Activated Iron Sludge Treatment Using a Sequencing Batch Reactor: Performance evaluation with both acidic and alkaline mine drainage

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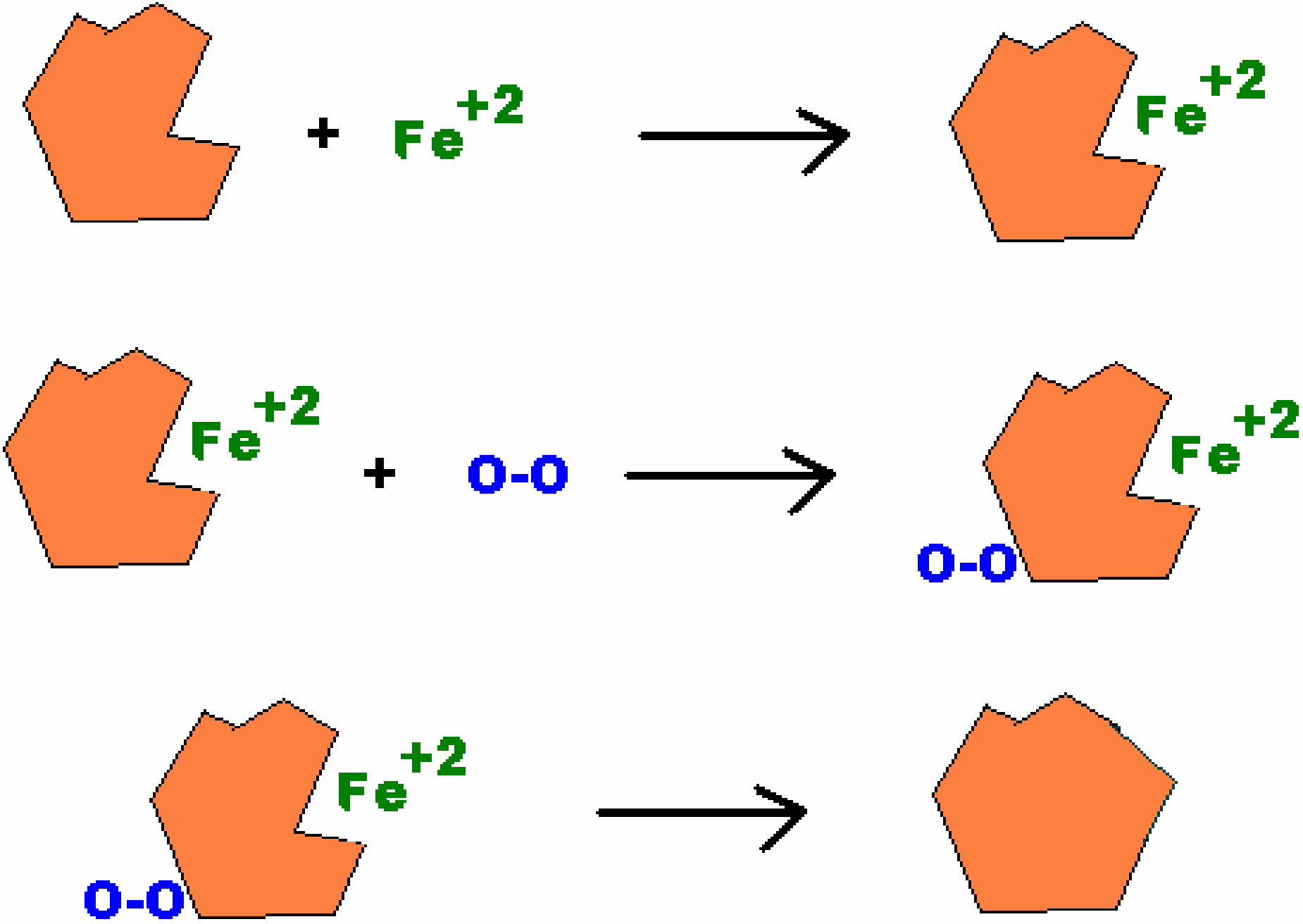
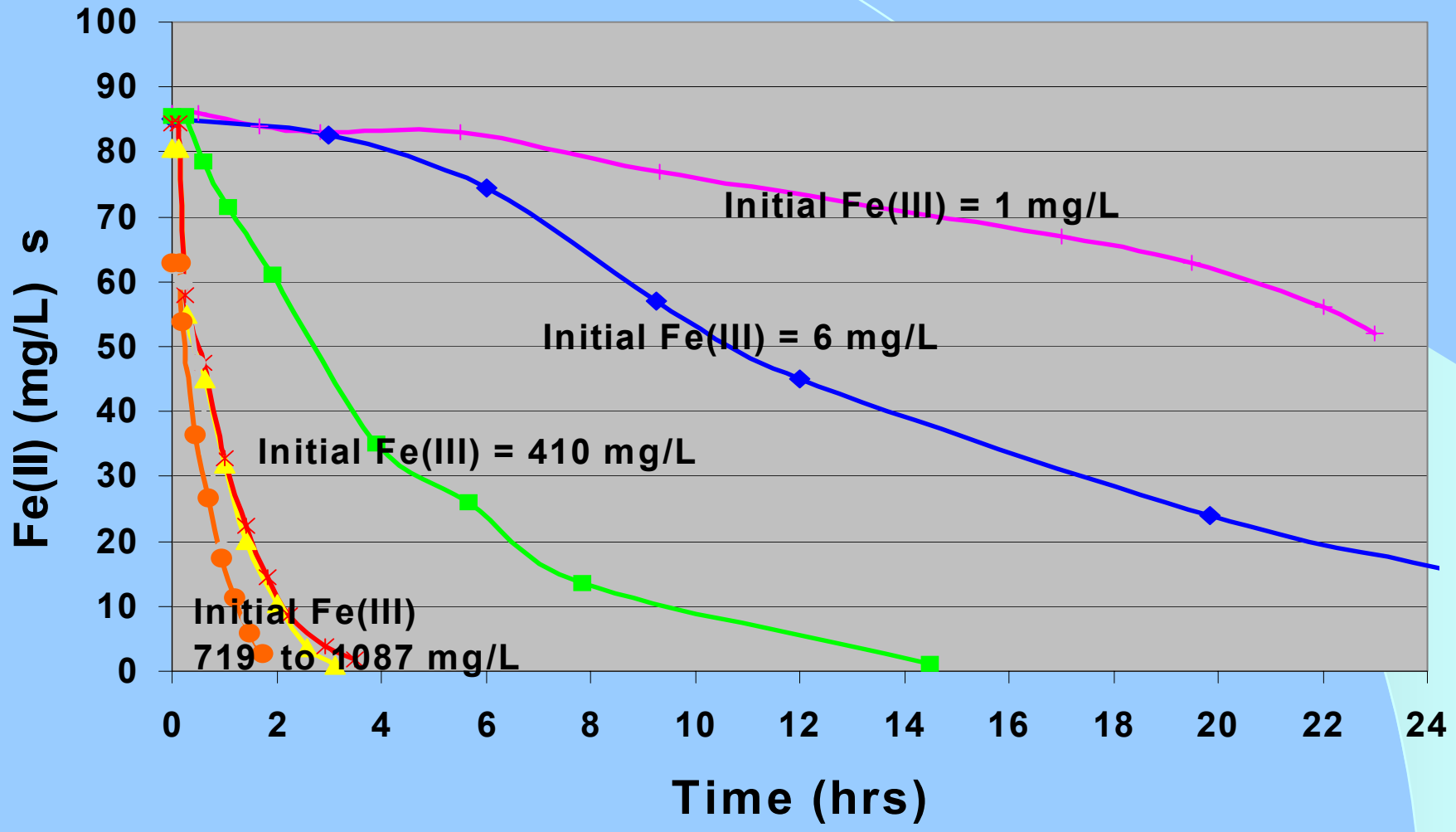
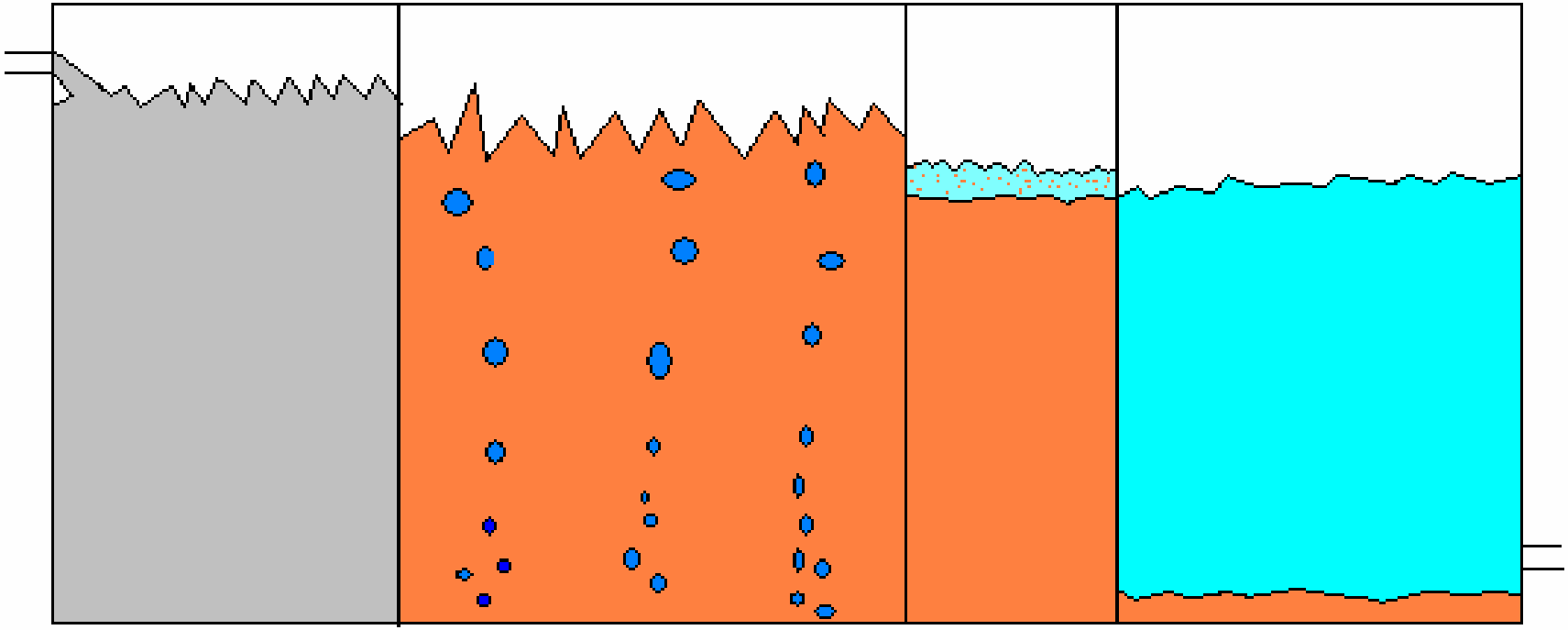

+ Fe+2
Fe+2
Fe+2
+ O-O
Fe+2
O-O
Fe+2
O-O

Field Batch Test Results



SBR Design



6,000 gal 9,500 gal 1,450 6,000 gal

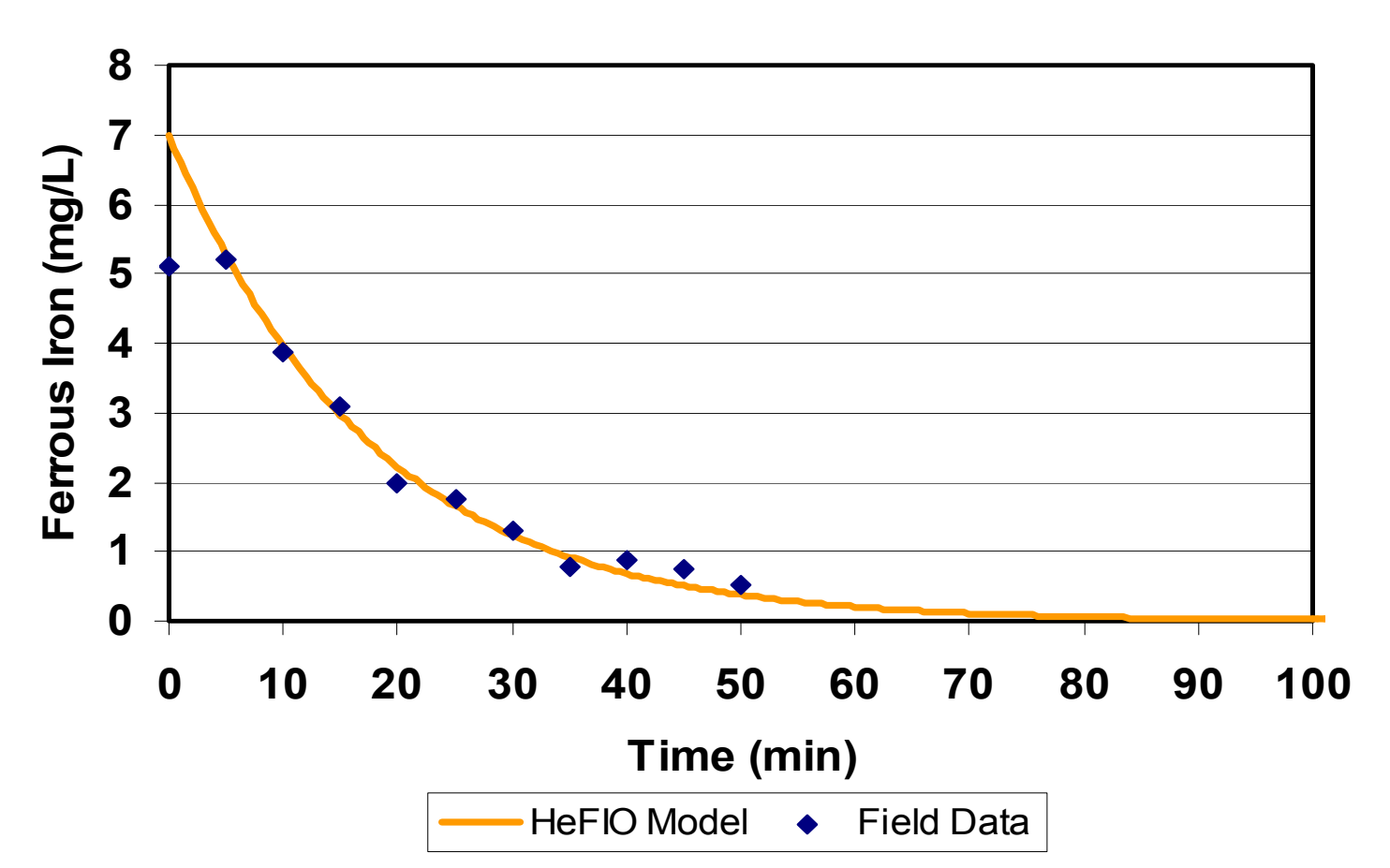
Water chemistry of the lower Saxman discharge.

Location	*Alkalinity (mg/l)*	*pH*	*Fe^{+2} (mg/l)*	*Fe^{+3} (mg/l)*	*Al^{+3} (mg/l)*
Discharge	48	5.75	32	ND	ND
ALD	118	6.00	32	ND	ND

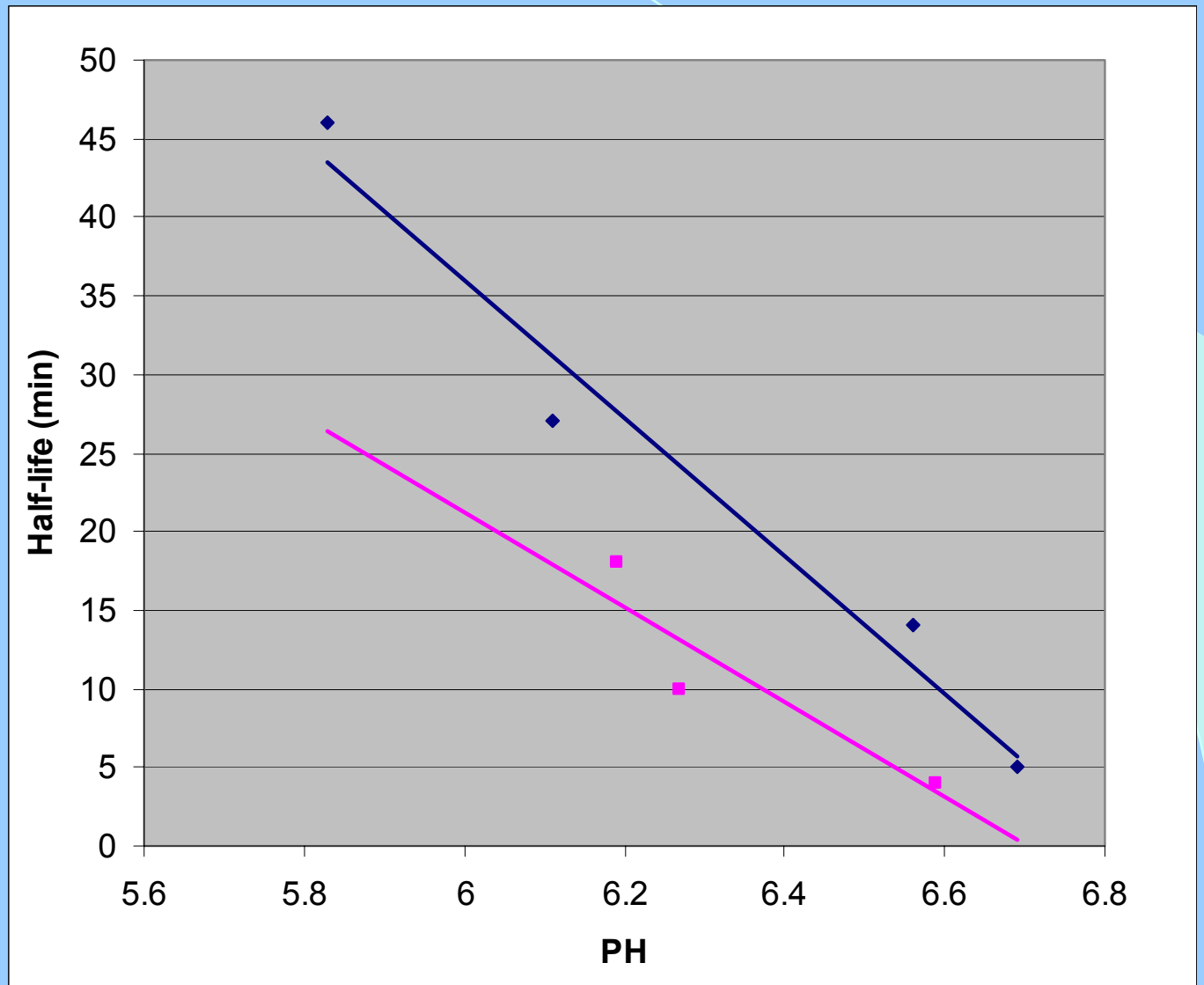
Iron Oxidation Kinetic Studies

Results from 5/25/04

pH = 6.6 to 6.9; DO=10.2; Temp.=13.6°C; FIO = 530 mg/L



The change in half-life with pH at 500 and 1500 mg/l of ferric iron.

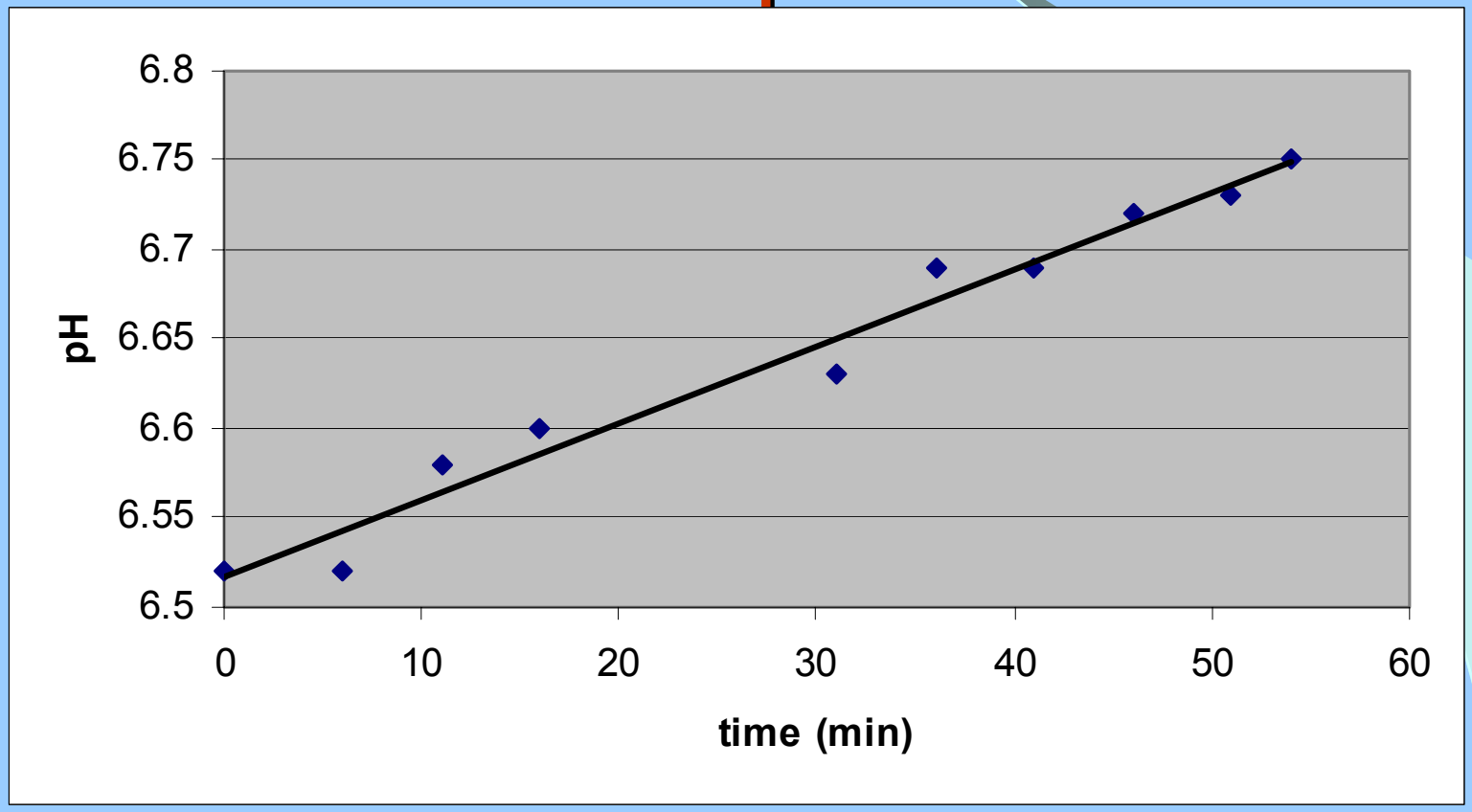


Henderson-Hasselbalch Equation

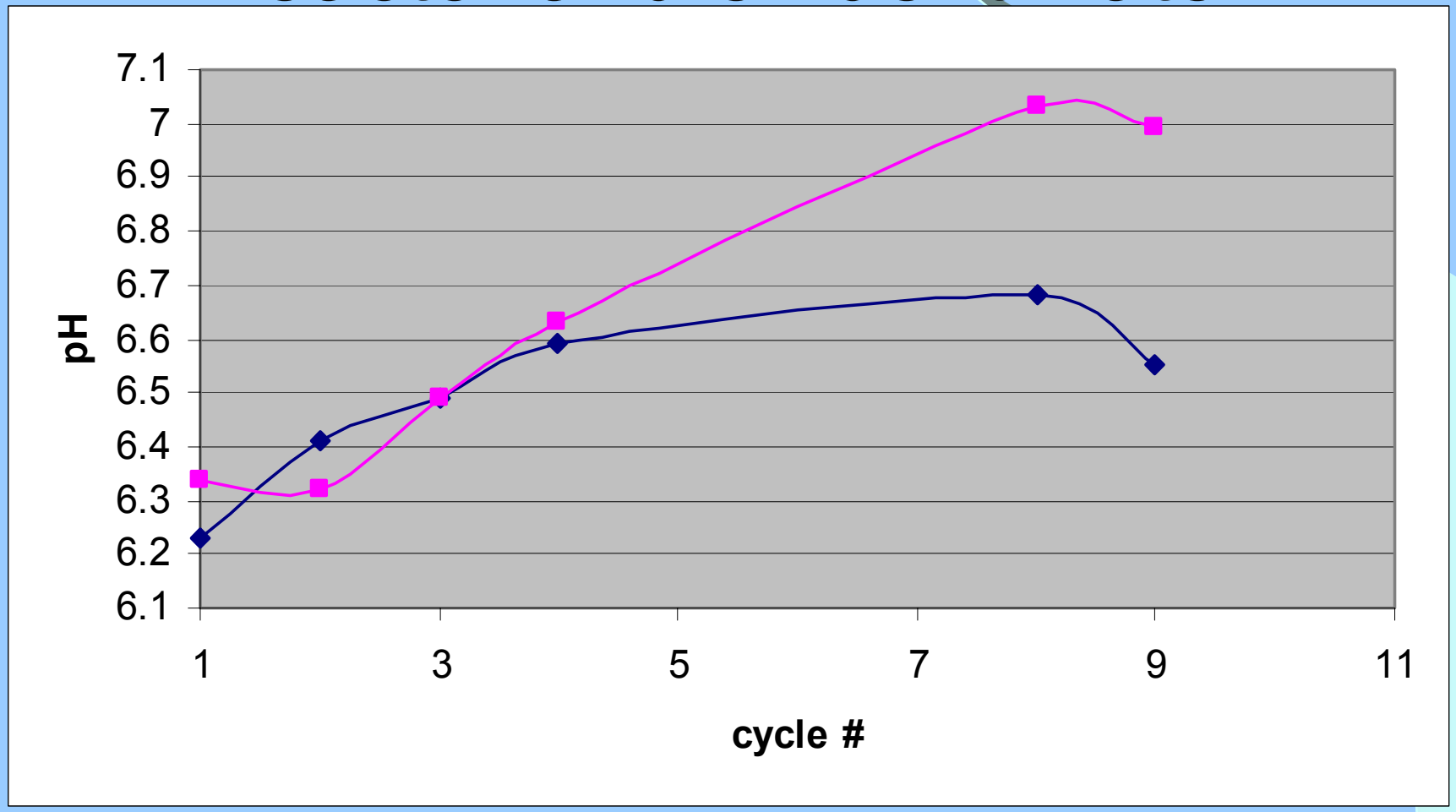
$$pH = pKa + \log ([HCO_3^-] / [H_2CO_3])$$

pH, temperature, and iron oxide concentration are all a function of time.

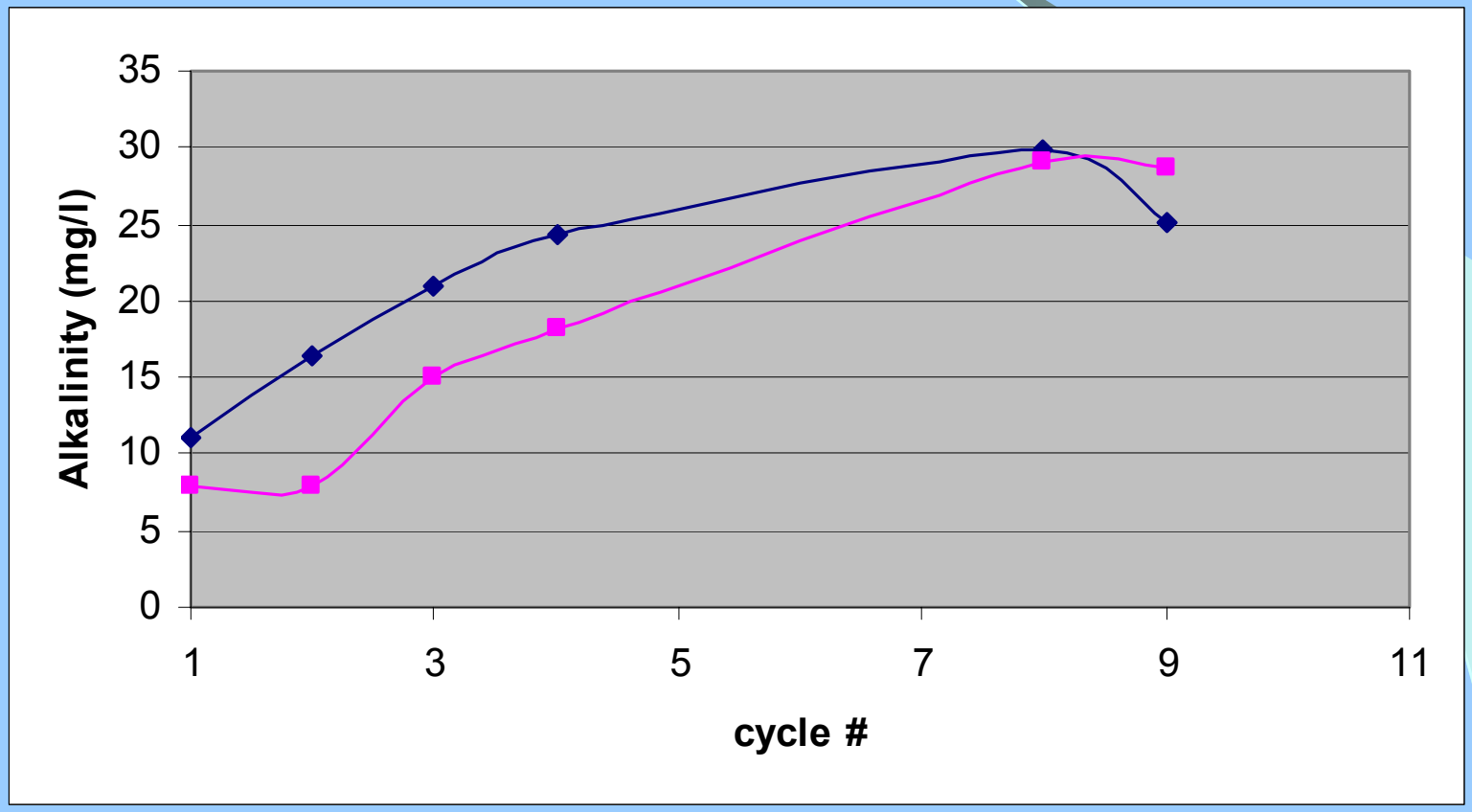
The change in pH during reaction for 500 mg/l Fe^{+3}, DO=11 mg/l, and Temp= 14°C



The impact of pulverized limestone on the pH of the reactor and effluent water



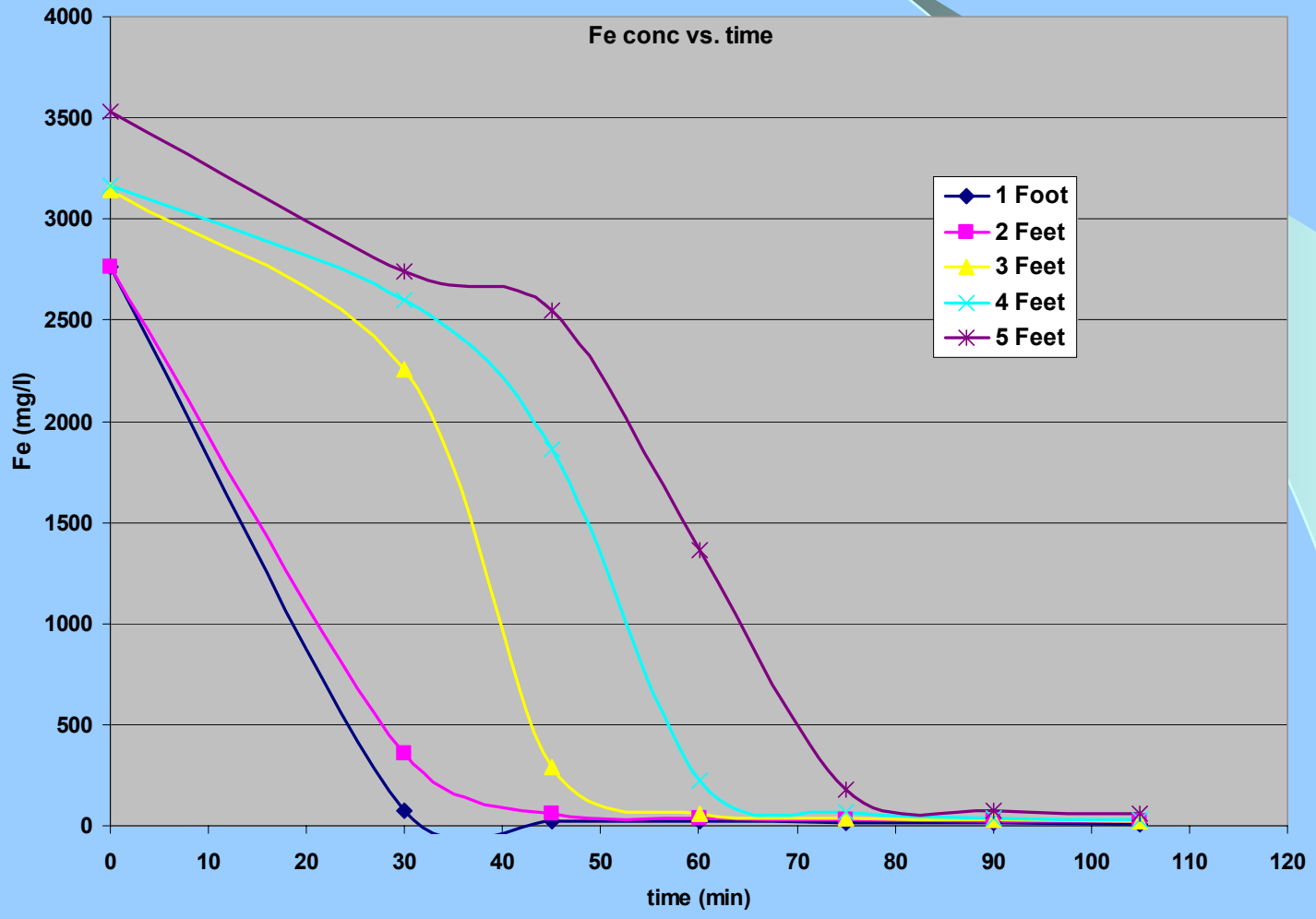
The impact of pulverized limestone on the alkalinity of the reactor and effluent water



The impact of adding 80 pounds of limestone on the alkalinity and pH at various cycles.

Cycle #	Reactor pH	Reactor Alkalinity (mg/l)
1	7.23	54
5	7.04	41
26	6.72	23
34	6.75	68

Column study of particulate iron concentrations at various depths



Iron concentrations in effluent waters treated with powdered limestone. Cycle 1 was not treated with the additive.

Cycle #	pH	Fe^{+2} (mg/l)	Fe^{+3} (mg/l)
1	6.34	0.96	5.40
2	6.32	1.04	1.10
3	6.49	1.12	1.36
4	6.63	0.58	1.70
8	7.03	0.20	2.86
9	6.99	0.16	1.36

TABLE 5a. Laboratory Analysis of AIS Sample from the Saxman Run AIS-SBR Demonstration System				
	Unit	**Detection Limit**	**Result**	**% Content**
Solids Content (Wet)	%	0.01		29.7
Dry Weight Basis				
Iron	Mg/kg	100	502,000	50.2
Manganese	Mg/kg	100	1,150	0.115
Aluminum	Mg/kg	500	1,020	0.102
Calcium	Mg/kg	1,000	6,820	0.682
Magnesium	Mg/kg	1,000	<1,000	0.05
Sodium	Mg/kg	2,000	<2,000	0.1
Potassium	Mg/kg	1,000	<1,000	0.05
Silica	Mg/kg	65	5,690	0.569
Sulfate	Mg/kg	123	1,710	0.171

TABLE 5b. Calculated AIS Composition Based on Analytical Results	
AIS Constituent	**% Dry Weight**
Iron Oxide as $Fe(OH)_3$	96.06
Aluminum Oxide as $Al(OH)_3$	0.22
Manganese Oxide as $Mn(OH)_3$	0.20
Calcite as $CaCO_3$	1.52
Silicate as SiO_4	1.54
Gypsum as $CaSO_4$	0.58
Total	**100.11**

Operation, Maintenance and Cost.

- Periodic Monitoring, Blower Maintenance.
- Impeller blades are clean and do not show ware.
- Total electrical cost = $120/month, SBR electrical cost = $45/month or $0.04 per 1000 gal.
- Limestone $25 per ton, At a dose of 2 lbs.. per cycle, the cost would be $6 per month or $0.005 per 1,000 gal.

Future Studies

- Continued operation and optimization of the AIS process.
- Pulverized limestone studies (optimization and mechanism).
- Treatment of highly acidic discharges (pH 2.5-3.5).
- Beneficial reuse of iron oxides and water.

Acknowledgements

- PA-DEP Growing Greener #SW20314
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- LCMDC
- Latrobe Municipal Authority