

A Tiered Approach to Data Quality Assessment

DEP EAS 00-01

The Department relies on environmental data from a variety of sources to carry out its mission. These data must satisfy the needs for which they were collected, comply with applicable standards, specifications and statutory requirements, and reflect a consideration of cost and economics. Careful project planning, and routine project and data reviews, are essential to ensure that the data collected are relevant to the decisions being made.

Many aspects of a project affect data quality. Sampling design, selection of parameters, sampling technique, analytical methodologies and data management activities are a few such aspects, whether the data are being collected for a compliance program, or for research activities. The level of quality of each of these elements will affect the final management decisions that are based on a project's outcome. Data quality assessment is one activity that is instrumental in ensuring that data collected are relevant and appropriate for the decisions being made.

Depending on the needs of the project, the intended use of the final data and the degree of confidence required in the quality of the results, data quality assessment can be conducted at many levels, or tiers. This tiered approach is applicable to data existing in both paper and electronic formats, and builds on the tier below it (i.e., a Tier 2 data assessment includes activities in both Tiers 1 and 2). For electronic data, a rapid quality assessment can be conducted at Tiers 1 and 2 using software tools. For more extensive data quality assessment, review of related paper documentation is included in the process (Tier 3). For a comprehensive project or program assessment (Tier 4, a "Quality of Science Review"), aspects of study design, field collection and data management are examined, in conjunction with some or all of the elements of Tiers 1-3.

Tier 1 (Basic electronic data review): This level of assessment seeks to answer the question: Do the data meet the basic quality requirements for the legal acceptability of the data? Examples of items that are assessed are:

- Holding times
- Minimum detection limits
- Descriptive keywords in comments fields
- Sample preservation
- Data qualifiers
- Reversals (e.g., ortho < total phosphorus)
- Range checks (e.g., pH)

To conduct a complete Tier 1 data assessment, the data elements noted in Table 2 for Tier 1 review should be included with submitted data. This additional information allows a basic automated quality assessment checking on the data routinely submitted to Department compliance programs. If this additional information and the associated data are submitted in an electronic format, any Department program can implement electronic assessment as appropriate for a particular data stream. Some

programs may decide to take a conservative approach and assess all data, whereas others may take a more limited approach by focusing only on those areas deemed to impact a program most significantly.

Tier 2 (Advanced electronic data review): This more extensive level of review attempts to answer the question: In addition to the minimum requirements, does the additional quality control information support the data being used? Examples of elements reviewed are:

- Blank contamination
- Matrix spike recovery/precision
- Duplicate precision
- Surrogate recovery

To conduct a complete Tier 2 data quality assessment, the data elements noted in Table 2 for Tiers 1 and 2 should be included with any reported data. This level of review is generally most appropriate for research projects or work done in connection with consent orders. However, any program that has previously detected deficiencies in data quality, or that anticipates an increased impact based upon acceptance of poor quality data (such as the TMDL program), should consider conducting a Tier 2 review of all data submitted. Upon such review, staff may decide to continue with Tier 2 submissions, to implement a percentage of Tier 2 reviews (e.g., 10% get Tier 2 assessment, 90% Tier 1), or to relax standards to Tier 1.

If the data and applicable data elements are in an electronic format, Tier 1 and 2 assessments can be performed automatically on large volumes of data using software tools, without significant impact to staffing. Department programs can realize significant improvement in environmental protection without additional process using these types of reviews routinely.

Tier 3 (Manual data review of paper records): If a more extensive data assessment is required, paper records are inspected, such as:

- Calibration curves
- MDL studies
- Mass spectra, chromatograms and other instrument traces
- Bench notes, lab notebooks
- Field notes

This type of review is generally done in conjunction with a field or laboratory audit. A Tier 3 review usually is warranted when automated quality assessment or other stimuli (e.g., a tip regarding data fraud or audit findings) generate a significant concern regarding quality. The Department of Health's Laboratory Certification Program performs routine laboratory audits that follow the Tier 3 standards. In

addition, for specific concerns related to DEP projects, the Bureau of Laboratories may be engaged to conduct targeted project audits of both field and laboratory activities.

Tier 4 (Quality of Science Review): A data set may pass all three tiers of data quality assessment and be deemed of acceptable quality. However, a program area may also be interested in answering the question: Are the data appropriate for their intended use? Tier 4 review (i.e., a “Quality of Science Review”) is a broad-based assessment technique used to investigate the scientific basis of a project and to determine if the resulting data support the project goals.

While elements of all of the three lower tiers may be specifically assessed at the Tier 4 level, a graded approach is utilized by targeting those areas determined to be of significant impact on the purpose and scientific basis of the project or program. In addition to those quality assessment checks conducted for Tiers 1-3, field sampling design, statistical assessment protocols, QA project plans (if applicable) as well as lab and field methods are assessed in light of the project’s goals, rather than solely in terms of level of quality achieved. A Tier 4 review can be appropriate for any program seeking an unbiased assessment of the technical merit of its project(s). Tier 4 reviews are very useful in determining if the changing needs of a project/program require modifications to data collection and evaluation strategies.

The following tables note the specific quality assessment activities that may be performed (Table 1), and the accompanying data elements necessary to conduct this tiered data assessment (Table 2).

Table 1: Possible Quality Assessment Checks

Quality Test	Required Data Element(s)	Tier
Holding times	6,7,8,9,10,11,13,14	1-4
Review qualifiers	4	1-4
Screen comments for keywords	5	1-4
Review laboratory certification status for particular analyte at the time analysis was performed	9,11,12	1-4
Reversals (e.g., ortho < total phosphorus) and range checks (e.g., pH)	1,2,3, 3a, 4	1-4
Review detection limits against Department criteria and program action levels to ensure adequate sensitivity	15	1-4
Evaluate field or lab precision on duplicate/replicate samples	16,17,18,24,25,	2-4
Evaluate matrix spike recovery, precision	16-25	2-4
Evaluate matrix spike level used relative to MDL, program requirements	15,16,19	2-4
Review for blank contamination	2,5,8,11,16,18,26	2-4
Determine if appropriate QC samples were included in analytical batch	7-10,16,18,20,21,25, 26	2-4
Conduct lab/field audit(s)	1-36, as appropriate	3-4
Review of sampling design, sampling techniques and lab methodologies selected for appropriateness to the activity	1-36, as appropriate	4
Develop/review project data quality objectives (DQOs)	1-36, as appropriate	4
Submission and assessment of blind check samples, PE samples, RR studies	36	3-4
Statistical assessment of data	1-36, as appropriate	4

Table 2: Data Elements Related to Quality Assessment

* QA Tier includes those elements referenced and all elements in the tier(s) below. QA Tiers 1 and 2 are applicable to electronic data review

ID	Element	Description	QA Tier *
1	Sample ID	Unique Field Sample Identifier	1
2	Parameter Name	Name of the parameter measured	1
3	Analytical Result	Result for the analytical measurement	1
3a	Result Units	Units in which measurement is reported	1
4	DEP Qualifiers	Qualifier code describing specific QA conditions as reported by the data provider	1
5	Result Comments	Free-form text where data provider relates information they consider relevant to the result	1
6	Date (Time) of sample collection		1
7	Date (Time) of sample preparation		1
8	Date (Time) of sample analysis		1
9	Analytical Method	Method number used for sample analysis	1
10	Prep Method	Method number used for sample preparation prior to analysis	1
11	Sample Matrix	Was the sample a soil or water sample	1
12	DOH Certificate Number/Laboratory ID	Certificate number issued by the Department of Health's lab certification program	1
13	Preservatives Added	Description of the preservatives added to the sample after collection	1
14	Preservation Intact?	Y/N – Was the preservation intact (i.e., was the sample pH really <2 when checked at the lab?) when the sample was received at the facility	1
15	MDL	Method detection limit for a particular result	1
16	Sample Type	Field identifying sample nature (i.e., environmental sample, trip blank, field blank, matrix spike, etc.	2
17	Duplicate Reference	Unambiguous reference to a field duplicate or laboratory replicate	2
18	Batch ID	Unambiguous reference linking samples prepared or analyzed together (e.g., trip, preparation, analysis batch Ids)	2
19	Matrix Spike Level	Level of analyte added to a spiked sample	2
20	Matrix Spike Recovery	Results for matrix spike/duplicate sample analysis required by methods	2
21	Matrix Spike Duplicate Recovery	Results for matrix spike/duplicate sample analysis required by methods	2
22	Matrix Spike Precision	Results for matrix spike/duplicate sample analysis required by methods	2
23	Matrix Spike Recovery Limits	In-house recovery limits used by the data generator to control their process	2

Table 2: Data Elements Related to Quality Assessment (continued)

ID	Element	Description	QA Tier *
24	Matrix Spike Precision Limits	In-house recovery limits used by the data generator to control their process	2
25	Results for Duplicate/Replicate Samples	Results for duplicate/replicate sample analysis required by methods	2
26	Field, Lab Blank Results	Results for field/laboratory blank analysis required by the methods	2
27	Sample Filtered?	Y/N – Was the sample filtered	2
28	Surrogate Recovery	Recovery of surrogate compounds added to organic samples	2
29	Surrogate Recovery Limits	Lab-generated internal limits	2
30	Calibration Standards		3
31	Sample prep and analysis bench sheets		3
32	Hard copies of instrument traces (chromatograms, mass spectra, etc.		3
33	QAPP (if applicable), study plan		4
34	Sampling protocols		4
35	Field sheets, notes and measurements		4
36	PE samples	Performance Evaluation samples, round robins, blinds, splits, etc.	4