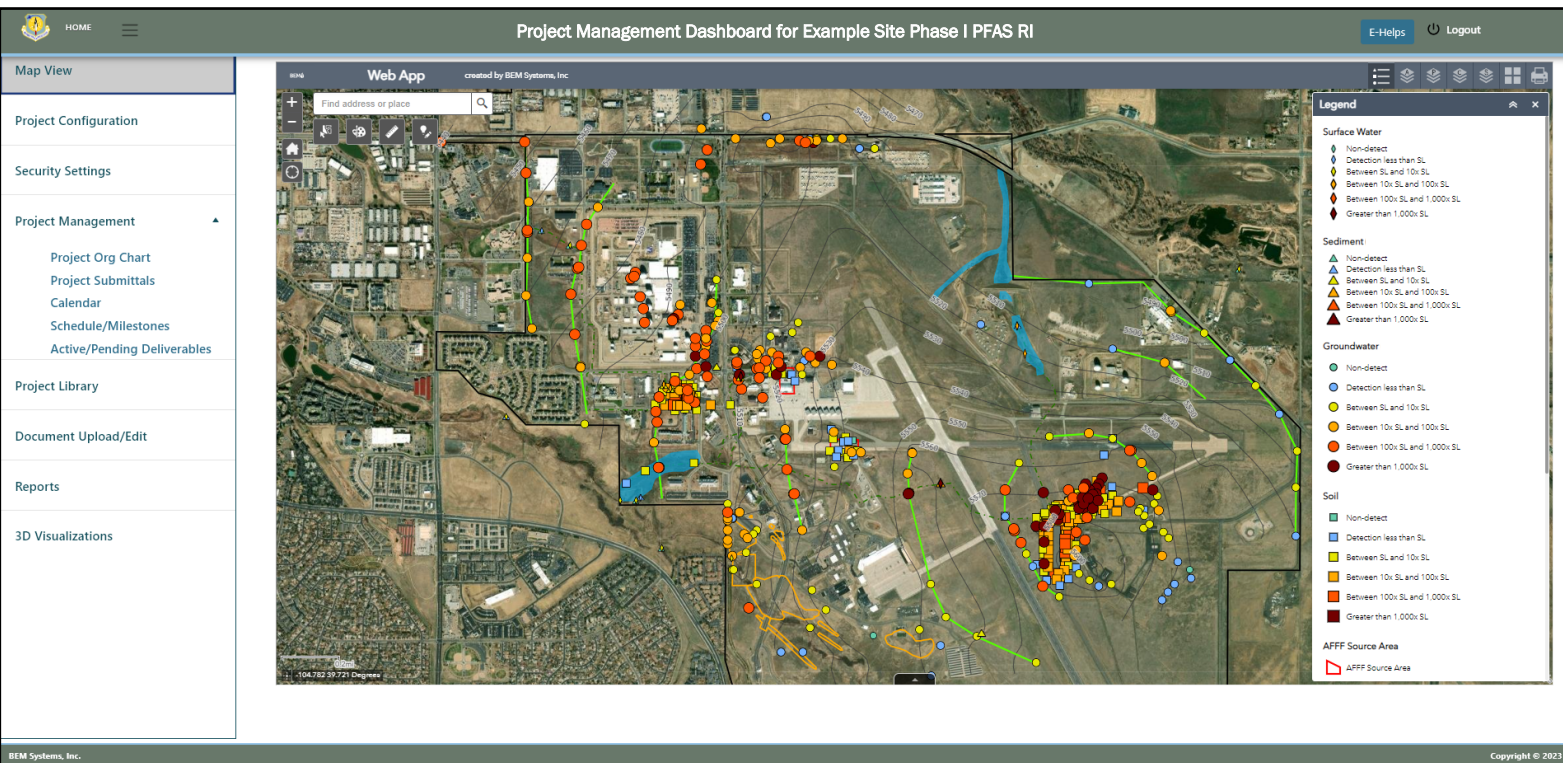


ACCELERATING SITE CHARACTERIZATION AND CONCEPTUAL SITE MODEL (CSM) DEVELOPMENT VIA TRIAD-LIKE STAKEHOLDER ENGAGEMENT STRATEGIES AND TECHNOLOGIES

13th Annual Battelle International
Conference on the Remediation of
Chlorinated and Recalcitrant Compounds

Session 15:
PFAS Conceptual Site Model Approaches

Presented by:
Arthur Wickham, MSc, PG, CHG
Sr. Project Manager | Sr. Hydrogeologist
BEM Systems, Inc. | Denver, CO



AGENDA

- DoD Environmental Priorities
- Traditional Site Investigation Approach
 - Existing Management & Execution Challenges
 - Critical Future Needs
- PFAS Site Investigation Case Studies
 - Technical Approach
 - Stakeholder Engagement Strategies
 - Supporting Technologies
- Recognized Benefits
- Considerations



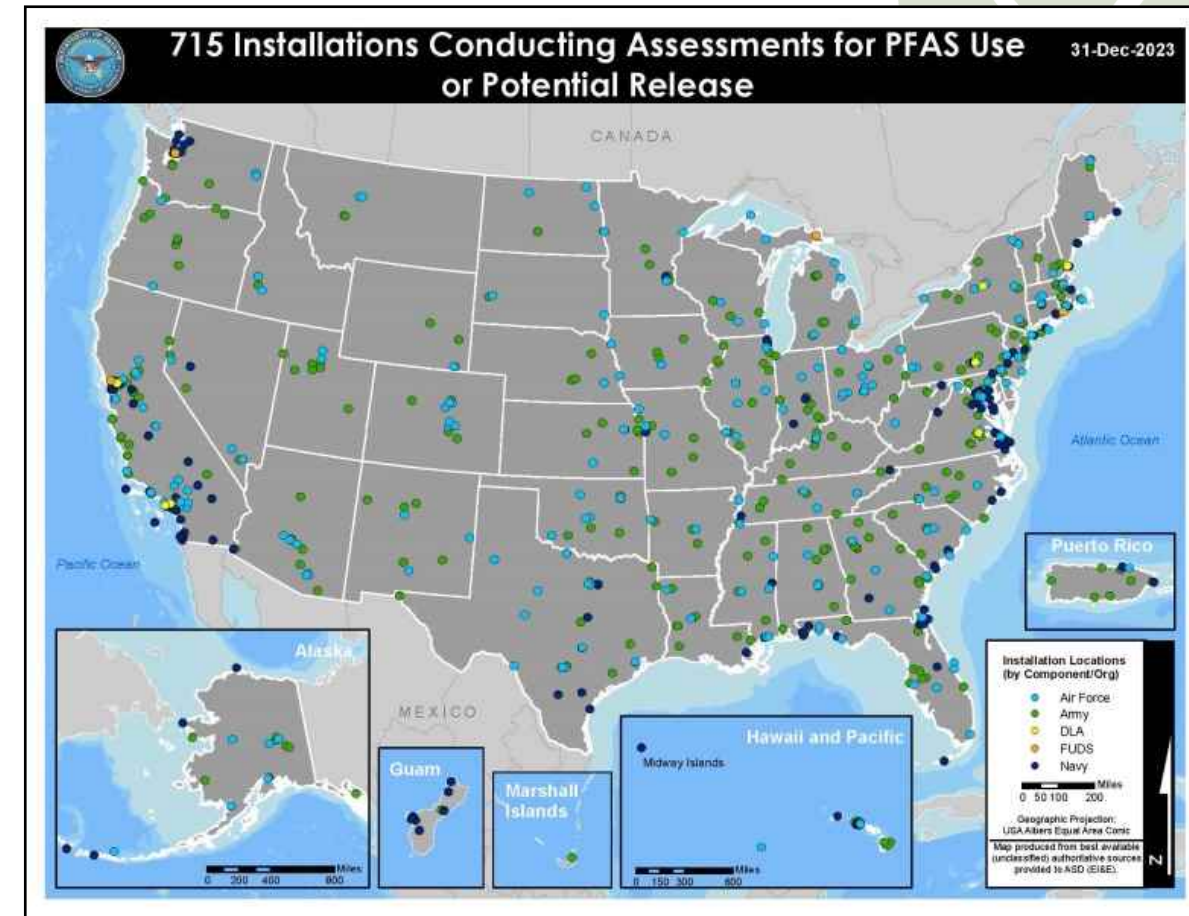
DoD ENVIRONMENTAL PRIORITIES

Investigation and Remediation of PFAS

- **Remedial Investigation (RI)** is a critical step in CERCLA to support:
 - **Assessing risk** to human health and the environment, and,
 - Performing interim **remedial action**

Challenges:

- Accelerating the CERCLA process
- Intensified regulatory and public stakeholder engagement
- Evolving nature of PFAS science and regulations
- Collaboration with MILCON activities



Source: <https://www.aco.osd.mil/eie/ee/ecc/pfas/data/cleanup-pfas.html>

133

No Further Action is
Required

707

Completed Preliminary
Assessment/ Site Inspection
(PA/SI)

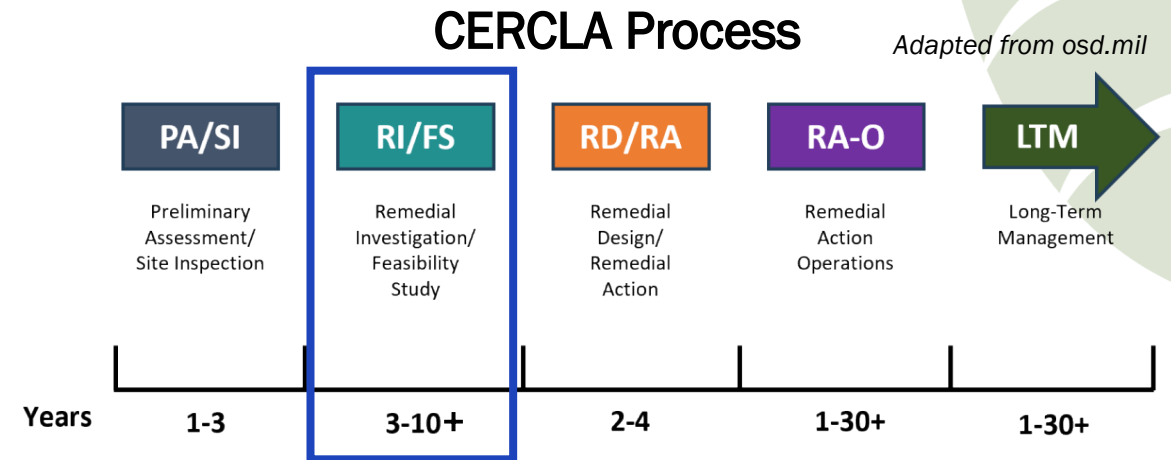
547

Proceeding to Next Phase in
CERCLA Process (i.e.
Remedial Investigation [RI])

TRADITIONAL SITE INVESTIGATION APPROACH

Management & Execution Challenges

- Slow performance schedule
- Data collection & review is inefficiently iterative
- Costly extraneous mobilizations
- Dataset is often of coarse resolution
- Unable to quickly adapt to changing regulatory standards
- Stakeholder engagement slows progress and is limited to end of project

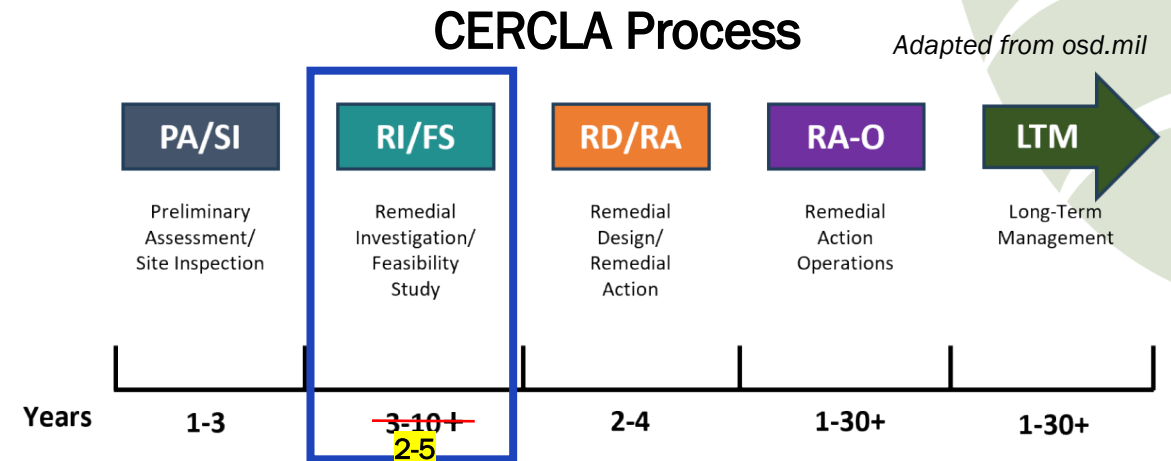


**DoD can and is taking short-term actions (e.g., providing bottled water, point of use filters) anytime during the process, if there are exceedances of OSD-accepted standards*

TRADITIONAL SITE INVESTIGATION APPROACH

Critical Future Needs

- **Accelerate** investigation schedules
- Leverage new **technologies** and strategies
- Build spatially (and ultimately temporally) robust datasets to support:
- **Risk assessment**
- Time-critical remedial action (e.g., source removal)
- Adapt to changing regulatory standards (particularly emerging contaminants, e.g., PFAS)
- **Collaborate** transparently with regulatory agencies, communities and facilities



*DoD can and is taking short-term actions (e.g., providing bottled water, point of use filters) anytime during the process, if there are exceedances of OSD-accepted standards

PFAS SITE INVESTIGATION CASE STUDIES



48

AFFF Source Areas

9

Project Sites

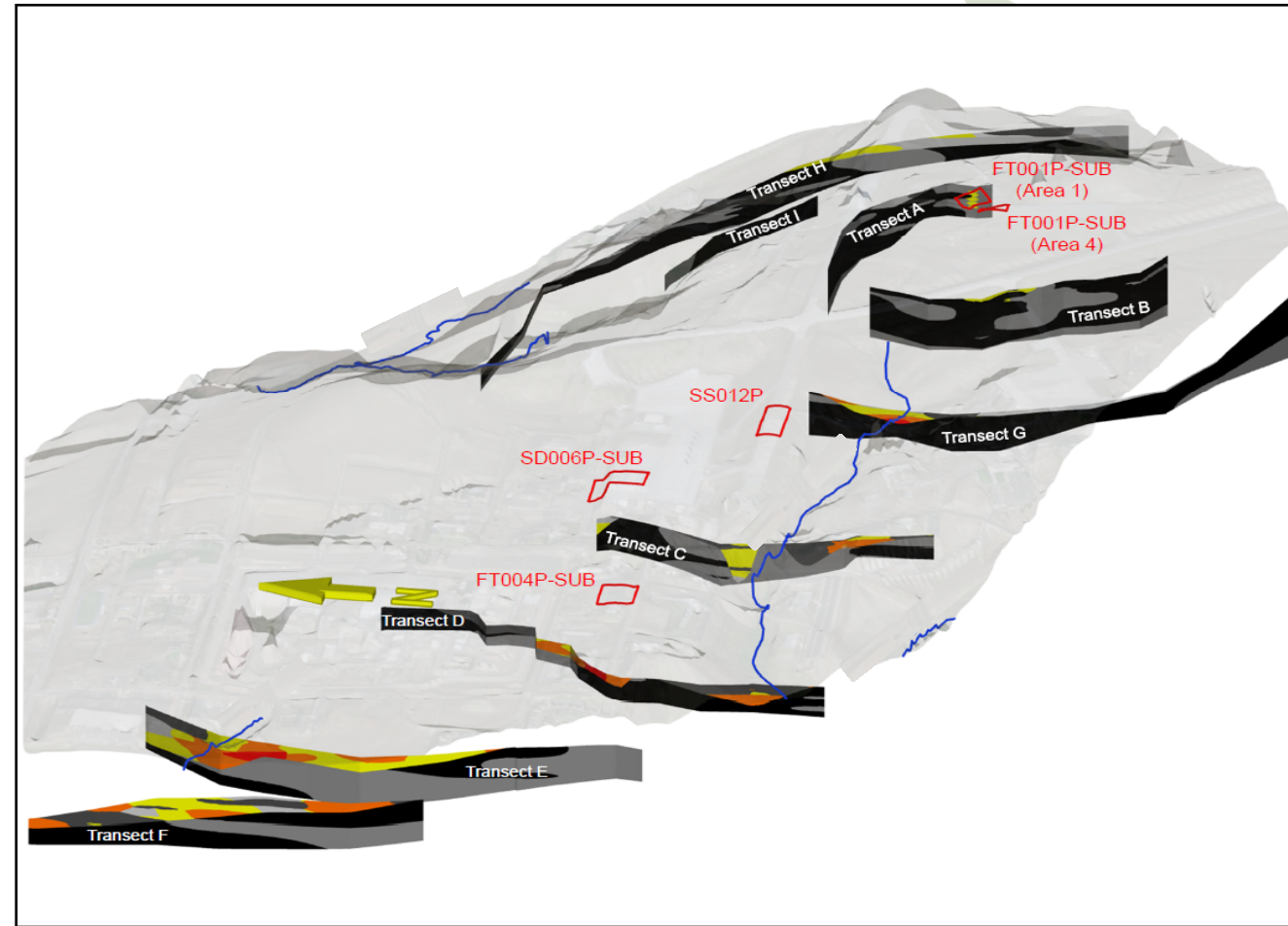


OBJECTIVES

- Characterize and delineate PFAS in multiple media on- and off-base
- Develop/Update CSM for each PFAS validated source area & Basewide/ Off-Base
- Rank & prioritize source areas based on risk to human health and the environment
- Provide high-quality / defensible data to support ecological and human health risk assessment and remedial alternative evaluations

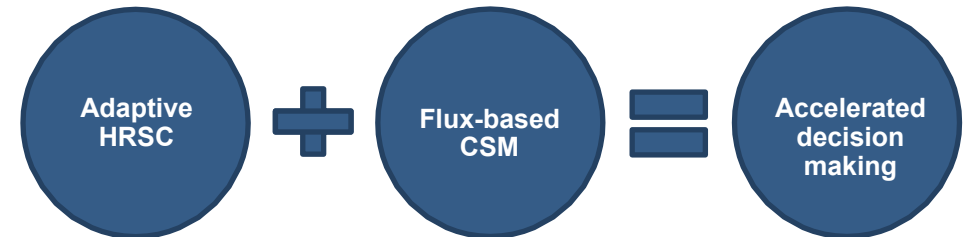
TECHNICAL APPROACH

- TRIAD-like HRSC approach
- Stratigraphic flux-based CSMs
- Multiple AFFF source-strength leaching evaluations
- Downgradient groundwater vertical aquifer profiling (VAP) transects to map PFAS mass flux
- Groundwater-surface water interaction assessments



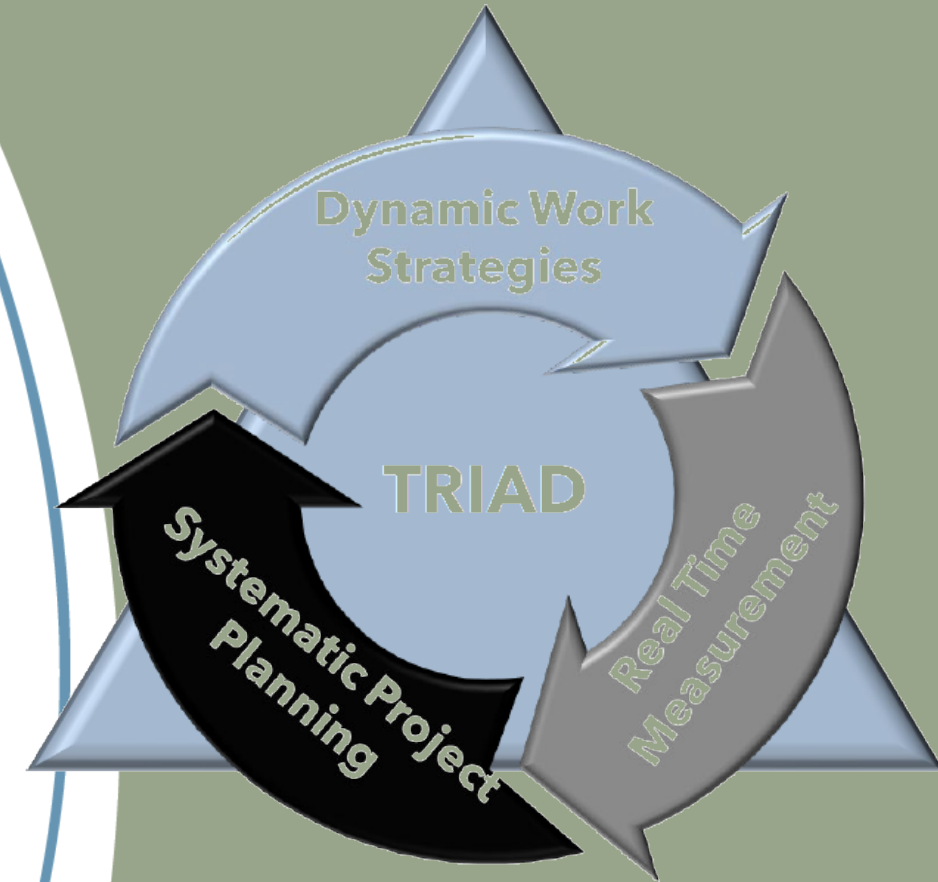
RI data also supported BEM conducting:

- Phase I Human Health & Ecological Risk Assessments
- Bench- and field-scale in-situ stabilization (ISS) treatability studies



TRIAD STRATEGY

- EPA-approved strategic process designed to **reduce decision uncertainty** and **improve data defensibility**
- Based on science and technology using an **adaptive process**
- Developed in the 1990s-2000s
- Built on 3 interactive pillars:
 - **Pillar 1** - Systematic Project Planning
 - **Pillar 2** - Dynamic Work Strategies
 - **Pillar 3** - Real Time Measurement Technologies



REAL-TIME MEASUREMENT TECHNOLOGIES

NELAP-CERTIFIED ON-SITE PFAS MOBILE LAB



*Alternatively: screening-level analytical methods with quicker TATs than
EPA Method 1633 (e.g. ASTM D8421, EPA Method 8327)*



VERTICAL AQUIFER PROFILING

Source: BEM Systems, Inc.

COMMUNICATION & MANAGEMENT TECHNOLOGIES

- BEM Team developed a centralized web-based portal for project information and environmental data.
- Provided tiered, secure access to client and regulatory stakeholders.
- Included:
 - document sharing and archiving
 - project communication
 - schedule tracking
 - work planning
 - data visualization and querying, and
 - 3D CSM development.

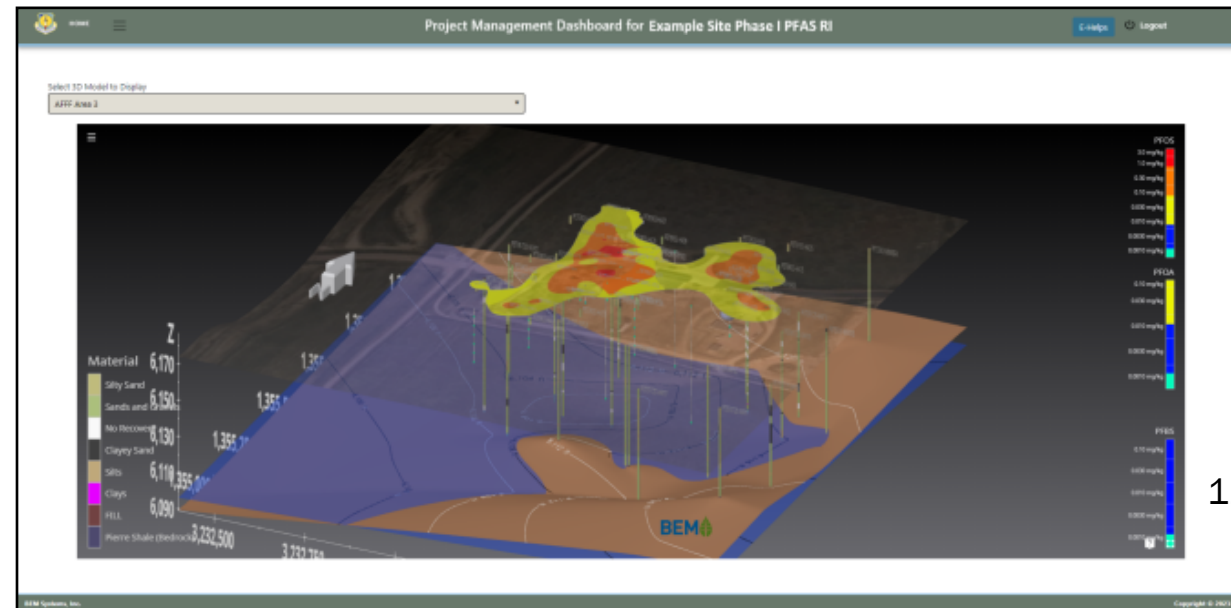
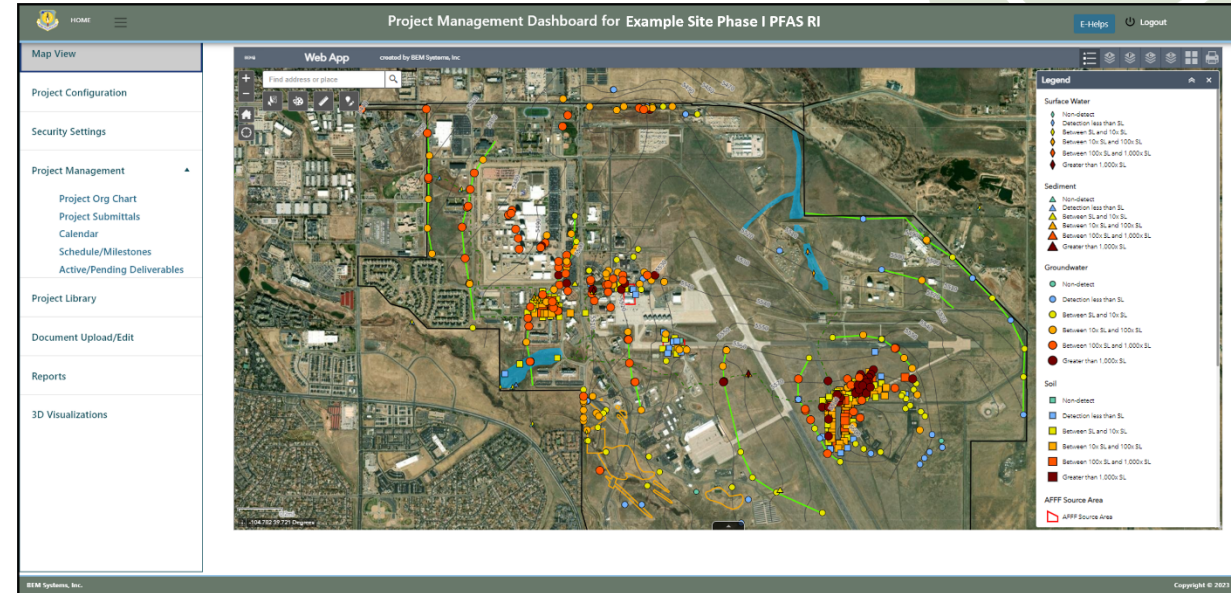


PROJECT MANAGEMENT DASHBOARD (PMDB) & DIGITAL CONCEPTUAL SITE MODEL (DCSM)

- Used by project team & stakeholders to obtain real-time data for monitoring the project's progress and schedule.
- Adaptable as new compounds or screening values are promulgated.
- Cybersecurity Maturity Model Certification (CMMC) compliant
- Supported generating and updating visuals of PFAS impacts in 2-D and 3-D CSM deliverables

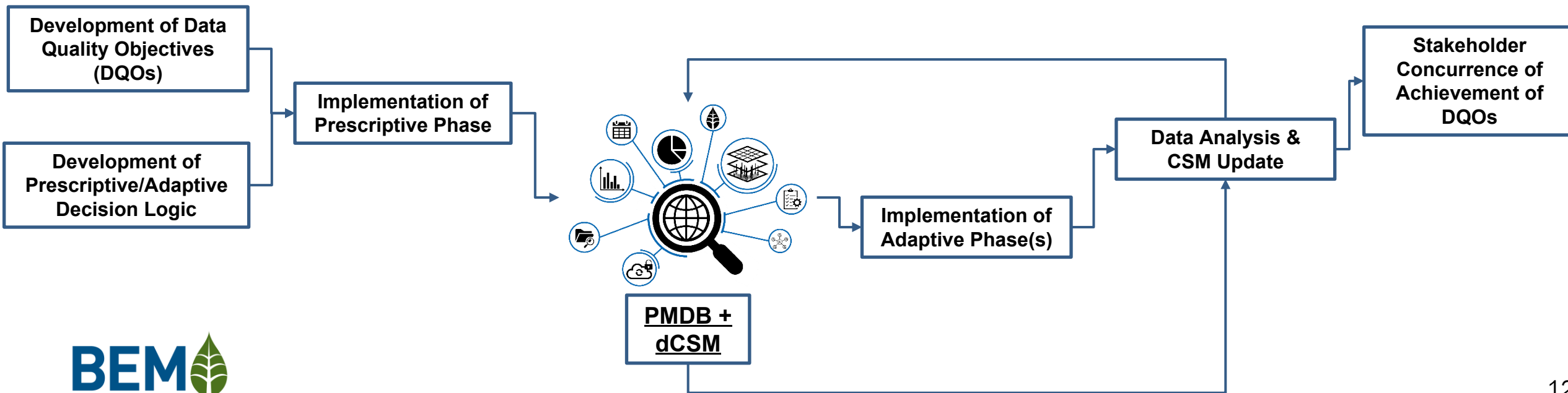


Source: BEM Systems, Inc.



STAKEHOLDER ENGAGEMENT STRATEGIES

- Adaptive logic defined and approved in Work Plan
- Real-time data review & CSM updates
- Interim scoping decisions and concurrence on achievement of DQOs were made **collaboratively** with stakeholders
- Supported by **PMDB+dCSM**
 - Allowed DoD & regulatory stakeholders to track project progress and review interim data and deliverables
- Interim decisions and work plan deviations efficiently documented



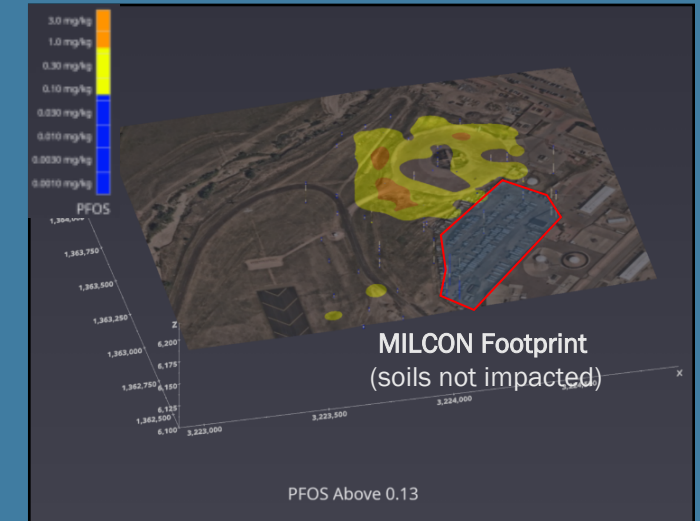
RECOGNIZED BENEFITS

- Accelerating RI process
- Refining CSMs and building robust, defensible datasets
- Increasing collaboration and data transparency
- Prioritizing source areas
- Quantifying off-site migration and assessing risk
- Identifying data gaps
- Programming interim remedial action or supplemental investigation
- Adapting to changing regulatory screening limits
- Coordinating with MILCON activities

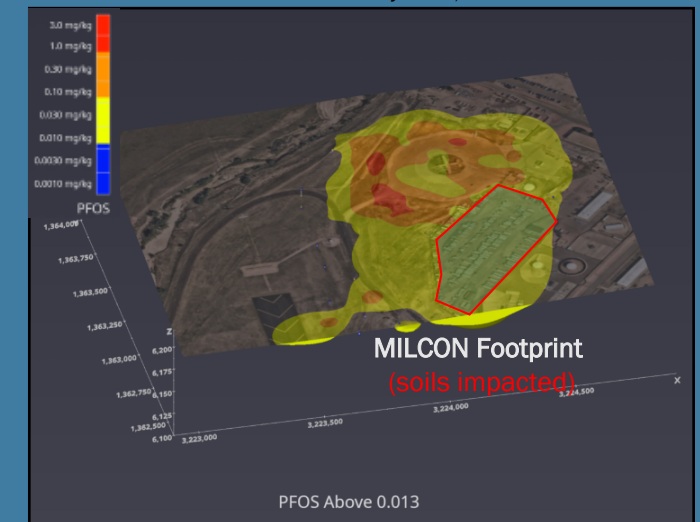
Proven success at installations with support by multiple EPA Regions¹ and State Agencies²



² Colorado Department of Public Health and Environment (CDPHE), South Dakota Department of Agriculture and Natural Resources (SD DANR), Alaska Department of Environmental Conservation (ADEC)



Source: BEM Systems, Inc.



CONSIDERATIONS FOR APPLICATION

- Identification of key stakeholders to advocate for adapting to new workflows for interim decision-making and documentation approval
- Coordination across multiple entities
 - (e.g., between Installation MILCON & Environmental Restoration programs)
- Securing access to confidential or preliminary info
- Analytical data turn-around times, acceptance of screening analytical methods
- Quality and format of third-party data sources



THANK YOU, QUESTIONS?

Arthur Wickham, MSc, PG, CHG
Sr. Project Manager | Sr. Hydrogeologist
awickham@bemsys.com | 908.598.2600 x278

Colorado Office
12265 W Bayaud Ave, Suite 235
Lakewood, CO

Acknowledgements:

Air Force Civil Engineering Center (AFCEC)
Arcadis (Teaming Partner)
Pace Analytical Mobile Lab

