INNOVATIVE TREATMENT OF A LARGE, DILUTE, AND COMMINGLED PLUME USING A **SOLAR-POWERED IN-SITU BIOREMEDIATION AND PHYTOREMEDIATION SYSTEM**

SITE HISTORY

- Closed landfill in Nebraska
- Operated 1970 to 1995
- No on-site utilities
- VOCs, 1,4-dioxane, and metals are COPCs
- GOAL = NE Title 118 Standards (i.e. MCLs) at property line





PREVIOUS REMEDIATION

- 2012 Remedial Action Plan (RAP)
- Solar-powered GW extraction and off-site disposal
- Aerobic bioremediation with ORC
- In-situ chemical oxidation w/ RegenOx



IBS PILOT TEST RESULTS

- HRC injection near monitoring well MW-8M
- 99% concentration reductions of cis-DCE and vinyl chloride



SOLAR-POWERED BIOREMEDIATION



- ISB demonstrated for chlorinated VOCs in pilot test and elsewhere
- Maximize injection volume for wide well spacing Maximize use of existing infrastructure





- ISB AMENDMENT • Soybean oil (35%) and lactate (35%) emulsified vegetable oil (EVO) bioamendment selected
- 10 250-gallon totes plumbed together to allow unmanned operation



- **MIXING SYSTEM**
- Proportional mixer used to mix groundwater with EVO at 1.5% concentration
- Mixer actuated by water pressure, requires no electricity



- Client owned solar-powered pumping system
- Trihydro re-configured to support ISB remediation rather than offsite groundwater disposal.
- Makeup water source is unimpacted groundwater



- **INJECTION PERFORMED** • Soybean oil (35%) and lactate (35%) emulsified vegetable oil (EVO) bioamendment selected
- 10 250-gallon totes plumbed together to allow unmanned operation



ISB RESULTS

- Downgradient location
- Shift to by-products (VC)
- ~90+% concentration decreases



ISB RESULTS • In treatment zone

• Non-detect since late 2018



Graphic from ITRC Phyto-3, 2009, Figure 1-8

PHYTOREMEDIATION

• 1,4-Dioxane moves in through roots, up xylem, out to atmosphere





PHYTO DESIGN

- 1,4-Dioxane impacts extend 20 ft below first water, i.e., diving plume
- Solar-powered extraction system already present at downgradient
- Pump 1,4-dioxane impacted groundwater to the trees



PLANTING

- 1,4-Dioxane impacts extend 20 ft below first water, i.e., diving plume
- Solar-powered extraction system already present at downgradient area
- Pump 1,4-dioxane impacted groundwater to the trees

OPTIMIZATION

- Increased pumping capacity in 2020
- Additional extraction wells with solar-powered pumps
- Target 6MM gallons/year
- 3 years to remove 1 pore volume of 1,4-dioxane plume



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CARBON BALANCE

- Previous emissions hauling water to POTW 15,000 lbs/yr
- Trees in phyto plot sequester 10,000 lbs/yr now and 100,000 lbs/yr when mature





CONCLUSIONS

- Simple solar-powered systems effective at this site
- Anaerobic bio processes treated chlorinated compounds (who knew?)
- Phytoremediation being ramped up for 1,4-dioxane treatment