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Dynamic Characterization of Soil Contamination at Former Small Arms Training Ranges

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Introduction

- A good understanding of the extent of contamination is critical to the evaluation of potential remediation techniques.
- Objective was to evaluate the extent of lead contamination in an expedited manner.
- The site characterization utilized a strategic investigative process.

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Triad Approach

- The foundation of the strategic process is an integrated triad consisting of
  - Systematic Planning
  - Dynamic Work Plans
  - Real-time Measurement Technologies

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Systematic Planning

- Translate the project goals into realistic technical objectives.
- Identifies decisions, develops decision logic and manages decision uncertainties.
- Conceptual site model (CSM) focuses what is already known.
- CSM is used to direct fieldwork and evolves as site work progresses and data gaps are filled.

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Dynamic Work Plan

- Success hinges on the presence of a senior technical staff in the field to “call the shots”.
- Data visualization to maintain close communication with team members as work progressed.
- Creates opportunities for real-time decision making to save significant time and money.

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On-Site Analytical Tools

- A Niton 300 Series XRF was used to generate real time data.
- Collaborative samples were verified by laboratory analysis by ICP or ICP-MS methods.
- A statistical correlation between the XRF measurements and the collaborative laboratory samples was established during the demonstration of method applicability (DMA).

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Uncertainty Management

- Uncertainty intervals are set where it is judged that field data results can be confidently trusted to declare areas as
  - “Clean” - No Further Investigation
  - “Dirty” - Remedial Action Needed
  - Ambiguous – Further Data Required

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Uncertainty Reduction

- Collaborative samples were collected within the ambiguous “window of uncertainty”.
- Co-located field duplicates site to assess impact of site heterogeneity.
- Precision samples to assess impact of within sample heterogeneity.
- Collection additional samples by immediate step-out.

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Demonstration of Method Applicability

- Evaluate site-specific heterogeneities
  - Sampling Design
  - Refine CSM
- Evaluate performance on site matrices
- Evaluate bias of the field-based instrument technology

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Additionally,

- Develop decision thresholds or “action levels”.
- Determine the correlation between XRF and fixed-lab analysis.
- Confirm proposed method for soil sample collection meets project data quality requirements.

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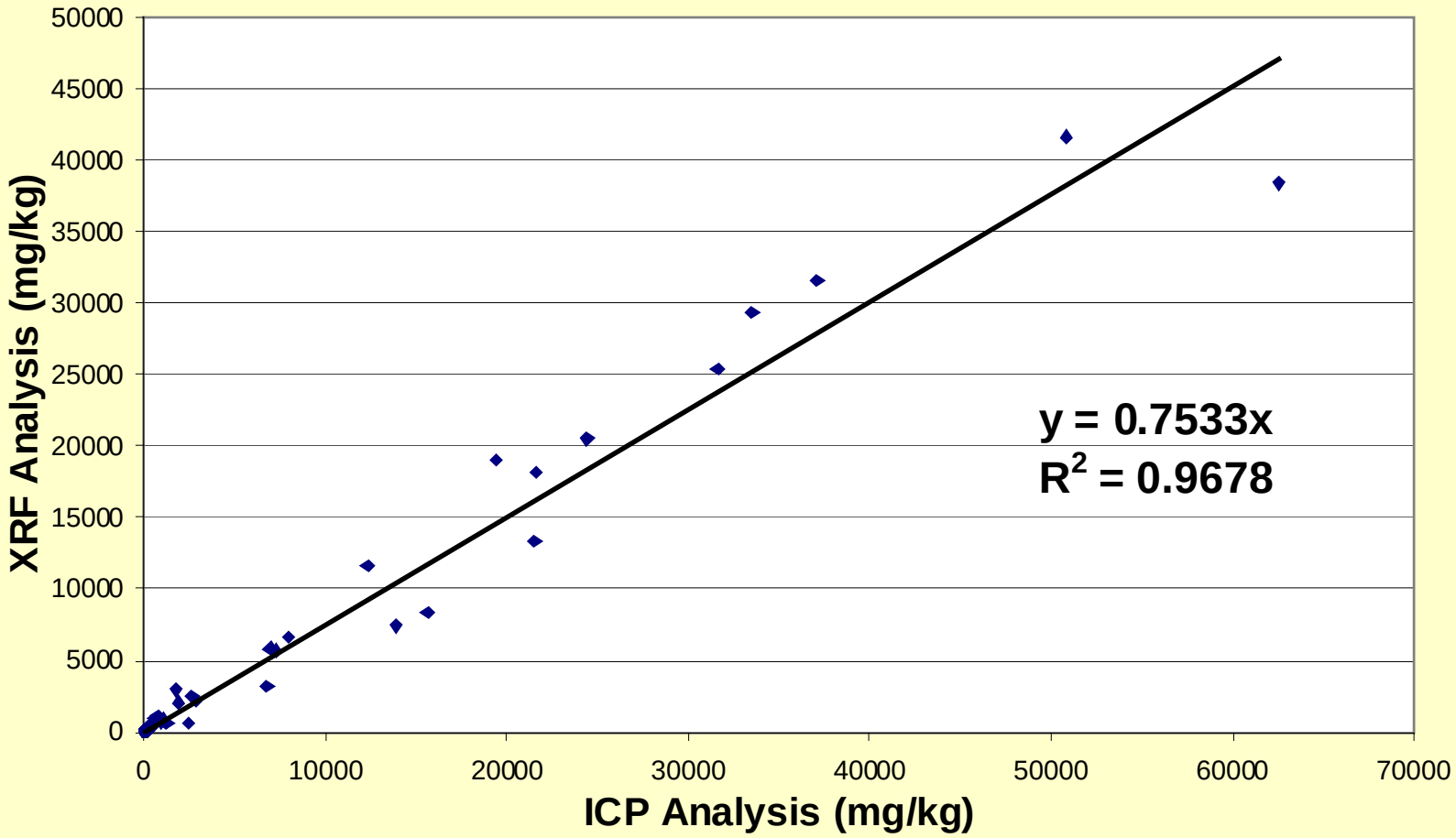
Project XRF vs. ICP Correlation for Lead



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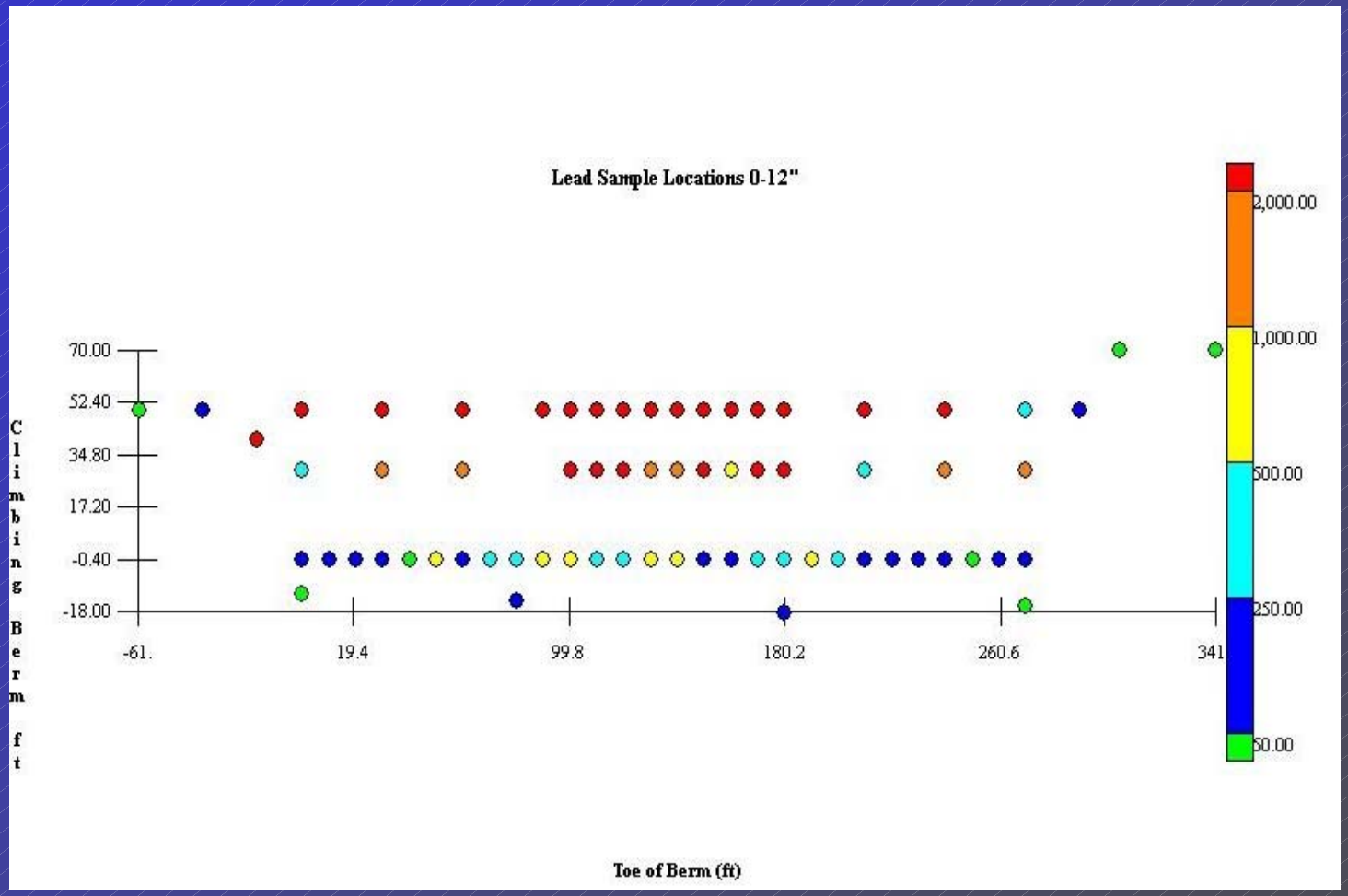

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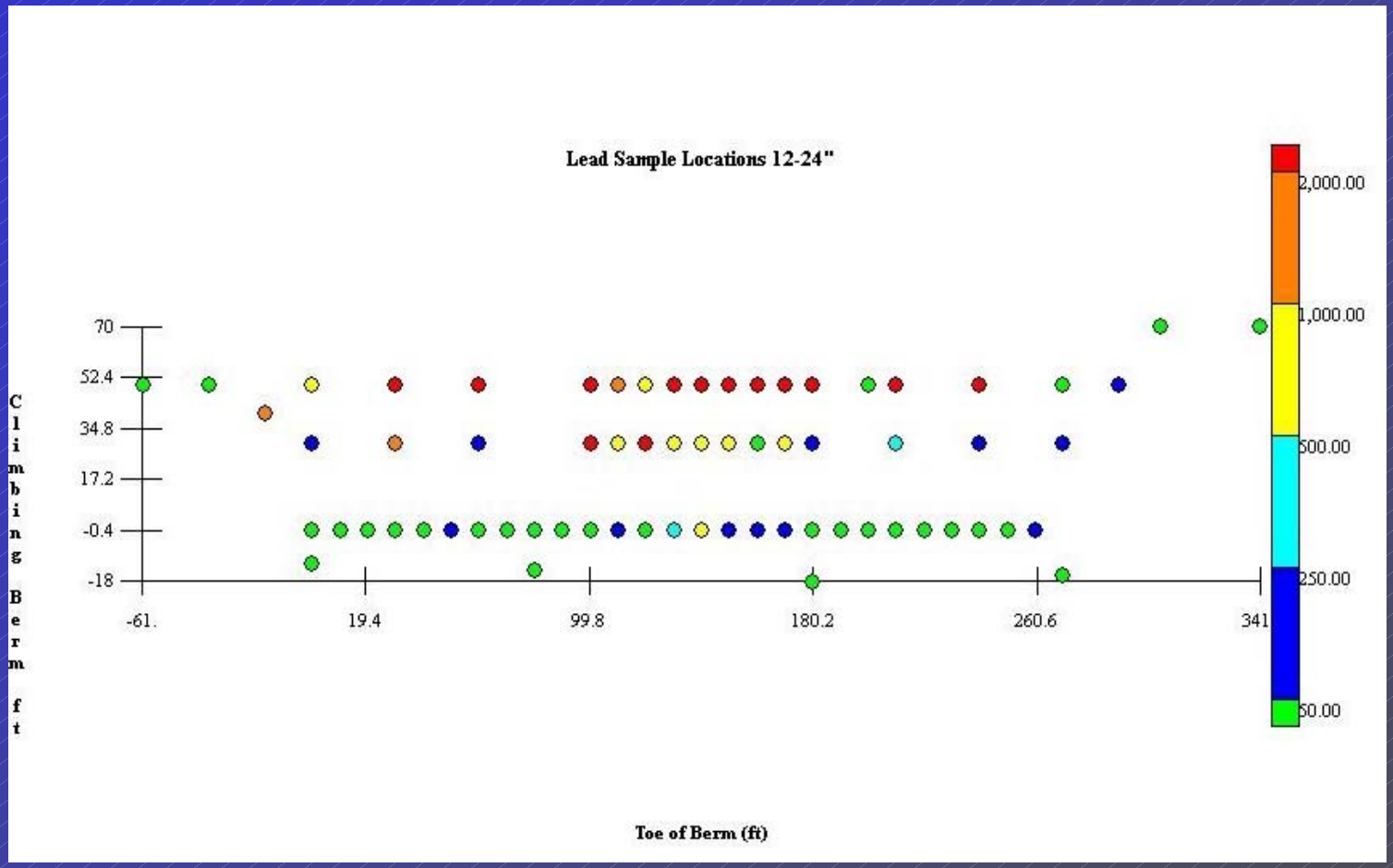

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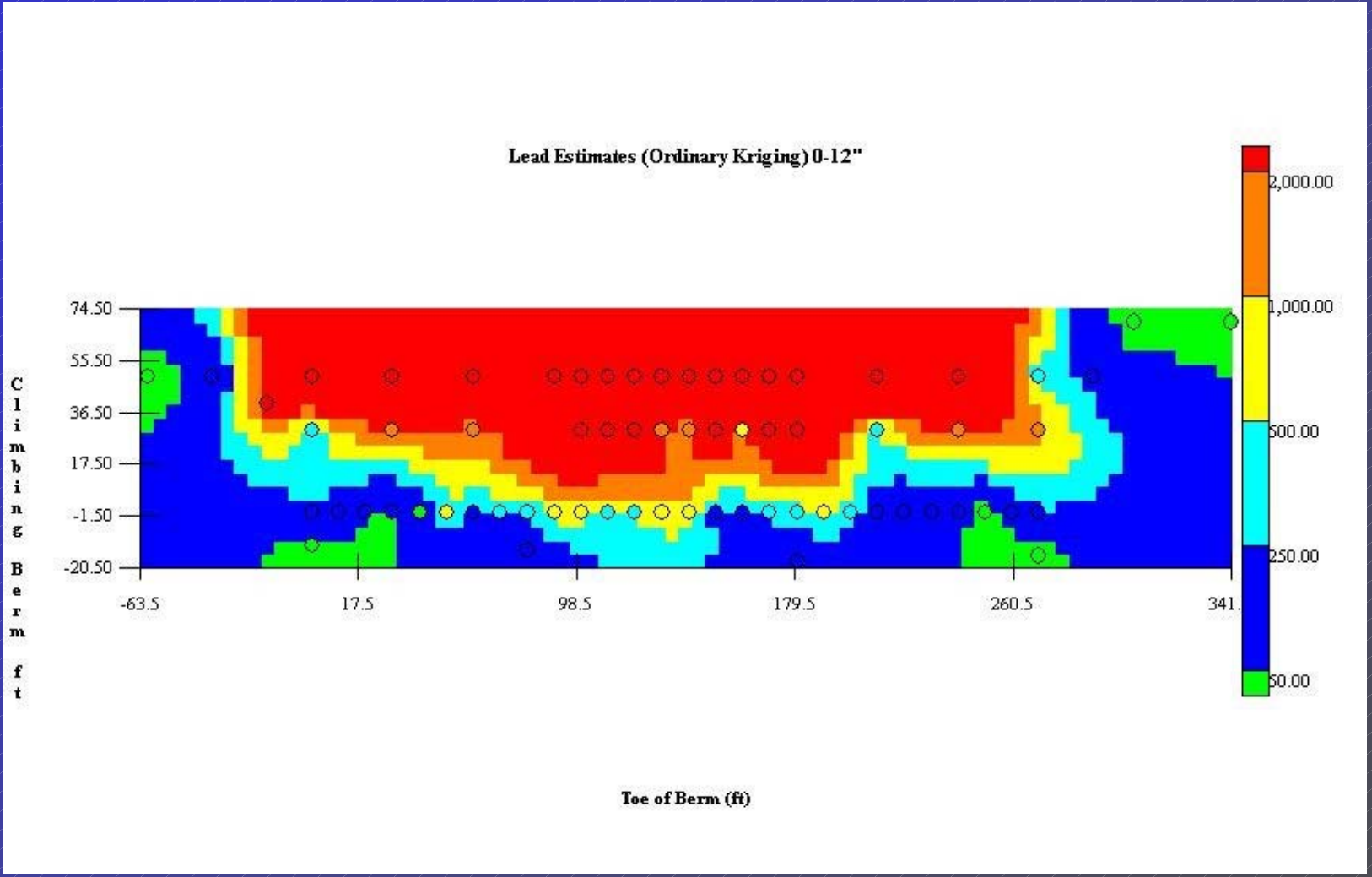

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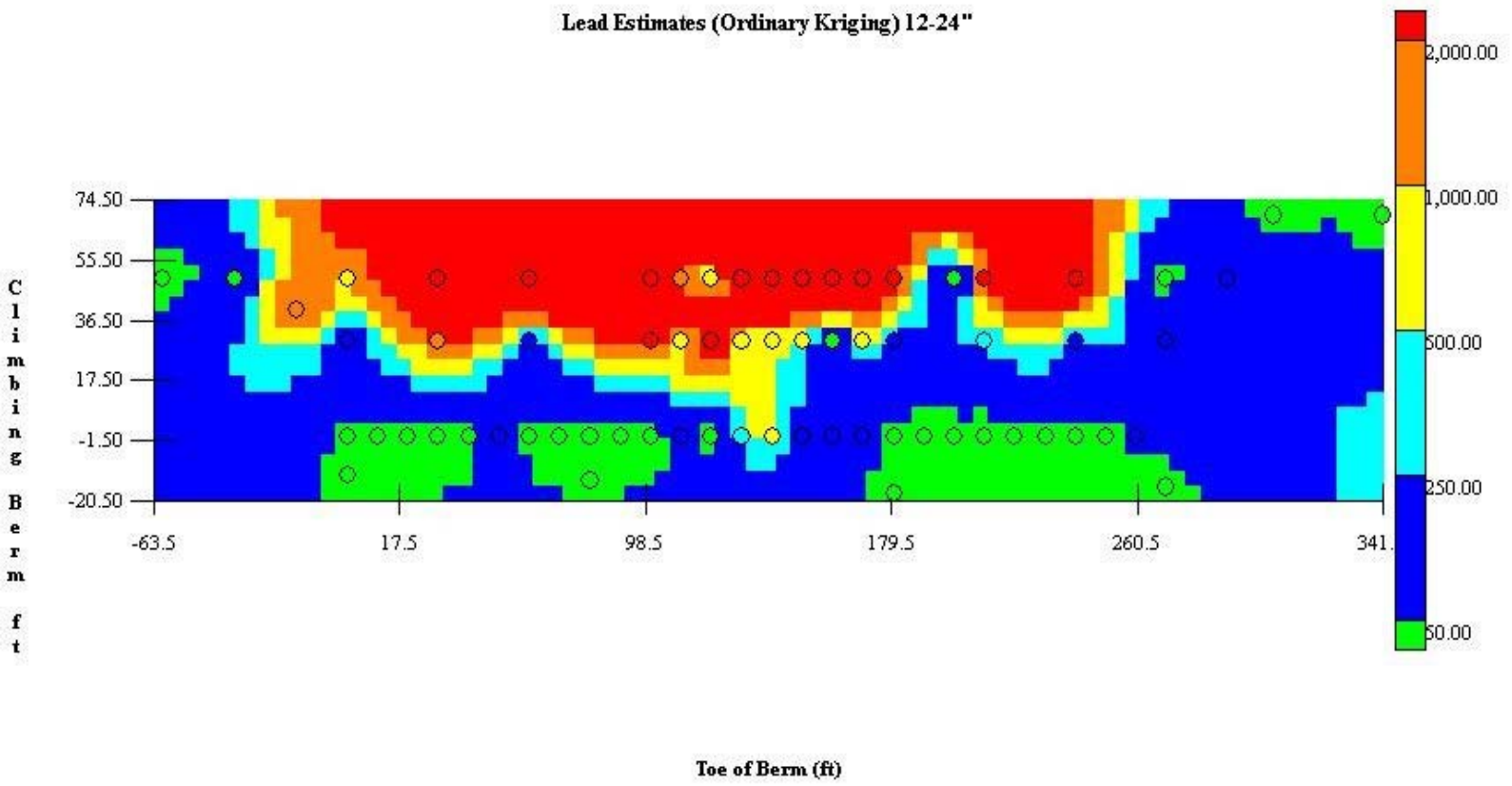

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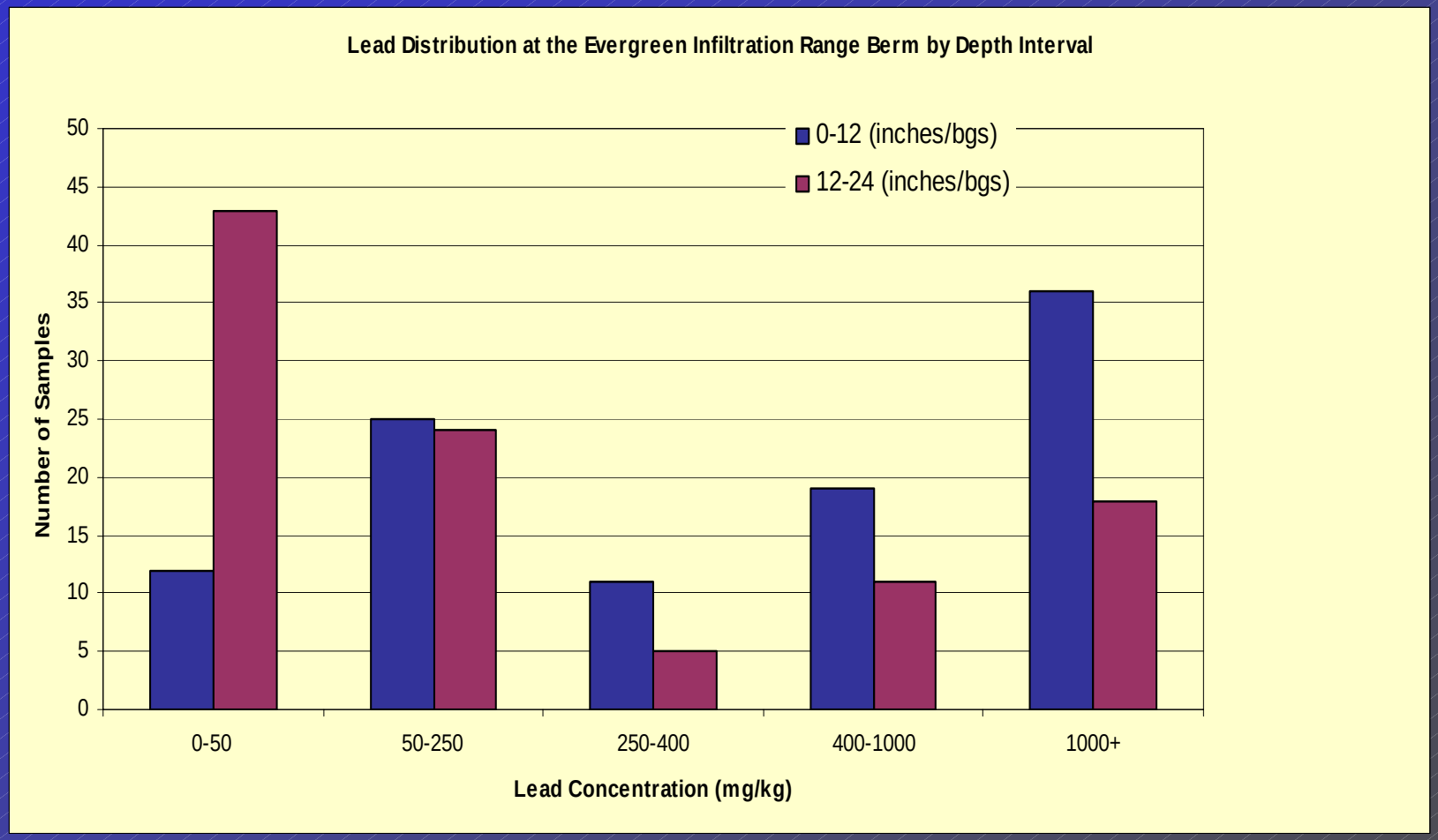

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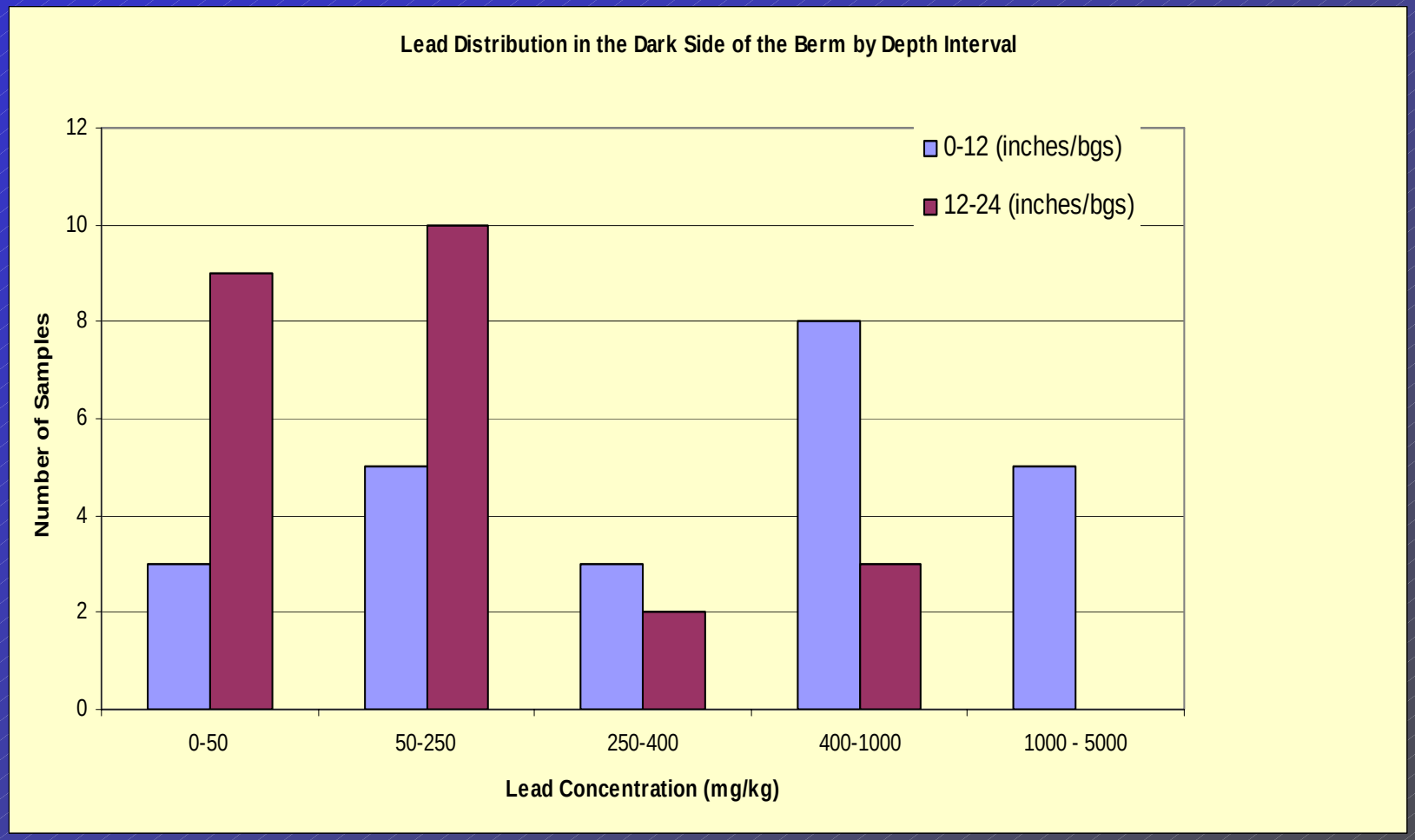

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Conclusions

1. Dynamic work plans and rapid results can guide sampling locations expediting site characterization and allowing for rapid delineation of extent of contamination.

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2. Reductions in analytical costs result in increased data density allowing for more accurate characterization.

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3. Statistically valid conclusions as both sampling and analytical uncertainties were managed.

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4. Sufficient data was generated to proceed with the feasibility study.

- Additional benefits included quantitative volume estimate of soil to be excavation.

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Action Level (mg/kg)	Excavation Effort	Volume in Feet^3	Volume in Yards^3
250	Minimal	9800	363
250	Moderate	104,204	3859
250	Maximum	688,000	25,481
1000	Moderate	53,104	1967

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Software Sources

- Spatial Analysis and Decision Assistance (SADA) http://www.tiem.utk.edu