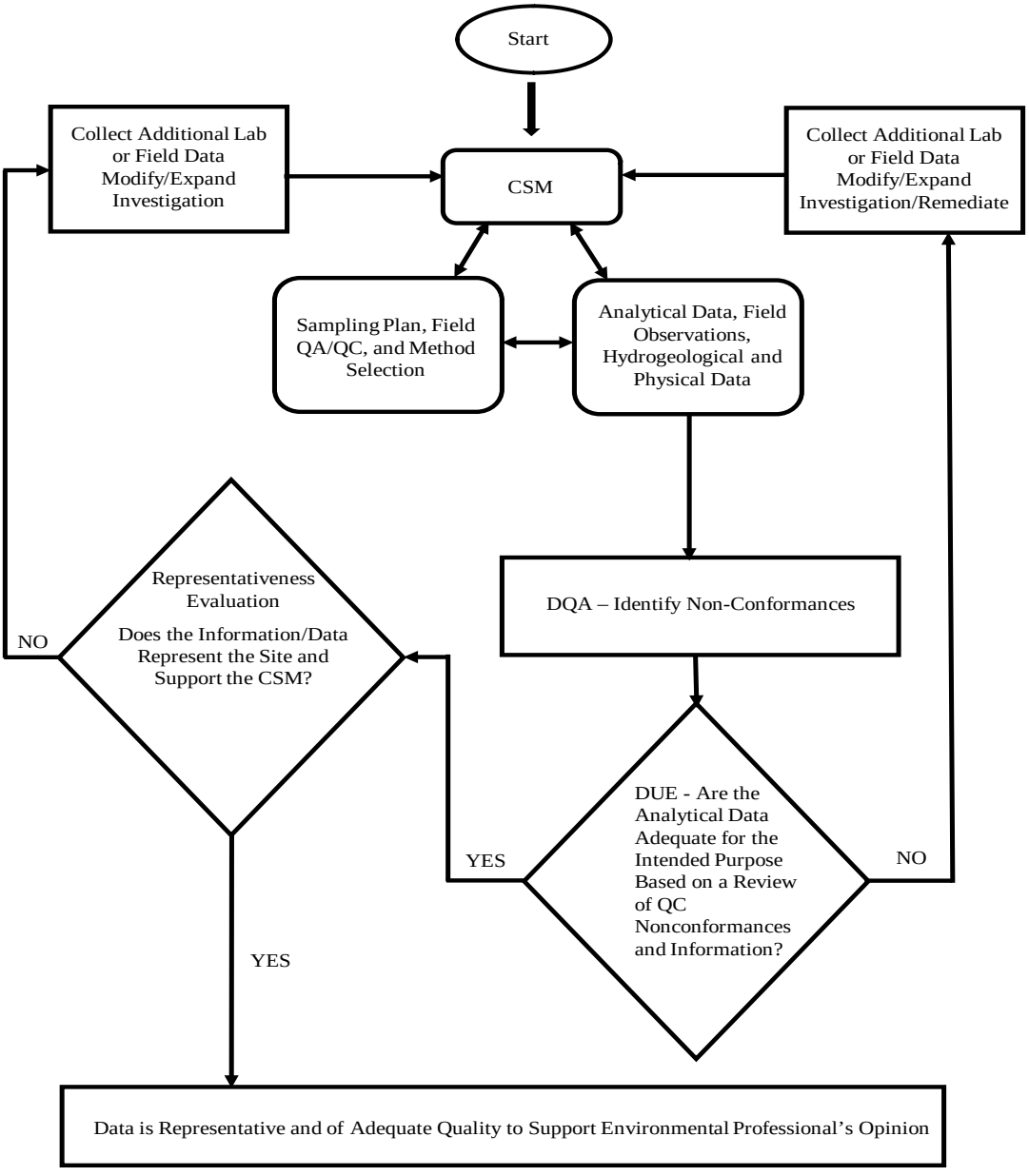
4. Procedures

The process of obtaining analytical data of sufficient quality for the intended purpose and evaluating the quality of analytical data in relation to project-specific DQOs and the CSM occurs throughout the course of a project. This process includes the following:

- Development of project-specific DQOs in accordance with professional judgment taking cognizance of published applicable rules and guidance documents.
- Communication with the laboratory regarding project-specific DQOs and the selection of appropriate analytical methods with the appropriate analytical sensitivity;
- Performance of QA and QC activities during the analysis of the samples and reporting of QC results by the laboratory;
- Performance of a DQA by the investigator when analytical results are received from the laboratory to identify QC nonconformances; and,
- Performance of a DUE by the investigator to determine if the analytical data are of sufficient quality for the intended purpose. The DUE uses the results of the DQA and evaluates the quality of the analytical data in relation to the project-specific DQOs and the CSM.

This process is described in Figure 1: DQA and Due Flow Chart.

Figure 1: DQA and DUE Flow Chart**



** State Of Connecticut, Department of Environmental Protection, Laboratory Quality Assurance and Quality Control, Data Quality Assessment And Data Usability Evaluation Guidance Document, May 2009, Revised December 2010.

4.1 Data Quality Objectives

DQOs are developed by the investigator to ensure that a sufficient quantity and quality of analytical data are generated to meet the goals of the project and support defensible conclusions that protect human health and the environment. DQOs should be developed at the beginning of a project and revisited and modified as needed as the project progresses. Similarly, the quality of analytical data is evaluated in relation to the DQOs throughout the course of a project.

It is important to document the DQOs for a project in the context of the CSM so there is a roadmap to follow during the project and so there is documentation that the DQOs were met after the project is finished. The DQOs for a project can be documented in a project work plan, a QAPP, environmental investigation report, or other document. DQOs are a required QAPP element per N.J.A.C. 7:26E 2.2. Sources of detailed information regarding the development of DQOs and QAPPs are listed in Appendix A of this document.

Typical analytical DQOs include, but are not limited to the following:

- The QA/QC criteria specified in the DKQPs or in other analytical methods with an equivalent degree of QA/QC as in the DKQPs;
- The applicable regulatory criteria, for example, the Appendix Table 1 - Specific Ground Water Quality Criteria noted in the Ground Water Quality Standards, N.J.A.C. 7:9C; and
- The target reporting limit (RL) for a specific substance when determining the extent and degree of contamination.

The DQOs, which are based on the intended use of the analytical data, define how reliable the analytical data must be to make sound, rational decisions regarding data usability. For example, analytical data can be used by an investigator to determine if a discharge took place, evaluate the nature and extent of a discharge, confirm that remediation is complete, or determine compliance with an applicable standard/screening level as described in the “Definition of Terms” above.

4.2 Uncertainty in Analytical Data

Uncertainty exists in every aspect of sample collection and analysis. For example:

- Sample collection and homogeneity;
- Sample aliquoting:
- Sample preservation;
- Sample preparation; and
- Sample analysis

The overall measurement error is a combination of the sum of all the errors associated with all aspects of sample collection and analysis. The investigator needs to understand the impact of these uncertainties in order to establish data of known quality.

It is important to understand this uncertainty because analytical data with an unknown amount of uncertainty may be difficult to use. However, it may still be possible to use the analytical data if the investigator understands the degree of uncertainty, which is assessed using the DQA/DUE process. The intended use of the analytical data determines how much uncertainty is acceptable and how dependable the analytical data must be.

For example, when analytical data will be used for determining if a site meets the Residential Direct Contact Soil Remediation Standards with a goal of obtaining an unrestricted Remedial Action Outcome (RAO), the investigator must have a greater degree of confidence in that data and must understand whether or not the degree of uncertainty will affect the usability of the data for its intended purpose. Conversely, in cases where contaminants are known to be present at concentrations significantly greater than Non-Residential Direct Contact Soil Remediation Standards and further investigation and remediation will be conducted, the amount of uncertainty associated with that analytical data can be greater.

4.3 Types of Analytical Data

There are two types of data: data that are generated from DKQPs and data that are not. For the data generated from DKQPs, a lesser degree of scrutiny needs to be applied since the

uncertainty of these data is better understood. For data not generated from DKQPs, a higher degree of scrutiny may be required since these data may have greater uncertainty. The type of data will usually determine the level of effort that is required for the DQA and DUEs. For data generated from DKQPs, an example of the information that should be submitted in a conformance/nonconformance summary is included in the DKQPs Guidance ("**Data of Known Quality Conformance/Nonconformance Summary Questionnaire**"). Because many environmental investigation and remediation projects have been on-going for a period of time before the DKQPs were developed and because DKQPs are not published for all methods of analysis, it is likely that many investigators will need to integrate the data generated by methods other than the DKQPs with data generated in accordance with the DKQPs. This evaluation should be performed on a site-specific basis relative to the CSM and DQOs, but the basic principles should be similar for each situation. Section 4 of the DKQP Guidance presents information on the types of laboratory QC information that are needed to demonstrate equivalency with the DKQs.

4.4 PARCCs Parameters

The PARCCs parameters are used to describe the quality of analytical data in quantitative and qualitative terms using the information provided by the laboratory quality control information. The PARCCS parameters – precision, accuracy, representativeness, comparability, completeness, and sensitivity – are described below. The types of QC information that can be used to evaluate the quality of analytical data using the PARCCS parameters are provided in Appendix B of this document. Also found in Appendix B is a table that summarizes DKQ performance parameters and the recommended frequency for the various types of QC elements. Acceptance criteria associated with PARCCs Parameters are included in any site-specific QAPP and are also discussed in the "*SRP Technical Guidance for Quality Assurance Project Plans"* at

http://www.nj.gov/dep/srp/guidance/index.html#analytic_methods

4.4.1 Precision

Precision expresses the closeness of agreement, or degree of dispersion, between a series of measurements. Precision is a measure of the reproducibility of sample results.

The goal is to maintain a level of analytical precision consistent with the DQOs. As a conservative approach, it would be appropriate to compare the greatest numeric results from a series of measurements to the applicable regulatory criteria.

Precision is measured through the calculation of the relative percent difference (RPD) of two data sets generated from a similar source or percent relative standard deviation (%RSD) from multiple sets of data. The formula for RPD is presented in the definition for precision in the Definition of Terms section of this document. For example, the analytical results for two field duplicates are 50 milligrams per kilogram (mg/kg) and 350 mg/kg for a specific analyte. The RPD for the analytical results for these samples was calculated to be 150%, which, although it doesn't actually represent a numerical measure of heterogeneity, suggests a high degree of heterogeneity in the sample matrix and a low degree of precision in the analytical results. Duplicate results varying by this amount may require additional scrutiny, including qualification and/or resampling. When using duplicate results that have met DKQP acceptance criteria, the QAPP should discuss whether the average or the higher of the two values would be used for making data usability decisions.

4.4.2 Accuracy

Accuracy is used to describe the agreement between an observed value and an accepted reference or true value. The goal is to maintain a level of accuracy consistent with the DQOs. Accuracy is usually reported through the calculation of percent recovery using the formula in the definition for accuracy included in the Definition of Terms section of this document. For example, the analytical result for a Laboratory Control Sample (LCS) is 5 mg/kg. The LCS was known to contain 50 mg/kg of the analyte. The percent recovery for the analytical results for this analyte was calculated to be 10%, which indicates a low degree of accuracy of the analytical results for the analyte and would indicate a low bias of that analyte to any associated field sample in that analytical batch. Therefore, the actual concentration of the analyte in samples is likely to be higher than reported. All of the possible field sample collection and analytical issues which may affect accuracy should be evaluated to determine overall accuracy of a specific reported result. These data may require additional scrutiny with the possibility of qualification or rejection based upon the DQO. A list of common qualifiers has been included in Appendix D of this Guidance document.

4.4.3 Representativeness

Representativeness is a qualitative measurement that describes how well the analytical data characterizes an area of concern. Many factors can influence how representative the analytical results are for an area sampled. These factors include the selection of appropriate analytical procedures, the sampling plan, matrix heterogeneity and the procedures and protocols used to collect, preserve, and transport samples. Information to be considered when evaluating how well the analytical data characterizes an area of concern is presented in various SRP technical guidance documents and manuals.

For example, as part of a sampling plan, an investigator collected soil samples at locations of stained soil near the base of several above-ground petroleum storage tanks known to be more than seventy years old and observed to be in deteriorated condition. The samples were analyzed for extractable petroleum hydrocarbons (EPH). The concentrations of all EPH results were below the method RL or not detected (ND). The investigator evaluated these results in relation to visual field observations that indicated that petroleum-stained soil was present. The investigator questioned how well the analytical results characterized the locations where stained soil was observed and collected several additional samples for EPH analysis to confirm the results. The results of the second set of samples collected from locations of stained soil indicated the presence of EPH at concentrations of approximately 5,000 mg/kg. Therefore, the investigator concluded that the original samples for which the analytical results were reported as ND for EPH were not representative of the stained soil and that the second set of samples were representative of the stained soil.

4.4.4 Comparability

Comparability refers to the equivalency of sets of data. This goal is achieved through the use of standard or similar techniques to collect and analyze representative samples. Comparable data sets must contain the same variables of interest and must possess values that can be converted to a common unit of measurement. Comparability is primarily a qualitative parameter that is dependent upon the other data quality elements. For example, if the RLs for a target analyte were significantly different for two different methods, the two methods may not be comparable and more importantly, it may be

difficult to use those data to draw inferences and/or make comparisons. Use caution in combining data sets especially if the quality of the data is uncertain.

4.4.5 Completeness

Completeness is a quantitative measure that is used to evaluate how many valid analytical data were obtained in comparison to the amount that was planned. Completeness is usually expressed as a percentage of usable analytical data. Completeness goals are specified for the various types of samples that will be collected during the course of an investigation. Completeness goals are used to estimate the minimum amount of analytical data required to support the conclusions of the investigator. If the completeness goal is 100% for samples that will be used to determine compliance with the applicable regulations, all of the samples must be collected, analyzed and yield analytical data that are usable for the intended purpose. Critical samples include those samples that are relied upon to determine the presence, nature, and extent of a release or determine compliance with applicable regulations. The completeness goal for critical samples is generally 100%. Overall project completeness goals are generally below 100% (e.g., QAPP DQO for overall project completeness may be 90%) to account for losses due to unintended issues with sample collection (e.g., well will not purge properly or possible breakage of sample in-transit to the laboratory) or to account for quality issues which affect usability of sample data.

4.4.6 Sensitivity

Sensitivity is related to the RL. In this context, sensitivity refers to the capability of a method or instrument to detect a given analyte at a given concentration and reliably quantitate the analyte at that concentration. The investigator should be concerned that the instrument or method can detect and provide an accurate analyte concentration that is not greater than an applicable standard and/or screening level. In general, RLs should be less than the applicable standard and/or screening level. Analytical results for samples that are non-detect for a particular analyte that have RLs greater than the applicable standards and/or screening levels cannot be used to demonstrate compliance with the applicable standards and/or screening levels.

The issue of analytical sensitivity may be one of the most difficult to address as it pertains to data usability evaluations. Samples that are contaminated with sufficient quantity of material, such that dilutions are performed, are a leading cause of RLs exceeding applicable criteria. However, there may be instances where such exceedances are insignificant relative to the site specific DQOs. As an example, the project may be on-going and/or other compounds are "driving" the cleanup such that not meeting applicable criteria for all compounds at that particular juncture is not an issue.

4.5 Data Quality Assessment

A DQA is the process of identifying and summarizing QC nonconformances. The DQA process should occur throughout the course of a project. The DKQP Guidance "**Data of Known Quality Conformance/Nonconformance Summary Questionnaire**", laboratory narrative, and analytical data package should be reviewed by the investigator soon after it is received, so the laboratory can be contacted regarding any questions, and issues may be resolved in a timely manner. The DQA is to be performed prior to the DUE. The level of effort necessary to complete this task depends on the type of analytical data described above in Section 2.3 of this guidance document. The types of QC information that are to be reviewed as part of the DQA are described in Appendix C of this document. Results from the DQA are used during the DUE to evaluate whether the analytical data for the samples associated with the specific QA/QC information are usable for the intended purpose.

Appendix B of this Guidance document includes a table that summarizes the DKQ parameters and the recommended frequencies for various types of QC information. The actual QC checks, target acceptance criteria and information required to be reported under the DKQPs are provided in Appendix B of the DKQ Guidance.

The DQA is usually most efficiently completed by summarizing QC nonconformances on a DQA worksheet or another manner that documents the thought process and findings of the DQA (e.g., NJDEP Full Laboratory Data Deliverable Form available at: http://www.nj.gov/dep/srp/srra/forms/).

Sample DQA worksheets are included in Appendix D of this document. These worksheets may be modified by the user. Appendix D also presents a summary of selected DKQ acceptance criteria which may be useful during the completion of DQA worksheets.

4.5.1 Batch Quality Control versus Site Specific Quality Control

Laboratory QC is performed on a group or “batch” of samples. Laboratory QC procedures require a certain number of samples be spiked and/or analyzed in duplicate. Since a laboratory batch may include samples from several different sites, the accuracy and precision assessment for organic samples will not be germane to any site in the batch except for the site from which the QC samples originated. QC samples from a specific site are referred to as site specific QC. Since batch QC for organic samples may include samples from different sites, it may be of limited value when evaluating precision and accuracy for a site. For inorganic samples, the sample chosen for the QC sample pertains to all inorganic samples in the batch because the inorganic methods themselves include little sample-specific quality control. Typically, organic analyses require an MS/MSD pair for every twenty samples of similar matrix (e.g., soil, water, etc.). Inorganic analyses usually have a matrix spike and a matrix duplicate (MD) for every twenty samples; however, an MS/MSD pair for inorganic analyses is acceptable. Information regarding MS/MSDs is presented in Section 5.6.3.7 of this document. The results of the MS spike can be used to evaluate accuracy, while the results of the MS and MSD analysis (or sample and MD) can be used to assess precision. Similarly, LCSs and LCS/LCSDs are used by laboratories as a substitute to or in addition to MS/MSD where the LCS is used to evaluate method accuracy, while a LCS/LCSD pair can be used to evaluate both precision and accuracy. Information regarding LCS/LCSD is presented in Section 4.6.3.6 of this document.

There may be instances where the investigator incorporates site or project specific QC samples as part of the DQO. Examples of where this may be appropriate are:

- Complex or unique matrix;
- Contract specific requirements;
- High profile cases;
- Sites containing contaminants such as dioxins or hexavalent chromium

If project specific QC samples are required to meet the DQO, then the investigator should supply sufficient sample volume for the analyses.

4.5.2 Evaluating Significant Quality Control Variances

Some QC nonconformances are so significant that they must be thoroughly evaluated. Some examples are the absence of QC analyses, gross exceedance of holding time, and exceeding low recoveries of spikes and/or surrogates. Appendix E of this document presents a summary of significant QC variances or gross QC failures.

If the DQA is performed when the laboratory deliverable is received it may be possible for the investigator to request that the laboratory perform reanalysis of the sample or sample extract within the holding time. During the DUE, data with gross QC failures in most cases will be deemed unusable, unless the investigator provides adequate justification for its use. However, samples with significant QC variances could be used if the results are significantly above remedial standards/screening levels.

4.5.3 Poorly Performing Compounds

Not all compounds of interest perform equally well for a given analytical method or instrument. Typically, this is due to the chemical properties of these compounds and/or the limitations of the methods and instrumentation, as opposed to laboratory error. These compounds are commonly referred to as "poor performers," and the majority of QC nonconformances are usually attributed to these compounds. Appendix F of this document presents a summary of compounds that are typically poorly performing compounds. Each method specific DKQ acceptance criteria table (*QAPP Worksheet*) notes the method-specific poor performers. A laboratory's list of poorly performing compounds should not be substantially different from this list. The investigator should, through the QAPP, have the laboratory confirm which compounds are poor performers for the methods used prior to the analysis of samples. This information should be used during the DUE. The investigator may decide not to use the entire data set should "too many" compounds fail to meet acceptance criteria as this may be an indication of general and significant instrumental difficulties. For example, the investigator may decide that if QC results for more than 10% of the compounds fail to meet acceptance criteria for DKQ Method 8260 or more than 20% fail to meet criteria for DKQ Method 8270, the data may not be usable to demonstrate that concentrations are less than applicable standards without additional lines of evidence to support such a decision.

4.5.4 Common Laboratory Contaminants

During the course of the analysis of samples, substances at the laboratory may contaminate the samples. The contamination in the sample may come from contaminated reagents, gases, and/or glassware; ambient contamination; poor laboratory technique; et cetera. A list of common laboratory contaminants can be found in Appendix G of this document. However, not all sample contamination can be attributed to the compounds on the laboratory contaminant list. During the DUE, the investigator must take the CSM and site-specific information into account to support a hypothesis that the detection of common laboratory contaminants in environmental samples is actually due to laboratory contamination and not due to releases at the site or due to sampling efforts.

4.5.5 Bias

When QC data for analytical results indicates that low or high bias is present, this means that the true values of the target analytes are lower or higher than the reported concentration, respectively. Bias can also be indeterminate, which means that the analytical results have poor analytical precision or have conflicting bias in the data. Additionally, as bias ultimately can affect the actual concentration reported, all bias has the potential to affect accuracy. Bias is evaluated by the investigator as part of the DUE.

Bias can be caused by many factors, including improper sample collection and preservation, exceedances of the holding times, the nature of sample matrix, and method performance. The sample matrix can cause matrix interferences. Typically, matrices such as peat, coal, coal ash, clay, and silt can exhibit significant matrix interferences by binding contaminants or reacting with analytes of concern. The investigator should contact the laboratory to determine the appropriate laboratory methods to address these difficult matrices. The evaluation of bias is further discussed in Section 5.6.1 of this document.

4.6 Data Usability Evaluation

The DUE is an evaluation by the investigator to determine if the analytical data are of sufficient quality for the intended purpose and can be relied upon by the investigator with the appropriate degree of confidence to support the conclusions that will be made using the data.

The investigator uses the results of the DQA to evaluate the usability of the analytical data during the DUE in the context of project-specific DQOs and the CSM.

One of the primary purposes of the DUE is to determine if any bias that might be present in the analytical results, as identified during the DQA, affects the usability of the data for the intended purpose. The DUE can use multiple lines of evidence from different types of laboratory QC information or from site-specific conditions described in the CSM to evaluate the usability of the analytical data.

The initial DUE should evaluate precision, accuracy, and sensitivity of the analytical data compared to DQOs. Representativeness, completeness, and comparability should be evaluated as part of a DUE and should be considered when incorporating analytical data into the CSM.

More scrutiny regarding the quality of analytical data may be necessary when the investigator intends to use the data to demonstrate compliance with an applicable standard/screening level than when the data are used to design additional data collection activities or when remediation will be conducted. Data that may not be deemed to be of sufficient quality to demonstrate compliance with applicable standard/screening level may be useful for determining that a discharge has occurred in cases when remediation will be conducted or to guide further data collection activities.

Typically, the most challenging DUE decisions are for situations when the analytical results are close to, or at, the applicable standard/screening level and there are QC nonconformances that might affect the usability of the data. In situations such as this, the NJDEP expects that the investigator will use an approach that is protective of human health and the environment. Coordination with the laboratory to understand QC information, additional investigation, and re-analysis of samples may be necessary in some cases. If the DQA is performed when the laboratory deliverable is received and issues are raised, it may be possible to perform re-analysis of the sample extract within the holding time and still use the sample data.

To help expedite the DUE, it may be useful to determine if the QC nonconformances identified in the DQA are significant for a particular project. The types of questions listed below are not inclusive. They are intended to give examples to the investigator to help

evaluate QC nonconformance for a particular project. See the DUE Worksheet provided in Appendix I of this document for additional examples.

- Will remediation be conducted at the area of concern? If remediation will be conducted, the investigator should use the QC information supplied by the laboratory (or request additional assistance from the laboratory when necessary) to minimize QC issues for the samples to be collected to evaluate the effectiveness of remediation. Alternately, if remediation will not be conducted, the analytical data should be of sufficient quality to demonstrate compliance with an appropriate and applicable standard/screening level.

- Were significant QC variances reported? Analytical data with gross QC failures are usually deemed unusable (rejected) unless the investigator provides adequate justification for its use. Significant QC variances are discussed in Appendix E of this document.

- Were QC nonconformances noted for substances that are not constituents of concern at the site as supported by the CSM? QC nonconformance assessments for contaminants that are not of concern may not be critical to meeting project DQOs. However, limiting the list of contaminants of concern without appropriate investigation and analytical testing (i.e., incomplete CSM) can inadvertently overlook substances that should be identified as contaminants of concern.

- Were QC nonconformances reported for compounds that are poorly performing compounds? If the nonconformances are noted for poorly performing compounds that are not contaminants of concern for the site, then they have little or no impact on data usability. However, if the nonconformances are noted for poorly performing compounds that are compounds of concern for the site, then the investigator may have to address these issues, including but not limited to re-sampling and/or re-analysis. Poorly performing compounds are discussed in Section 3.3 and Appendix F of this document.

The DUE process is discussed in detail using examples in the sections that follow. The examples presented below are for illustrative purposes only and are not meant to be a strict or comprehensive evaluation of all types of laboratory QC information or all the possible

outcomes of data quality evaluations. The discussion begins with examples of less complex QC information and concludes with the use of multiple lines of evidence to evaluate more complicated DUE issues using more than one type of laboratory QC information and information from the CSM for a hypothetical site. The standards/screening levels identified in the examples are for illustrative purposes and may not be consistent with actual levels.

Appendix H of this document illustrates many common QC issues and a range of potential DUE outcomes for each issue. The DUE is usually most efficiently completed by using a worksheet or another manner that documents the thought process and findings of the DUE. Appendix I of this document presents a DUE Worksheet that can be used and modified as needed to summarize the types of issues that should be discussed in the investigator written opinion regarding data usability.

4.6.1 Evaluation of Bias

The types of bias are discussed in Section 4.5.5 of this document. Bias can be low, high or indeterminate.

High or low bias can be caused by many factors. Investigators should be cautioned that it is never acceptable to “adjust laboratory reported” compound concentrations or RLs based on percent recovery.

Indeterminate or non-directional bias means that the analytical results exhibit a poor degree of precision (e.g., as demonstrated by high RPD in sample/MD measurements) or there are cumulative conflicting biases in the data set (e.g., surrogate recoveries for a sample are low but LCS recoveries are high). Duplicate sample results are used to evaluate the degree of precision between the measurements. Indeterminate bias may occur when heterogeneous matrices, such as contaminated soil or soil containing wastes such as slag, are sampled. The heterogeneity of the matrix causes the analytical results to vary and may cause a large RPD between the sample results. The degree to which the analytical results represent the environmental conditions is related to the number of samples taken to characterize the heterogeneous matrix and how those samples are selected and collected. For example, as a greater number of samples are analyzed, the analytical results will better represent the concentrations of the analytes present in the environment.

Bias for a particular result should not be evaluated until all sources of possible bias in a sample analysis have been evaluated. Evaluating the impact of bias on one's data set is not always straightforward. For example, judging bias only on surrogate recovery and ignoring LCS recovery results may lead to erroneous conclusions. Therefore, overall bias for a result must be judged by the cumulative effects of the QC results.

Examples of the actions suggested based on the type of bias observed (L= low; I=indeterminate; H=high; None = within limits) on non-detect data (ND) are shown below. For the purposes of the table, bias refers to agreement with *method defined QA/QC limits.*

Table1: Summary Actions Due to Bias.

		ACTIONS		
Bias ⇒	L	I	H	w/in limits
Conc. ⇓				
ND<Reg Lev	Further	Further	None	None
ND=Reg Lev	Further	Further	None	None
ND>Reg Lev	Not usable to determine clean areas	Not usable to determine clean areas	Not usable to determine clean areas	Not usable to determine clean areas

Further = Look at Site; evaluate complete data set; Reanalyze; speak to lab; resample if necessary.

Ultimately it is the investigators' responsibility to use professional judgment when determining the use of any data.

- If the detected concentrations of analytes are below the applicable standard/screening level, the bias may have limited impact on the usability of the data. If the concentration is just below the regulatory limit, evaluation of bias can be critical, especially when data are being used to demonstrate compliance (i.e., issuance of a RAO).

- If the detected concentrations of analytes are above the applicable standard/screening level, the bias may have limited impact on the usability of the data unless these data are being used to demonstrate compliance (i.e., issuance of a RAO).

4.6.2 General Quality Control Information

The following subsections discuss issues associated with QC information related to sample management, preservation, holding times, and field QC samples.

4.6.2.1 Chain of Custody Forms

Chain of Custody (COC) forms are used to document the history of sample possession from the time the sample containers leave their point of origin (usually the laboratory performing the analyses) to the time the samples are received by the laboratory. COCs are considered legal documents. Sometimes incorrect information is on the COC form, such as incorrect dates, sample identification numbers, and analysis requested. Usually these errors are found through the course of the project. However, simply correcting this information without documentation of the problem and the resolution may amount to falsification of the chain of custody or cause confusion. The error may be corrected by the investigator with a single-line cross-out of the error, initialing/signing, dating of the correction, and an explanation for the correction. If the laboratory notices an error on the COC, this should be noted in their sample receiving documentation and in the laboratory narrative and the laboratory should contact the investigator. Any changes to the COC should be approved by the investigator and documented by the laboratory.

4.6.2.2 Sample Preservation Holding Times and Handling Time

Once a sample is collected, changes in the concentrations of analytes in the sample can occur. To minimize these changes, the sample must be collected, stored, and preserved as specified in the analytical method and for non-aqueous volatile organic compounds as specified in the NJDEP's N.J.A.C. 7:26E-2.1(a)8. The sample must also be analyzed within the specified holding and handling times. The holding time for a sample has two components. The first component is the time from when a sample is collected to when it is prepared for analysis or, if no preparation step is required, the time from when the sample is collected to when it is analyzed. (For environmental samples, handling time is included in this first component.) If a test requires a preparation step, such as solvent extraction for determination of polychlorinated

biphenyls (PCBs) or acid digestion for determination of metals, there is a second holding-time component referred to as the extract holding time. This is the time between when the sample is prepared and when the resultant extract or digestate is analyzed. Failure to analyze a sample within the prescribed holding time could render the data unusable. The laboratory should be made aware (usually in the QAPP) that if holdings times are not going to be met, then the laboratory should contact the investigator and check to see if the samples should still be analyzed. The use of laboratory data from a sample with a failed holding time must be evaluated for usability.

The determination made by the investigator to use data with failed holding times is based on the critical nature of the sample, the type of sample and the analytical results. The conventional conclusion with organic samples that exceeded holding times is that there is a loss of compound and the concentration may be biased low.

It should be noted that certain constituents are not necessarily adversely affected by holding time exceedances providing the samples are preserved and stored properly. If the contaminants of concern were PCBs, PCDDs/PCDFs and metals, holding time exceedance may not adversely affect usability. In these situations, the data should be qualified and discussed by the investigator. However, attempts should be made to meet the method required holding times.

Example 1: Meeting standards –exceeded holding times

Benzene and 1,2-dichloroethane were found in a water sample at concentrations of 0.9 ug/L and 1 ug/L, respectively. This sample was to be the last round of sampling prior to the intention of issuing a RAO. Applicable ground water quality criteria for benzene and 1,2-dichloroethane are 1 and 2 ug/L respectively. However, the data were obtained from samples that exceeded holding time to analysis by 4 days. Because the overriding consensus with a holding time exceedance is that data are biased low and, because of the proximity of the concentration to the applicable criteria, the investigator should probably not use these data.

Example 2 – Holding time exceedance – ground water monitoring

Trichloroethene, tetrachloroethene and 1,1,1-trichloroethane are present in a water sample at concentrations of 80 ug/L, 140 ug/L and 125 ug/L, respectively. Compound-specific ground water criteria apply in this situation for the trichloroethene, tetrachloroethene and 1,1,1-trichloroethane at concentrations of 1 ug/L, 1 ug/L and 30 ug/L, respectively. The sample is part of a routine, quarterly monitoring program of a contaminated ground water aquifer and the sample results are similar to those determined from previous rounds of sampling and analyses. It is expected that quarterly monitoring will continue for a minimum of three additional years. However, the data were from a sample that exceeded the holding time to analysis by 3 days. Based on this information, the data would most likely be used because there will be additional rounds of sampling prior to terminating the remedial activities, data are consistent with previous results and the concentrations reported were significantly above the applicable standards such that the effect of a holding time exceedance on the accuracy of the numbers reported would probably be negligible.

Sample preservation can be either physical or chemical. Physical preservation might be cooling, freezing, or storage in a hermetically sealed container. Chemical preservation refers to addition of a chemical, usually a solvent, acid, or base to prevent loss of any analyte in the sample. An example of physical storage is the freezing of soil samples for determination of volatile organic compounds (VOCs). This procedure and other procedures for preserving soil samples for the determination of VOCs can be found in the NJDEP Field Sampling Procedures Manual.

NJDEP expects that all non-aqueous samples collected for the purpose of laboratory analysis for VOCs be collected and preserved in accordance with the procedures described in N.J.A.C. 7:26E-2.1(a)8 and all appropriate analytical methods and technical guidance. If proper preservation of soils sampled for volatiles is not performed, VOCs may be biased low and may be unusable. Based on this evaluation, additional investigation and/or remediation may be warranted. Improperly preserved samples should not be used to determine compliance with regulatory standards and/or criteria.

4.6.2.3 Equipment, Trip and Field Blanks

Equipment-rinsate, trip, and field blank samples can be used to evaluate contamination in a sample as a result of improperly decontaminated field equipment or contamination introduced during transportation or collection of the sample. Trip and field blanks (including laboratory analyte-free water which may be used to produce an equipment-rinsate blank) must be transported to the site with sample containers and must be received at the site within one day of preparation in the laboratory. Blanks may be held on-site for no more than two calendar days and must arrive back at the lab within one day of shipment from the field. If the handling time is not met, then it is possible that the field blanks will not represent the site conditions. Handling times are established more from logistical reasons than from scientific reasons. It is possible that sample containers kept on-site or in construction trailers on site have a greater chance of picking up contamination the longer they are stored. This may present a challenge to the investigator for scheduling sample collection activities especially following weekends and holidays.

The investigator should be cognizant that laboratories have a limited amount of time to prepare/extract and analyze samples, some of which may require additional effort such as reanalysis and as such, the quicker samples get to the laboratory, the better it is for all parties concerned.

Low concentrations of contaminants may be detected in samples as a result of non-site-related contamination. Organic compounds typically found include, but are not limited to, methyl ethyl ketone (MEK), acetone, and methylene chloride which are commonly used as laboratory solvents. Bis(2-ethylhexyl) phthalate is also a common laboratory contaminant; however, it is also observed from field sample collection activities such as use of plastics. Additional scrutiny should be taken if these are contaminants of concern at the site.

The presence of any analytes in any blanks is noted in the DQA review of the data. The concentrations of the analytes in the blanks are compared to any detected analyte concentrations in the associated samples, taking into account any dilution factors. Analytes that are detected in the blanks, but ND in the sample, can be ignored. Analytes detected in the laboratory method blank (not the field and/or trip blank) and

detected in any associated sample should be flagged by the laboratory with a "B" suffix to draw attention to the data user.

SRP has been using a 3 times to 10 times policy to evaluate the potential presence of compounds in an environmental sample when the same compounds are also found in a blank sample. The specific policy is as follows.

If the concentration of a given compound in a sample is less than or equal to three (3) times the concentration of that compound in the associated equipment, trip or field blank, then it is unlikely that the compound is present in the sample. If the concentration is between 3 and 10, although it is present in a corresponding blank, the presence of the compound in the site sample is considered real; however, if the concentration is greater than 10 times the concentration in the corresponding blank, the impact of the blank on the sample results is considered negligible.

All compounds that are present in a sample at a concentration of less than or equal to 10 times the concentration in the corresponding blank should be qualified (conventionally, a “B” qualifier is added next to the concentration of the affected compound) to indicate possible blank contamination.[1]

Example 3: Application of 3x Rule:

Benzene was found in a ground water sample collected at the site at concentration of 2 µg/L. Benzene is also present at a concentration of 1.0 µg/l in the associated equipment blank. The concentration in the sample is less than 3 times but less the concentration of the blank. Therefore, the result may not be real; however, the result should be qualified B and discussed by the investigator.

Example 4: Application of 10x Rule

[1] Strict validation protocols may have more robust procedures for blank qualification (e.g., in addition to the “B” qualifier, concentrations between 3 and 10 times the associated blank should also be reported with the "J" qualifier.) However, for the purpose of the DUE, addition of the “B” qualifier (or other user-defined qualifier) will suffice to denote corresponding blank contamination.

Benzene was found in a ground water sample collected at the site at concentration of 4 µg/L. Benzene is also present at a concentration of 0.5 µg/l in the associated equipment blank. The concentration in the sample is greater than 3 times but less than 10 times the concentration of the blank. Therefore, the result is real and should be qualified B which may indicate quantitative uncertainty. Additional site investigation may be warranted including an evaluation of the sampling protocol.

Example 5: Application of 10x Rule

Benzene was found in a ground water sample collected at the site at concentration of 20 µg/L. Benzene is also present at a concentration of 0.5 µg/l in the associated equipment blank. The concentration in the sample is greater than 10 times the concentration of the blank. Therefore, the sample result is considered real and may be used.

The investigator should review all blank related results in relation to the CSM for the site, including results for other samples in the vicinity, in order to determine if this evaluation is reasonable before concluding that a compound is or is not site related. This policy cannot be used to eliminate detections of analytes that can be attributed to a release or a potential release. Special attention should be paid to concentrations that may be blank related at or near regulatory/screening levels.

4.6.2.4 Field Duplicates

Field duplicates are replicate or split samples collected in the field and submitted to the laboratory as two different samples. Field duplicates measure both field and laboratory precision. Blind duplicates are field duplicate samples submitted to the laboratory without being identified as duplicates. Duplicate samples are used to evaluate the sampling technique and homogeneity/heterogeneity of the sample matrix. The results of field duplicates are reported as the RPD between the sample and duplicate results. As a conservative approach, the higher of the two results for field duplicate samples would be compared to the applicable regulatory criteria.

In general, solid matrices have a greater amount of heterogeneity than liquid matrices. When the RPD for detected constituents (concentrations greater than the RL) is

greater than or equal to 50 percent for nonaqueous matrices or greater than or equal to 30 percent for aqueous matrices, the investigator is advised to consider the representativeness of the sample results in relation to the CSM. **If the field duplicates are not collected and analyzed from your site, then field duplicate precision cannot be part of your DUA**.

Field duplicate results should be evaluated along with any laboratory duplicate results that are available in an attempt to identify whether the issue is related to the sample matrix, collection techniques, or the laboratory analysis of the sample. (Laboratory duplicates are obtained from one environmental sample in one sample container that is extracted and analyzed twice. Refer to Section 4.3.4 of this guidance document for additional information.) If the laboratory duplicates are acceptable, but the field duplicates are not, the likely source of this lack of reproducibility is heterogeneity of the matrix or the sampling or compositing technique. If the laboratory duplicates are not acceptable, laboratory method performance may be the source for the lack of reproducibility. The RL for the analyte in question must be considered in this evaluation because, typically, analytical precision decreases as the results get closer to the RL.

One could also evaluate precision by comparing a sample result to a sample duplicate result (no spiking is performed), although representativeness of the samples could be a factor when evaluating the results of duplicate analyses. Furthermore, if the results for a specific analyte are ND in both samples, the evaluation of precision, through calculation of RPD, cannot be performed

Example 6: Duplicate Sample Results – Heterogeneity

Duplicate soil sample analytical results for lead for two soil samples were 500 mg/kg and 1,050 mg/kg. The RL was 1 mg/kg. The RPD for these samples is approximately 71 percent, which is greater than the guideline of 50 percent. The lack of precision for these sample results indicate that the samples are heterogeneous and may not be representative of the site location for lead. The investigator is advised to consider the representativeness of the sample results in relation to the CSM. Additional investigation and analysis are needed to evaluate the actual concentrations and distribution of lead at the site.

4.6.3 Laboratory Quality Control Information

The DKQPs and commonly used analytical methods for environmental samples have been verified to produce reliable data for most matrices encountered. The reliability of the results to represent environmental conditions is predicated on many factors including:

- The sample must be representative of field conditions;
- The sample must be properly preserved and analyzed within handling and holding times;
- The preparation steps used to isolate the analytes from the sample matrix must be such that no significant amounts of the analytes are lost;
- The analytical system should not have contamination above the RL;
- The analytical system must be calibrated and the calibration verified prior to sample analysis; and
- No significant sample matrix interferences are present which would affect the analysis.

With the exception of the first bullet, the laboratory can provide the data user with laboratory QC information that provides insight into these key indicators. The determination that a sample is representative of the field conditions is based on reviewing the CSM, the sampling plan, the field team's SOPs and field logs, and the results for other samples including field and laboratory duplicates.

The primary laboratory QC data quality information that the investigator considers during the DQA are the DKQP "**Data of Known Quality Conformance/Nonconformance Summary Questionnaire**", the chain of custody form, sample preservation, handling and holding times, RLs, laboratory and field duplicates, surrogates, MSs and MSDs (when requested by the investigator), method blanks, and laboratory control samples. However, there are other non-standard types of

QC information (e.g., regulator pressure from a canister) that are required to be reported by the DKQPs that are described in Appendix B of the DKQP Guidance.

4.6.3.1 Data of Known Quality Conformance/Nonconformance Summary Questionnaire

The DKQP "**Data of Known Quality Conformance/Nonconformance Summary Questionnaire"** is used by the laboratory to certify whether the data meet the requirements for "Data of Known Quality." The DKQP **"Data of Known Quality Conformance/Nonconformance Summary Questionnaire"** is presented in Appendix A of the DKQ Guidance and can be found at the NJDEP website at http://www.nj.gov/dep/srp/guidance/index.html#analytic_methods. All of the questions on the "Data of Known Quality Conformance/Nonconformance Summary Questionnaire" should be answered, the questionnaire should be signed, and a narrative of nonconformances included with the analytical data package. If all of the questions are not answered, or the questionnaire is not signed, or if a narrative of nonconformances is not included with the data package, then the investigator should contact the laboratory to obtain a properly completed questionnaire and/or the missing narrative. If the laboratory cannot supply the requested information, the investigator should demonstrate equivalency with the DKQPs for the data set by following the guidance presented in Sections 5 and 6 of the DKQP Guidance.

4.6.3.2 Reporting Limits

The RL is the lowest concentration that a method can achieve for a target analyte with the necessary degree of accuracy and precision. As defined in N.J.A.C. 7:26E 2.1(a)3, the RL for an organic compound is derived from the lowest concentration standard for that compound used in the calibration of the method as adjusted by sample-specific preparation and analysis factors (for example, sample dilutions and percent solids). The RL for an inorganic compound is derived from the concentration of that analyte in the lowest level check standard (which could be the lowest calibration standard in a multi-point calibration curve). RLs are method and laboratory-specific. Laboratories are required to report the RLs for all compounds for all samples per Appendix A of N.J.A.C. 7:26E.

RLs and their association with meeting standards and/or screening levels present one of the most significant challenges to laboratories and investigators. A commonly occurring scenario that arises is with volatile analyses and default impact to ground water standards where multiple aliphatic compounds are present, the sample is diluted because of the presence of one analyte with a very high standard, resulting in an inability to “see down to the standard” for another compound. This frequently occurs where samples from petroleum discharges areas are required to be diluted due to the presence of compounds such as xylenes and/or ethyl benzene and the 0.005 mg/kg default impact to ground water soil screening level for benzene cannot be attained. Dilutions occur not only to obtain an accurate concentration but also to prevent temporary damage to the instrumentation. Where laboratories are having difficulties reporting down to a low value, laboratories should perform and report sample results that are derived from the lowest level of dilution

Multiple dilutions and alternative methods of analysis (e.g., gas chromatography with a photoionization detector, Method 8010/8020) should be considered to obtain the desired levels of quantitation.

Example 7: Reporting Limits and Dilution Factor

Results for soil samples tested for PCE (a primary driver at the site) are ND, with a RL of 1,000 µg/kg) with a dilution factor of 20. Dilutions of the samples were performed when the laboratory determined by pre-screening the samples that undiluted analyses may cause contamination of the instrument that is difficult and time consuming to remove and because the analyte concentrations would be above the calibration curve. However, based on other analyses, it was determined that there are other drivers that would result in the site undergoing remediation. In this instance, as the remediation will also remove the PCE (even if it is above a regulatory criteria), it would be acceptable for the laboratory to report PCE as ND with a RL greater than the regulatory level.

Example 8: Reporting Limits and Dilutions

Results for a soil sample tested for BTEX are ND for benzene at a RL of 10 m/Kg and xylenes was detected at 800 mg/Kg. The sample required a dilution of 100 due

to the concentration of xylene. (The Residential Direct Contact Soil Remediation Standard for benzene is 2 mg/Kg and 12000 mg/Kg for xylenes.) However, while the concentration for xylene is below its regulatory level, the ND for benzene at the RL is above the regulatory level. If further delineation is to occur at the site, then the exceedance of benzene should be noted but should not prevent the investigator from proceeding with the remediation. If however, this analysis was to be used for purposes of issuing a RAO, reanalysis and or resampling may be required and/or further remediation may be required prior to resampling and reanalysis. If it is **absolutely necessary** for benzene to be evaluated at or below the regulatory level with high levels of xylene in the sample, the laboratory should be contacted to discuss analytical options which may include alternative methodologies, sample preparation and/or methods of detection.

Example 9: Reporting Limits

The ND result for PCE for a groundwater sample has a RL of 12 µg/L. The GWQS for PCE is 1 µg/L. Additionally, the data cannot be used to show that PCE is not present at a concentration less than the RL of 12 µg/L. However, this sample was to be used to demonstrate compliance with the GWQS for PCE. Therefore, the data are not usable for this project decision.

4.6.3.3 Method Blanks

Most analytical methods require method blanks. The purpose of the method blank is to determine the presence and concentration of any contamination associated with the processing or analysis of the samples at the laboratory. Laboratories are required to summarize method blank results for all samples per Appendix A of N.J.A.C. 7:26E. Ideally, method blanks should not contain any detected analytes above the RL, but for certain tests, low levels of common contaminants are not unusual because of the nature of the typical commercial analytical laboratory. Common laboratory contaminants or artifacts include methylene chloride, acetone, MEK, for VOCs and/or any phthalate for SVOCs. A summary of common laboratory contaminants is presented in Appendix G of this document.

The presence of any analytes in any method blanks that are detected should be noted during the review of the data. The concentrations of contaminants in method blanks are compared to any detected analyte concentrations in the associated samples, including field and trip blanks taking into account any dilution factors. Analytes present in the blanks, but ND in the sample can be ignored. Analytes detected in the laboratory method blank and detected in any associated sample should be flagged by the laboratory with a "B" suffix to draw attention to the data user.

Refer to Section 5.6.2.3 of this document for further information on blank action.

4.6.3.4 Laboratory Duplicates

Laboratory duplicates measure laboratory precision. The analytical results for laboratory duplicates are reported as the RPD between the sample and duplicate results. Laboratory duplicates are replicate samples and are prepared by taking two aliquots from one sample container. Duplicate results are only used to determine precision and not compliance with a standard and/or criteria.

Laboratory duplicate results should be evaluated along with any field duplicate results to identify whether any precision issues are related to the sample matrix and collection techniques or to the laboratory analysis of the sample. Information regarding the interpretation of duplicate sample results can be found in Section 4.2.4 of this document.

4.6.3.5 Surrogates

A surrogate is an organic compound that is similar to the target analyte(s) in chemical composition and behavior in the analytical process but is not normally found in environmental samples. Laboratories are required to summarize surrogate recoveries for all samples per Appendix A of N.J.A.C. 7:26E. Spiking the samples (including any batch QC such as method blanks and LCSs) with surrogate compounds prior to extraction and/or analysis and determining the percent recovery of the spiked surrogate compound evaluates sample matrix effects, accuracy, and

laboratory performance on individual samples. The surrogate concentration is measured using the same procedures used to measure other analytes in the sample. Certain analyses that have extensive target compound lists require several surrogates.

If the reported recovery for a surrogate is outside acceptance criteria for VOCs, then all VOC results should be considered to be biased high or low depending on whether the surrogate was higher or lower than the acceptance criteria. For SVOCs, if two or more surrogates in the same fraction (acid SVOC surrogates or base neutral SVOC surrogates) are outside acceptance criteria, all results in that fraction should be considered to be biased high or low depending on whether the surrogate was higher or lower than the acceptance criteria. For SVOCs, by understanding which surrogates are related to which target compounds, the percent recovery of a surrogate can be related to constituents of concern, which may be useful in evaluating whether or not the data are useable. If a surrogate is not within the DKQ criteria, the associated quantitative data may be suspect and may require further scrutiny. Information regarding the surrogates for volatiles, SVOCs, chlorinated pesticides and aroclors are presented in the tables in Appendix J of this document.

The evaluation of interfering matrix effects or high concentrations of target compounds that may mask the detection of surrogate recoveries is a complex issue and not straightforward in some cases. Common problems include the presence of non-target compounds. The review and evaluation of surrogate compound results involves the evaluation of multiple lines of evidence and is described in Section 4.4 of this document. Data from surrogate results should be used in conjunction with other QC data, such as LCS and MS. The performance standards for surrogates are presented in the DKQ protocols (Appendix B of the DKQ Guidance) and in Appendix D of this document.

Surrogate recoveries may be affected when the sample or sample extract undergoes dilution. Under severe instances, the surrogates may be “diluted out” and no surrogate recovery is reported. When surrogate recoveries are affected due to dilutions, the investigator may have to increase his/her reliance on other QC information such as internal standard response, LCS and MS.

Example 10: Surrogates – High Recovery

A soil sample analyzed by Method 8270 was collected to determine if further remediation was needed.

- The percent recovery for the surrogate pyrene-d10 was reported to be 159% and for the surrogate benzo(a)pyrene-d12 was reported to be 145%. The method specifies that the recovery limits for SVOC surrogates must be within 30 to 130 percent.

- Benzo(a)pyrene was reported at a concentration of 10 mg/kg, which is greater than the Residential Direct Contact Soil Remediation Standard of 0.2 mg/Kg applicable in this example.

Since the reported concentration of benzo(a)pyrene is well above the regulatory level for benzo(a)pyrene, the reported QC information has no bearing on the usability of the results and therefore further remediation is needed.

Example 11: Surrogates – Low Recovery

A soil sample was analyzed by Method 8260. The intended use of the analytical data was to determine if contaminants were present at concentrations that exceed the applicable regulatory level (Impact to Ground Water Screening Level in this example).

- The percent recovery for the surrogate Toluene-d8 was reported to be 20 percent. The DKQ protocol specifies that the recovery limits for surrogates should be within 70 to 130 percent for this method. Because the reported recovery for this surrogate is outside acceptance criteria for VOCs, then all VOC results may be biased low.

- 1,1,1-Trichloroethane was reported at a concentration of 0.1 mg/Kg, which is just below the regulatory level (of 0.2 mg/Kg).

The reported percent recovery for the surrogate toluene-d8 indicates a potential low bias for 1,1,1-trichloroethane. Because the reported concentration of 1,1,1-

trichloroethane is just below the regulatory level, the reported potential low bias means the results should not be used to determine that 1,1,1-trichloroethane is present at a concentration less than the regulatory level. Before drawing any conclusions regarding the effect of the low bias reported by the surrogate, the investigator should consider using multiple lines of evidence, as described in Section 4.4 of this document. This example is evaluated further in Appendix J of this document, with Example J-1 using multiple lines of evidence.

4.6.3.6 Laboratory Control Samples (LCS)

Laboratory control samples (sometimes referred as blank spikes) are used to monitor the accuracy of the analyst(s) performing the laboratory method. The LCS should contain all target analytes. By evaluating the accuracy of the LCS analysis (percent recovery of the target analytes), one can evaluate the laboratory performance of the entire analytical process. The evaluation of results of LCS involves the evaluation of multiple lines of evidence, as described in Section 4.6.4 of this document. Data from LCS should be used in conjunction with other QC data. The performance standards for LCS are presented in the DKQ protocols (Appendix B of the DKQ Guidance) and in Appendix D of this document. When required by the method, laboratories are required to summarize LCS recoveries associated with the samples from your site per Appendix A of N.J.A.C. 7:26E.

Example 12: Laboratory Control Samples – Low Recovery

Groundwater samples were analyzed by DKQ Method 8260. The purpose of sampling was to determine compliance with Regulatory criteria. The GWQS for benzene is 1 µg/L.

- The results for the LCS indicate a 54 percent recovery for benzene. The DKQ protocol specifies that the recovery limits for the LCS should be within 70 to 130 percent.

- The analytical results were ND for benzene at a RL of 0.5 µg/l.

The results of the laboratory control sample indicate a possible low bias in the accuracy of the method. The results reported could have been affected by the low bias of the method, and therefore it is possible that benzene may not have been ND below the GWQS. Before drawing any conclusions regarding the effect of the low bias reported associated with the LCS, the investigator should consider using multiple lines of evidence, as described in Section 4.6.4 of this document. Resampling and reanalysis may be appropriate. This example is further evaluated in Appendix J of this document, with Example J-2 using multiple lines of evidence.

Example 13: Laboratory Control Samples – High Recovery

Groundwater samples were analyzed using DKQ Method 8260. The purpose of sampling was to evaluate groundwater contamination prior to the start of remediation. The GWQS for trichloroethene (TCE) is 1 µg/.

- The LCS indicates a 190 percent recovery for TCE, which was detected in the sample at a concentration of 10 µg/L. DKQ Method 8260 specifies that the recovery limits for the LCS should be within 70 to 130 percent.

The results for the LCS sample indicate a potential high bias. However, the reported concentration of TCE is over the GWQS. Therefore, this high bias does not affect the usability of the data for the intended purpose.

4.6.3.7 Matrix Spike/Matrix Spike Duplicates and Matrix Spike/Matrix Duplicate

The purpose of a MS sample is to determine whether the sample matrix contributes bias to the analytical results. A MS is an environmental sample to which known quantities of target analytes are added or spiked by the laboratory prior to sample analysis. A matrix spike/matrix spike duplicate (MS/MSD) pair is prepared by spiking two aliquots of an environmental sample with all target analytes. (Please keep in mind that at such time in an investigation where site-specific concerns have reduced the number of target analytes/compounds from a “full” list to a subset thereof, then the MS/MSD fortifications may contain only the site-specific compounds of concern.) Certain protocols do not require spiking with all analytes. However, DKQPs, with the exception of air methods, do require the spiking of all target analytes. The two

aliquots are analyzed separately, and the results are compared. A MS can be used to evaluate method accuracy, while a MS/MSD pair can be used to evaluate both precision and accuracy. MS should not be performed on trip, equipment, or field blanks. For analysis of samples for organic analytes, a MS/MSD pair is typically performed. For inorganic analysis, a matrix spike/matrix duplicate (MS/MD) is typically performed, although a MS/MSD pair is acceptable. Samples chosen for MS/MSD and MS/MD should be chosen from samples that are similar in geological/chemical characteristics to those actual site samples. It should be noted that samples chosen are frequently from “other sites”. Although this practice is not prohibited (and the use of site-specific QA/QC is generally not required), MS/MSD and MS/MD results need to be used with discretion. It may or may not add value to the data assessment process. When required by the method, laboratories are required to summarize MS/MSD results per Appendix A of N.J.A.C. 7:26E.

To evaluate accuracy one must compare the results of the unspiked sample against the spiked sample. To evaluate precision, the results of the matrix spike are compared to those for the matrix spike duplicate. To evaluate accuracy, the percent recoveries of the matrix spike compounds in both the sample and the duplicate are compared (taking into consideration any concentration of the compounds in the unspiked sample). Poor recoveries may be the result of matrix interference and indicate that the sample results have a significant bias. The RPD between a set of duplicate results (either a sample and duplicate pair or a MS/MSD pair) is used to evaluate precision. High RPDs may indicate a lack of sample homogeneity. Poor recoveries or high RPDs can also be caused by laboratory error, which would affect the interpretation of results.

The sample submitted for MS/MSD evaluation should be representative of the potentially contaminated matrix. Ideally, the sample selected for MS/MSD should be spiked at a concentration which will allow for measurement of the spiked sample matrix. (If the concentrations of compounds of concern in the unspiked sample are very high, then it may be necessary to spike the sample at a high level concentration.) The laboratory will need additional sample quantity when MS/MSDs are requested and the need for these QC samples must be addressed prior to sample collection.

The evaluation of precision and accuracy using MS/MSDs or sample/duplicate results is a complex issue and not straightforward in some cases. For organics, the results of the MS/MSD only impact the sample used for the spike while for metals, the MS/MSD or MS/MD affect the entire associated batch. Common problems include interfering matrix effects or high concentrations of target compounds or non-target compounds that mask the detection or quantitation of spiked compounds. This review and evaluation involves the evaluation of multiple lines of evidence, as described in Section 4.6.4 of this document. Data from MS results should be used in conjunction with other QC data, such as LCS, duplicate samples, and surrogates.

The performance standards for MS/MSDs are presented in the DKQ protocols (Appendix B of the DKQ Guidance) and in Appendix D of this document.

Example 14: Matrix Spike/Matrix Spike Duplicates – Low Recovery

A water sample was evaluated for metals by DKQ Method 6010. The intended purpose of the analysis was to confirm that remediation was needed.

- Lead was detected at 4 ug/L. The effective GWQS is 5 ug/L.
- The MS/MSD percent recoveries for lead were 28 percent and 32 percent. The DKQ protocol specifies that MS/MSD spike recovery limits should be from 75 percent to 125 percent.
- The RPD for the MS/MSD pair is 13.3 percent. The DKQ protocol specifies that RPD should be less than 30 percent for the MS/MSD pair.
- All other QC criteria were within the DKQ protocol acceptance criteria.

The RPD for the MS/MSD was well within the acceptance criteria specified in DKQ protocol, indicating acceptable laboratory precision for the site matrix for the method of analysis. The MS/MSD percent recoveries indicated a potential low bias for lead. Therefore, these results should not be used to indicate lead was below the GWQS for lead.

Care must be taken in evaluating the MS/MSD recoveries if the unspiked sample contains high concentrations of compounds used in the spike.

Example 15 Matrix Spike/Matrix Spike Duplicates – High Recovery

A residential soil sample was analyzed by DKQ Method 8260 for VOCs. The intended use of the data is to determine compliance with the residential direct contact soil remediation standard.

- TCE was reported at a concentration of 8 mg/kg, which is just above the residential direct contact soil standard of 7 mg/kg.
- The percent recoveries for TCE generated by a MS/MSD pair are 180 and 185 percent respectively. According to the DKQ protocol, the recovery limits for the MS/MSD should be within 70 to 130 percent.
- The RPD for the MS/MSD pair is 2.7 percent. The RPD should be less than 30 percent for the MS/MSD pair.

The spike recoveries indicate a potential high bias for trichloroethene. Because of the reported high bias and the sample result just above the soil standard, the actual concentration of TCE in the sample may be lower and may be less than the soil standard. However, the investigator cannot adjust the concentrations of the reported values lower. The RPD for the MS/MSD pair was within the acceptance criteria specified in DKQ protocol; therefore, MS/MSD results show an acceptable degree of the precision. Further evaluation of these results in conjunction with multiple lines of evidence, as described in Section 4.6.4 of this document, is needed to assess this potential high bias. This example is evaluated further in Appendix J of this document, with Example J-3 using multiple lines of evidence.

4.6.3.8 Internal Standards

The purpose of an internal standard is to determine the existence and magnitude of instrument drift and physical interferences. Internal standard performance criteria ensure that the instrument's sensitivity and response are stable (i.e., the analytical behavior of compounds is uniform in each analytical run) during each analysis.

Laboratories are required to submit internal standard summaries for all samples per Appendix A of N.J.A.C. 7:26E.

Per the analytical methods, target compounds are associated to and quantitated with specific internal standards. Refer to Appendix J in this guidance document for specific compound-to-internal standard associations. When results deviate from acceptance criteria, the analytical results are considered unreliable and thus qualified as estimated values. When internal standard acceptance criteria are not met, all quantitative data associated with the non-compliant internal standard may be suspect. When the internal standard result is below the lower limit of the acceptance range, RLs may be suspect. Information regarding and internal standards for Volatiles and SVOCs and their corresponding target compounds and surrogates are presented in Appendix J of this document.

4.6.3.9 Serial Dilutions (ICP and ICP/MS)

The purpose of a serial dilution is to determine whether or not physical or chemical interferences exist (on an analyte-specific basis) with the analysis of samples for metals due to the sample matrix. If an analyte concentration is sufficiently high (i.e., minimally, a factor of 10 above a RL) an analysis of a 1:5 dilution should agree within +/- 10% of the original sample result. Serial dilutions are required for analyses by ICP and less frequently by ICP/MS. Analytes whose concentrations are outside the 10% difference in sample concentration (i.e., 90 – 110%) are quantitatively qualified. Laboratories are required to submit serial dilution summaries for all samples per Appendix A of N.J.A.C. 7:26E.

4.6.3.10 Interference Check Solution

The commonly occurring analytes aluminum, iron, magnesium and calcium may cause interferences with the detection and/or quantitation of other analytes. The instrument can correct for these interferences. The purpose of the Interference Check Solution (ICS) is to demonstrate the instrument's ability to overcome interferences and report data for analytes of concern within an acceptable accuracy of 80 – 120% of the actual spiked amount. The effects of the ICS results are applied

to all samples within the associated analytical batch. Laboratories are required to submit ICS summaries for all samples per Appendix A of N.J.A.C. 7:26E.

In general the ICP sample data can be accepted if the concentrations of the aluminum, iron, magnesium and calcium in the field sample are found to be less than or equal to their respective concentrations in the ICS. If analytes aluminum, iron, magnesium and calcium are present in a field sample at levels greater than the ICS, then the following should occur:

Example 16: ICS Low Recovery

Groundwater samples were analyzed by DKQ Method 6010. The purpose of sampling was to determine compliance with Regulatory criteria. The GWQS for Arsenic and Cadmium are 3 ug/L and 4 ug/L, respectively.

- The results for the ICS indicate a 54 percent recovery for arsenic and 60 percent recovery for cadmium. The DKQ protocol specifies that the recovery limits for the ICS should be within 80 to 120 percent.

- The analytical results were both at the GWQS of 3 ug/L and 4 ug/L for Arsenic and Cadmium, respectively.

The results of the ICS indicate a possible low bias in the accuracy of the method. The results reported could have been affected by the low bias of the method, and therefore it is possible that arsenic and cadmium may be above the GWQS. Before drawing any conclusions regarding the effect of the low bias reported associated with the ICS, the investigator should consider using multiple lines of evidence, as described in Section 4.6.4 of this document. Resampling and reanalysis may be appropriate. This example is further evaluated in Appendix J of this document, with Example J-4 using multiple lines of evidence.

Example 17: ICS – High Recovery

Soil samples were analyzed using DKQ Method 6010. The purpose of sampling was to evaluate if the soil samples exceeded the residential direct contact soil

remediation standard for lead. The residential direct contact soil remediation standard for lead is 400 mg/kg.

- The ICS indicates a 150 percent recovery for lead, which was detected in the sample at a concentration of 1000 mg/kg. The DKQ protocol for method 6010 specifies that the recovery limits for the ICS should be within 80 - 120 percent.

The results for the ICS sample indicate a potential high bias. However, the reported concentration of lead is much greater than the applicable standard. Therefore, this high bias does not affect the usability of the data for the intended purpose. Further remediation would be required.

4.6.3.11 Matrix Spikes and Duplicates

The purpose of a matrix spike and duplicate is to determine whether the sample matrix contributes bias to the analytical results. The sample that is spiked should be representative of the soil type from the site under investigation/remediation. Documenting the effect of the matrix for a given preparation batch consisting of similar sample characteristics should include the analysis of at least one matrix spike and one duplicate unspiked sample or one matrix spike/matrix spike duplicate pair. The decision of whether to prepare and analyze duplicate samples or MS/MSD should be based on knowledge of the samples in the sample batch or as noted in the QAPP. If samples are expected to contain target analytes, then the laboratory may use one MS and a duplicate analysis of an unspiked field sample. If samples are not expected to contain target analytes, then the laboratory should use a MS/MSD. Unknown source investigations should employ the use of a MS/MSD.

Sample requirements are specified in the DKQ methods attached to the *NJDEP Site Remediation Program, Data of Known Quality Protocols Technical Guidance April 2014.* Actions to be taken on affected samples are the same as those noted in Section 5.6.3.7 above. However qualifications of data affected by MS, MS/MSD/ and duplicate outliers affect all samples associated with the corresponding digestion batch.

4.6.3.12 Internal Standards for ICP/MS (for Metals)

The purpose of internal standards is to determine the existence and magnitude of instrument drift and physical interferences. Internal standards are added to every sample, calibration standard and QC sample. Laboratories are required to submit internal standard summaries for all samples per Appendix A of N.J.A.C. 7:26E. If the QC criteria are not met, then the sample must be diluted five-fold and reanalyzed with the appropriate amounts of internal standard. If the first dilution does not correct the deficiency, then the procedure should be repeated until the internal standard intensities fall within the method-defined acceptance criteria.

4.6.4 Using Multiple Lines of Evidence to Evaluate Laboratory QC Information

The use of several different types of laboratory QC information as multiple lines of evidence to understand complex QC issues is an important component of DUEs. A conclusion about possible bias in data should not be drawn until the results of all QC samples are assessed since cumulative quality control effects may confound results. The following examples illustrate the evaluation of commonly reported QC information using a "multiple lines of evidence" approach. The investigator should seek experienced assistance, as needed, when evaluating QC data involving multiple lines of evidence. These examples are intended to build on the information presented earlier in this document. Additional examples using multiple lines of evidence are also presented in Appendix J of this document.

Example 18: Multiple Lines of Evidence – Low Recovery for LCS and MS/MSD

A soil sample was analyzed by DKQ Method 8260 for VOCs. The intended purpose of the analysis was to evaluate the concentrations of VOCs that were present at a release area.

- The reported concentrations of the constituents of concern are just below (e.g., the concentrations are 9 ug/Kg and the regulatory levels are 10 ug/Kg) the applicable regulatory criteria.

- The percent recoveries for TCE generated by a MS/MSD pair are low and are less than 45 percent. According to the DKQ protocol, the recovery limits for the MS/MSD should be within 70 to 130 percent.

- LCS percent recoveries are low and are less than 35 percent. The DKQ protocol specifies that the recovery limits for the LCS should be within 70 to 130 percent. About 25% of the DKQ Method 8260 target compounds, including TCE, are outside of the acceptance criteria specified in the DKQ protocol.

In this example, the most important QC component is the LCS data as it is indicative of the overall performance of the laboratory.MS/MSDs evaluate method precision and accuracy in relation to the sample matrix. LCSs evaluate the laboratory's performance. The QC sample results indicate consistent low bias associated with both the sample analysis and the laboratory's performance for the analysis of TCE; however, the LCS results indicate laboratory performance issues. The LCS is a measure of how well the laboratory can perform a given method in a clean sample matrix. Failure to get adequate LCS recoveries can indicate a problem with the compound-specific results for the samples associated with the LCS. Therefore, the actual concentrations of the constituents of concern may be higher than reported and actually above the regulatory level.

The investigator may need to contact the laboratory for guidance on how to best resolve issues associated with the failure of an LCS to meet acceptance criteria. Reanalysis of the samples (if within holding time), use of alternative analytical methods, or collection of additional samples may be necessary to obtain data that could be used to demonstrate that the reported concentrations are less than the applicable regulatory criteria.

Example 19: Multiple Lines of Evidence – Low MS/MSD Recovery

A soil sample was analyzed by DKQ Method 8260 for VOCs. The intended purpose of the analysis was to evaluate the concentrations of VOCs that were present due to a discharge.

- The reported concentrations of the constituents of concern are ND, and the RLs are well below (e.g., a factor of 100 times lower) the applicable regulatory criteria.

- The MS/MSDs are from the site being investigated.

- The MS/MSD recoveries were outside acceptance limits. Recoveries were in the 40-50% range. According to the DKQ protocol, the recovery limits for the MS/MSD should be within 70 to 130 percent.

- The results for the surrogates and the LCS were within acceptance limits.

The results for the surrogates and the laboratory control sample indicate laboratory and method performance are acceptable indicating that the data are not biased due based on these QC indicators. The results for the MS/MSD indicate a potential low bias, but as no compounds were detected and the RLs were far below the regulatory criteria, there is no significant impact on the usability of the data.

4.6.5 Data Usability Evaluations for Non-DKQ Analytical Data

In order to evaluate if Non-DKQ data can be used to support environmental decision-making, the investigator should go through a multi-step evaluation process. One objective of that evaluation would be to make a decision as to whether additional data collection is necessary to corroborate the Non-DKQ data or whether the quality of the Non-DKQ data is such that it could be used for its intended purpose without the collection of additional data. Such an evaluation process includes the following steps:

- The QAPP should identify acceptance criteria for the non-DKQP methods and the associated DQOs.

- Perform a DQA and DUE to evaluate precision, accuracy and sensitivity. The investigator must evaluate the RLs, method detection limits (if available), handling and holding times, sample preservation, and results of QC measures (surrogates, LCS, MS/MSD or MS/MD, method blank results). Review any data narratives which may explain issues with sample receipt and analysis.

- Consider such factors as the age of previously generated data, limitations and benefits of analytical method(s), laboratory QA/QC results, and how any of those factors might affect the quality of the data or the usability of the data with respect to its intended purpose.

- Determine whether any newer data corroborate the older results and whether all sets of data are consistent with the CSM.

- Review available field collection information, preservation techniques, filtering, et cetera for the older samples to evaluate how those techniques compare to current knowledge and how any differences from more recent scientific perspectives might affect the quality of the data.

- Consider decisions that have already been made based on the old data.

- Consider future decisions that will be made based on the old data.

- Consider any other site-specific factors.

NJDEP expects that more scrutiny regarding the quality of previously generated data will be necessary when the investigator intends to use that data to demonstrate compliance with applicable regulations than when that data are used to design additional data collection activities.

If the investigator does not fully understand all of the issues associated with the data quality assessment of non-DKQP, then it is highly recommended that they consult with experts more knowledgeable in this field. The investigator may seek additional guidance from the Department's or USEPA Region 2 SOPs. Region 2 data validation guidance documents and SOPs may be found at

http://www.epa.gov/region2/qa/documents.htm

4.6.6 Data Usability Evaluations Using Multiple Lines of Evidence from DQOs and the CSM

Using multiple lines of evidence during a DUE is not limited to the use of analytical QC data. Multiple lines of evidence using DQOs and CSM can also be used to determine if the quality of the analytical data is adequate for the intended purpose. The DQOs are used to determine if a sufficient quantity and quality of analytical data was generated to meet the goals of the project and support defensible conclusions that are protective of human health and the environment. Information regarding the DQOs is presented in Section 2.1 of this guidance document. The investigator will also evaluate the analytical data in relation to the CSM to determine if any significant data gaps result from the quality of the data. For these evaluations, the SRP expects that the investigator will use an approach that is fully protective of human health and the environment. This evaluation includes, but is not limited to, the following actions:

- Evaluate the analytical data to determine if the DQOs for precision, accuracy, representativeness, comparability, completeness and sensitivity are met.

- Evaluate the entire body of information (type, amount, and quality data) available for the specific area/discharge for which the data are presumed to be representative.

- Determine whether the data are consistent with the CSM and if any significant data gaps are present.

- Consider the effects of having insufficient and/or inaccurate information relative to the risk to potential receptors and the risk to human health and the environment.

- Consider the source of data (e.g., whether the data were generated by the investigator's own firm or some other firm, the investigator's own involvement with the project, the method of collection for the samples, and the reporting methods by other firms/laboratories generating the data). Perform a critical review of these data to evaluate its reliability.

- Consider any other site-specific factors.

In addition to the items listed above the reader should also refer to the Data Usability Evaluation Worksheet presented in Appendix H-2 for further information to consider during this evaluation.

4.6.7 Factors to be Considered During Data Usability Evaluations

Factors that must be considered during DUEs are presented below:

- Adjusting analytical results reported by the laboratory based on laboratory QC information is not appropriate. For example, if the results for a matrix spike indicate a percent recovery of 150%, it is not scientifically valid to adjust the results downward by 50 %. If a contaminant is reported in a blank, it is never appropriate to subtract the concentration of the concentration found in the blank from the sample results.

- False positives can occur due to contamination from commonly used laboratory contaminants, interferences in laboratory methods themselves or sample preservation procedures. For example, methyl ethyl ketone can be formed when sodium bisulfate is used to preserve a soil sample for volatile organic compound analysis. The investigator should contact the laboratory for assistance when the results do not make sense in relation to the CSM.

- In addition to evaluating high or low bias, it is also necessary to consider indeterminate or non-directional bias caused by high RPDs or conflicting biases in the data. High RPDs may indicate a lack of sample homogeneity and raise questions regarding the representativeness of the sample.

- The investigator is responsible for evaluating overall data quality and usability and should not ask the laboratory to perform the DQA nor the DUE of their data (e.g., it is not appropriate to have the laboratory complete the NJDEP Full Laboratory Data Deliverable Form). If the laboratory is required by the investigator to complete the NJDEP Full Data Deliverable Form and/or the

NJDEP Reduced Deliverable Form, the investigator is forewarned that they and not the laboratory are responsible for the content of that information.

- It is important that the meaning of laboratory acceptance criteria be understood when evaluating QC results. The purpose of acceptance criteria is to define a range where data are acceptable as reported. Any data within an acceptable recovery window is appropriate for use. When QC results and information are within acceptance criteria, the reported value is "accepted" as the concentration that should be used for decision-making purposes.

- Results from surrogate analytes do not automatically indicate that a QC issue exists for a specific compound. Matrix spikes are used to evaluate the performance of a specific compound on the spiked sample.

- Soil and sediment results should be reported on a dry-weight basis. Tissues are reported on a wet-weight basis. If sample results are reported incorrectly the laboratory should be contacted for assistance.

- Sample heterogeneity issues or RL issues are to be considered when evaluating total results and results following SPLP or Toxicity Characteristic Leaching Procedure (TCLP) extraction. For example, the total sample results of analysis for total VOCs are "ND," while the results for the SPLP or TCLP leachate indicate the presence of VOCs at substantial concentrations.

- It is inappropriate to conclude in all instances that because the matrix spike and matrix spike duplicate results are biased low, the contaminants are bound up in a sample matrix that has not undergone some form of treatment, and therefore the low bias is irrelevant. (There may be instances where the compounds of concern do exhibit low MS/MSD recoveries due to a treatment of the matrix designed for exactly that purpose.) The investigator should contact the laboratory to determine, if possible, how to overcome such matrix interference issues. An evaluation to determine if a compound is bound up in the sample matrix is outside of the scope of this document and may involve a significant study.

- It is important to work with the laboratory to minimize analytical difficulties or bias. There are several options for sample clean-up and analysis. Typically, sediment samples for pesticides or PCBs need extensive sample clean-up because naturally occurring interferences can cause analytical problems. Should the resultant effect of cleanup be an increase in the RL, the laboratory should contact the investigator and inquire as to how the laboratory is to proceed.

4.6.8 Documentation of Data Quality Assessments and Data Usability Evaluations

Documentation of the thought process used, as well as the outcomes of the DQA and DUE is an essential task that is necessary to support the investigator's decisions regarding the usability of the analytical data for the intended purpose. This documentation is a thoughtful and succinct evaluation and presentation of the findings and conclusions of the DQA and DUE process. NJDEP expects that this documentation will be presented in the documents submitted to the Department where the analytical data are used to support the investigator's opinion that the quality of analytical data is appropriate, or not appropriate, for the intended purpose(s).

As stated previously, there are various ways to document this information, including the DQA Worksheets in Appendix D, NJDEP Full Laboratory Data Deliverable Form in http://www.nj.gov/dep/srp/srra/forms/, DUE Worksheet in Appendix I of this document and the text of the document that uses the analytical data. The DQA and DUE worksheets may be modified by the user as deemed appropriate, provided the end result meets the objectives expressed in this guidance document.

Typical documentation of a DQA and DUE includes a written summary regarding data usability and DQA and DUE Worksheets. The report that presents the analytical data should also include:

- The laboratory reports, laboratory narratives, and "**Data of Known Quality Conformance/Nonconformance Summary Questionnaire**" and chain of custody form;

- Project communication forms (if used); and

- Any other pertinent information.

The investigator should work with the laboratory to receive the analytical data in a convenient format, particularly if the laboratory report is provided in electronic format. The use of electronic deliverables from the laboratory can make the transfer of data into computer spreadsheets and databases more efficient, which in turn will improve efficiency when performing the DQA and DUE.

REFERENCES

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Appendix A
Supplemental Information on Data Quality Objectives and Quality Assurance Project Plans

APPENDIX A
SUPPLEMENTAL INFORMATION ON DATA QUALITY OBJECTIVES AND QUALITY ASSURANCE PROJECT PLANS

Data Quality Objectives (DQOs) are project-specific goals for an environmental investigation that address the generation, assessment, and intended use of the data associated with that investigation. DQOs express the qualitative and quantitative measures that will be used to determine whether the amount and quality of data associated with the investigation are sufficient and sufficiently accurate to draw the conclusions that will be necessary. Information on developing Data Quality Objectives can be found in the United States Environmental Protection Agency (EPA) Quality Assurance guidance document: *Guidance on Systematic Planning Using the Data Quality Objective Process* (QA/G-4), February 2006, EPA/240/B-06/001.

A Quality Assurance Project Plan (QAPP) documents the planning, implementation, and assessment procedures for a particular project, as well as any specific quality assurance and quality control activities. It integrates all the technical and quality aspects of the project in order to provide a "blueprint" for obtaining the type and quality of environmental data and information needed for a specific decision or use. All work performed or funded by EPA that involves the acquisition of environmental data must have an approved QAPP. In these instances, the State of New Jersey Department of Environmental Protection and EPA must review all QAPPs prior to the commencement of any monitoring component of the project. All QAPPs shall be written in conformance with N.J.A.C. 7:26E 2.2 and the Site Remediation Program's "Technical Guidance for Quality Assurance Project Plans". These and other quality assurance documents can be accessed at the following websites:
www.epa.gov/region1/lab/qa/qualsys.html and,
http://www.nj.gov/dep/srp/guidance/index.html

Appendix B
QC Information Summary and Measurement Performance Criteria

APPENDIX B-1

SUMMARY OF QUALITY CONTROL CHECKS AND SAMPLES

QC Sample or Activity used to Assess Measurement Performance	Frequency*	Measurement Performance Criteria
Field Duplicate	One in 20 samples per matrix for each parameter	See Appendix D-4
Site Specific Matrix Spike, Matrix Spike Duplicate (MS/MSD) Pair	One in 20 samples, one MS/MSD per matrix for each parameter	
Laboratory Control Sample, Laboratory Control Sample Duplicate (LCS/LCSD) Pair	One per batch of up to 20 samples per matrix	
Field Blank	Project specific	
Equipment Blank	One in 20 samples with non-dedicated equipment	
Trip Blank	One per cooler (VOCs only) per event for VOCs and volatile organic compounds	
Performance Evaluation Sample	Project specific	
Inter-Lab Split Samples	Project specific	
Methanol Trip Blank	Project specific	

*Frequency determined by method and/or project-specific requirements

APPENDIX B-2
TYPES OF INFORMATION USED TO EVALUATE PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY, COMPLETENESS AND SENSITIVITY

QC Element	Laboratory Measures	Field Measures
Precision	Laboratory Control Sample/ Laboratory Control Sample Duplicate Pair	Field Duplicates
	Matrix Spike Duplicates	Matrix Spike/Matrix Spike Duplicates pairs (collect samples for) Matrix Duplicate (collect samples for)
	Historical Data Trends	Appropriate Sampling Procedure
Accuracy	Laboratory Control Samples	Matrix Spikes/Matrix Spike Duplicates (collect samples for)
	Matrix Spikes and Matrix Spike Duplicates	Inclusion of "Blind" Samples
	Internal Standards	Appropriate Sampling Procedures
	Surrogate Recovery	Appropriate Sample Containers
	Initial Calibration	Appropriate Sample Preservation
	Continuing Calibration	Handling & Holding Times
	Standard Reference Material	Equipment Blank/Field Blank
Representativeness	Laboratory Homogenization	Appropriate Sampling Procedures Appropriate Sample Containers
	Appropriate Sub-sampling	Appropriate Sample Preservation
	Appropriate Dilutions	Incorporation of Field Screening Data
	"As Received" Sample Preservation Meeting Hold Times	Appropriate Number of Samples
Comparability	Gas Chromatography/Mass Spectrometry Tuning	Comparison to Previous Data Points
	Calibration	Comparison to Similar Data Points
	Analytical Method Followed	Similar Methods of Analysis used
Completeness	Percent Sample Per Batch Analyzed and Reported	Percent Planned Samples Collected
	All Critical Samples Reported and Unqualified	All Critical Samples Collected
Sensitivity	Method Blanks	Equipment Blank/Field Blanks
	Instrument Blanks	Appropriate Sample Volume or Weight
	Reporting Limit (Lowest Calibration Standard)	
	Appropriate Analytical Method	

Adapted from Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, *MCP Representativeness Evaluations and Data Usability Assessments, Policy #WSC-07-350*, September 19, 2007.

APPENDIX B-3
INFORMATION DERIVED FROM QUALITY CONTROL CHECKS AND SAMPLES

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preserva-tion Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Prepara-tion Reagents	Sample Prepara-tion Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
Accuracy/Bias (Contamination)	**Equipment Blank (Rinsate Blank)**	X	X	X		X	X	X	X	X	X	To evaluate carryover contamination resulting from successive use of sampling equipment.
	Bottle Blank (per Lot #)		X					X	X	X	X	To evaluate contamination introduced from the sample container.
	VOA Trip Blank		X	X		X	X	X	X	X	X	To evaluate contamination introduced during shipment.
	Storage Blank						X	X	X	X	X	To evaluate cross contamination introduced during sample storage.
	Method Blank							X	X	X	X	To evaluate contamination introduced during sample preparation and/or analysis by laboratory, including reagents, equipment, sample handling and ambient laboratory conditions.
	Reagent Blank (per Lot #)							X	X	X	X	To evaluate contamination introduced by specific method reagents.
	Instrument (System) Blank									X	X	To evaluate contamination originating from the analytical reagents instrumentation.

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preserva-tion Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Prepara-tion Reagents	Sample Prepara-tion Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
Accuracy/Bias	Matrix Spike				X			X	X	X	X	To determine laboratory preparatory and analytical bias for specific compounds in specific sample matrices.
	Surrogate Spike				X			X	X	X	X	To evaluate laboratory preparatory and analytical bias for specific sample matrices.
Accuracy/Bias	Laboratory Control Sample (LCS)							X	X	X	X	To evaluate the laboratory's ability to accurately identify and quantitate target compounds in a reference matrix at a known concentration, usually mid-range of the calibration curve.
	Perfor-mance Evaluation Samples-Ampulated Single Blind							X	X	X	X	To evaluate sample handling procedures from field to laboratory. To evaluate the laboratory's ability to accurately identify and quantitate target compounds in a reference matrix. Frequently used for data quality assessments and for laboratory self-assessments and external assessments.
	Perfor-mance Evaluation Sample-Full Volume Single Blind		X	X		X	X	X	X	X	X	

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preserva-tion Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Prepara-tion Reagents	Sample Prepara-tion Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
Accuracy/Bias	Perfor-mance Evaluation Sample Double Blind		X	X		X	X	X	X	X	X	To evaluate sample handling procedures from field to laboratory. To evaluate the laboratory's ability to accurately identify and quantitate target compounds in a reference matrix.
	Laboratory Fortified Blank (LFB) or Laboratory Control Sample (LCS)							X	X	X	X	A type of LCS used to evaluate laboratory (preparatory and analytical) sensitivity and bias for specific compounds in a reference matrix at the quantitation limit concentrations.
Accuracy/Bias	Initial Calibration									X	X	To ensure that the instrument is capable of producing acceptable qualitative and quantitative data.
	Continuing Calibration/ Continuing Calibration Verification									X	X	To ensure the accuracy and stability of the instrument response.
	Instrument Perfor-mance Check Sample									X	X	To verify that an instrument can accurately identify and quantitate target analytes at specific concentration levels.

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preserva-tion Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Prepara-tion Reagents	Sample Prepara-tion Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
Accuracy/Bias (Preservation)	**Cooler Temp. Blank (VOC only)**			X								To evaluate whether or not samples were adequately cooled during shipment.
Sensitivity	**Low-level calibration standard**							X	X	X	X	A standard used to evaluate accuracy and sensitivity at a specific concentration. Used to evaluate laboratory sensitivity and bias for specific compounds in a reference matrix at the quantitation limit concentrations.
	Method Detection Limit Studies				X (if performed using same reference matrix)			X	X	X	X	A statistical determination that defines the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.
Sensitivity	**Low Point of Initial Calibration Curve (Reporting Limit)**									X	X	To ensure that the instrument is capable of producing acceptable qualitative and quantitative data at the lowest concentration that sample results will be reported; the Reporting Limit.

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preserva-tion Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Prepara-tion Reagents	Sample Prepara-tion Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
Precision	Field Duplicates	X	X	X	X	X	X	X	X	X	X	To measure overall precision by evaluating cumulative effects of both field and laboratory precision.
	Laboratory Duplicates				X			X	X	X	X	To evaluate laboratory preparatory and analytical precision.
	Matrix Spike Duplicates							X	X	X	X	To determine laboratory preparatory and analytical bias and precision for specific compounds in specific sample matrices.
	Analytical Replicates (e.g., duplicate injections)										X	To evaluate analytical precision for determinative instrumentation.
	Internal Standards										X	To evaluate instrument precision and stability.
Inter-laboratory Comparability	Field Splits					X	X	X	X	X	X	To evaluate sample handling procedures from field to laboratory and to evaluate inter-laboratory comparability and precision.

Notes:

Not all of the types of QC checks and samples listed in this table are standard deliverables that are reported or required by the RCPs.

Table adapted from Region I, EPA New England *Compendium of Quality Assurance Project Plan Requirements and Guidance, Final October 1999, Attachment A*: Region I, EPA-NE Quality Assurance Project Plan Manual, Draft, September 1998, Table 4, pages 83-87.

Appendix C
QC Information to be Reviewed During Data Quality Assessments

APPENDIX C

QUALITY CONTROL INFORMATION TO BE EVALUATED DURING DQA AND DUES

NJDEP expects that the investigator will evaluate all laboratory reported QC information and nonconformances in accordance with this guidance. Nonconformances that are found may be noted on the DQQ Worksheets found in Appendix D of this document, the SRP Full Laboratory Data Deliverables form and the SRP Reduced Laboratory Data Deliverables section appearing in key documents.

The information below summarizes standard, required deliverables to obtain Data of Known Quality. The QC information that must be reviewed during the DQA by the investigator includes, but is not limited to the following:

STANDARD DKQ DELIVERABLES

Laboratory Report Inspection

Goal: Determine if all laboratory deliverables are provided and complete:

Tasks:

- Review the laboratory report to determine that the following items are present for all sample batches:
  - DKQ Conformance/Nonconformance Summary Questionnaire(C/NCSQ)
  - Narrative identifying QC nonconformances;
  - Analytical results;
  - Chain of Custody Form; and,
  - Quality control results, including but not limited to:
    - Method Blanks;
    - Laboratory Control Samples (LCS);
    - MS/MSD (when requested);
    - Surrogates (as appropriate for method); and,
    - Other QC results and information provided in the laboratory report.

- Review information on the C/NCSQ to determine that:
  - All the questions in the C/NCSQ are answered;
  - The C/NCSQ is dated and signed; and,
  - The narrative includes an explanation for the questions which were answered “NO.”

- Review the laboratory narrative to identify QC nonconformances:
  - Review the narrative for significant findings (i.e., QC nonconformances that could affect usability of the reported results) and request additional information from the laboratory, if applicable.

- Review the Chain of Custody Form for completeness and correctness:

    - Review Chain of Custody Form to ensure form is complete and correct;
    - Verify sample identification numbers and collection information;
    - Verify that there is an acceptance signature for each relinquished signature documenting the delivery of the samples to the laboratory facility. Check for errors in noted dates and times;
    - Correct any errors with a single line cross-out, initial/date and note reason for correction; and,
    - Contact the laboratory for help or clarification if needed.

Data of Known Quality Evaluation

Goal: Determine if Data of Known Quality was achieved.

Tasks: Review the C/NCSQ to determine if data are of known quality was achieved.

Chain of Custody (COC) Evaluation

Goal: Evaluate the information presented on the Chain of Custody Form to determine if any QC issues or nonconformances are present.

Tasks:

- Determine whether Handling Time was met;
- Determine if samples appropriately preserved/refrigerated/iced; and,
- Determine if samples were received by the laboratory an appropriate temperature.

Sample Result Evaluation

Goal: Determine if sample results have been properly reported.

Tasks: Evaluate the sample results:

- Determine that reporting limits (RLs) were noted;
- Verify that concentrations greater than the RL were reported;
- Verify that concentration reported below the RLs are qualified "J"
- Verify that the results for soils and sediments were reported in mg/kg on a dry weight basis;
- Verify that results for aqueous samples are reported in ug/L;
- Verify that air vapor samples are reported in ug/m3;
- Check dilution factor to see if a dilution was performed and if so, the RL adjusted accordingly;
- Determine that RLs are less than, or equal to the regulatory criteria; and,
- Determine if sample results are provided for the each requested analysis

Sample Preservation and Holding Times Evaluation

Goal: Determine if samples were preserved properly and analyzed within holding times.
Tasks:

- Review the chain of custody and or narrative to determine if the samples were preserved in accordance with the requirement of the DKQ Method reported.

- Review the narrative to determine if the holding time specified in the DKQ Method was met.

- **Review the chain of custody for other sample/method-specific QA (e.g. vacuum readings on vapor canisters).**

Method, Field or Trip Blank Evaluation

Goal: Determine the existence and magnitude of contamination resulting from laboratory or field activities.

Task: Review all blank data and narratives for possible contamination.

Field Duplicates and Laboratory Duplicates

Goal: Evaluate Precision

Task: Review all duplicate sample information.

Laboratory Control Samples Evaluation

Goal: Evaluate accuracy of laboratory method.

Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

Surrogate Results Evaluation

Goal: Evaluate accuracy in the sample matrix.

Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

Matrix Spike/Matrix Spike Duplicate Results Evaluation

Goal: Evaluate accuracy (Matrix Spike) and precision (Matrix Spike Duplicate) in the sample matrix.

Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

Other Information and QC Information:

Other Laboratory Information:

Evaluate precision, accuracy, representativeness, comparability, completeness, and sensitivity as appropriate

Review information provided.

Appendix D
Data Quality Assessment Worksheets and Summary of DKQ Acceptance Criteria

APPENDIX D-1

INSTRUCTIONS FOR THE USE OF THE DATA QUALITY ASSESSMENT WORKSHEETS

The worksheets presented in Appendices D-2 and D-3 are two examples of Data Quality Assessment Worksheets (DQA Worksheets) that may be used to summarize the QC nonconformances that are reported for a laboratory deliverable for each sample in one place. The "NJDEP Site Remediation Program Full Laboratory Data Deliverable Form" must be submitted to the Department pursuant to N.J.A.C. 7:26E-2.1(a)15 when submitting analytical results for samples of Immediate Environmental Concern (IEC), potable well samples, and vapor intrusion cases pursuant to N.J.A.C 7:26E-1.14, 1.17, and 1.18 and for polychlorinated dibenzo-p-dioxins/polychlorinated dibenzofurans and all hexavalent chromium soil samples pursuant to N.J.A.C. 7:26E-2.1. This form and instructions are available on the NJDEP website at http://www.nj.gov/dep/srp/srra/forms/. These worksheets are intended to be a starting point and can be modified by the user. A summary of the QC information to be reviewed as part of a Data Quality Assessment is presented in Appendix C of this document. It is the investigator's responsibility to complete these worksheets (i.e., they should not be completed by the laboratory).

If needed, the NJDEP DKQ acceptance criteria for each of the common analytical methods can also be found in Appendix D-4 of this document and Appendix B of the DKQ Guidance.

Appendix D-2, DQA Worksheet 1

QC for DKQ deliverables and other information is shown on the left hand side of the form. QC nonconformances, if any, are circled and described on the right hand side of the form. A space for notes is also provided on the right hand side of this form.

Appendix D-3, DQA Worksheet 2

This one page worksheet can be used to list all of the nonconformances for a sample in one place. To help streamline data entry this form can be filled out electronically by using a spreadsheet program. For smaller projects, it may be useful to add a columns to list applicable regulatory criteria and preliminary DUE findings.

APPENDIX D-2
DATA QUALITY ASSESSMENT WORKSHEET 1

PAGE __ OF __

PROJECT:				**FILE NUMBER:**		
LABORATORY WORK ORDER				**REVIEWER:**		**DATE:**
BLANKS		**Compound**	**Compound**	**Compound**	**Compound**	**Notes**
Method Blank, VOCs	>RL?					
Method Blank, SVOCs	>RL?					
Method Blank, VPH	>RL?					
Method Blank, EPH	>RL?					
Method Blank, PCBS	>RL?					
Method Blank, Pest	>RL?					
Method Blank, Metals	>RL?					
Method Blank, Total Cyanide	>RL?					
Method Blank, ETPH	>RL?					
Method Blank Hex Chrome	>RL?					
Field Blank	>RL?					
Trip Blank	>RL?					
VPH Blank (methanol)	>RL?					
Blank Soil VOCs (methanol)	>RL?					
Blank Soil VOCs (water/bisulfate) circle	>RL?					
LCS	**SV**	**Low Bias**	**High Bias**	**Compound**	**Compound**	**Notes**
VOCs	<10%	> 10% & < LCL	>UCL			
SVOCs	<10%	> 10% & < LCL	>UCL			
VPH	<10%	> 10% & < LCL	>UCL			
EPH	<10%	> 10% & < LCL	>UCL			
PCB	<10%	> 10% & < LCL	>UCL			
PEST	<10%	> 10% & < LCL	>UCL			
Hex Chrome	<70%	>70 % & <LCL	> UCL			
Metals	<10%	> 10% & < LCL	>UCL			
Total Cyanide	<10%	> 10% & < LCL	>UCL			
ETPH	<10%	> 10% & < LCL	>UCL			
SURROGATES	**SV**	**Low Bias**	**High Bias**	**Compound**	**Compound**	**Notes**
VOCs	<10%	> 10% & < LCL	>UCL			
SVOCs	<10%	> 10% & < LCL	>UCL			
VPH	<10%	> 10% & < LCL	>UCL			
EPH	<10%	> 10% & < LCL	>UCL			
PCB	<10%	> 10% & < LCL	>UCL			
PEST	<10%	> 10% & < LCL	>UCL			
MS/MSDS	**SV**	**Low Bias**	**High Bias**	**QC Source**	**RPDS**	**Notes**
VOCs	<10%	> 10% & < LCL	>UCL	Batch? Site?		
SVOCs	<10%	> 10% & < LCL	>UCL	Batch? Site?		
EPH	<10%	> 10% & < LCL	>UCL	Batch? Site?		
PCB	<10%	> 10% & < LCL	>UCL	Batch? Site?		
PEST	<10%	> 10% & < LCL	>UCL	Batch? Site?		
Hex Chrome	<50%	> 505 & < LCL	>UCL	Batch?		
Metals	<10%	> 10% & < LCL	>UCL	Batch? Site?		
Total Cyanide	<10%	> 10% & < LCL	>UCL	Batch? Site?		
ETPH	<10%	> 10% & < LCL	>UCL	Batch? Site?		
FIELD DUPLICATES RPDS		**Soil**	**Water**	**Compound**	**Compound**	**Notes**
VOCs		RPD > 50%	RPD > 30%			
SVOCs		RPD > 50%	RPD > 30%			
VPH		RPD > 50%	RPD > 30%			
EPH		RPD > 50%	RPD > 30%			
PCB		RPD > 50%	RPD > 30%			
PEST		RPD > 50%	RPD > 30%			
Metals		RPD > 50%	RPD > 30%			
Total Cyanide		RPD > 50%	RPD > 30%			
EPH		RPD > 50%	RPD > 30%			
LAB DUPLICATES RPDS		**Soil**	**Water**	**Compound**	**Compound**	**Notes**
		RPD > 50%	RPD > 30%	Batch? Site?		
Hex Chrome		RPD >20%	RPD >20%	Batch		
Reasonable Confidence Achieved? Y/N		Significant QC Variances Noted? Y/N		Requested Reporting Limits Achieved? Y/N		
Preservation Requirements Met? Y/N		Holding Time Requirements Met? Y/N				

Abbreviations: RL = Reporting Limit; LCS = Laboratory Control Sample; SV = Significant QC Variance; LCL= RCP Lower Control Limit; UCL= RCP Upper Control Limit; RPD = Relative Percent Difference; VOCs = Volatile Organic Compounds; SVOCs = Semivolatile Organic Compounds; VPH = Volatile Petroleum Hydrocarbons; EPH = Extractable Petroleum Hydrocarbons; PCBs = Polychlorinated Biphenyls; Pest = Pesticides; ETPH Extractable Total Petroleum Hydrocarbons

APPENDIX D-3

DATA QUALITY ASSESSMENT WORKSHEET 2

Project:
File Number:
Reviewer:
Date:
Notes:

Sample Number(s)	Compound(s)	Quality Control Nonconformance	Percent Recovery	Relative Percent Difference	High/Low or Indeterminate Bias	Comments
Note other QC nonconformances below (data package inspection, reasonable confidence. chain of custody, sample result, sample preservation and holding time evaluations.						

Notes:
Bias High: Reported result may be lower. Reporting Limit (RL) is acceptable as reported.
Bias Low: Reported results may be higher. Reporting Limit (RL) may be higher than reported.
Bias Indeterminate: Reported result may be biased; however, it's unclear whether the results may be biased low or high.

APPENDIX D-4

SUMMARY OF DKQ ACCEPTANCE CRITERIA

QC Parameter	Holding Time (1)	Method Blank	Site Specific Matrix Spike/Matrix Spike Duplicate	Laboratory Control Sample
Method 6010 Trace Metals Inductively Coupled Plasma-Atomic Emission Spectrometry	Aqueous soil, sediment, and high concentration waste samples, 180 days. Mercury 28 days.	Target analytes must be < RL.	Percent recovery limits must be between 75-125%. If MS/MSD run, for aqueous samples, if concentration > 5x the RL, RPD < 20%. If concentration < 5x RL, difference ± RL; for solids, if concentration > 5x RL, RPD < 35%. If concentration < 5x RL, difference ± 2x RL.	LCS recoveries ± 20% for aqueous samples and within vendor control (95% confidence limits) for solids.
Method 6020 Trace Metals Inductively Coupled Plasma-Mass Spectrometry	Aqueous, soil, sediment, and high concentration waste samples, 180 days. Mercury 28 days.	Target analytes must be < RL.	Percent recovery limits must be between 75-125%. If MS/MSD run, for aqueous samples, if concentration > 5x the RL, RPD <20%. If concentration < 5x RL, difference ± RL; for solids, if concentration > 5x RL, RPD < 35%. If concentration < 5x RL, difference ± 2x RL.	LCS recoveries ± 20% for aqueous samples and within vendor control (95% confidence limits) for solids.
Method 7000 Series Metals (Flame and Graphite Furnace Atomic Absorption Spectroscopy)	Aqueous, soil, sediment, and high concentration waste samples, 180 days.	Target analytes must be < RL.	Percent recovery limits must be between 75-125%. If MS/MSD run, for aqueous samples, if concentration > 5x the RL, RPD ± 20%, if concentration < 5x RL, difference ± RL; for solids, if concentration > 5x RL, RPD ±35%. If concentration < 5x RL, difference ± 2x RL.	LCS recoveries ± 20% for aqueous samples and within vendor control (95% confidence limits) for solids.

APPENDIX D-4

SUMMARY OF DKQ ACCEPTANCE CRITERIA

QC Parameter	Holding Time (1)	Method Blank	Site-Specific Matrix Spike/Matrix Spike Duplicate	Site-Specific Matrix Spike/ Matrix Spike Duplicate (Aqueous Only)	Site-Specific Sample Matrix Duplicate	Site-Specific Soluble and Insoluble Cr6+ Matrix Spike (Solid Only)	Laboratory Control Sample
Method 7196 Hexavalent Chromium	Aqueous 24 hours; Soil/sediment samples, digest within 30 days. Analyze digestate within 7 days of preparation. High concentration waste samples Digest within 30 days. Analyze digestate within 7 days of preparation. Soil/sediment pH and ORP 24 hours of sample preparation. Soil/sediment, ferrous iron and sulfide 7 days	Cr6+ must be < RL	(Not Applicable	(Matrix spike only for Hexavalent Chromium, not MS/MSD pair) Percent recovery limits must be between 75-125%.	Must be performed on a Site field sample. Aqueous/ Soil/Sediment: RPD ≤ 20%; a control limit of ± RL if original or duplicate is < 4 times the RL.	Percent recovery limits must be between 75-125%.	LCS recoveries ±20% for aqueous samples and within vendor control (95% confidence limits) for solids or the NIST 2701 control limits.
Method 7470/7471 Mercury Cold Vapor Atomic Absorption Spectroscopy	Aqueous, soil, sediment, and high concentration waste samples, 28 days.	Mercury must be <RL	Percent recovery limits must be between 75-125%.	Not applicable	For aqueous samples RPD ± 20% if conc. >5x the RL. If conc. < 5x RL, the limit is ± RL. For solids RPD ±35% if conc. >5x the RL. If conc. < 5x the RL, limit is ± the RL.	Not applicable	LCS recoveries ±20% for aqueous samples and within vendor control (95% confidence limits) for solids.

APPENDIX D-4

SUMMARY OF DKQ ACCEPTANCE CRITERIA

QC Parameter	Holding Time (1)	Method Blank	Surrogates	Site-Specific Matrix Spike/Matrix Spike Duplicate	Laboratory Control Sample	Endrin and DDT Breakdown Standard
Method 8021 Volatile Organic Com-pounds	Aqueous 14 days (2) Soil/sediment, 14 days if preserved. 48 hours if unpreserved (Note 3). High concentration waste samples, 14 days.	Target analytes must be < RL except for common lab contaminants which must be < 3x the RL (contaminants are acetone, methylene chloride, and 2-butanone).	Laboratory determined percent recoveries must be between 70-130% for individual surrogate compounds. Laboratory determined recovery limits may be outside 70-130 % limits for difficult matrices (e.g. waste, sludges, etc.).	Laboratory determined percent recoveries should be between 70-130 % for target compounds. RPD's should be ≤ 30%.	Laboratory determined percent recoveries must be between 70-130% for target compounds.	Not applicable
Method 8081 Pesticides	Aqueous, 7 days to extraction. 40 days from extraction to analysis. Soil/sediment samples, 14 days to extraction. 40 days from extraction to analysis. Up to one year for samples frozen within 48 hours of collection (Note 1). High concentration waste samples 14 days to extraction. 40 days from extraction to analysis.	Target analytes must be < RL.	Recovery limits lab generated and within maximum range of 30-150% for both compounds on both columns. Labs must develop own in-house limits, which fall within 30-150% limits.	Laboratory determined percent recovery limits must be between 30-150% RPD's ≤ 20% for water and ≤ 30% for solids	Laboratory determined percent recovery limits must be between 40-140% except for difficult analytes, which must be between 30-140% recovery.	Breakdown must be ≤ 15% for each compound.

APPENDIX D-4

SUMMARY OF DKQ ACCEPTANCE CRITERIA

QC Parameter	Holding Time (1)	Method Blank	Surrogates	Site Specific Matrix Spike/Matrix Spike Duplicate	Laboratory Control Sample
Method 8151 Chlorinated Herbicides	Aqueous 7 days to extraction, 40 days from extraction to analysis Soil/Sediment, 14 days to extraction. 40 days from extraction to analysis. Up to one year for samples frozen within 48 hours of collection. (Note 4) High concentration waste samples, 14 days to extraction. 40 days from extraction to analysis	Target analytes must be <RL.	Recovery limits lab generated and within 30-150% for both compounds on both columns. Labs must develop own in-house limits that fall within 30-150% limits. If surrogate exceeds limits on one column and herbicide concentrations reported at > RL but dual column precision not acceptable (RPD > 40%), re-extract and reanalyze samples.	Laboratory determined percent recovery limits must be between 30-150%, RPDs ≤ 20% waters and ≤ 30% solids.	Laboratory determined percent recovery limits must be between 40-140% except in-house limits for Dinoseb. Labs expected to develop own in-house control limits that meet or exceed limits listed above.
Method 8082 Polychlori-nated Biphenyls	Aqueous 7 days to extraction, 40 days from extraction to analysis. Soil/Sediment 14 days to extraction. 40 days from extraction to analysis. Up to one year for samples frozen within 48 hours of collection. (Note 4) High concentration waste samples, excluding transformer oils, 14 days to extraction. 40 days from extraction to analysis. Transformer/Waste Oils, 1 yr	Target analytes must be <RL.	Recovery limits lab generated and within maximum range of 30-150% for both compounds on both columns. Labs must develop own in-house limits that fall within 30-150% limits.	Laboratory determined percent recovery limits for AR-1016/1260 must be between 40-140%. Recoveries for all Aroclors or Congeners 40-140% Congeners must contain all target congeners. RPD's ≤ 20% for waters and ≤ 30% for solids.	Laboratory determined percent recovery limits must be between 40-140%. Labs are required to develop own in-house limits that meet or exceed limits listed above.

APPENDIX D-4

SUMMARY OF DKQ ACCEPTANCE CRITERIA

QC Parameter	Holding Time (1)	Method Blank	Surrogates	Site Specific Matrix Spike/Matrix Spike Duplicate	Laboratory Control Sample
Method 8260 Volatile Organic Com-pounds	Aqueous, 14 days, 7 days if unpreserved (2) Soil/Sediment, 14 days if preserved. 48 hours if unpreserved. (Note 3). High concentration waste samples, 14 days.	Target analytes must be <RL except for common lab contaminants which must be <3x the RL (Contaminants are acetone, methylene chloride, and 2-butanone).	Laboratory determined percent recoveries must be between 70-130% for individual surrogate compounds. Laboratory determined recovery limits may be outside 70-130% limits for difficult matrices (e.g. waste, sludges, etc.).	Laboratory determined percent recoveries should be between 70-130% for target compounds. RPDs should be ≤ 30%	Laboratory determined percent recoveries must be between 70-130% for target compounds. Can also be used as CCAL. Lab may have difficult compounds out of criteria as long as within 40-160% recovery.

APPENDIX D-4

SUMMARY OF DKQ ACCEPTANCE CRITERIA

QC Parameter	Holding Time (1)	Method Blank	Surrogates	Site Specific Matrix Spike/Matrix Spike Duplicate	Laboratory Control Sample
Method 8270 Semivolatile Organic Compounds	Aqueous, 7 days to extraction. 40 days from extraction to analysis Soil/sediment, 14 days to extraction. 40 days from extraction to analysis. Up to one year for samples frozen within 48 hours of collection. (Note 4) High concentration waste samples 14 days to extraction. 40 days from extraction to analysis.	Target analytes must be < RL except for common lab contaminants which must be < 5x the RL (Contaminants are phthalates).	Soil recovery limits lab generated and within 30-130%. Water recovery limits lab generated and within 30-130% for base-neutrals, 15-110% for acid compounds.	Laboratory determined percent recovery limits must be between 70-130% except 20-160% for difficult compounds. RPD's ≤ 20% for waters and ≤ 30% for soils.	Laboratory determined percent recovery limits must be between 70-130% except 20-160% for difficult compounds.
Method 9010/9012/9014 Total Cyanide	Aqueous, soil, sediment and high concentration waste samples: Cyanide 14 days from collection to analysis, (from date when thawed if solid samples frozen). Can maintain samples up to 1 year if frozen	Cyanide must be < RL.	Not applicable	Percent recovery limits must be between 75-125%. For aqueous samples RPD ≤ 20% For solids RPD ≤ 35%	LCS recoveries ±20% for aqueous samples and within vendor control (95% confidence limits) for solids.

APPENDIX D-4

SUMMARY OF DKQ ACCEPTANCE CRITERIA

QC Parameter	Holding Time (1)	Method Blank	Surrogates	Site Specific Matrix Spike/Matrix Spike Duplicate	Laboratory Control Sample	Fractionation Check Standard
NJDEP Extractable Petroleum Hydrocarbons (EPH)	Aqueous, soil, and sediments, samples must be extracted within 14 days of collection. Extracts must be analyzed within 40 days of extraction.	All components should be < 5 times their respective MDLs.	Labs develops own in-house limits which must be within 40-140% for each surrogate. Sample recoveries and must be within 40-140%. Conc. of fractionating surrogates naphthalene and 2-methylnaphthalene in aliphatic fraction < 5% total conc. of those 2 compounds (in the batch-related LCS or LCSD)	Lab develops own in-house recovery range but percent recoveries should be: Fractionated = between 40 and 140% for each carbon range. Non-Fractionated = between 40 and 140% for each compound RPDs should be ≤ 50% for waters and soils/sediments if MSD is performed.	Percent recoveries between 40 and 140% for all compounds in the LCS; n-nonane must be between 25-140%. If #2 fuel used as the LCS, percent recoveries must be between 40 and 140% for the #2-fuel Retention times of surrogates in LCS must be within retention time windows	Every lot of silica gel/SPE cartridges checked. Percent recoveries between 40 and 140% for each compound, except for n-nonane which must be between 25-140%.

APPENDIX D-4

SUMMARY OF DKQ ACCEPTANCE CRITERIA

Notes:

Not all method QA/QC deliverables are listed here. .

(1) See the Method for specific preservation requirement for each method.
(2) If aqueous samples effervesce upon addition of hydrochloric acid, samples must be collected unpreserved and stored at 4 ± 2º Celsius. Holding time is 7-days from collection.
(3) Samples should be collected and stored according to N.J.A.C. 7:26E-2.1(a)8.
(4) If the freezing option is selected, the sample must be frozen within 48 hours of collection. The holding time recommences when thawing begins. The total holding time is calculated from the time of collection to freezing plus the time allowed for thawing. The total elapsed time must be less than 14 days. Although the USEPA removed the holding time requirements for PCBs, NJDEP still requires the method – specified holding times to be followed.

Abbreviations:
CCAL Continuing Calibration
Cr Chromium
EPA United States Environmental Protection Agency
EPH Extractable Petroleum Hydrocarbons
LCS Laboratory Control Sample
LCSD Laboratory Control Sample Duplicate
ORP Oxidation Reduction Potential
RPD Relative Percent Difference
RL Reporting Limit
YR Year

Appendix D-5
Common Laboratory Data Qualifiers

Organics:

U This flag indicates the compound was analyzed for but not detected at a listed and appropriately adjusted reporting level.

J This flag indicates an estimated value. This flag may be used when:
(1) estimating a concentration for TICs where a 1:1 response is assumed;
(2) the mass spectral and Retention Time (RT) data indicate the presence of a compound that meets the volatile and semivolatile GC/MS identification criteria, and the result is less than the adjusted Reporting Limit; and
(3) the RT data indicate the presence of a compound that meets the pesticide and/or Aroclor identification criteria, and the result is less than the adjusted Reporting Limit but greater than zero. For example, if the sample's adjusted Reporting Limit is 5.0 µg/L, but a concentration of 3.0 µg/L is calculated, report it as 3.0J.

N This flag indicates presumptive evidence of a compound. This flag is only used for TICs, where the identification is based on a mass spectral library search and must be used in combination with the J flag. It is applied to all TIC results. For generic characterization of a TIC, such as chlorinated hydrocarbon, or for an "unknown" (no matches ≥ 85%), the "N" flag is not used.

P This flag is used for pesticide and Aroclor target compounds when there is greater than 40% relative percent difference (RPD) for detected concentrations between the two GC columns (see Form X). The "P" flag is not used unless a compound is identified on both columns.

C This flag applies to pesticide and Aroclor results when the identification has been confirmed by GC/MS. If GC/MS confirmation was attempted but was unsuccessful, do **not** apply this flag; use a laboratory-defined flag instead (such as the X-qualifier).

B This flag is used when the analyte is found in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user to take appropriate action. This flag shall be used for a TIC as well as for a positively identified target compound. Blank contaminants are flagged "B" only when they are detected in the sample.

E This flag identifies compounds whose response exceeds the response of the highest standard in the initial calibration range of the instrument for that specific analysis. (If one or more compounds of concern have a response greater than the response of the highest standard in the initial calibration, the sample or extract should be diluted and reanalyzed according to the specifications of the method and a new result reported.)

D If a sample or extract is reanalyzed at a dilution factor greater than 1(e.g., when the response of an analyte exceeds the response of the highest standard in the initial calibration), the D qualifier is attached to the sample result.

Organics (continued):

A This flag indicates that a TIC is a suspected Aldol-condensation product.

S This flag is used to indicate an estimated value for Aroclor target compounds where a valid 5-point initial calibration was not performed prior to the analytes detection in a sample. If an "S" flag is used for a specific Aroclor, then a reanalysis of the sample is required after a valid 5-point calibration is performed for the detected Aroclor.

(Obtained from the USEPA Contract Laboratory Program Statement of Work for Organics Analysis Multi-Media, Multi-Concentration SOM1.1May 2005 (revised in SOMO1.2).

Inorganics:

X The reported value is estimated due to interferences.

* QC analyses are outside control limits.

D The reported value is from a dilution.

J The reported value was less than the CRQL, but greater than or equal to the MDL.

U The result was less than the MDL. For Hardness, if the results for both Ca and Mg were less than their respective MDLs.

N Spiked sample recovery not within control limits.

E The reported value is estimated due to the presence of interference. An explanatory note should be included in a comments section.

Obtained From USEPA Contract Laboratory Program Statement of Work for Inorganic Superfund Methods (Multi-Media, Multi-Concentration) ISM01.2 January 2010.

Appendix E
Evaluating Significant QA/QC Variances

APPENDIX E

EVALUATING SIGNIFICANT QA/QC VARIANCES

On occasion, the investigator may encounter Quality Control (QC) nonconformances that are so excessive that they must be considered as significant or gross violations of QC criteria. Causes may range from problems associated with the sampled medium, such as severe matrix interference, or may be the result of improper sample handling and management. Whatever the cause, the investigator must determine whether or not the data associated with such significant QC violations can be used in making the environmental decisions for which the associated samples were collected.

In general, data associated with significant QC violations will be of limited use in decision-making, and it is the responsibility of the investigator to demonstrate that such data are, in fact, usable for a particular purpose. It should be understood that the same data set with the same QC issues may be usable for one purpose but not for another. It is certainly possible that data associated with significant violations of QC might be used for qualitative or screening purposes, but it is highly unlikely that such data would be suitable for demonstrating compliance with applicable regulations. However, samples with significant QC variances can be used to determine that remediation is needed. The extent to which such data may be relied upon clearly depends on the intended use of that data.

It is possible to review a data set with significant QC violations and, depending on the intended purpose, the investigator may choose to use or qualify the data in one case and reject it in another. For example, if significant QC failures occur, but an analyte is detected and the purpose of the sample analysis is to characterize environmental matrices to determine if a release has occurred, the investigator can reasonably justify using that data to determine that there was, in fact, a release of the specific compounds that were detected. The data may not be usable to determine all of the contaminants that may have been released (i.e., determine the full nature of the release), and it should be clearly understood that additional measures should be taken to ensure that QC results for sampling during follow-up portions of the investigation are within acceptable limits.

If significant QC failures occur and the purpose of the sampling was to conclusively demonstrate compliance with regulations, then it is unlikely that the data will be usable for that purpose.

If there are years of previous data or many other samples from a particular release area that are consistent with the results of the data associated with significant QC failures and site conditions have not changed as demonstrated through subsequent data, then it is possible that the data with poor QC could be used with qualification. If the data with poor QC appear anomalous relative to previous results, then it is unlikely that they can be relied on to draw final conclusions.

QC results for laboratory data associated with investigation and remediation projects should always be evaluated with respect to the intended use of that data and the project-specific or task-specific data quality objectives that were established for types of decisions that will be made using that data. NJDEP expects that data with significant QC failures will be deemed unusable, unless the investigator provides adequate justification for the use of such data and qualifies the data accordingly, such as indicating that such data is used as qualitative, rather than quantitative, information. Once the investigator comes to the conclusion that data are unusable, NJDEP expects that any data deemed unusable will not be used to demonstrate compliance with regulatory criteria.

The following paragraphs identify typical types and causes of significant QC violations and provide a discussion of the factors that an investigator should consider when evaluating whether or not the associated data is usable.

General QC Infractions

Sample Receipt Issues

- Field and trip blanks were not received at the site within 1 day of their preparation at the laboratory;
- Blanks and associated samples were held longer than 2 days on-site and/or did not arrive back at the laboratory within 1 day of shipment;
- Samples to be analyzed are received outside a temperature of 4 +/-2º Celsius (C);
- Samples received above a maximum temperature of 12ºC more than 24 hours from collection; and

- Lack of evidence of cooling with ice or use of artificial ice substitutes, such as “blue ice,” which are not acceptable as evidence of cooling if the sample temperature is outside the acceptance limits specified in the DKQ protocols and the three prior bullets above.

Sample Containers

Any improper sample container, as described in the applicable analytical method, or a sample container that is not properly sealed or has been otherwise compromised, should be considered to be a significant QC infraction.

Sample Preservation

Analytical results from samples that are not preserved in accordance with the requirements of the analytical method should be considered to be a significant QC infraction.

Analysis Holding-time Excursions (total holding time from collection)

Analytical results that are greater than the applicable regulatory criteria can be considered usable, regardless of the holding time, as long as the intended use of the data is to identify locations where concentrations of contaminants exceed those criteria. However, analytical results less than regulatory criteria that were analyzed and/or extracted after more than two times the holding time has passed should not be considered usable unless the investigator can provide the rationale for the use of the data. Similarly, if samples for which analytical results are greater than regulatory criteria were subject to holding-time issues and such results are intended for use in demonstrating compliance in any way, such as using an alternative criterion, those results must be considered in a manner similar to results that are less than regulatory criteria.

Calibration Issues

If calibration issues are reported the investigator should contact the laboratory, as needed, for guidance. Although reporting of calibration QC is not required under the DKQs on a routine basis, the DKQ protocols require that the laboratory narrate nonconformance of calibration issues, as described in the DKQ protocols for various analytical methods. The following calibration issues are among those that would be considered significant QC infractions:

- Instrument not calibrated by an initial calibration (ICAL);

- No continuing calibration standard analyzed within 24 hrs of ICAL;
- Gas Chromatography/Mass Spectrometry tune criteria significantly out of criteria (greater than 20 percent for any one atomic mass unit); and
- Relative Response Factor (RRF) less than 0.05 (with no technical justification for low RRF), for DKQ Methods 8260B and 8270C should result in rejection of all results reported as below the reporting limit for associated samples.

Reporting Issues

Issues of suspected data fraud should be forwarded to the appropriate authorities, e.g. the NJDEP Office of Quality Assurance.

Professional Judgment

In some cases, it is appropriate to reject data based on professional judgment. These cases include, but are not limited to the following:

- Severely poor overall instrument performance;
- Low percent solids (less than 10 percent); and
- Multiple QC nonconformances and gross failures.

Significant QC Violations for Specific Analytes

The following situations are considered to be significant QC violations. If any of the following issues are reported, the investigator is encouraged to contact the laboratory for guidance.

Inorganic Compounds

LCS recovery is less than 50 percent of the control limit - An LCS less than 50 percent of control limit may be off-set by matrix spike data within acceptance criteria to reasonably determine that the problem is only associated with the LCS.

MS recovery is less than 30 percent for all affected analytes in a batch, with the exception of hexavalent chromium if supported by Oxidation Reduction Potential (ORP) and pH data which

indicates reducing conditions Hexavalent chromium readily reduces to trivalent chromium in a reducing environment.

Organic Compounds

LCS recovery is less than 10 percent - Usability of results reported as below the reporting limit for analytes with LCS recovery less than 10 percent is severely limited and would require substantial justification by the investigator.

Surrogate recoveries for organics less than 10 percent - Usability of results reported as below the reporting limit for analytes associated with surrogates with LCS recovery less than 10 percent is severely limited and would require substantial justification by the investigator.

MS/MSD recoveries for organics less than 10 percent - Usability of results reported as below the reporting limit for affected compound in the unspiked sample (i.e., field sample used for MS/MSD only) is severely limited and would require substantial justification by the investigator. The investigator should also evaluate how these results may affect the usability of other sample results in the batch.

Internal standard area counts in a sample are less than 20 percent of associated calibration check standard area counts – generally associated non-detects for analytes which are quantitated using the internal standard are rejected and would not be usable for project decisions.

Fractionation Check Standard (FCS) recovery for EPH for any analyte included in the FCS that is not between 40% and 140% (with lower recoveries permissible for n-Nonane but recovery must be >25%) - results are generally rejected and are not usable for project decisions.

Endrin/DDT Breakdown Check Standard, breakdown should be less than 15 percent - Non-detected results for endrin or DDT, whichever compound is affected, should be rejected and detected results for the breakdown projects should be considered biased high. This indicates the equipment was in need of maintenance at the time of analysis.

Dual column precision percent difference is greater than 100 percent for single response pesticides and herbicides - Reject all results for affected pesticides and herbicides. Dual columns are used to confirm the presence of analytes.

Dual column precision percent difference is greater than 500 percent for multi-response pesticides and polychlorinated biphenyls - Reject all results for affected data.

Appendix F
Poorly Performing Compounds

APPENDIX F

POORLY PERFORMING COMPOUNDS[1]

Method 8260

The following compounds are poorly performing compounds: acetone, bromoform, bromomethane, 1,2-dibromo-3-chloropropane, dichlorodifluoromethane, cis-1,3-dichloropropene, 1,4-dioxane, 2-hexanone, 2-butanone (MEK), 4-methyl-2-petanone (MIBK), naphthalene, styrene, and 1,1,2,2-tetrachloroethane. (See EPA Methods 8000 and 8260 for more detail.) Acetone, 2-hexanone, MEK and MIBK are water soluble and are therefore poor purgers; they are not easily purged from the water sample onto the trap. 1,4-Dioxane has poor purging efficiency and is subject to poor recovery if chlorinated solvents are present in the sample. 1,4-dioxane should not be analyzed by Method 8260; a modified version of Method 8270 is to be used. Naphthalene is a relatively high boiling compound for volatiles, and is also poorly purged from the sample. The remaining compounds, bromoform, bromomethane, 1,2-dibromo-3-chloropropane, dichlorodifluoromethane, cis-1,3-dichloropropene, styrene, and 1,1,2,2-tetrachloroethane, are easily degraded by heat as found in the injection port of the gas chromatograph or can react in certain sample matrices resulting in poor recovery. Additionally bromomethane and dichlorodifluoromethane are gases and are sometimes lost from the trap during analysis.

[1] Poorly Performing Compounds are those compounds whose characteristics are such that routine analytical method criteria are difficult to achieve. In the data assessment and data usability evaluation, added scrutiny should be given to the “analytical behavior” of these compounds.

Method 8270

The following compounds are poorly performing compounds: 4-chloraniline, 4-chloro-3-methylphenol, 4,6-dinitro-2-methylphenol, 2,4-dinitrophenol, 1,4-dioxane, hexachlorocyclopentadiene, 2-nitroaniline, 3-nitroaniline, 4-nitroaniline, 4-nitrophenol, pentachlorophenol, phenol, pyridene, 2,4,5-trichlorophenol and 2,4,6-trichlorophenol. (See EPA Methods 8000 and 8270 for more detail.) Most of these compounds are thermally reactive and are potentially lost in the injection port of the gas chromatograph. All of the phenolics are reactive with base and relatively water soluble. They are sometimes poorly extracted from aqueous samples and if a soil sample has a basic pH, may not be extracted at all. 1,4-Dioxane has poor extraction efficiency; however, Method 8270 has been modified by the department to include an option. The isotopically labeled compound 1,4-dioxane-d8 is added to the sample prior to extraction and is used both as an internal standard (to quantitate 1,4-dioxane) and a surrogate (1,4-Dioxane-d4 is used to quantitate 1,4-dioxane-d8 as a surrogate). This option is available for certification by the NJDEP Office of Quality Assurance.

Appendix G
Range of Data Usability Evaluation Outcomes

Appendix G
Range of Data Usability Evaluation Outcomes

The table which follows provides the data reviewer and the investigator with options addressing how to use data. It discusses what to look for and how to use data that may be qualified due to a variety of issues. The user is cautioned that each element of quality needs to be addressed before deciding that data are not usable. Any of the elements should undergo review by the investigator to determine if there is anything that is correctable prior to a usability evaluation.

Data with certain quality assurance deficiencies may be usable in certain circumstances. In the worst case scenario, depending on the severity of the deficiency, the data may be unusable.

APPENDIX G

DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Nonconformance	Possible Causes	Major PARCCS Parameters Affected (Note 2)	Possible Effects on Data Usability (Note 3)
Chain of Custody	Chain broken, incomplete, or not kept	Missing signatures, missing seals, missing dates or times, type of analysis requested not listed	Completeness	If confirmed that sample set is complete and samples not compromised, data are usable.
Sample labeling	Sample labels unreadable, missing, or not attached to containers	Failure to protect label from moisture, failure to use appropriate marker or labels, improper standard operating procedure (SOP)	Representative-ness Completeness	If the sample can be unambiguously identified, then samples are usable.
Sample labeling	Samples mislabeled or labeled incompletely	Sampler error Improper SOP	Representative-ness	If the sample can be unambiguously identified, then samples are usable.
Sample containers	Plastic containers for organic analytes	Samplers unaware of container requirements, improper SOP, failure to read SOP, SOP incorrect, insufficient quantity of correct containers samplers used containers on-hand	Representative-ness Accuracy Completeness	Possible phthalate interference and/or volatile loss may be present.
Sample containers	Glass containers for metals	Samplers unaware of container requirements, improper SOP, failure to read SOP, SOP incorrect, insufficient containers	Representative-ness Accuracy Completeness	Possible inorganic contamination may be present.
Headspace	Bubbles in water inside volatile organic chemical (VOC) vial	Poor sampling technique, caps not sealed tightly, septum caps not used, water vials not completely filled, improper	Representative-ness Accuracy Completeness	Loss of volatiles may occur.

APPENDIX G (CONTINUED)

RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Nonconformance	Possible Causes	Major PARCCS Parameters Affected (Note 2)	Possible Effects on Data Usability (Note 3)
		SOP		
Preservation – soil and sediment samples	VOC soil or sediment samples not properly preserved	Varies	Accuracy Representative-ness Completeness Comparability	Loss of volatiles may occur.
Preservation – aqueous samples	No preservative or wrong pH	No preservative added or improper amount of preservative added	Representative-ness Accuracy Completeness	This is an analyte- and method-dependent issue. Loss of analytes may occur.
Preservation – aqueous samples	Wrong preservative	Improper SOP, failure to read SOP, SOP incorrect, correct preservative unavailable	Representative-ness Accuracy Completeness	This is an analyte- and method-dependent issue. Loss of analytes may occur
Preservation	Improper temperature (temperature outside 4 ± 2° C Note (4)	Insufficient ice, samples too cold, shipping container inadequately insulated, samples adequately cooled at time of sampling and during shipping, transit time too long or too short for samples to reach temperature	Representative-ness Accuracy Completeness	Loss of analytes may occur if temperature is too high. If temperature is too low, check container for integrity.

APPENDIX G (CONTINUED)

RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Nonconformance	Possible Causes	Major PARCCS Parameters Affected (Note 2)	Possible Effects on Data Usability (Note 3)
NJDEP certification status	Laboratory not certified or approved for specific analytes by NJDEP.	Varies	All may be affected	Except in limited circumstances, data should not be used.
Handling or Holding times	Handling and/or Holding times exceeded	Excessive analysis time; tardy ship date; inappropriate shipping method; slow laboratory turn-around time.	Representative-ness Accuracy Completeness	Loss of analytes may occur. (Note 5)
Analysis method	Wrong method used to analyze samples	Incorrect laboratory method specified on chain of custody form; laboratory/analyst unaware of requirement; failure to read SOP; SOP incorrect.	Representative-ness Comparability Completeness Accuracy Sensitivity	Except in limited circumstances, data should not be used.
Reporting Limit (RL)	RL too high	Insufficient measures to combat interferences (i.e., cleanup, background correction); insufficient sample; high dilution factor; wrong or inappropriate method.	Comparability Completeness Sensitivity	If the RL for site-specific compounds of concern > the standards/screening levels, then NDs cannot be used to determine compliance. If a compound is detected and the RL is elevated, the data are usable.
Method blank (MB)	Method blank absent (Note 6)	Improper SOP	Representative-ness Accuracy Completeness	Data may contain false positives and in some circumstances, data should not be used.
Method blank (MB)	Contamination	Contaminated reagents, gases, glassware; ambient contamination; poor laboratory technique.	Representative-ness Accuracy Completeness	Data may contain false positives and/or high bias
Equipment blank (EB) or Rinsate blank	Contamination	Improper decontamination of field sampling equipment; contaminated rinsate water,	Representative-ness Accuracy	Data may contain false positives and/or high bias

APPENDIX G (CONTINUED)

RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Nonconformance	Possible Causes	Major PARCCS Parameters Affected (Note 2)	Possible Effects on Data Usability (Note 3)
		containers, or preservatives.	Completeness	
Trip blank (TB) for analysis of VOCs	Trip blank absent	TB not included; Improper SOP; TB broken during shipment; TB lost during shipment.	Representative-ness Accuracy Completeness	Data may contain false positives and/or high bias.
Trip blank for analysis of VOCs	Contamination	Cross-contamination during shipment or storage; contaminated reagent water, glassware, or preservatives	Representative-ness Accuracy Completeness	Data may contain false positives and/or high bias.
Laboratory Control Sample (LCS)	LCS absent (Note 7)	Improper laboratory SOP	Accuracy Completeness Comparability	Complete evaluation of the data may not be possible.
LCS, Laboratory Control Sample Duplicate (LCSD), blank spike (BS), blank spike duplicate (BSD)	Low recoveries	Method failure; improper spiking; degraded spiking solution; failed spiking device.	Accuracy Completeness Comparability	Data may contain false negatives and/or low bias
LCS, LCSD, BS, BSD	High recoveries	Method failure; improper spiking; degraded spiking solution; failed spiking device; contaminated reagents, gases, glassware, etc.	Accuracy Completeness Comparability	Data may contain false positives and/or high bias
LCS, LCSDs	High RPDs	Method failure; improper spiking; failed spiking device; contaminated reagents, gases, glassware, etc.	Representative-ness Precision Completeness. Comparability	Poor precision exists in the analytical procedure.
Surrogates in MB, LCS, LCSD, BS, BSD	Low recoveries	Method failure; improper spiking; degraded spiking solution; failed spiking device.	Accuracy Completeness	Laboratory performance should be questioned.

APPENDIX G (CONTINUED)

RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Nonconformance	Possible Causes	Major PARCCS Parameters Affected (Note 2)	Possible Effects on Data Usability (Note 3)
Surrogates in MB, LCS, LCSD, BS, BSD	High recoveries	Method failure; improper spiking; degraded spiking solution; failed spiking device; contaminated reagents, gases, glassware. etc.	Accuracy Completeness	Laboratory performance should be questioned
Surrogates in samples	Low recoveries	Matrix effects; inappropriate method; method failure; improper spiking; degraded spiking solution; failed spiking device.	Accuracy Completeness	Data may contain false negatives and/or low bias.
Surrogates in samples	High recoveries	Matrix effects; inappropriate method; method failure; improper spiking; degraded spiking solution; failed spiking device; contaminated reagents, gases, glassware, etc.	Accuracy Completeness	Data may contain false positives and/or high bias.
MS, MSD (Note 8)	Low recoveries (Note 9)	Matrix effects; inappropriate method; method failure; inadequate cleanup; inadequate background correction; failure to use method of standard additions; improper spiking; degraded spiking solution; failed spiking device.	Accuracy	Data may contain false negatives and/or low bias.
MS, MSD (Note 8)	High recoveries (Note 9)	Matrix effects; inappropriate method; method failure; inadequate cleanup; inadequate background correction; failure to use method of standard additions; improper spiking; degraded	Accuracy	Data may contain false positives and/or high bias. Qualify sample results greater than the RL (i.e., possible matrix effects).

APPENDIX G (CONTINUED)

RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Nonconformance	Possible Causes	Major PARCCS Parameters Affected (Note 2)	Possible Effects on Data Usability (Note 3)
		spiking solution; failed spiking device; contaminated reagents, gases, glassware, etc.		
MS, MSD (Note 8)	High Relative Percent Difference	Sample heterogeneity; inadequate sample mixing for non-voc samples in the laboratory or the field; samples misidentified; method failure; improper spiking; failed spiking device, duplicate spiking of a sample, contaminated reagents, gases, glassware, etc.	Representative-ness Precision	The sample itself may be heterogeneous leading to poor precision (high variability).
Dilution factors	Extremely high dilution factors	High concentrations of interferences or analytes; inappropriate analytical method used or selected	Accuracy Comparability Completeness	Samples with high RLs may not meet DQO and RLs may become greater than regulatory criteria.
Field Duplicates	Field duplicates are not comparable within DQOs	Sample inhomogeneity; insufficient mixing in field; samples not split but collocated (Note 10); insufficient mixing in laboratory.	Representative-ness Precision	The sample itself may be heterogeneous leading to poor precision (high variability). The sample may not be representative of site conditions.

APPENDIX G (CONTINUED)

RANGE OF DATA USABILITY OUTCOMES[1]

This table was adapted from US Army Corps of Engineers, Environmental Quality Assurance for HTRW Projects, Engineer Manual. October 10, 1997, EM 200 1-6, table 3-1.

APPENDIX G (CONTINUED)

RANGE OF DATA USABILITY OUTCOMES[1]

Notes:

(1) Entries in the Possible Causes, PARCCS Parameters Affected, Effect on Data, and Possible Data Evaluation columns assume only one type of failure occurring at any one time. The cumulative or synergistic effects of more than one failure type occurring simultaneously make data usability evaluation more complex. Data usability evaluations involving multiple failure types are beyond the scope of this table. Not all possible QC failures and outcomes are illustrated on this table.
(2) The PARCCS parameters most affected are listed. All of the PARCCS parameters may affected in some cases. Any failure that results in invalid data affects Completeness.
(3) All data usability evaluations are subject to discretion of the investigator taking into account project DQOs, and the intended use of the analytical data. The DQA and DUE thought process must be documented in the report using the data.
(4) Refrigeration not required for trace metals (excluding mercury).
(5) Exceeding holding times on some analyses can produce false positives (i.e., carbonates, dissolved oxygen, etc.) and high bias (i.e., pH, carbonates, dissolved oxygen, etc.). High bias and false positives can also occur when degradation products of contaminants are also themselves analytes, i.e., when 4,4'-DDT is present and holding times are exceeded, high bias and false positives for the degradation products 4,4 DDD, 4,4 DDE, 4,4 DDT, 2,4 DDD, 2,4 DDE, 4,4'-DDT can occur.
(6) Method blanks are not appropriate for all analyses, i.e. pH, conductivity, % solids, etc.
(7) Laboratory control samples are not appropriate for all analyses, i.e. pH, conductivity, % solids, etc.
(8) Matrix spike and matrix spike duplicates are performed at the request of the investigator and may not be present.
(9) Note that when the native sample concentrations are significantly greater than the effective spike concentration that the conclusion of the matrix effect is only tentative. As a general rule of thumb, the native sample concentration should be no more than four times higher than the effective matrix spike concentration of for the matrix effect to be considered probably present.
(10) Conventional sampling protocols for some analyte classes (i.e., VOCs) prohibit sample mixing and splitting because it results in the loss of analytes. Field and QC samples for these analytes are more appropriately collected as sample pairs.

Appendix H
Data Usability Evaluation Worksheet

APPENDIX H-1

INSTRUCTIONS FOR USE OF THE DATA USABILITY EVALUATION WORKSHEET

The Data Usability Evaluation Worksheet (DUE Worksheet) can be used to document the investigator's thought process during a DUE of the QC nonconformances that were cataloged as part of the DQA. A description of the "Nonconformance DQA Review Elements" listed in the left hand column can be found in Appendix C of this document. The DUE worksheet is available below in Appendix H-2 and can be modified by the user.

APPENDIX H-2

DATA USABILITY EVALUATION WORKSHEET

Project Name: _____
Laboratory: _____
Sample Delivery Group: _____
Sample Delivery Group Number: _____
Date Samples Collected: _____
Reviewer: _____

Describe the intended use of the data:

Nonconformance DQA Review Elements	**Briefly Summarize DQA Nonconformances**
Laboratory Report Inspection	
Reasonable Confidence Evaluation	
Chain of Custody Evaluation	
Sample Result Evaluation	
Sample Preservation and Holding Time Evaluation	
Blank Evaluation	
Laboratory Control Samples	
Surrogates	
Site Specific Matrix Spikes and Matrix Spike Duplicates	
Tentatively Identified Compounds	
Other QC data	

APPENDIX H-2 (CONTINUED)

DATA USABILITY EVALUATION WORKSHEET

Provide a summary statement describing how the analytical data set relied upon is of adequate quality and of sufficient accuracy, precision, and sensitivity for the intended purpose. Questions for the investigator to consider during the DUE include, but are not limited to, the following, please see the text of this guidance for additional information:

How will the analytical data be used:

- Is this the initial site investigation to determine if and what contamination exists?
- Will the analytical results be used to determine compliance with Regulatory criteria (e.g. post excavation samples)?
- Will remedial action be conducted?
- Has remedial action been conducted?
- Are the results going to be used to guide further remedial investigation?
- Are the results going to be used to guide further remedial action (including monitored natural attention of groundwater)?
- Evaluate seasonal variability, or homogeneity in an environmental sample?

Laboratory QC Information

- If the results are close to a regulatory limit, does any QC bias affect the interpretation of the data?
  - Are significant QC variances reported?
  - Are the biases high or low?
  - Are the identified QC nonconformances related to results for substances that are reported as "ND," and the reporting limits are less than regulatory criteria?
  - Are the nonconformances related to poorly performing compounds that are not constituents of concern?
  - Are the nonconformances related substances that are not constituents of concern?
  - How do the nonconformances affect "NDs" and reported concentrations?

DQOs

- Were the DQOs precision, accuracy, representativeness, comparability, completeness and sensitivity met?
- Are all critical samples usable for the intended purpose(s)?
- Does sample homogeneity or heterogeneity affect the representativeness of the samples?

CSM

- Do any analytical QC nonconformances create significant data gaps in the conceptual site model?
- Evaluate the entire body of information (type, amount, and quality data) available for the specific area/release for which the data are presumed to be representative. Determine whether any newer data corroborate the older results and whether both sets of data are consistent with the CSM.
- Consider the risk of being wrong based on risk to potential receptors and the risk to human health and the environment.
- Consider the source of data (e.g., whether the data were generated by the investigator's own firm or some other firm, the investigator's own involvement with the project, method of collection for the samples, and reporting methods by other firms/laboratories generating the data). Perform a critical review of these data to evaluate its reliability.
- Consider any other site-specific factors.

Appendix I
Surrogates and Internal Standards

APPENDIX I-1
SEMI-VOLATILE INTERNAL STANDARDS AND THEIR CORRESPONDING TARGET COMPOUNDS AND SURROGATES

This table lists the commonly used (e.g. DKQ Methods 8260 and 8270) internal standards and their associated target compounds and surrogates for semi-volatiles. If the laboratory data indicates a problem with the internal standard(s) and/or surrogate(s), this table can be used to evaluate which target compounds are effected. For instance, if the surrogate 1,2-Dichloroethane-d4 had a low recovery, the compounds listed in the same column would potentially be effected as well, and low bias should be suspected unless otherwise indicated by additional QC data.

1,4-Dichlorobenzene-d4	**Naphthalene-d8**	**Acenaphthene-d10**	**Phenanthrene-d10**	**Chrysene-d12**	**Perylene-d12**
Aniline	Nitrobenzene	Hexachlorocyclopentadiene	4,6-Dinitro-2-methylphenol	Pyrene	Di-n-octyl phthalate
Phenol	Isophorone	2,4,6-Trichlorophenol	4-Bromophenyl-phenylether	Butylbenzylphthalate	Benzo(b) fluoranthene
bis-(2-Chloroisopropyl ether)	2-Nitrophenol	2,4,5-Trichlorophenol	N-Nitroso-diphenylamine	3,3'-Dichlorobenzidine	Benzo(k) fluoranthene
2-Chlorophenol	2,4-Dimethylphenol	2-Chloronaphthalene	Hexachlorobenzene	Benzo(a)anthracene	Benzo(a)pyrene
2-Methylphenol	bis-(2-Chloro ethoxy)methane	2-Nitroaniline	Pentachlorophenol	Chrysene	Indeno(1,2,3-cd)-pyrene
Pyridine	2,4-Dichlorophenol	Dimethylphthalate	Phenanthrene	bis-(2-Ethylhexyl)phthalate	Dibenzo(a,h)-anthracene
2,2'-oxybis-(1-Chloropropane)	Naphthalene	2,6-Dinitrotoluene	Anthracene	Terphenyl-d14 (surr)	Benzo(g,h,i)perylene
4-Methylphenol	4-Chloroaniline	Acenaphthylene	Carbazole		
N-Nitroso-di-n- propylamine	Hexachlorobutadiene	3-Nitroaniline	Di-n-butylphthalate		
Hexachloroethane	4-Chloro-3- methylphenol	Acenaphthene	Fluoranthene		
2-Fluorophenol (surr)	2-Methylnaphthalene	2,4-Dinitrophenol	Pentachloronitro-benzene		
Phenol-d5 (surr)	1,2,4-Trichlorobenzene	4-Nitrophenol	2,4,6-Tribromophenol (surr)		
2-Chlorophenol-d4 (surr)	Nitrobenzene-d5 (surr)	Dibenzofuran			
1,2-Dichlorobenzene-d4 (surr)		2,4-Dinitrotoluene			
		Diethylphthalate			
		Fluorene			
		4-Chlorophenylphenylether			
		4-Nitroaniline			
		1,2,4,5-Tetrachlorobenzene			
		2-Fluorobiphenyl (surr)			

APPENDIX I-2
VOLATILE INTERNAL STANDARDS AND THEIR CORRESPONDING TARGET COMPOUNDS AND SURROGATES

1,4-Difluorobenzene (I.S.)	Chlorobenzene-d5 (IS)	1,4-Dichlorobenzene-d4 (IS)
Dichlorodifluoromethane	1,1,1-Trichloroethane	Bromoform
Chloromethane	Cyclohexane	1,3-Dichlorobenzene
Vinyl chloride	Carbon tetrachloride	1,4-Dichlorobenzene
Bromomethane	Benzene	1,2-Dichlorobenzene
Chloroethane	Trichloroethene	1,2-Dibromo-3-chloropropane
Trichlorofluoromethane	Methylcyclohexane	1,2,4-Trichlorobenzene
1,1-Dichloroethene	1,2-Dichloropropane	1,2,3-Trichlorobenzene
1,1,2-Trichloro-1,2,2-trifluoroethane	Bromodichloromethane	1,2-Dichlorobenzene-d4 (DMC)
Acetone	cis-1,3-Dichloropropene	
Carbon disulfide	4-Methyl-2-pentanone	
Methyl acetate	Toluene	
Bromochloromethane	trans-1,3-Dichloropropene	
Methylene chloride	1,1,2-Trichloroethane	
trans-1,2-Dichloroethene	Tetrachloroethene	
Methyl tert-butyl ether	2-Hexanone	
1,1-Dichloroethane	Dibromochloromethane	
cis-1,2-Dichloroethene	1,2-Dibromoethane	
2-Butanone	Chlorobenzene	
Chloroform	Ethylbenzene	
1,2-Dichloroethane	m,p-Xylene	
1,4-Dioxane	o-Xylene	
Vinyl chloride-d3 (DMC)	Styrene	
Chloroethane-d5 (DMC)	Isopropylbenzene	
1,1-Dichloroethene-d2 (DMC)	1,1,2,2-Tetrachloroethane	
2-Butanone-d5 (DMC)	Benzene-d6 (DMC)	
Chloroform-d (DMC)	1,2-Dichloropropane-d6 (DMC)	
1,2-Dichloroethane-d4 (DMC)	trans-1,3-Dichloropropene-d4 (DMC)	
1,4-Dioxane-d8 (DMC)	Toluene-d8 (DMC)	
2-Hexanone-d5 (DMC)		
1,1,2,2-Tetrachloroethane-d2 (DMC)		

APPENDIX I-3

Surrogates for Chlorinated Pesticides and Aroclors

Decachlorobiphenyl

Tetrachloro-*m*-xylene

Appendix J
Supplemental Examples Using Multiple Lines of Evidence

APPENDIX J

SUPPLEMENTAL EXAMPLES USING MULTIPLE LINES OF EVIDENCE

These examples illustrate how multiple lines of evidence may be used to address QC nonconformances.

Example J-1: Surrogates – Low Recovery, Expanded Version of Example 11

A soil sample was analyzed by DKQ Method 8260. The intended use of the analytical data was to determine if contaminants were present at concentrations that exceed the Impact to Ground Water Screening Level (IGWSL).

The percent recovery for the surrogate Toluene-d8 was reported to be 20 percent. The method specifies that the recovery limits for surrogates must be within 70 to 130 percent. Because the reported recovery for this surrogate is outside acceptance criteria for Volatile Organic Compounds (VOCs), then all VOC results are biased low.

- 1,1,1-Trichloroethane was reported at a concentration of 0.1 mg/kg, which is just below the applicable criteria of 0.2 mg/kg.
- MS/MSD percent recoveries from a soil sample collected at the site, from substantially the same type of unconsolidated material as the sample, were within the RCP acceptance criteria for all compounds reported by RCP Method 8260. 1,1,1-Trichloroethane was not detected (ND) as a target compound in the MS/MSD sample.
- The RPD for the MS/MSD for pair for 1,1,1-trichloroethane is 13.3 percent. The method specifies that relative percent difference must be less than 30 percent for the MS/MSD pair.
- All other quality control criteria were within the DKQ acceptance criteria.

The reported percent recovery for the surrogate toluene-d8 indicates a potential low bias for all volatile organic compounds. Because the reported concentration of 1,1,1-trichloroethane is just below the IGWSL, the reported potential low bias associated with the surrogate recovery means the results should not be used to solely determine that 1,1,1-trichloroethane is present at a concentration less than the regulatory criteria. Multiple lines of evidence such as matrix spikes

and matrix spike duplicates were used to evaluate this data set further. However, the MS/MSD percent recoveries for soil samples collected at the site, from substantially the same type of unconsolidated material as the sample were reported within DKQ acceptance criteria.

Conclusion: The evaluation of these results using multiple lines of evidence would not prevent the investigator from concluding that 1,1,1-trichloroethane is not present at a concentration greater than the regulatory criteria.

Example J-2: Laboratory Control Samples – Low Recovery, Expanded Version of Example 12

Ground water samples were analyzed by DKQ Method 8260. The purpose of sampling was to determine compliance with regulatory criteria. The GWQS for benzene is 1 µg/l.

- The results for the LCS indicate a 54 percent recovery for benzene. The method specifies that the recovery limits for the LCS must be within 70 to 130 percent.
- The analytical results were ND for benzene at a reporting limit of 0.5 µg/l.
- The surrogate recoveries are within the DKQ method acceptance criteria.
- The MS/MSD percent recoveries from a water sample collected at the site, from substantially the same aquifer as the sample, were within the DKQ method acceptance criteria for all compounds reported by DKQ Method 8260. Benzene was ND as a target compound in the MS/MSD sample.
- The RPD for the MS/MSD for pair for Benzene is 23.3 percent. The method specifies that the RPD must be less than 30 percent for the MS/MSD pair.
- All other QC criteria are within the RCP acceptance criteria.

The results of the laboratory control sample indicate a potential low bias in the accuracy of the method. Therefore, the results reported could have been affected by the low bias of the associated with the method, and the results should not solely be used to determine if benzene is present at a concentration greater than the GWQS. Multiple lines of evidence such as surrogates, and matrix spikes and matrix spike duplicates were used to evaluate this data set further. However, the surrogate recoveries were within DKQ method acceptance indicating an acceptable degree of accuracy with the analytical method. In addition, the MS/MSD percent

recoveries from a water sample collected at the site, from substantially the same aquifer were reported within DKQ acceptance criteria.

Conclusion: The evaluation of these results using multiple lines of evidence would indicate to the investigator that benzene is below the applicable GWQS.

Example J-3: MS/MSD High Recoveries, Expanded Version of Example 15

A residential soil sample was analyzed by DKQ Method 8260 for VOCs. The intended use of the data is to determine compliance with the residential direct contact soil remediation standard.

- Trichloroethene (TCE) was reported at a concentration of 8 mg/kg, which is just above residential direct contact soil standard of 7 mg/kg.
- The percent recoveries for TCE generated by a MS/MSD pair are 180 and 185 percent respectively. According to the DKQ method, the recovery limits for the MS/MSD should be within 70 to 130 percent.
- The RPD for the MS/MSD pair is 2.7 percent. The relative percent difference should be less than 30 percent for the MS/MSD pair.
- The surrogates are within DKQ acceptance criteria.
- In a duplicate sample, TCE was reported at a concentration of 10 mg/kg, which is just above the residential direct contact soil standard of 7 mg/kg. The relative percent difference between the original and duplicate sample is 18.2 percent, which indicates an acceptable degree of precision between the two samples.
- All other QC criteria were within the DKQ acceptance criteria.

The spike recoveries indicate a potential high bias for TCE. Because of the reported high bias and the sample result just above the residential direct contact soil standard of 7 mg/kg., the actual concentration of TCE in the sample may be lower and may be less than the residential direct contact soil standard of 7 mg/kg. However, the investigator cannot adjust the concentrations of the reported values lower. The RPD for the MS/MSD pair was within the acceptance criteria specified in DKQ method, and therefore, MS/MSD results show an acceptable degree of the precision. Because of the reported high bias associated with the MS/MSD pair, the MS/MSD results should not be used solely to determine if TCE is present at a concentration greater than the residential direct contact soil remediation standard.

Multiple lines of evidence, including surrogate recoveries, duplicate samples and, were used to further evaluate this data set. The surrogate recoveries are within the range specified in the

DKQ method. The duplicate sample results indicate that the concentration of TCE is above the residential direct contact soil standard of 7 mg/kg.

Conclusion: The evaluation of these results using multiple lines of evidence would indicate that TCE is above the applicable residential direct contact soil standard of 7 mg/kg.

(Note: Using the same example as above for a non-residential site, the conclusion is that the concentration of TCE is below the non-residential direct contact soil remediation standard (20 mg/kg); however, the concentration of TCE would exceed the default impact to ground water criteria (0.007 mg/kg) necessitating the evaluation of that pathway.)

Example J4- ICS Low Recoveries, Expanded Example 16

Ground water samples were analyzed by DKQ Method 6010. The purpose of sampling was to determine compliance with Regulatory criteria. The GWQS for Arsenic and Cadmium are 3 ug/L and 4 ug/L, respectively.

- The results for the ICS indicate a 54 percent recovery for arsenic and 60 percent recovery for cadmium. The DKQ protocol specifies that the recovery limits for the ICS should be within 80 to 120 percent.

- The analytical results were both at the GWQS of 3 ug/L and 4 ug/L for Arsenic and Cadmium, respectively.

- The Matrix spike results for arsenic and cadmium were below the QC limit of 75% at 65% and 60 percent, respectively.

- The duplicate results were both acceptable for arsenic and cadmium.

Due to the proximity of the sample results to the GWQS, multiple lines of evidence should be evaluated. The results of the ICS indicate a possible low bias in the accuracy of the method. The result of the MS provides additional evidence that results are biased low. The duplicate result demonstrates acceptable precision.

Conclusion: Based on the data reviewed one would conclude that the sample results are likely above the applicable GWQS and additional sampling and analyses would be recommended.

Appendix K:
Glossary

Term	Definition
Accuracy	Accuracy describes the closeness of agreement between an observed value and an accepted reference value that is accepted as the true value. Accuracy is typically evaluated using spikes (laboratory control samples, surrogate spikes, and matrix spikes) and blanks (trip, field, and method), or any other standard subjected to the entire analytical process. Accuracy is usually reported as a percentage of the observed value divided by the reference value (percent recovery) using the following equation: $\%R = \frac{\text{observed value}}{\text{reference value}} \times 100$ Where %R = percent recovery
Acid Semivolatile Organic Compound Surrogates	Acid surrogates are compounds routinely used with semi-volatile methods that exhibit similar chemical behavior to acidic organic compounds such as phenols. Common acid surrogates include: 2-Fluorophenol, phenol-d5 (a deuterated phenol), and 2,4,6-Tribromophenol. (See also surrogate).
Analyte	Analyte means the substance being measured by an analytical procedure.
Analytical Batch	An analytical batch is a group of samples that are processed and analyzed as a unit. For quality control purposes, the maximum number of samples in a batch is 20 per matrix.

Term	Definition
Applicable Standard/Screening Level	Residential Direct Contact Health Based Criteria and Soil Remediation Standards (RDC SRS),[2] http://www.nj.gov/dep/srp/regs/rs/rs_rule.pdf Nonresidential Direct Contact Health Based Criteria and Soil Remediation Standards (NRDC SRS),[3] http://www.nj.gov/dep/srp/regs/rs/rs_rule.pdf Default Impact to Ground water Soil Screening Levels for Contaminants;[4] http://www.nj.gov/dep/srp/guidance/rs/partition_equation.pdf Default Leachate Criteria for Class II Ground Water (Synthetic Precipitation Leachate Procedure);[5] http://www.nj.gov/dep/srp/guidance/rs/splp_guidance.pdf Specific Ground Water Quality Criteria (Groundwater Quality Standards);[6] http://www.nj.gov/dep/rules/rules/njac7_9c.pdf Surface Water Quality Criteria for Toxic Substances (SWQC);[7] http://www.nj.gov/dep/rules/rules/njac7_9b.pdf Maximum Contaminant Levels (MCL) for State Regulated VOCs;[8] http://www.state.nj.us/dep/rules/rules/njac7_10.pdf NJDEP MASTER TABLE GENERIC VAPOR INTRUSION SCREENING LEVELS including • Vapor Intrusion Groundwater Screening Levels (GWSL);[9] • Vapor Intrusion Residential Indoor Air Screening Level (RIASL);[10] • Vapor Intrusion Nonresidential Indoor Air Screening Level (NRIASL);[11] All at http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_tables.pdf NJDEP Action Levels for Indoor Air ;[12] http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_tables.pdf Vapor Intrusion Health Department Notification levels (HDNL);[13] http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_tables.pdf Extractable Petroleum Hydrocarbons (EPH);[14] http://www.nj.gov/dep/srp/guidance/srra/eph_method.pdf

Term	Definition
Applicable Standard/Screening Level (continued)	Hexavalent Chromium Cleanup Criterion;[15] http://www.state.nj.us/dep/srp/guidance/rs/chrome_criteria.pdf Ecological Screening Criteria;[16] http://www.nj.gov/dep/srp/guidance/ecoscreening/esc_table.pdf Site specific criteria developed for the investigation and remediation according to the applicable NJDEP guidance.
Area of Concern	"Area of concern" means any existing or former distinct location or environmental medium where any hazardous substance, hazardous waste, or pollutant is known or suspected to have been discharged, generated, manufactured, refined, transported, stored, handled, treated, or disposed, or where any hazardous substance, hazardous waste, or pollutant has or may have migrated, including, but not limited to, each current and former objects and/or areas defined in N.J.A.C. 7:26E-1.8.
Base Neutral Semivolatile Organic Surrogates	Base neutral semivolatile organic surrogates exhibit similar chemical behavior to the base-neutral semivolatile organic compounds. Common examples include: Nitrobenzene-d5, 2-Fluorobiphenyl, and terphenyl-d14. (See also surrogate).
Bias	Bias is the deviation of the measured value from the true value. This can be analytical bias within the analytical procedure, or it can be due to matrix effects. There is inherent bias within all analytical procedures. Quality control measurement tools that can be used to evaluate bias include laboratory control samples, check standards, matrix spikes, or any other standards used for analysis.

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[2] NJDEP, *Remediation Standards*, N.J.A.C. 7:26D
[3] NJDEP, *Remediation Standards*, N.J.A.C. 7:26D.
[4] NJDEP, *Development of Site-Specific Impact to Ground Water Soil Remediation Standards Using the Soil-Water Partition Equation,* December 2008, http://www.nj.gov/dep/srp/guidance/rs/.
[5] NJDEP, *Guidance for the use of the Synthetic Precipitation Leaching Procedure to Develop Site-Specific Impact to Ground Water Remediation Standards*, June 2, 2008, http://www.nj.gov/dep/srp/guidance/rs/.
[6] NJDEP, *Groundwater Quality Standards*, N.J.A.C. 7:9C
[7] NJDEP, *Surface Water Quality Standards*, N.J.A.C. 7:9B
[8] NJDEP, *Safe Drinking Water Act Regulations*, N.J.A.C. 7:10
[9] NJDEP, *Vapor Intrusion Technical Guidance*, criteria dated March 2013., http://www.nj.gov/dep/srp/guidance/vaporintrusion/.
[10] Ibid.
[11] Ibid.
[12] Ibid.
[13] Ibid.
[14] NJDEP, *Protocol for Addressing Extractable Petroleum Hydrocarbons,* Version 5.0, August 9, 2010, http://www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf.
[15] NJDEP, *Chromium Soil Cleanup Criteria,* April 2010,
[16] NJDEP, *Ecological Screening Criteria,* March 10, 2009, http://www.nj.gov/dep/srp/guidance/ecoscreening.

Term	Definition
Calibration Curve/Initial Calibration	A calibration curve/initial calibration curve is generated by analyzing a series of standards and plotting instrument response versus concentration. A calibration curve is used to calibrate an analytical system. Calibration criteria are specified in each analytical method.
Check Standard	A check standard is a solution of one or more analytes that is used to document laboratory performance. This check standard can go by many different names including laboratory control samples and laboratory fortified blank. Consult with the laboratory to understand the naming scheme used to identify such standards. This standard can also be used to check the validity of a purchased stock or calibration standard.
Comparability	Comparability refers to the equivalency of two sets of data. Comparability may be achieved through the use of standard or similar techniques to collect and analyze representative samples. Comparable data sets must contain the same variables of interest and must possess values that can be converted to a common unit of measurement. Comparability is normally a qualitative parameter that is dependent upon other data quality elements.
Completeness	Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions.
Conceptual Site Model	Defined in NJDEP Conceptual Site Model Technical Guidance, 2012.
Contaminant or Contamination	Contamination or contaminant means any discharged hazardous substance as defined pursuant to N.J.S.A. 58:10-23.11b, hazardous waste as defined pursuant to N.J.S.A. 13:1E-38, or pollutant as defined pursuant to N.J.S.A. 58:10A-3.
Contaminant of Potential Ecological Concern (COPEC)	COPEC means a substance detected at a contaminated site that has the potential to adversely affect ecological receptors because of its concentration, distribution, and mode of toxicity; contaminants with concentrations above their respective New Jersey Surface Water Quality Standards or ecological screening criteria are identified as contaminants of potential ecological concern.
Control Sample	Control sample means a quality control sample introduced into a process to monitor the performance of a system.
Critical Sample	Critical samples are user defined where the completeness goal is usually 100 percent.
Data of Known Quality	When “Data of Known Quality” is achieved for a particular data set, the investigator will have “Data of Known Quality” that the laboratory has followed the Data of Known Quality Protocols, has described non-conformances, if any, and has adequate information to make judgments regarding data quality.

Term	Definition
Data of Known Quality Protocols (DKQPs)	DKQPs include specific laboratory quality assurance and quality control (QA/QC) criteria that produce analytical data of known and documented quality. The DKQ protocols are shown in Appendix B of the *NJDEP Site Remediation Program, DATA OF KNOWN QUALITY PROTOCOLS TECHNICAL GUIDANCE, April 2014*. *(*DKQ Guidance)
Data Quality Objectives (DQOs)	DQOs, developed by the investigator, are qualitative and quantitative statements derived from the DQO Planning Process that clarify the purpose of the study, define the most appropriate type of information to collect, determine the most appropriate conditions from which to collect that information, and specify tolerable levels of potential decision errors.
Environmental Sample	An environmental sample is a sample of soil, groundwater, surface water, soil vapor, sediment, air, or any other environmental matrix collected for analysis.
Equipment-Rinsate Blank	An equipment-rinsate blank is a sample of analyte-free water that is used to rinse the sampling equipment. An equipment-rinsate blank is collected after decontamination to assess potential contamination from inadequate decontamination of field equipment. An equipment-rinsate blank can also be used to evaluate the potential for field sampling equipment to leach contaminants into a sample and cause cross contamination.
Field Blank	A field blank is analyte-free matrix, usually water, prepared in the laboratory and transported to the sampling location along with the empty sample containers. At the sampling location the matrix is used to fill randomly selected sample containers and then returned to the laboratory for analysis. The field blank is treated as a sample in all respects, including exposure to sampling location conditions, storage, preservation, and all analytical procedures. Field blanks are used to assess any contamination contributed from sampling location conditions and the transport, handling, and storage of the samples.
Field Duplicates	Field duplicates are replicates collected from the same location in the field and submitted to the laboratory as two distinct samples. Duplicates are used to evaluate precision, sample homogeneity, and field sample collection activities.
Field Reagent Blank	See “Field Blank.”
Gas Chromatography/ Mass Spectrometry	Gas Chromatography/Mass Spectrometry is an analytical procedure in which a gas chromatograph is connected to a mass spectrometer. The technique allows for both accurate identification and quantitation of analytes.
Handling Time	The maximum amount of time for a QC sample (e.g., field or trip blanks) to be transported to a site and/or the maximum amount of time for transport of site field samples and field QC samples back to the laboratory. Samples held beyond the allowed handling time may be considered biased low or invalid, depending on the intended use of the data (see NJDEP Field Sampling Procedures manual, August 2005).

Term	Definition
Holding Time	The holding time is the maximum time that a sample may be held, after the sample is taken prior to preparation and/or analysis and still be considered valid or not compromised. Holding times can include time to extraction and time allowed after extraction before analysis and time allowed prior to digestion and after digestion prior to analysis based on method specific requirements. Samples analyzed past the holding time are determined to be compromised and may be considered invalid, depending on the intended use of the data.
Instrument Blank	An instrument blank is analyte-free matrix (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. Typically gas chromatography methods (excluding volatile organic compounds) use pure solvent as an instrument blank while metals and wet chemistry techniques use water or acidified water. Gas chromatography methods for volatile organic compounds use either acidified water or methanol.
Internal Standards	For certain analytical methods, internal standards are compounds that are added, immediately prior to analysis, at a known concentration to every standard, blank, sample, and quality control sample. Internal standards are used to calibrate the analytical system by plotting the response of the internal standards versus the compound(s) of interest. Internal standards should closely match the chemical behavior of the compound(s) of interest and be known not to be present in the sample.
Laboratory Control Sample (LCS)	A LCS is a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes from the same source as the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. The LCS is carried through the analysis along with the samples. LCSs are also known as laboratory fortified blanks or blank spikes.
Laboratory Fortified Blank	See “Laboratory Control Sample.”
License Site Remediation Professional (investigator)	An individual who is licensed by the board pursuant to section 7 of P.L. 2009, c.60 (C.58:10C-7) or the department pursuant to section 12 of P.L. 2009, c.60 (C.58:10C-12).
Matrix Duplicates	Matrix duplicates refer to the replicate analyses of samples taken from the same sample container and prepared in the laboratory. Matrix duplicates are used to evaluate precision and sample homogeneity.
Matrix Interference	Matrix interferences are manifestations of non-target analytes or physical/ chemical characteristics of a sample that prevents the quantification of the target analyte (i.e., the compound or element of interest being effectively quantified by the test method) as it is routinely performed, typically adversely impacting the reliability of the determination. For example, some matrices including silt, clay, coal, ash, and peat effectively bind analytes which may lead to low biased results for certain extraction/analysis procedures. Co-eluting peaks in a GC chromatogram may result in a high bias for an analyte of concern.

Term	Definition
Matrix	The matrix is the material of which the sample is composed or the substrate (e.g., surface water, ground water, drinking water, soil, sediment, air) that may or may not contain an analyte of interest.
Matrix Spike	A matrix spike is an aliquot of an environmental sample to which known quantities of target analytes are added in the laboratory. The matrix spike is analyzed in an identical manner as a sample. The purpose of a matrix spike sample is to determine the quantitative accuracy of the overall analytical procedure for determining the analytes of concern in the sample.
Matrix Spike Duplicate	A matrix spike duplicate is an intra-laboratory split sample, with both aliquots spiked with identical concentrations of method analytes. The spiking occurs prior to sample preparation and analysis. The results are used to document the precision and accuracy of a method in a given sample matrix. See also “Matrix Spike.”
Method Blank	A method blank is an “analyte-free” matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, labeled compounds, internal standards, and surrogates that are used with samples. The method blank is used to determine if analytes or interferences are present in the laboratory environment, the reagents, or the apparatus. A method blank may also be referred to as a laboratory reagent blank.
Nonconformance	A nonconformance is an occurrence during the processing or analysis of a sample that deviates from the quality control performance criteria of the analytical method. Examples of nonconformances include, but are not limited to, missed holding times, temperature excursions, recoveries of surrogates or matrix spikes outside of performance criteria, initial or continuing calibration failures.
Non-target compounds	Non-targeted compound means a compound detected in a sample using a specific analytical method that is not a targeted analyte (see below), a surrogate compound, a system monitoring compound, a deuterated monitoring compound or an internal standard compound.
PARCCS Parameters	The PARCCS parameters are precision, accuracy, representativeness, comparability, completeness, and sensitivity.
Performance Evaluation Sample	See “Proficiency Test Sample.”
Petroleum (or Petroleum Product)	Petroleum" or "petroleum products" means oil or petroleum of any kind and in any form, including, but not limited to, oil, petroleum, gasoline, kerosene, fuel oil, oil sludge, oil refuse, oil mixed with other wastes, crude oils, and substances or additives to be utilized in the refining or blending of crude petroleum or petroleum stock in this State. However, any compound designated by specific chemical name on the list of hazardous substances adopted by the department pursuant to this section shall not be considered petroleum or a petroleum product for the purposes of P.L.1976, c.141, unless such compound is to be utilized in the refining or blending of crude petroleum or petroleum stock in this State.

Term	Definition
Precision	Precision is the consistency of measurement values quantified by measures of dispersion such as the sample standard deviation. Precision must be defined in context – e.g., for a certain analyte, matrix, method, perhaps concentration, lab or group of labs. Precision for laboratory and field measurements can be expressed as the relative percent difference (RPD) between two duplicate determinations or percent relative standard deviation (%RSD) between multiple determinations.
Proficiency Test Sample	Proficiency test sample is a sample provided to a laboratory for the purpose of demonstrating that the laboratory and the individual analyst performing the test can successfully analyze the sample within acceptable limits. The true value of the sample is unknown by the analyst.
Quality Assurance Project Plan (QAPP)	A QAPP is a document which describes the procedures necessary to produce an orderly assemblage of detailed procedures designed to produce data of sufficient quantity and quality to meet the data quality objectives for a specific data collection activity.
Quality Assurance/Quality Control (QA/QC)	QA is an integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to establish the reliability of laboratory data to ensure that a process, item, or service is of the type and quality needed and expected by the client. QC procedures are the specific tools that are used to achieve this reliability. QC is the overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users. QC procedures measure the performance of an analytical method in relation to the QC criteria specified in the analytical method. QC information documents the quality of the analytical data.
Qualified Data	Qualified data are analytical results that have an affixed code placed there by laboratories, and/or individuals conducting independent data review, to denote that quality control requirements or other evaluation criteria are not met. Data reviewers assess these and other criteria to determine the usability of data.
Reagent water	Reagent water is water (generally that has been generated by any purification method) demonstrated to be free from the analytes of interest and potentially interfering substances at the method detection limit for the analyte.
Reasonable Confidence	When “Reasonable Confidence” is achieved for a particular data set, the investigator will have “Reasonable Confidence” that the laboratory has followed the Reasonable Confidence Protocols, has described nonconformances, if any, and has adequate information to make judgments regarding data quality.
Rejected Data	Rejected data are data that have failed to meet QC requirements and/or method specific/contractual requirements to such an extent that the data are determined to be unusable.

Term	Definition
Relative Percent Difference (RPD)	The RPD is defined by the following equation: $RPD = \frac{\lvert A-B \rvert}{((A+B)/2)} \times 100$ Where A = Analytical results from first measurement and B = Analytical results from the second measurement.
Reporting Limit	As per N.J.A.C. 7:26E-1.8, “Reporting limit" means, for a compound analyzed by a particular method, the sample equivalent concentration (i.e., based on sample specific preparation and analysis factors), for organics, associated with the lowest concentration standard used in the calibration of the method and for inorganics, derived from the concentration of that analyte in the lowest level check standard (which could be the lowest calibration standard in a multi-point calibration curve).
Representativeness	Representativeness is a qualitative measurement that describes how well the analytical data characterizes a discharge or area of concern under investigation as part of an environmental site assessment. Many factors can influence how representative the analytical results are for a discharge. These factors include, the selection of appropriate analytical procedures, the sampling plan, and the procedures and protocols used to collect, preserve, and transport samples.
Sensitivity	Sensitivity refers to the ability of an analytical procedure to detect and quantify an analyte at a given concentration.
Spike	A known quantity of an analyte added to a sample for the purpose of determining recovery or efficiency (analyst spikes), or for quality control (blind spikes).
Split Sample	A split sample is prepared when aliquots of sample taken from the same container and then analyzed independently. Split samples are usually taken after mixing or compositing and are used to document intra- or inter-laboratory precision.
Standards	Standards are solutions that contain known concentration of target analytes. Examples include stock standards and calibration standards.
Surrogate	A surrogate is an organic non-target analyte that has similar chemical properties to the analyte of interest. The surrogate standard is added to the sample in a known amount and used to evaluate the response of the analyte to preparation and analysis procedures. The surrogate concentration is measured using the same procedures used to measure other analytes in the sample. Surrogate recoveries are used to evaluate the performance of the analysis.
Target Analytes	Target analytes are the compounds included on the list of analytes for an analytical method. Site-specific target analytes are defined in the QAPP.
Tentatively Identified Compound (TIC)	As per N.J.A.C. 7:26E-1.8, TIC means a non-targeted compound detected in a sample using a GC/MS analytical method which has been tentatively identified using a mass spectral library search. An estimated concentration of the TIC is also determined.

Term	Definition
Trip Blank	Trip blanks originate within the laboratory. Trip blanks are sample containers that have been filled with analyte-free reagent water carried with other sample containers out to the field and back to the lab without being exposed to sampling procedures. Trip blanks are used to ascertain if sample containers may have been contaminated during transportation and storage.
Turn-Around Time	The turn-around time is the amount of time it takes for the laboratory to report the analytical results to the customer following the submittal of the samples to the laboratory.
Uncertainty	A measure of the total variability associated with sampling and measuring that includes the two major error components: systematic error (bias) and random error.

Appendix L:
List of Acronyms

List of Acronyms

% R	Percent Recovery
BEHP	bis(2-ethylhexyl) phthalate
ºC	Degrees Celsius
CCAL	Continuing Calibration
CFR	Code of Federal Regulations
Cr	Chromium
CSM	Conceptual Site Model
DDT	Dichloro-diphenyl-trichloroethane
DKQ	Data of Known Quality
DQA	Data Quality Assessment
DQO	Data Quality Objective
DUE	Data Usability Evaluation
EPA	United States Environmental Protection Agency
EPH	Extractable Petroleum Hydrocarbons
Hg	Mercury
ICAL	Initial Calibration
LSRP	Licensed Site Remediation Professional
LCL	Lower Control Limit
LCS	Laboratory Control Sample
LFB	Laboratory Fortified Blank
MEK	Methyl Ethyl Ketone
MIBK	4-Methyl-2-petanone
µg/kg	Micrograms per Kilogram
µg/l	Micrograms per Liter
mg/kg	Milligrams per Kilogram
MS/MSD	Matrix Spike/Matrix Spike Duplicate
ND	Not Detected (i.e., below the Reporting Limit)
PAHs	Polycyclic Aromatic Hydrocarbons, also known as Polynuclear Aromatic Hydrocarbons
PARCCS	Precision, accuracy, representativeness, comparability, completeness, and sensitivity
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene, also known as Tetrachloroethylene or Perchloroethylene
Pest	Pesticides

QA/QC Quality Assurance/Quality Control
QAPP Quality Assurance Project Plan
RL Reporting Limit
RPD Relative Percent Difference
RRF Relative Response Factor
SOP Standard Operating Procedure
SPLP Synthetic Precipitation Leaching Procedure
SVOCs Semi-volatile Organic Compounds
TCLP Toxicity Characteristic Leaching Procedure
TICs Tentatively Identified Compounds
TCE Trichloroethene
UCL Upper Control Limit
VOCs Volatile Organic Compounds
Work Group NJDEP Analytical Methods Technical Guidance Work Group