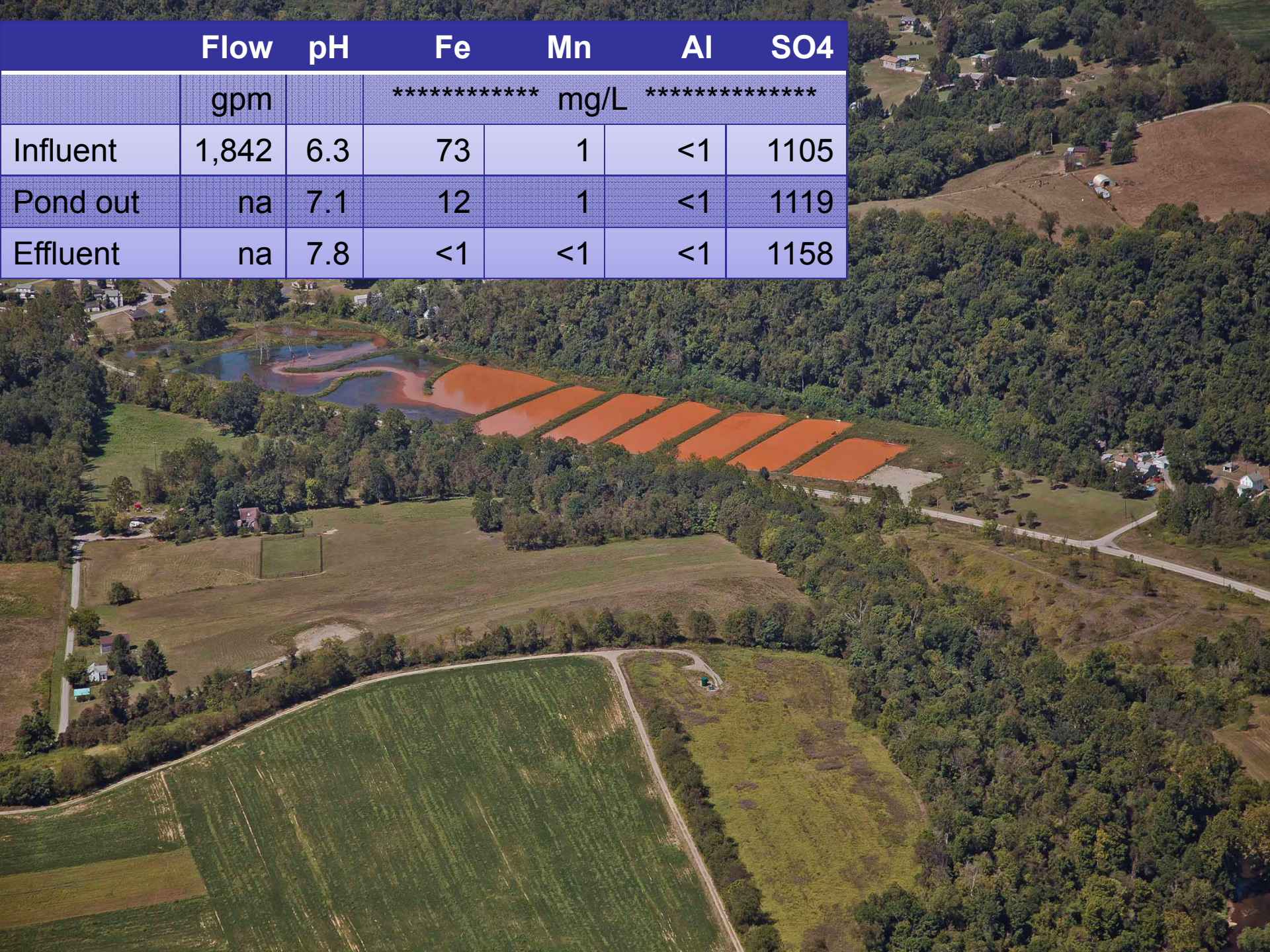


Production of Saleable Iron Oxide Products from Coal Mine Drainage

Robert Hedin
Iron Oxide Recovery, Inc.
Hedin Environmental

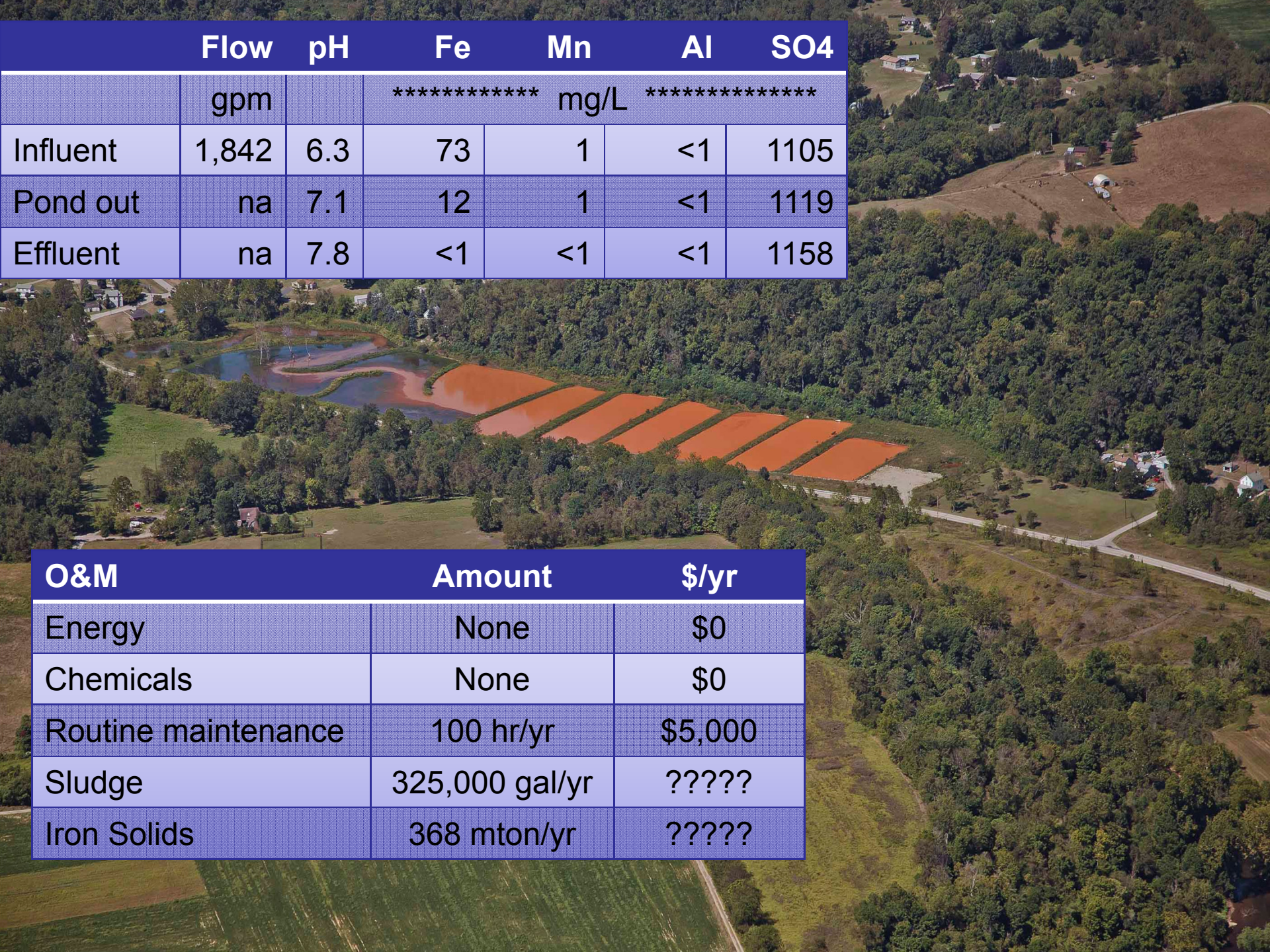




	Flow	pH	Fe	Mn	Al	SO4
	gpm		*****	mg/L	*****	
Influent	1,842	6.3	73	1	<1	1105
Pond out	na	7.1	12	1	<1	1119
Effluent	na	7.8	<1	<1	<1	1158

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O&M	Amount	\$/yr
Energy	None	\$0
Chemicals	None	\$0
Routine maintenance	100 hr/yr	\$5,000
Sludge	325,000 gal/yr	?????
Iron Solids	368 mton/yr	?????



A photograph of a riverbank. The foreground shows a body of water with a yellowish-brown tint, reflecting the surrounding trees and sky. The middle ground features a prominent, layered bank of reddish-brown soil, likely a type of clay or silt. The background consists of a dense line of bare, deciduous trees, suggesting a late autumn or winter setting. The overall scene is a natural landscape with a focus on the soil and water.

Does this have valuable characteristics?

Challenges

- Find valuable aspect(s) of the material
- Find customers for the product
- Develop procedures to process the material to form customer will buy

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 - 1997: FeOOH sludge characterization determines that it may have pigmentary value
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 - 1999: Hoover Color Corp. agrees to buy dewatered product
- Develop procedures to process the material to saleable form

Challenges

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 - 1996: FeOOH sludge characterization determines that it may have pigmentary value
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- **Develop procedures to process the material to saleable form**



Frame Press



Belt Press



GeoTube



Sludge Dewatering Basin









Current Iron Oxide Product

- Goethite (FeOOH and $\text{Fe}(\text{OH})_3$)
- 65-75% solid
- Screened
 - 100% < 10 mm; 50% < 2 mm; 10% < 0.2 mm
- Sales
 - Bulk & Super sacks
- \$300/ton solid

Analysis of Iron Oxide Products

	Farmington	Marchand
Type water	Acid, Fe 110	Alk, Fe 73
Treatment	Natural, pH 3-6	Passive, pH 6-8
Fe ₂ O ₃ (%)	74.0	77.5
Al ₂ O ₃ (%)	0.7	0.3
SiO ₂ (%)	4.9	5.4
CaO (%)	0.2	1.2
MgO (%)	<0.1	0.1
LOI (%)	18.3	14.6
S (%)	0.9	0.3

Markets for Mine Drainage Iron Oxide

- Pigments
- Remediation



Goethite + heat → Hematite

Iron Oxide Pigments

- Commodity (established markets)
- US consumption in 2008
 - 240,000 mtons
 - \$282 million
 - Finished premium pigments: ~\$2,000/ton
- Two primary sources of pigment grade iron oxide
 - Natural: mined, lower purity and value
 - Synthetic: manufactured, highest purity and value
- Mine drainage iron oxide is intermediate in quality



NEEDS
PARKING





environoxideTM

- Registered trademark in US and EU
- The mark identifies products containing iron oxide recovered from mine drainage
- Hoover Color has developed a line of **environoxide** pigments

Markets for Mine Drainage Iron Oxide

- Pigment
- Chemical Reactivity

Chemical Reactivity Opportunities

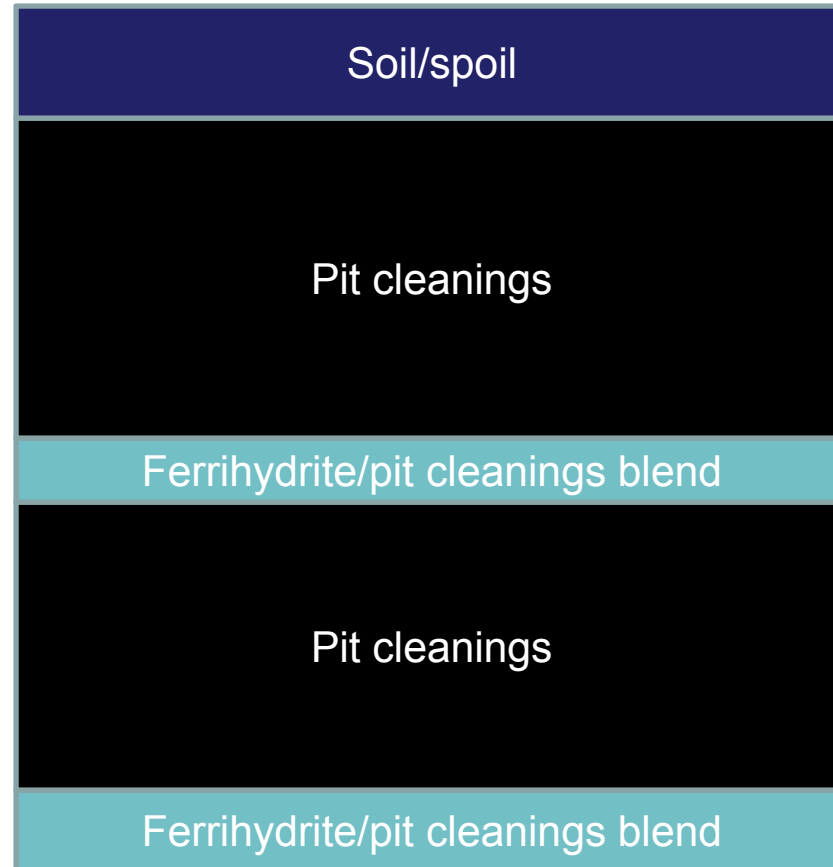
- Reaction with reduced sulfur compounds
 - H_2S removal in natural gas operations
 - Bioreactors with excessive H_2S
- Adsorption of metal ions
 - Selenate & selenite
 - Lead oxyanions
 - Arsenate
 - Phosphate
 - Molybdate?

Selenium Treatment

- Experimental use to lessen release of Se in situ
- Experimental use to lessen dissolved Se in mine drainage

Special Handling Cell:

Ferrihydrite application in unlined cell



Placement of pit cleanings over ferrihydrite



Addition of IO to Se-contaminated drainage



Remediation of Pb contaminated soils

- Slater Limited
 - UK firm marketing TRAPPS™
 - Phosphate & Iron Oxide mixture
 - Positive bench tests
 - Test plots at Fort Dix (New Jersey)

0.1 g Iron Oxide in 100 mL solution, pH 7, 24 hr

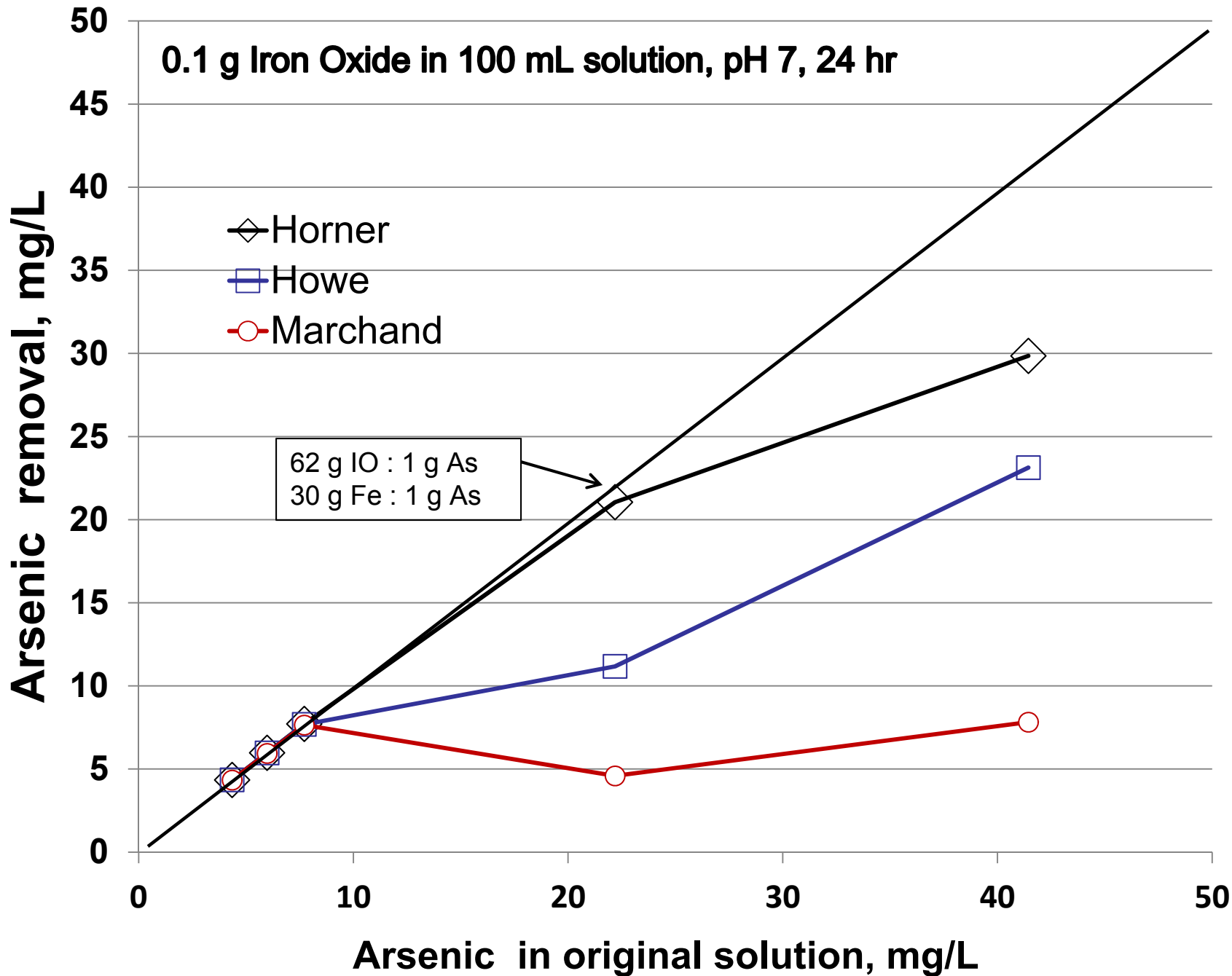
Arsenic removal, mg/L

- ◆ Horner
- Howe
- Marchand

62 g IO : 1 g As
30 g Fe : 1 g As

0 10 20 30 40 50

Arsenic in original solution, mg/L

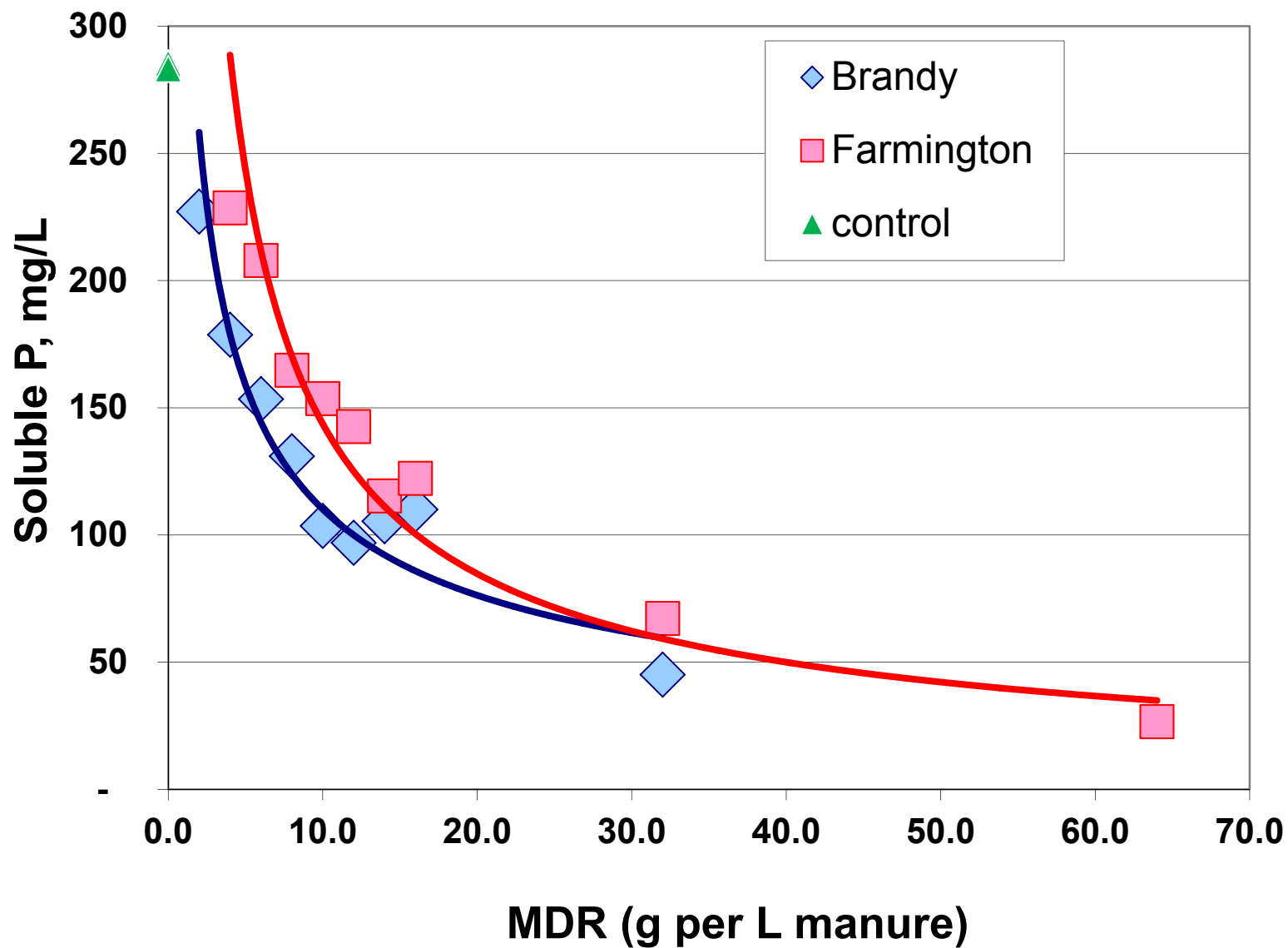


Phosphate Control





Soluble P vs. MDR Addition (June 2009)



Continuing challenges

Product

- Decrease moisture further
- Decrease transportation costs
- Increase sustainable supply of clean IO

Market

- Solidify pigmentary values
- Advance green product values
- Develop proven uses in remediation

Questions?

