Headquarters U.S. Air Force

Integrity - Service - Excellence

Tinkering with Innovation
Air Force Strategy for using Multi-Incremental Sampling (MIS)

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Goal of this Presentation

- Introduce a better sampling technique based on good science
  - Adopt modern characterization & modeling strategies
  - Triad approach (rapid site characterization)
  - Cost savings generated by strategic planning and better understanding of site conditions through development of more representative Conceptual Site Models (CSM)
- Introduce multi-increment sampling (MIS) at USAF sites other than exploded ordinance sites
- Better preparation and understanding of CSM
- Data collection design and analysis that supports DQOs and RAOs

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USAF Thoughts & Philosophy

- Potential uses of MIS at USAF sites
  - Incorporation of MIS (and Triad) at sites other than MMRP sites
    - pesticide sites
    - tank farms
    - asbestos in soil
    - metals in soil
- Preliminary screening tool; prioritize cleanups
- Larger pool of representative site data at a lower cost
- US Army Ranges and USAF Ranges are different
- Opportunities for program optimization
- Potential for significant reduction in analytical costs

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History of Past Multi-Increment Sampling Successes

- Case studies from the Army Corps of Engineers demonstrate MIS effectiveness
- Explosive residues, PCBs, surface soils, sediments
- State Governments and Mining Industry
  - Ranges
  - Mining industry for vertical assessment
  - POL in Alaska and Hawaii
  - Pesticides in Hawaii

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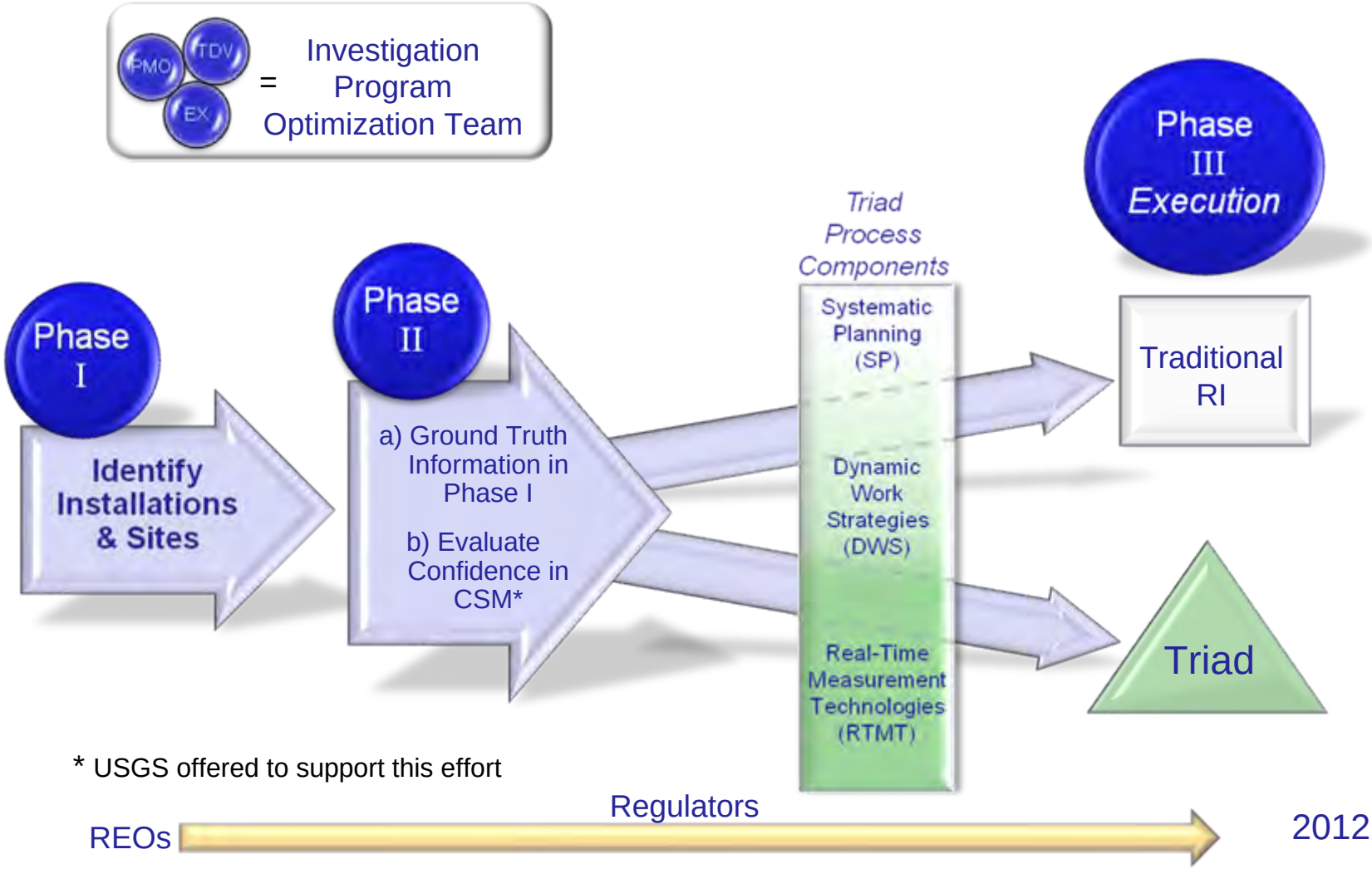
Investigation Program Optimization (IPO) – Process



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Goal of Triad Initiative

- Triad is a tool for expedited site characterization
- Lead environmental community
  - Adopt 2nd-generation practices
  - Difficult transitions but worthwhile benefits
- “Upgrading practices”
- Improve CSM
  - Accuracy
  - Cleanup efficiency
  - Achieve cleanup program goals
  - Cost effectiveness

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Multi-Increment Sampling (MIS)

- Based upon particulate theory (Gy 1992, Pitard 1993)
- Incorporates relationships between
  - Soil variability
  - Particle sizes
  - Distribution of contaminants
  - Sample size
- Reduces heterogeneity within sample and decision unit
- Multiple individual increments from a decision unit are pooled
  - Generates estimate of mean concentrations
  - Reproducible results
  - May include laboratory sub-sampling

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MI Sampling Approach Theory

- Sample Plan
- Sample Site and Location
- Decision Units
- Locations – Tank Farms, Military Housing, Spill Sites
- Sampling Procedures
  - VOCs, SVOCs, Asbestos, Pesticides, and Metals
- Subsampling

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Decision Unit Identification

- A decision unit: specific area to be represented by each MIS sample
- Use existing data to delineate decision unit if unknown source
  - For example, historic photos, site information, interviews
- MIS is not used to “dilute” contamination or eliminate the need for cleanup
- “Dilution” occurs if decision unit includes large, uncontaminated areas

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Systematic Planning

- **Systematic Planning & Data Collection Design**
  - **Defines problem requiring solution**
  - **Identifies acceptable solutions and goals**
  - **Defines decisions needed to meet goals**
  - **Identifies decision units**
  - **Identifies sample support requirements**
  - **Identifies sources of decision uncertainty**
  - **Provides strategies for uncertainty management**
  - **Ensures cleanup standards are clearly defined**
  - **Ensures data collection supports CSM definition**
  - **Ensures all actions are congruent with the established RAOs and DQOs**

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Conceptual Site Model

- CSM is a tool used to represent hydrogeology, contaminant distribution, fate and transport of contaminants and potential receptors
  - Exposure scenarios
  - Strategies to reduce risk
- A representative CSM of sufficient accuracy is key to successful projects
- CSM is not just fate/transport or exposure scenario models
- Provides basis for decisions related to risk, remediation, reuse
- Inaccurate or incomplete CSMs
  - Potentially may put receptors at risk and create conflict
  - Include untested assumptions
  - Lead to faulty project designs

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AFCEE MI Sampling Methodology

- Define the decision unit(s) both horizontally and vertically
- Identify random sample locations & depths in each decision unit
- Submit the work plan for peer and QA review
- Collect 30-50 increments per decision unit
- Collect triplicate samples at independent locations
- Sieve non-volatiles to 2 mm, sub-sample & submit 30-50 g
- Conduct cost effective data package Quality Assurance review
- Calculate and report all relevant quality control parameters
- Submit report for review
  - Source “US Army Corps of Engineers - Improving the Quality of Environmental Sampling”

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MI Sampling Vertically

- **Used in mining industry to obtain objective information about a population in specific lithologic units**
- **Requires:**
  - **Good Sampling Plan**
  - **Good Decision Unit Definition based on lithology**
  - **Understanding of chemicals of concern**
- **Ply method - sampling each distinct individual layer is more accurate and preferred**

  - ***Source "Society for Mining, Metallurgy, and Exploration, Inc. (SME) Mining Reference Handbook" SME, 2002***

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MI Sampling Vertically

- **Two methods of vertical sampling:**
  - **In situ (from cores or outcrop [tank pit, etc.]) or**
  - **Ex situ sampling after sample is removed from original deposit (e.g., truck, conveyor belt, or stockpile)**
- **In situ sampling**
  - **Preferred for a non-weathered sample of deposit**
  - **Sample can be recorded as a whole or in plies (individual layers)**

  - ***Source "Society for Mining, Metallurgy, and Exploration, Inc. (SME) Mining Reference Handbook" SME, 2002***

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MI Sampling
Pesticides & SVOCs

- **Ideal for areas with widespread contamination, such as**
  - **Chlordane and pesticide application areas (i.e., base housing)**
  - **Large tank farms (reduce uncertainty due to soil heterogeneity)**
  - **PCB spill areas**
  - **Areas with asbestos-containing materials**
- **Uses same sampling methodology same as for exploded ordinance sites**

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MI Sampling of VOCs

- Sampling for VOCs under MIS methods is problematic:
- Volatiles samples must not be sieved or pulverized
- Homogenization can result in VOC loss
- The State of Alaska recommends in Draft Guidance:
  - Collect VOC samples prior to non-volatile samples
  - Collect small increments (2-5 g) & place directly into jar containing methanol (minimum 1:1 methanol/soil ratio)
  - Collect at least 50g of sample to decrease total sampling error
  - Individual increments should be small particle size (<2mm) to be similar to nonvolatile sample matrix after sieving

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MI Sampling of Metals

- **MIS process for metals analysis:**
  - **30g field sample is more than needed for analysis**
  - **Small samples (1g) normally digested & analyzed in lab**
  - **Grinding of samples required to decrease particle size & reduce sample bias … increased digestion required**
- **Benefits – Distinguish between naturally-occurring metals and anthropogenic metals (e.g., lead-based paint)**

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Sample Processing & Sub-sampling Biases

- Highly biased values will result if sampling procedures are not appropriately matched to sample matrices
- Biases based upon distributional heterogeneity due to gravitational effects leads to grouping and segregation error
- Laboratory QA process
  - Addresses procedural, instrumental and analyst issues
  - Ignores sample processing/sub-sampling

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Limitations of MI Sampling

- Not appropriate for groundwater and fractured bedrock
- Large particle sizes increase uncertainties in VOC analysis
- Vertical MIS is constrained by limited number of boreholes
- Laboratory sub-sampling can negate representativeness

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Experience Collecting Representative Samples

- Studies at variety of explosives-contaminated sites
  - Ammunition plants, depots, ranges, industrial sites
  - TNT, RDX, HMX,2,4-DNT,Ammonium Picrate
- Discrete samples yield variance in sampling error due to
  - Insufficient mass
  - Insufficient number of samples
  - Incorrect sample locations
- Sample processing & subsampling may produce data that passes the validation process; however, the analytical results would not be representative of site conditions

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QA/QC

- Triplicate samples critical to validate MI sample representative of decision unit both horizontally and vertically
  - One decision unit = one triplicate sample
  - > 1 decision unit: 1 triplicate per 10 decision units (10%)
  - Vertical samples: 1 triplicate per 10 cores within decision unit
- Allows calculation of Relative Standard Deviation (RSD; indicator of data distribution & precision)
- Define collection of triplicates in Sampling and Analysis Plan
- Laboratory QA process ignores sample processing/subsampling

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Summary

- Employs USAF / Triad approach
- Incorporates better science & new technologies
- Adopts modern characterization & modeling strategies
- Results in potential cost reductions
- Provides better understanding of CSM
- Potential use at areas with widespread contamination
  - Vertical delineation
  - VOC analysis
  - SVOCs, metals and pesticides