QUALITY ASSURANCE CONSIDERATIONS FACT SHEET

Unit Errors

A common error is assuming that parts per billion by volume (ppbv) is equivalent to micrograms per liter (µg/L) or that parts per million by volume (ppmv) is equivalent to milligrams per liter (mg/L). A separate fact sheet (Units and Unit Conversions Fact Sheet) discusses the units used in vapor intrusion.

Sampling and Analysis Plans and Data Quality Objectives

Quality assurance and quality control (QA/QC) procedures are important tools for ensuring the data that are produced meet the required data quality objectives (DQOs). A detailed sampling and analysis plan (SAP) will describe QA/QC protocols for field and laboratory efforts. A quality assurance project plan (QAPP) is a written document that outlines and describes the anticipated tasks for an entire project. This ensures that the investigatory portion of a project produces reliable data that can be used to meet the overall DQOs. A QAPP will provide details on applicable field procedures (e.g., soil vapor probe installation process and sampling procedures), field and laboratory methods, and QA/QC samples that will be required. A well-written SAP and QAPP can help ensure the appropriate data will be produced and will reduce the potential for confusion and costly delays. For many projects, an SAP and/or QAPP may be stand-alone documents; however, some smaller projects may incorporate both into an investigation work plan. Many state and federal oversight agencies require the development of a QAPP prior to mobilization for any investigation. Practitioners should make sure to check with their appropriate regulatory agency on these requirements. This fact sheet discusses some QA/QC considerations for field and laboratory activities, many of which may be addressed in a project SAP and/or QAPP.

Many problems can be avoided by discussing the SAP, any expected high-concentration samples, and the analysis needs and expectations with the analytical laboratory early in the process and at multiple times thereafter.

Quality Assurance / Quality Control for Active Sampling

Much of the soil vapor and indoor air sampling conducted for the investigation of the vapor intrusion pathway is for volatile organic compounds (VOCs). For vapor intrusion studies where relatively low concentrations are expected, U.S. Environmental Protection Agency (USEPA) Method TO-15 is frequently used. TO-15 specifies the collection of samples in canisters that are leak free and that are cleaned after each use. Canisters are shipped to the field under a vacuum of approximately −30 inches mercury (Hg). Flow controllers, calibrated by the laboratory, are sent with the canisters to allow the canisters to collect the samples over a set time period. For projects where extreme scrutiny may occur, individually certified clean canisters are recommended. While labs will add a fee for this, the potential for false positive results will be reduced.

USEPA Method TO-17 uses a sorbent tube and sampling pump to target a broad range of VOCs and lighter semivolatile organic compounds that are beyond the upper range of a canister sample. Very volatile compounds such as methane are nonadsorbable and cannot be targeted on sorbent tubes. Larger volumes of gas can be sampled (e.g., 10 to 100 liters), which may allow the laboratory to report lower reporting limits (RLs) than methods that are only able to sample a fixed volume. The sampling methodology for collecting sorbent tubes for USEPA Method TO—17 analysis is presented in Section 7.4.1.1.2 of the main document.

TO-17 traps the VOCs it samples and can be used to sample a large volume of air, achieving very low detection limits. Not all regulatory agencies accept data that has been generated using TO-17. Adsorbent tubes have a breakthrough volume, and once that volume has passed through the tube, the tube begins to release some of the VOCs it has captured. If high concentrations are expected and breakthrough is a potential concern, a backup tube can be placed in line with the sampling tube to trap any compounds that were to breakthrough. This requires a separate analysis of the backup tube. As with all sampling methods, TO-17 sampling should only be performed by appropriately trained personnel.

The use of either TO-15 or TO-17 is one QA/QC issue that must be considered. Below are examples of additional QA/QC issues that should be considered. This list is not meant to be exhaustive:

- **Analyte list and RLs:** Discuss your program-required analyte list and RLs with the laboratory to ensure they will be met.
- **Type of RL:** Determine from the laboratory whether its RL refers to a limit of quantitation (LOQ) or method detection limit (MDL) and verify with the project regulators that this type of RL is acceptable.
- **Specific minimum sampling times:** Some sorbent-based methods and analytes require very specific minimum sampling times in order to meet RL requirements. As such, it is essential to check with the laboratory prior to selecting a specific sampler for a field campaign.
- **Laboratory certification:** Many regulatory agencies require laboratories to be certified to conduct air analysis.
- **Prepared sampling media:** The laboratory must provide sampling media that is ready for use both in the field and in the laboratory, such as canisters, pumps, or adsorbent tubes that are in good operating condition, clean, and leak-free, and flow controllers must be calibrated over the appropriate flow range. The laboratory should agree upon how this is to be established and documented (if documentation is required). The laboratory should provide a component (e.g., flow controllers, canisters, etc.,) tracking system with forms for the samplers to complete prior to laboratory submission. Should questions arise following analysis, this may help identify whether a component has failed or been contaminated prior to the sampling event.
- **Standard operating procedures (SOPs):** SOPs are an important part of QA/QC for a laboratory, but SOPs for sample collection that ensure that the sampling crew follows documented, reproducible field procedures are an equally important part of the QA/QC procedures for sample collection. SOPs must be followed during sample collection as well as during sample analysis.
- **System leak checks for soil vapor samples:** A tracer gas can be used to check for leakage around the sampling probe and analytical sampling train. The choice of a tracer gas has important implications both for the laboratory and the regulator, so if system leak checks are to be used, make sure they are properly vetted, documented in the SAP, and approved prior to field mobilization. For more details regarding leak checks for soil vapor samples, refer to **Section 7.4.1.3.3** of the main document.
- **Field documentation:** The sampler should be careful to record specifics about the sampling. The specific details to be recorded should be discussed in the SAP and may include weather observations (e.g., barometric pressure trends and wind speeds and directions), before-and-after canister vacuum readings, pump flow rates, collection start and stop times, a “box” sketch of the sampling apparatus, and field photographs.
- **Background contamination precautions:** Our daily use of VOCs sometimes causes our procedures to overlook common causes of sample interference. These should be addressed in the SAP and should include avoiding fueling vehicles immediately before sample collection or using permanent marking pens when collecting gas samples.

- **Required laboratory QC samples:** These include mass spectral tuning, initial calibration, continuing calibration verification, laboratory control spikes, and method blank. These are method requirements for both Method TO-15 and TO-17; it should be decided prior to sample analysis what level of data package will be provided and which of the QC results will be included in the laboratory report.
- **Additional QC samples (if needed):**
    - Trip blanks refer to canisters sent out with the canister batch to test for the presence of contaminants introduced during canister cleaning, preparation, transit, and storage. The USEPA recommends one trip blank per batch of sample collection vessels.
    - Equipment blanks are used to ensure that equipment used to collect multiple samples is clean between uses. It is good practice to collect at least one equipment blank for each sampling event.
- **Analytical holding time per the appropriate analytical method:** Check with the state or region to verify holding time requirements.

Duplicate and replicate samples are media samples collected from the same location as the primary (or parent) sample. A duplicate sample is collected from the source medium at the same time as the primary sample. A replicate sample is collected directly after the collection of the primary sample. Both are analyzed separately by the laboratory to assess the precision and variability of the sampling and analysis process. USEPA guidance recommends collecting one duplicate/replicate sample for every 20 primary samples; however, the frequency of duplicate/replicate collection may vary in some states. Note that the USEPA recommends collecting field duplicate samples at a minimum frequency of 10 percent (one duplicate for every 10 primary) for soil, sediment, and groundwater (USEPA 2014).

QA/QC for Passive Volatile Organic Compound Sampling

As with any site investigative tool, passive sampling requires adequate QA/QC to provide data of sufficient quality to ensure proper decision-making. Methods TO-17, 8260, or 8270 combined with a desorption method may be used for analysis. Required QC samples are based more on DQOs than on prescriptive procedures. Specific QA/QC procedures vary depending on the manufacturer of the sampler and on the analytical laboratory. Therefore, it is important to understand what procedures will be used and to determine whether they are adequate to meet the DQOs. At a minimum QA/QC procedures should consider the following:

- **Passive sampler installation, retrieval, and handling:** This will ensure consistency of deployment and sample integrity prior to analysis.
- **Units of measure such as concentration or mass (or some other relative) units:** If concentration data are to be provided, verify how the sampling rates were determined and that they are appropriate for the media being sampled (i.e., low sampling rates are required for soil vapor sampling).
- **Type of RL:** Determine from the laboratory whether its RL refers to an LOQ or MDL and verify with the project regulators that this type of RL is acceptable.
- **Specific minimum sampling times:** Some methods and analytes for passive sorbents require very specific minimum sampling times in order to meet RL requirements. As such, it is essential to check with the laboratory prior to selecting a specific sampler for a field campaign.
- **Cleanliness of sampler:** Verify procedures are in place to document the cleanliness of the samplers. The sampler background must be sufficiently less than RLs. Also, determine whether the samplers are batch or individually certified clean. Samplers analyzed by thermal desorption can be individually

certified clean, while samplers analyzed by solvent extraction techniques can only be batch-certified clean.

- **Required laboratory QC samples:** These include mass spectral tuning, initial calibration, continuing calibration verification, laboratory control spikes, and method blanks. These are method requirements for Methods TO-17, 8260, and 8270; it should be decided prior to sample analysis what level of data package will be provided and which of the QC results will be included in the laboratory report. For control samples, method, trip, and field blanks are used to verify the integrity of samples during shipment and potential background levels.
    - Method blanks are clean adsorbent material analyzed by the applicable analytical method to determine whether any potential background levels of target compounds in the sorbent media or analytical instruments contributed to the results.
    - Trip blanks are unexposed passive samplers that accompany samplers during transport to the field and then to the laboratory to determine whether any potential background levels of target compounds may have been contributed during transport or storage. It is recommended that at least one trip blank be collected for each box of passive samplers.
    - Field blank samples (for soil vapor sampling only) are typically not required.
- **Replicate analyses:** If replicate analysis is required, determine whether the sampler allows for multiple analyses or whether multiple samplers need to be colocated. Like with active sampling, it is generally recommended to collect one replicate sample for every 20 primary samples.

Additionally, the following points should be considered:

- Passive samplers should be transported in a sealable container to preserve cleanliness prior to use and to prevent additional adsorption of compounds in surrounding air during return shipment to the analytical laboratory.
- Field sampling personnel must record deployment and collection dates and times. Accurate time recording is important for results interpretation.

Group Analytes (Total Petroleum Hydrocarbon Ranges)

In both active and passive sampling, there is a wide variation of total petroleum hydrocarbon (TPH) definitions; they vary in the range of included hydrocarbons, whether specific compounds are excluded from the reported result, and what compound(s) is(are) used to calibrate the instrument results. If any type of TPH is one of your target analytes, it must be completely spelled out in the SAP and needs to be discussed with the laboratory before samples are collected. Since there are many applications of TPH, there is no single correct definition of it. However, if TPH data are collected for a particular project, it is important that everyone in a project uses the same definition (Rago et al. 2013).

Data Verification and Validation of Vapor Samples

Data verification and validation is a systematic process for reviewing a body of data against a predefined set of criteria to ensure the data are usable for their intended purpose (sufficient quality). The objective of the data assessment process is to determine whether and how the usability of the analytical data are affected by the overall analytical process and sample collection and handling procedures. The USEPA developed a set of guidance documents, the *National Functional Guidelines for Organic Superfund Methods Data Review* (USEPA 2020b) and the *National Functional Guidelines for Inorganic Superfund Methods Data Review* (USEPA 2020a), which are collectively referred to as the "NFGs," to aid in the quality assessment of analytical data generated using USEPA-approved analytical methodologies.

The practitioner must consider the conceptual site model when developing the sampling plan investigation strategy. Carryover in the field from sampling equipment is evaluated by the collection of field and equipment blanks. Analytical method banks are also evaluated with the field blanks and field samples to develop a framework understanding of site conditions at the time of sampling. A comprehensive review of the field data and how it relates to the specified sampling procedure (for example, filling evacuated sample tanks only to a partial vacuum, as indicated by the gauge on the tank) and a review of the completeness of field notes that must include key meteorological information (such as the relative temperature, wind speed and direction, barometric pressure trend, and humidity) should be included as detailed in USEPA (2021). It is important to document the barometric pressure pattern and trend that occurred during the sampling event. For instance, a dropping barometric pressure may induce upward advective vapor flux into buildings due to the pressure gradient, while a stable or rising barometric pressure occurs without upward advective flux. The barometric pressure pattern and trend can impact the results and interpretation (Kram et al. 2020).

Data Quality

If the project was planned using the DQO process (USEPA 2006: USEPA QA/G-4, USEPA/240/B-06/001) or other standard project planning process, then the quantity and quality of data, including the measurement quality objectives, will have been specified in the SAP. Some common data quality issues are listed in **Table 1**. All of the data should be examined for these types of issues to ensure that data are of adequate quality prior to using the data to evaluate the vapor intrusion pathway.

Table 1. Data quality issues to consider.

Data Quality Issue	Factors to Keep in Mind
Detection limits	• Ensure that detection limits are less than the applicable screening values for the chemicals of concern. • Consider whether more than one compound is of concern at the site. • Screening levels might be lower to account for cumulative effects and hence, detection limits must also be lower.
False positives	• Be aware of potential cross-contamination from probes, canisters, other materials, and indoor sources. • Remember that screening levels for vapor intrusion are low and the chances for false positives increase as contributions from other sources increase.
False negatives	• Consider that false negatives can be due to losses in sampling equipment, leaks, and other factors. Ask yourself: o Was the leak-detection compound detected in the sample? o Is O_2 higher in deeper samples of soil vapor? o Was the proper type of tubing used in the soil vapor probe? o Was the proper type of sample container used? o Were the chain of custody documents completed properly?
Sampling errors	• Remember to keep sampling hardware properly checked and maintained. • Minimize operator errors by properly training field staff. Ask yourself: o Did canisters fill to the target pressure? o Was the leak-detection compound applied and measured correctly? o Were canister pressures recorded for both start time and end times? o Ensure that sampling durations are adequate.

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