Commitment to Long-Term Stewardship: An Overview of Scientific Processes and Technical Innovation to Ensure Safe and Resilient Management of Legacy Sites

U.S. DEPARTMENT *of* ENERGY

Office of Legacy Management

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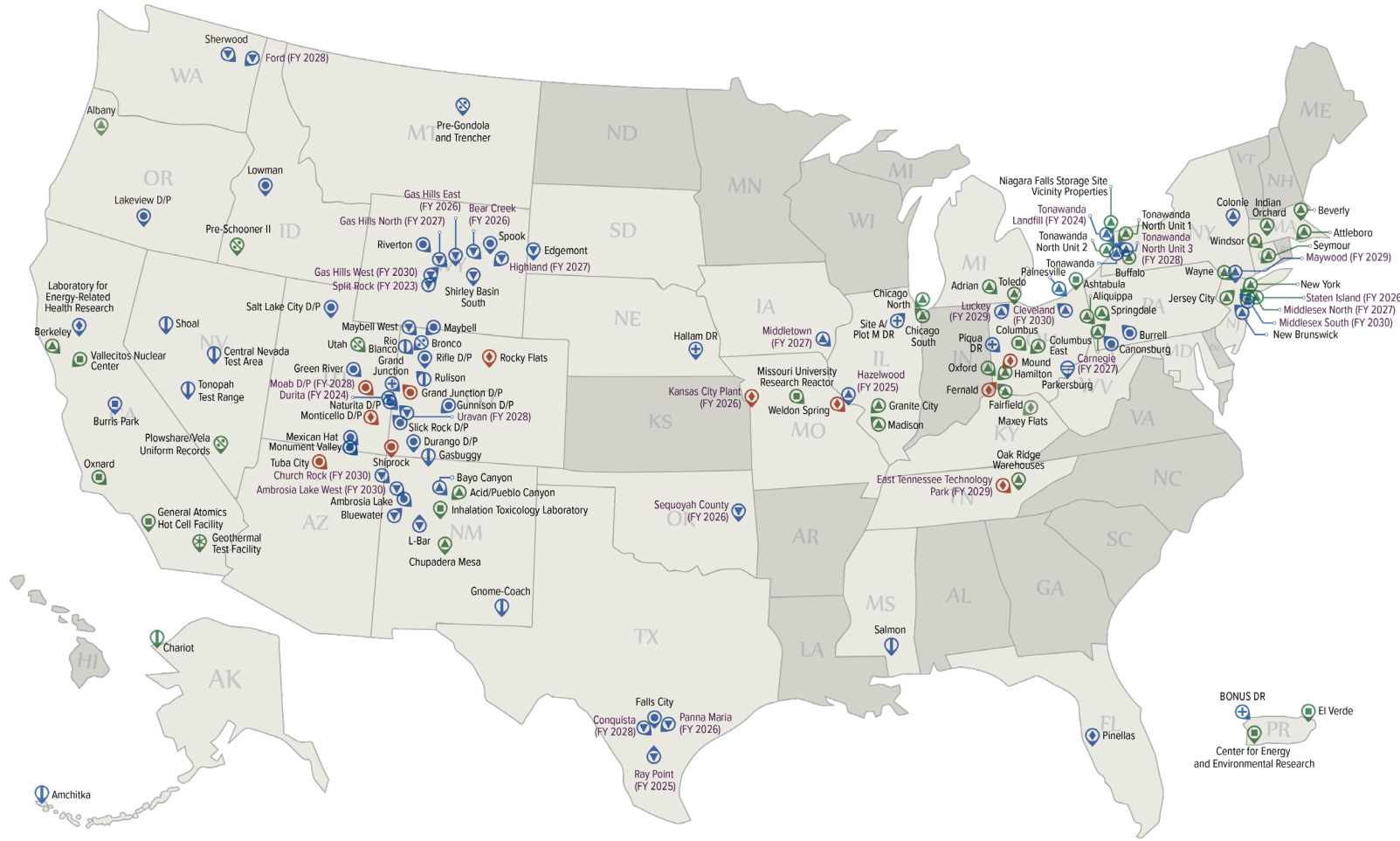
Site Map

Through 2030



Anticipated Sites in LM Through FY 2030 Requiring LTS&M				
CERCLA/ RCRA	D&D	FUSRAP	MED/AEC Legacy Site	Nevada Offsites
NWPA	Plowshare/ Vela Uniform Program	State Water Quality Standards	UMTRCA Title I	UMTRCA Title II

Site Category

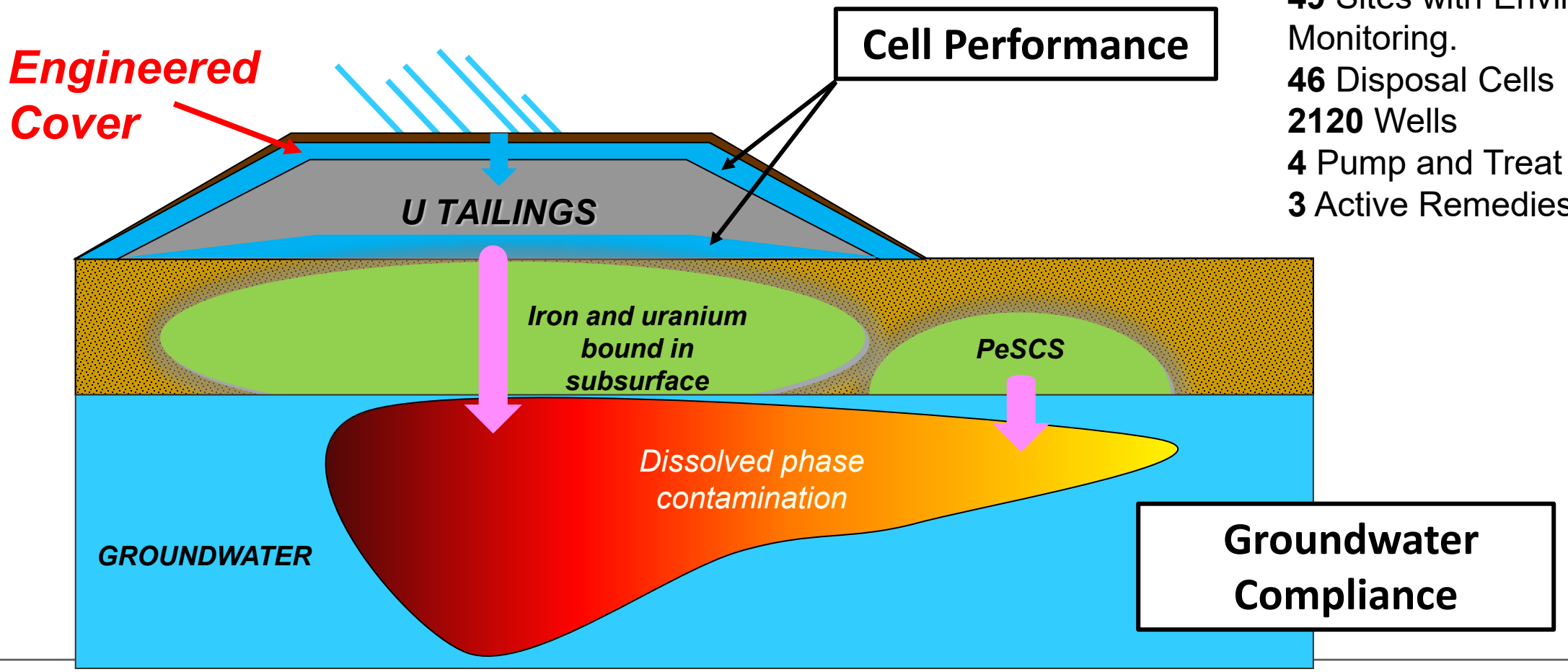
Category 1 activities typically include records-related activities and stakeholder support.

Category 2 activities typically include routine inspections (site visits are conducted to verify the integrity of engineered or institutional barriers) and monitoring/maintenance, records-related activities, and stakeholder support.

Category 3 activities typically include operation and maintenance of active remedial action systems, routine inspections (site visits are conducted to verify the integrity of engineered or institutional barriers) and monitoring/maintenance, records-related activities, and stakeholder support.

D/P = Disposal/Processing DR = Decommissioned Reactor 04/2023

Long-term Stewardship Inventory



49 Sites with Environmental Monitoring.
46 Disposal Cells
2120 Wells
4 Pump and Treat Systems
3 Active Remedies in evaluation

3

Support to the Site Life Cycle

Contamination Identified

Site Investigation/ Alternative Evaluation (UMTRCA)

Remedy Decision
Control Selection

Industrial
Residential
Recreation

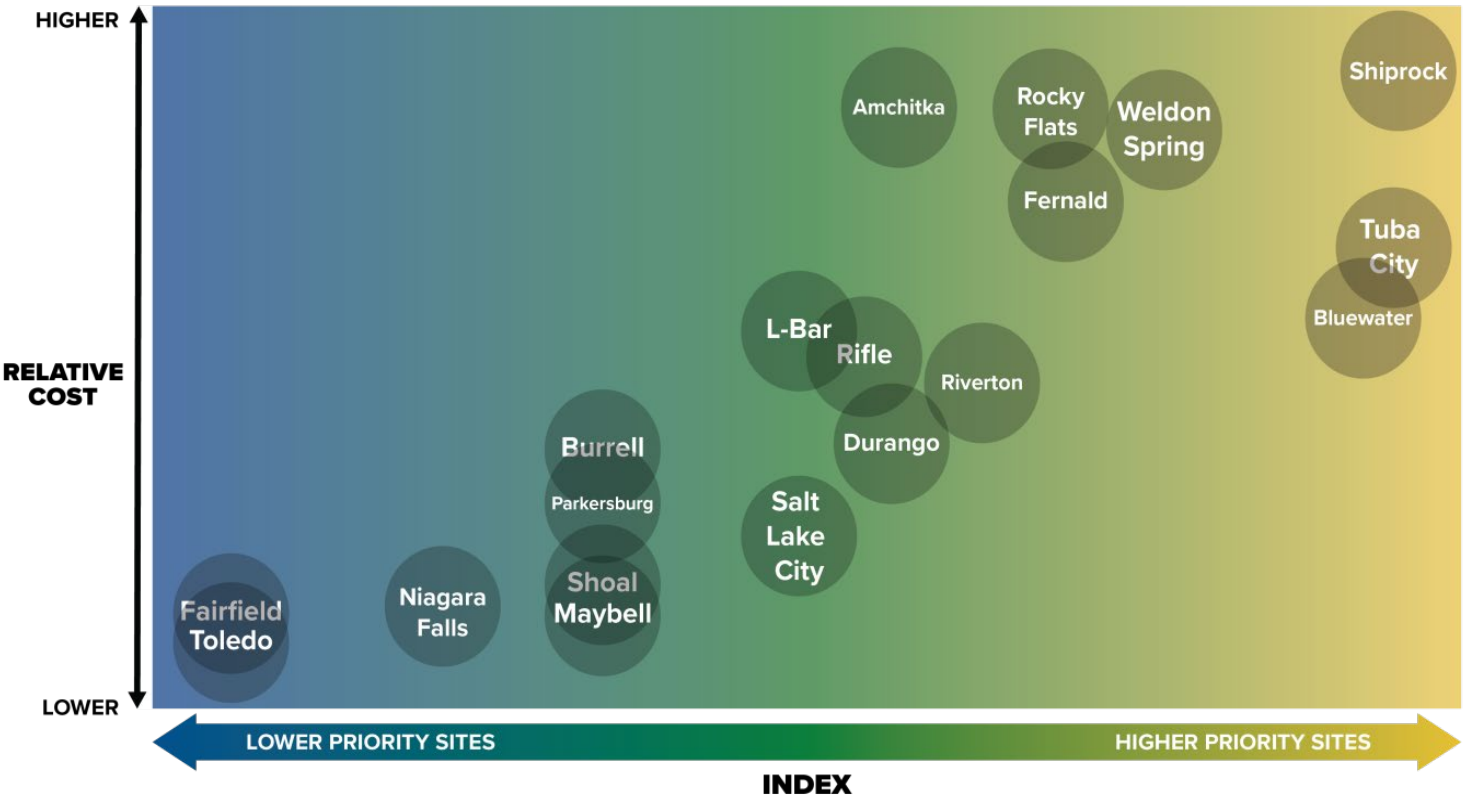
Remedy Implementation

Long-Term Stewardship

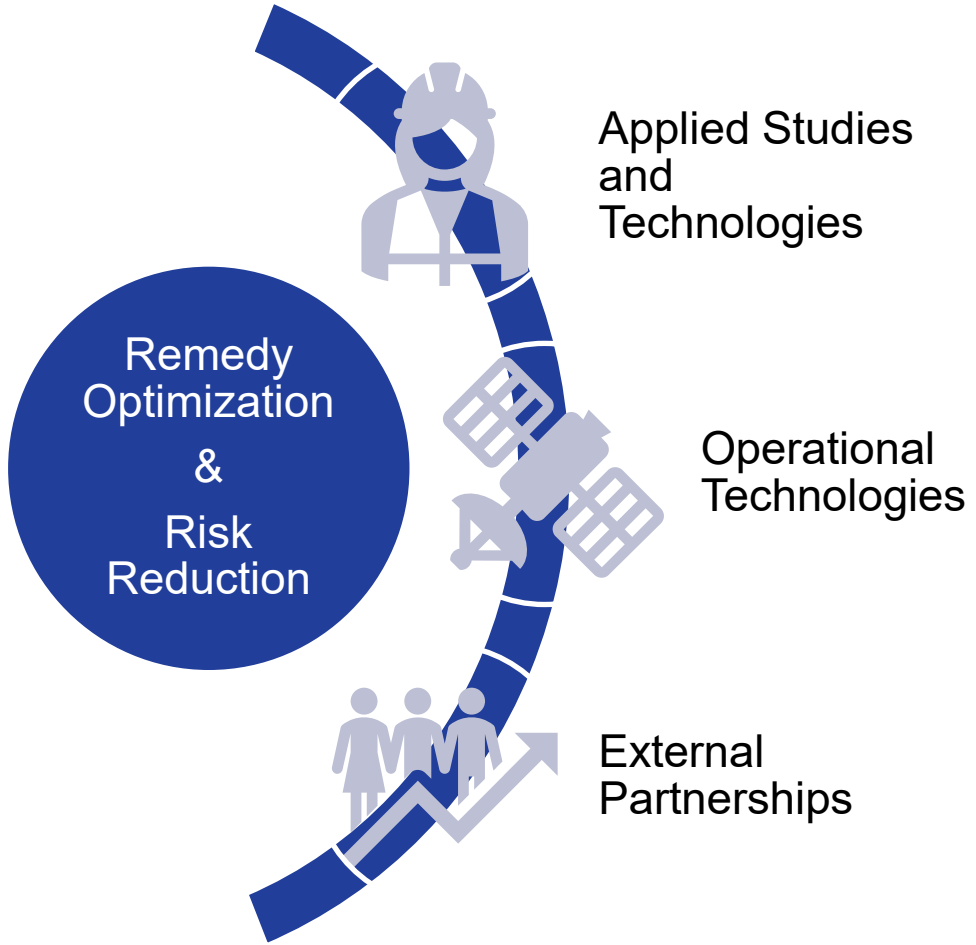
Revisiting/Optimizing Remedy

Remediation Goals Achieved

Overview of Scientific Processes and Technical Innovation



Risk screening completed in 2020



Applied Studies and Technology Program

The Applied Studies and Technologies Program

- **Focus area investigations**

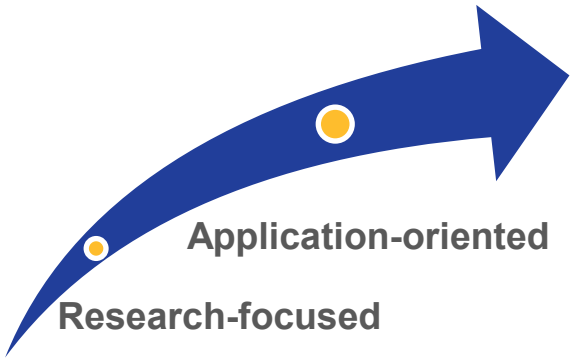
  Current focus areas:

  1. Disposal cell performance
  2. Groundwater
  3. Advanced technology applications

- **Technical support to site operations**
- **Support to educational collaborations and technical exchanges**
- **Support to NNLEMS engagements and working groups**
- **Support to Long-Term Stewardship Working Group**

The Applied Studies and Technologies Program

Right application … Right place … Right time



Program Management Plan

Support to Sites

Focus Area Investigations

Risk Informed Approach

Strategic View

Program Committee*

*Program Committee Members

- Darina Castillo
- Ken Kreie
- Mary Young
- Annette Moore

Educational Collaboration

We partner with academic institutions to support workforce development and produce actionable studies and technology targeted to address technical challenges at current sites.

AS&T facilitates these activities:

- Lectures and seminars emphasizing LM's mission and careers in geosciences
- Site tours to highlight remedies, studies, and long-term stewardship concepts
- Faculty collaboration to identify students
- Internships

Recent collaborations

- Colorado Mesa University
- Colorado School of Mines
- Diné College
- Navajo Technical University
- Michigan State University
- Ohio State University
- University of Arizona
- New Mexico Tech University
- University of Wisconsin-Madison

Site Support to LM's Mission

Decision support for risk reduction, remedy prioritization

- Performance and root cause failure analysis
- Regulatory collaboration
- Monitoring strategies
- Transitioning site risk assessment
- GCAP technical support
- National labs collaboration
- Educational collaboration

Technical expertise

- Erosion characterization and risk assessment
- Evapotranspiration analysis
- Enhanced cover design and analysis
- Water balance analysis
- Radon diffusion investigation
- Remote sensing and machine learning applications
- Mill tailings analysis
- Data mining and visualization

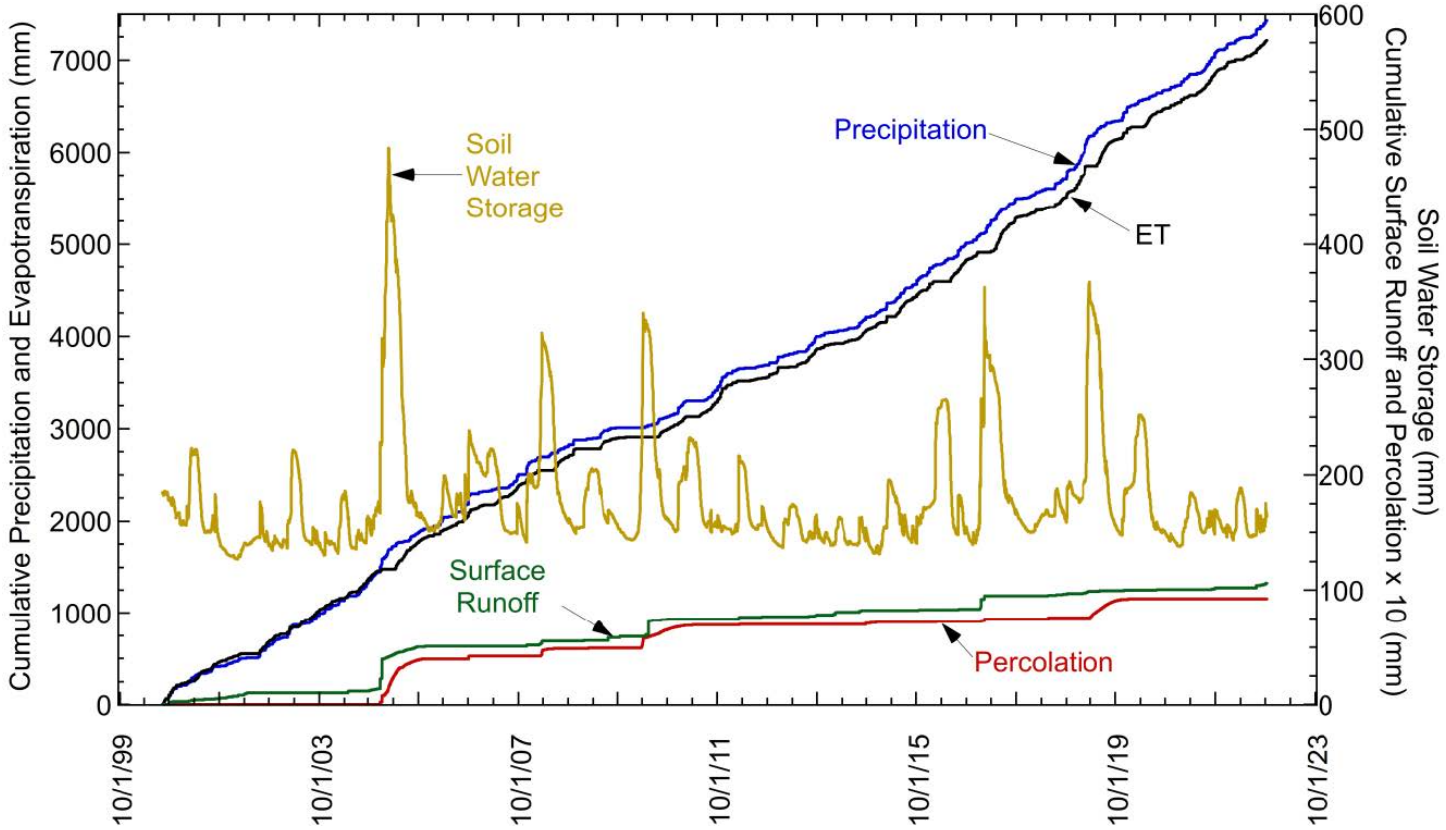
Recently Supported Sites (Q3 – Q4 FY25)

AS&T Support to Sites	Site	AS&T Study/Application Leveraged
Regenerative grazing study	Shirley Basin*	ECAP
ET forward/backward modeling	Gunnison*	Sensor Continuity
ET modeling	Old Rifle*	Sensor Continuity
Baseline Aerial Survey SOW review	Rifle	UAV tech feasibility/multispectral calibratic
Soil probe calibration and QA/QC	Mexican Hat	Water Balance
Review of final cover designs for two FUSRAP landfill sites	Tonawanda/Seaway*	READR
Technical review of Draft Completion Review Report	Ray Point, TX	DSALT, READR
Vegetation management	Durango	ECAP
Vegetation management	Splitrock	ECAP
Baseline Aerial Survey SOW review	Gunnison	UAV tech feasibility/multispectral calibratic
Cover Design Repair/Improvement Alternatives Analysis	Bluewater	DSALT/READR/RADAR
Subsurface characterization report review	Bluewater	READR, Erosion risk
CWG support	Mexican Hat	DSALT/RADAR
Technical input on draft LTSP	Panna Maria	DSALT/READR
Technical review and input on ET cover design document	Homestake/Grants	ECAP, Erosion risk
Vegetation survey and report	Bronco	ECAP
Targeted Enhanced Cover planning	Mexican Hat	ECAP, Erosion Risk, READR
Phase II Geotechnical Report	Mexican Hat	DSALT, READR, Erosion risk
Data management	Mexican Hat	Erosion risk
Vegetation survey, radon assessment, grazing survey	Burrell	ECAP
Aerial Survey Close Out Report	Weldon Spring	UAV tech feasibility/multispectral calibratic
Waste Management paper & presentation requested by:	Mexican Hat	READR, DSALT
Waste Management paper & presentation requested by:	Monticello	ECAP, Wate Balance, Sensor Continuity

** Previous to Q3, ongoing*

Cell Performance

Lysimeter **data informs compliance strategies** for enhanced covers, GCAP completion, risk prioritization, and long-term performance.



Instrumented site data

+

Remote sensing

Applications to other sites

- Improved LTS&M strategies
- Cost reduction
- Reduced instrumentation
- Compliance strategies
- Targeted enhancements
- Risk reduction

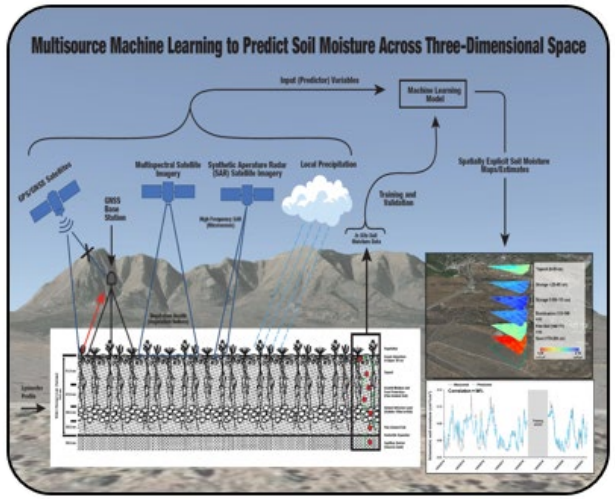
Key Technical Challenge

Development of Groundwater Remediation Strategies

Advanced technologies are currently being used to develop and train powerful data-driven machine learning algorithms to **improve ET, groundwater flow, contaminant transport, and soil moisture models.**

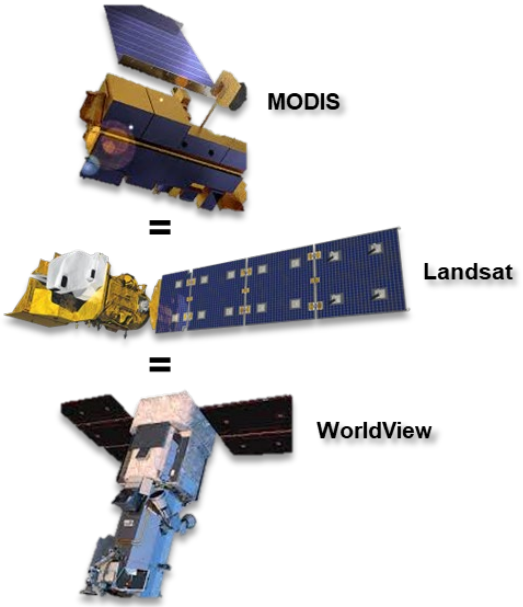
Multisource Machine Learning for Applied Monitoring of Soil Moisture

(Delivery: FY26)



Ensuring Sensor-Independent Vegetation Index ET Estimates

(Delivery: FY26)



In the near and long-term future, these models will be applied at LM sites **where ground data are lacking** to address regulator recommendations and improve LTS&M.

Key Technical Challenge

Erosion Risk

Poor cover construction practices, lacking QAQC, and inadequate assumptions, (e.g. subsurface erosion) was unanticipated problem

Key Objectives and Applications (delivery)

- Characterize and prioritize risk → DSALT FY25
- Advance innovative approaches → RADAR (Joint DOE-NRC project) FY26-27
- Inform cover design and remediation strategies → RADAR, READR FY26
- Support compliance → READR, RADAR, AMPER FY26-27
- Reduce costs
- Share knowledge → AltCDR FY27

DSALT = decision support/erosion scoring; RADAR = flume studies; READR = retrospective design; AMPER = repair; AltCDR = alternate cover

Key Technical Challenge

Enhanced Cover Applications

Pilot tests reinforce the feasibility and potential impact of full-scale enhancements

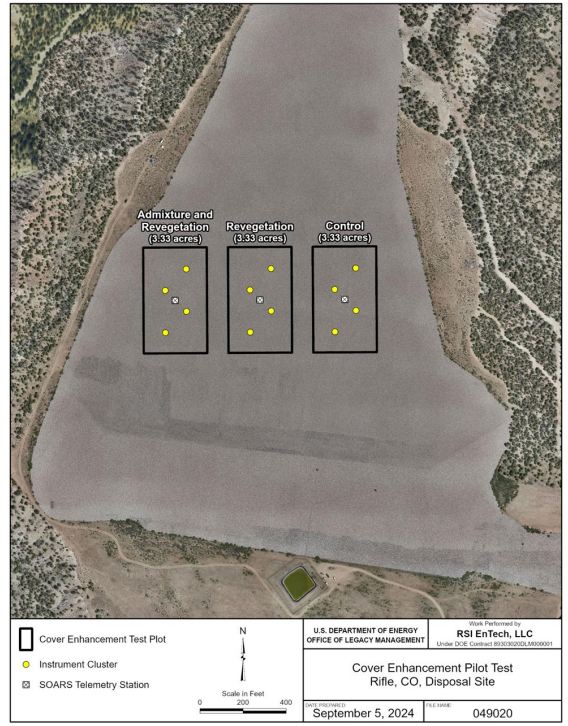
Critical findings: ~10% vegetative cover can reduce percolation by over 90% (vs. conventional riprap cover)

Achieving regulatory agreement:

Cover enhancement strategies mature as a **compliance strategy**

Future Outcomes

- More efficient surveillance and monitoring
- Reduction in site maintenance
- Collaborative pairing with:
  - Site operations
  - Erosion risk studies
  - Remote sensing studies
  - GCAP planning

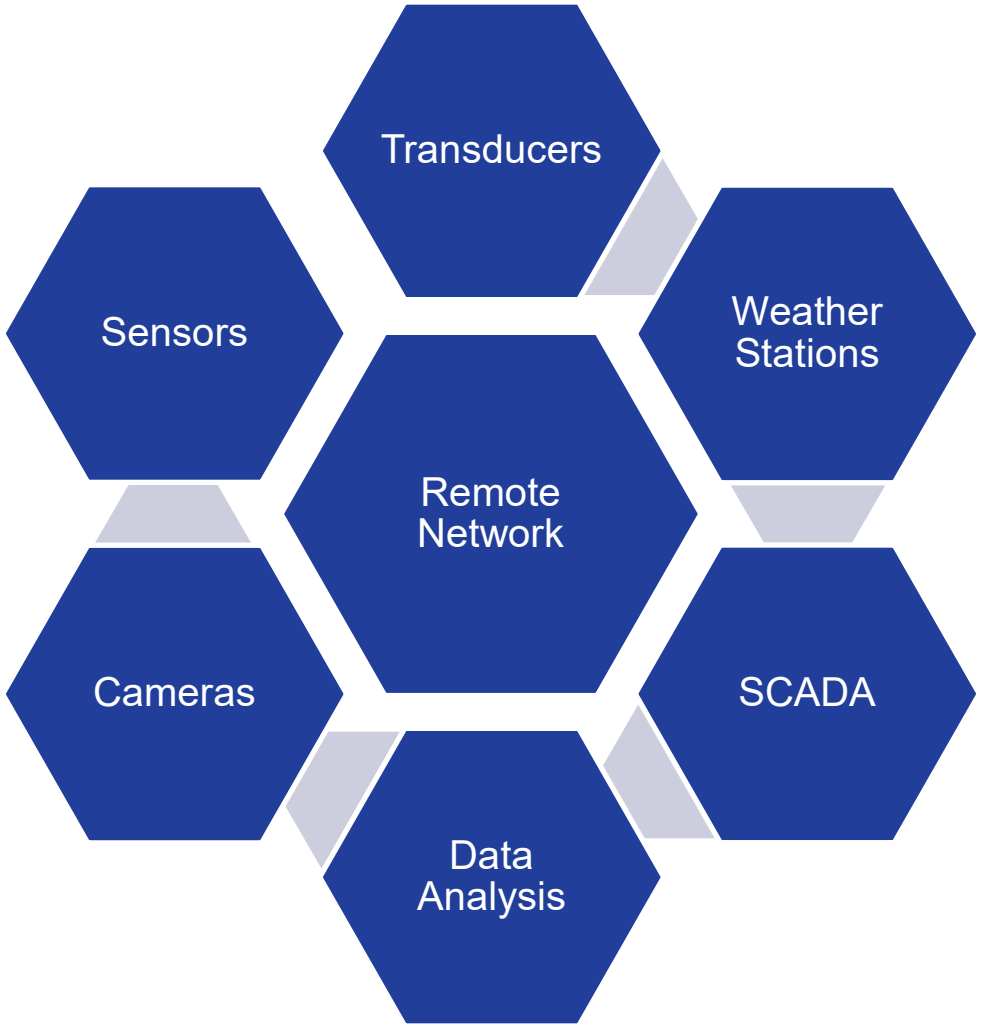


Candidate Sites

- **Pilot implementations:** Grand Junction, Rifle
- **Requested implementation:** Mexican Hat
- **Considered implementations:** Bluewater, Tuba City, Shiprock, Transitioning Title II sites

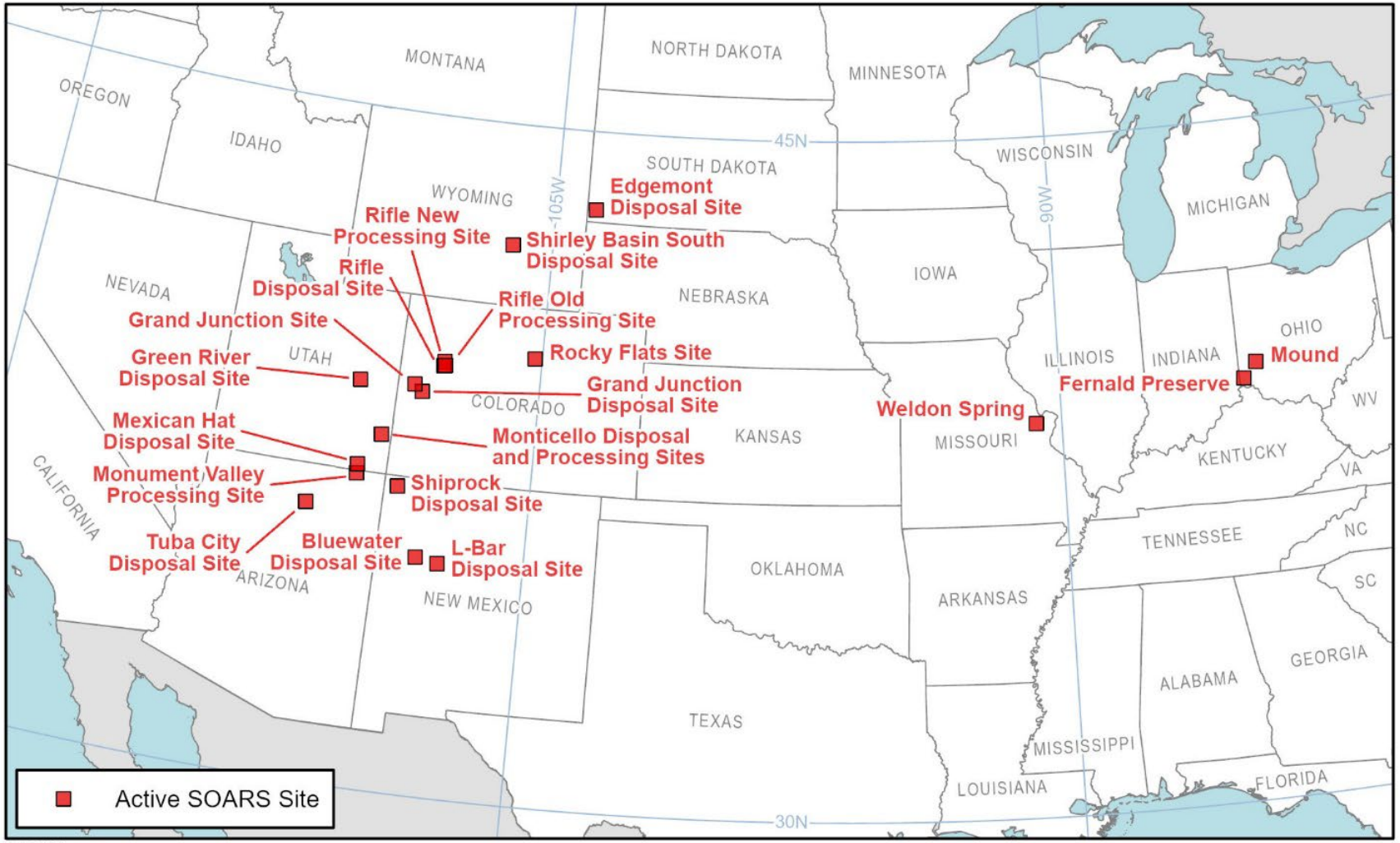
Operational Technologies

Automating LTS&M Processes



Soil moisture monitoring at GJDS ECAP pilot plots

System Operation And Analysis at Remote Sites (SOARS)



SOARS Installations are at 21 Sites in 9 states

Current (2024)

Benefits of Remote Telemetry

Reduce Field Trips

Deployment of remote equipment in the field allows for frequent checks of the state of the environment.

Personnel are not needed to check rain gauges, intermittent channels, or water levels.

Time Visits

In some cases, a visit to site is most prudent during or after a specific event.

Monitoring real time data and setting up alerts allows staff to plan timely trips to site following anticipated events.

Operate Equipment

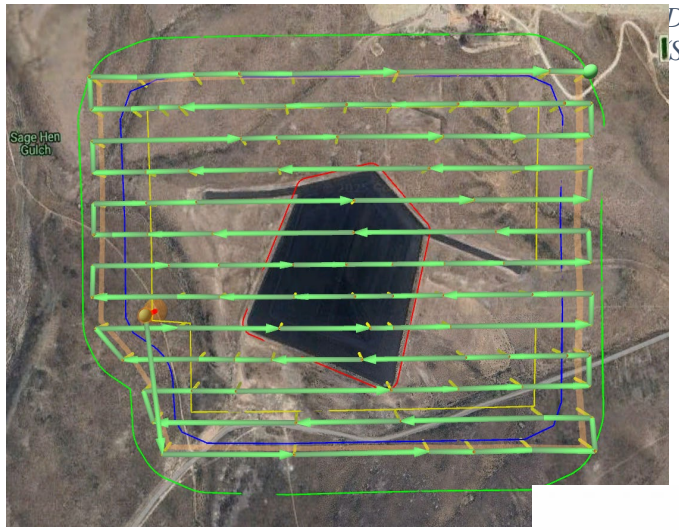
The data loggers can be programmed to turn equipment on or off based on pre-determined conditions.

Pumps, fans, and lights can be programmed to turn on and off when conditions meet those requirements.

Remote Sensing and Unmanned Aerial Systems

- Lidar and Photogrammetry
  - Monitoring terrain vegetation, and infrastructure.
  - Detect early warning signs for erosion
  - Integrated in site inspection activities.

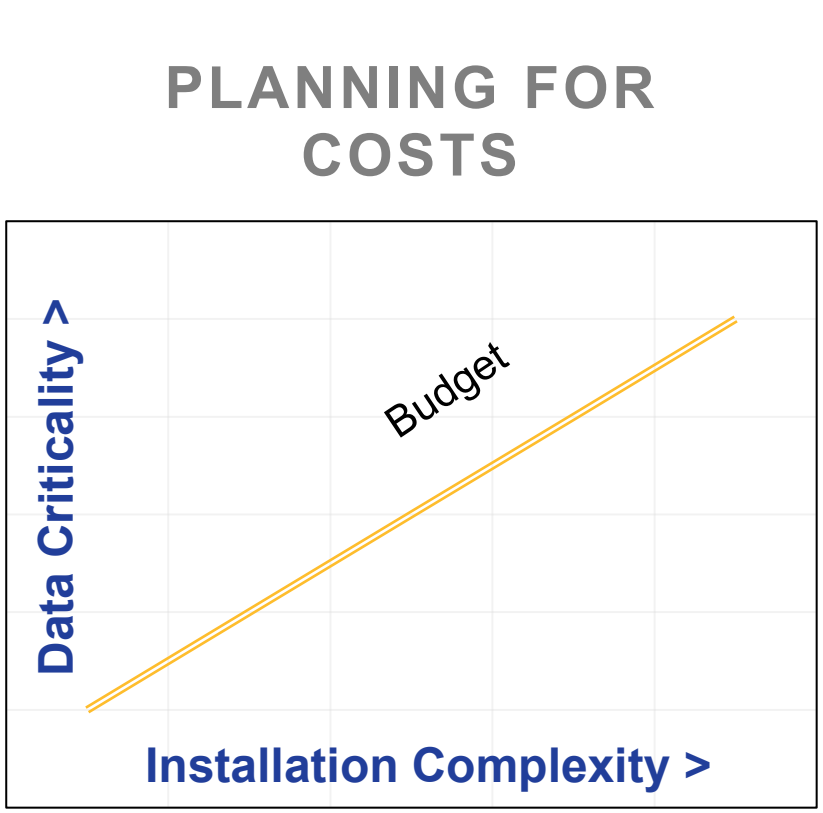
- Exploring
  - Multispectral imaging
  - Satellite Imagery



Disposal Site Lidar Acquisition flight path (Skyfront Mission Software)

Skyfront Perimeter 8+

Lifecycle Baseline Planning – Factors to Consider



Criticality of the Data

If the data is critical for decision making, plan to succeed by budgeting for maintenance and replacement.

Quantity of Stations

The more equipment means more opportunity for issues.

Complexity of Sensors

Complex sensors include:

Anything collecting water, measuring flow, plus radio communication pathways

Known issues

Weather exposure
Previous domestic or wild animal
History of corrosion
Known vandalism

External Partnerships

Partnerships to Problem Solving

NNLEMS

Universities

Consultants

Federal Partners

Regulators

Stakeholders

Examples of Partnership Solutions

Identification of Risk Management Strategies

- High Risk Working Groups
- Climate Risk Analysis
- Disposal Cell Performance

Remedy Optimization ($6M Cost Savings/Cost Avoidance)

- Mound - Remedy Change from Active to Passive and reduction of sampling
- Pinellas - Clean Closure of 2 Operable Units and Reduction Bio Injections

Enhancing Communications

Public Communication

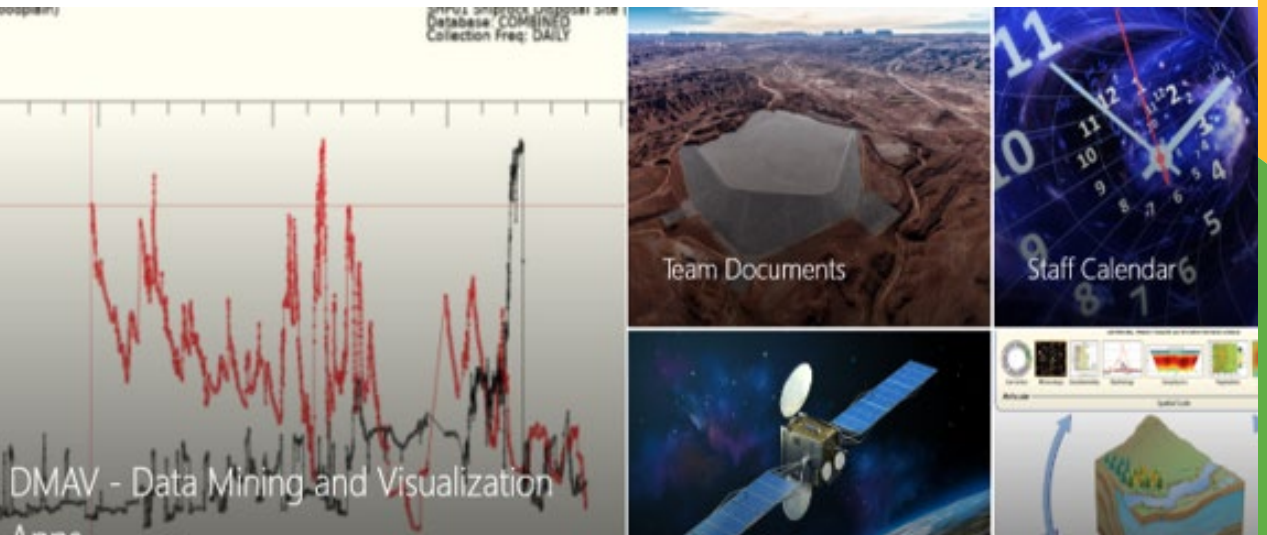
- Social Media and LM Publications
- Scientific Reports/Peer Review Publications

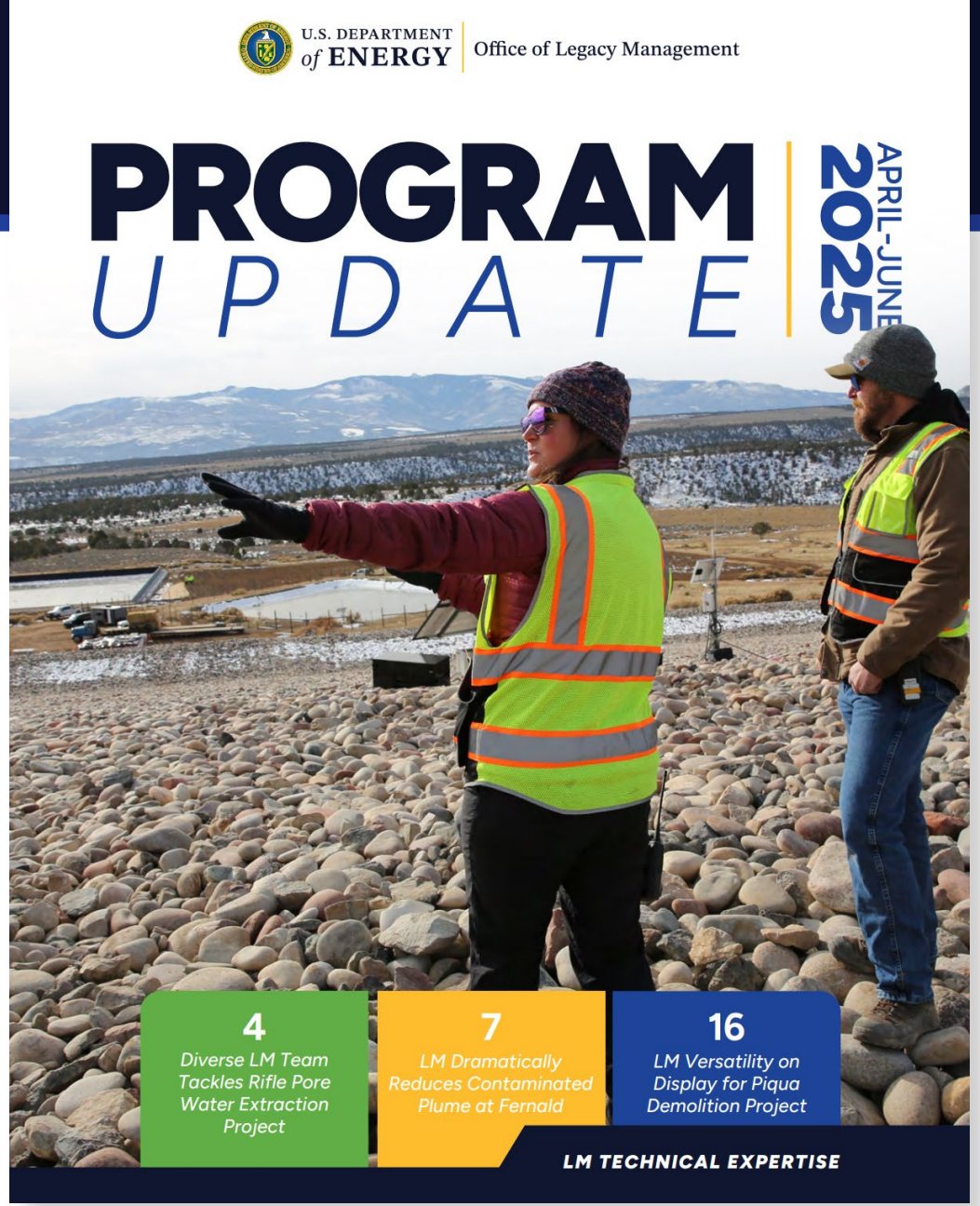
AS&T SharePoint

- View our expertise and capabilities
- View available tools and applications
- Key word search our past reports

Enhanced reporting

- SITREP
- LM weekly reports





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