

Quality Assurance and Control Procedures

AgSource Laboratories utilizes a rigorous Quality Assurance and Quality Control (QA/QC) program supported by an experienced, full-time analytical team. The quality assurance program for each area of testing is defined in specific Standard Operating Procedure (SOP) documents. These SOP's dictate the steps taken in the following processes:

- Sample receiving, handling and storage prior to analysis, including sub-sampling.
- Preparation of sub-samples for analysis including any extraction or digestion required, filtering or dilution, and presentation of processed samples for each analytical method.
- Recording the preparation of analytical methods including the first use and expiration dates for standards, extracting or digesting solutions and analytical reagents.
- Documenting instrument set up, calibration and maintenance in instrument or method logs.
- Including Quality Control (QC) samples such as known samples, standard check solutions, blanks, spiked samples or duplicates along with all unknown samples. The acceptance criteria for all the QC results are detailed for each testing method.
- Review, recording, and transfer of all analytical data, and final reporting of accepted results.

Overview of Quality Control for Soil Testing

The specific requirements of the QA/QC program are detailed in the specific SOPs for each analytical method. The general criteria for compliance are described below.

Sample Preparation

- When samples are received at the laboratory, sample bags and information sheets are matched and numbered with a unique identification number. The samples are transferred to trays for drying in a specific, consistent order.
- Soil samples are air-dried below 110°F and ground in automatically controlled grinders to provide a uniform grinding process. Ground samples are collected in small boxes and ordered in trays of 50 or 60.

Quality Control (QC) Samples

- In each tray of samples there are at least two known QC samples that are processed along with the soil samples for every test.
- The QC samples are inserted in a predetermined order in the tray and the box at that position is occupied with a marker to identify the location of the QC.
- The QC sample is a premixed bulk sample that is sub-sampled for each analytical run.

Recognized Analytical Methods

- Standardized sub-samples are then measured (scooped) from each soil sample or from the QC sample for each test.
- These sub-samples are prepared for analysis according to the recognized methods of the North Central region of states (NCERA-13) and according to state certification requirements.

Instrument Calibration and Control

- Each instrument used in the analysis of the soil samples is calibrated against a set of standards. The standard calibration curve must have a high correlation coefficient

(typically >0.995) and a check solution must read back with expected values before sample analysis begins.

- The check solution is analyzed after every 10 - 20 samples, depending on the instrument set-up, and if it fails (does not read as expected) the instrument is recalibrated before proceeding. The previously analyzed set of samples are re-tested if the instrument drift is greater than 15%.

QC Sample Review

- During the analytical run the technician can observe the values of the QC samples and evaluate the quality of the data against expected ranges for the QC samples.
- If the QC sample results fall outside these ranges, the technician will reject the accompanying sample results and notify the QC Manager to determine what corrective steps to take. These steps could be to:
 - recalibrate the instrument and read the sample tray again,
 - or have the tray re-scooped and re-extracted for another analysis.
- All the data for each analysis are reviewed by the technician and by the QC Manager for quality control compliance before being passed on for reporting. (see below)

Sample Reporting

- Sample results are identified by a unique sample ID in Labworks, the Laboratory Information Management System (LIMS) used in all AgSource Laboratories.
- When all the required analytical data is entered the LIMS performs any calculations and reporting routines before generating the PDF and electronic file reports that are automatically sent to the clients.
- Clients that submit samples also provide email addresses or digital transfer details maintained under the client account to ensure that the reports are securely distributed.

QC Data Analysis and Acceptance Criteria

The laboratory maintains a complete record of all supporting QC data for each analytical method. The data are statistically reviewed for average and standard deviation and these values are regularly updated in the AgSource LIMS system.

When data are reviewed in the LIMS for approval and reporting they are compared against the range of standard deviations around the mean.

- If a QC sample result falls outside two standard deviations from the mean it is flagged with a 'Warning'.
- If two consecutive QC samples in an analytical run receive a 'Warning' the QCs are considered as having failed and the associated sample results are rejected.
- If a QC sample result falls outside three standard deviations from the mean it is flagged as 'Failed' and the associated sample results are rejected.
- Rejected sample results are the samples that fall in the group between the prior passing QC sample and the next passing QC sample.
- Rejected samples are re-scooped and processed for analysis.
- The same QC criteria are applied to these re-tested samples when being reviewed.

All QC results are compiled and plotted over the course of the time that the QC sample is in use. By graphing this data it is possible to pick up trends in the results that are not apparent on a daily basis. These trends include rising or falling average values that may indicate deterioration of instrument sensitivity, electrode quality or stability of a reagent used in the analytical processes.