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Standard Guide for Developing Appropriate Statistical Approaches for Groundwater Detection Monitoring Programs at Waste Disposal Facilities¹

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1. Scope*

1.1 This guide covers the context of groundwater monitoring at waste disposal facilities. Regulations have required statistical methods as the basis for investigating potential environmental impact due to waste disposal facility operation. Owner/operators must typically perform a statistical analysis on a quarterly or semiannual basis. A statistical test is performed on each of many constituents (for example, 10 to 50 or more) for each of many wells (5 to 100 or more). The result is potentially hundreds, and in some cases, a thousand or more statistical comparisons performed on each monitoring event. Even if the false positive rate for a single test is small (for example, 1 %), the possibility of failing at least one test on any monitoring event is virtually guaranteed. This assumes you have performed the statistics correctly in the first place.

1.2 This guide is intended to assist regulators and industry in developing statistically powerful groundwater monitoring programs for waste disposal facilities. The purpose of this guide is to detect a potential groundwater impact from the facility at the earliest possible time while simultaneously minimizing the probability of falsely concluding that the facility has impacted groundwater when it has not.

1.3 When applied inappropriately, existing regulation and guidance on statistical approaches to groundwater monitoring often suffer from a lack of statistical clarity and often implement methods that will either fail to detect contamination when it is present (a false negative result) or conclude that the facility has impacted groundwater when it has not (a false positive). Historical approaches to this problem have often sacrificed one type of error to maintain control over the other. For example, some regulatory approaches err on the side of conservatism, keeping false negative rates near zero while false positive rates approach 100 %.

¹ This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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1.4 The purpose of this guide is to illustrate a statistical groundwater monitoring strategy that minimizes both false negative and false positive rates without sacrificing one for the other.

1.5 This guide is applicable to statistical aspects of groundwater detection monitoring for hazardous and municipal solid waste disposal facilities.

1.6 It is of critical importance to realize that on the basis of a statistical analysis alone, it can never be concluded that a waste disposal facility has impacted groundwater. A statistically significant exceedance over background levels indicates that the new measurement in a particular monitoring well for a particular constituent is inconsistent with chance expectations based on the available sample of background measurements.

1.7 Similarly, statistical methods can never overcome limitations of a groundwater monitoring network that might arise due to poor site characterization, well installation and location, sampling, or analysis.

1.8 It is noted that when justified, intra-well comparisons are generally preferable to their inter-well counterparts because they completely eliminate the spatial component of variability. Due to the absence of spatial variability, the uncertainty in measured concentrations is decreased, making intra-well comparisons more sensitive to real releases (that is, false negatives) and false positive results due to spatial variability are completely eliminated.

1.9 Finally, it should be noted that the statistical methods described here are not the only valid methods for analysis of groundwater monitoring data. They are, however, currently the most useful from the perspective of balancing site-wide false positive and false negative rates at nominal levels. A more complete review of this topic and the associated literature is presented by Gibbons (1).²

1.10 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

² The boldface numbers given in parentheses refer to a list of references at the end of the text.

*A Summary of Changes section appears at the end of this standard