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Title: Guidance for Statistical Evaluation Plan Preparation and Review

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Brief Description of Subject Matter: This guidance lists items that should be included in Statistical Evaluation Plans (StEPs). StEPs must be submitted by solid waste disposal facilities that are required to apply statistical tests to ground water monitoring results.

Citations Affected: 329 IAC 10-21-6, 329 IAC 10-21-8

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GUIDANCE FOR STATISTICAL EVALUATION PLAN PREPARATION AND REVIEW

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The Solid Waste Geology Section has prepared the following list of items that should be contained in Statistical Evaluation Plans (StEPs) submitted to our office to satisfy 329 IAC 10-21-6 (c). This list can be used by facilities and their consultants to guide preparation of StEPs, and by consultants contracted by IDEM to review StEPs.

In general, the StEP should not be a report on statistical methods for ground water monitoring data, nor should it repeat the statistical methods and performance standards contained in 329 IAC 10-21-6. Rather, the StEP should explain which specific method or methods will be applied to specific parameters and wells for a specific site, with the overall objective of balancing false positive and false negative rates.

1. Background Data

The StEP should contain the analytical results gathered during at least four (4) independent background sampling events from all wells in the facility's ground water detection monitoring well system. The StEP should be submitted three months after four (4) background samples have been collected. The StEP should summarize background analytical results in tables. For results above detection limits, the StEP should include time series plots for each constituent sampled during background and should include boxplots that compare results for each constituent in each well. Figure 1 is an example of boxplots comparing arsenic concentrations in six wells.

2. Defined Statistical Tests

The StEP should define the specific statistical test that will be applied to each parameter that will be statistically evaluated. Considering analytical results gathered during background sampling, the plan must define the background distribution for each parameter, identify any data transformations applied to specific parameters, and demonstrate that the statistical test to be applied is appropriate for the distribution and proportion of non-detects. The StEP should also define how background and compliance data will be screened for outliers.

3. Verification Resampling

The StEP should define, for each specific parameter and each specific statistical test to be applied, how verification resamples (confirmatory resamples) are to be incorporated in the statistical decision rule.

4. False Positive Rates & Statistical Power

The StEP must include the false positive rate (significance level) for each statistical test that will be applied to each parameter. In addition, the facility-wide false positive rate should be provided. The StEP should also contain statistical power curves for each statistical test that will be applied to each parameter. Determinations of false positive rates and statistical power must incorporate the effects of the proposed verification resampling plan.

5. Interwell and Intrawell Statistical Comparisons

The StEP should define, for each compliance well, whether an interwell or intrawell comparison will be applied. Historical ground water data and site geology must be considered in justifying intrawell comparisons for each hydrostratigraphic unit to be monitored. In general, specific statistical tests should be appropriate for the site specific geology and the site hydrostratigraphic unit or units that are being monitored.

6. Background Sample Size

The StEP should define the background sample size, n , for each parameter. The StEP should discuss whether the initial four (4) background samples are adequate for balancing false positive rates and statistical power. If additional background samples

are required, a timetable for collecting the additional background samples must be specified.

7. Expanding Ground Water Database

The StEP should explain how future sampling results at background and compliance wells will be incorporated into statistical decisions regarding background sample size, distributional testing, and resampling plans. The plan should describe when and how trend analysis will be applied to make statistical decisions. Facilities should reevaluate the statistical tests being applied every four (4) to six (6) sampling events and submit trend analysis data and graphs to document that no significant changes have occurred in the background levels. If a significant change occurs in the background levels, a new statistical evaluation plan must be submitted that explains the change and proposes appropriate modifications in the statistical evaluation plan to accommodate the revised background levels.

8. Iron and Manganese

The StEP should describe how background and the ground water protection standard will be defined for secondary constituents iron and manganese of 329 IAC 10-21-11 (c) that are not subject to detection monitoring statistical evaluation.

9. Separate Documents

StEPs should be separate documents. StEPs should not be included in Statistical Evaluation Reports required by 329 IAC 10-21-6 (e), or in Sampling and Analysis Plans required by 329 IAC 10-21-2.

References

The following references may be valuable aids in developing site specific StEPs.

American Society for Testing and Materials. 1996. Provisional Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs. ASTM Designation PS 64-96.

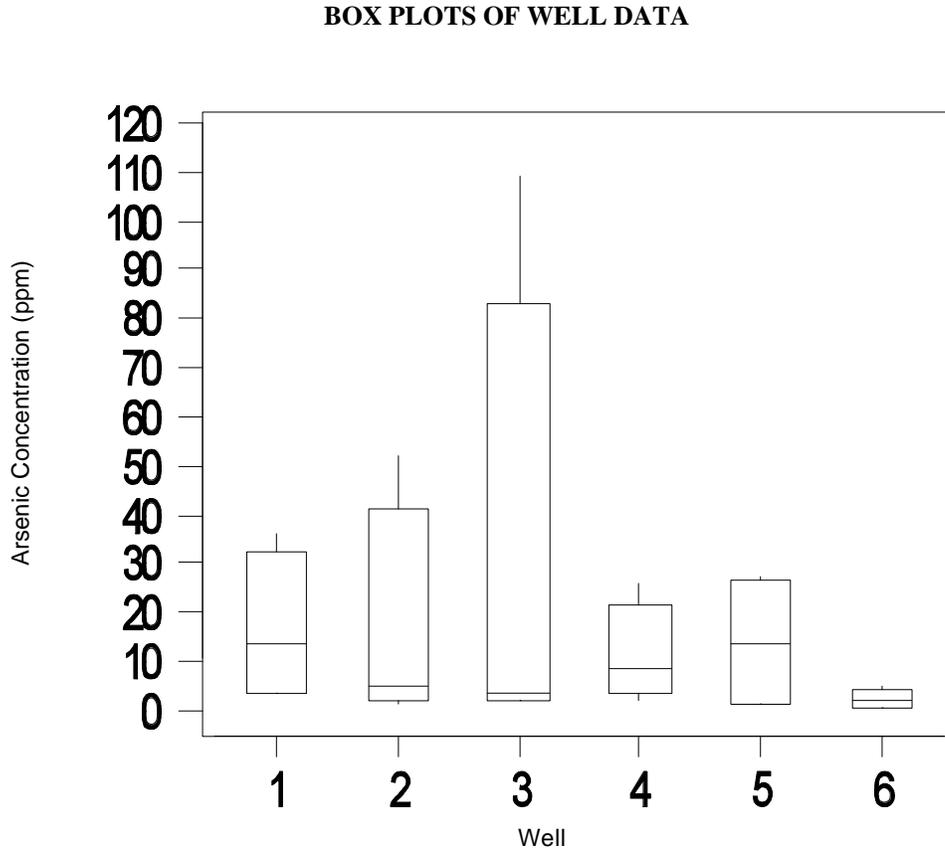
Davis, C.B., and R.J. McNichols. 1994. Ground Water Monitoring Statistics Update: Part II: Nonparametric Prediction Limits. *Ground Water Monitoring and Remediation* 14, No. 4.

Gibbons, R.D. 1994. *Statistical Methods for Groundwater Monitoring*. New York: Wiley.

Helsel, D.R., and R.M. Hirsch. 1992. *Statistical Methods in Water Resources*. Elsevier

U.S. EPA. 1992. Statistical analysis of ground-water monitoring data at RCRA facilities: Addendum to interim final guidance, in *Statistical Training Course for Ground-water Monitoring Data Analysis*. EPA530-R-93-003

Figure 1. Example of Box Plot Presentation for StEP Guidance



Example Data for Box Plots

Month	Arsenic Concentration (ppm)					
	Well 1	Well 2	Well 3	Well 4	Well 5	Well 6
1	22.9	2.0	2.0	7.84	24.9	.34
2	3.09	1.25	109.4	9.3	1.3	4.78
3	35.7	7.8	4.5	25.9	.75	2.85
4	4.18	52	2.5	2.0	27	1.2