Incremental Sampling Methodology (ISM) at Polychlorinated Biphenyl (PCB) Cleanup Sites

Incremental Sampling Methodology (ISM) is a method used in the environmental field for taking samples of potentially contaminated soils for chemical analysis in a way that allows accurate characterization of contamination in soils at a site.

Introduction to ISM

ISM has been shown to be a valid and effective method for determining, with a higher degree of confidence, the concentrations of contaminants, including PCBs, in heterogeneous soils, as long as the site-specific use of the methodology is designed and implemented appropriately (Interstate Technology & Regulatory Council, Incremental Sampling Methodology Team, 2012). ISM provides representative samples through collection of numerous increments of soil that are combined, processed, and subsampled according to specific procedures in order to reduce the deleterious effects that soil heterogeneity has on environmental data.

To achieve the goal of reducing the potential effects of soil heterogeneity on sampling accuracy, the use of ISM at a site must be carefully planned. Specifically, Decision Units (DUs) must be defined appropriately to ensure applicable cleanup levels are met. This is accomplished by taking into account the site history and characteristics in developing a conceptual site model that identifies potential locations of PCBs at the site, considering factors such as PCB releases and PCB transport (e.g., leaching, material disturbance/movement). Laboratory processing and subsampling must also be conducted appropriately to reduce heterogeneity within the collected samples. Verification procedures, such as replicate sampling/subsampling, may be required to confirm that DUs have been defined appropriately, field and within-sample heterogeneity have been sufficiently managed, and data quality objectives are met.

Use of ISM at Toxic Substances Control Act (TSCA) PCB Cleanup Sites

Under the TSCA PCB cleanup regulations of 40 CFR Part 761, EPA will review and, as appropriate, approve site-specific applications to use ISM at PCB-contaminated sites under only 40 CFR 761.61(c), which provides for risk-based approval of alternate cleanup and disposal methods. As part of EPA's review of the application, EPA will evaluate the proposed ISM design to determine if its implementation will result in (1) accurate characterization of PCBs and/or verification of the PCB cleanup, and (2) accurate information for evaluation of human exposure to PCBs and other potential risks. The proposed application of ISM must be designed and implemented appropriately for the specific characteristics of the site. DUs must be defined appropriately to ensure that the concentration of PCBs in the soil is properly characterized and data quality objectives are defined and met. Sufficient information must be provided in the application so that EPA is able to evaluate the proposed site-specific ISM design and make a no unreasonable risk determination under 40 CFR 761.61(c).

While ISM is a reliable sampling technique that can be used at PCB cleanup sites, it may not be the most appropriate sampling technique for a specific site. For example, a discrete sampling method may be determined to be more appropriate for a site based on the characteristics of that particular site.

Note that more research is needed before EPA can determine whether ISM can be used effectively at sediment sites contaminated with PCBs.

What is ISM?

ISM, also referred to as Multi-Increment® Sampling (MIS)[1], is a suite of planning, sampling, sample preparation, and subsampling techniques that addresses heterogeneous soil contamination, increases sample representativeness, and reduces data variability. ISM provides representative samples using a specific planning and sampling technique where numerous increments of soil are collected from a DU and are combined, processed, and subsampled according to specific procedures (Figure 1). As an example, approximately 75 increments might be collected for a DU potentially containing PCBs, or possibly as many as 200 might be required in a case of extreme soil heterogeneity. Verification procedures, such as field and/or lab replicates, are then applied to ensure that the DUs have been appropriately sampled. The goal of ISM is to reduce the deleterious effects that soil heterogeneity has on environmental data. Soil is very heterogeneous, which is a particular concern when measuring PCB contamination because the chemical properties of PCBs lead to preferential adsorption onto certain soil components. Significant sampling error is introduced when sample methods do not account for potentially dramatic spatial variations in concentration.

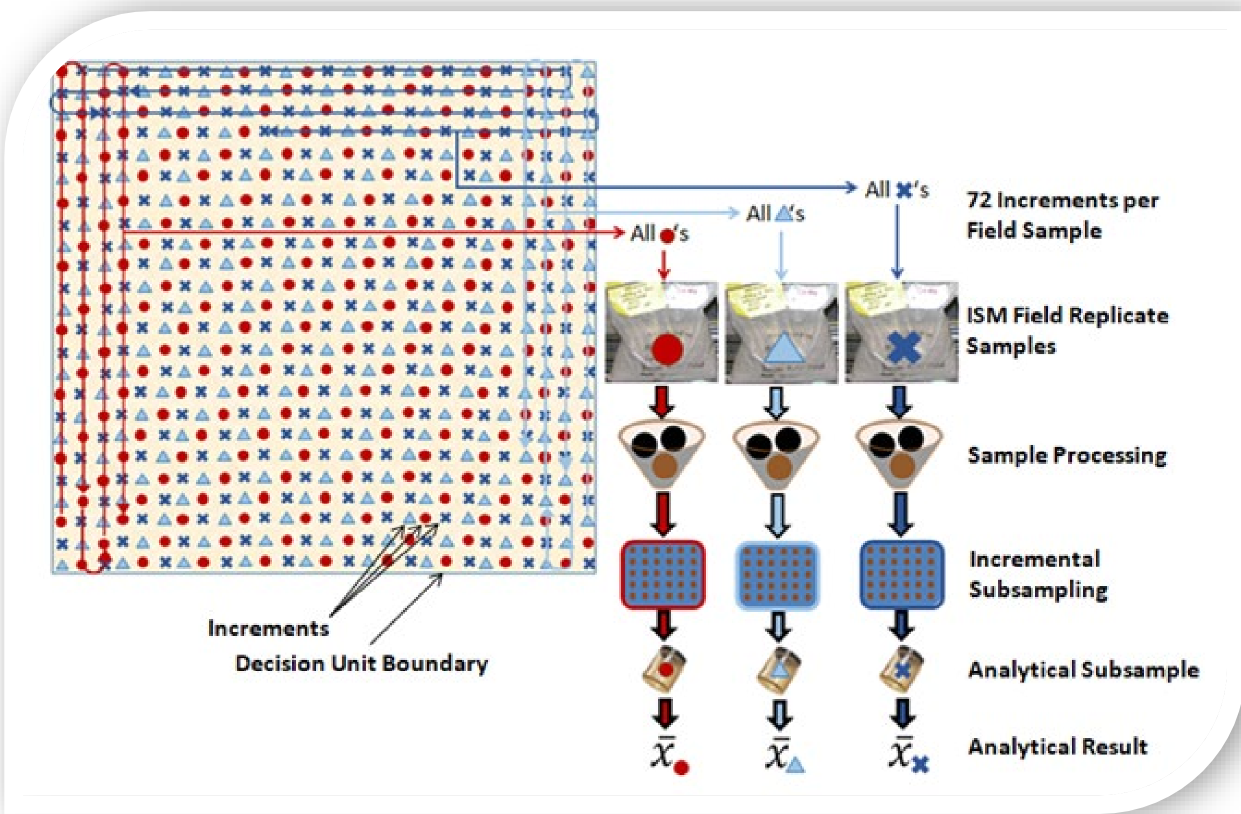

Figure 1: This figure shows the process of collecting increments of soil that are combined, processed, and subsampled according to specific procedures in order to produce a representative sample for a DU. Credit: Adapted from The Interstate Technology& Regulatory Council, Incremental Sampling Methodology Team, 2012.

[1] MULTI INCREMENT® is a registered trademark of EnviroStat, Inc.

An “ISM sample” is a sample created by pooling the many soil increments collected from a designated volume of soil. In this way, soil heterogeneity is managed so the ISM sample represents the true concentration of the area and volume of soil that is treated as a single unit during the decision-making process. This volume of soil is called a Decision Unit (DU). All decisions made and actions taken are made on a DU basis.

ISM DUs are created based on site-specific conceptual site models, project-specific needs, site history, and site-specific data quality objectives. DUs represent the smallest volume of soil about which a decision is to be made. DUs may be as small as the 1.5 x 1.5-meter grid that is specified in the TSCA PCB regulations, although experience has often shown this to be smaller than appropriately defined DUs for assessment of PCB contamination. DUs may be defined in regularly spaced and equal volumes in established exposure areas, or they may be based on irregular features of the site which define contaminant transport or receptor exposure. DUs may take into account an understanding of contaminant distributions and geological considerations, for example, in and around source areas. Overall, DUs must be defined appropriately to ensure that the concentration of PCBs in the soil is properly characterized and data quality objectives are defined and met.

For more information on ISM and DUs see guidance developed by The Interstate Technology & Regulatory Council (ITRC) at www.itrcweb.org/ism-1/.

How was incremental sampling developed?

A package of sampling procedures to control soil heterogeneity developed and researched by the U.S. Army Corps of Engineers (USACE) Cold Regions Research and Engineering Laboratory (CRREL) in the 1990s was called “Multi-Increment® Sampling (MIS).” CRREL’s work was adapted from the sampling theory developed by Pierre Gy for the mining industry. It was initially applied to improving data reliability for characterizing TNT and other explosives compounds in soil on military bases. After extensive testing and experimentation, CRREL’s procedures were included in the 2006 update of EPA’s SW-846 method for analyzing soil for explosives residues. Application of Gy’s sampling theory to the measurement of soil contamination was also recommended in three earlier documents issued by EPA, including the RCRA Waste Sampling Technical Guidance (EPA, 1999; EPA, 2002; EPA, 2003).

More recently, several EPA regions and state agencies began testing MIS procedures at non-military cleanup sites for other analytes, such as metals, dioxin, and VOCs. In particular, the Hawaii Department of Health (DOH) conducted extensive field testing of MIS procedures for a variety of organic and inorganic contaminants. Based on their research and a wide range of site experience, the Hawaii DOH produced extensive training materials and guidance for using incremental sampling for surface and subsurface sampling. In 2009, the Interstate Technology and Regulatory Council (ITRC) convened a team to formally evaluate MIS, practitioner experiences and the then-current state of the practice. In 2012, ITRC produced an extensive on-line technical document discussing the theory and practice of MIS, but under the acronym “ISM” (Incremental Sampling Methodology) because the “MIS” terminology had been trademarked. Concurrent with ITRC’s work, EPA’s Superfund program issued guidance for using ISM to characterize dioxin sites. Furthermore, ITRC is in the process updating their

ISM guidance by improving the practical implementation of ISM-type sample collection and analysis, and incorporating experience gained since 2012 (https://www.itrcweb.org/Team/).

Additional Resources

CalEPA. 2013. *Incremental Sampling: Challenges and Opportunities for Environmental Forensics*.
This article was developed by CalEPA and presents an introduction to incremental sampling. It discusses the opportunities for, and challenges of, ISM. The article was published by Paul W. Hadley and Ioana G. Petrisor in *Environmental Forensics, Vol 14*, pp 109-120.

Hawai'i DOH. Interim Final 2016. *Technical Guidance Manual for the Implementation of the Hawai'i State Contingency Plan.*
The state of Hawaii encourages the use of ISM in the investigation of contaminated soils and has developed this guide for designing, collecting, and processing ISM samples.
http://www.hawaiidoh.org/tgm.aspx?p=0402a.aspx

ITRC. 2012. *Incremental Sampling Methodology*.
The Interstate Technology & Regulatory Council (ITRC) developed guidance on developing a decision unit, and provides instructions on the technical how-to for ISM sample processing, subsampling, and calculations.
www.itrcweb.org/ism-1/

USEPA. 1999. *Correct Sampling Using the Theories of Pierre Gy*. Office of Research and Development.
This Technical Support Project document, issued by EPA's Office of Research and Development, discusses the types of sampling-related errors that occur for solid materials such as soil. This document explains how application of Gy sampling and subsampling methods can produce data that better represent site-related decisions.
https://www.itrcweb.org/ism-1/references/csutpg.pdf

USEPA. 2002. *RCRA Waste Sampling Draft Technical Guidance*. EPA530-D-02-002. Office of Solid Waste.
See Section 6: Controlling Variability and Bias in Sampling. This RCRA document presents an easily understandable explanation of sampling and subsampling errors and mechanisms to address them.
https://www.epa.gov/sites/production/files/2015-10/documents/rwsdtg_0.pdf

USEPA. 2003. *Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples.* EPA/600/R-03/027. Office of Research and Development.
This document reports the results of experiments performed by EPA's ORD to test the ability of a variety of subsampling techniques to produce a representative subsample, and thus representative data results.
https://itrcweb.org/ism-1/references/guidancerl.pdf

USEPA. 2011. *User Guide - Uniform Federal Policy Quality Assurance Project Plan for Soils Assessment of Dioxin Sites*.

USEPA's Superfund program developed an ISM guidance for dioxin sites. Also see, Template - User Guide Uniform Federal Policy Quality Assurance Project Plan Template for Soils Assessment of Dioxin Sites.
www.epa.gov/superfund/site-evaluation-dioxin-superfund-sites