Sample This? Asbestos in Soil

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Introductory Discussion

The "Framework" Document: The Technical Review Workgroup for Asbestos, a national U.S. Environmental Protection Agency committee within the Superfund program, developed a decision framework for assessing Asbestos releases at Superfund sites. The principles presented in the framework may be applicable to some Brownfields sites. Addressing Asbestos in building demolition is a subject already covered well by federal, State, and sometimes local regulations which serve to minimize Asbestos releases and protect workers. The decision framework does not address this subject. However, Brownfields sites may instead be faced with legacy Asbestos contamination from a release that already occurred. In this situation, the decision framework provides guidance and tools for site assessment from a human health perspective, so that decisions can be made about what clean-up is needed. The complete "framework" document can be found at: http://www.epa.gov/superfund/health/contaminants/asbestos/pdfs/framework_asbestos_guidance.pdf. A thorough reading of the entire document is necessary to properly apply the framework principles summarized in the flow chart.

Activity-Based Sampling: For many chemicals, there is an established screening or clean-up level. Asbestos is unique in that the screening or clean-up level is best determined on a site-specific basis. Also, the level of interest is based upon air rather than soil. Asbestos levels in Soil, while useful for site characterization, cannot be used directly for risk assessment. Additionally, the levels that are monitored in ambient air may be a poor indicator of exposure and are not preferred for risk assessment. The framework discusses Activity-Based Sampling (ABS), which is the measurement of breathing zone levels for a person who is engaged in an activity that may release fibers from the soil. While similar in concept to worker monitoring approaches, ABS differs in the analytical methods used and in how decisions are made from the data. ABS is the preferred method for risk assessment purposes. ABS is conducted by trained personnel in Personal Protective Equipment (PPE) to prevent their actually being exposed during the sample collection. The activities can be of a generic nature such as raking or of a site-specific nature such as playing baseball. Site-specific activities are usually preferred, when such can be identified based upon intended use of the property.

Analytical Methods: The framework recommends the use of Transmission Electron Microscopy (TEM) as the analytical method of choice. Specifically, the fairly complex structure counting and recording scheme in the ISO 10312 method is recommended. Since existing toxicity information is based primarily upon Phase Contract Microscopy (PCM), only the structures that fall into a PCM-equivalent size category are used for risk assessment. (Actually using PCM as a substitute for PCMe by TEM is not recommended). PCM has limitations in an environmental setting, such as being unable to distinguish Asbestos fibers from other fibers.

Risk Assessment: The framework provides guidance on risk calculations, such as consideration of time weighting factors for different activities and variations on the toxicity value based on expected age of first exposure and expected number of years of exposure. Currently the framework and toxicity values are limited to the consideration of cancer risk, though Asbestos also presents non-cancer risk. Until non-cancer toxicity values are finalized, the assessment of cancer risk only should be recognized as an uncertainty in the risk assessment. This uncertainty may be considered when making a clean-up decision.

Note on the Case Study: While this Brownfields Conference session and the case study to follow focus on the usefulness of soil data in site characterization, particularly where there is buried material, the final clearance of the remediated site in the case study did rest on Activity-Based Sampling. It is important to keep in mind the need for Activity-Based Sampling in making risk assessment and clean-up level calculations. Activity-Based Sampling bridges the gap between what is present in the soil and what is released into the breathing zone for exposure. In general, field decisions vary from site to site, and the approaches applied for GAO 144, while very successful for that site, may not be the best approach for every situation.

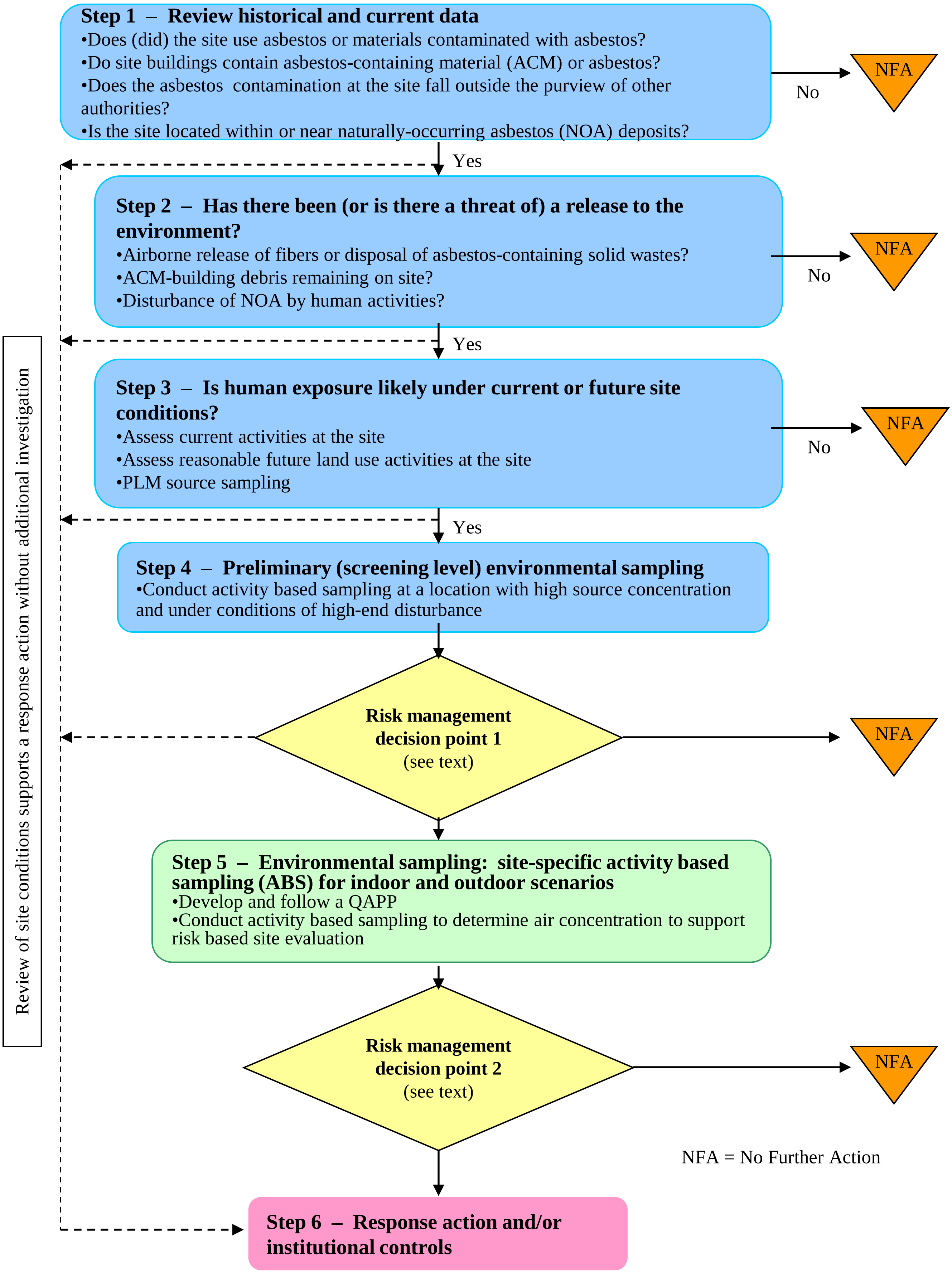
Note on Presentation on Incremental Sampling Methodology: The presentation "Soil Sampling Techniques and Application" was co-authored by another member of the Asbestos Technical Review Workgroup, Tim Frederick. This presentation is included as an additional reference on a soil sampling approach that may be applicable to Asbestos in soil.

Important Note:

- **These presentation materials provided for the Brownfields Conference 2013 represent my views as a member of the Asbestos Technical Review Workgroup and as a regional scientist.**

- **These presentation materials do not constitute official agency guidance or policy.**

Recommended Asbestos Site Assessment Framework



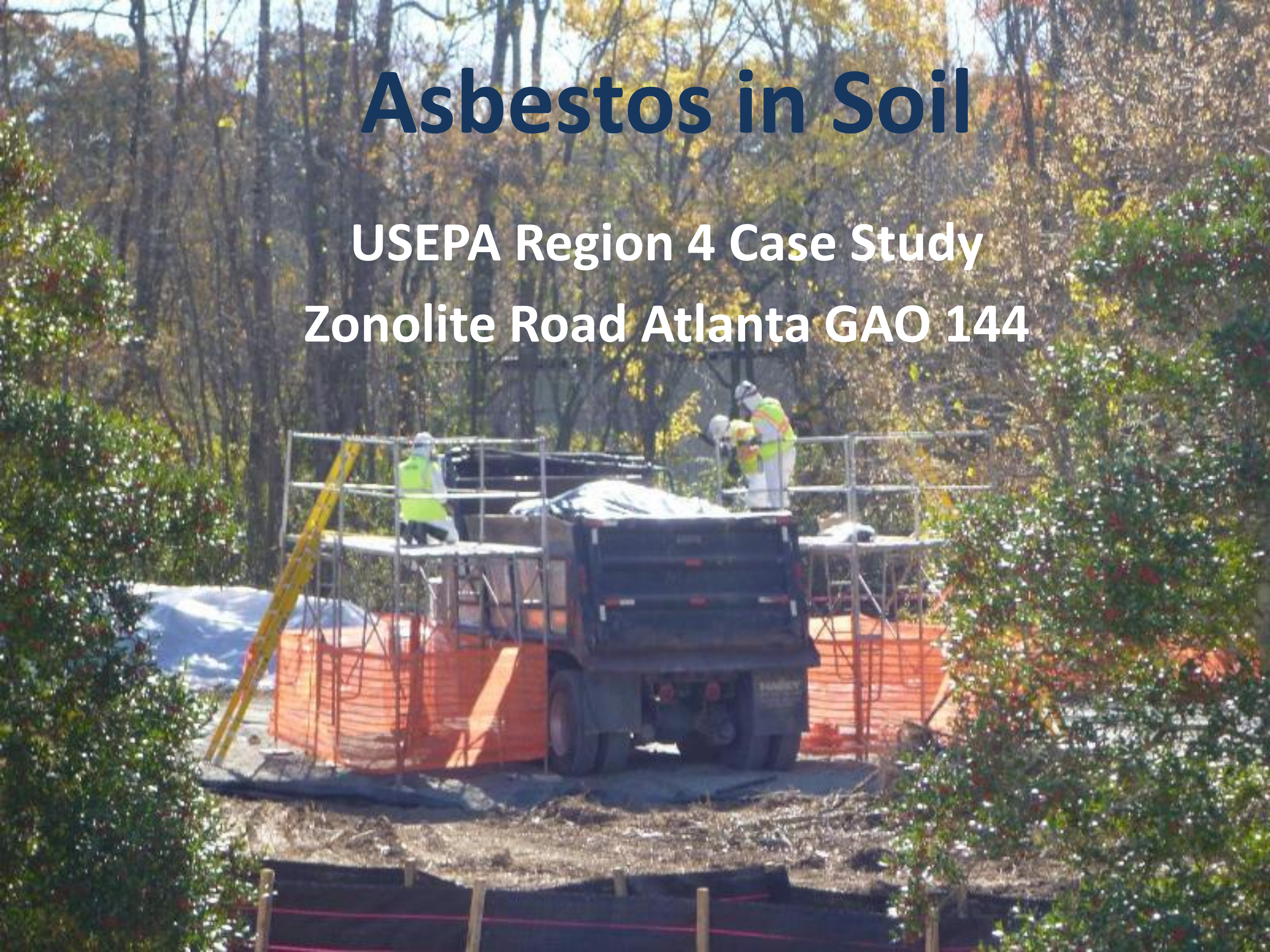
Note of Caution on “Recommended Asbestos Site Assessment Framework” Flow Chart:

The complete “framework” document can be found at: **http://www.epa.gov/superfund/health/contaminants/asbestos/pdfs/framework_asbestos_guidance.pdf**.

A thorough reading of the entire document is necessary to properly apply the framework principles summarized in the flow chart.

Asbestos in Soil

USEPA Region 4 Case Study
Zonolite Road Atlanta GAO 144

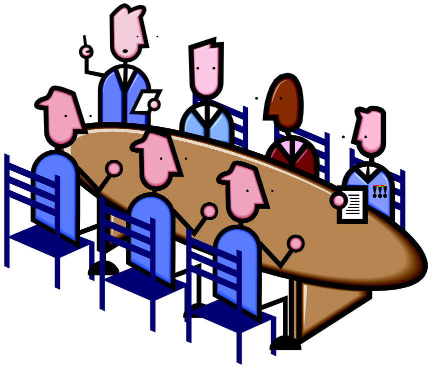


The story begins….in Montana

- November 1999: Concerns arise about asbestos-contaminated vermiculite from a former mine; USEPA investigates
- July 2000: Investigation expands throughout the country to facilities that may have received material from the mine
- Assessment tools are limited

The story continues….in D.C.

- August 2004: USEPA Directive clarifies that 1 percent Asbestos is not a risk assessment level
- April 2005: Technical Review Workgroup (TRW) for Asbestos forms to develop assessment tools



- September 2008: USEPA Directive presents TRW's final "Framework" document
- October 2008: USEPA Headquarters provides a vermiculite site re-assessment strategy to the Regions

Meanwhile….in Atlanta

- The site of a former vermiculite company is mostly owned by Dekalb County, Georgia

- The scenic property is used for recreation and is mostly wooded with trails

- USEPA Region 4 has not yet identified any concerns for this property

2009: Re-assessment begins in Region 4

- Of 105 vermiculite exfoliation sites listed across the 10 Regions, 22 are in the southeast (USEPA Region 4)

- Most require sampling, which involves:
  - source sampling, such as vermiculite and soil
  - activity-based air sampling (ABS)
  - stationery air monitors (to monitor perimeters)

Zonolite Road Atlanta GAO 144

- March-April 2010: Region 4 decides to sample the Atlanta site
- Neither the air results nor the soil results are very dramatic
- The results do confirm presence of Asbestos and the need for further study

GAO=Government Accountability Office

GAO 144 Soil Sampling

- October – December 2010: Technical Review Workgroup visits the site and observes subsurface vermiculite in the “plateau area”; EPA Region 4 visually confirms with test pits and further confirms with soil samples

GAO 144 Clean-up Activities

- Action Memorandum is signed in April 2011 and W.R. Grace and Co. enters into a voluntary agreement with USEPA Region 4 to perform the clean-up
- After a time of work plan development, the Removal begins in October 2011 and lasts about five months

Monitoring during the clean-up

- OSHA required monitoring throughout event for workers and perimeter

- Important not to confuse OSHA monitoring with Activity-Based Sampling for exposure assessment under the framework

Monitoring during the clean-up

- Soil samples used for screening only
- Excavation surface tested until non-detect at 0.25%
- 0.25% was the detection level available and is not a risk-based number
- Visual observation for vermiculite

Issues with Soil Analysis

- Split samples between two laboratories differed in both <u>type</u> and <u>amount</u> of Asbestos reported using Polarized Light Microscopy (PLM)
- Both laboratories are accredited, have been reviewed on-site by USEPA, and generally have good quality systems
- Difficult to obtain reliable and reproducible results for Asbestos in Soil with usual bulk material analysis methods

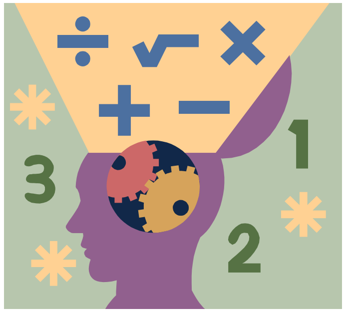
Calculating Asbestos Risk

- Equation for estimating cancer risks from inhalation to asbestos is: **ELCR = EPC x IUR x TWF**

  Where:

  - ELCR = Excess Lifetime Cancer Risk (the risk of developing cancer as a consequence of the site-related exposure).
  - EPC = Exposure Point Concentration (f/cc). ← Air Units!
  - IUR = Inhalation Unit Risk (f/cc)-1.
  - TWF = Time Weighting Factor (unit-less), this factor accounts for less-than-continuous exposure during a 1-year exposure

- Non-cancer toxicity value is still under development and is not addressed in the framework



Calculating Asbestos Clean-up Goals

ELCR = EPC x IUR x TWF, so re-arranging the formula:

ELCR Goal/(IUR x TWF) = EPC Goal (Clean-up Goal)

- Considering the site scenario, select appropriate values for the following:
  - ELCR Goal (Excess Lifetime Cancer Risk)
  - IUR (Inhalation Unit Risk)
  - TWF (Time Weighting Factor)

Site-specific Values for GAO 144

- Step 1: Select the scenario/activity that will be used to calculate the clean-up goal
  - More than one scenario may be calculated for comparison
  - Clean-up goal selected should reflect an intended use of the site, but should represent the highest exposure activity at the site
  - Three site-specific scenarios were calculated and the <u>gardening</u> scenario, represented by raking activity, was used for the final clean-up goal

- Step 2: Select the target ELCR
  - Acceptable range is 1 in 10,000 (10^{-4}) to 1 in 1,000,000 (10^{-6})
  - Selected 10^{-4} as the number that must be met

Site-specific Values for GAO 144

- Step 3: Select the IUR that best applies to the scenario from Table 2 of the "Framework"
  - Lifetime Inhalation Unit Risk or a Less-than-Lifetime Unit Risk (considers age at first exposure; duration of exposure)
  - Selected 0.075 $(f/cc)^{-1}$ (Age 20 at first exposure; 30 years duration of exposure)

- Step 4: Select an appropriate TWF
  - For gardening, 10 hours/day for 50 days/year
  - TWF = 10/24 hours x 50/365 days = 0.057 ≈ 0.06

Calculate the Allowed Exposure Point Concentration (Clean-up Goal)

ELCR Goal/(IUR x TWF) =
EPC Goal (Clean-up Goal)

$$10^{-4}/(0.075\ (f/cc)^{-1} \times 0.06) \approx 0.02\ f/cc$$

CAUTION: This clean-up goal of 0.02 f/cc is site-specific for the Zonolite Road Atlanta GAO 144 site and cannot be applied directly to other sites. Each site must calculate a site-specific clean-up goal based on site-specific information and assumptions. The calculated goal may be well below this value for some sites.

Confirmation Sampling

- Activity-Based Sampling was used for final decision
- ABS conducted within excavation area and on building slab
- ABS results were compared to the site-specific clean-up goal calculated by risk assessor

GAO 144 Removal Completed

- 1,857 truckloads of material were excavated and removed from the site
- 26,064 tons of material were removed
- Over $2 million dollars were spent

Summary of Approach

- **Soil Results**
  - **Used to locate and characterize buried material**
  - **Drove the decision for clean-up in this case**
  - **Used to guide excavation progress**
- **Air Results (Activity-Based Sampling personal monitors)**
  - **Used for risk assessment, but in this case did not adequately capture risk from buried material**
  - **Used for quantitative decision-making to establish that the final clean-up goal was achieved**
- **Air Results (Worker personal monitors and perimeter monitors)**
  - **Used for health and safety compliance/work practice control only**
  - **Different methods and purpose from the Activity-Based Sampling**

Acknowledgements

EPA On-Scene Coordinators for Vermiculite Reassessment during 2009-present:
- Leonardo Ceron, Kevin Eichinger, Greg Harper, Terry Stilman

EPA Risk Assessor for Vermiculite Reassessment: Tim Frederick

EPA’s Contractors for GAO 144:
- Batta Environmental Associates, Inc.
- J.M. Waller Associates, Inc.
- TetraTech EM, Inc.

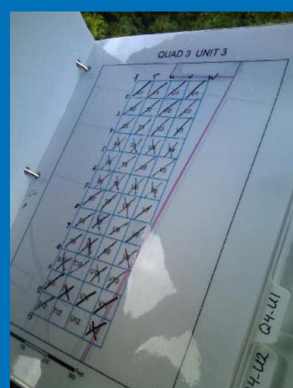
Remedium Group, Inc.’s Contractors for GAO 144:
- Materials Analytical Services, LLC
- GeoSurvey, Ltd.
- One Consulting Group, Inc.
- URS Corporation
- Winter Construction Company

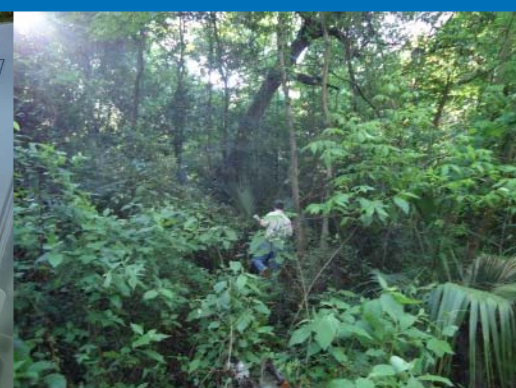
Additional Reference Material on Soil Sampling – Presentation on Incremental Sampling Methodology

United States Environmental Protection Agency

Soil Sampling Techniques and Application

Tim Frederick, Erik Spalvins, & Glenn Adams





Region 4
Atlanta, GA

February 4, 2013

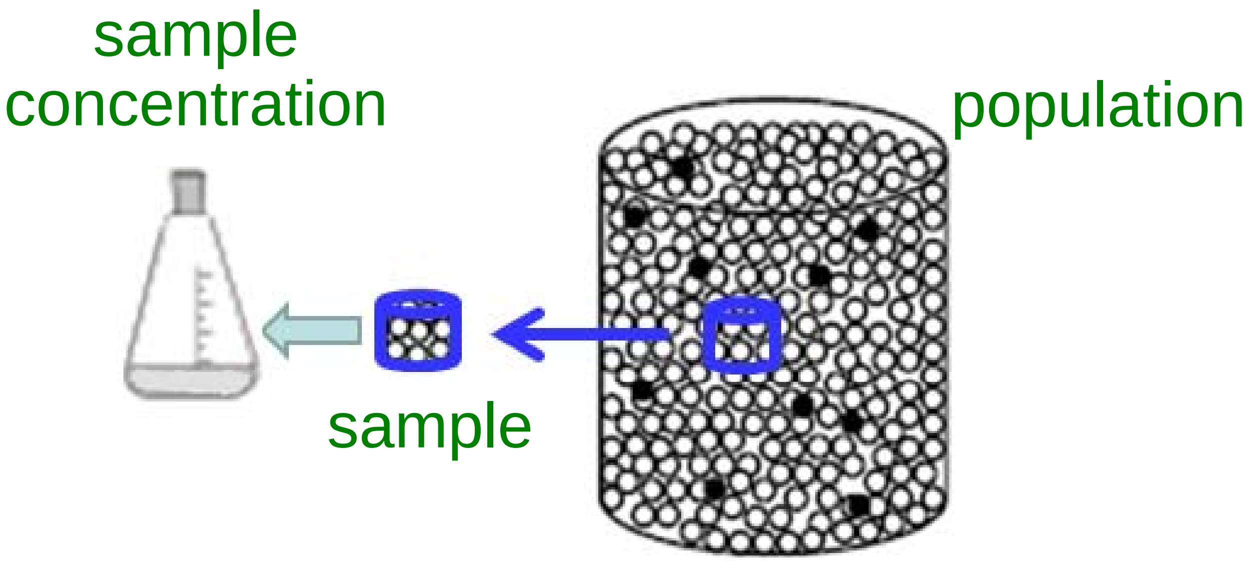
Soil Sampling Toolbox

Grab/Discrete

Composite

Incremental

Particulates and Sampling Errors



- **Sampling Error:** The proportion of particle types in the sample, especially particles laden with contaminant, do not represent the proportion present in the population

Soil Sampling Goal

representative sampling

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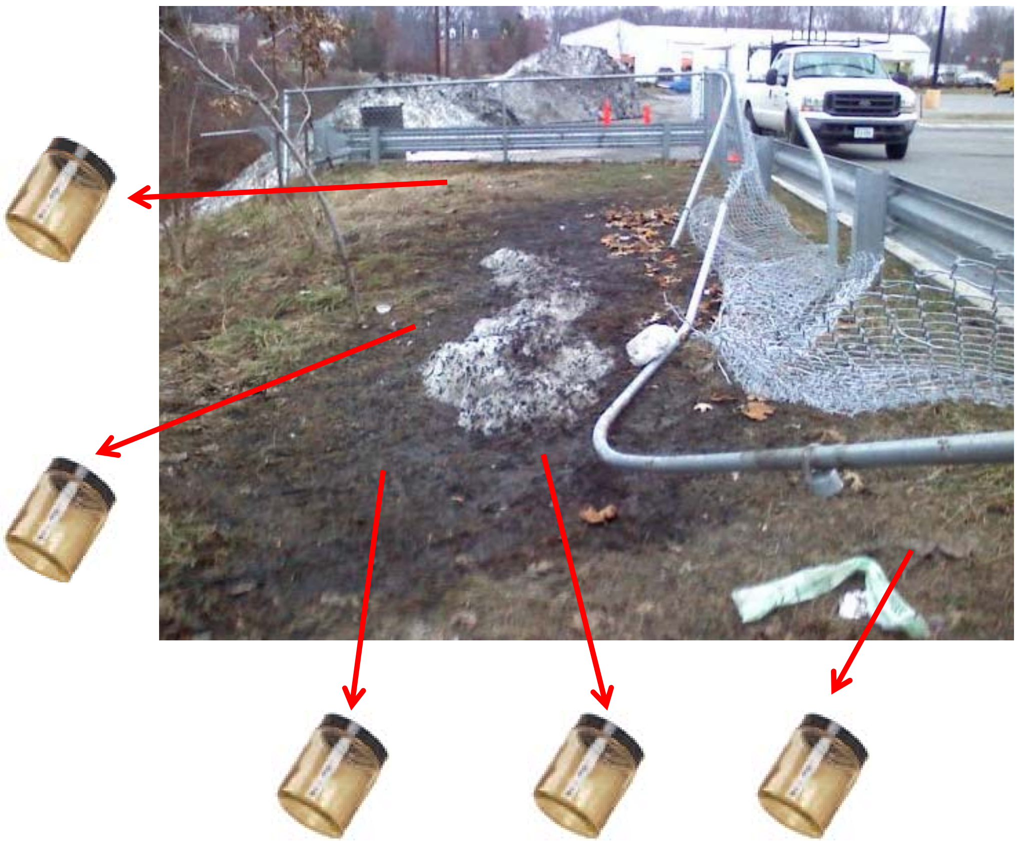
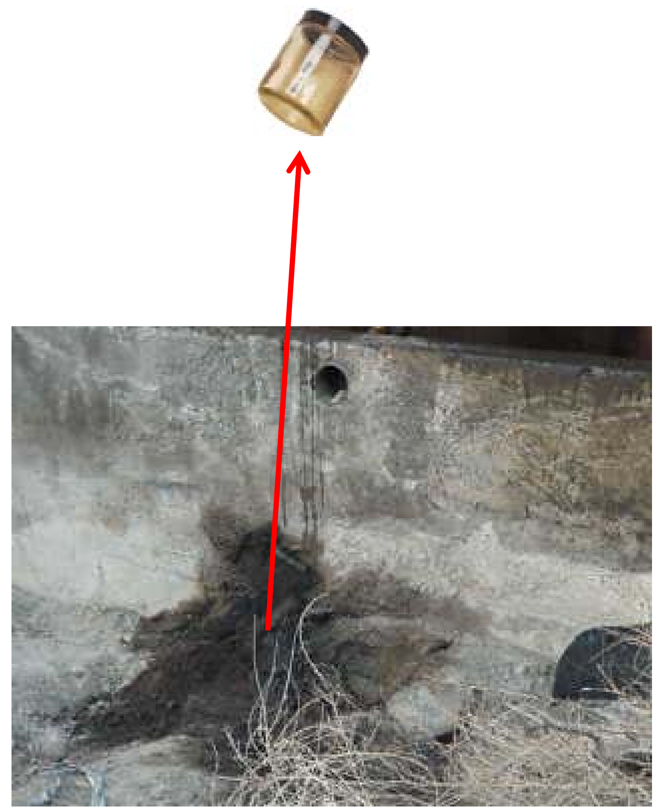
Grab/Discrete





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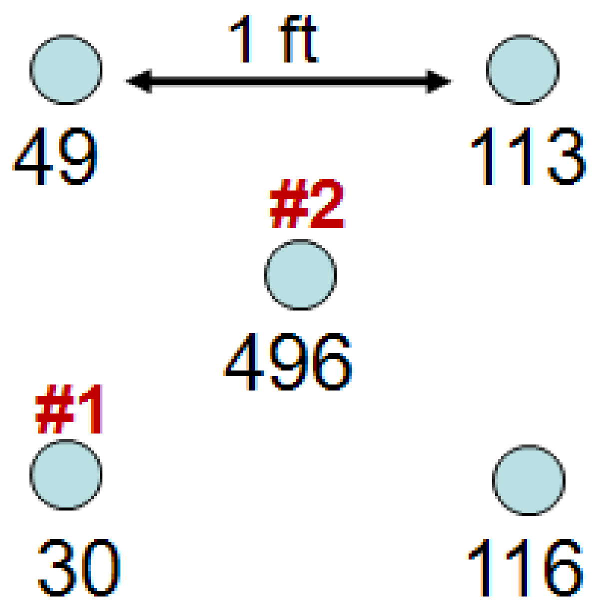
Grab/Discrete

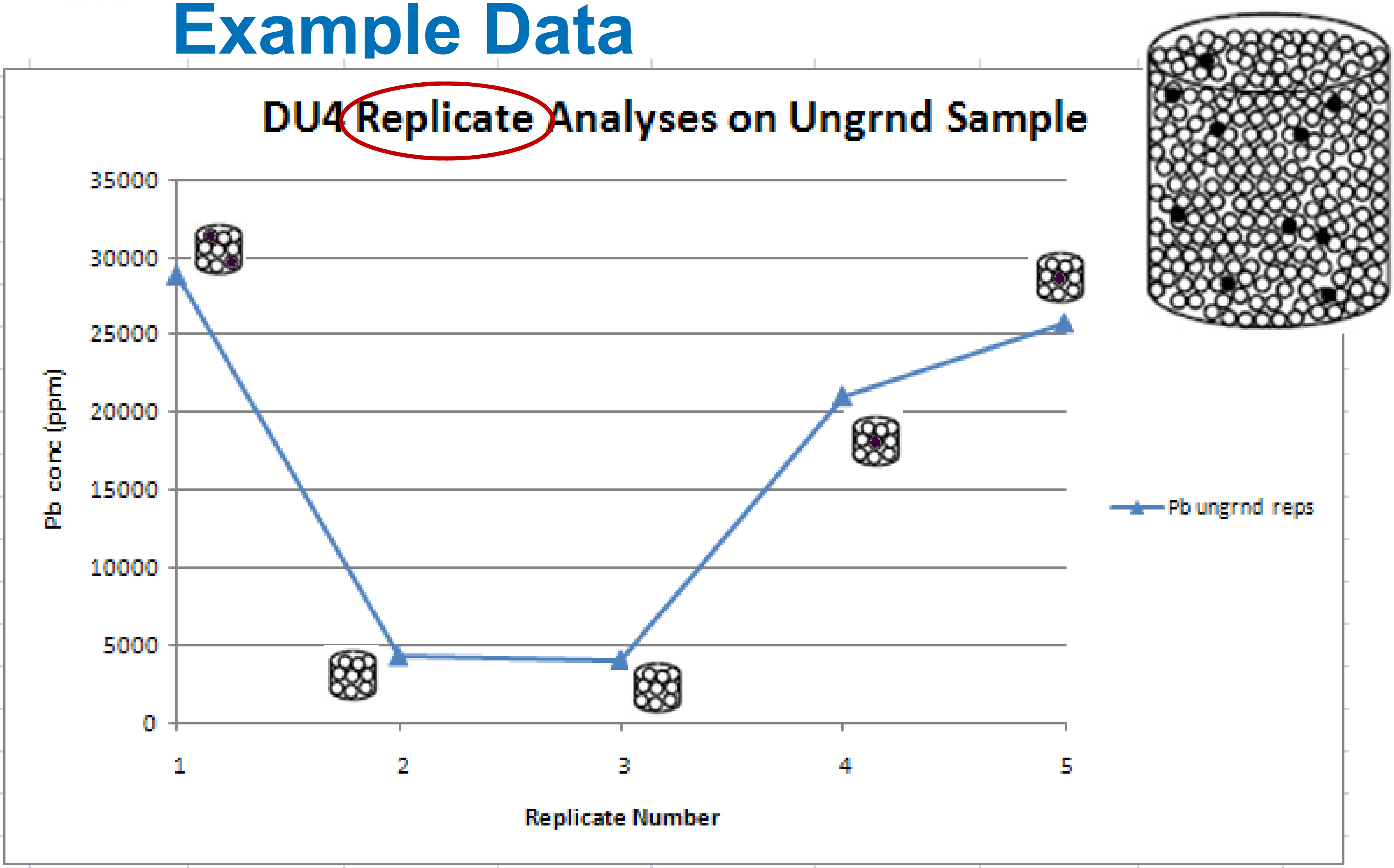
- Pros
  - Provide spatial data
  - Good for confirming what we “know”
  - Easy to collect
  - No special lab procedures
- Cons
  - Variability
  - May not be representative

Short-scale variability

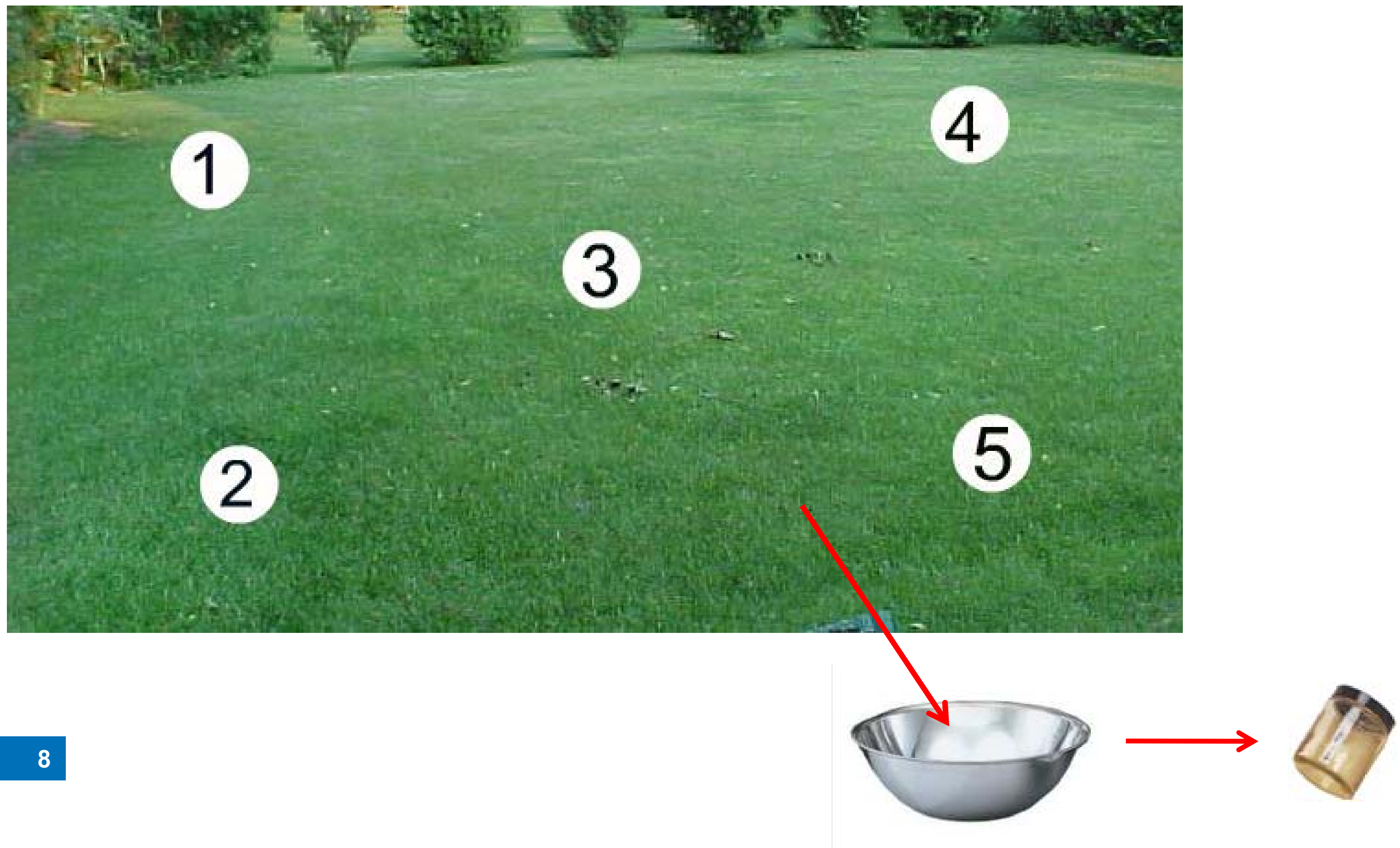


Set of co-located samples for uranium (mg/kg)

Example Data



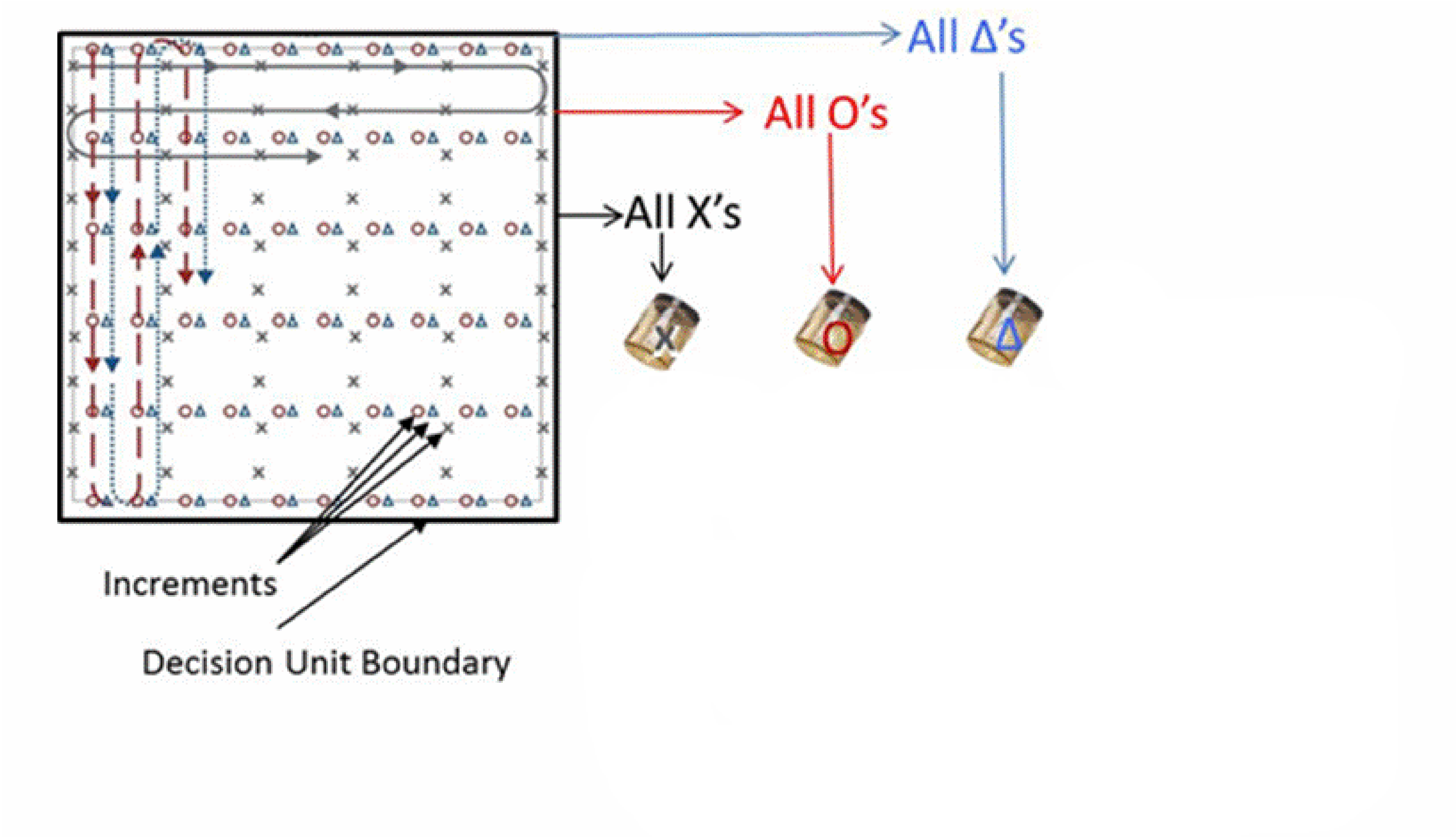
Composite Sampling



Composite Sampling

- Pros
  - Easy to collect
  - Can overcome short-scale variability
  - Provides "average" of area sampled
- Cons
  - Variability
  - Not collected in uniform way
  - Not technically comparable to discrete/grab data

Incremental Sampling



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Incremental Sampling

- Pros
  - Representative
  - Good estimate of the mean of an area
  - Controls for variability
  - May save overall lab costs
- Cons
  - No spatial data
  - Requires detailed planning
  - Labor intensive
  - Not technically comparable to discrete/grab or composite data

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What's in it for <u>you</u>?

- Fewer analyses but a more representative sample
- High quality data = more confident decision
- Potential for cost savings

Tools: Sample coring device

Increments collected across DU

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Sample Conditioning: Drying

Sieving

Unsieved Sample

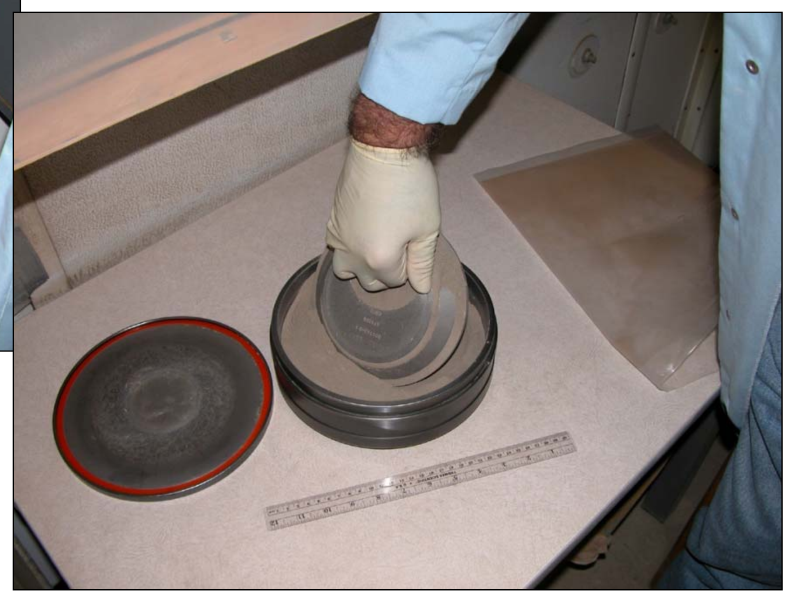
Photo credits: Deana Crumbling

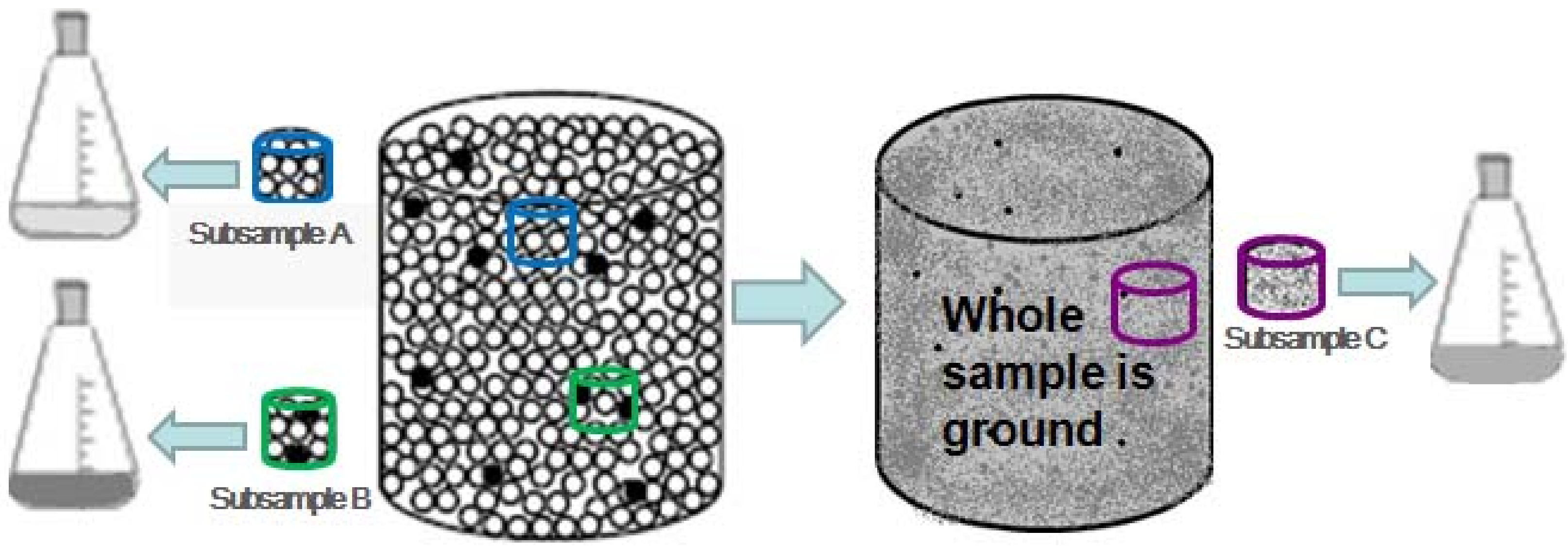
United States Environmental Protection Agency

Sieved

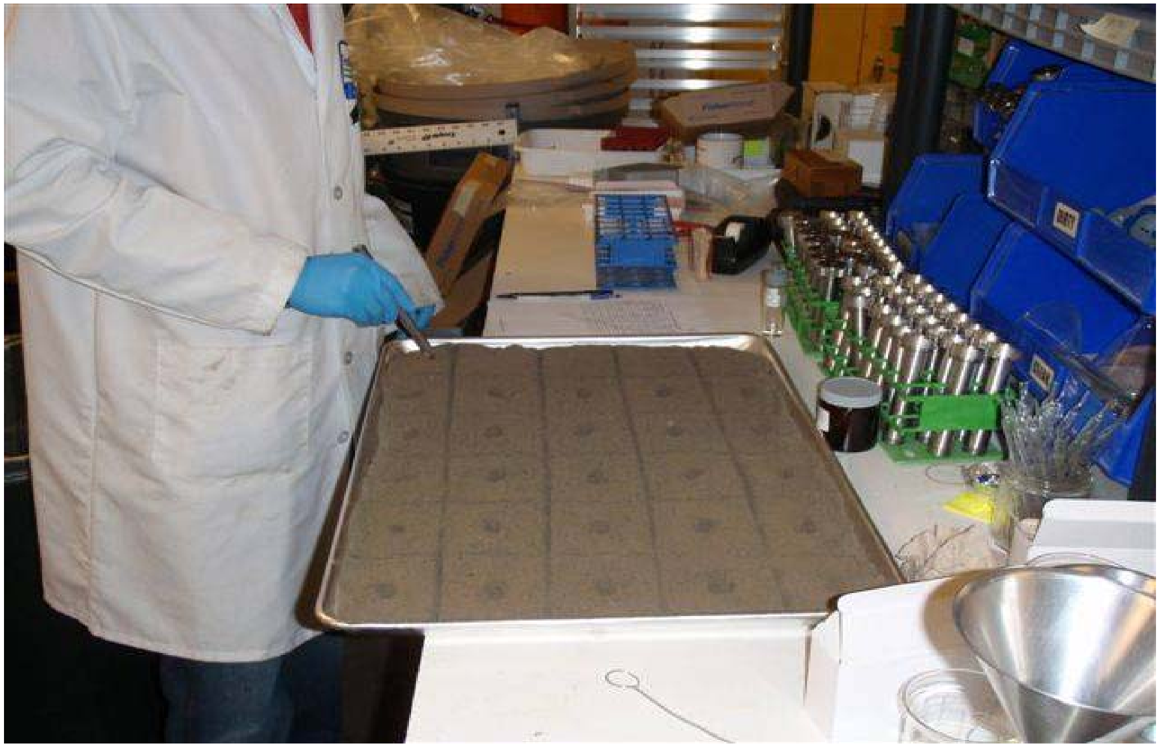
EPA United States Environmental Protection Agency

Grinding




Subsample A
Subsample B
Whole sample is ground.
Subsample C

Laboratory Subsampling



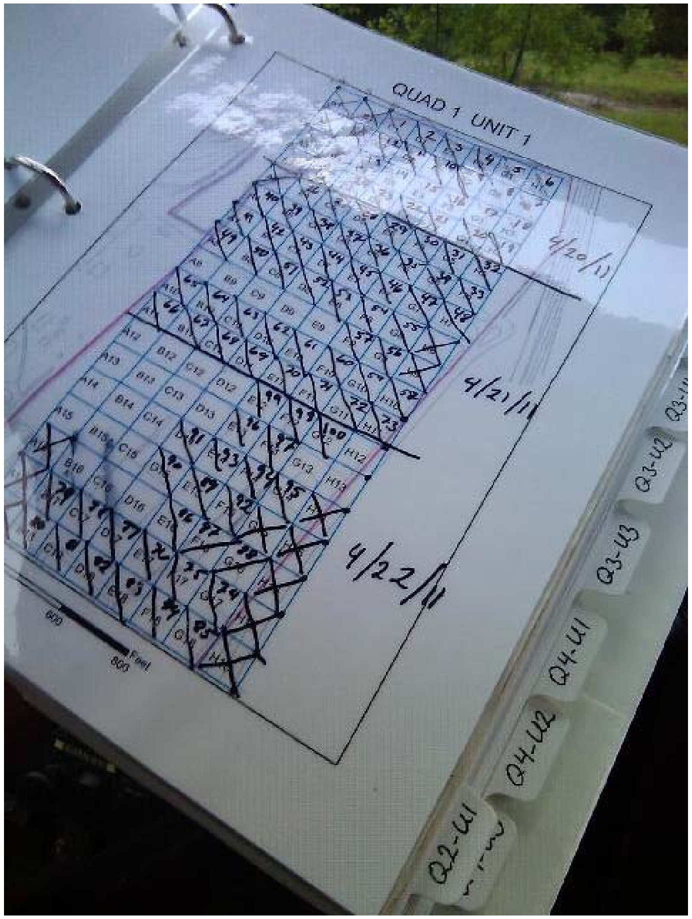
LCP Sampling Plan

- 32 acres
- 100 increments
- 3 replicates
- 2 lab duplicates
- 1 sampling unit = 1 decision unit

The Field: LCP

Eventual Sampling Method

Keeping Track



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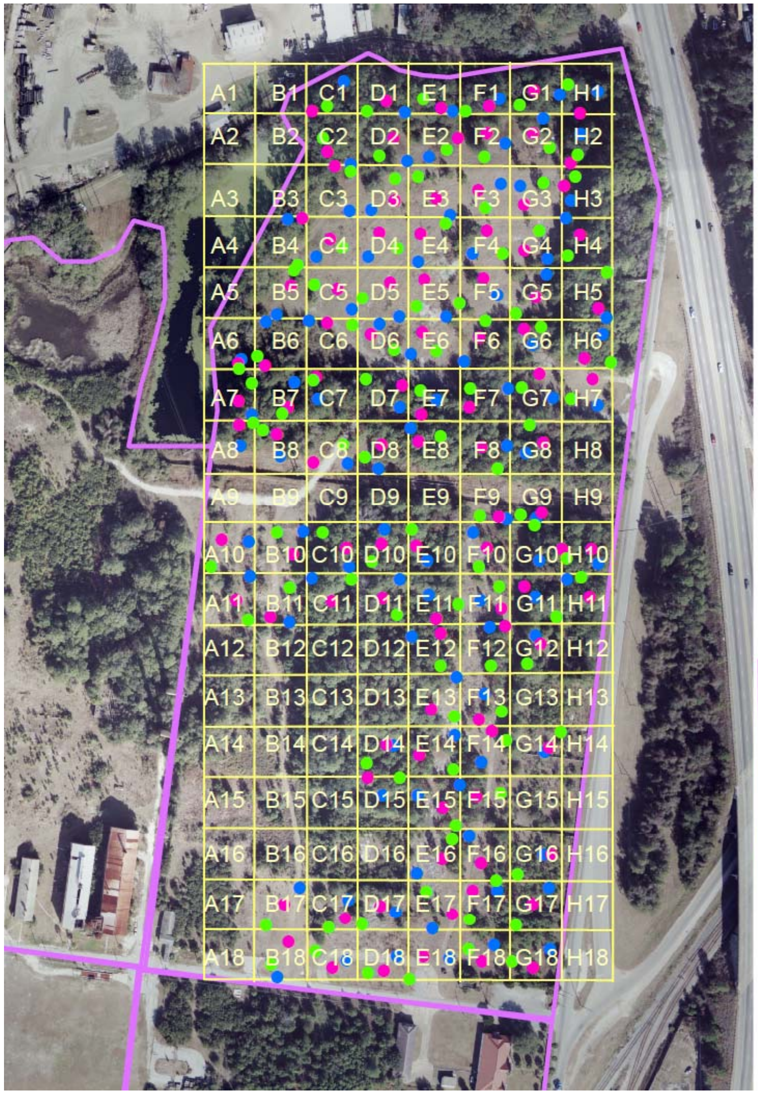
ISM Results



Results: Quadrant 1

Soil Concentrations in ng/kg

Sample ID	Dioxin TEQ (1/2 DL for ND)	Dioxin TEQ (KM Method for NDs)
Q1-U1-R1	6.3	6.4
Q1-U1-R1 (lab dup B)	5.6	5.5
Q1-U1-R1 (lab dup C)	6.6	6.9
Q1-U1-R2	5.5	5.2
Q1-U1-R3	6.3	6.3

Summary Statistics: Quadrant 1

Statistic	TEQ ½ DL (ng/kg)	TEQ KM Method (ng/kg)
Mean All	6.1	6.1
Std Deviation All	0.5	0.7
Mean Lab Dups	6.0	6.0
Std Deviation Lab Dups	0.5	0.7

*the calculated RSD for 3 replicates is 0.144 (14.4%)

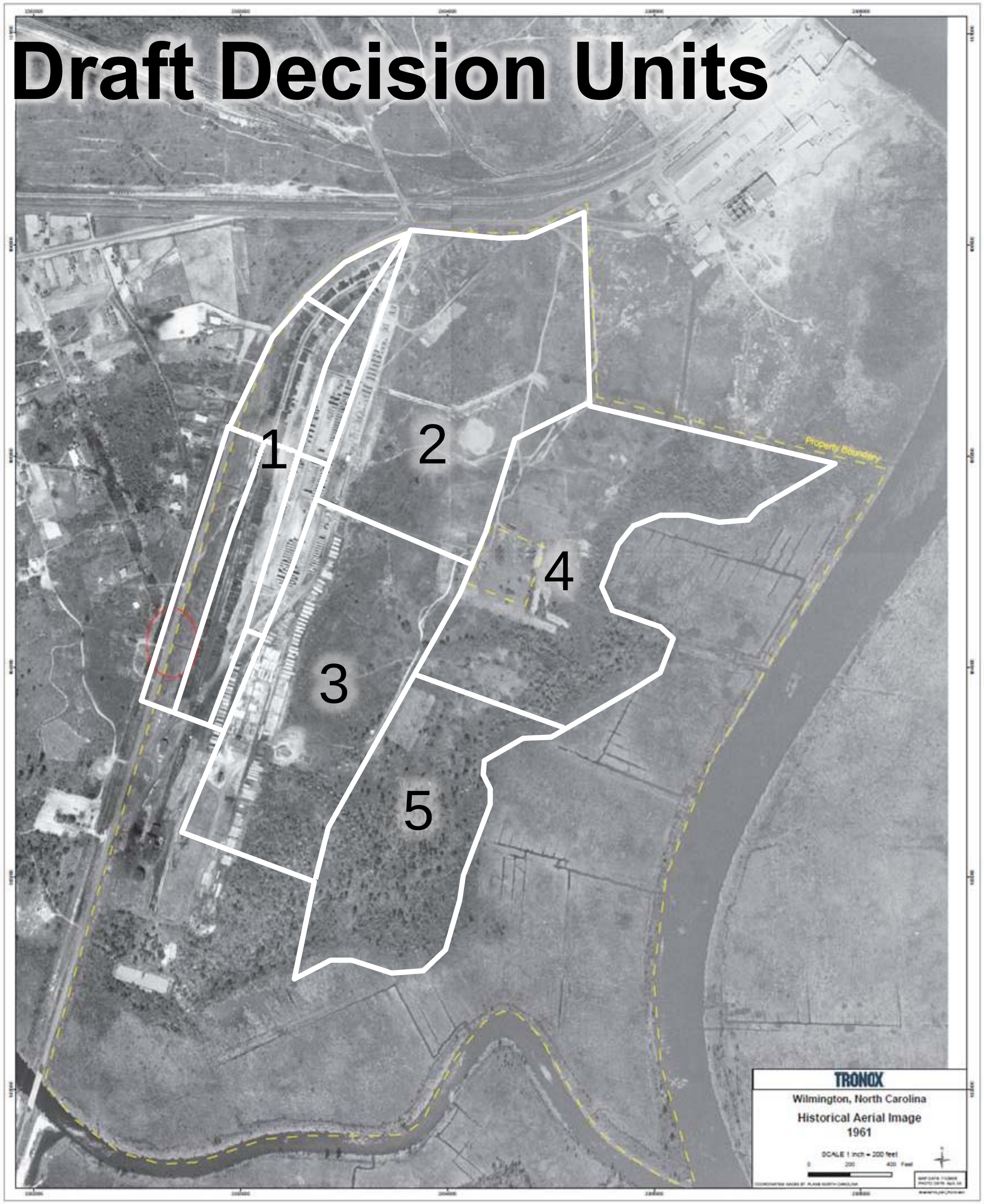
Kerr-McGee, Navassa, NC

2004

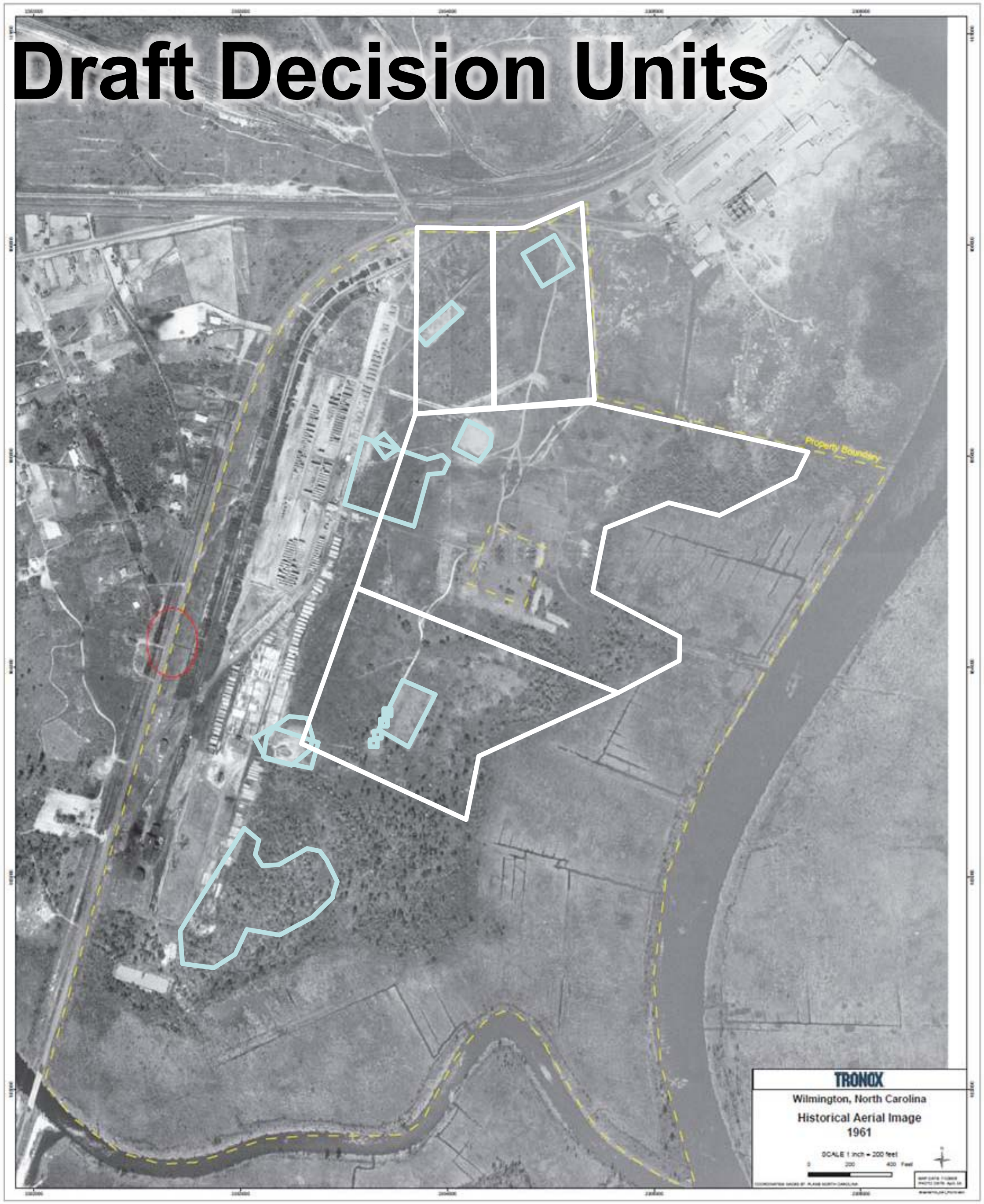
Drawing Decision Units

- Decision Units should reflect the Conceptual Site Model and support the decision you are trying to make.
- CSM based on historical use
- Decision is to determine areas that do not require cleanup and area that require further study

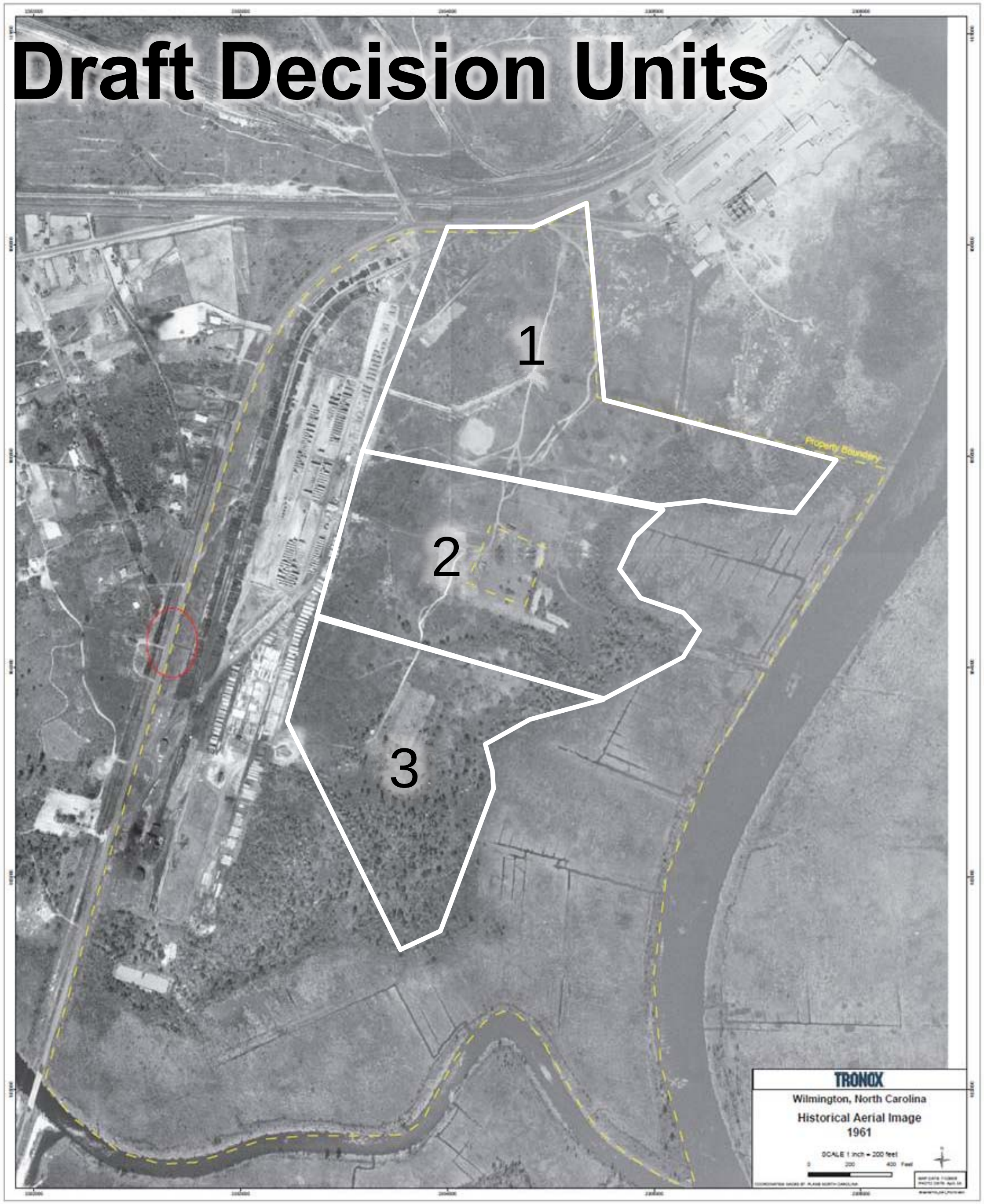
Draft Decision Units



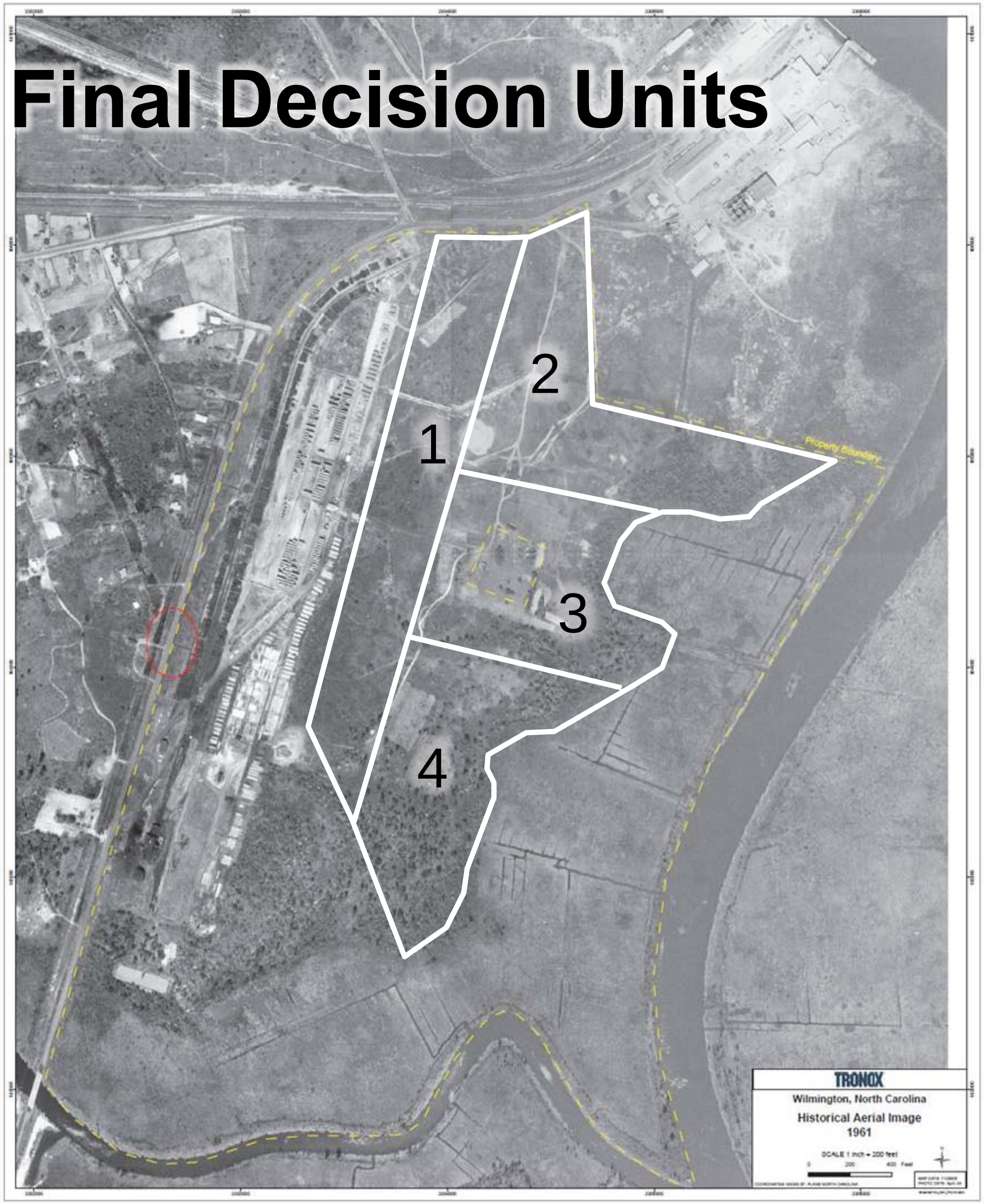
Draft Decision Units

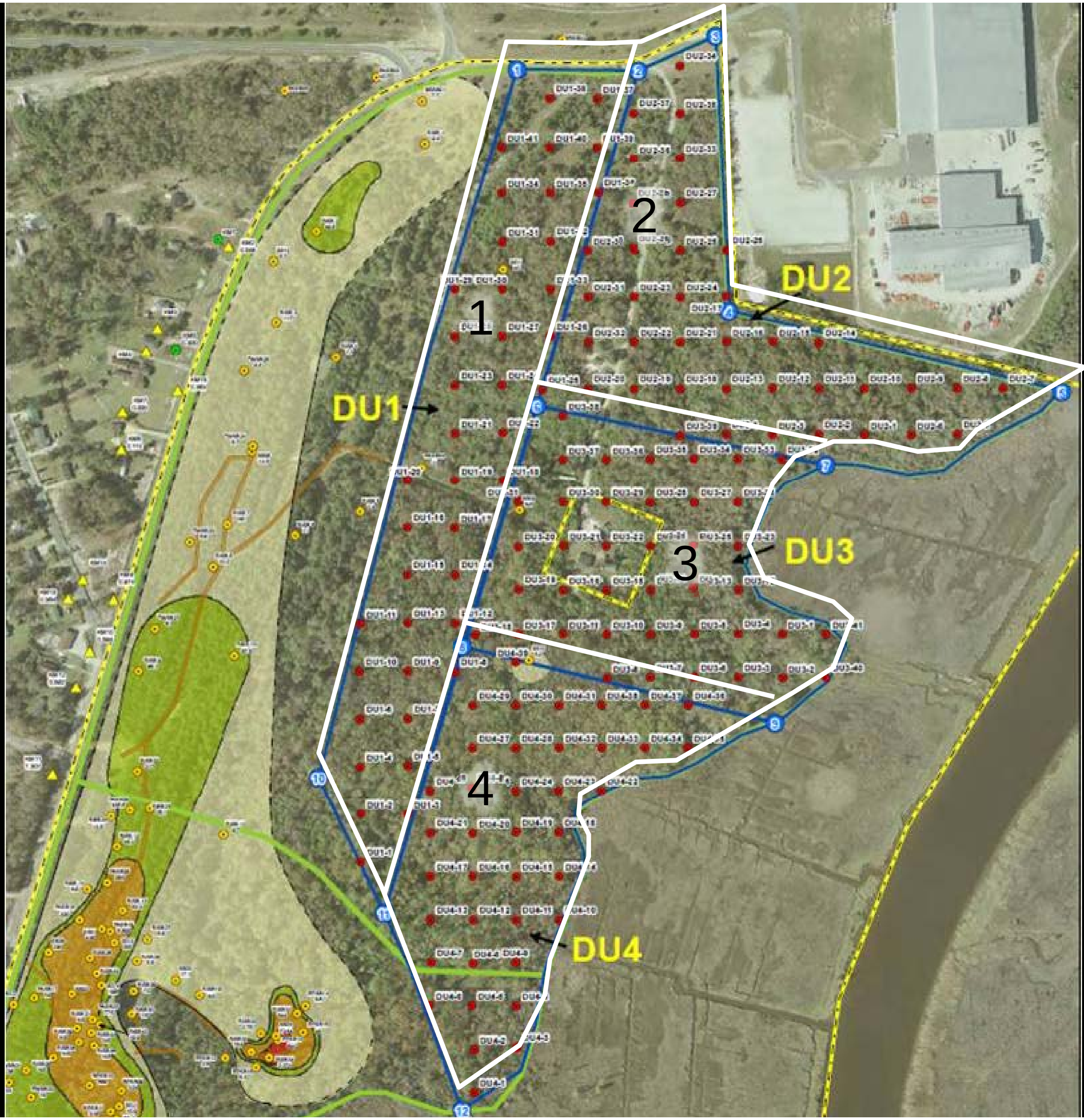


Draft Decision Units



Final Decision Units



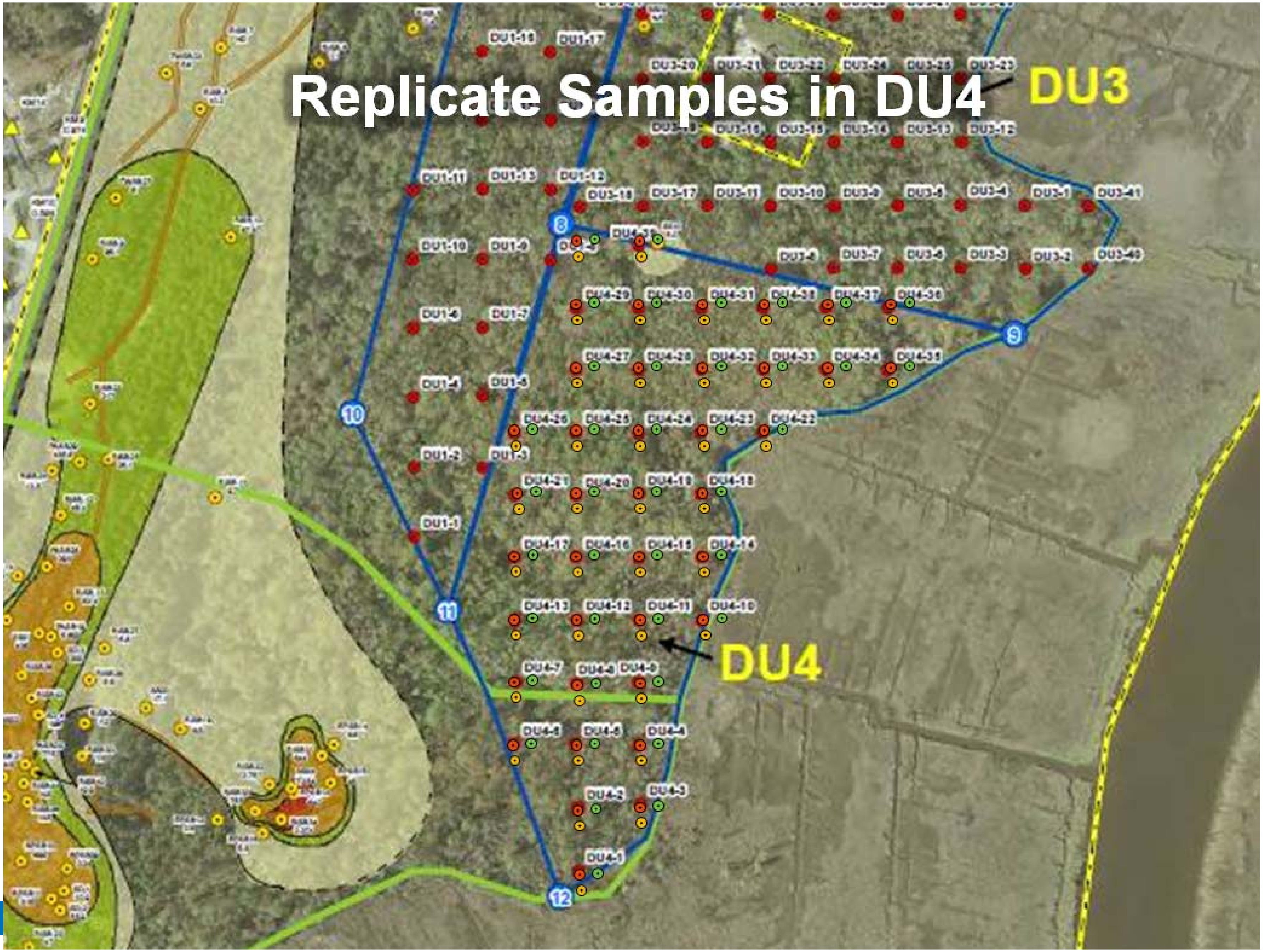


DU1
DU2
DU3
DU4
1
2
3
4

Increment Collection

- One inch stainless steel soil coring device
- Debris or vegetation on soil removed
- Increment collected from 0 to 1 foot BLS
- Increments transferred to a large glass jar

Replicate Samples in DU4



Lab Sample Processing

- Soil sieved using #10 (< 2 millimeter size)
- Two dimensional slab-cake method
- Spread evenly on a sample tray (or pan) and air dried, as needed
- A grid pattern with at least 30 grid squares
- Increment collected from each grid square

Results

Decision Unit	# of Increments	# of Replicates
DU1	41	1
DU2	37	1
DU3	37	1
DU4	39	3

Results

Sample	Benzo(a)pyrene (µg/kg)
DU1	44
DU1 Extraction Dup	39
DU2	1.1
DU3	1
DU4AA	1.3
DU4AB	1.1
DU4AB1	1.4

What DUs on a Removal Site Might Look Like

Source Area DUs: Heavy contamination + leaching

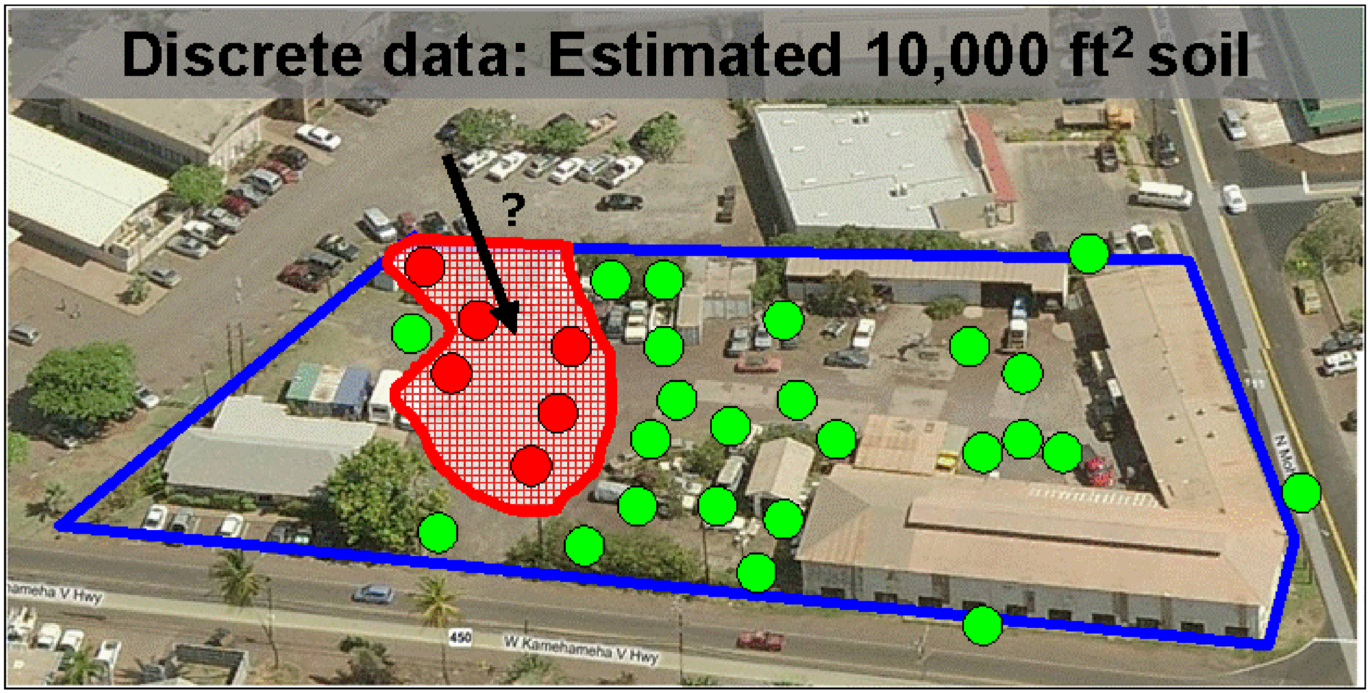
Exposure Area DUs: Maximum 5,000 ft^2

Can also be used to sample small areas

- Identify increment locations in field
  - Utilize similar site investigation tools

Typical Discrete Sampling

>Action Level ≤Action Level



PCB sample aliquot = 30 grams (one spoonful of soil)

100′

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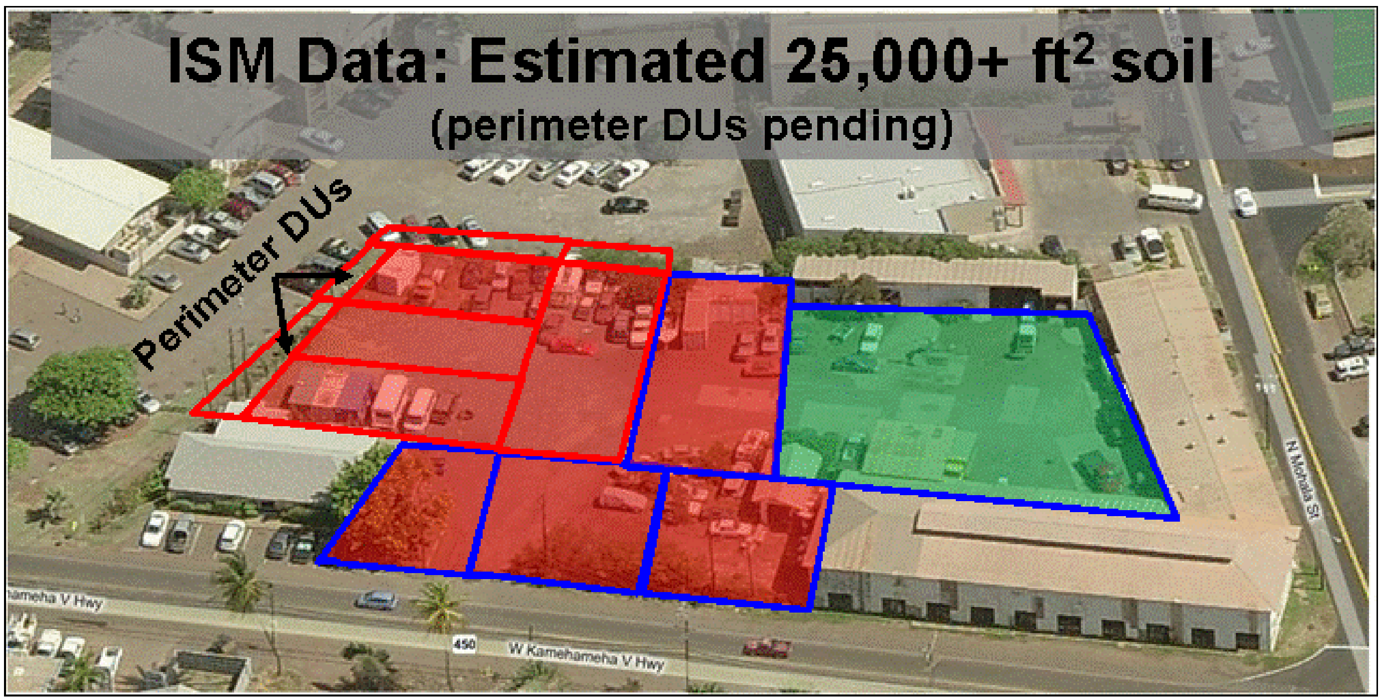
When re-evaluated with ISM

> Action Levels   ≤ Action Levels



November 08, 2008

December 10, 2009

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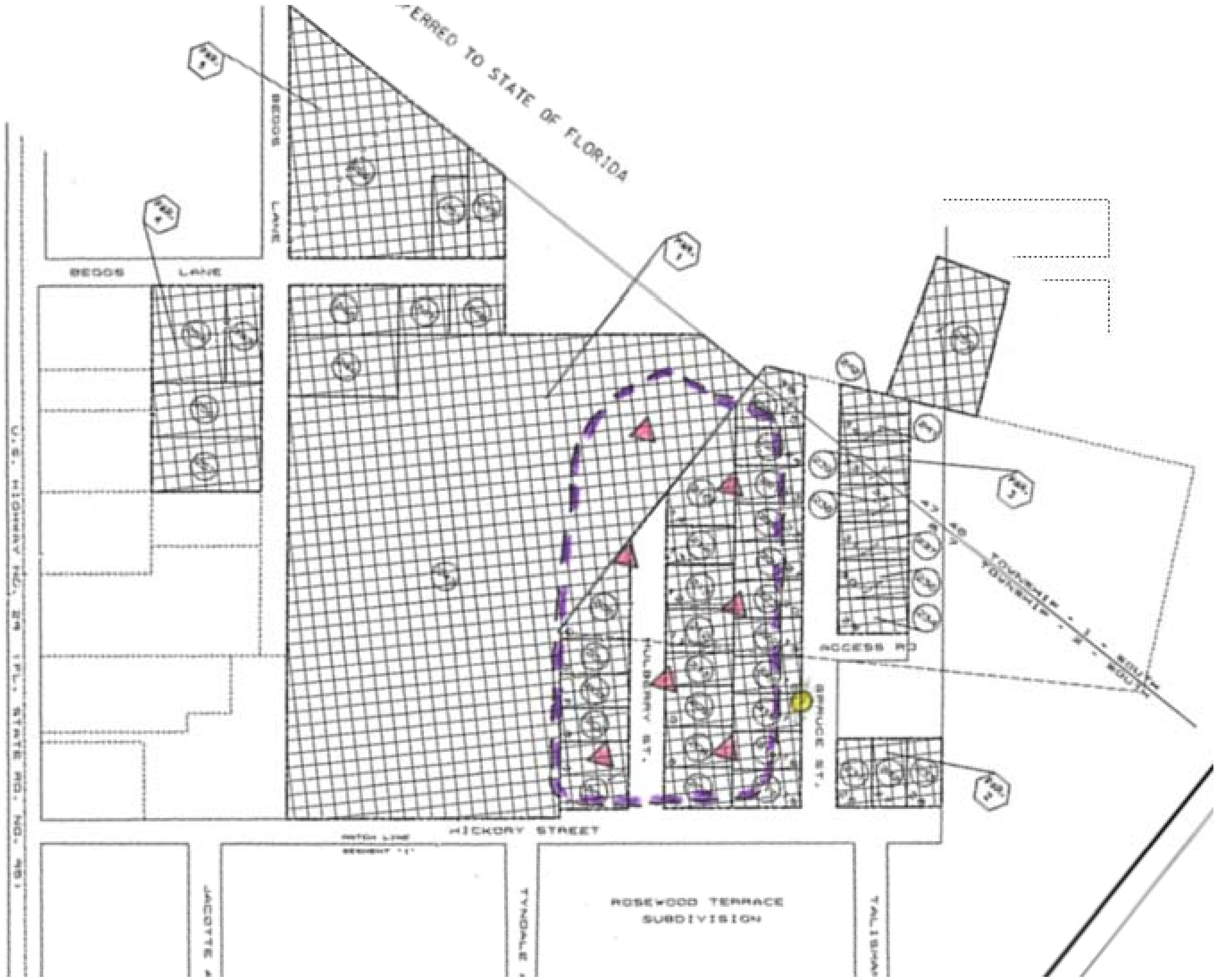
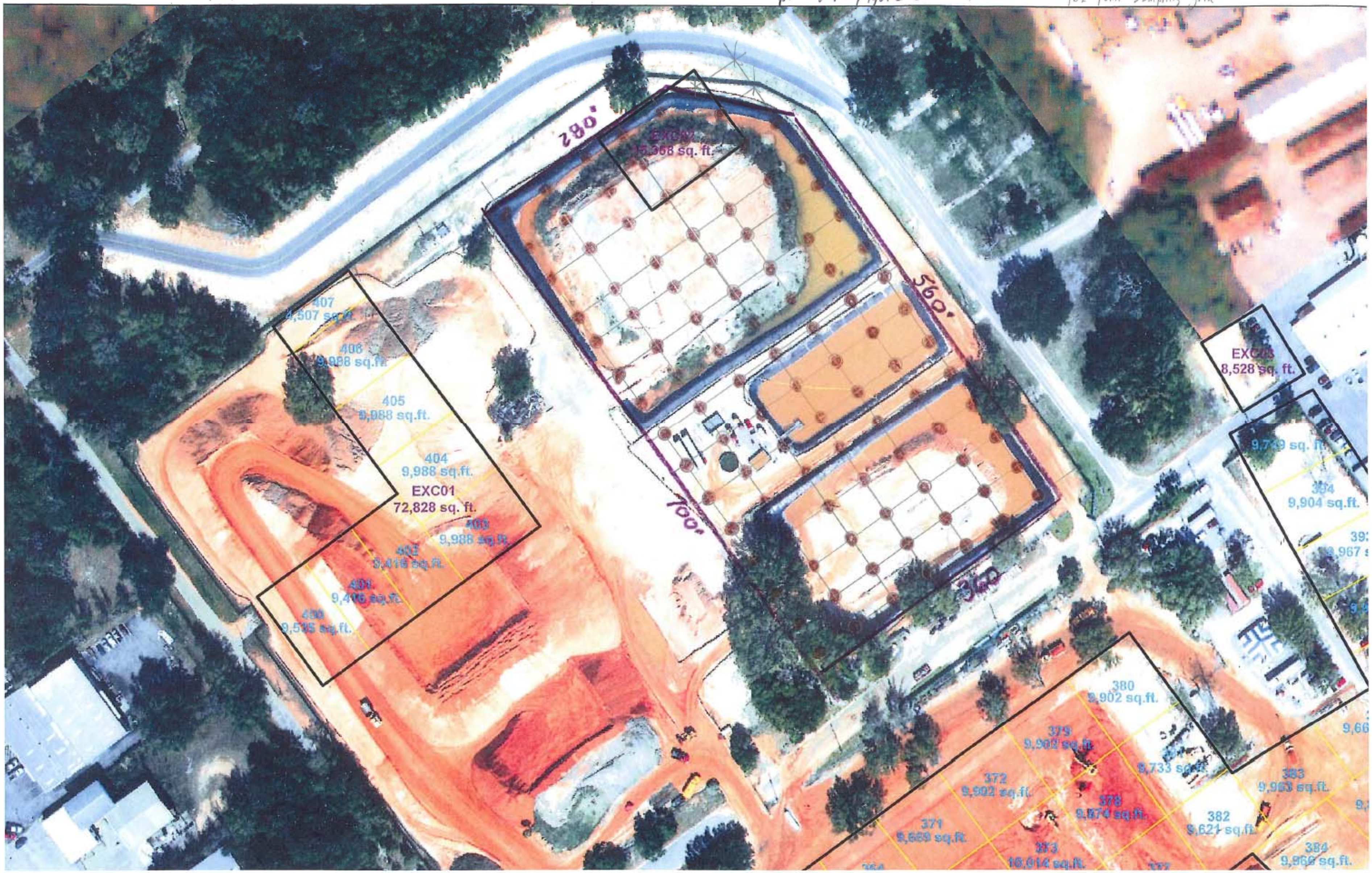
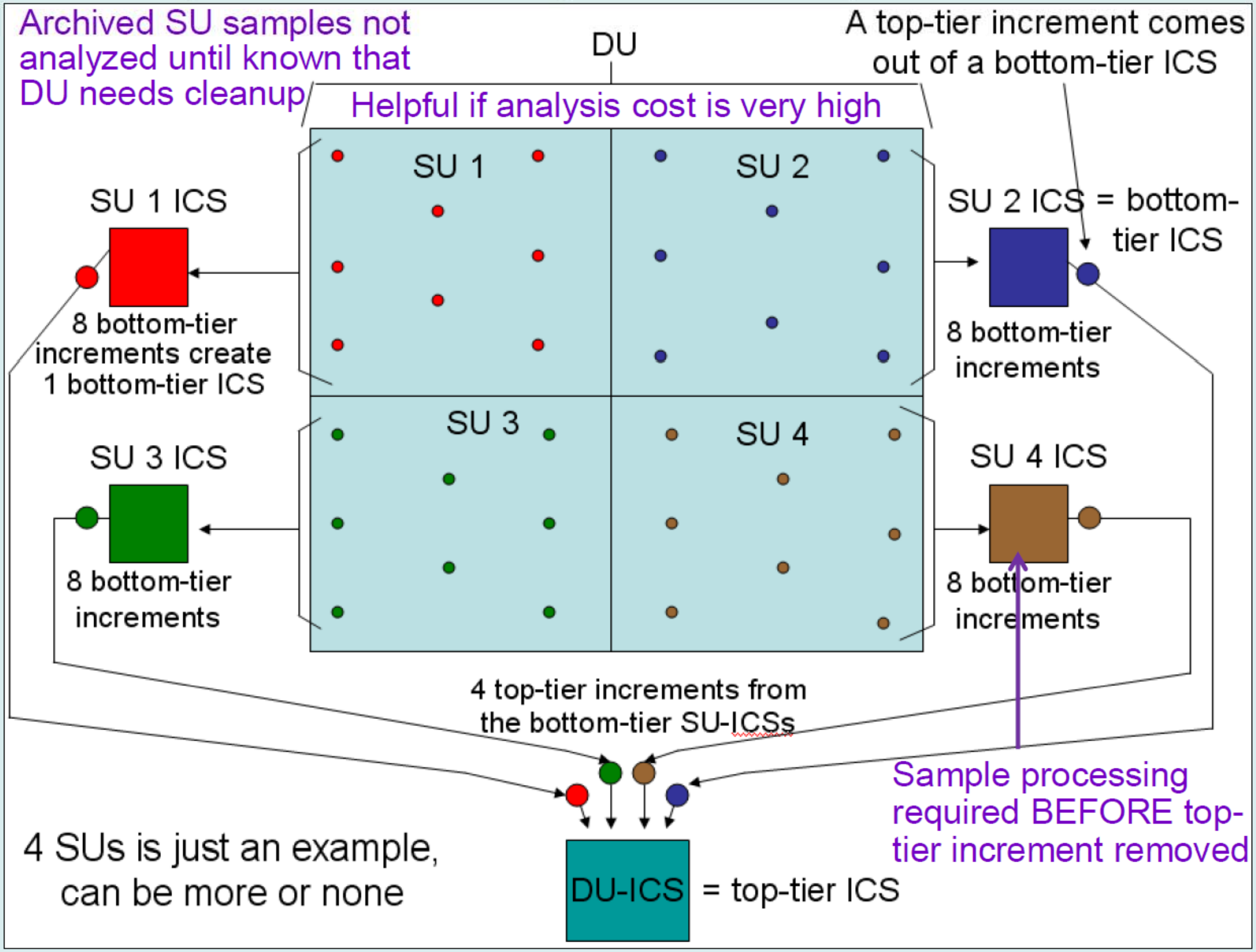


1" = 100'   for SAP Figure 2   102-point sampling grid



A Hybrid, Tiered Design to Retain Spatial Information

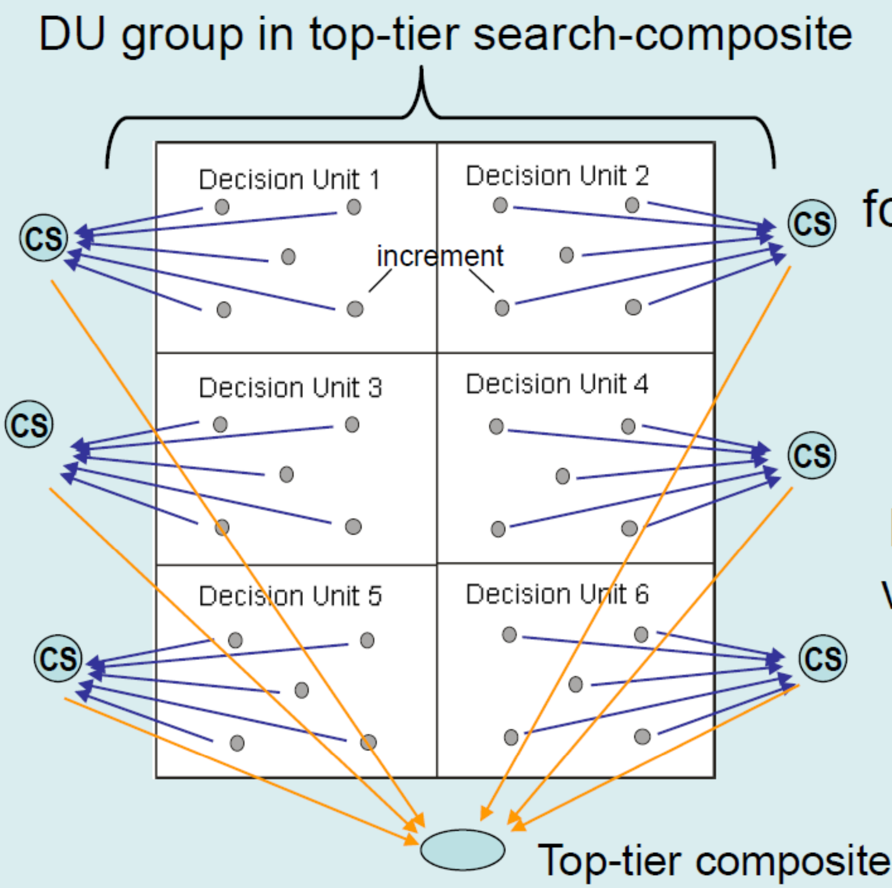


Compositing-Searching Design: Goal

- Goal is to identify "dirty" areas within a larger area that is mostly "clean"
  - Looking for contamination > designated action level
- Assumptions:
  - Contamination believed to be spotty
  - Action level significantly > background levels
  - Sample acquisition/handling costs significantly < analytical costs
  - Usually used to search for small contaminated areas (e.g., DUs of 500-700 sq ft each)

(continued)

Composite-Searching Design



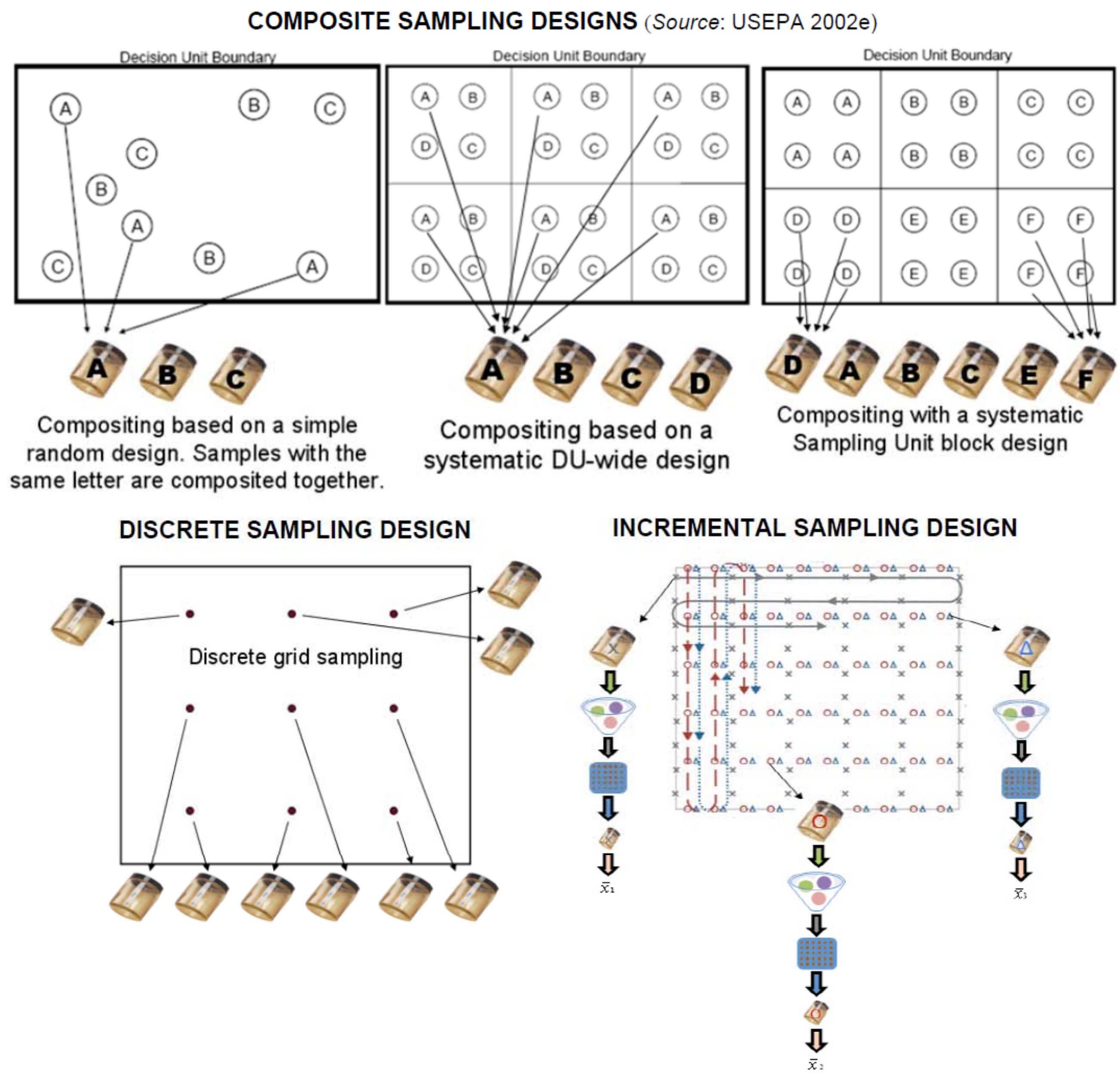
Form search-composite for analysis

Top-tier search-composite formed of increments taken from the bottom tier DU composite samples (CSs)

For details & a case example, listen to the recorded EPA ICS webinar, Module 2, Section 2.3
http://www.cluin.org/live/archive/
Search the archives for "incremental"

What About Dilution Concerns?

- For area-averaging goals, the concern doesn't apply
  - Goal <u>is</u> to get average concentration over the DU
  - High increment density incorporates high & low concentration areas in same proportions as in the DU
- For hot spot detection, compositing works *against* missing hot spots:
  - Hot spots also an average concept, but over smaller area
  - Compositing *increases* likelihood that hot spots will be incorporated into the ICS sample, raising its concentration
  - Higher sample concentration flags area for more investigation
  - This has been <u>consistently</u> demonstrated when incremental sampling is compared to traditional discrete sampling



Source: ITRC Incremental Sampling Methodology February 2012 http://itrcweb.org/ism-1/