Off-Grid Sustainable Remediation Norfolk Southern Derailment

August 25, 2017

Scott Pittenger, Norfolk Southern Railway Company

Train Derailment Background

39 of 90 cars derailed

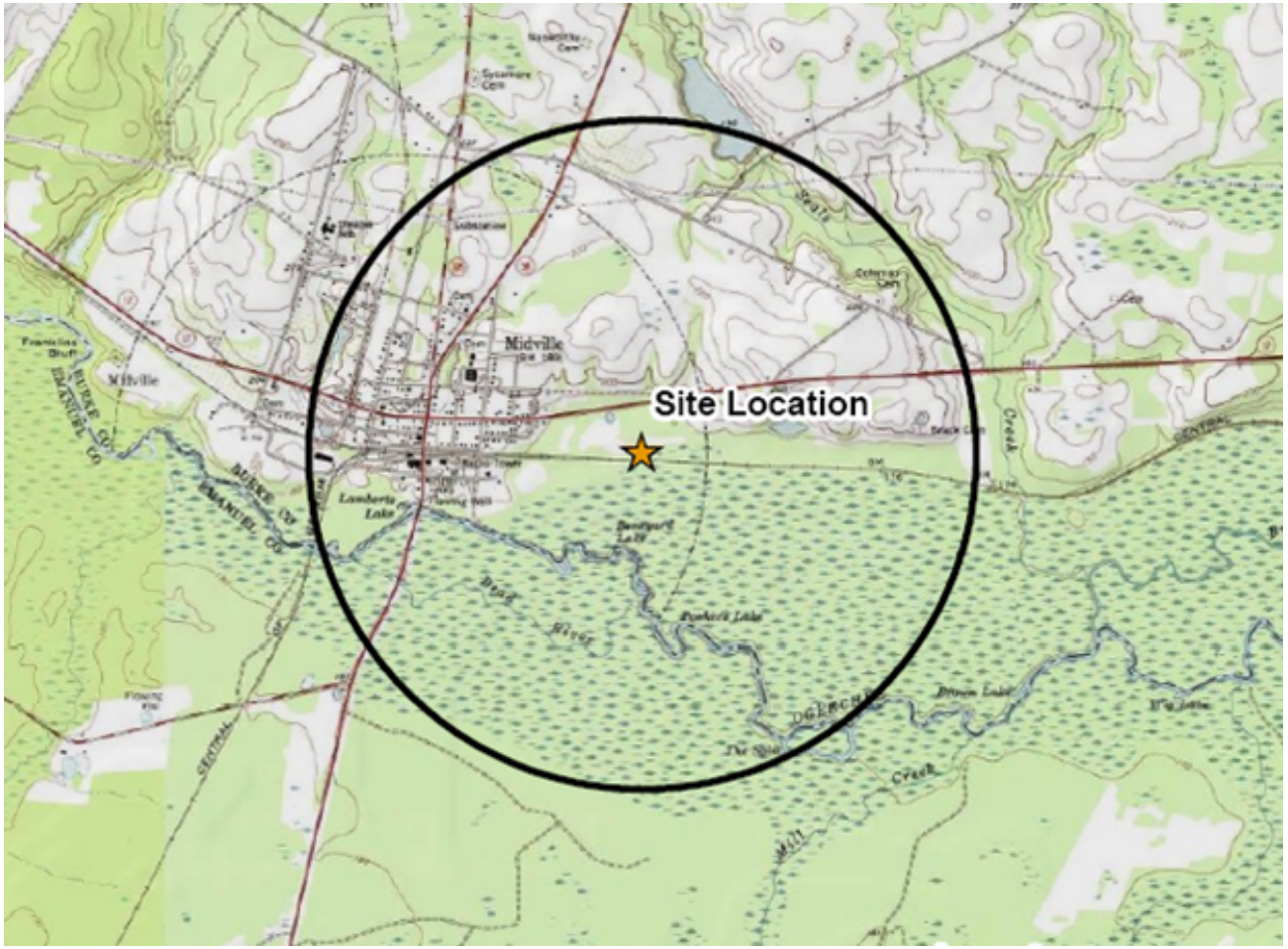
30,000 gallons of highly flammable MEK solvent spilled

Unknown amount of MEK burned

Train Derailment Background

…Other chemicals derailed and released included potassium chloride, sodium hydroxide.

Site Location



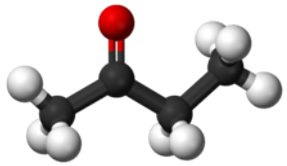
Methyl Ethyl Ketone (MEK)

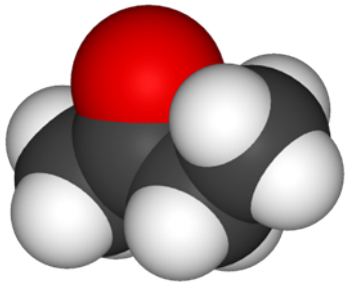
Highly soluble (240,000 mg/L or 24% in water)

Highly flammable (PVC solvent, like finger nail polish remover)

Relatively low toxicity (not a carcinogen)

Methyl Ethyl Ketone (MEK)





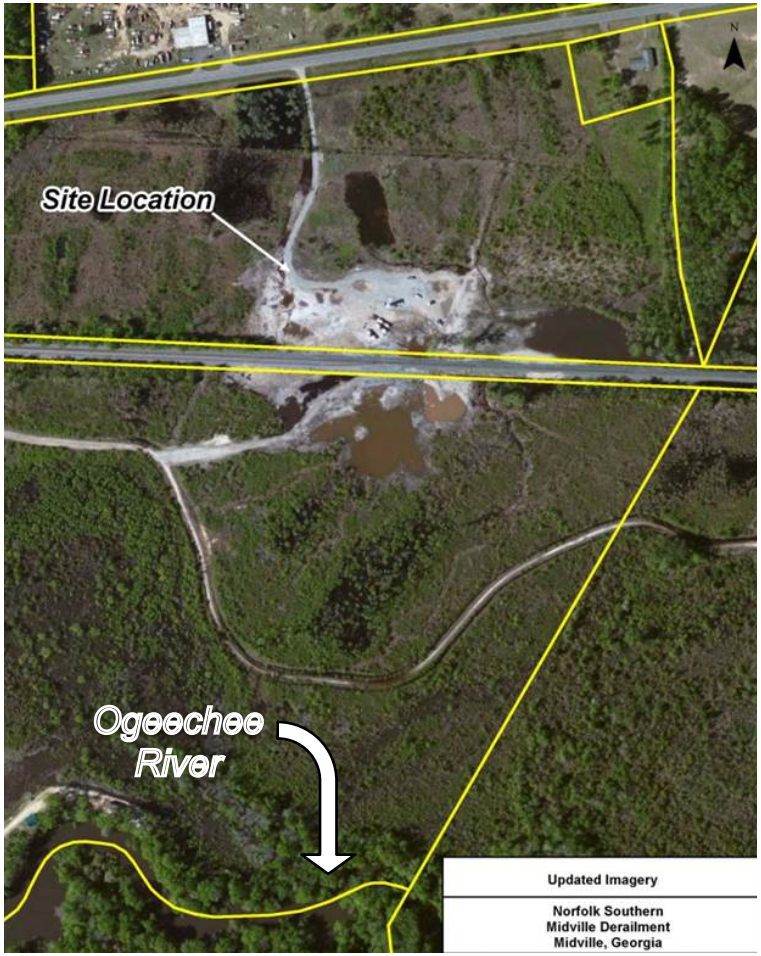
Easy to bio-degraded under aerobic (oxygen containing) and anoxic (sulfate and iron reducing) conditions

BUT – spill area 96,000 mg/L = sterile

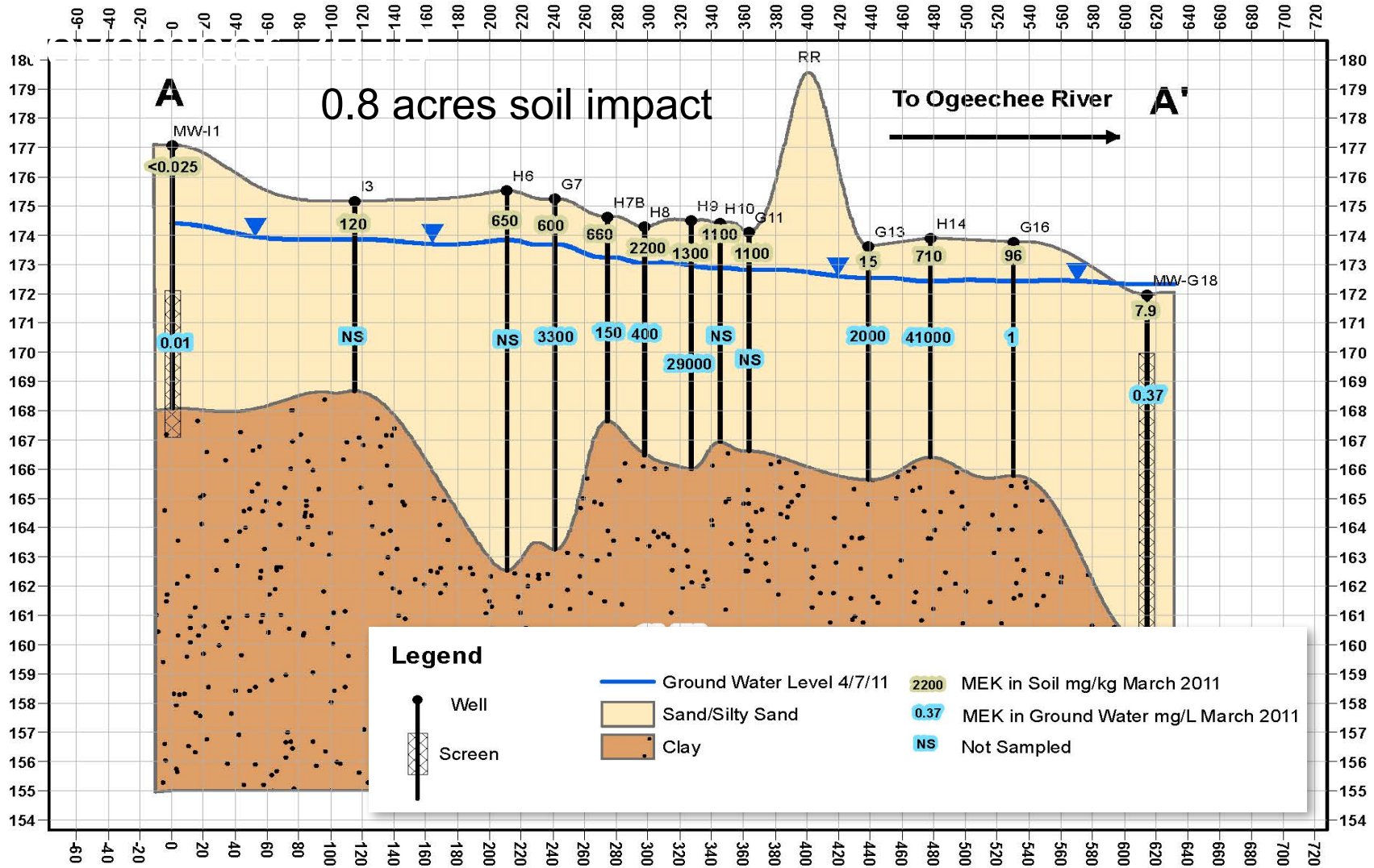
Derailment Site

Prior Derailment

Post Response



Conceptual Site Model



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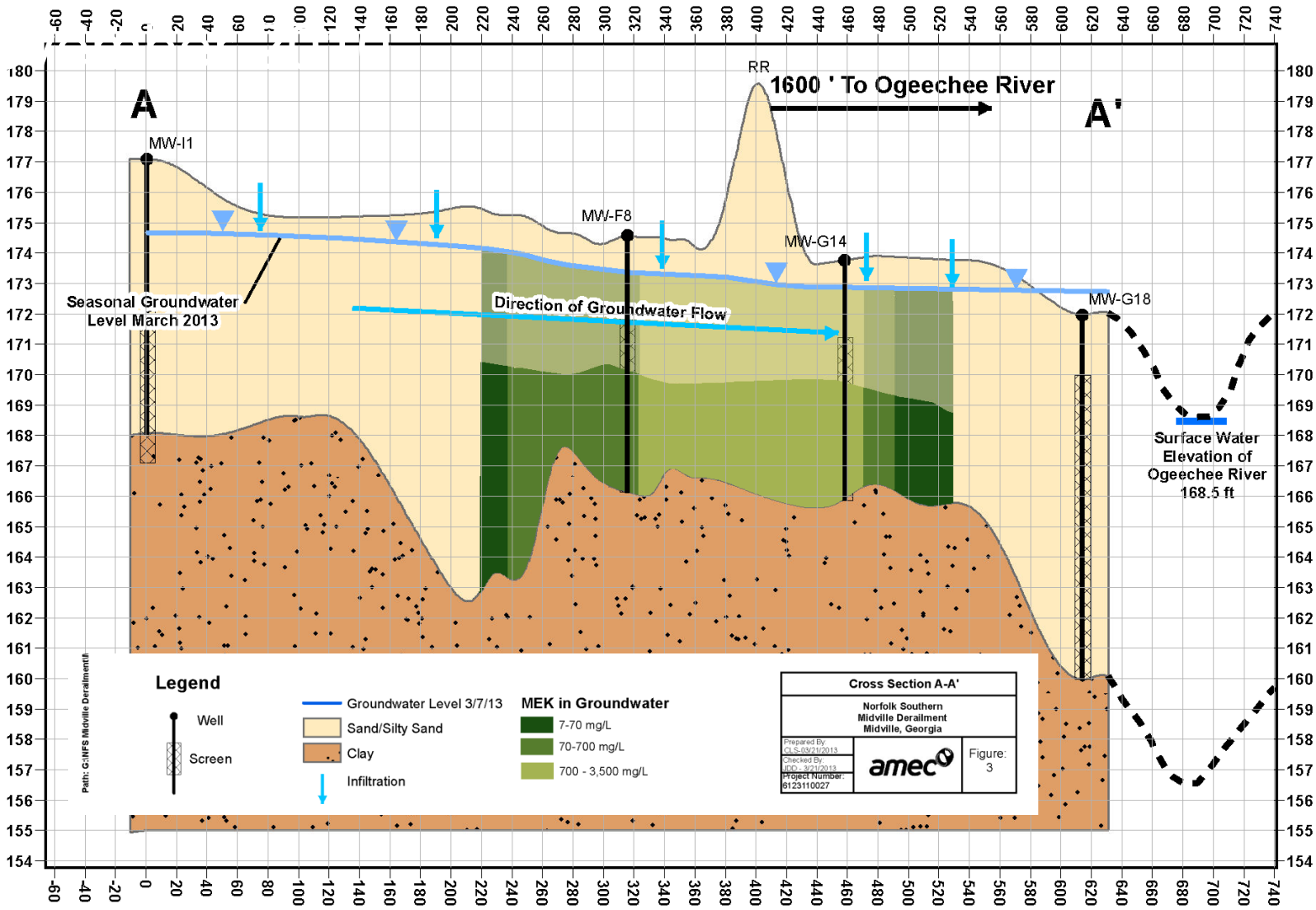
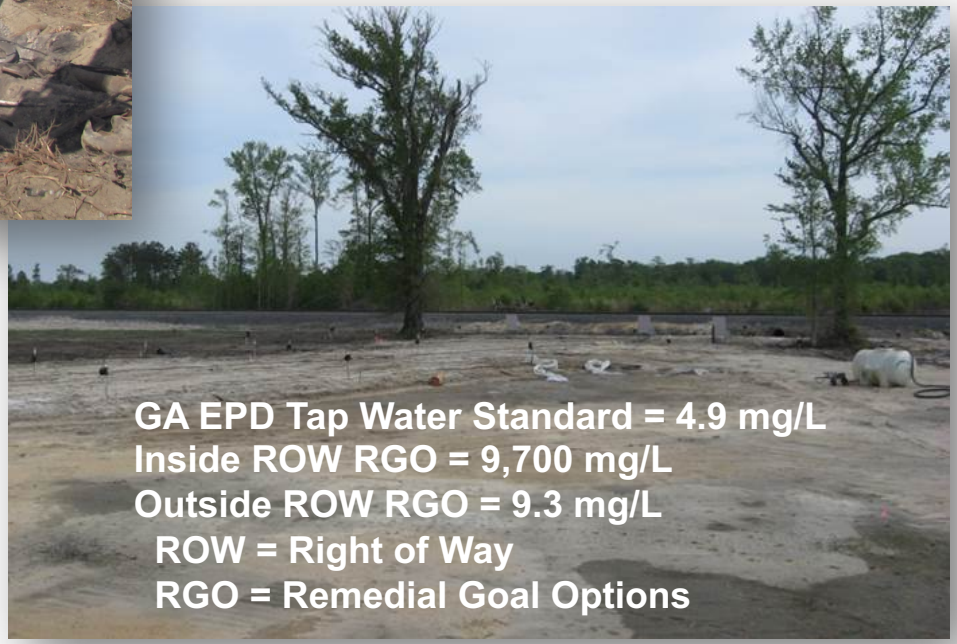


Remediation Objectives (Exit Strategy)

- Clean soil and groundwater to levels acceptable to GA EPD – out of HSRA
- Negotiate risk-based, site-specific cleanup standards



- Restore surface soil/vegetation to pre-derailment condition
- Low cost remedy; minimize impact to local community
- Incorporate sustainable remediation elements

Remediation Alternatives

Dig and Haul (non-hazardous landfill)

- 10,500 cubic yards of material
- $2+ million cost, 90 day remediation period
- 140,000 miles with 15 cubic yard dump trucks (700 trips)
- Can't excavate under tracks

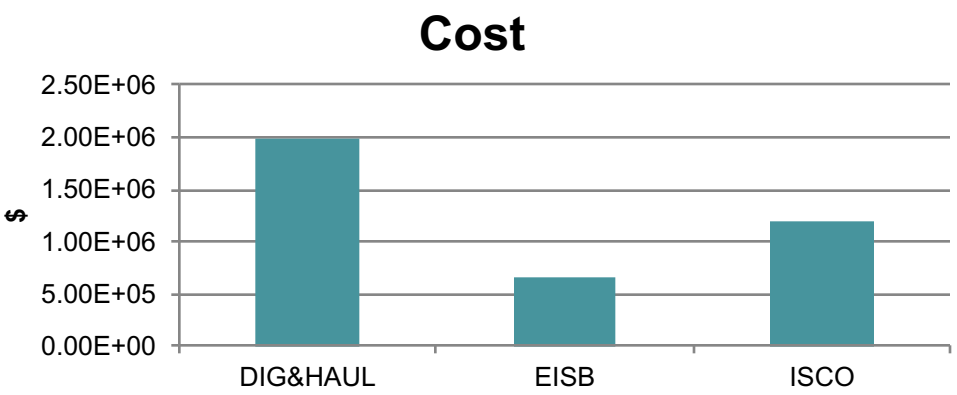
In-Situ Chemical Oxidation

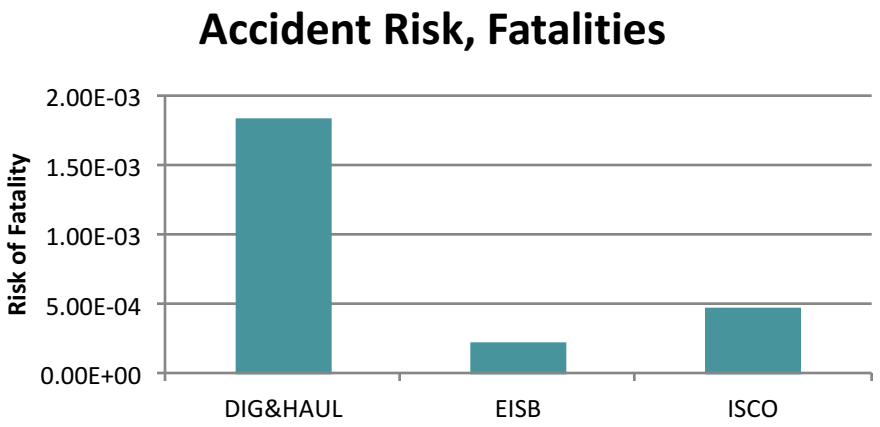
- Peroxide or persulfate chemical injection
- $1.2 million cost, 180-day remediation period
- Difficult to reach under tracks

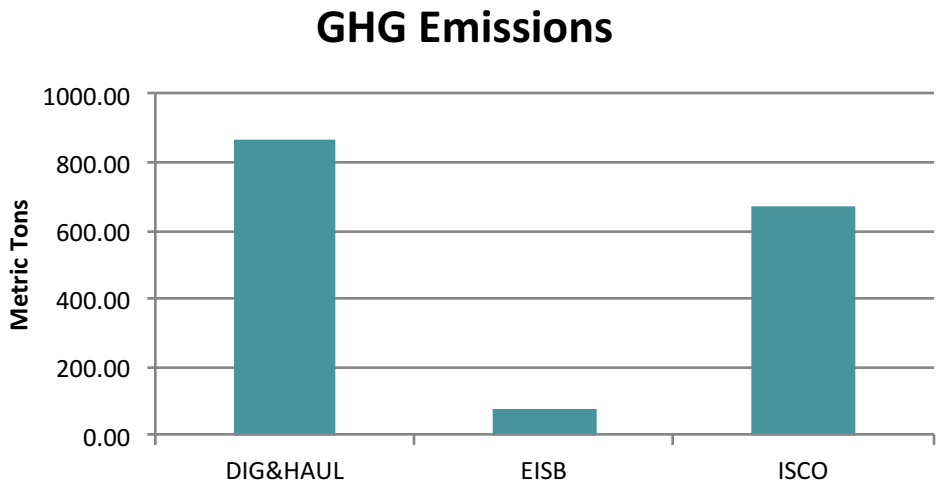
Enhanced In-Situ Bioremediation

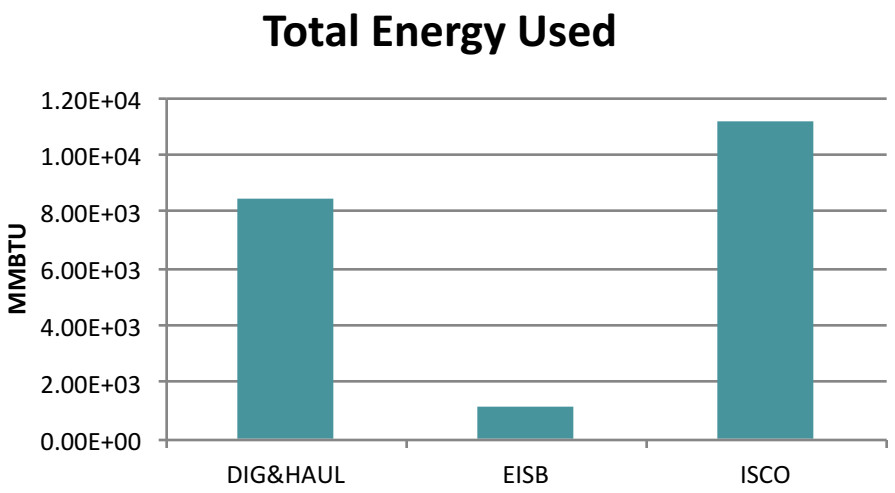
- ✓ Inject nutrients and oxygen into ground
- ✓ $ 650,000 cost, uncertain remediation period
- ✓ Potential treatment under tracks

Comparison of Alternatives *(SiteWise® Output)*









The Liquid Oxygen System

Radiant heat: O2 (l) -> O2 (g)

- Vapor directly injected
- Fertilizer + bicarbonate injected

Delivery

- 57 injection points
- ¾ inch stainless steel & 1 ft screen

Operation & Maintenance

- Minimal attention (visit 2-4 wks)
- Remote monitoring

  Cell phone communications
- System pressure and flow
- Solar powered

Oxygen Tank and Evaporators

Injection Wells/Oxygen Delivery

DPT Install

Soil cores

Supply main

Flow control

Well Head

Remote/Off-Grid Monitoring System

Remediation System Performance

Take Aways

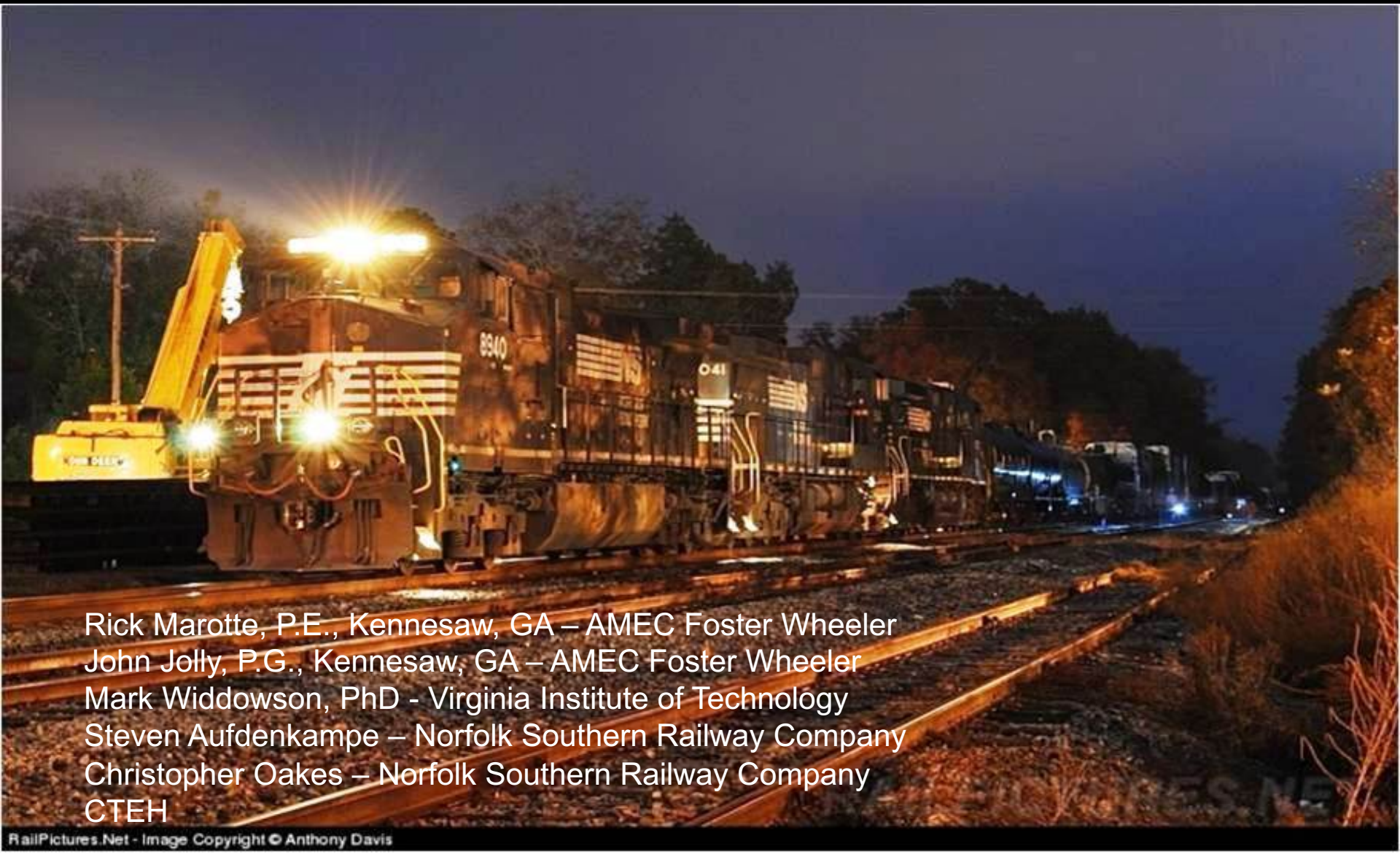
Enhanced In-Situ Bioremediation

- Lowest cost - little operator attention
- Smallest environmental footprint use simple available equipment
- No external power & no hazardous chemicals on-site
- No heavy truck traffic (monthly oxygen delivery)
- Sustainable
- Quickly remediated MEK - goals achieved & site closed early 2017 (<0.003 & 3.7 mg/L in May 2016)

Optimizations & Innovations

- ✓ Bioavailable iron bench – check before switch anaerobic
- ✓ Regulatory relationship – teaming partner
- ✓ Site risk based goals – effective & reasonable cleanup
- ✓ Accept RR easement equivalent Uniform Envir. Covenant

Questions & Acknowledgments



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