

# Rapid Perchlorate Destruction in Soil and Groundwater Through Bioaugmentation

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# Introduction

Successful full scale in-situ bioaugmentation approach for perchlorate degradation:

- Vadose zone soils
- Overburden soil and groundwater
- Wetland soils and groundwater
- Bedrock groundwater

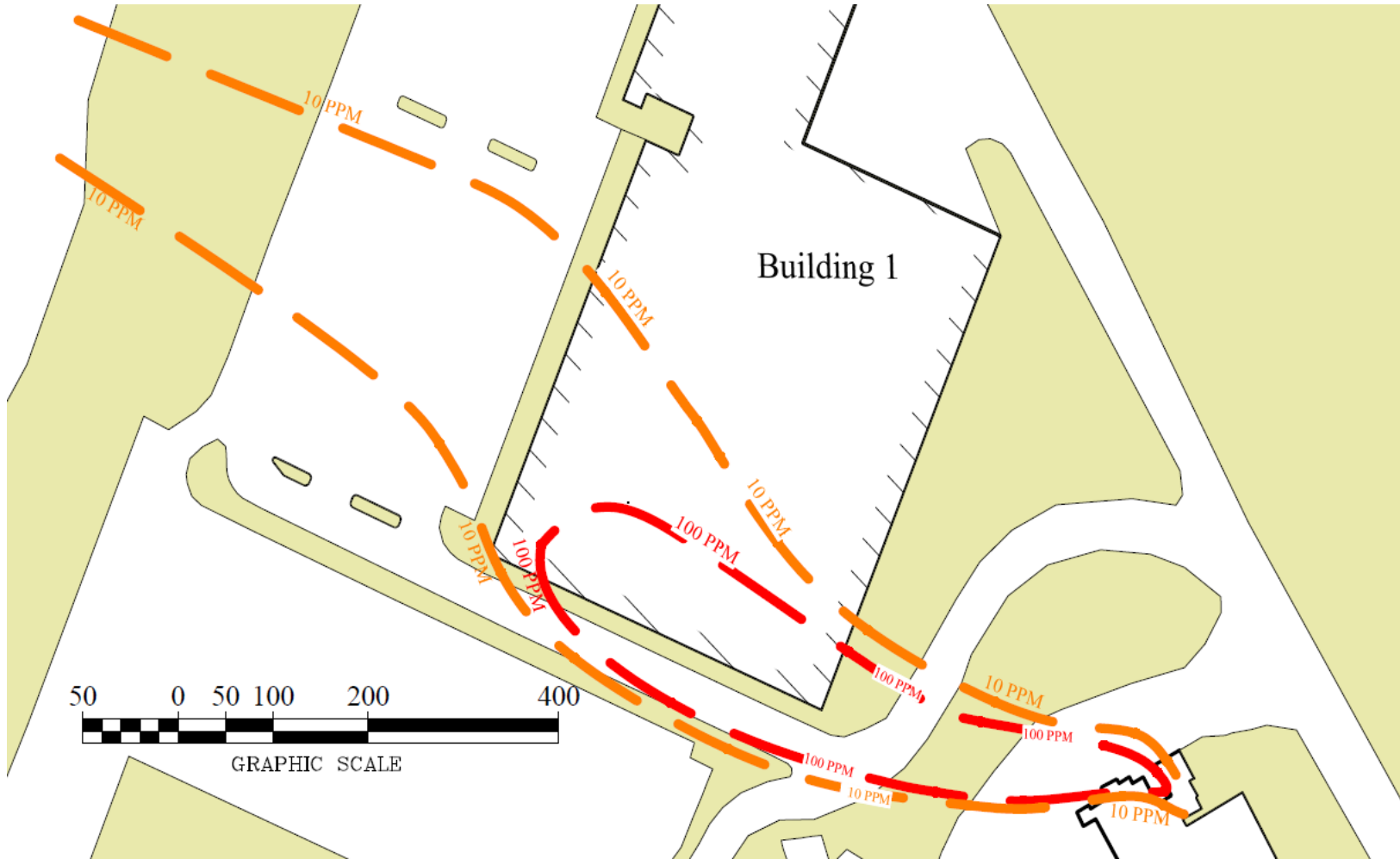


# Important Site Conditions

- Plume area: 2.2 acres
- Nitrate to perchlorate ratio: 3:1
- Acidic plume: pH 3.5 – 6 SU
- Maximum perchlorate concentrations:
  - Overburden groundwater: 680 ppm
  - Bedrock groundwater: 12 ppm
- Perchlorate mass: 1500± lbs



# Shallow Groundwater Contamination Plume – May 2011



# Challenging Hydrogeology

- Low permeability overburden soils
  - Hydraulic Conductivity = 3.5 ft/day
- Saturated thickness: 7-8 feet
- Plume length: >800 ft



# Remediation Approach

- Initial approach: groundwater extraction with offsite disposal
  - Plume containment – 450,000 GPY
  - Collection of dry weather flow – 100,000 GPY
- Other approaches considered
  - Onsite treatment with discharge (1 PPB limit)
    - Ion exchange
    - Ex-Situ biological
  - In-situ bioremediation



# In-Situ Bioremediation

- Biostimulation
  - Native anaerobes
- Bioaugmentation
  - CL-OUT<sup>®</sup>
    - Used at sites for degrading chlorinated solvents
    - Reduce nitrate in anoxic conditions

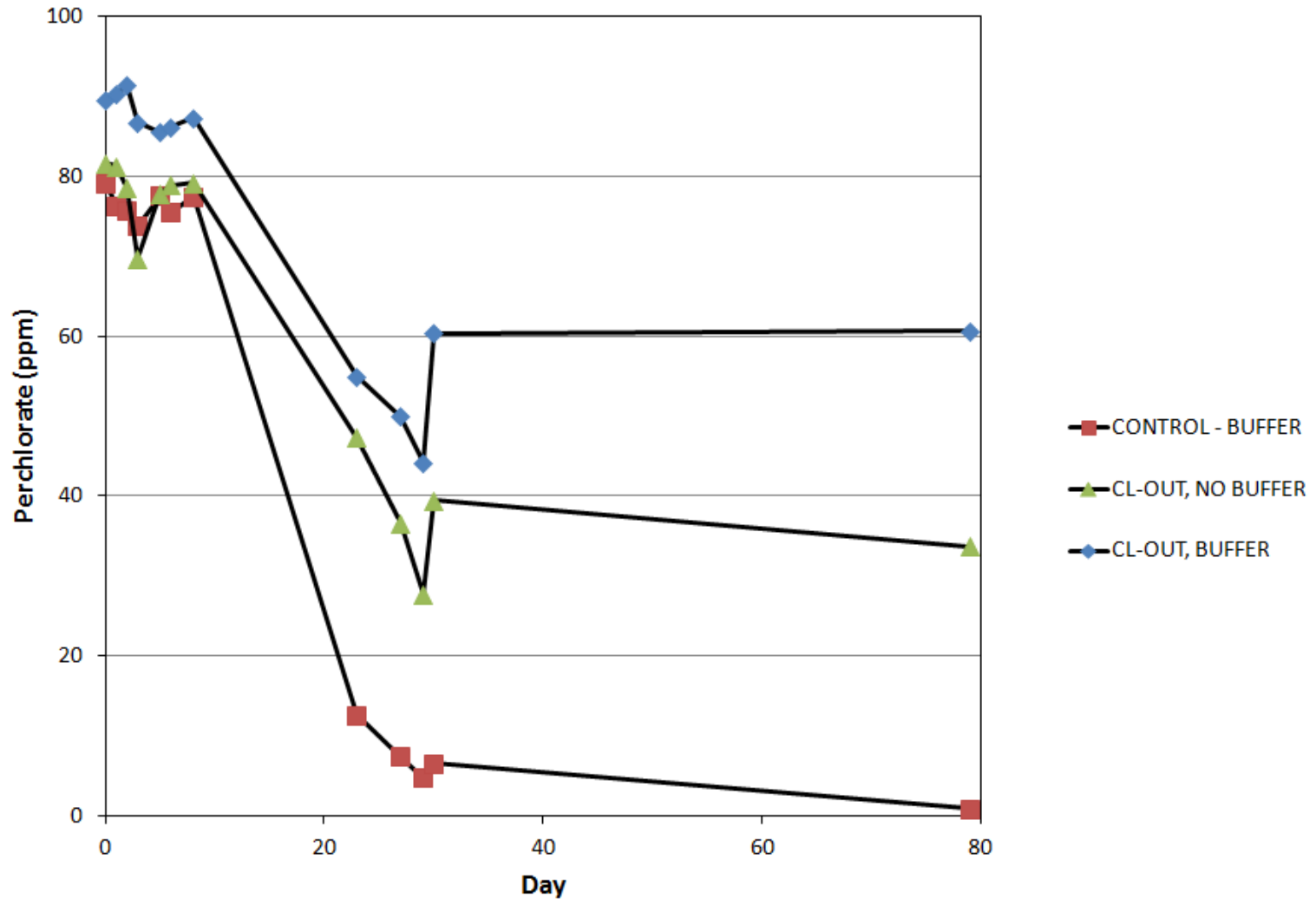


# Benchscale Microcosm Study

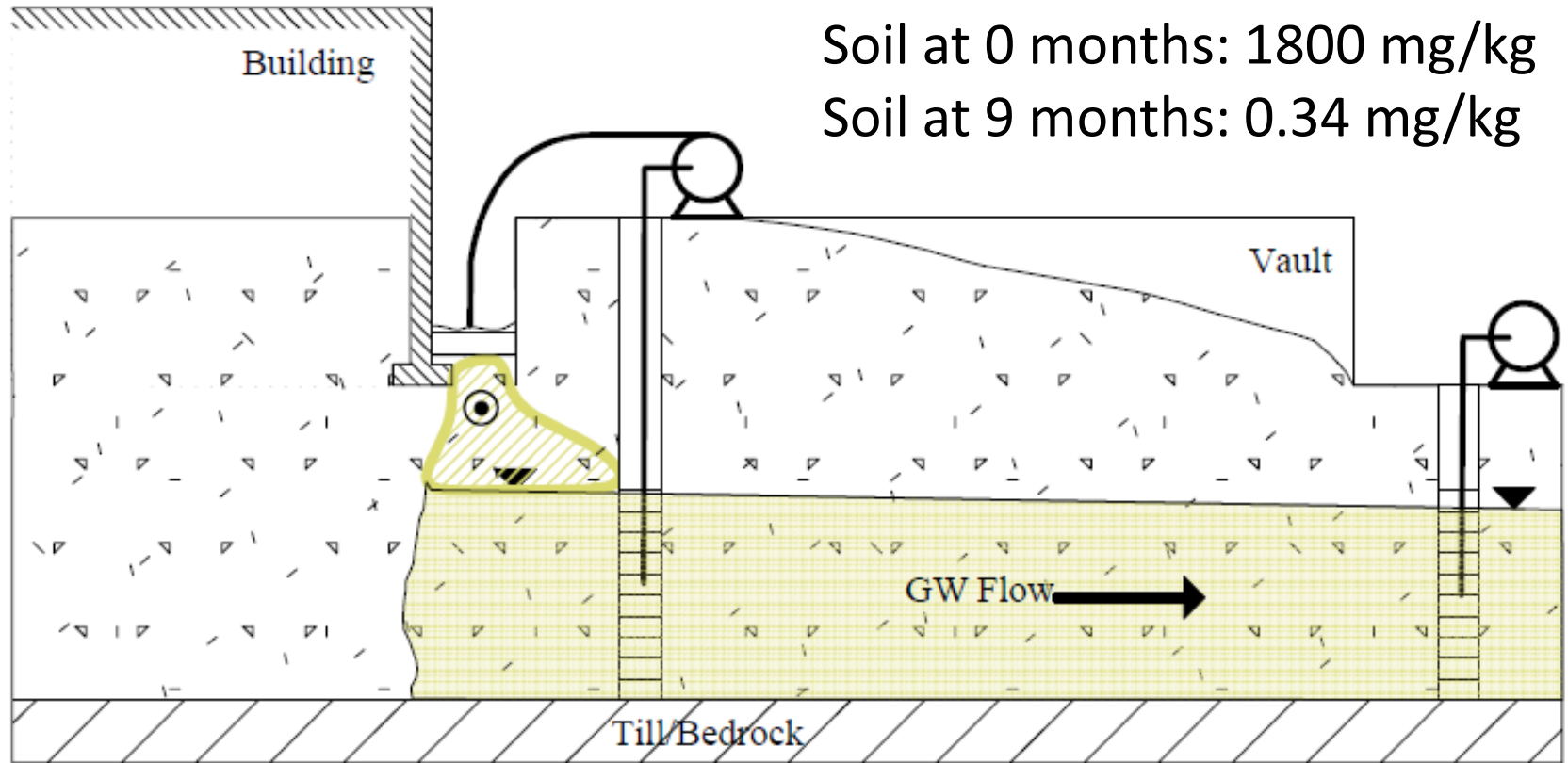




# Bench Scale Test Results

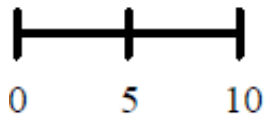


# Vadose Zone Soils Remedy

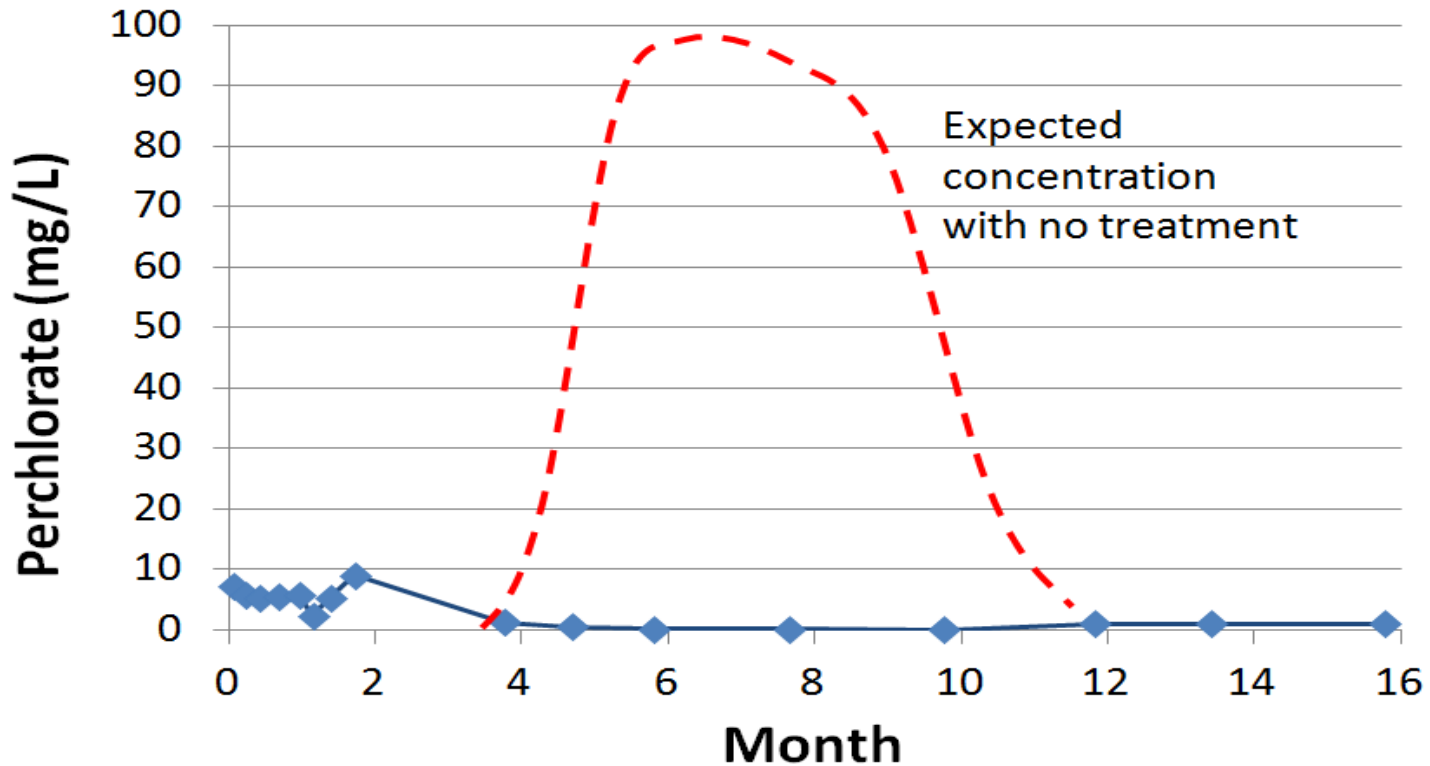


Soil at 0 months: 1800 mg/kg

Soil at 9 months: 0.34 mg/kg



# Downgradient Groundwater During Vadose Zone Soil Flushing Treatment



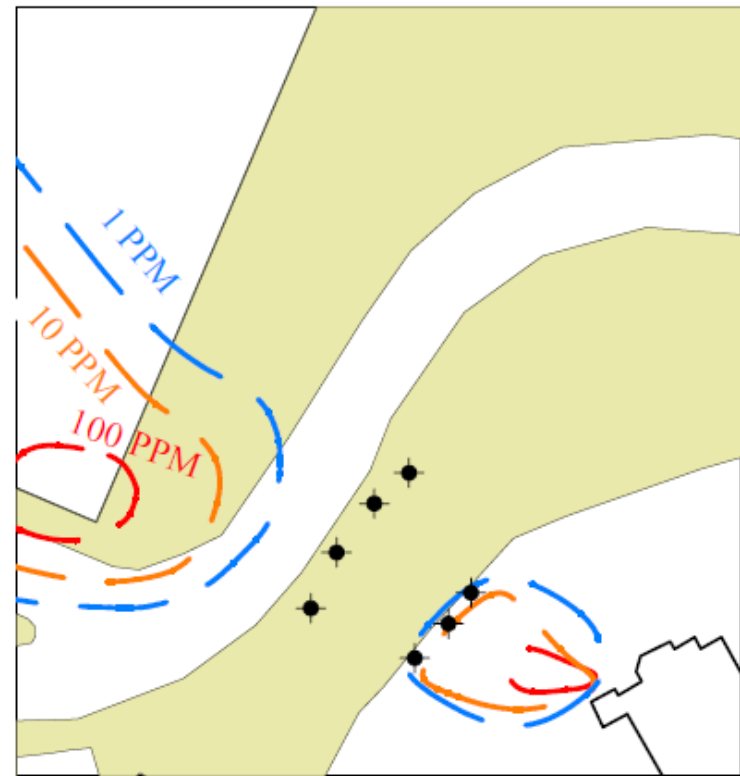
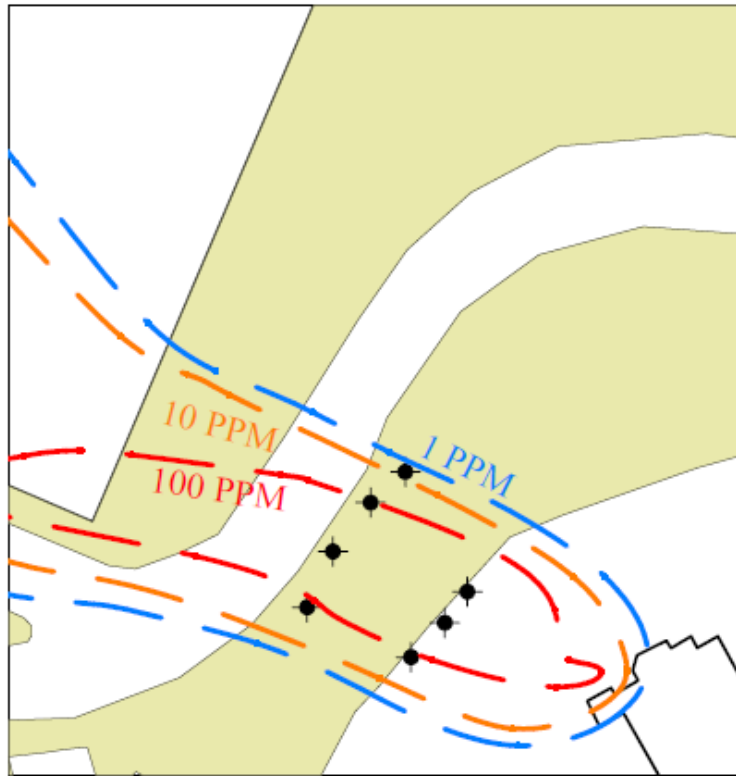
GW travel time: 6 months



# Overburden Groundwater Remedy Pilot Test

BEFORE

4 MONTHS LATER



GRAPHIC SCALE

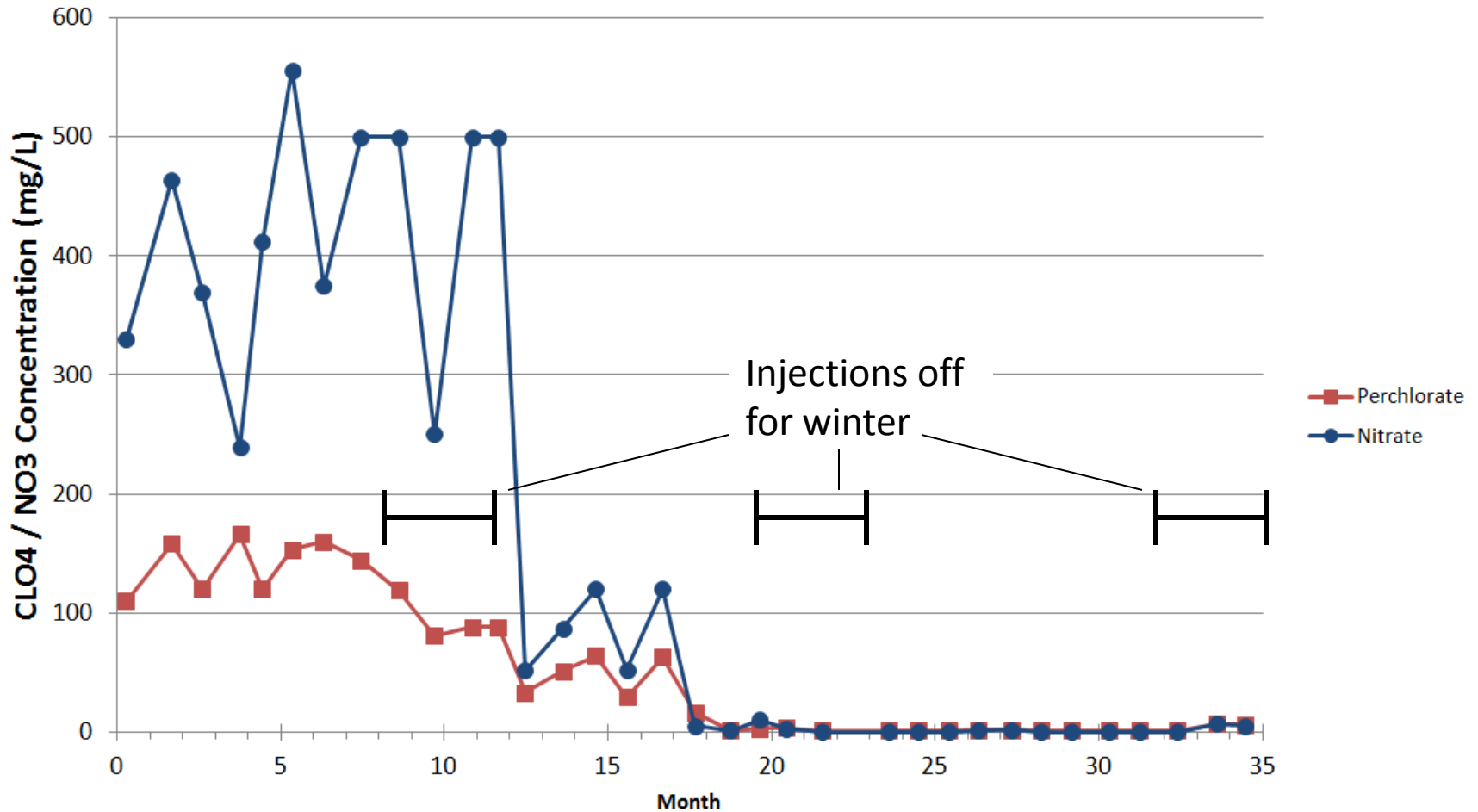
◆ INJECTION WELL



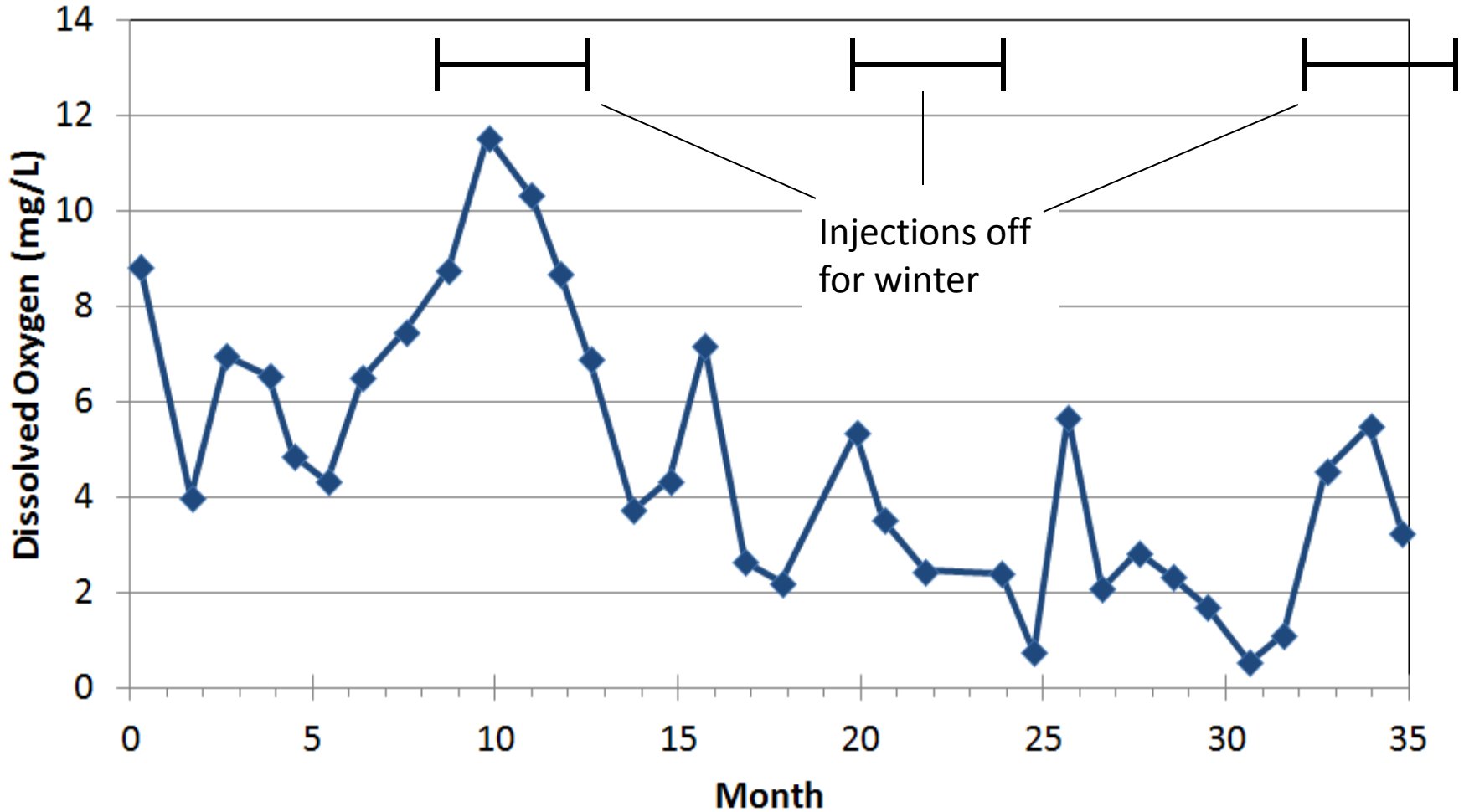
# Full Scale In-Situ Bioremediation Implementation

- Massachusetts regulatory approval for injection in drinking water source area
- Greener Cleanup
  - Gravity feed system
  - Reuse of extraction wells as injection wells
  - Horizontal wells
    - Access under building
    - Distribution across plume cross-section with single feed point

# Perchlorate and Nitrate in Groundwater 100 Feet Downgradient from Injection

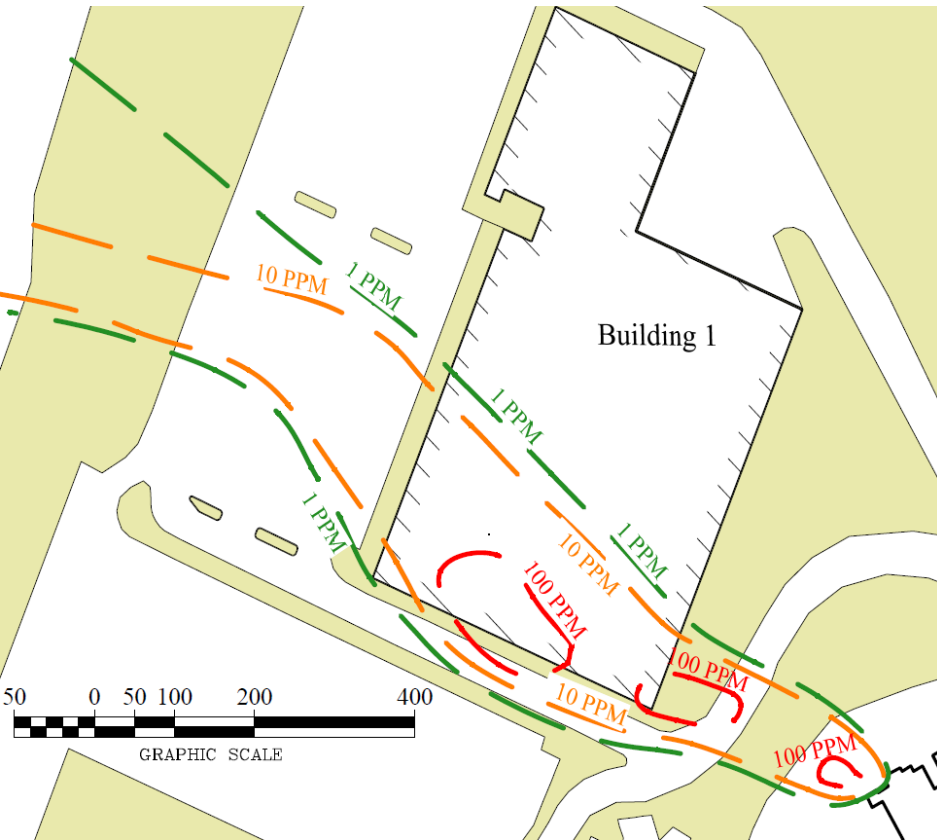


# Groundwater Remedy - DO

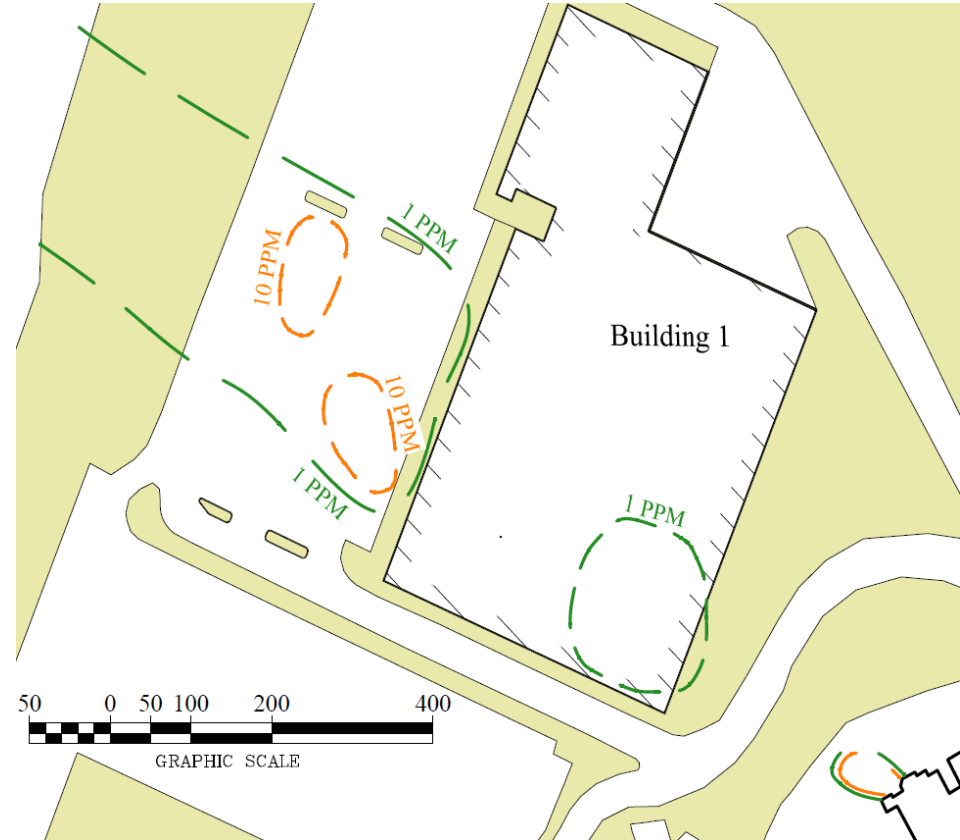


# Overburden Plume Reduction

August 2012



December 2015





# Conclusion

- 2.2 Acre site-wide *in-situ* mass reduction of perchlorate using CL-OUT<sup>®</sup>:
  - Vadose soils: 99.9+%
  - Overburden GW: 95% +
  - Wetland GW: 95% +
  - Bedrock GW: 99.9+%
- Project duration shortened by years
- Less than half the cost of pump and treat

