Evaluating Technology Transfer Challenges and Successes: The XRF Case Study

Battelle 2018

Carlos Pachon, U.S. EPA

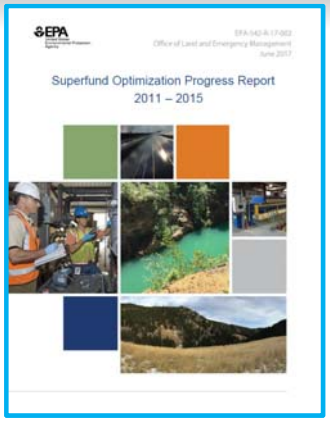
Jed Costanza, Deana Crumbling, Linda Fiedler, Ed Gilbert (U.S. EPA)

Wendy Condit (Battelle)

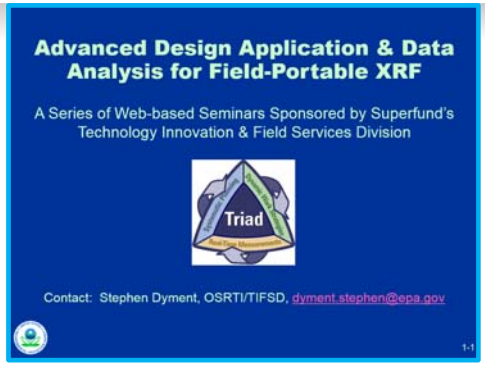
OVERVIEW

- Superfund's Tech Transfer Mission & Approach
- Case Study Analysis on Advancing the Use of XRF
  - EPA XRF and Triad Tech Transfer Efforts
  - Tracking Tech Transfer Results: Measuring Impact
- Conclusions

US EPA TIFSD TECH TRANSFER FRAMEWORK



ORD/TIFSD Collaboration



EPA

Superfund Tech Transfer Outputs (FY 2017)

- 33 In-person training courses for 688 participants
- 106 Live seminars with 26,595 attendees
- 506,909 downloads and 20,604 online replays of 54 archived seminars hosted in FY17
- CLUIN had over 2.8 million sessions in FY17, with 736,000 document downloads (that doesn't count seminar downloads)
- TIFSDs collective web presence across all our websites had 4.3 million sessions in FY17
- Optimization or technical support provided at 90 sites

XRF: EMERGENCE OF A DISRUPTIVE TECHNOLOGY

The Basics

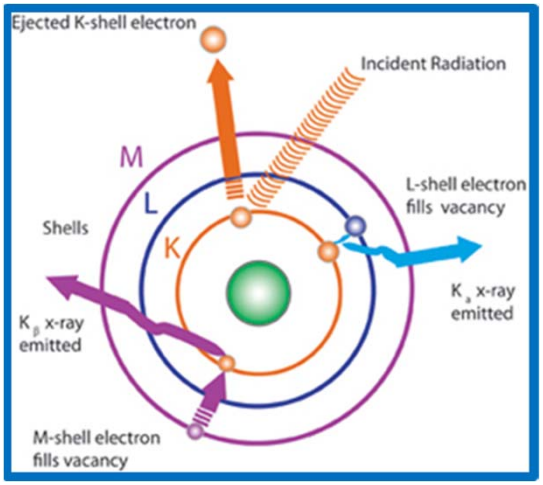
- X-ray source irradiates sample
- Target emits characteristic x-rays
- Spectrum produced from frequency and energy level of detected x-rays
- Concentration estimate based on sample assumptions

Development Milestones

- 1948 First Commercial XRF Prototype
- 1960s Portable XRF Technologies Available
- 1980s Miniaturization, Improvements in X-Ray Tube Source, Detectors, Battery Life, Algorithms, Connectivity to Devices, Price
- 1990s Demonstrations (ETV, SITE…)

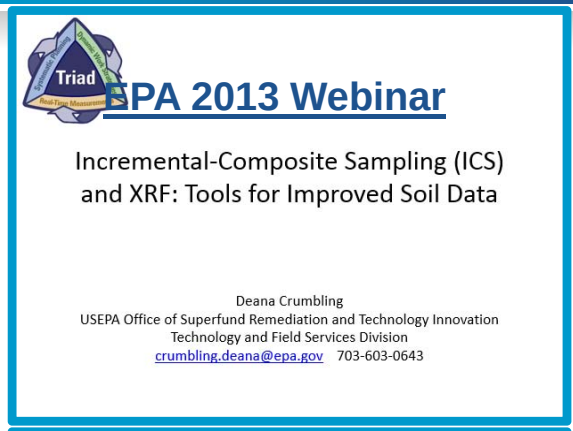
A Disruptive Technology

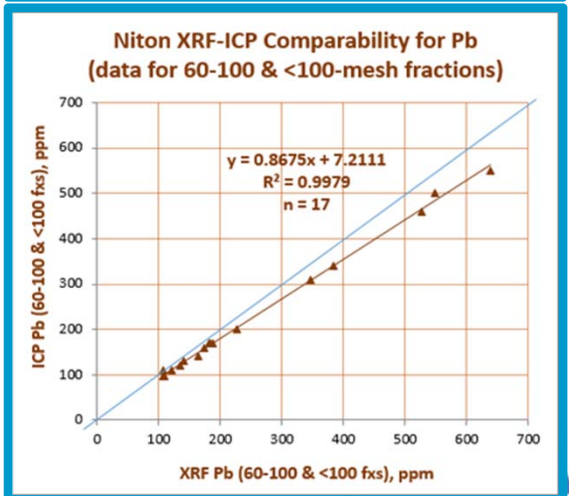
- Real-time data metal sites
  - Potential for fewer mobilizations
  - Immediate detection and correction of sampling and analysis issues
- Lower per-samples costs
- Higher sampling density



XRF TECHNOLOGY CHALLENGES

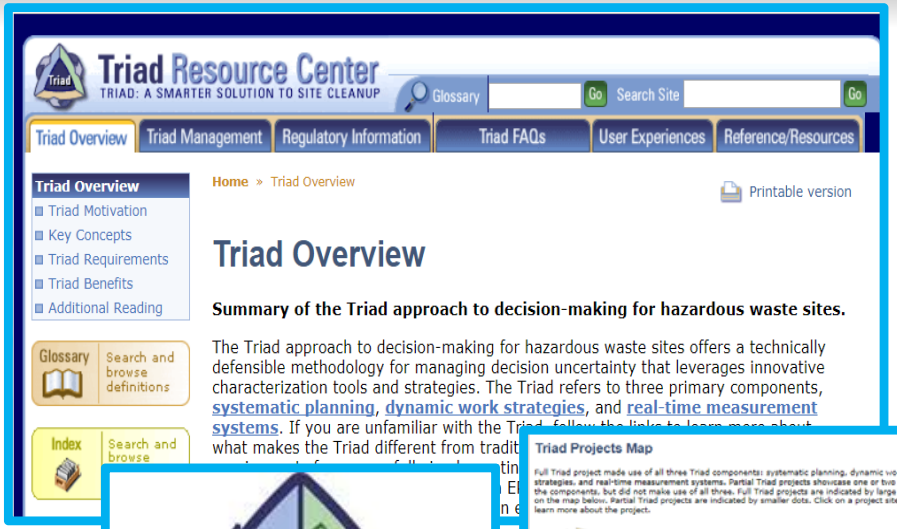
- XRF detection limits and costs decreased
- Radiological issues were addressed
  - Radioisotope source to x-ray tube
- Widespread use still hindered
  - Legacy sampling protocols & heterogeneity
  - Inadequate quality assurance
  - Site operations unable to maximize the value to real-time data
  - Challenging contracting mechanisms





TRIAD APPROACH:
It takes more than a new technology

- EPA TIFSD Developed
- Multi-Agency Buy-In
- Triad Central Web Site
  - 2004 to present
  - 11 XRF case studies (‘98 to ‘10)
- EPA/ITRC Triad Guides (2)
- Triad Training Courses
  - 2001 to present
  - 15 course titles; 45 sessions



US EPA XRF TRAINING TIMELINE

ETV Webinar
Evaluations of Lead-in-Dust Technologies

NIEHS/EPA
Metals Analytical Methods

EPA Regional XRF Workshops (139)
'07, '08, '09, '14, '17

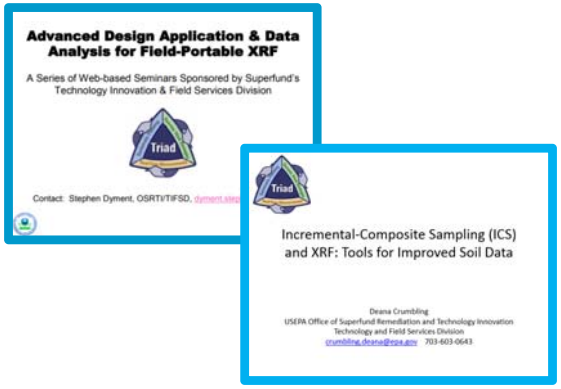
EPA CEC
Advanced Design Application and Data Analysis for Field XRF (8 offerings; '07 to '09)

Clu-In
XRF Sessions 1 to 8

2014 International Workshop on the Incremental Sampling and Field XRF for Metals Contamination in Soils (75)

Clu-In
Improving Data Quality with XRF and Incremental Sampling

2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015



XRF Session 1: Introduction and Basic XRF Concepts
XRF Session 2: Representativeness Part 1
XRF Session 3: Representativeness Part 2
XRF Session 4: Demonstration of Method Applicability (DMA)
XRF Session 5: Quality Control
XRF Session 6: Dynamic Work Strategies Part 1
XRF Session 7: Dynamic Work Strategies Part 2
XRF Session 8: Q&A and Resource Review

Note: Additional Brownfields, CEC, NARPM, and OSC Readiness Academy courses covered XRF as part of coursework

EPA

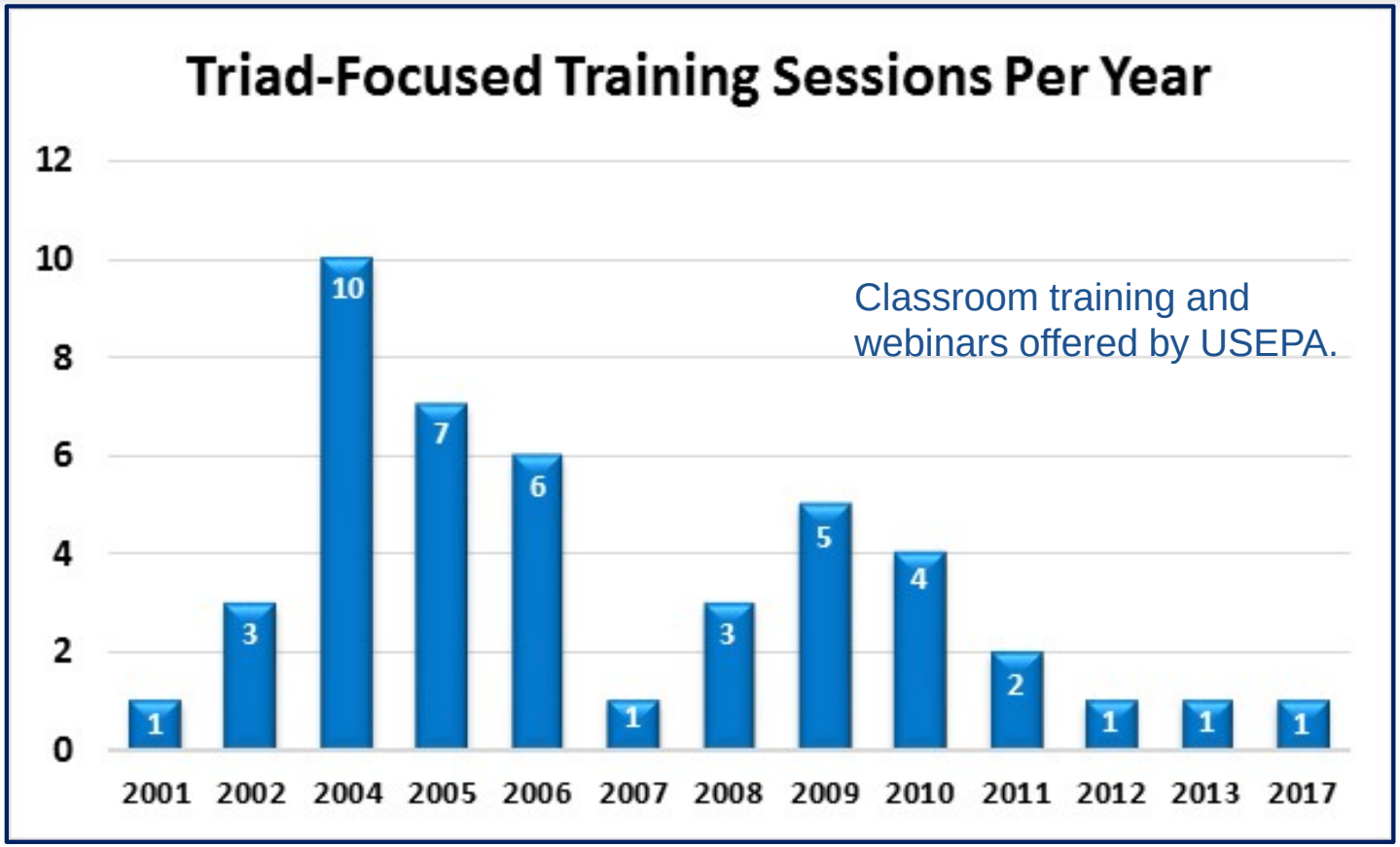
TECHNICAL SUPPORT AND PARTNERING

- Tech Support and Evaluations
  - Superfund Optimization Efforts
  - Region-Specific Support
- Partnering
  - Triad Community of Practice
  - Federal Remediation Technologies Roundtable (FRTR)
  - Interstate Technology Regulatory Council (ITRC)

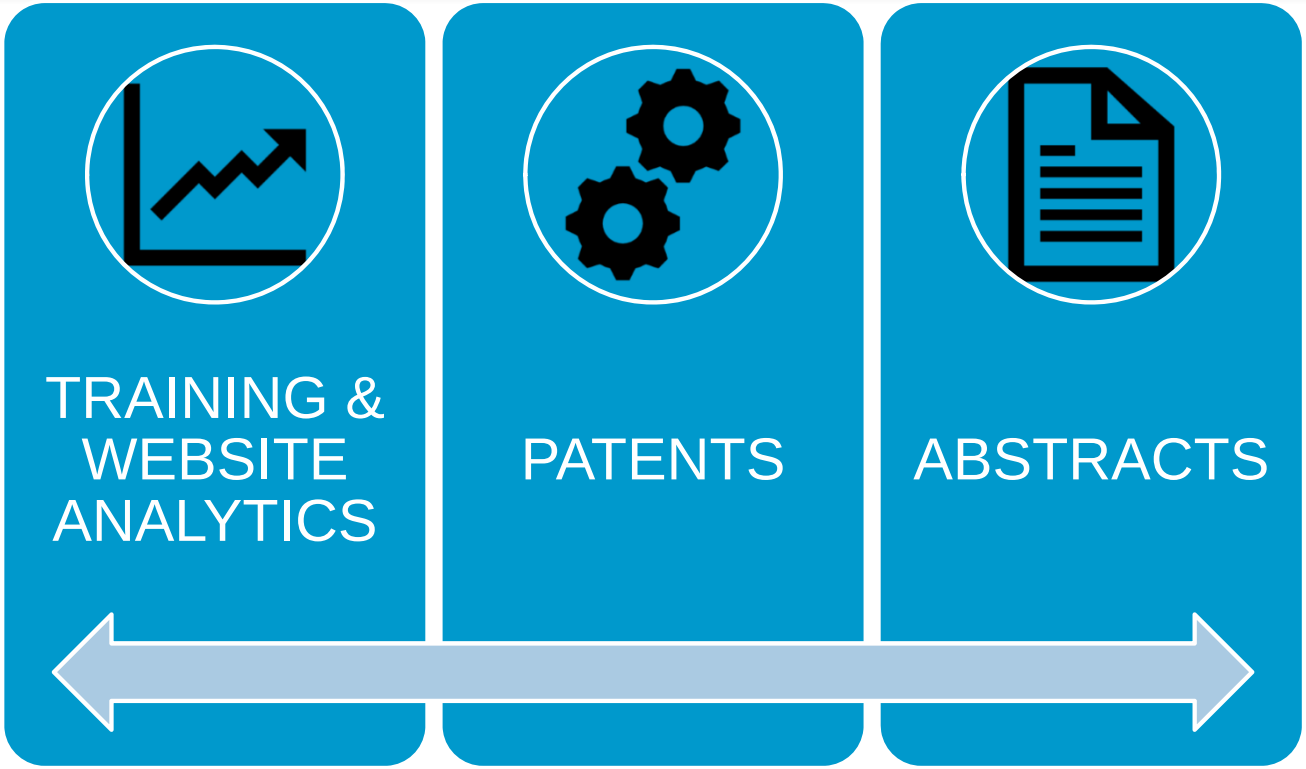
XRF Field Projects Designed and Implemented by TIFSD

2009 Jacobs Smelter, UT (Pb)	2015 Colorado Smelter, CO (Pb & As)	2015 U.S. Forest Service, AR
2016 Furnace Creek, MO (Pb)	2017 Wilcox Oil, OK (Pb)	2017 Carson River Mercury Site, NV (Hg)

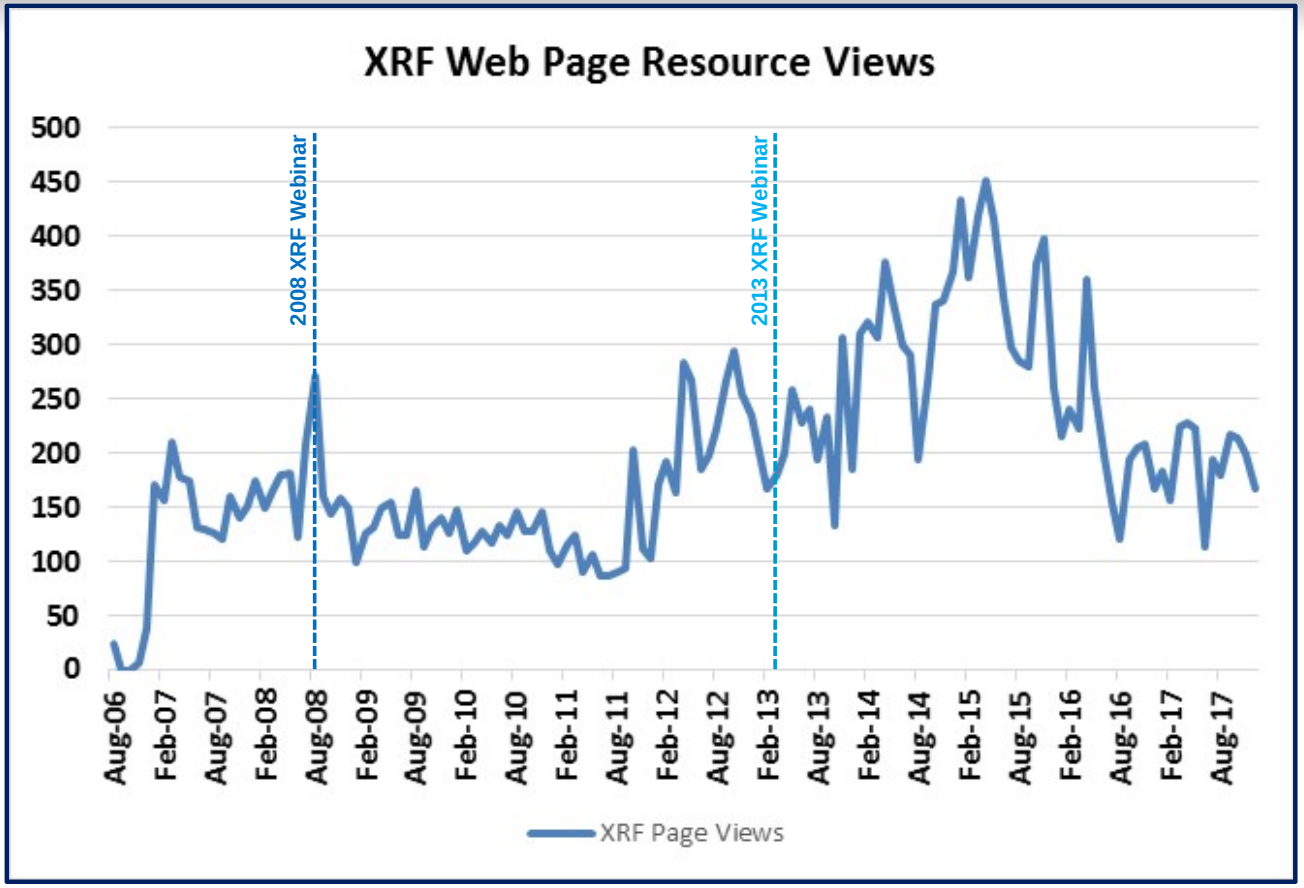
TRIAD TRAINING TIMEFRAME



MEASURING IMPACT: DATA SOURCES REVIEWED



XRF WEB RESOURCES VIEWS

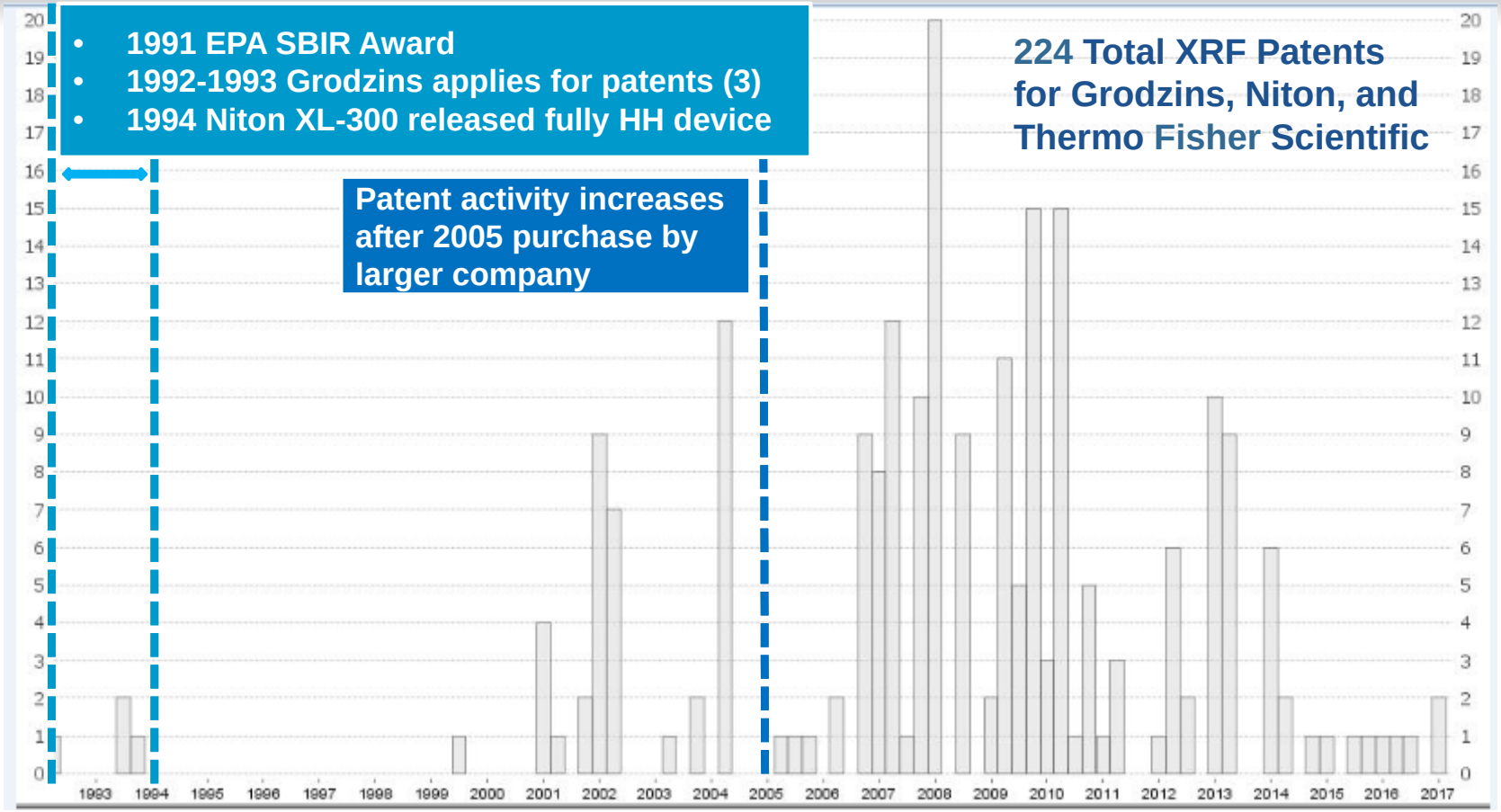


HANDHELD XRF TECHNOLOGY ENTERS MARKET

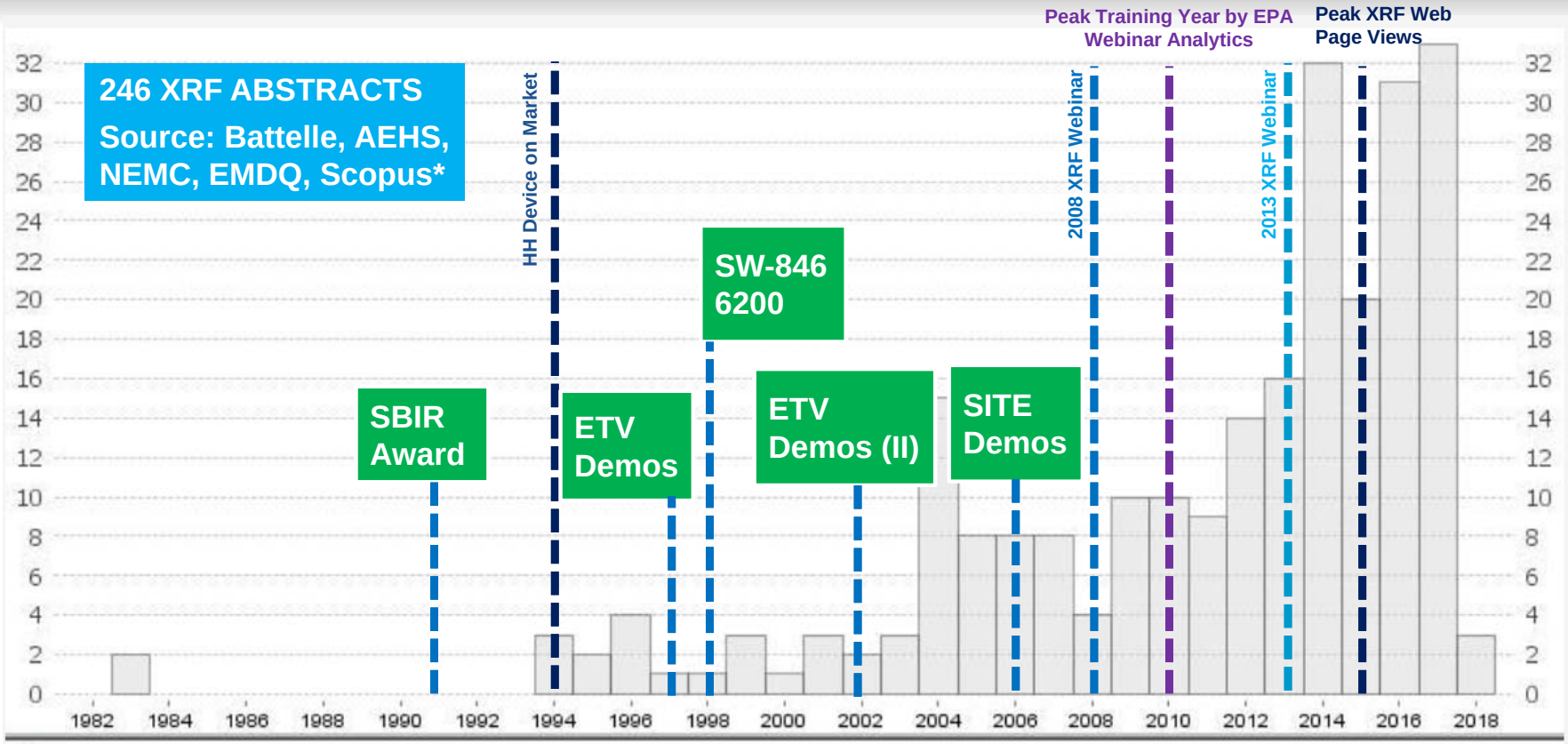
- 1991 EPA SBIR Award
- 1992-1993 Grodzins applies for patents (3)
- 1994 Niton XL-300 released fully HH device

Patent activity increases after 2005 purchase by larger company

224 Total XRF Patents for Grodzins, Niton, and Thermo Fisher Scientific

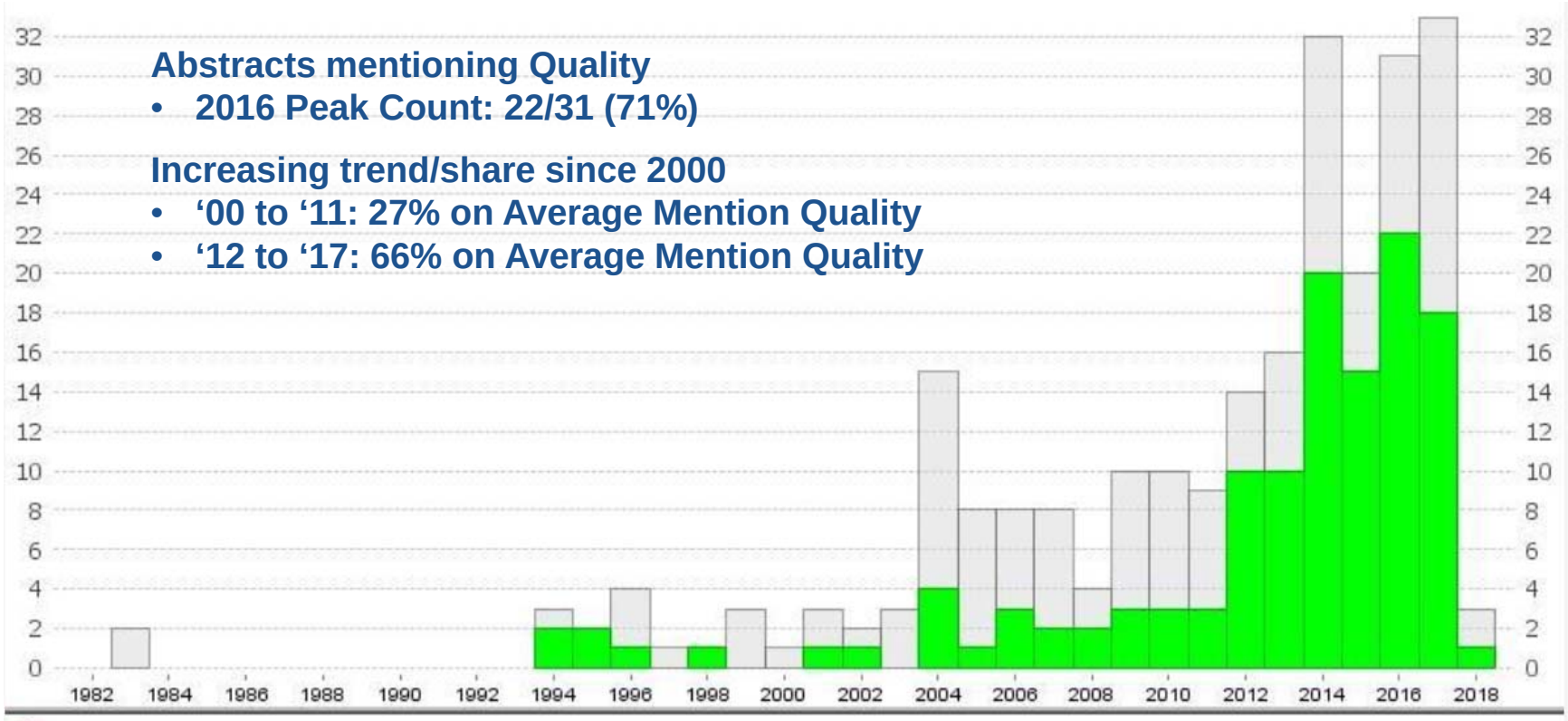


XRF ABSTRACTS: TREND OVER TIME

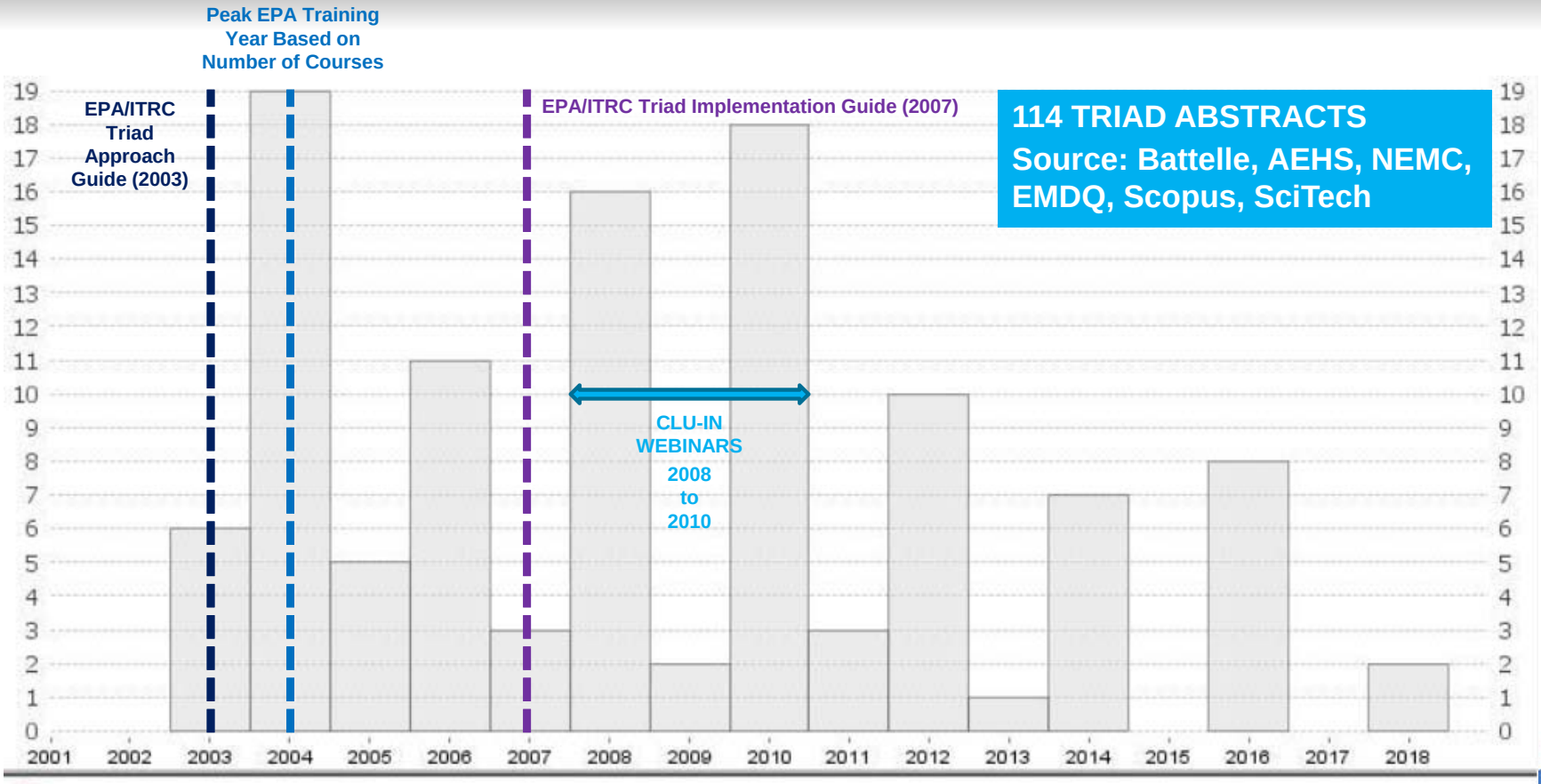


Scopus search = XRF, x-ray fluor; soil; and portable or handheld

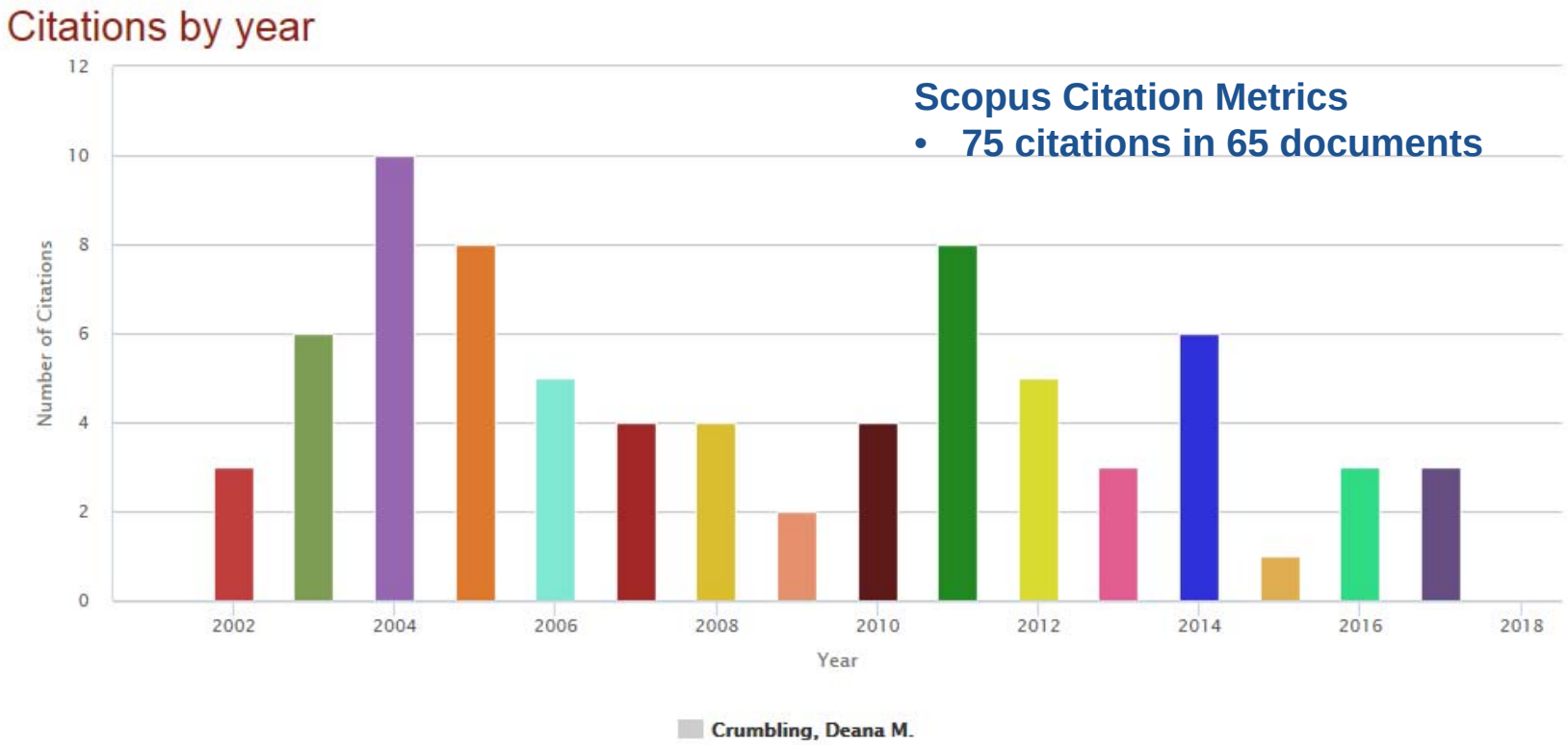
XRF ABTRACTS THEMES: “QUALITY”



TRIAD ABSTRACTS: TREND OVER TIME



TRIAD ABSTRACTS: EPA MENTIONS



Scopus Citation Metrics

- **75 citations in 65 documents**

TRIAD ABSTRACTS: EPA MENTIONS

"*The Triad Approach developed by the **Technology Innovation Office of EPA** saves considerable time and money at complex sites.*" **– G.E. Conrad, Interstate Compact Mining Commission (2003)**

Triad Implementation at Brownfield Sites

*"New Jersey has more than 10,000 contaminated sites, many of them brownsfields' areas where timely remediation is critical to commercial viability. **The Triad approach promoted by the United States Environmental Protection Agency and the Interstate Technology Regulatory Council**, has been adopted by the New Jersey Department of Environmental Protection (NJDEP) as a way to expedite the cleanup of such contaminated sites."* **- Nagourney and Sogorka (2004)**

Automated Environmental Monitoring, Data Visualization, and Critical Resource Management

"Over the past several decades, …practitioners have developed field analytical methods… These… "innovative" approaches are now commonplace and even standardized, as the cost and time benefits have been conclusively documented and even promoted through technology transfer vehicles such as **Triad workshops**, Interstate Technology and Regulatory Council (ITRC) technical regulatory guides…" **- Kram et al. (2010)**

Application of the Triad Investigation Approach in a Traditional Regulatory Framework

*"The project team worked with state regulatory officials and **U.S. EPA staff in the Triad Technical Support Program** to develop an alternate adaptive investigation strategy that evaluated the extent of VOCs, metals, and PAHs at the site…"* **- Connolly et al. (2014)**

EXAMPLES OF DESIRED OUTCOMES

Battelle Abstract (Connolly, 2014)

Application of the Triad Investigation Approach in a Traditional Regulatory Framework

- Geosyntec, among Top 100 C&E firms incorporating Triad into their standard practices
- XRF used with other field portable sampling and analytical technologies dynamically updating the CSM

Battelle Abstract (Hess, 2014)

Characterization for Lead in Soil at Munitions Sites throughout the United States

- A dynamic investigation strategy at projects at DoD facilities across the country
- Consulting firm (Gilbane) also has openings for environmental scientist specifying operating XRF in the field (posted mid-March)

EMDQ Workshop (Blake, 2016)

EPA Triad Approach: Former Naval Petroleum Reserve #1, As in Soil Assessment

- Environmental Monitoring & Data Quality Workshop (DENIX, online)
- Presented by Athna, subsidiary of an Alaska Native Corporation.
- Definitive, representative and fully defensible data for supporting risk assessment decisions
- Triad applied, as well as ISM, to address sample heterogeneity

CASE STUDY CONCLUSIONS

- **Impact of TRIAD Tech Transfer: Lines of Evidence**
  - Triad abstracts are evidence of EPA TIFSD-developed initiative
  - Higher number of abstracts during more intensive period of EPA/ITRC guidance release and training (‘03 to ‘10)
  - Data mining identified EPA TIFSD themes in abstracts (data quality, decision uncertainty, etc)
- **Impact of XRF Tech Transfer: Lines of Evidence**
  - Increasing trend in abstracts; majority mention EPA (58%)
  - EPA TIFSD themes are noted; significant increase in “Quality” focus of XRF abstracts
  - Similar trend in increasing abstracts and XRF tech transfer product usage
    - 2010 Peak EPA CLU-IN Webinar Views; 2015 Peak XRF Web Page Views
    - 2014 to 2016 Peak Years for Abstract Mentions of EPA, EPA Authors, EPA Method 6200, Demonstrations, and SOP Resources

EPA

SUPERFUND TECH TRANSFER CONCLUSIONS

- XRF entered the contaminated site characterization field with force, as a true “disruptive technology”
- Progress was slow at first, though significant tech transfer investments by Superfund and others have helped it become mainstream
- Several options are available, and needed, to advance the use of innovative technologies: Each overcomes a different market access barrier yet not all can implemented due to resource constraints
- Superfund will continue to focus tech transfer efforts to areas where it has the highest return on investment

Thank You

www.cluin.org
www.trainex.org
www.triadcentral.org
www.epa.gov/remedytech

Carlos Pachon, U.S. EPA - pachon.carlos@epa.gov