SUGGESTIONS FOR REDUCTION OF ANALYTICAL COSTS BY ELIMINATION OF UNNECESSARY QUALITY CONTROL (QC) SAMPLES

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ABSTRACT

A rationale is presented for collecting fewer QC samples for hazardous-waste projects and to encourage project managers and quality assurance project officers to question the need for every QC sample or activity. Many field QC samples can be eliminated from hazardous waste site investigations, resulting in significant analytical cost savings, without any effect on the quality of the overall investigation. The categories of QC samples or analyses which could be reduced include second column confirmations, field blanks, matrix spike and matrix spike duplicates, and duplicate samples. Additional cost reductions could be realized through careful selection of analytical methods and the use of on-site methods, where feasible.

INTRODUCTION

Many field QC samples can be eliminated from hazardous waste site investigations with no effect on the quality of the overall investigation. The QA/QC requirements for environmental investigations were derived under CERCLA and RCRA with the purpose of generating legally defensible results. "The EPA Contract Laboratory Program (CLP) is intended to provide analytical services for Superfund waste site samples. As discussed in the User's Guide to the Contract Laboratory Program (EPA 1988), the program was developed to fill the need for legally defensible results supported by a high level of quality assurance (i.e., data of known quality) and documentation."[1] All analyses performed for CERCLA (Superfund) investigations were initially required to be conducted at DQO Level IV (CLP). The initial (discovery) stage of a site investigation should be conducted at Level III or IV. Once the origin and responsibilities are established for a site, the purpose of QA/QC should be adjusted to new DQOs. Determining the extent of contamination, conducting RI/FS, and monitoring remediations may be successfully accomplished with field screening methods, on-site Level II analyses, and fixed laboratory Level II, with some samples (generally 10%) confirmed at Level III or Level IV.

Significant analytical cost reductions could be realized by eliminating unnecessary second column confirmations, field blanks, matrix spike and matrix spike duplicates, and duplicate samples. Second column confirmations, field blanks, matrix spikes/spike duplicates, and field duplicates can, in most cases, be reduced or eliminated. This should result in a reduction in the number of QC samples, a better understanding of the effect of QC on the data, and reduced costs in time and money for the work.

QUALITY CONTROL SAMPLES AND PROCEDURES

SECOND-COLUMN CONFIRMATIONS

Second column confirmations apply to organic analyses using GC methods, such as SW846 methods SW8010, SW8020, SW8021, SW8080, SW8081 and SW8280. A second column confirmation often is billed by the laboratory as a separate sample analysis. Method 8000A of SW846 states in Paragraph 7.6.9.1 "Tentative identification of an analyte occurs when a peak from a sample extract falls within the daily retention time window. Normally, confirmation is required: on a second GC column, by GC/MS if concentration permits, or by other recognized confirmation techniques. Confirmation may not be necessary if the composition of the sample matrix is well established by prior analyses."[2] Methods SW8010B, SW8011, SW8015A, SW8020B, SW8021A, and SW8030A, include the statement "if analytical interferences are suspected, or for the purpose of confirmation, analysis using the second GC column is recommended."

Many projects have specified that all positive results for GC methods will be confirmed by second column confirmation only because the SW846 method provides for it. Many more projects have suffered from inflated analytical costs because second column confirmations were not discussed in the work plan or the QAPP and the laboratory performed these analyses because they were called for by the SW846 method. The large number of confirmations resulting from this protocol is excessive and often results in an unnecessary inflation of the analytical cost. If good historical data exists, the only analytes requiring confirmation are compounds not previously detected and confirmed. For example, if benzene was detected and confirmed by method SW8240 (a GC/MS method) or by method SW8020 with second column confirmation during Superfund investigations, a positive result for benzene in the RI/FS investigation does not need to be confirmed. Positive results less than Quantitation Limits, MCLs, ARARs, or cleanup levels should not be confirmed. Sampling efforts involving numerous samples at each site, e.g. grid sampling, should include only enough confirmations to confirm the identity of each analyte found at the site.

BLANKS

The field blanks collected at a site could include trip blanks, ambient blanks, bottle blanks, source water blanks, and equipment rinseate blanks. The reason for analyzing different types of blanks is to be able to trace the origin of contamination in order to take corrective action. This requires that the results be available as field work is being conducted. Generally, blank results are not available before the sample results are reported, which can be many weeks after the field effort is completed. A multiplicity of blanks may be justified, but the project manager should develop good reasons for them. Long-term programs involving numerous separate projects could benefit from different types of blanks, since corrective action can be taken between projects. If on-site analytical equipment is available, analysis of blanks on-site would allow corrective action to be taken rapidly and these are generally much less expensive than fixed-base laboratory analyses. On-site analysis of blanks must be conducted with methods which are analyte-specific, have quantitation limits lower than the action levels, and documented calibrations and detection limits. Many of the blanks submitted to laboratories for analysis are probably not necessary.

In many cases, two or more blanks could be combined; e.g., an equipment rinseate blank taken to the sampling site serves as an ambient blank and a bottle blank, and if this blank is shipped in a cooler with VOA analyses, it also serves as a trip blank. Another approach might be to collect a full set of field blanks and analyze only the most comprehensive (the equipment rinsate). As stated by Dr. Keith[3], "Sample analysis is often expensive. Sometimes it is prudent to collect a full suite of blanks but only analyze the field blanks. If the field blanks indicate no problems, the other blanks may be discarded or stored as necessary. If a problem is discovered, the individual blanks can be analyzed to determine its source. Resampling will still likely be necessary."

Data validation guidelines state that if a compound is found in any blank, positive sample results greater than the quantitation limit and less than five times the blank concentration are qualified as not detected (U or ND) at a quantitation limit (QL) equal to the sample result. If this adjusted QL is above the action level, it cannot be used to demonstrate a concentration below the action level. There is no difference between a positive sample result greater than an action level and a blank qualified result with a quantitation limit greater than the action level when the purpose is to demonstrate a concentration below the action level. Thus, if the purpose of sampling is to demonstrate that ARARs, MCLs, or cleanup levels have been met, or for monitoring remediation efforts, there may be no reason to take any field blanks. Since the resulting corrective action (i.e., resampling) based on a sample result above the action level is the same with or without blanks, the blanks are not necessary.

MATRIX SPIKE/MATRIX SPIKE DUPLICATES

It has been estimated that up to 90 percent of all environmental measurement variability can be attributed to the sampling process.[6] The matrix spiking protocol assumes that one sample out of a batch of twenty is adequate to assess the effect of the matrix on accuracy and precision. Much of the variability of the sampling process is due to the variability of environmental media and the contaminants within that media; likewise, the matrix effect is as variable as each medium and its contaminants. To be effective in defining method accuracy and precision, matrix spiking would have to be done for all samples.

Since data validation based on MS/MSD results is applied only to the sample spiked, the QA/QC value of MS/MSD samples is much lower than the value of surrogate recoveries and of laboratory control sample/laboratory control sample duplicate results (LCS/LCSD). Surrogates are added to every sample analyzed for organics and are the best measure of accuracy and matrix effects for an individual sample. LCS/LCSD results for each batch and the laboratory control charts are the best measure of laboratory accuracy and precision for organic analyses. The LCS/LCSD program is also the best measure of accuracy and precision for metals analyses. Laboratories do not charge for surrogates or LCS samples. The digestion procedure for metals virtually destroys the matrix so that the only interferences normally encountered in ICP and atomic absorption methods are from high concentrations of other metals. Elimination of MS/MSD samples could reduce analytical costs by 10%. For a project with analytical costs of $50,000, this represents a savings of $5,000.

FIELD DUPLICATES

The two types of Field Duplicates are split samples and co-located samples. A split sample is a sample which has been thoroughly blended and split between two containers. Often, the split samples are sent to different laboratories. Split samples are intended to measure the precision of the whole sampling and analysis procedure. Most often, if they contain anything to measure, split samples are a measure of how thoroughly the sample was blended before being split. There is no way to determine an effect on the rest of the samples at the site. Co-located samples are samples taken in the same location but not blended. The intent of co-located samples is to measure sampling precision or the variability of the matrix.

> "When designing experiments or procedures, it is important to keep in mind that the overall objective is accuracy. It naturally follows that those in charge of a project should ask whether additional measurements really contribute to the accuracy of a method, or simply to its precision.
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> In today's business world cost is very important, and each extra measurement adds to the cost of a project. We all know that precision is important, but we need to take a closer look at the costs and benefits to the customer when expenses are increased for the sake of improving precision without necessarily increasing accuracy."[7]

Often, the stated purpose of field duplicates is to measure the precision of the complete process from sampling through analysis. This is nice-sounding phraseology in a work plan, but what can you do with the results? Due to the potentially large variability inherent in the media being sampled particularly for soils and sediments, one sample location out of twenty probably will not represent the sampling or matrix variability. The result is that these measurements are often reported as measures of "precision", but they have no effect on the flagging or the use of the data. As stated above, the source of the greatest variation in environmental analytical results is the variability of the media. Comparable results (<40% RPD) are seldom achieved from co-located duplicate soil samples, even with the best efforts of the best sampling technicians available. A statistical evaluation of all sample results at a site should be used to measure the precision and representativeness of the sampling program. These statistical measures may provide confidence intervals for establishing extent of contamination in a medium.

SUMMARY

Since the purpose of this paper is to encourage the use of performance-based criteria to the selection of QC samples, the recommended guidelines listed in this section should not be used as a prescriptive set of guidelines. Any and all QC which contributes to the quality of the data or are required for other reasons should be included regardless of arguments presented in this paper. For each QC sample or analysis proposed, Project Managers (PMs) and Quality Assurance Project Officers (QAPOs) should ask what that determination contributes to the quality of the data and whether it helps meet the project DQOs. If a QC sample contributes nothing toward the DQOs, an argument should be made against incurring the cost for that sample.

RECOMMENDATIONS

The following are recommended guidelines and uses for QA/QC samples:

Second-Column Confirmations

1. If historical data exist, the laboratory should be directed to conduct second-column confirmations only for compounds not previously detected. When second-column confirmations are deemed necessary, the laboratory should confer with the PM or the QAPO.

2. Positive results less than Quantitation Limits, MCLs, ARARs, or cleanup levels should not be confirmed.

3 . Sampling efforts involving numerous samples at each site, e.g. grid sampling, should have a limited number of confirmations.

Blanks

1. For sampling efforts undertaken to demonstrate that ARARs, MCLs, or cleanup levels have been met, eliminate all field blanks.

2. For projects which require blanks, use the following criteria for determining the frequency and type of blanks to take:

    1. Ambient blanks - Collect only in the event that the field team observes nearby activities that could contaminate VOC samples.

    2. Equipment blanks - Collect rinseates on bailers used to collect groundwater samples. Collect equipment rinseates for each decontamination event. Do not collect rinseate blanks for soil or sediment samples.

3. Combine blanks (Equipment Rinseate, Ambient, and Trip Blanks) wherever possible. When equipment rinseate or ambient blanks are taken, eliminate trip blanks and ship all sample VOCs in the same cooler as the blank.

4. If sampling of multiple types of blanks cannot be avoided, analyze only the equipment rinseate. If a problem is found, then analyze the remainder of the blanks.

5. If corrective actions are possible, submit source blanks as needed to implement those corrective actions. During long-term programs, submit source water blanks from water purification systems either to a fixed base laboratory or to an on-site chemist to maintain quality control of that system.

Matrix Spike/Matrix Spike Duplicates

1. Use surrogate recoveries to measure matrix effects for organic analyses.

2. Use Laboratory Control Spikes/Duplicates (LCS/LCSD) rather than MS/MSDs for determining precision and accuracy.

3. Use control charts for warning and control limits on precision and accuracy.

4. Avoid MS/MSD for metal analyses; metal analyses do not generally require a measure of matrix effects since the digestion and analytical methods destroy the matrix.

Field Duplicates

1. Collect and analyze field duplicates for Level IV (CLP) projects only. Eliminate or greatly reduce the requirements for field duplicates for Levels I, II, and III projects, unless it is necessary to establish statistical measures of uncertainty in the definition of extent of contamination.

LIST OF REFERENCES

1. EPA, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (PartA),* p. 5-5, EPA/540/1-89/002, December 1989.
2. EPA, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, Final Update 1,* November 1990.
3. Keith, Lawrence H., Ph.D., *Environmental Sampling and Analysis, A Practical Guide,* Lewis Publishers, Inc., 1992.
4. Taylor, John K., Ph.D., *Quality Assurance of Chemical Measurements,* Lewis Publishers, Inc., 1990.
5. USEPA Contract Laboratory Program, *National Functional Guidelines for Organic Data Review,* June, 1991.
6. Homsher, M.T.; Haeberer, Fred; Marsden, Paul J.; Mitchum, R.K.; Neptune, Dean; and Warren, John, *Performance Based Criteria, A Panel Discussion,* Environmental Lab, October/November 1991.
7. Phifer, Lyle H., *Accuracy Versus Precision,* Environmental Testing & Analysis, March/April 1995.
8. EPA, *Data Quality Objectives Process for Superfund, Interim Final Guidance,* p. 42, EPA540-R-93-071, September 1993.