Idaho National Engineering and Environmental Laboratory

Underground Corrosion After 32 Years: A Study of Fate and Transport

Kay Adler Flitton, PI

INEEL
SRTC
Edward Escalante
Boise State University
Ohio State University
NIST
Diversa Corporation
GoldSim Consulting Group

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Objective

Improve the quality of long-term corrosion data and understanding of the interrelation between underground metal exposure and the surrounding environment to reduce the uncertainty of fate and transport models.

Buried Waste Containers and Activated Metal

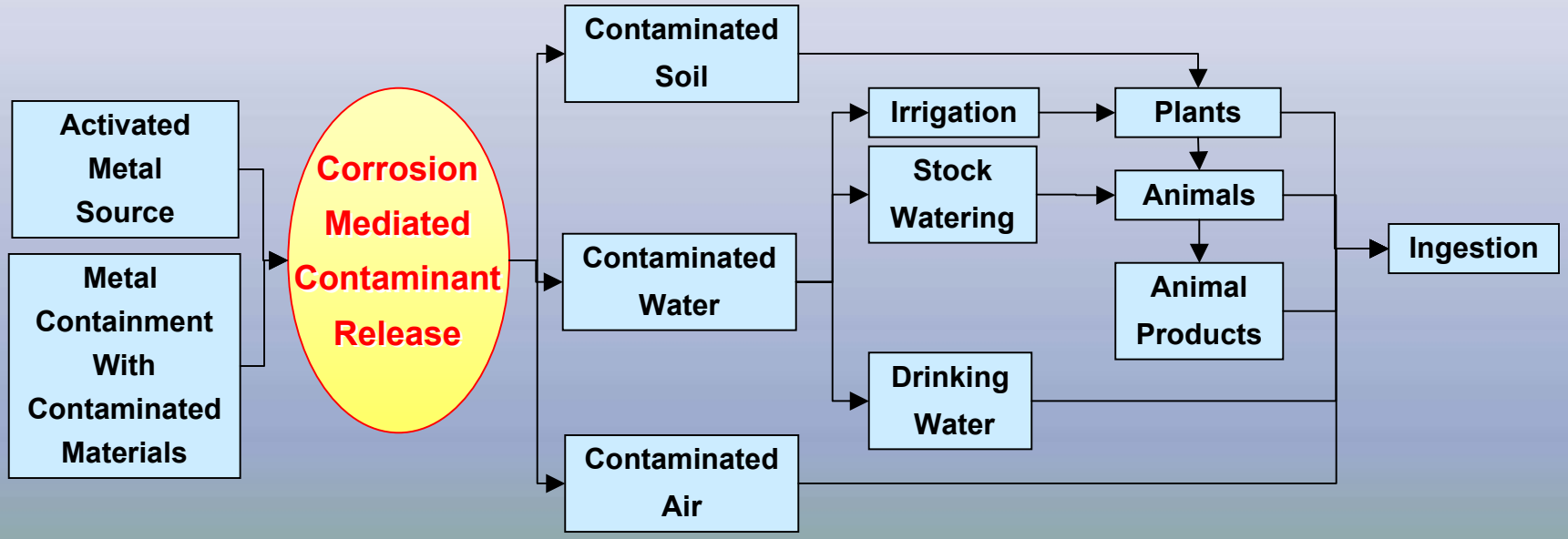
Contaminant Release to the Environment

Magnitude of the Problem

- *DOE is responsible for cleaning up over 2 million acres of operational and disposal sites across the complex as a result of testing nuclear weapons and energy research activities.*
- *Hundreds of containers contain highly activated waste and non-fuel activated metal reactor components.*
- ***The buried activated metals and metal containment represent a serious long-term environmental impact.***

Significance of Research for DOE

DOE has published needs for validated and verified corrosion data to support fate and transport models used in contamination risk assessments.



304 Underground Corrosion Data

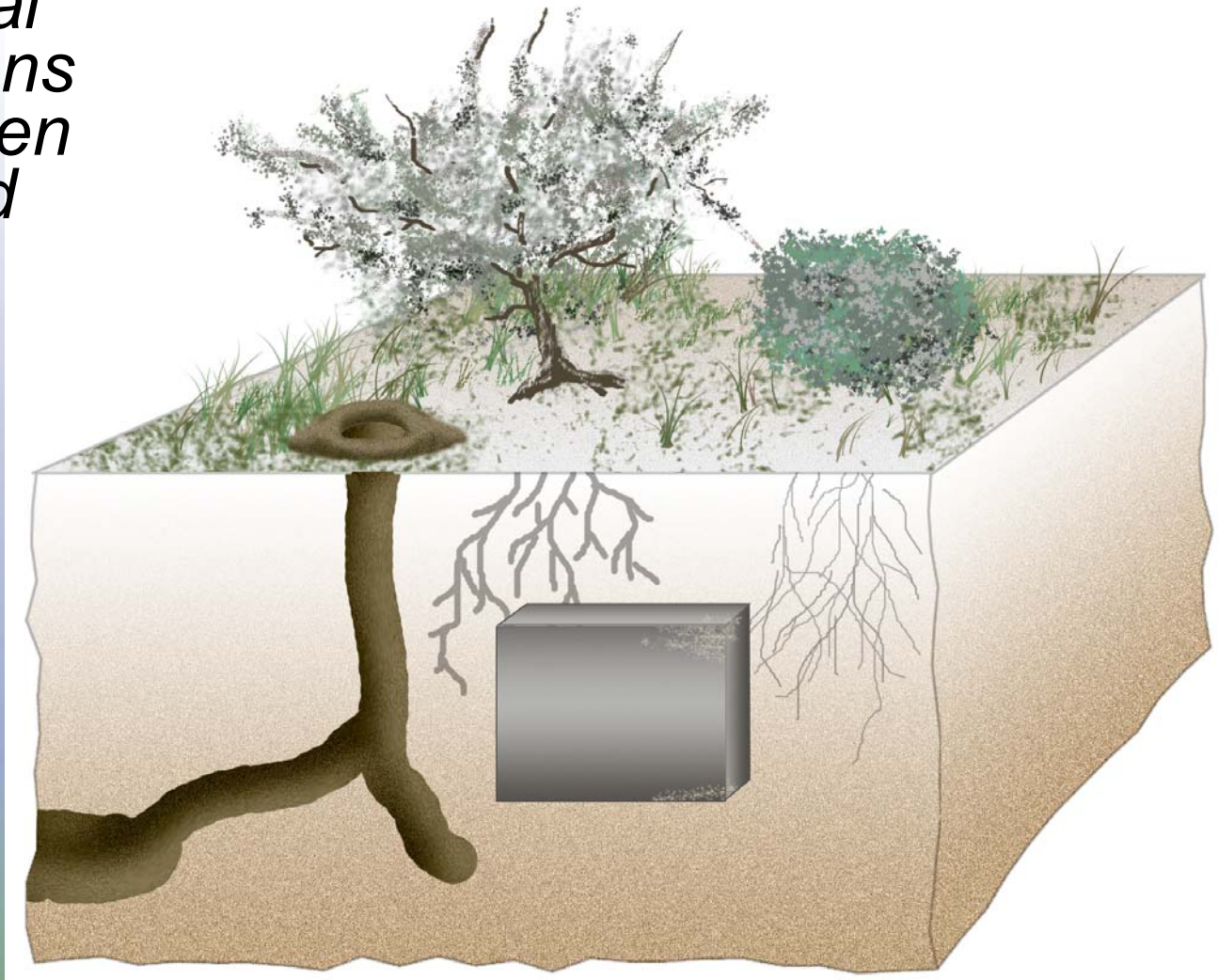
Site	Metal Condition	Test Duration (days)	Mass Loss (mg/dm^2)	mm/y	y/mm
Site A	Annealed	2989	8	1.2E-05	82,213.9
	Sensitized	**413**	**20**	**0.00022**	**4543.9**
	Sensitized	791	18	0.000103	9669.7
	Sensitized	1442	49	0.000154	6475.6
	Sensitized	2989	68	0.000103	9672.2

(Gerhold et al. 1981)

Approach

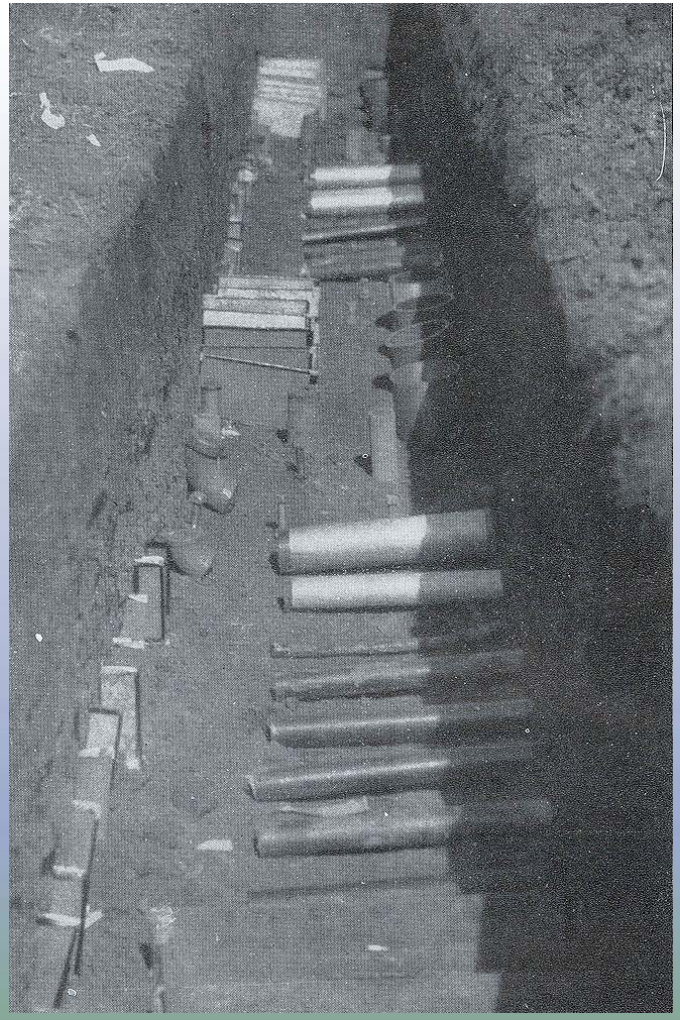
1. Retrieve and analyze metal test specimens that have been in the ground for over 32 years.

2. Sample and analyze the environment surrounding the metal.



An Underground Corrosion Test That Has Been Around for Over 32 Years

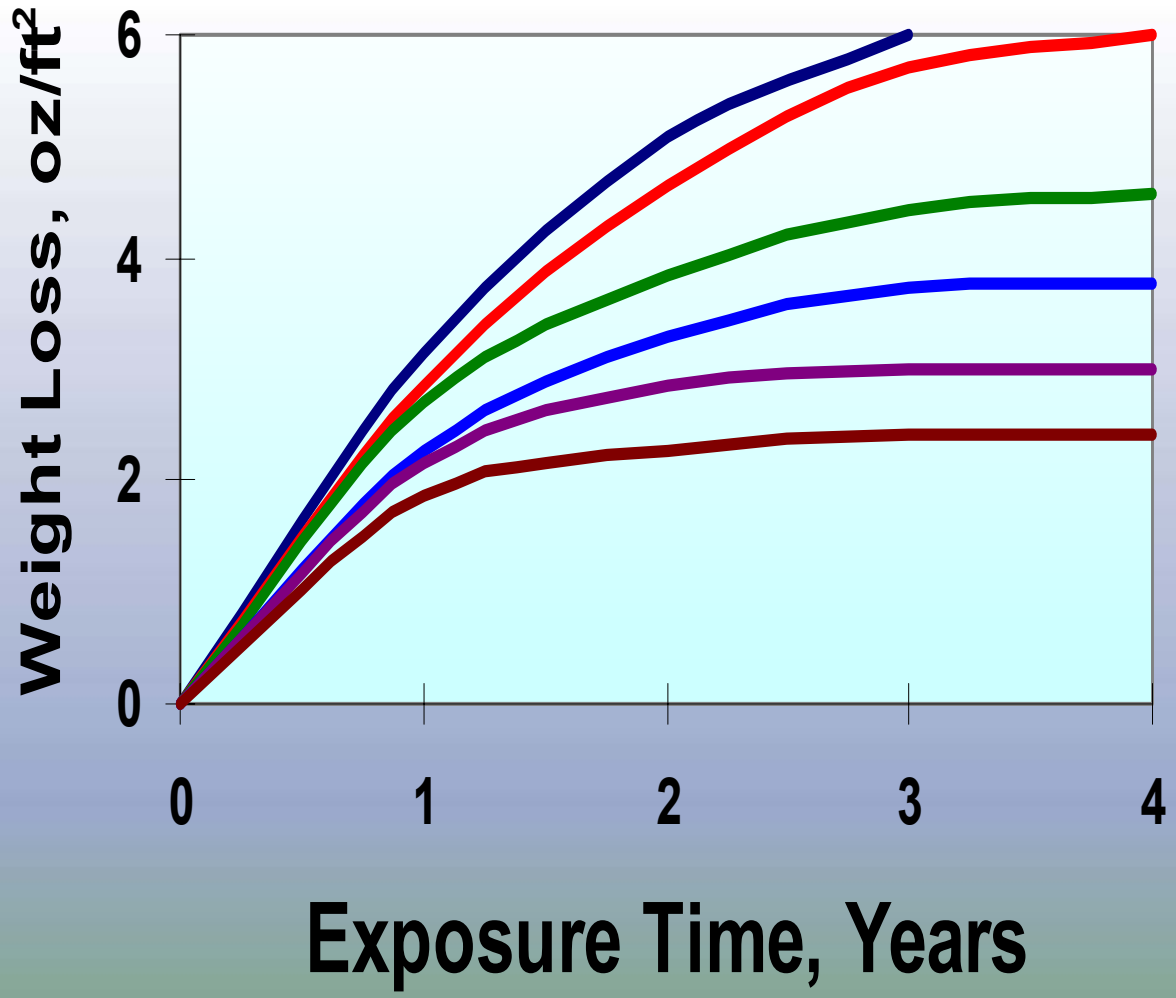
- *In 1970 National Bureau of Standards started a long-term corrosion study of stainless steel in soils.*
- *Six locations, each with unique soil types were selected.*
- *Thousands of samples were placed in shallow trenches – plates, pipes, welds, coatings,stressed & galvanic samples.*
- *Retrievals took place after 1, 2, 4, and 8 years.*
- *The last set, nearly 200 samples at each location, have not been recovered.*



Test Sites

SITE A	Sagemoor silty loam →	Yakama Nation
SITE B	Hagerstown loam →	Lock Raven Water Works
SITE C	Clay soil →	Cape May, USCG
SITE D	Lakewood sand →	Loran Support Unit, USCG
SITE E	Costal sand →	Loran Support Unit, USCG
SITE G	Tidal marsh →	Putuxent Naval Air Station

Corrosion Effects at the Six Sites



G. Tidal Marsh

C. Clay

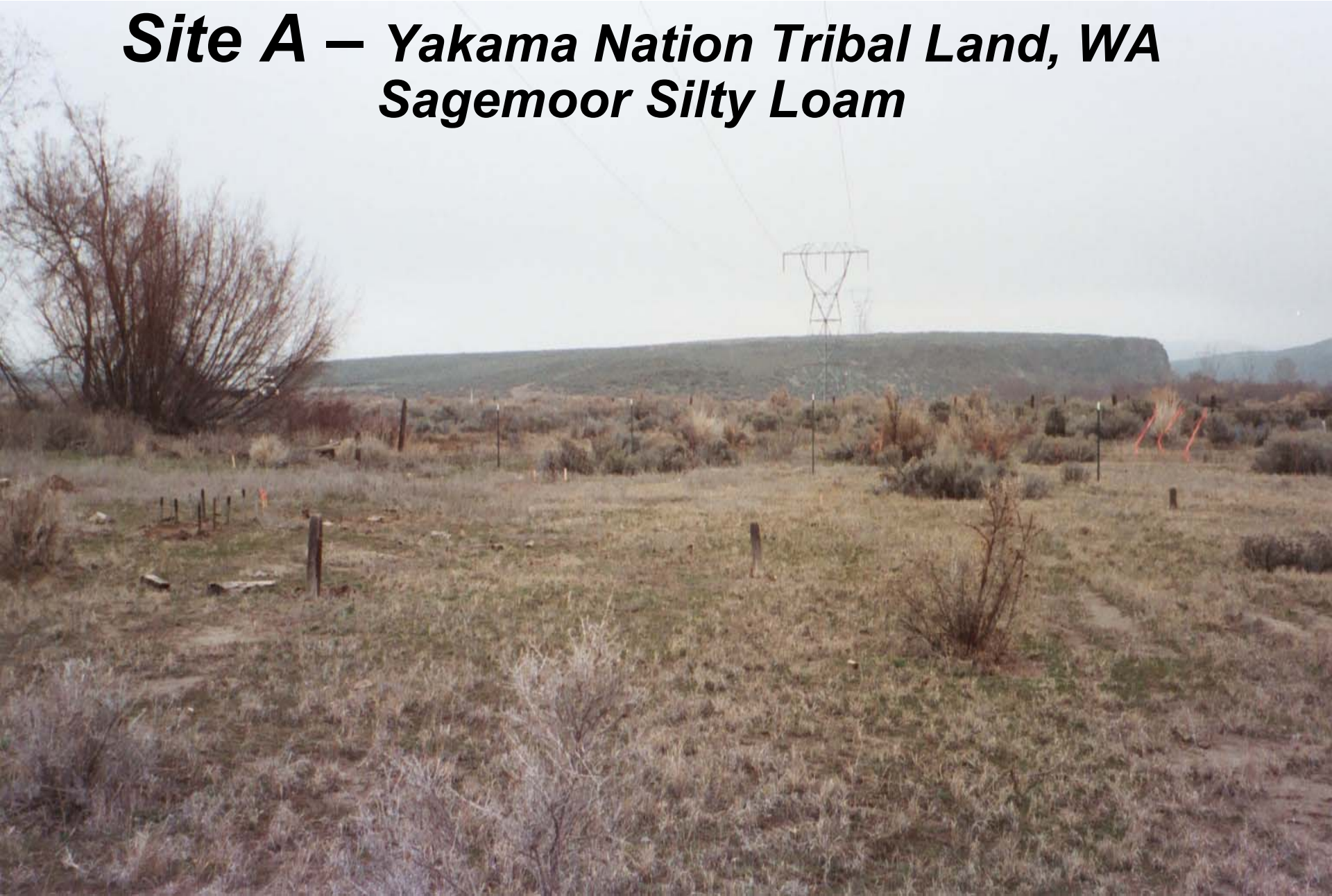
A. Sagemore Silty Loam

E. Costal Sand

D. Lakewood Sand

B. Hagerstown Loam

Site A – Yakama Nation Tribal Land, WA
Sagemoor Silty Loam



Metal Corrosion

- *Mass Loss*
- *Pit Depths*
- *Weld – HAZ*
- *Surface Analysis*
- *Coatings*
- *Stressed*
- *Galvanic*
- *Crevice*
- *Microstructure*

Soil

- Chlorides
- Sulfides & Sulfates
- Oxygen levels
- pH
- Electrical resistivity
- Bulk density
- Particle size/distribution
- Porosity
- Percent Saturation
- Moisture Content
- Alkalinity
- Acidity

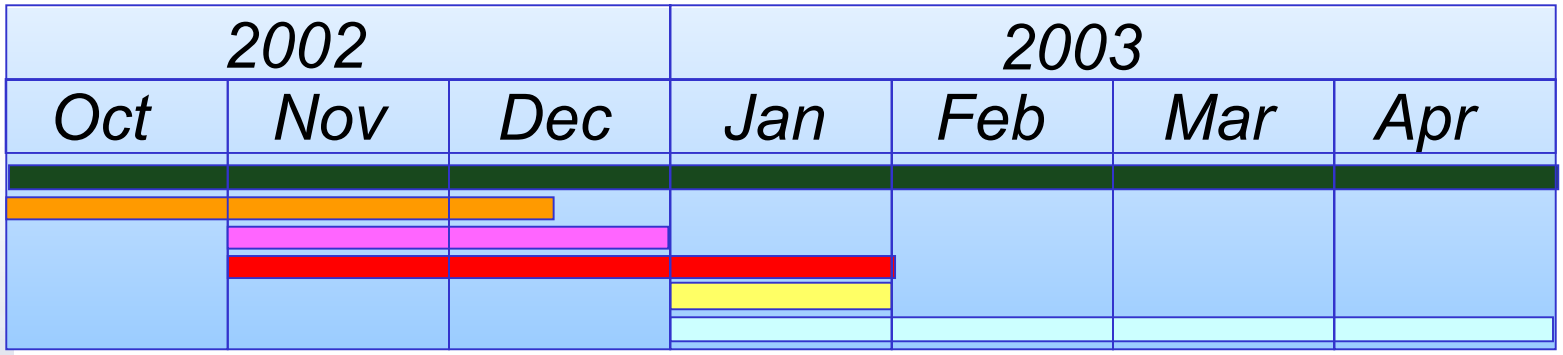
Biota Influences

- *Plant*
- *Animal*
- *Microbiological*
  - *Metal*
  - *Soils*
  - *Rhizosphere*

Metal Ion Migration

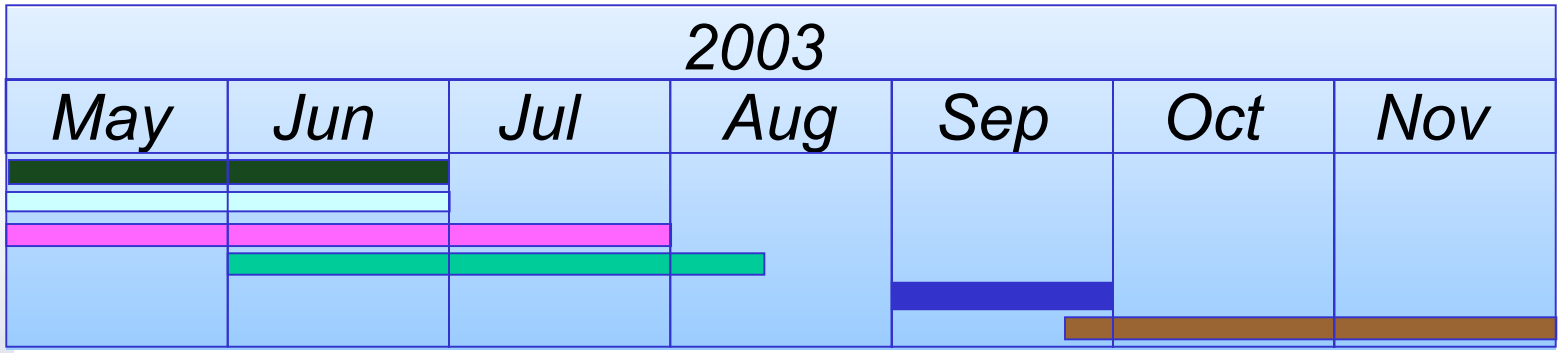
- Metal availability
- Mineral phase
- Elemental analysis
- Preferred path flow
- Vadose Zone processes
- Biota Influences

Schedule



- Research historical publications and obtain existing maps, photos, related scientific information.
- Initial sample analysis planning.
- Preliminary project plan development.
- Obtain point of contacts at each of the six test sites.
- Select a preferred site from the six test locations for this research scope.
- Obtain permission from landholder for the proposed research.

Schedule



- Research historical publications and obtain existing maps, photos, related scientific information.
- Obtain permission from landholder for the proposed research.
- Sampling and analysis planning, review, final.
- Non-intrusive site preparation.
- Intrusive site investigation – sample collection.
- Analysis of a limited number of samples.

October 2003-September 2005

- Analyze selected samples
- Additional samples available/collaboration
- Apply data to determine
  - Corrosion metal loss
  - Microbial influences
  - Fate and transport
  - Model comparisons
- Publish results

Future Direction

- *Workscope = one of the six sites*
  - *Six sites total*
  - *Six unique soil types*
  - *Same metals*

- *Future analysis and investigations*
  - *Intent is to sample the Site for future studies.*
  - *Additional research opportunities exist from the samples that will be collected.*

Impact of the Results

- Reduce the uncertainty of the data used for many Environmental Management fate and transport models.
- Expand long-term underground corrosion knowledge.
  - Rates
  - Mechanisms
  - Products
  - Migration
- Foster scientific collaboration and education.