Production of an Iron Oxide Product from Mine Water: 15 Year Report

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Imagery Date: 9/23/2013


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Imagery Date: 4/23/2013


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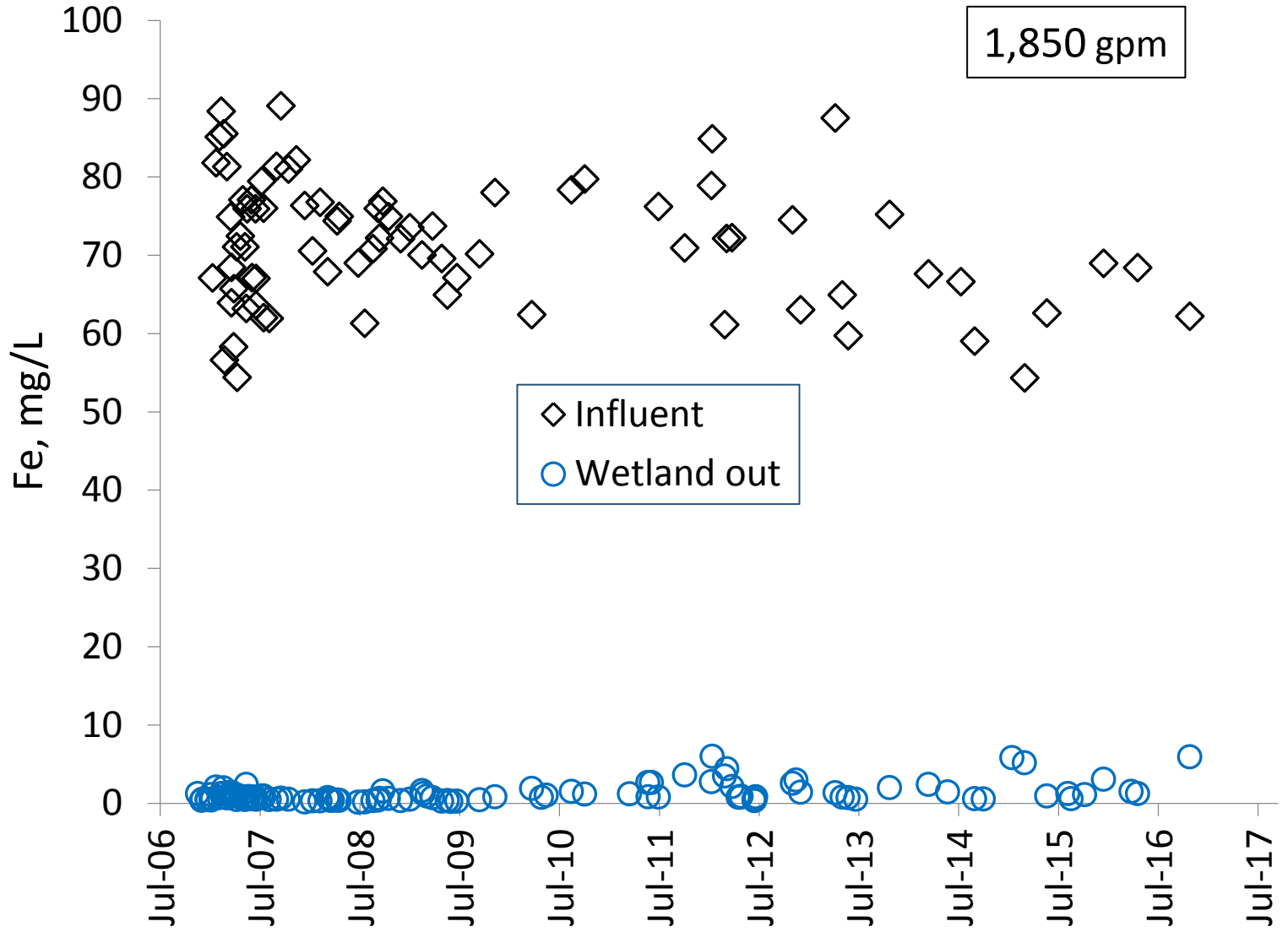
Imagery Date: 7/11/2013

Marchand System, Lowber PA


1,850 gpm
Influent
Wetland out
Fe, mg/L
100
90
80
70
60
50
40
30
20
10
0
Jul-06
Jul-07
Jul-08
Jul-09
Jul-10
Jul-11
Jul-12
Jul-13
Jul-14
Jul-15
Jul-16
Jul-17

The production of a high quality effluent from passive systems has always included wetlands

Constructed Wetlands for Wastewater Treatment (D.Hammer) 1989. CRC Press. 856 pp.

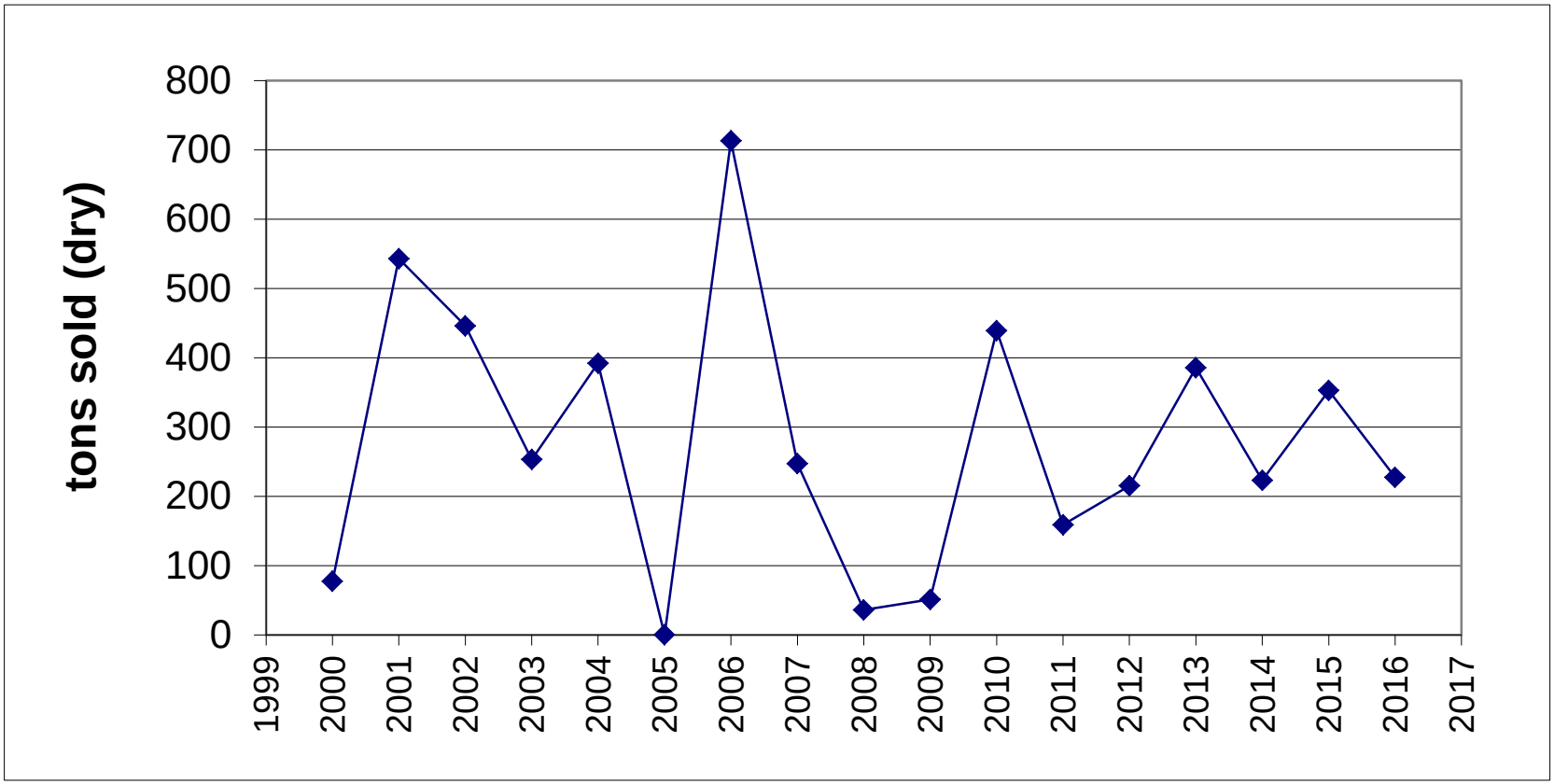
Designing and Sizing Passive Mine Drainage Treatment Systems. 1992. *WV Mine Drainage Task Force*

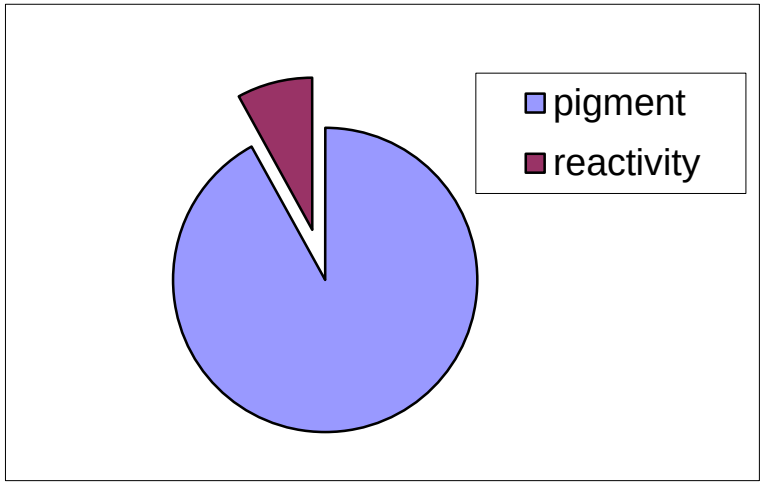
Passive Treatment of Coal Mine Drainage. 1994. *US Bureau of Mines* IC 9389

Iron Removal in a Passive System Treating Alkaline Coal Mine Drainage. 2008. Mine Water Env. *International Mine Water Association*

Iron sludge recovery steps

1. Isolate pond
2. Remove excess water
3. Pump to dewatering unit
4. Dewater and dry





Sales Summary

Total sales: 4,840 ton

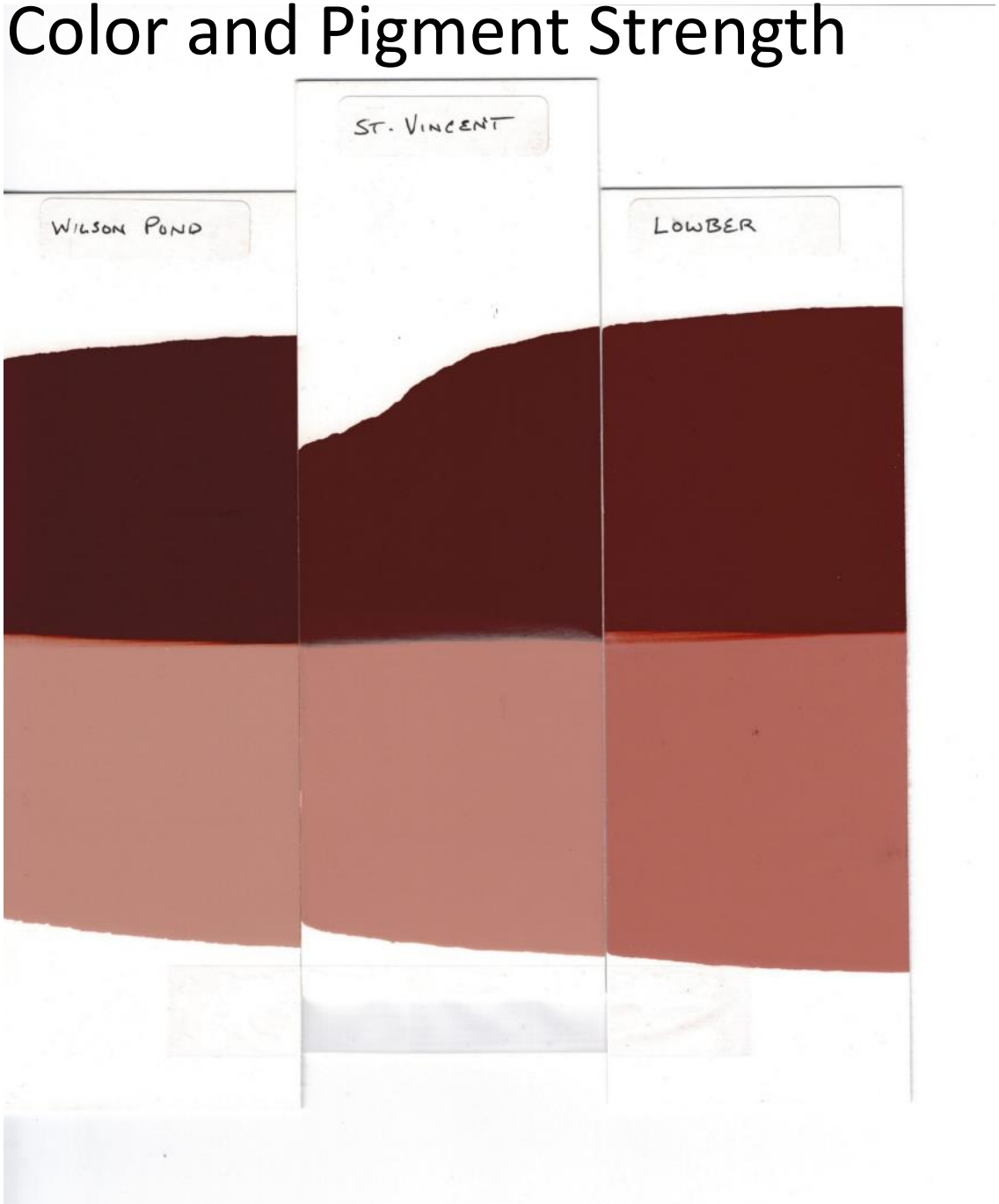
Average sales: 297 ton/yr

Pigment portion: 92%

Goethite + heat → Hematite

(sienna) (burnt sienna)

Color and Pigment Strength



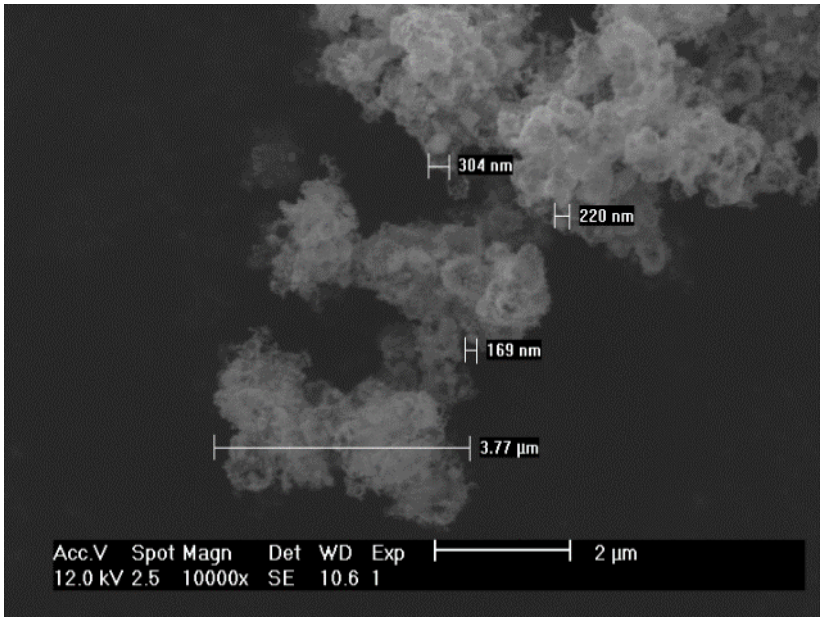

Varathane
WOOD STAIN
Dries in ONE hour
Achieve color in ONE coat
Covers 75% more (275 Sq.Ft.)
BEAUTIFUL RESULTS 3X FASTER
Satisfaction Guaranteed
BLACK CHERRY

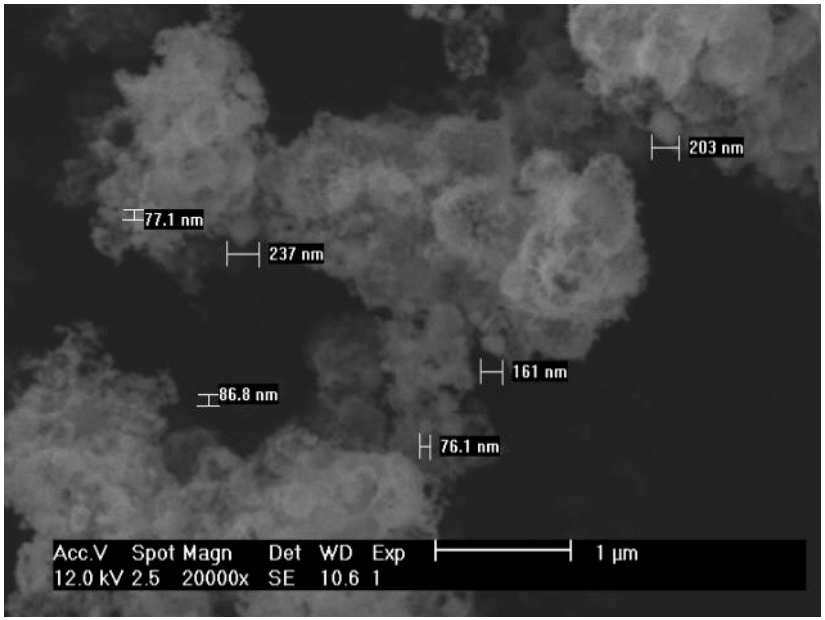

burnt sienna
siena rojizo
sienne brûlé

Iron Oxide Reactivity

- Sorption and reactivity
  - Metals: As, Cu, Cd, Zn, Pb, more
  - oxyyanions: AsO_4^{3-}, PO_4^{3-}, SeO_3^{2-}, Se_4^{2-}
- Redox reactions
  - $Fe(OH)_3 + H_2S \rightarrow FeS + FeS_2 + S^0 + Fe^{2+}$
  - $Fe(OH)_3 + organics \rightarrow Fe^{2+} + CO_2$
- Trace mineral and biologically active
- Catalyst

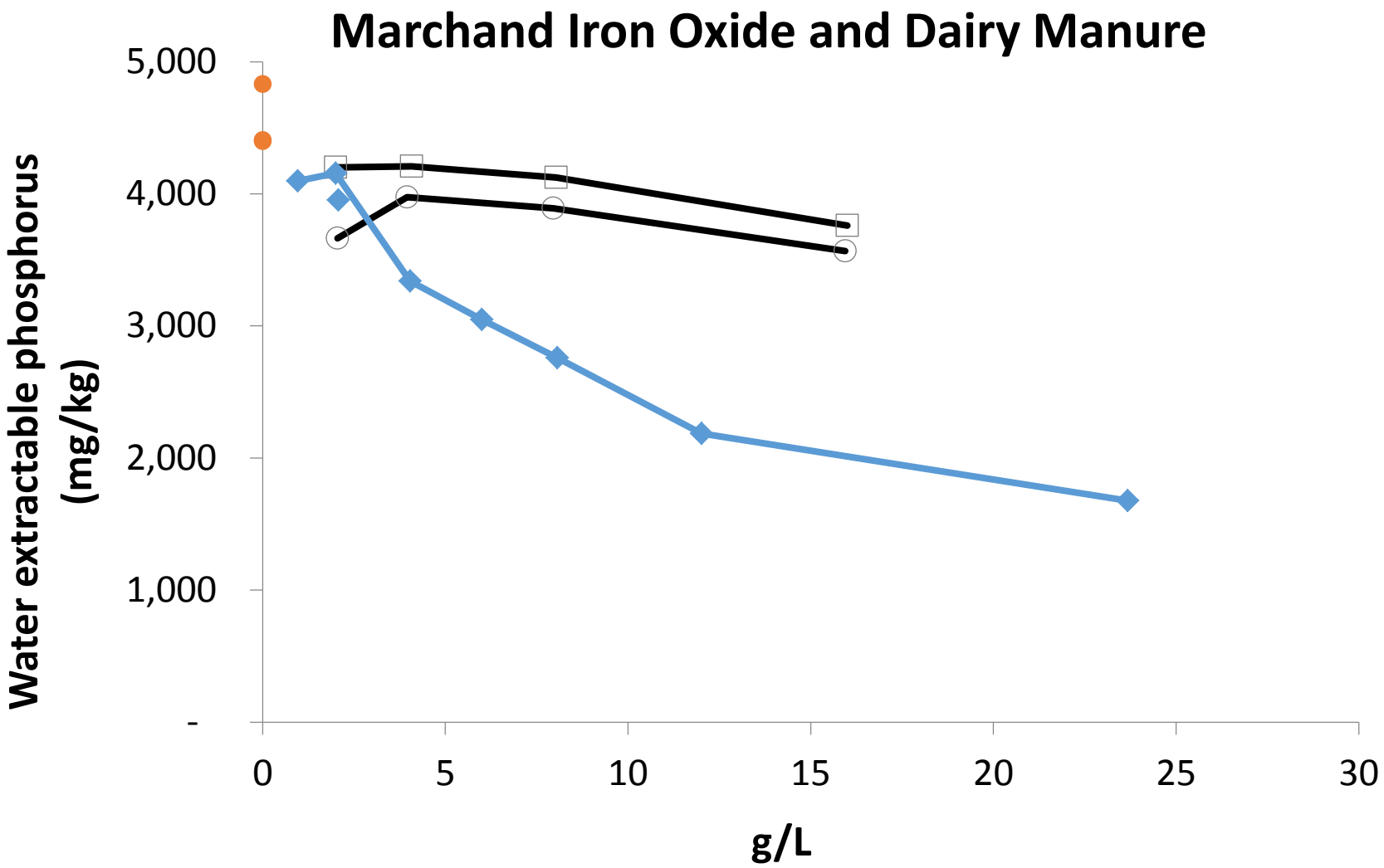
Particle Size and surface area affect pigment strength and reactivity





Laboratory	**Material**	**SA, m^2/g (BET method)**
University of Pittsburgh, Environmental Engineering Dept.	Marchand	144 (101-175)
Pennsylvania State University, Materials Science Laboratory	Marchand	125

TRAPPS: Amendment for Pb-contaminated soils

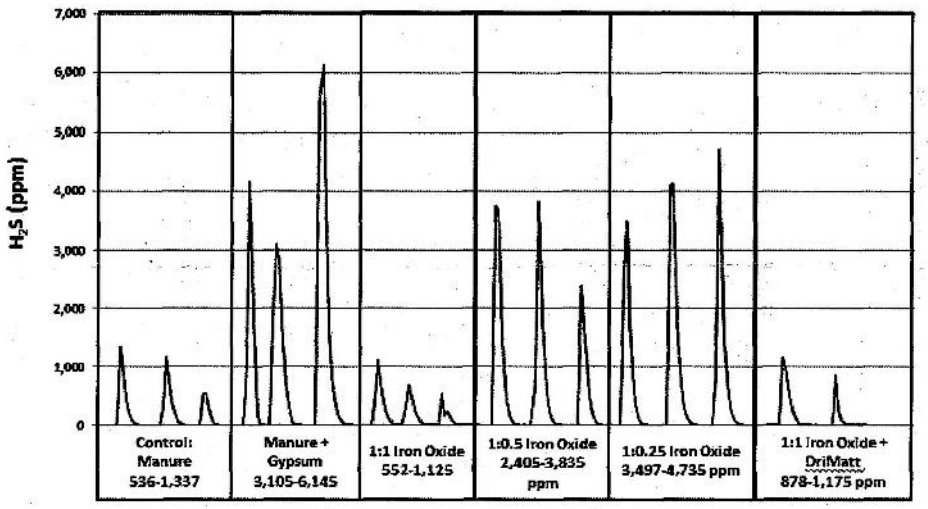

Marchand Iron Oxide and Dairy Manure
Water extractable phosphorus (mg/kg)
5,000
4,000
3,000
2,000
1,000
-
0
5
10
15
20
25
30
g/L

Trial 2: Fall 2015

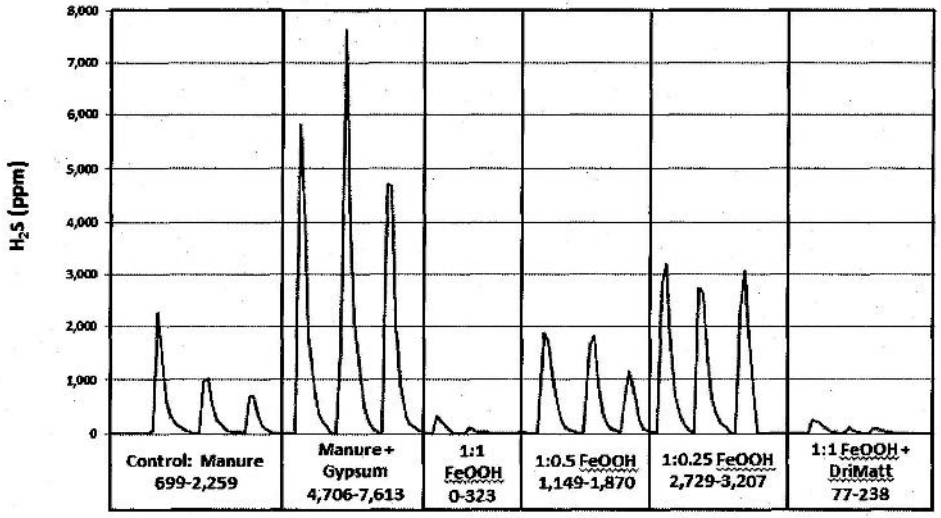
Use of IO to control H_2S

- React with H_2S
- Raise redox and prevent H_2S formation

H_2S Concentrations among treatments - MONTH 2



H_2S Concentrations among treatments - MONTH 3



Metals of concern in Marchand iron oxide

Element	**As**	**Cd**	**Co**	**Cr**	**Cu**	**Mo**
	ppm	ppm	ppm	ppm	ppm	ppm
Marchand	23	2	4	14	10	< 2
EPA Part 503 limits	41	39	na	1,500	1,500	57
Element	**Ni**	**Pb**	**Se**	**Zn**	**Hg**	
	ppm	ppm	ppm	ppm	ppb	
Marchand	9	11	< 3	23	<1	
EPA Part 503 limits	420	420	36	2,800	57	

Miscellaneous Potential IO Uses

- Control Se release from coal refuse
  - Donovon and Ziemkiewicz, *J Env Quality*, 2014
- Lessen Cd, Cu, and Zn in soil
  - Liu et al., *Soil and Sediment Contamination*, 2014
- Fertilize Fe-deficient soils and ecosystems
  - CO_2 sequestration: Hedin and Hedin, *Mine Water and the Environment*, 2015

Summary

- HE has sustained the sale of iron oxide recovered from mine drainage
- Majority of sales as pigment
- Growth is in use of iron oxide in remediation projects

Questions?