Sampling Design Approaches and Validation Issues

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ABSTRACT

In the event of a terrorist attack involving biological warfare agents (BWA) or chemical warfare agents (CWAs), there will be a need to design sampling plans to characterize the nature and extent of contamination, to locate hotspots, and to confirm that any decontamination methods have performed properly (i.e., clearance sampling). Sampling plans would detail the rationale for the number and locations of samples to be collected. These data would then be used to evaluate the spatial distribution of contamination in order to facilitate decision making. Sampling plan designs may include judgmental, statistical, and/or geostatistical methods. The sampling plans may also be adaptive, thereby using information from one round of sampling to guide the next round. Statistical and geostatistical methods may employ probability-based methods that allow confidence estimates to be made from the data. The GAO performed an audit of the response to the anthrax letter incidents of 2001 and concluded that probability-based sampling design methods should be used whenever possible, and that they needed to be validated. This project is validating the probability-based methods. A computer model, the Building Restoration Operations Optimization Model (BROOM), with decision support capabilities that employ the sampling design methods will also be presented.

Process Flow for Crisis and Consequence Management

Response and Recovery Activities					
Crisis Management		**Consequence Management**			
Notification	First Response	Remediation/Cleanup			Restoration (Recovery)
		Characterization	Decontamination	Clearance	
Receive and assess information	HAZMAT and emergency actions	Detailed characterization of BWA, CWA or TIC	Worker health and safety	Clearance sampling and analysis	Renovation
Identify suspect release sites	Forensic investigation	Characterization of affected site	Source reduction		Reoccupation decision
Relay key information and potential risks to appropriate agencies	Public health actions	Site containment	Decontamination strategy	Clearance decision	Long-term environmental and public health monitoring
	Screening sampling	Continue risk communication	Remediation Action Plan		
	Determination of agent type and concentration	Characterization environmental sampling and analysis	Site preparation		
			Waste disposal		
	Initial risk assessment		Decontamination of sites, items, or both		
	Risk communication				
		Clearance goals	Verification of decontamination parameters		

Sampling Design Approaches Are Important in Many Stages of the Process

Sampling Design Methods

- **Targeted** (*using expert judgment*)

- **Statistical Methods** (*classical approaches that may be probability-based*)

- **Geostatistical Techniques** (*explicitly account for spatial variability*)
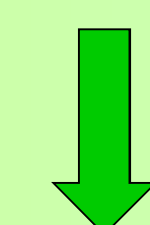
GAO (2005) critiqued the sampling design approach used in the USPS facilities following the 2001 anthrax attacks, and recommended:

- **Probability-based methods should be used in order to quantify confidence in the results**

- **The sampling design methods need to be validated**

Validation of Sampling Design Methods

Sandia National Laboratories, Lawrence Livermore National Laboratory, and Pacific Northwest National Laboratory are collaborating on a validation study, with support from the Department of Homeland Security. Key factors include:

- **Validating hot spot methods**

- **Validating probability-based statistical methods**

- **Validating geostatistical techniques**

Attention is focused on the rate of false positives and false negatives in the application of the methods to known or synthetic data sets. Results will be forthcoming during the coming year.

BROOM

Building Restoration Operations Optimization Model

- A decision support tool to collect, manage, and analyze sample data
  - Secure SQL database
  - GIS mapping
  - Geostatistical analysis tools
  - Uncertainty analysis
  - Sampling Design
  - Interfaces with VSP for statistical sampling design
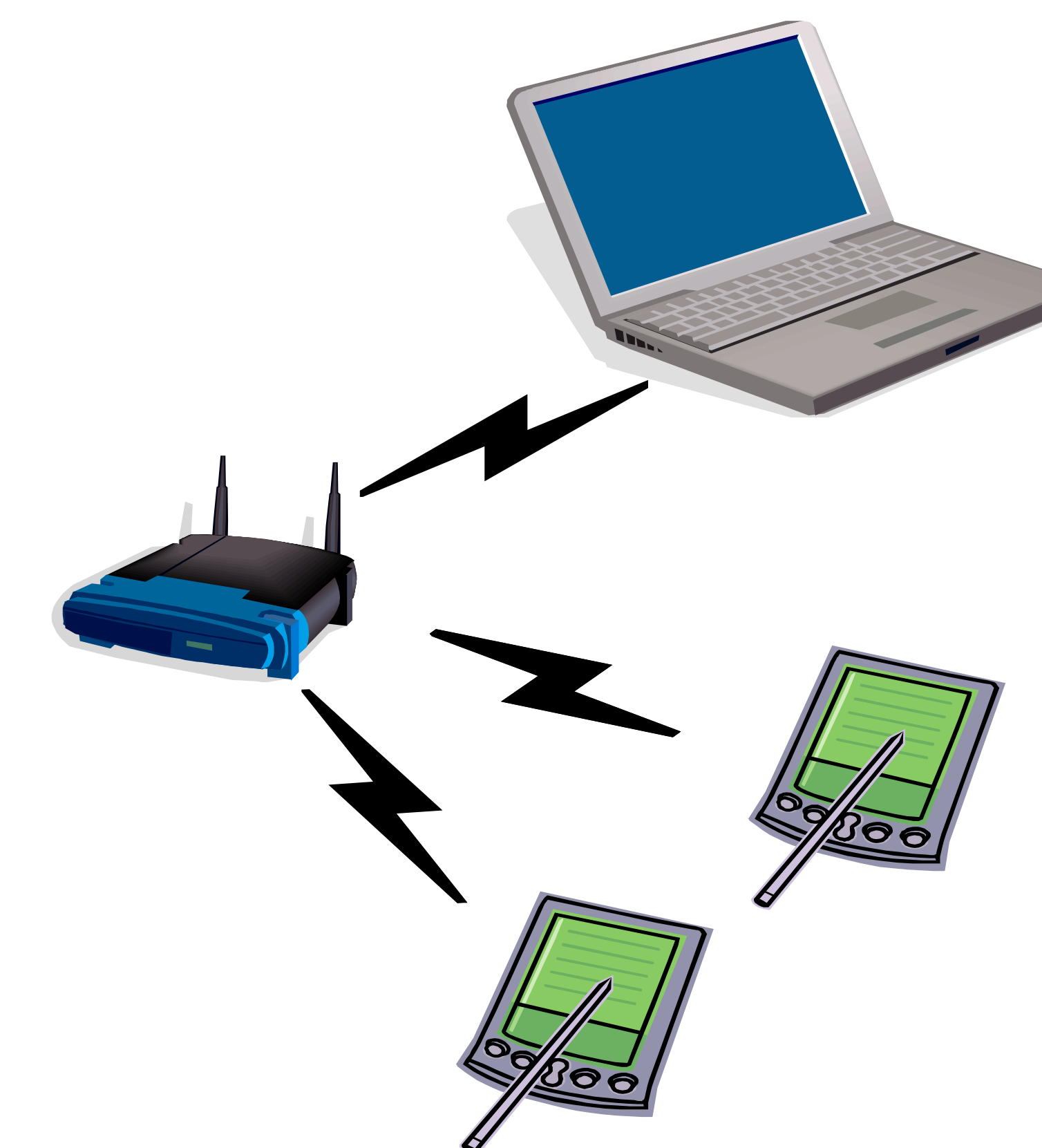
- Data collection
  - Hand-held wireless PDAs with barcode readers and laser rangefinders
  - Paperless data transfer
  - Secure transmission of data
  - Chain of custody
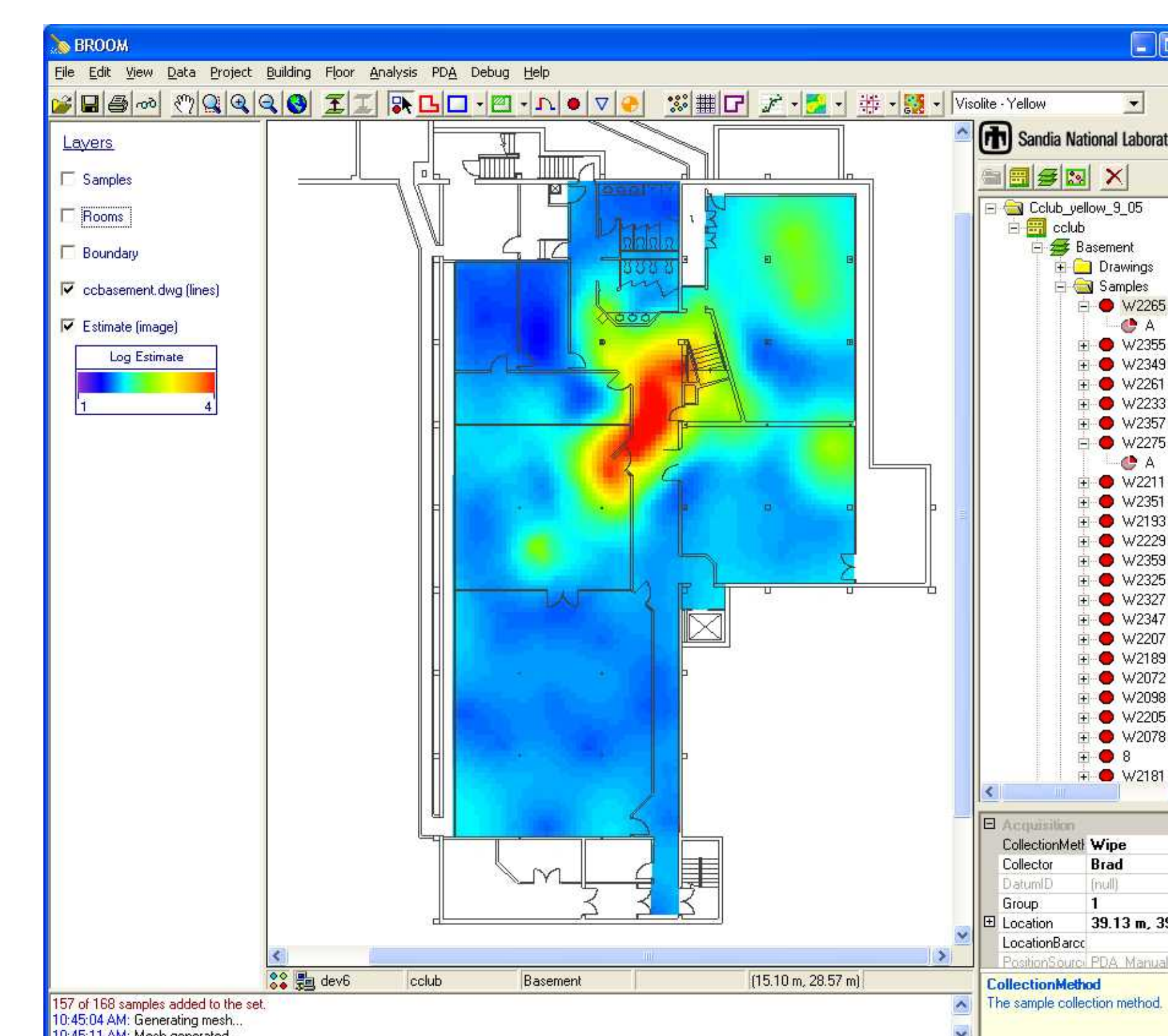
Mapping Contamination

3-D Visualization