Application of Innovative Technologies in Performance Based Contracting

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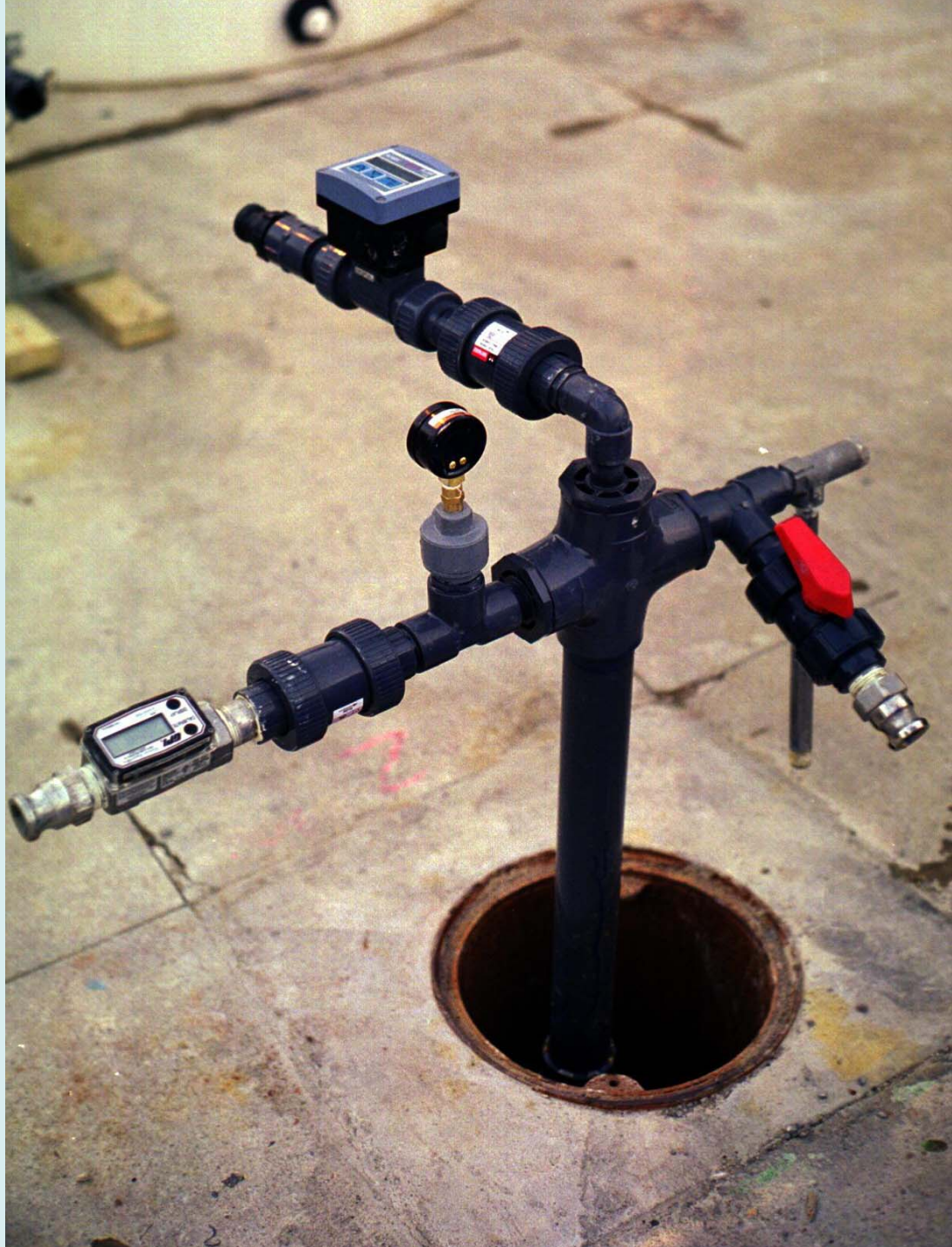
ARCADIS



3 Project Examples of Technology Applications that Enable the Realization of the Army's Goals (1)

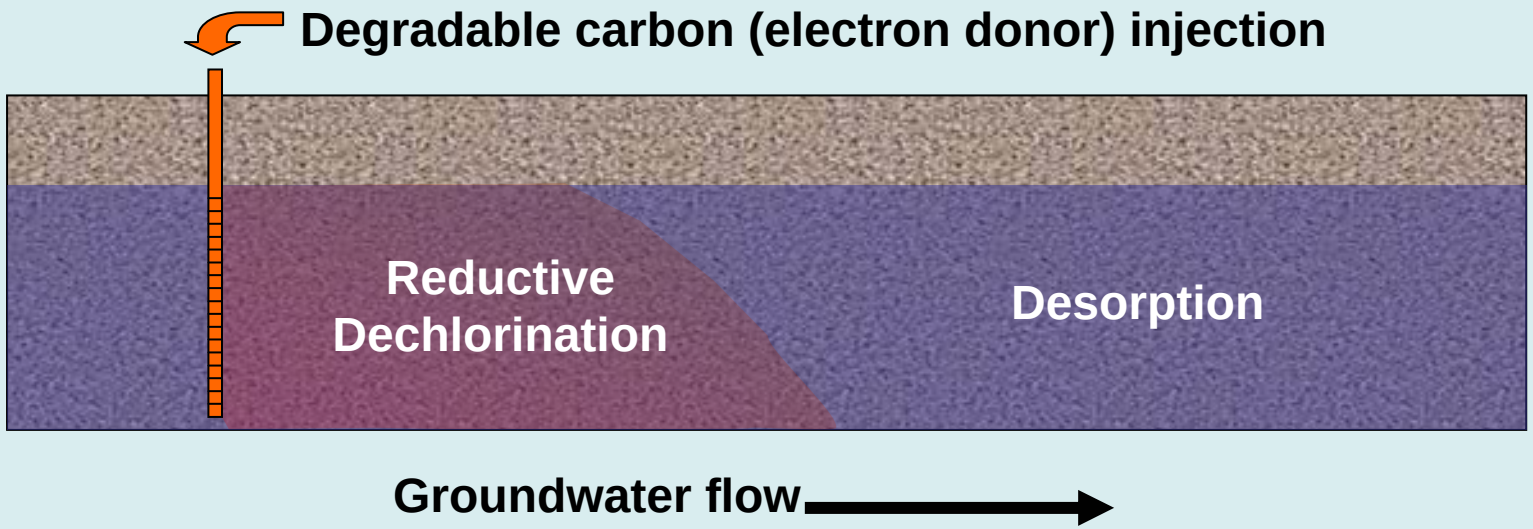
- Fort Leavenworth
  - Enhanced Reductive Dechlorination via Anaerobic IRZ
- Milan Army Ammunition Plant
  - Soil Composting for High Explosives
- Graces Quarters
  - Abiotic Dechlorination

(1) Accelerated closure – cost savings

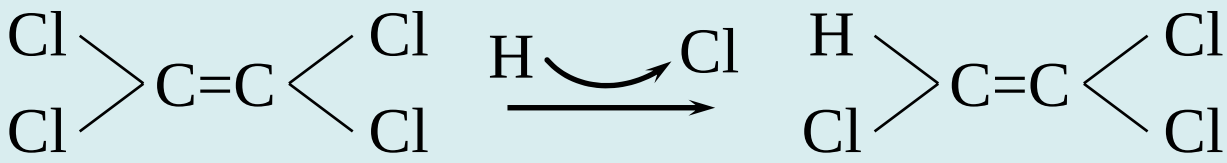
Fort Leavenworth: Pilot Test

- Enhanced Reductive Dechlorination (ERD) used on PCE plume in loess and till
- ERD utilized molasses and whey during a 1 year pilot study
- Focus on total contaminant mass removal (sorbed and soluble)
- Significant reduction of PCE in treatment area with complete degradation to ethene
- ERD with MNA proposed as final remedy for site

Enhanced Reductive Dechlorination



PCE Degrades to TCE



PCE **TCE**

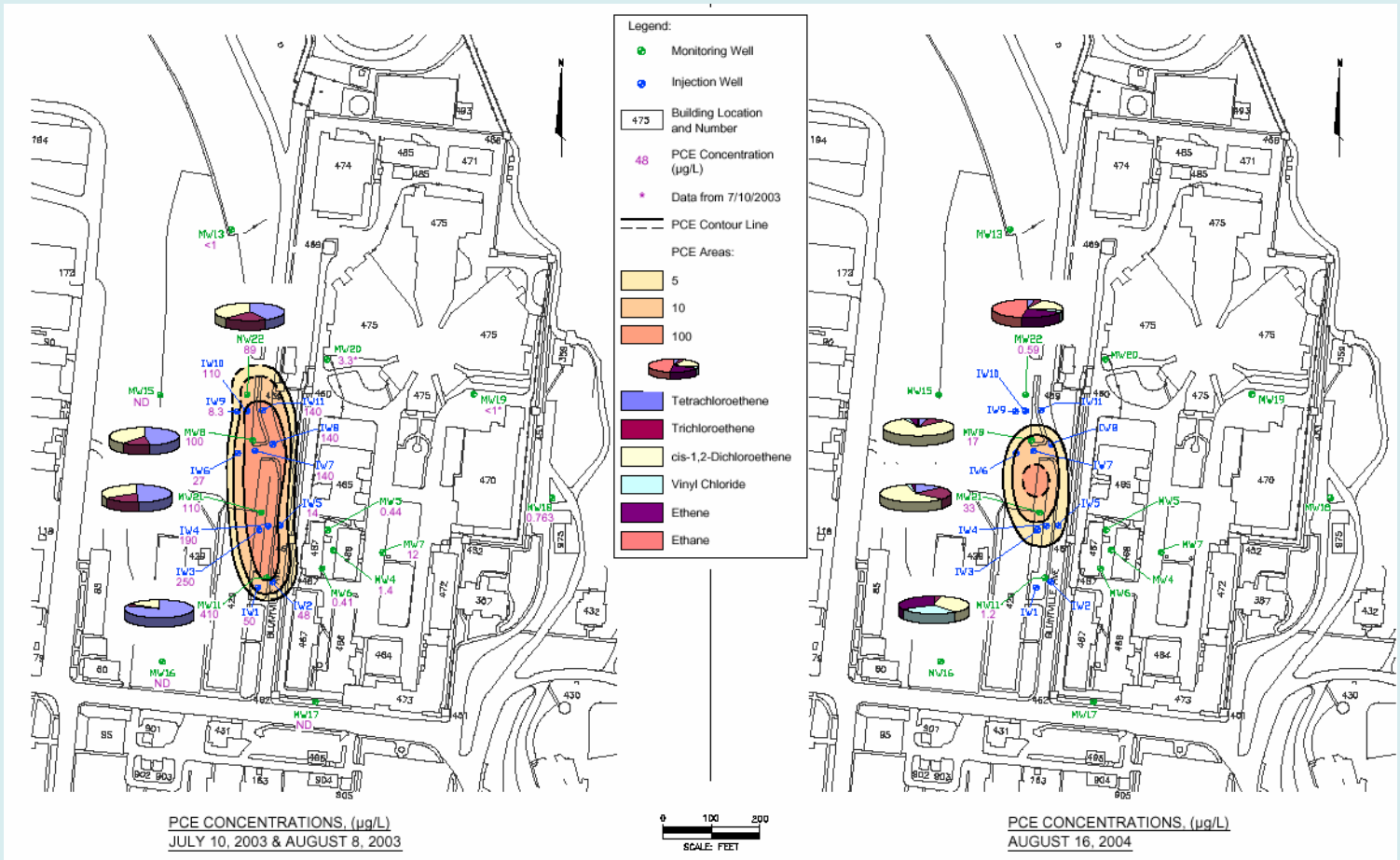
Full Degradation

PCE → TCE → DCE → VC → ETHENE → ETHANE → CO_2

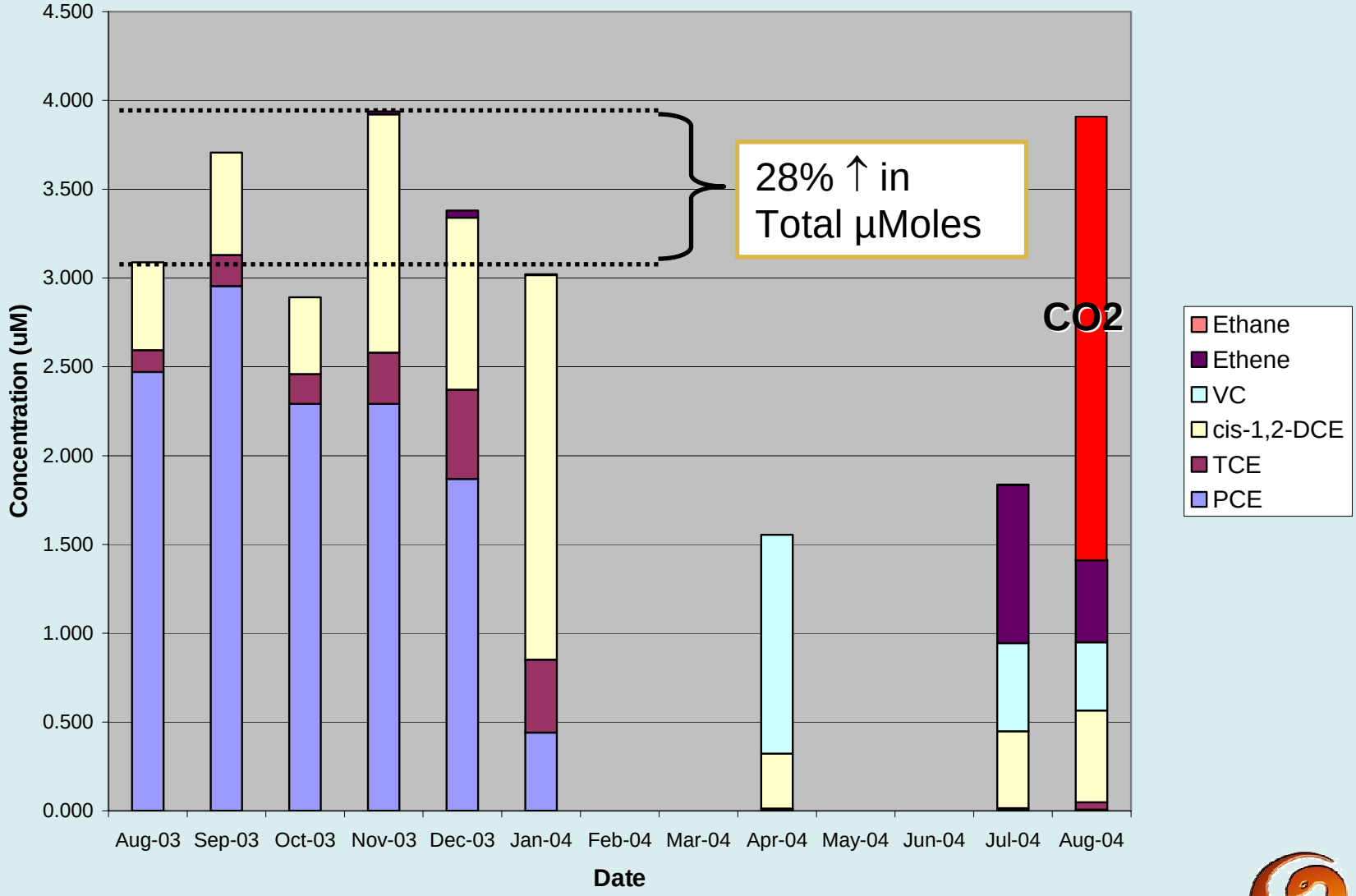
$CCl_2=CCl_2$ $CHCl=CCl_2$ $CHCl=CHCl$ $CH_2=CHCl$ $CH_2=CH_2$ C_2H_6 CO_2

Reductive Dechlorination of Tetrachloroethylene

Plume Isocontours (Pre and Post Pilot)



Molar Trends at MW-11

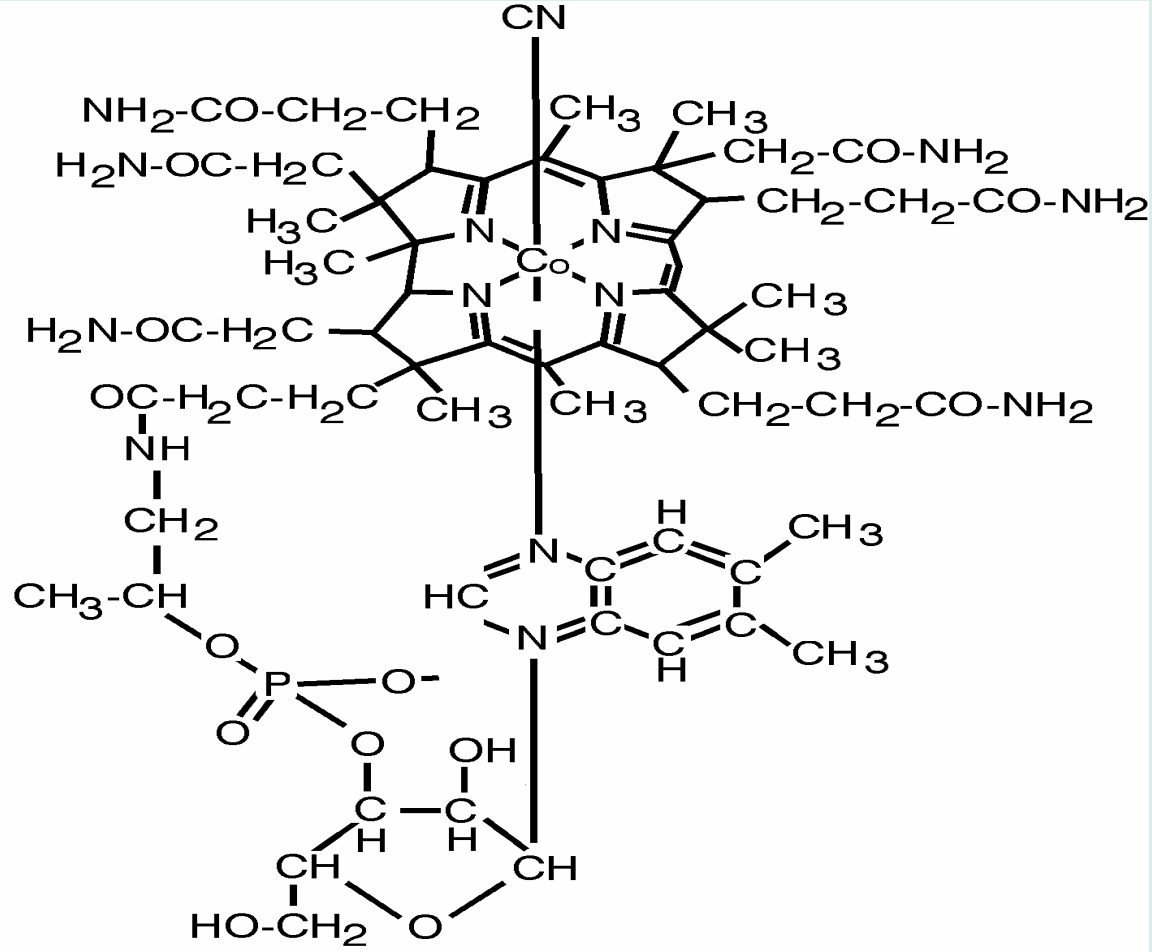


Graces Quarters - Aberdeen Proving Grounds

Abiotic Dechlorination:

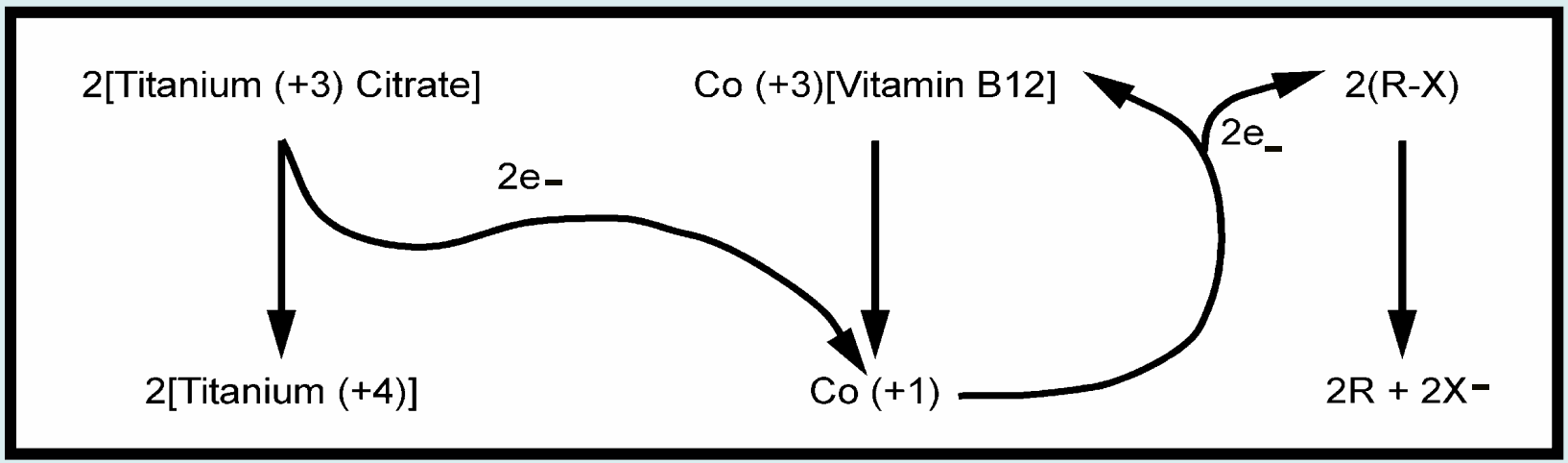
- Selected due to presence of 1,1,2,2 tetrachloroethane (TeCa) and carbon tetrachloride – which release chloroform
- Chloroform appears to be toxic to micro-organisms – effectively blocks biological processes
- Eliminate TeCa abiotically (chemically) using titanium driven Vitamin B-12 reduction – strong
- Elimination of TeCa enables subsequent biological activity to assist in dechlorination process

Vitamin B12-Catalyzed Reductive Dechlorination



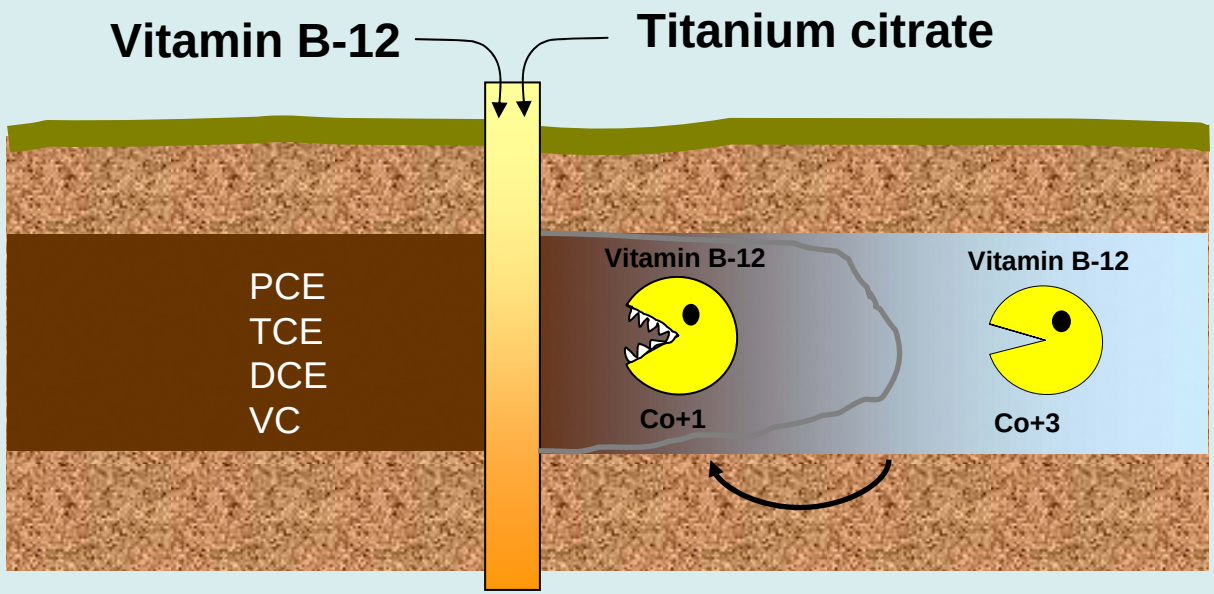
How Does it Work?

- Chelated Titanium (citrate) reduces and regenerates the cobalt atom in vitamin B_{12}
- Cobalt reacts with and abiotically reduces chlorinated solvents
- Citrate stimulates microbial activity, enhancing dechlorination



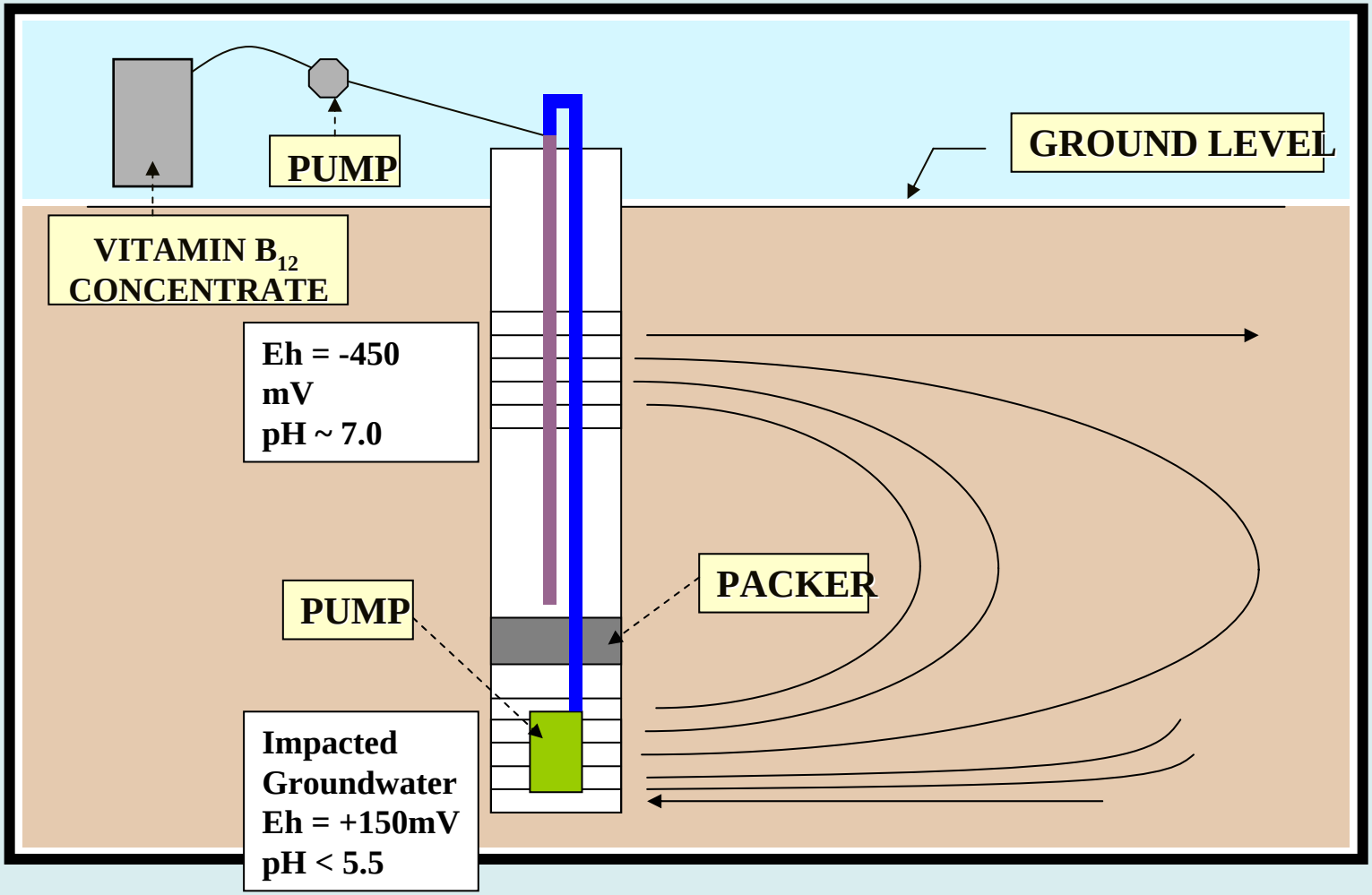
Vitamin B12-Catalyzed Reductive Dechlorination

(for those not wishing technical “punishment”)



Vitamin B-12
Titanium citrate
(catalyst or driver)

Implementation: Circulation Wells



Abiotic process is a contact driven process

Pilot Results: Before/After Treatment (ug/L)

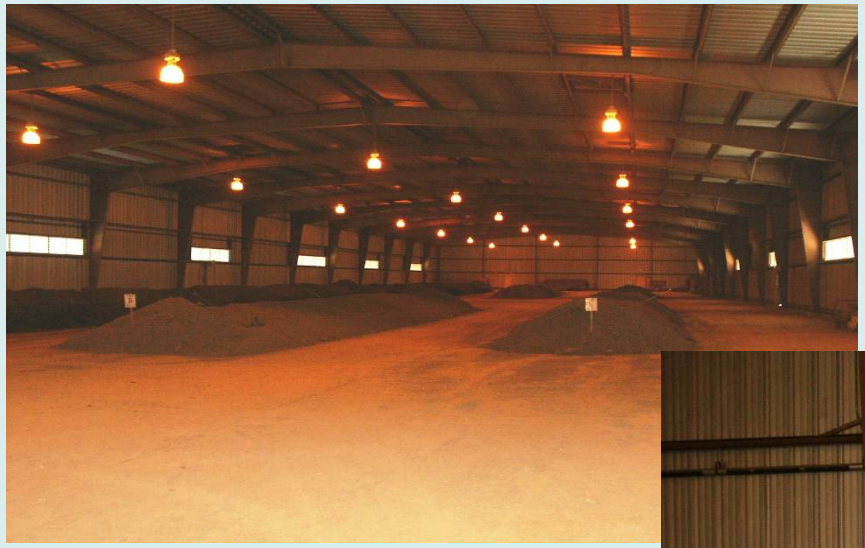
	TeCA	CT	TCE	DCE
Q14	1119/22	310/<1	276/1.6	0.8/43
Q54	1209/<1	1019/<1	448/<1	3.1/37
QRP2C	2850/0.84	1288/<1	563/0.6	<1/39
QRP4C	3625/130	2343/<1	963/17	<1/70
QRP9C	1320/1100	303/180	252/250	2.67/2.75

Treatment solution did not reach QRP9C

Down Side to Vitamin B-12 Applications:

One can needed per well per monthly application event

Milan Army Ammo Plant: Composting Facility (explosives in soils)



Layout of windrows

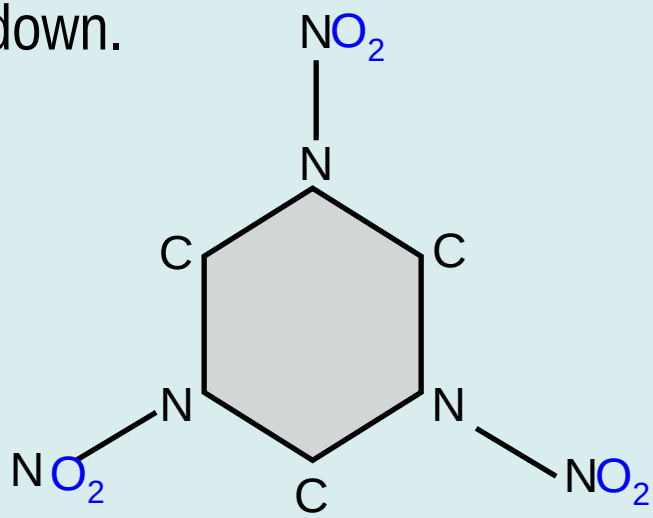
Windrow turner used to homogenize windrows

Composting Process

- Used for the biological treatment of RDX, TNT, and Tetryl impacted soils
- Raw soil mixed with organic carbon and bulking agents (e.g., cow manure, mulch, saw dust, and corn silage)
- Mixture constructed into windrows, periodically tilled
- Treatment progress monitored
- Target treatment completion 20 days following construction of the windrow
- Following treatment, the treated compost is re-used on-site

Simplistic View of RDX Breakdown

- Bacteria that are fed other food sources, when exposed to RDX, can “burn” it at a low temperature
- RDX contains within itself, both the fuel source, and the oxidizer necessary to burn. All we need for RDX treatment is the “match” to light it, and bacteria in the compost pile provided a safe match that can’t catastrophically ignite the RDX, but does provide rapid and complete breakdown.



Milan Composting Facility

- Typical Treatment Results
  - Treatment goal of 10 mg/kg for RDX

Windrow Name	Raw Soil (tons)	Initial RDX Conc. (mg/kg)	Final RDX Conc. (mg/kg)	Treatment Period (days)
WR18A-A0110-05	127	44.15	5.60	21
WR18A-C0208-05	119	24.73	5.10	20
WR18H-B0222-05	170	65.00	5.70	21
WR18H-A0317-05	168	26.60	4.30	20
WR18F-C0324-05	197	21.80	8.10	20