

# Sustainable Treatment of Perchlorate Contaminated Soil and Groundwater Using Local Resources

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# Introduction

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- Site Overview
- Problem
- Green and Sustainable Remediation
- Solution
- Data
- Conclusions

# Site Overview

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**Site located in Indiana within a mile of a large river system. Site has operated as a signal flare manufacturing facility since the late 1940's. Manufacturing process includes handling and mixing of ammonium perchlorate.**

# Problem

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- Perchlorate releases over a 30 to 40 year period from a mixing building had impacted shallow soils and groundwater.
- Perchlorate concentrations in soil beneath process building at 28,000  $\mu\text{g}/\text{kg}$ .
- Perchlorate in groundwater at 19,000  $\mu\text{g}/\text{L}$  with a plume approaching the property boundary.
- State agency requiring treatment of source area as well as mitigating migration of impacted groundwater.
- Area is rural farmland, therefore remediation has to consider potential impacts to local community

# Remediation Assessment

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- Remediation assessment included reviewing technologies based on effectiveness, implementability, cost and sustainability criteria.
- Technologies considered included excavation, pump and treat and in situ bioremediation.
- Stakeholders engaged during assessment included liability owner, regulatory agency and adjacent property owners.
- In situ bioremediation determined to be the most effective, implementable and sustainable remedy agreed upon by all stakeholders assuming risk-based remedial goals and use of locally sourced materials.

# Solution

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- Develop risk-based remedial goals that are protective of human health and the environment
- Install injection biobarrier immediately downgradient of mixing building
- Decontaminate and remove building and slab
- Source area bioremediation beneath building via in situ bioreactor
- Monitoring of soil and groundwater

# Remedy Selection Via the 3 Pillars

- Consider potential impacts to all stakeholders (including local community)
- Consider economic impact to client
- Consider environmental impact of the remedy while achieving risk-based remedial goals





# Bioreactors as Green & Sustainable Remediation

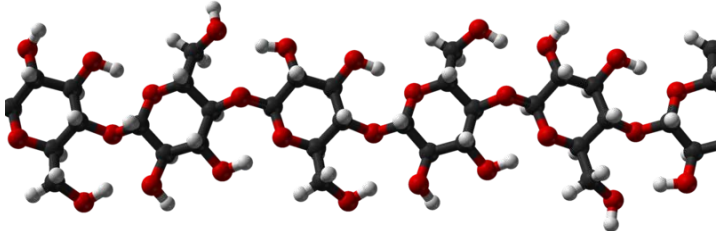
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- Relatively low energy usage for installations
- Carbon/electron donor source was obtained locally on site
- No O&M
- Low carbon footprint compared to other more energy intensive remediation strategies such as excavation and pump and treat



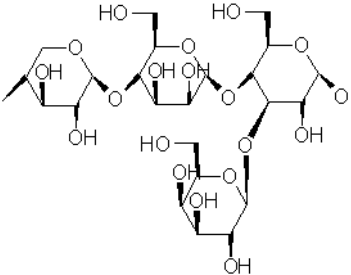


# Primary Components of Mulch



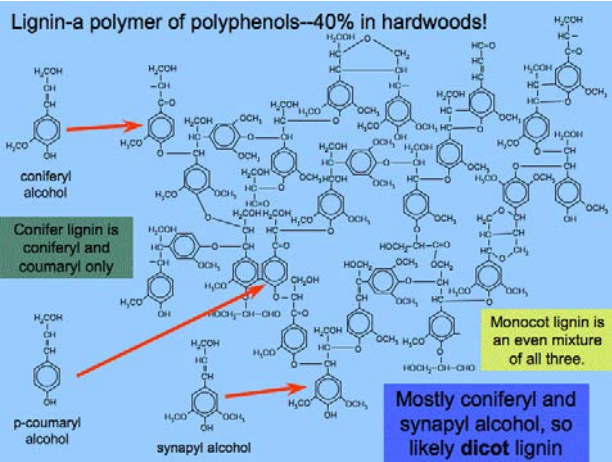
Cellulose

Hemicellulose



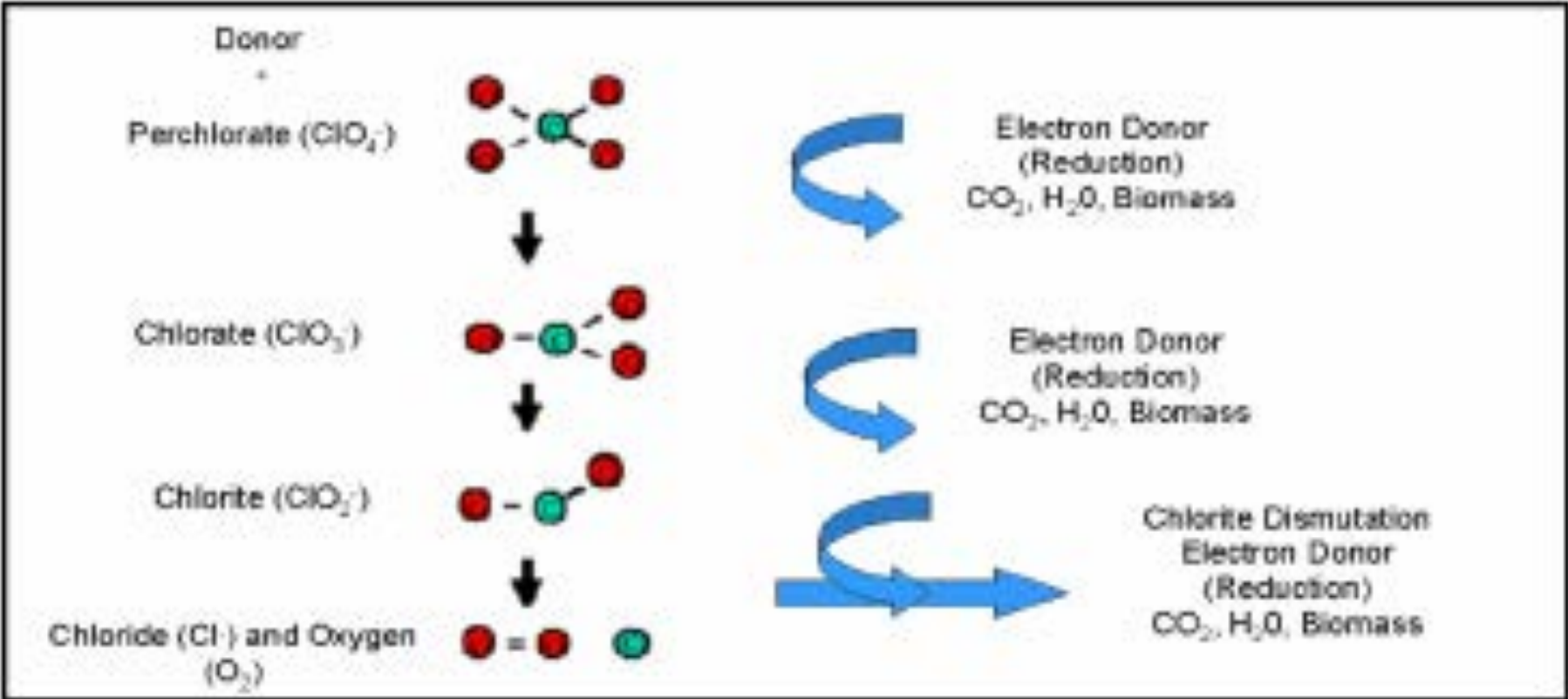
- Xylose -  $\beta(1,4)$  - Mannose -  $\beta(1,4)$  - Glucose -  
 -  $\alpha(1,3)$  - Galactose

Hemicellulose



Lignin

# Perchlorate Reduction



# Mixing Building



# Building Demolition

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# Demolition Continued

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# Remediation

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- Installed injection biobarrier in September 2010 (15 injection points downgradient of mixing building)
- Building decontaminated and demolished early October 2010
- Soils beneath former mixing building mixed with composted landscaping waste generated onsite down to a depth of 5 feet bgs
- Drip feed system saturates vadose soils with 10,000 gallons of water over 24 hours
- Area covered to prevent infiltration of oxygenated precipitation and maintain anoxic conditions.



# In Situ Bioreactor

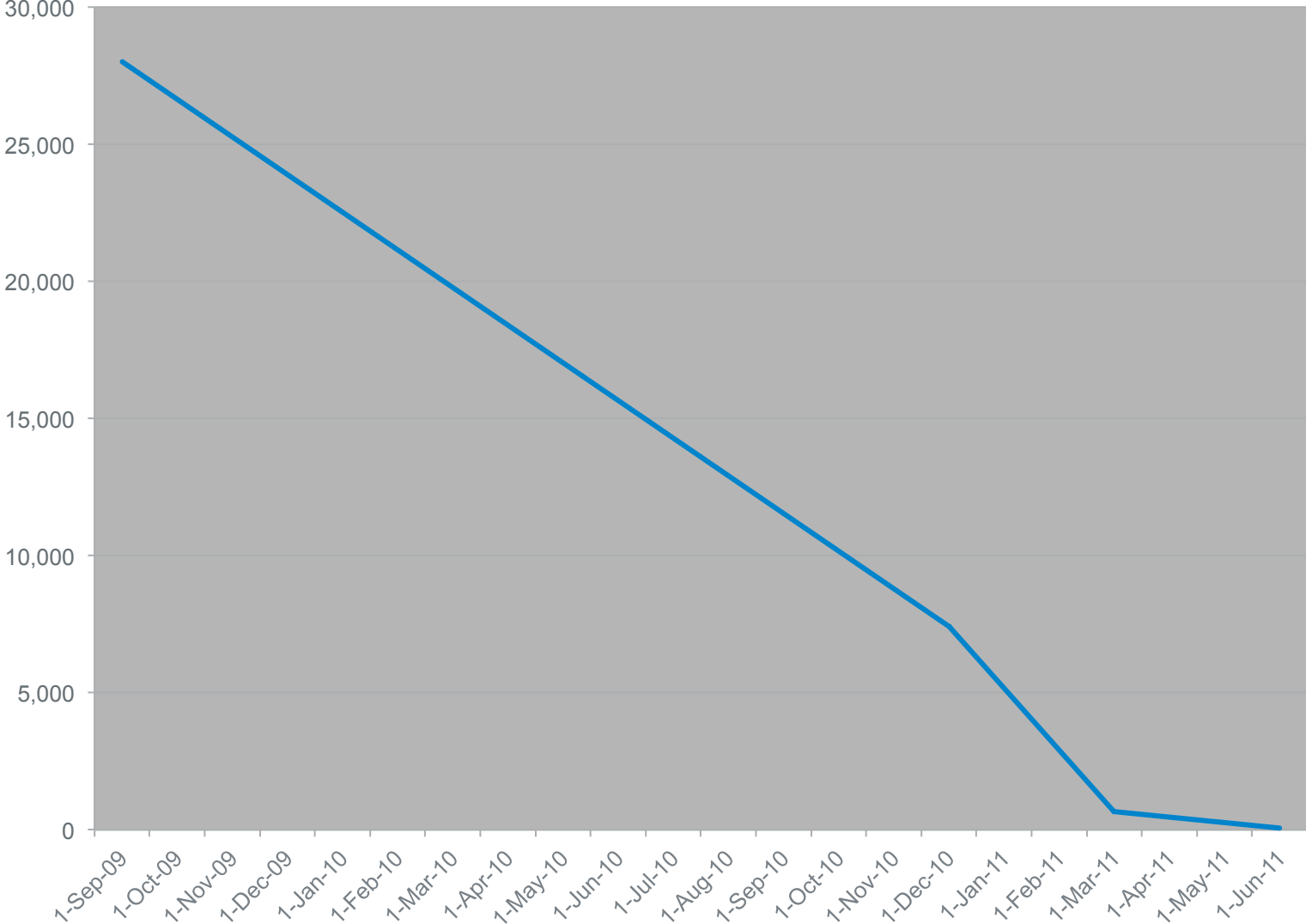




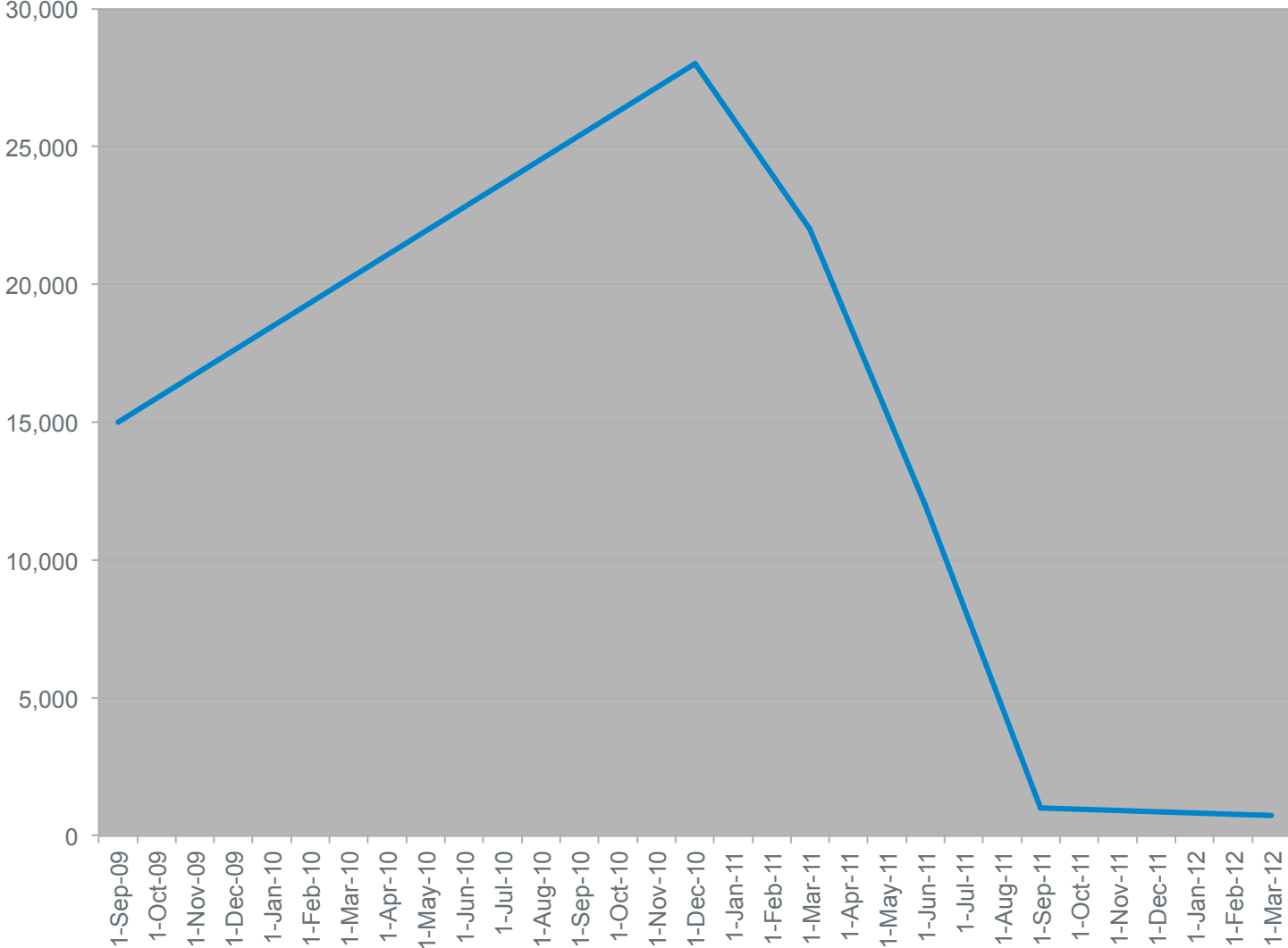
# Treatment Completed



# Perchlorate ( $\mu\text{g}/\text{kg}$ ) in Soil 1 - 2 feet bgs



# Perchlorate ( $\mu\text{g}/\text{kg}$ ) in Soil 5 – 6 feet bgs



# Observations

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- Perchlorate in groundwater has been reduced by 90%
- Perchlorate in soils were reduced by >90% within 2 years of remediation with no rebound
- IDEM has agreed to no further action with covenant not to sue based on positive results
- Redox conditions in groundwater continues to be reducing and are expected to allow for ongoing degradation of perchlorate

# Conclusions

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- Remediation successful at achieving risk based concentrations in soils
- Remediation effort also successfully mitigated migration of perchlorate from the site
- Remediation effort consumed little energy (3 days of heavy equipment for demolition and soil mixing)
- Remediation effort had no negative impact on local community

# Questions?

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