Application of MercLok™ to Remediate Abandoned Mercury Mines (& More!)

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A Terracon COMPANY

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MCCORD ENVIRONMENTAL

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Outline

- Background & Field Study
- Remediation Project Design & Implementation
- But Wait…There's More!

BACKGROUND & FIELD STUDY

2001 Report to CA Legislature

~40K mines (4K envir. hazards):

- ~1/2 on federal & private lands each (<2% state)
- Every county (58) has some
- Lots of **Hg** mined & wasted

Mainly desktop – need inspections

https://www.conservation.ca.gov/dmr/abandoned_mine_lands/

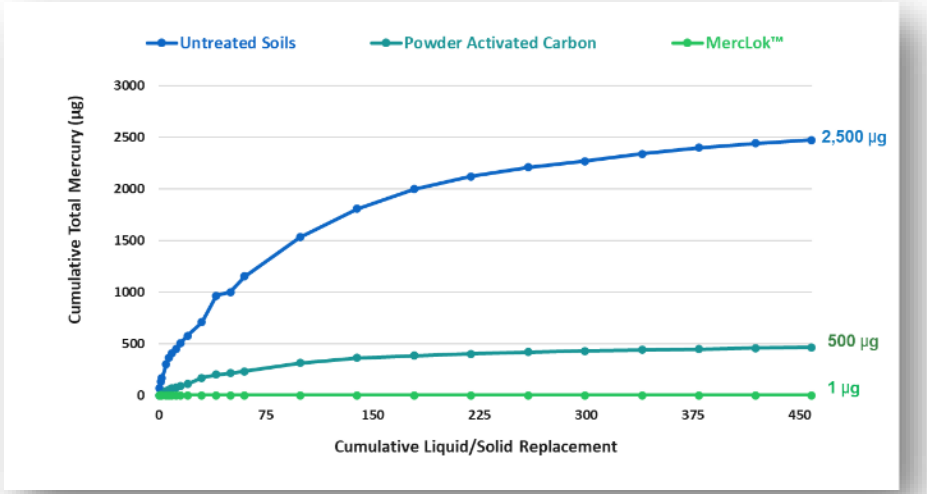
Legacy Mercury Mines and Their Environmental Impacts

- Mercury in soil, sediment, water
  - ➔ Impacts to aquatic biota & their consumers, on-site & downstream
- Encumbered property
  - ➔ Safety risks
  - ➔ Costly HazMat remediation

MercLok Provided an On-Site Option

Amend & manage **on-site** per CA Title 27:

- Minimize Hg leachability (<0.2 mg/L by STLC hazardous material limit)
- Title 27-compliant with exemptions (no liner & minimal monitoring)
- Long-term stability

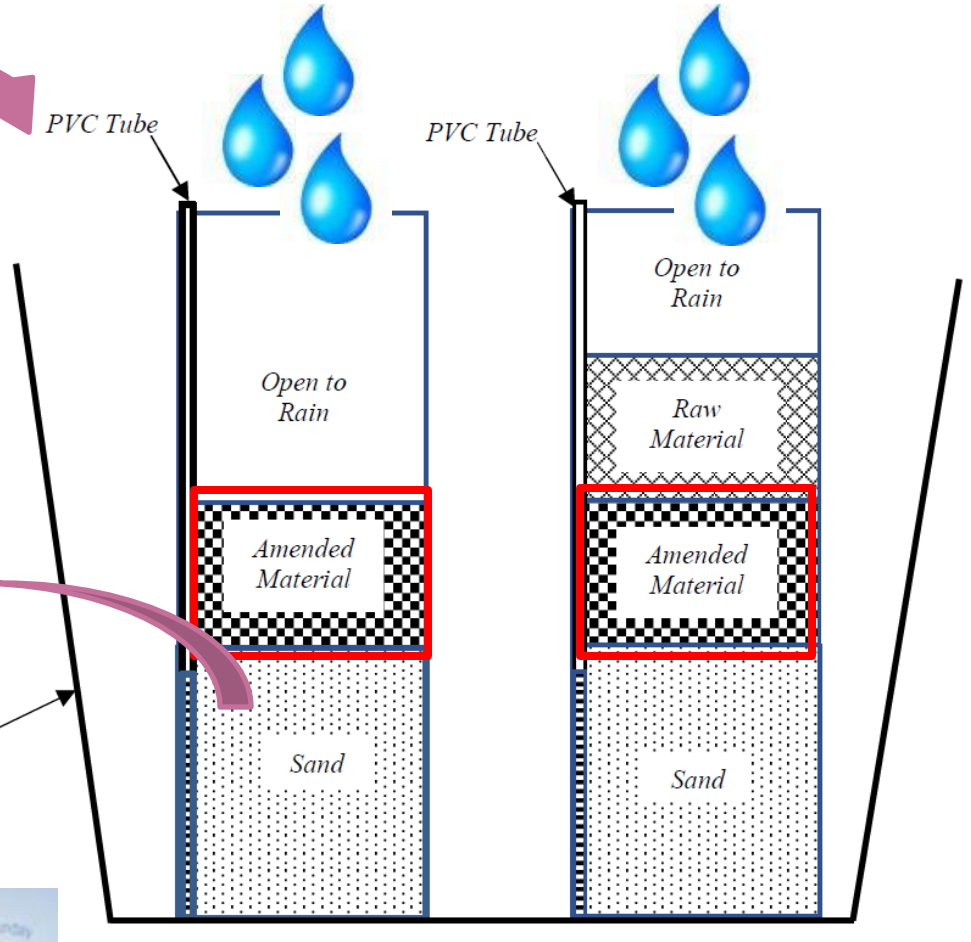


So, we found these sites…

Pilot Study Site (Elsewhere in Coast Range)

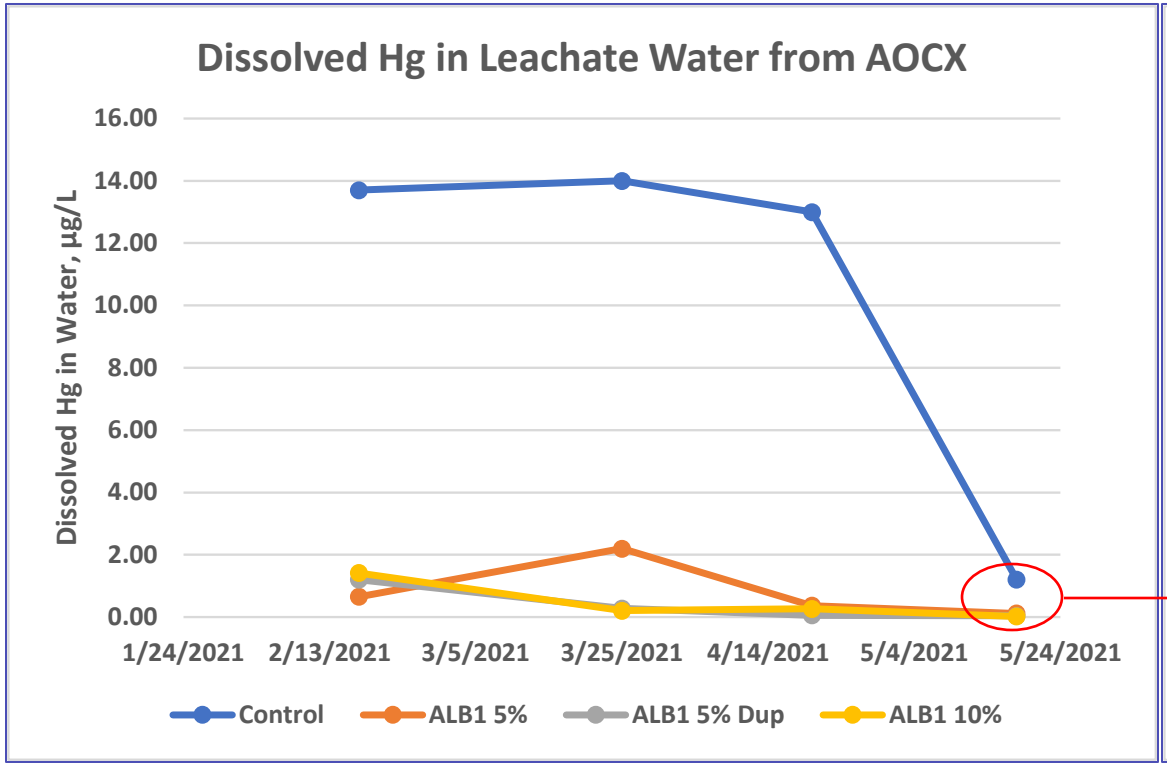
Elgin Hg Mine, view to southeast

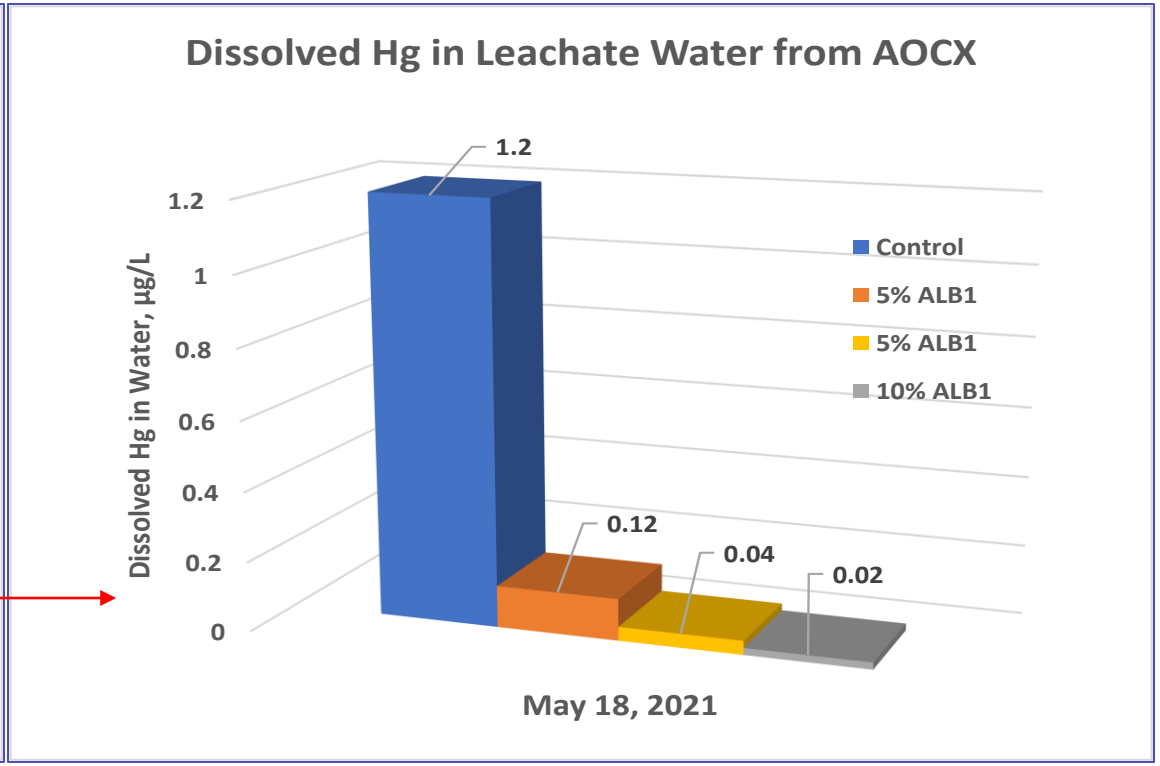
Pilot Study Design



Results – Worst-case Rainwater Leachate

Hg Leaching of Calcines in Barrels by Rainwater – Dissolved Hg





90%-95% Reduction After 1 Month

90%-98% Reduction After 5 Months

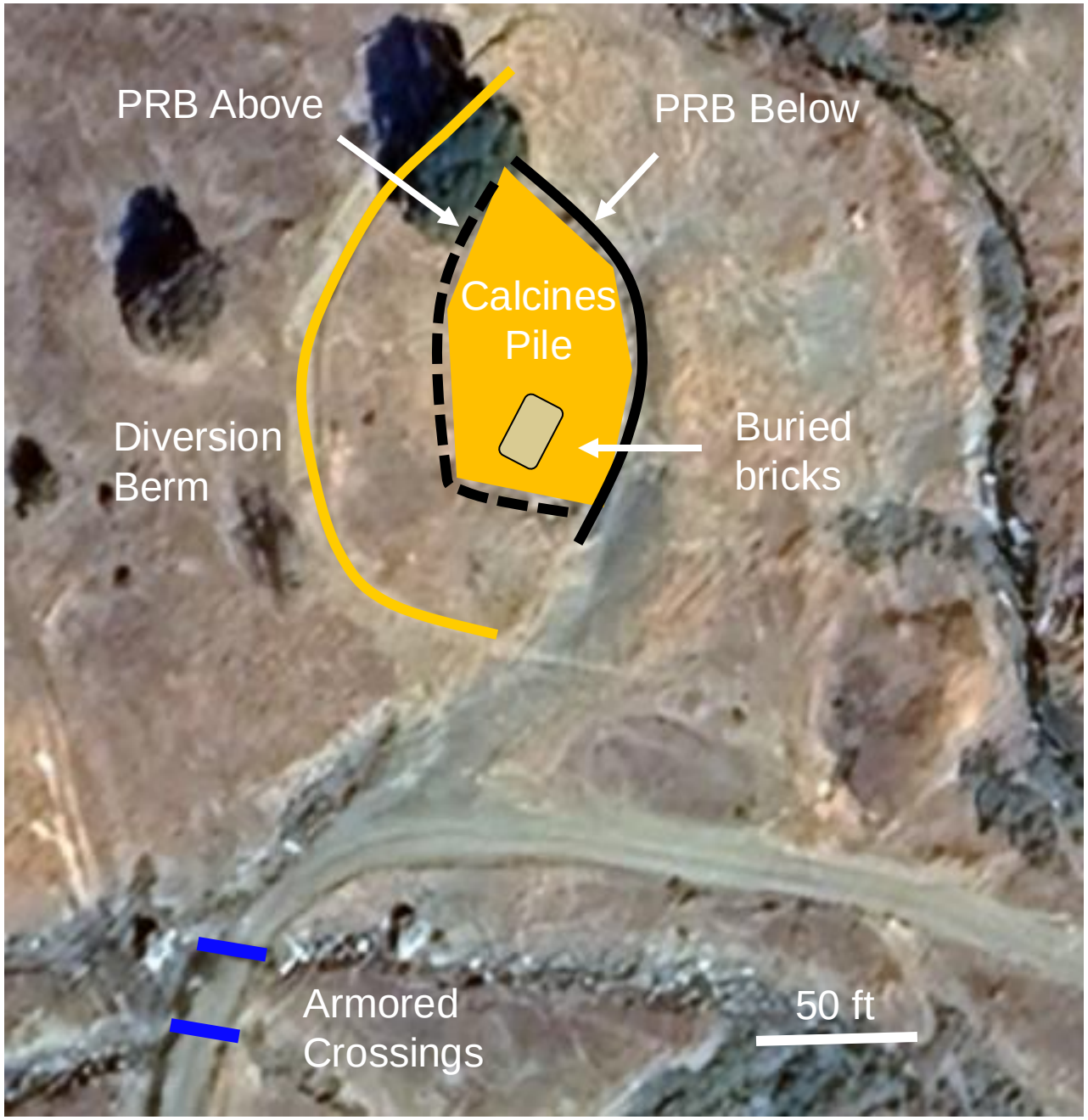
REMEDIATION PROJECT DESIGN & IMPLEMENTATION

Remediation Site Plan

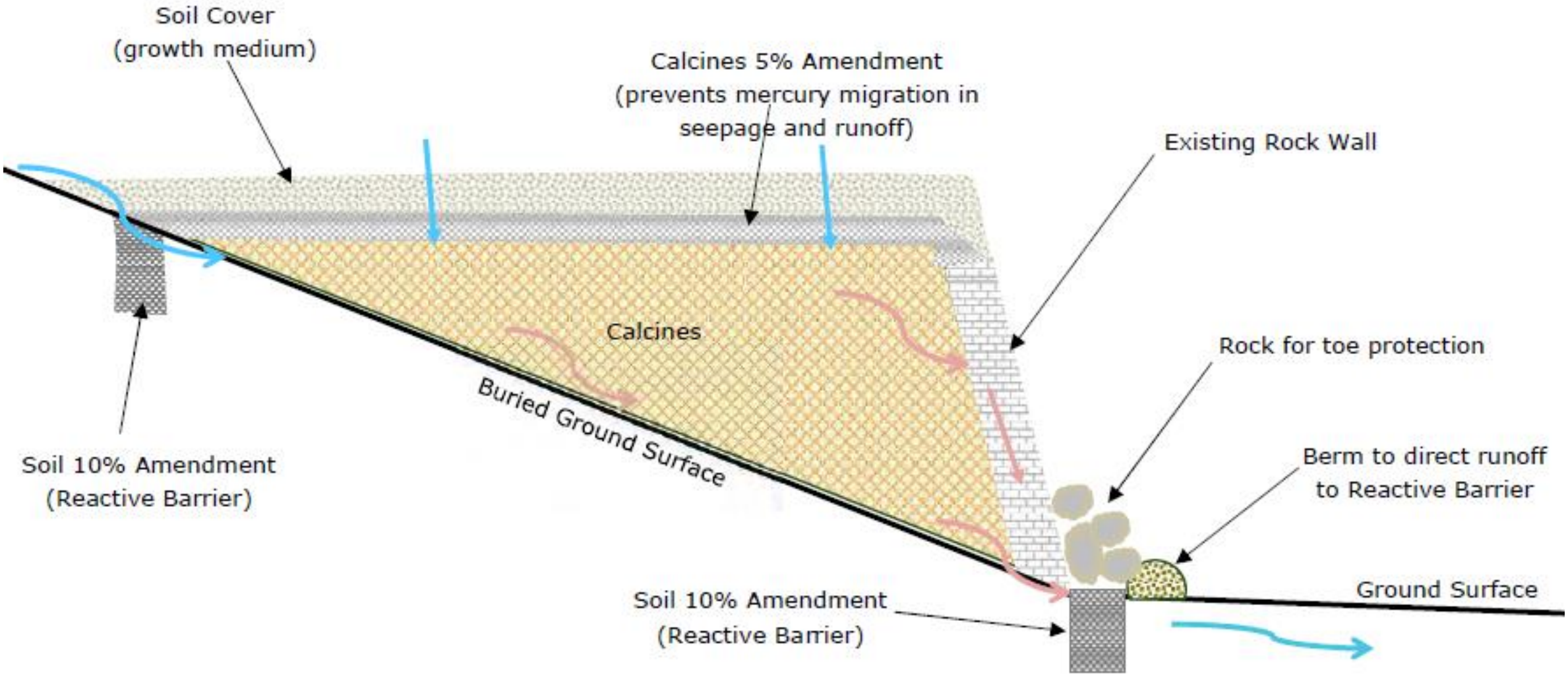
- **Crossings** stabilize road
- **Berm** controls run-on

- **Barriers** control seepage
- **Cap** minimized Hg mobility
- Brick **repository** prevents exposure

- **Owl box** inhibits burrows
- **Signage** restricts entry



Calcines Pile ➔ In-place Repository



Fall 2022 Repository Cap

- Grid areas for even dosing
- Manual & machine to spread, mix, level
- Spray water to distribute

Permeable Reactive Barrier

Confirmation Sampling Results (2022)

Material	Total Hg (mg/kg ww)	TCLP Extract Hg (mg/L)	STLC Extract Hg (mg/L)	DI WET Extract Hg (mg/L)
N Pile Calcines	865	0.0496	1.13	3.46
Untreated Retort Calcines	379	<0.010	0.441	0.2
Amended Retort Calcines	239-318	NA	0.119-0.184	<0.0010
Trench 1	19.9	NA	NA	NA
Trench 2	25.3	NA	0.00548	<0.0010
Area 1	66.9	NA	0.00710	<0.0010
Area 1 Duplicate	27.7	NA	0.00621	<0.0010
Area 2	48.5	NA	0.00493	<0.0010
Background Soil	259	<0.010	0.0224	0.0445
*Regulatory Thresholds**	*20*	*0.2*	*0.2*	*0.00005*

MercLok didn't add Hg

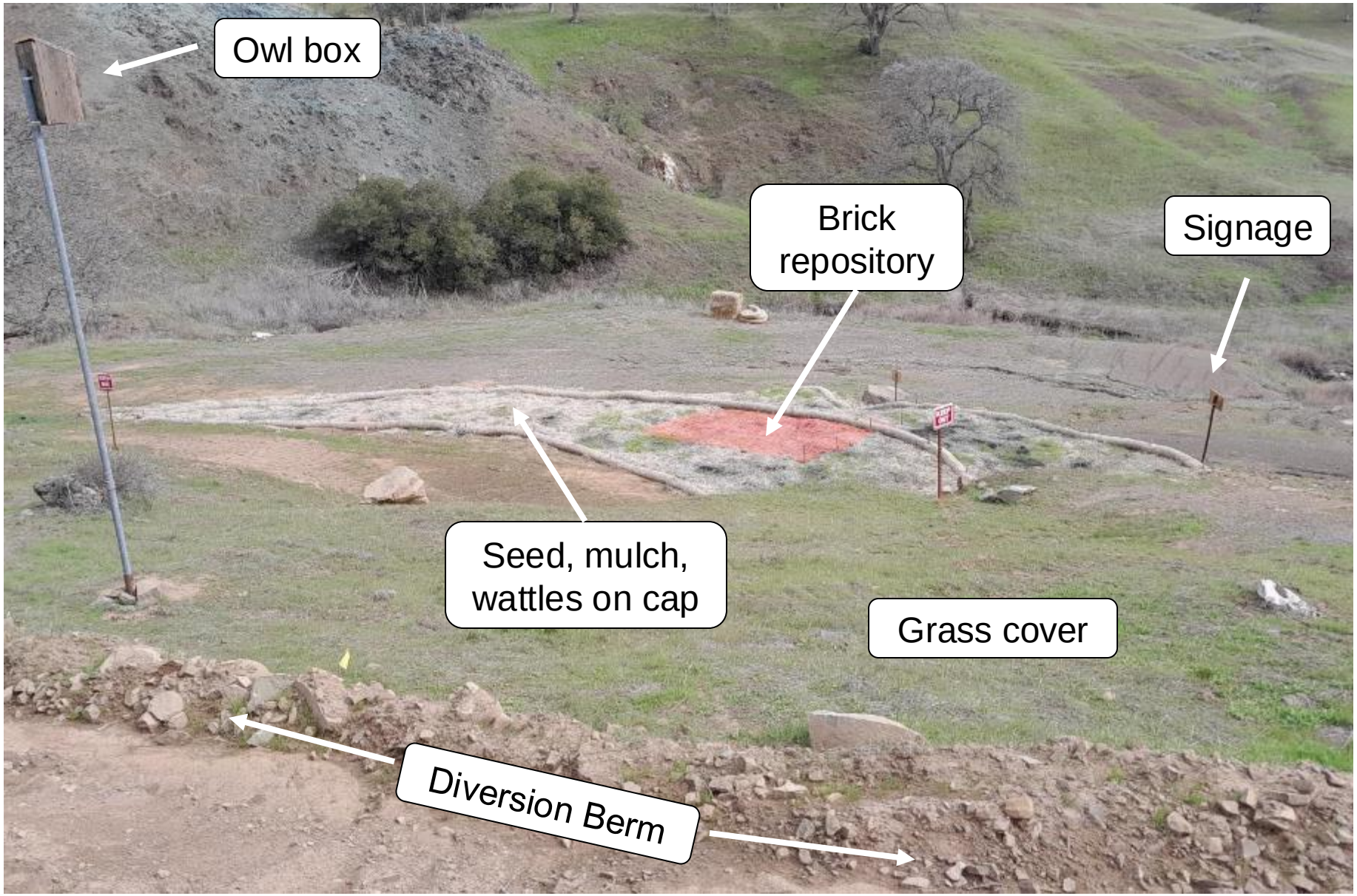
Good reproducibility

Hg naturally high

MercLok significantly lowered leachable Hg

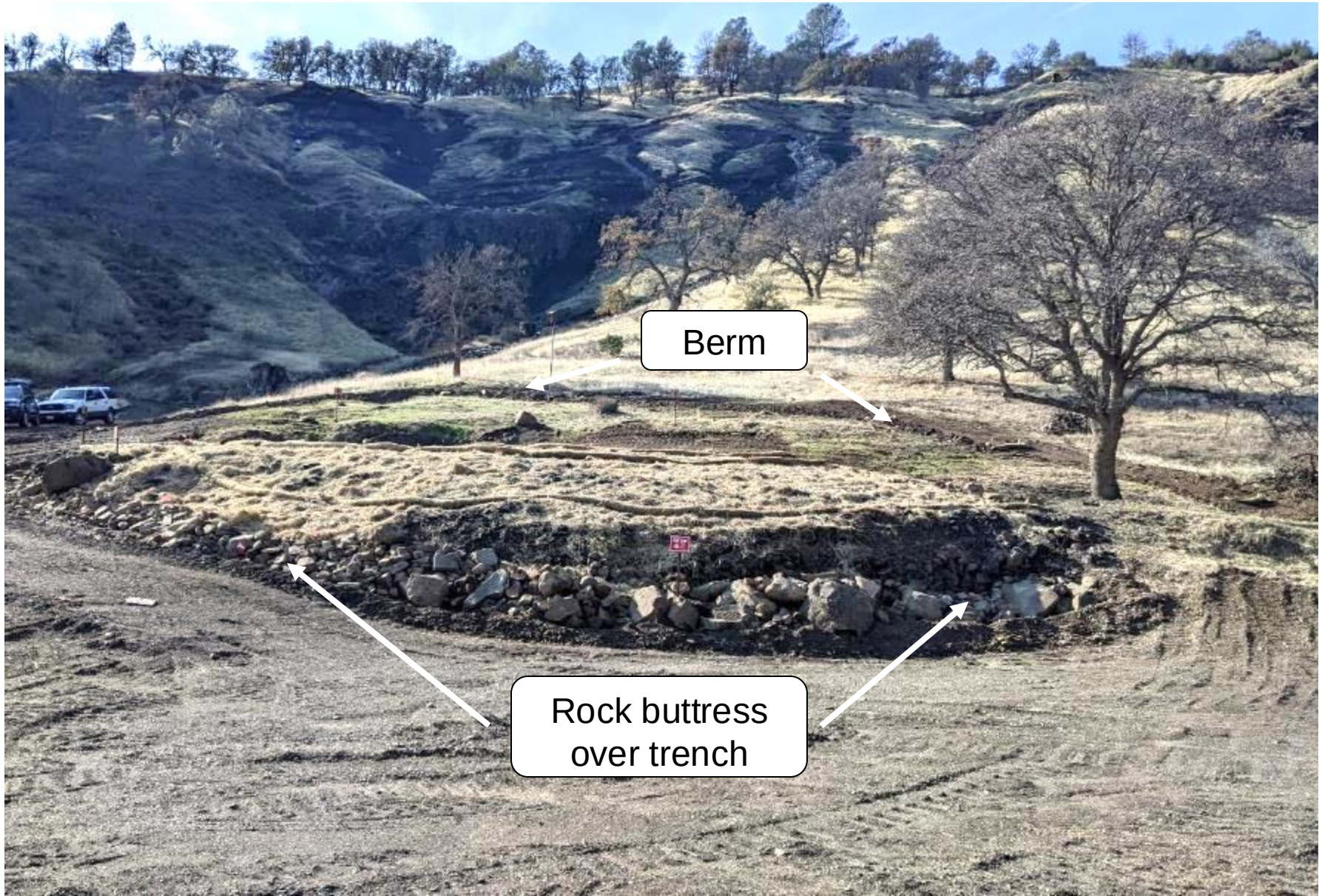
* Values in red exceed these thresholds.

Stabilized – From Above (2023)



Stabilized – From Above (2024)

Stabilized – From Below (2023)



Stabilized – From Below (2024)

BUT WAIT…THERE'S MORE!

Aggregate Mine Pit Ponds?

- Pump slurry onto surface
- Serve as sediment binder & barrier
- No ecological impact
- Also wetlands and reservoirs?

~40,000-lb. powder

Key Challenges for Site Remediation

Multiple Objectives

- Varied stakeholder interests
- Physical & chemical on-site hazards
- Downstream impacts

Complex Conditions

- Complex mercury speciation
- Difficult site access

Regulatory Green Tape

- "Good Samaritan" liability concerns
- Perfect (reg. limits) is the enemy of good (enough/better)

In Summary…

- Projects occurred in a naturally Hg-enriched area
- Other remediation options were prohibitively expensive
- MercLok significantly reduced leachable Hg, allowing for in-place repository
- Hydrological & administrative controls ensure long-term function

For more information

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All For One! A Team Effort

- **Albemarle** funded team, advised, provided amendment
- **MEI** managed
- **Burleson/Terracon** planned, designed, inspected
- External **labs** tested
- **Landowner** implemented
- **Regulators** reviewed, approved, oversaw

Cleanup Project Proponents

Federal Agencies	• Bureaus of Land Management & Reclamation • National Park, Forest, Fish & Wildlife Services • Office of Surface Mining • US Army Corps of Engineers • USEPA
State Agencies	• State and Regional Water Boards • Dept. Toxic Substances Control • Dept.'s Fish & Game, Water Res., Conservation • State Parks & Recreation • State Lands Commission • Conservation Corps
Many Others!	• Nonprofits: Tuleyome, The Sierra Fund, land trusts • Tribes • Municipalities (counties & cities) • Homeowner associations & private landowners • Irrigation, reclamation & open space districts • Mining companies • Land developers