By Jon Dietz, Ph.D.
Iron Oxide Technologies, LLC
jon.dietz@ironoxidetech.com
www.ironoxidetech.com
& Matt Morosetti
W.K. Merriman, Inc.

AN INNOVATIVE PACKAGE TREATMENT SYSTEM FOR THE ORCUTT-SMAIL DISCHARGES

IOT IRON OXIDE TECHNOLOGIES

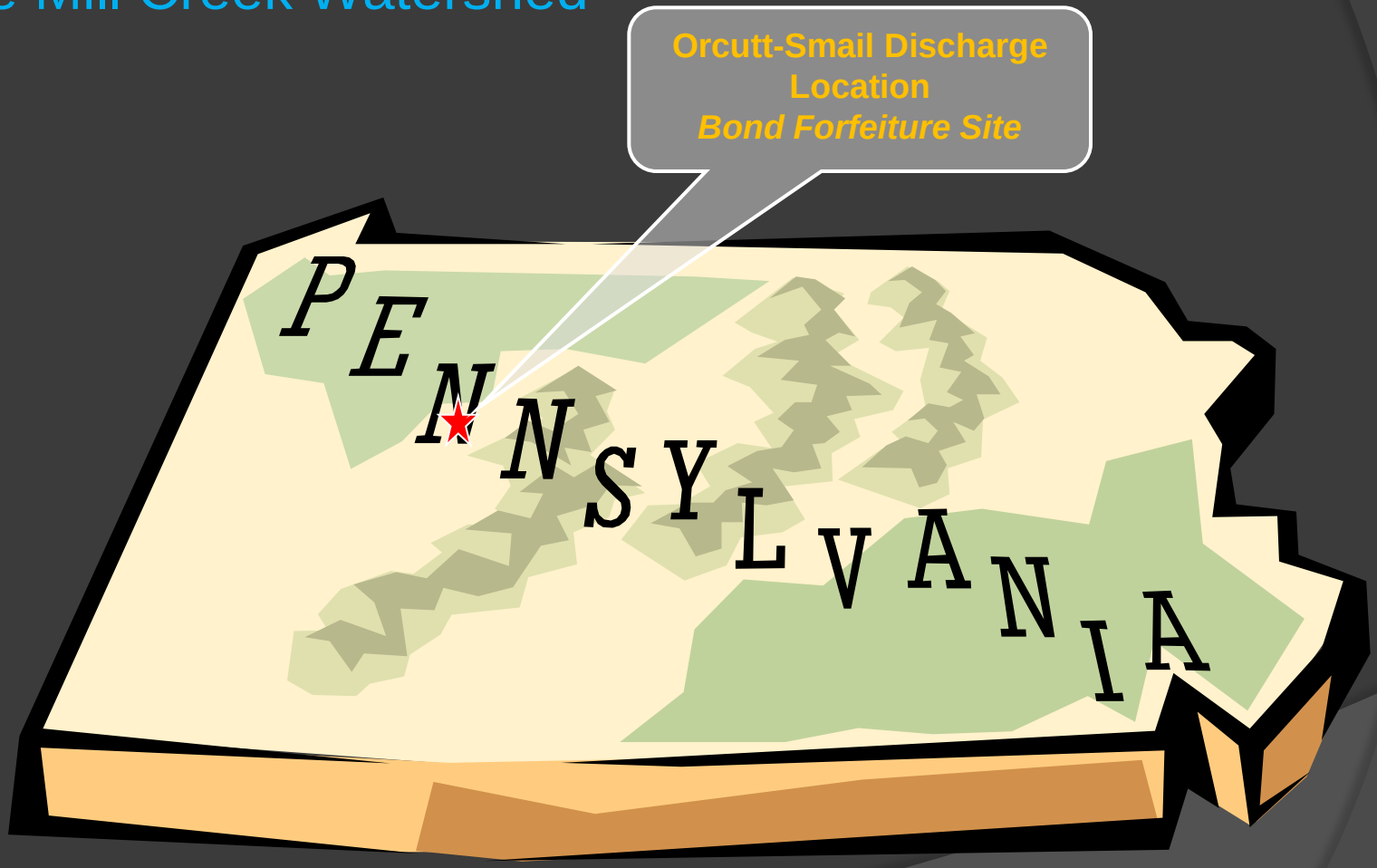
Who We Are?

IOT provides innovative and cost effective solutions to solve complex treatment challenges with simple and integrated treatment processes.

IOT IRON OXIDE TECHNOLOGIES

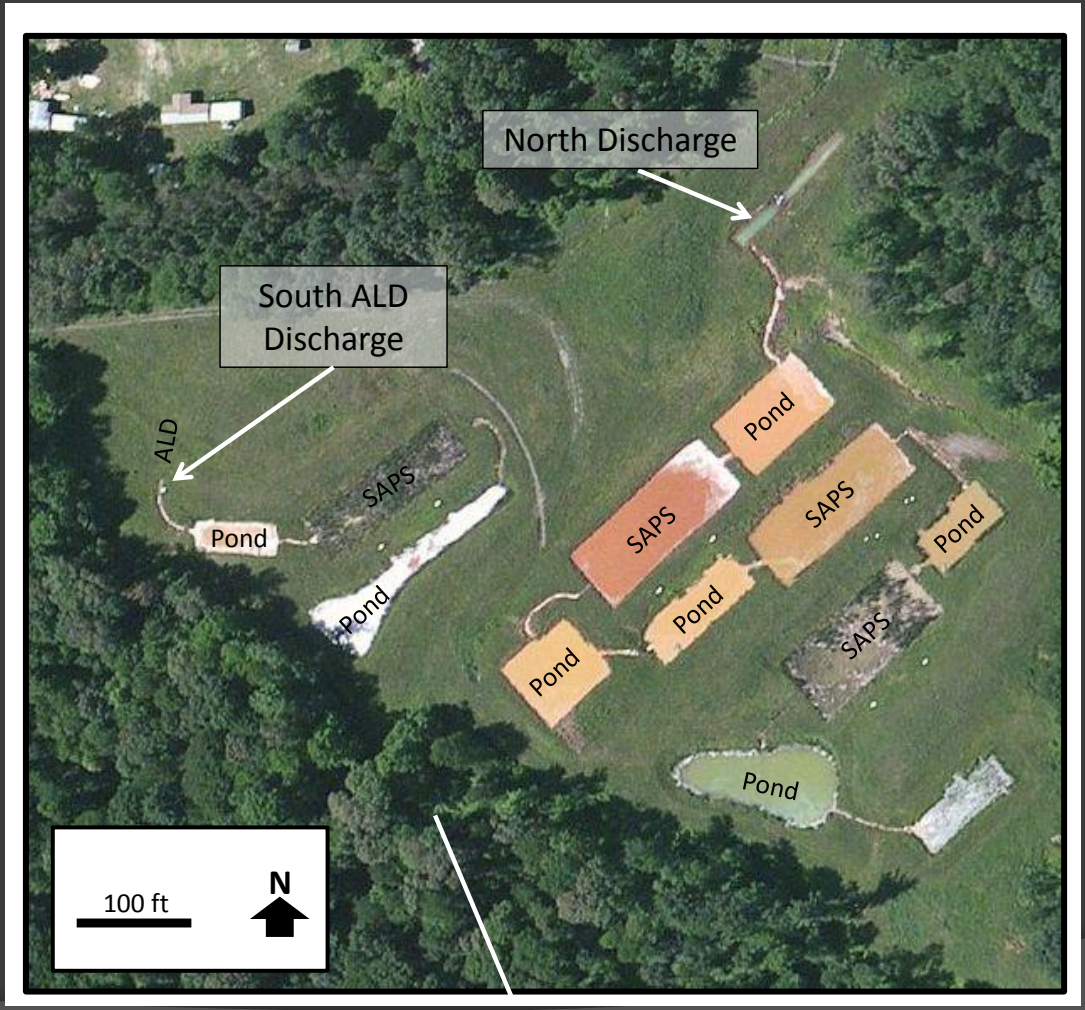
Orcutt-Smail Location in Jefferson County near Corsica, PA

in the Mill Creek Watershed



Orcutt & Smail Project
South & North Passive Treatment Systems

2010 Photo



- Designed by NRCS with assistance from Damariscotta
- State-of-the-Art Multi-cell SAPS Flushing System
- Constructed in 2006
- Construction Cost ~ $1.1 million
- Initial Deterioration Conditions 2009
- Effluent Net Alkalinity < 0
- System Failure 2011

Field and laboratory analysis of the South and North Discharges

5 : 2

Parameter	Unit	North	South	North/South Mixture
Field pH	s.u.	4.54	5.76	5.10
Lab pH	s.u.	4.57	6.00	4.99
Temperature	˚C	9.8	10.9	10.2
Field Conductance	µS	2800	1810	2430
Lab Conductance	µS	2942	2080	2550
TDS	mg/L	2089	1477	1811
Dissolved O_2	mg/L	0.8	0.35	0.7
“Cold” Acidity	mg/L as $CaCO_3$	877	539	767
“Hot” Acidity	mg/L as $CaCO_3$	629	245	481
Alkalinity	mg/L as $CaCO_3$	2	90	14
Total Iron	mg/L	309	148	284
Total Manganese	mg/L	111	63.6	103
Total Aluminum	mg/L	12.8	0.80	9.3
Total Calcium	mg/L	159	224	167
Total Magnesium	mg/L	229	135	215
Sulfate	mg/L	2640	1440	2110

Risk Analysis Matrix For Category 4 Passive Treatment Systems

Developed by PADEP with Technical Assistance by OSM

Risk Analysis Matrix				
Summation of Fe and Al Concentration	Design Flow Rate for each treatment cell			
	< 25 gpm	≥ 25 < 50 gpm	≥ 50 < 100 gpm	≥ 100 < 200 gpm
< 5 mg/L	Low	Low	Low	Low
≥ 5 but < 15 mg/L	Low	Medium	Medium	Medium
≥ 15 < 25 mg/L	Low	Medium	Medium	Medium
≥ 25 < 50 mg/L	Medium	Medium	Medium	High
≥ 50 mg/L	High	High	High	High
Summation of Fe and Al Concentration	Design Flow Rate for each treatment cell			
	≥ 200 < 400 gpm	≥ 400 < 800 gpm	≥ 800 < 1600 gpm	≥ 1600 gpm
< 5 mg/L	Medium	Medium	Medium	High
≥ 5 but < 15 mg/L	Medium	High	High	High
≥ 15 < 25 mg/L	High	High	High	High
≥ 25 < 50 mg/L	High	High	High	High
≥ 50 mg/L	High	High	High	High

Field Treatability Study

Field Equipment/Setup

No Aeration Tests

Step 1 - Lime Addition & Mixing Only

Aeration Tests

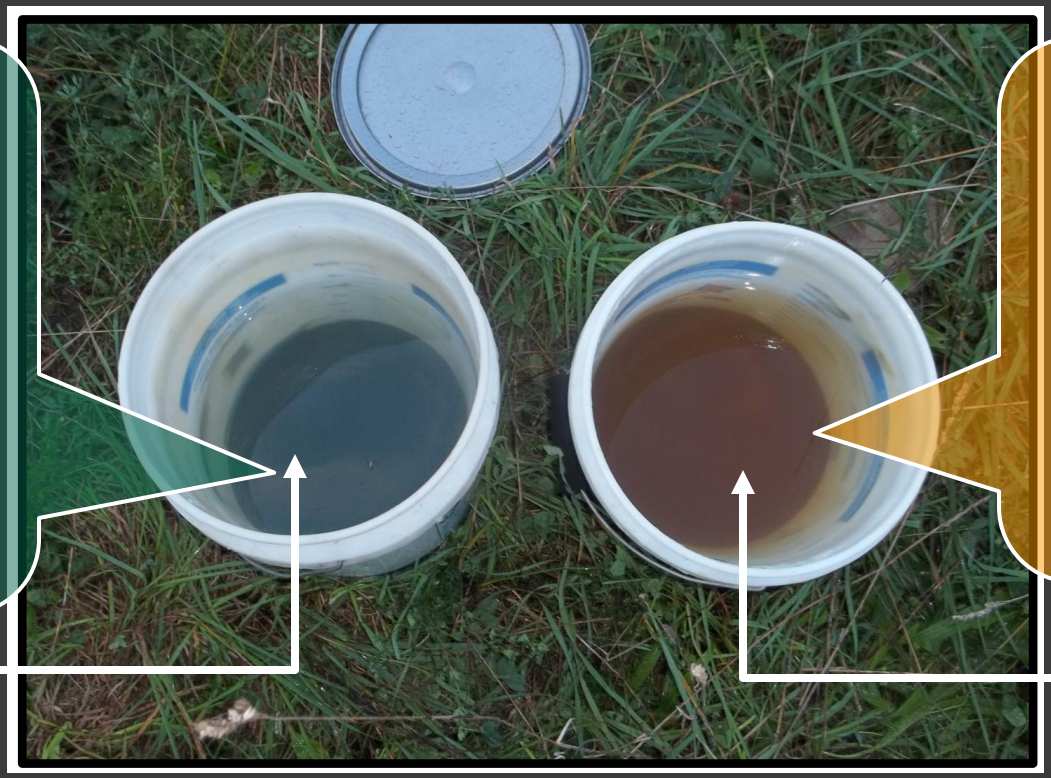
Step 1 – Pre-aeration

Step 2 – Aeration,
Lime Addition & Mixing

Comparison of No Aeration Versus Aeration Hydrated Lime Dose Tests

"Green Rust" or Ferrous Hydroxide- $Fe(OH)_2$ formation is evident.

Stability of $Fe(OH)_2$ sludge is a concern as any pH decrease to less than 8 will resolubilize .



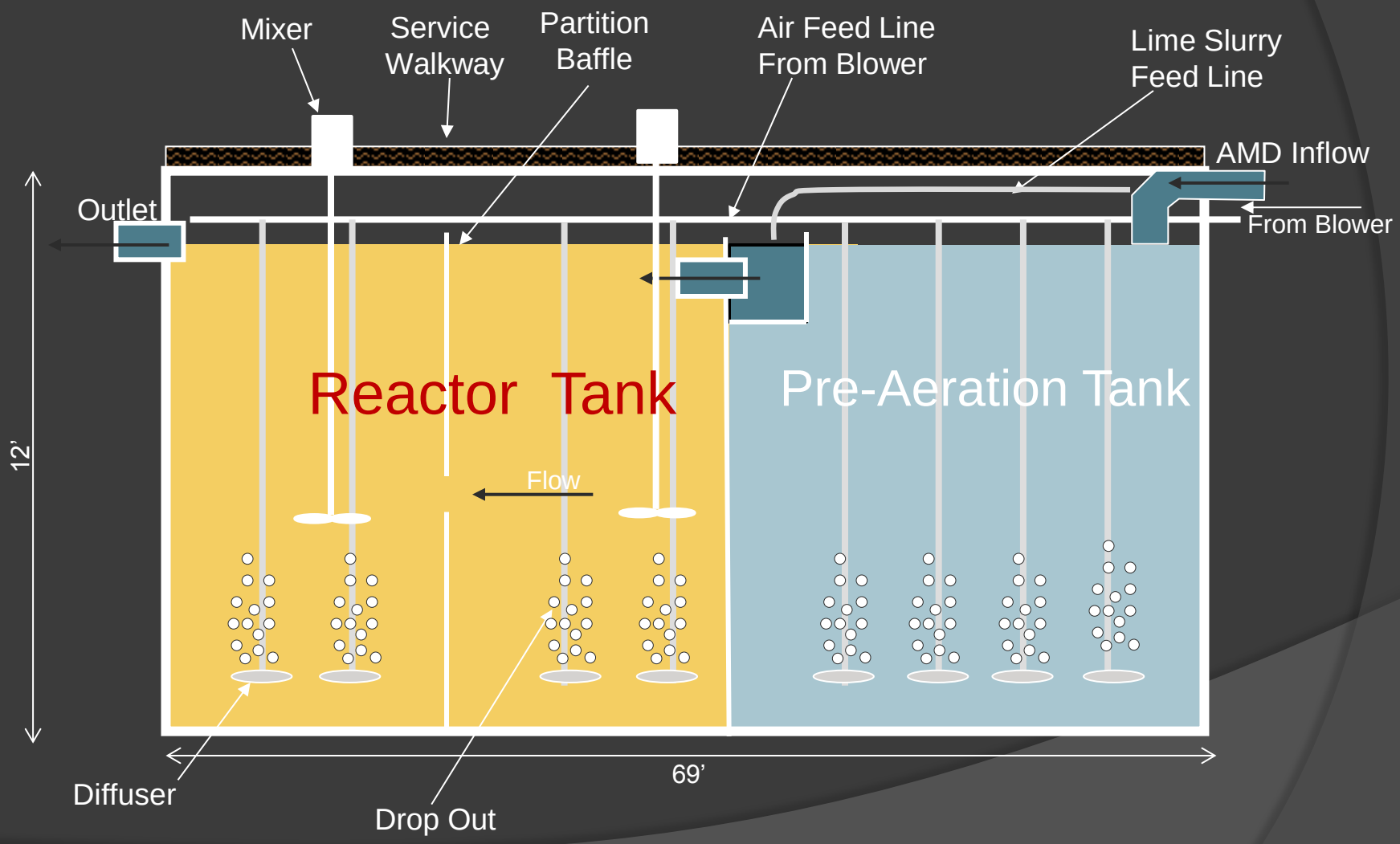
Ferric Hydroxide- $Fe(OH)_3$ formation is evident.

Stability of $Fe(OH)_3$ sludge is of limited or no concern a pH less than 3 is required to resolubilize.

NO AERATION TEST

AERATION TEST

Pre-Aeration/Reactor Tank Conceptual Cross-Section



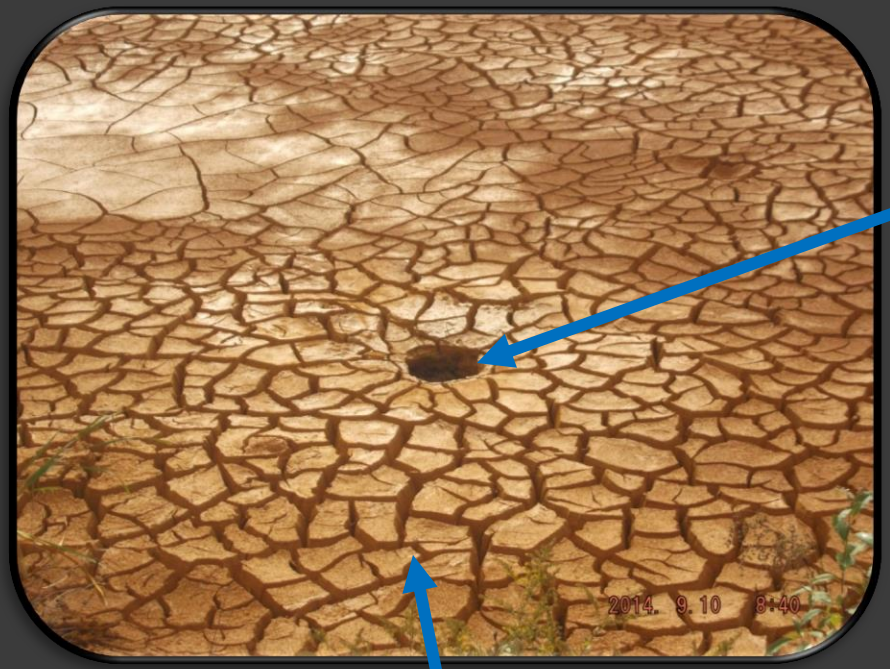
Not-to-Scale

Lime Slurry/Reactor System

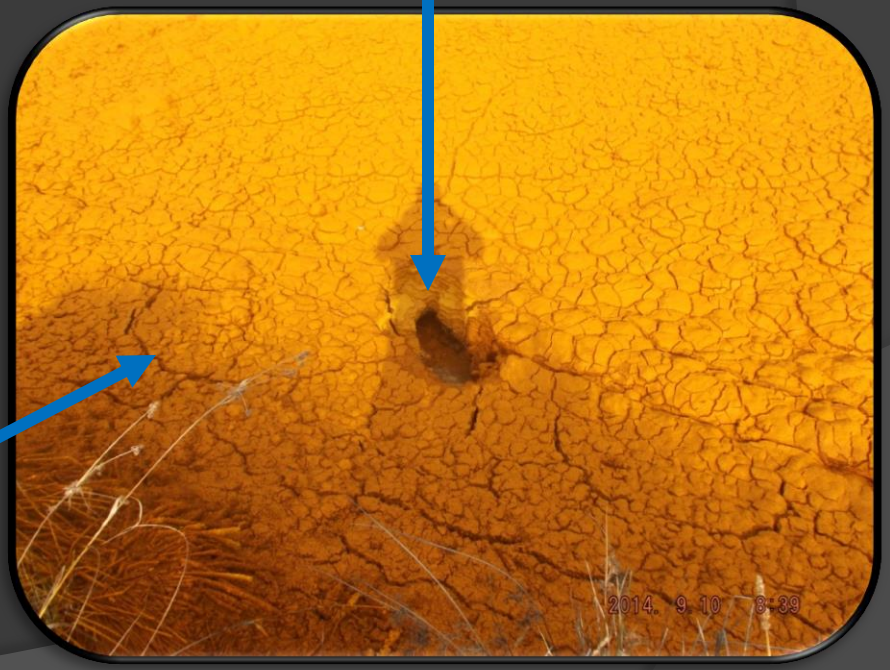
Construction Summer/Fall 2014

Start-up December 2014

Effects of Iron Accumulation & Repeated Flushing



Repeated Flushing Opens Drains Through Compost Directly to Limestone



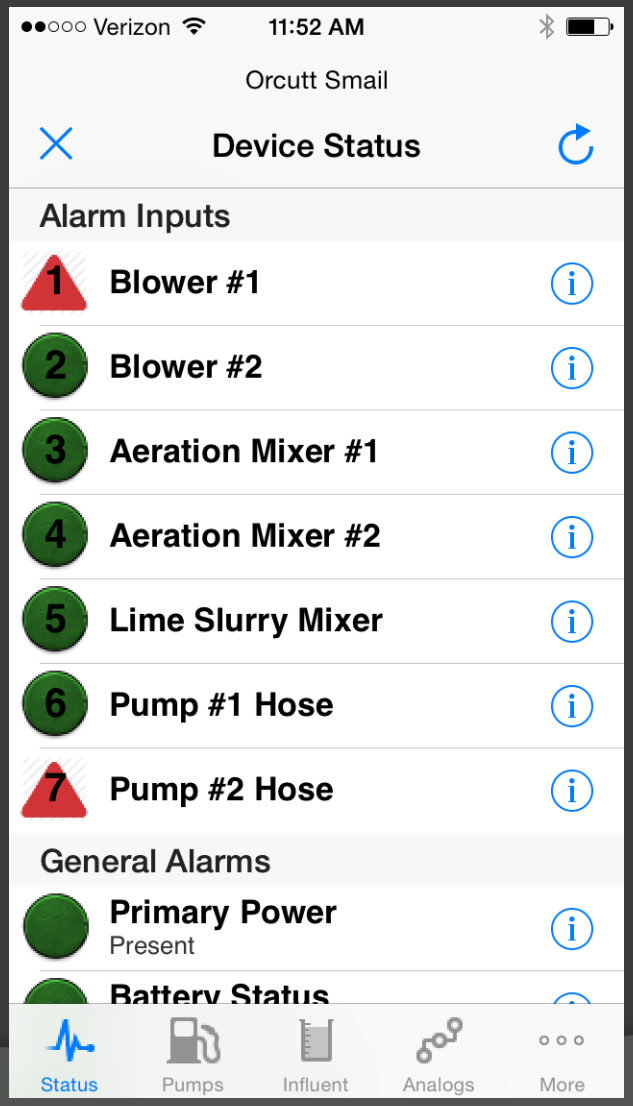
Thick Iron Oxide Deposits Limit Permeability of Compost

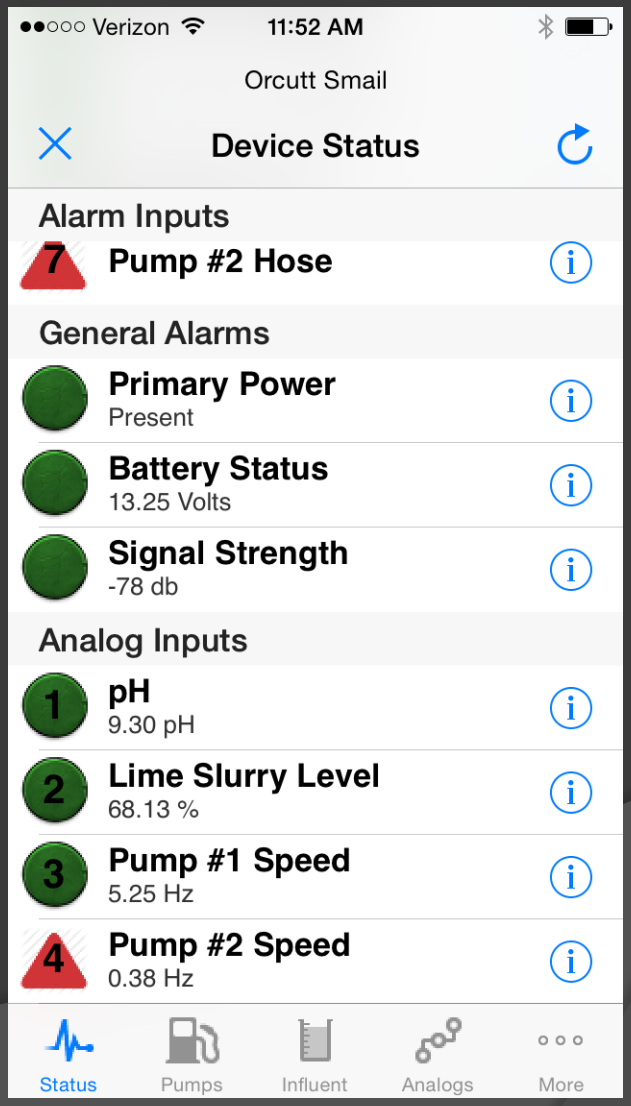
System Installation

Lime Slurry Tank Delivery & Placement

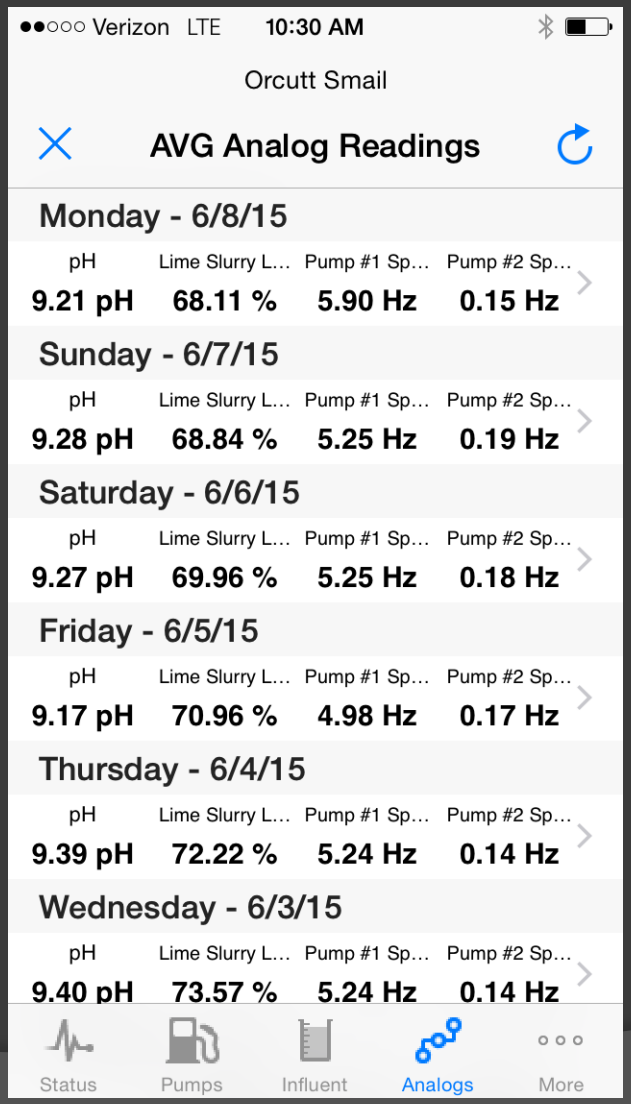
Reactor Tank System Delivery & Placement

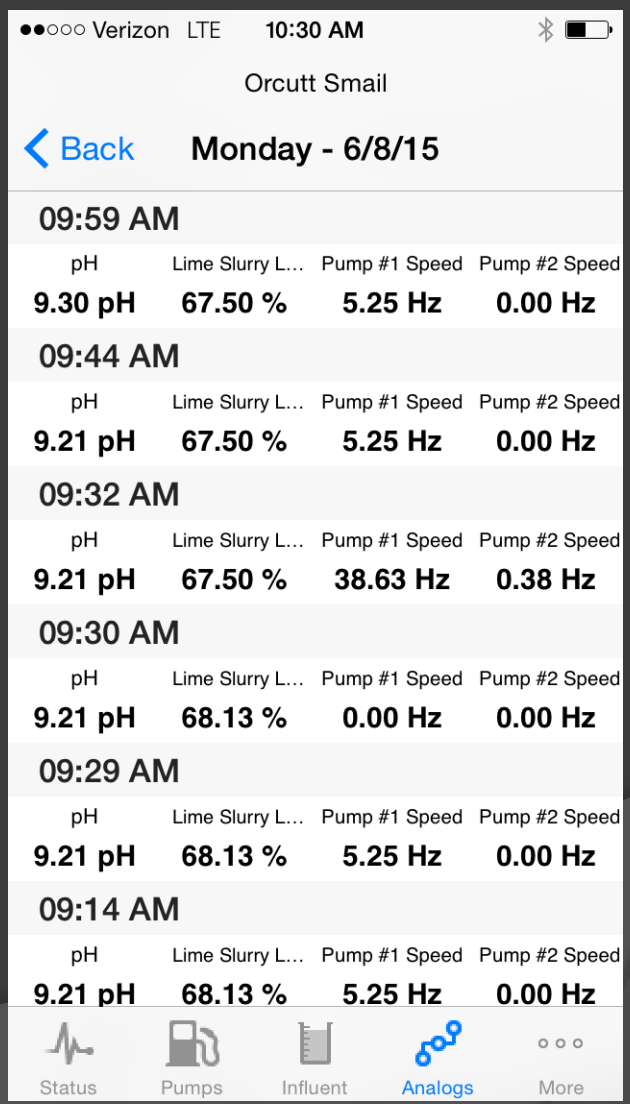
System Monitoring & Alarm Via Internet/Smart Phone



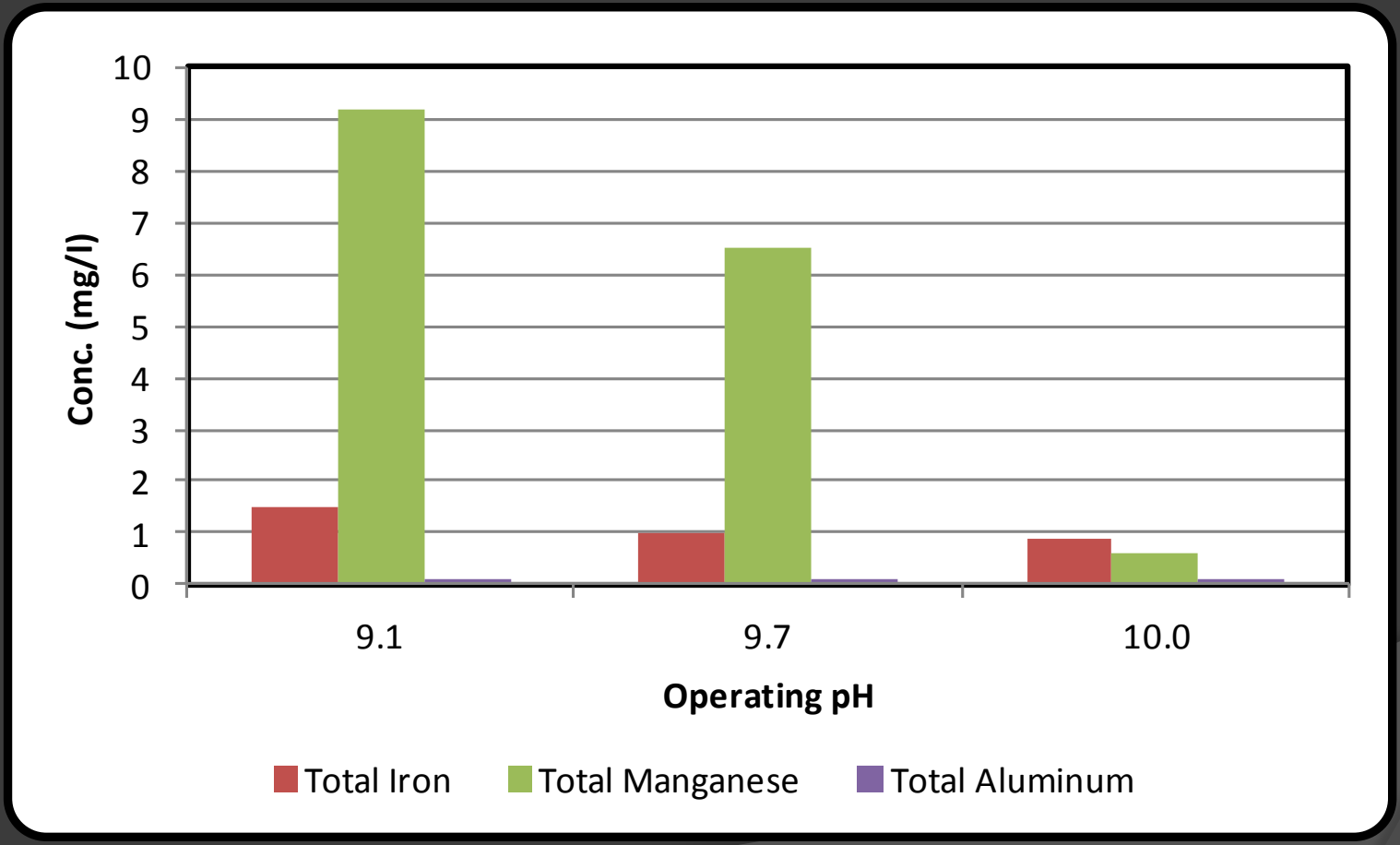


System Monitoring & Alarm Via Internet/Smart Phone

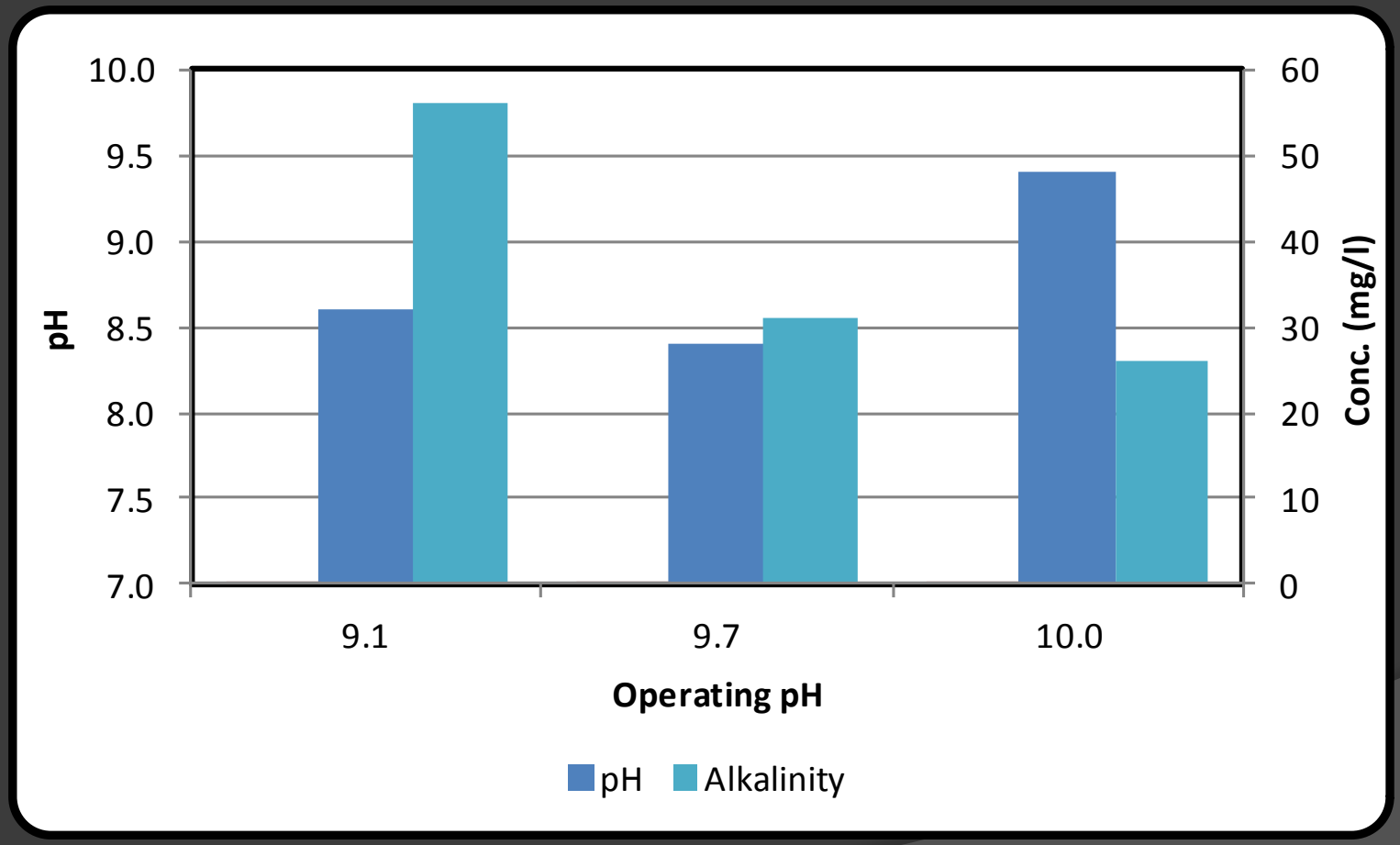




Treatment System Operating & Effluent Quality



Treatment System Operating & Effluent Quality



Summary of Estimated/Actual Operation & Maintenance Costs.

Item	Unit	Estimate $/yr	Actual[2] $/yr
Lime Slurry	Tons as $Ca(OH)_2$	$20,352.00	$18,450.00
Electricity	KwHr	$12,410.00	$9,400.00
Omnisite Service	NA	$275.00	$275.00
Routine Operation Labor	Hours	$10,400.00	$7,200.00
Routine Maintenance Labor	Hours	$3,670.00	$2,700.00
Routine Maint. Materials	$	$1,028.00	$1,028.00
Sludge Removal	Per event	$15,000.00	$15,000.00
Snow Plowing – Access	Per Event	$800.00	$400.00
Equipment Replacement[1]	*Varies*	*$11,500.00*	*$11,500.00*
ANNUAL O&M TOTAL		**$63,935.00**	**$54,453.00**

[1] Not included in annual O&M cost

[2] Based on 1st 6 months Operation

Can New Active Treatment Designs Operate at Lower Costs than Passive Treatment Systems for High Strength AMD

Special Thanks to:

Joe Ferrara, Mark Odenthal, Eli Heferle – PADEP, Knox Mining Office
Pete Dalby & Terry Morrow – Mill Creek Coalition
Janie French – Headwaters Charitable Trust

IOT IRON OXIDE TECHNOLOGIES