

Innovative Design for Treating High Flow & High Iron Waters

A non-chemical alternative for removal of iron from water

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How Did We Get Here?

IOT IRON OXIDE
TECHNOLOGIES



Iron Removal from Water

(e.g., Acid Mine Drainage & Groundwater)

A Two Step Process

1. *Ferrous Iron (Fe^{2+}) Oxidation to Ferric Iron (Fe^{3+}) – the rate limiting step in most treatment technologies*
2. *Precipitation of Ferric Iron (Fe^{3+}) to a hydroxide solid – very fast but the conditions (e.g., pH) determine solids quality*

Ferrous Iron Oxidation Processes In Water Treatment

Homogeneous Ferrous Iron Oxidation

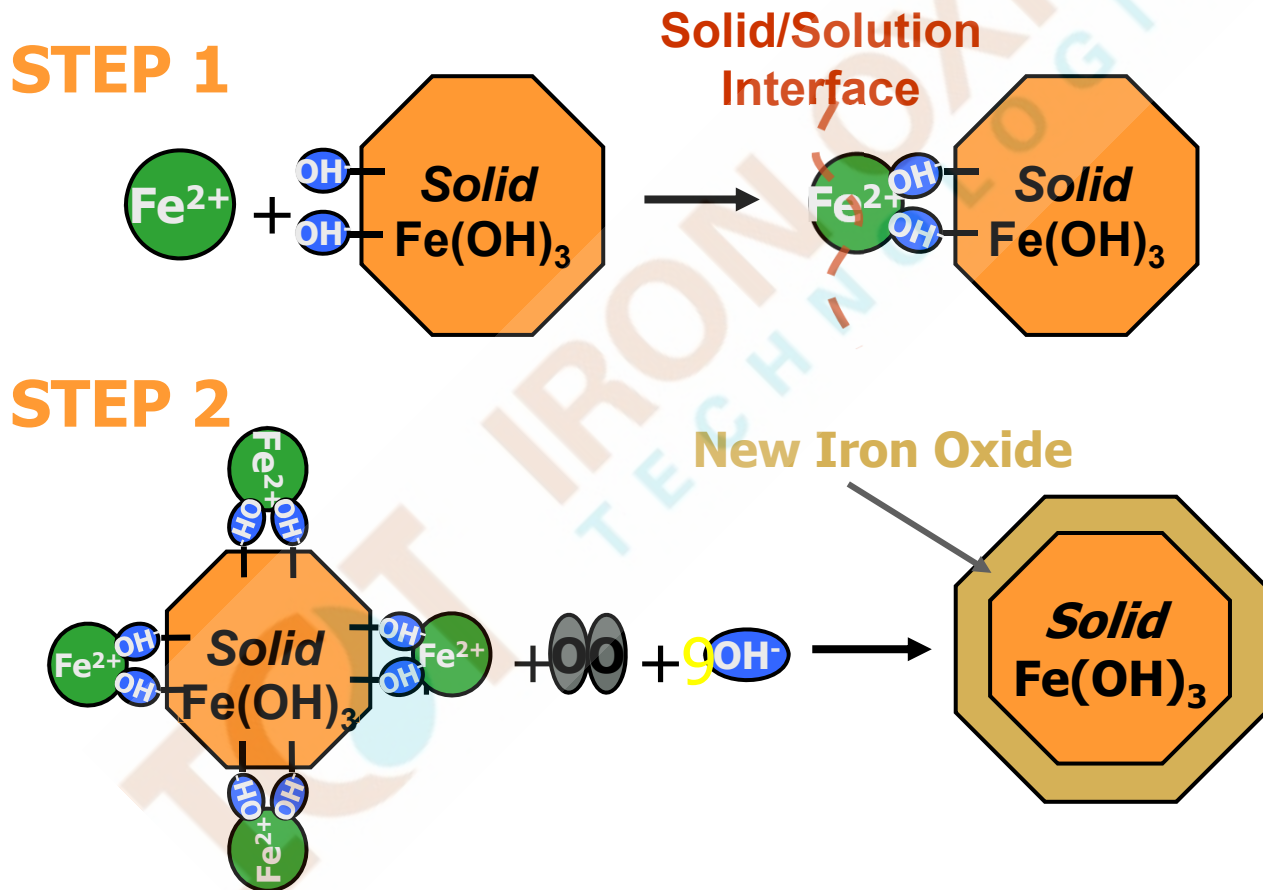
A solution-based oxidation process whereby Ferrous Ions and hydroxide complexes (Fe^{2+} , $\text{Fe}(\text{OH})^+$ & $\text{Fe}(\text{OH})_2^0$) react with dissolved oxygen to form ferric iron (Fe^{3+}). *Existing active (e.g., lime) and passive treatment oxidation process.*

Heterogeneous Ferrous Iron Oxidation

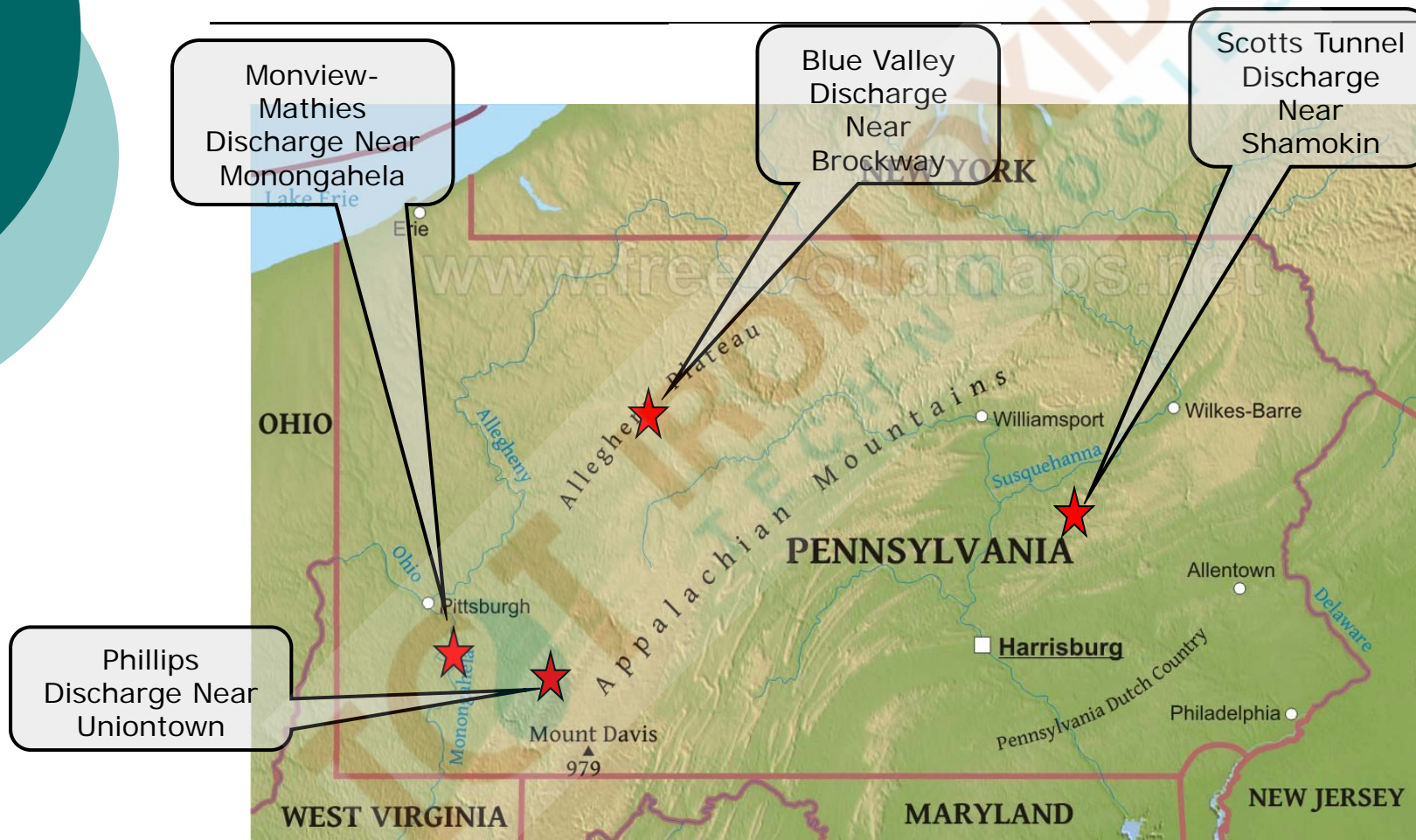
A solid/solution interface oxidation process whereby Ferrous Iron (Fe^{2+}) is sorbed to the surface of iron oxide (or other oxide surfaces) and in the presence of dissolved oxygen is catalytically oxidized to ferric iron (Fe^{3+}). *New active treatment known as AIS treatment utilizes this oxidation process.*

Heterogeneous Conceptual Ferrous Iron Oxidation

Surface-based Oxidation & Precipitation



AIS Pilot Study Locations



AIS Treatment Pilot Testing

Shamokin Scotts Tunnel Pilot Study

Scotts Tunnel AIS Treatment Study
Reactors, Floc Tank, Clarifier, Gyro Doser

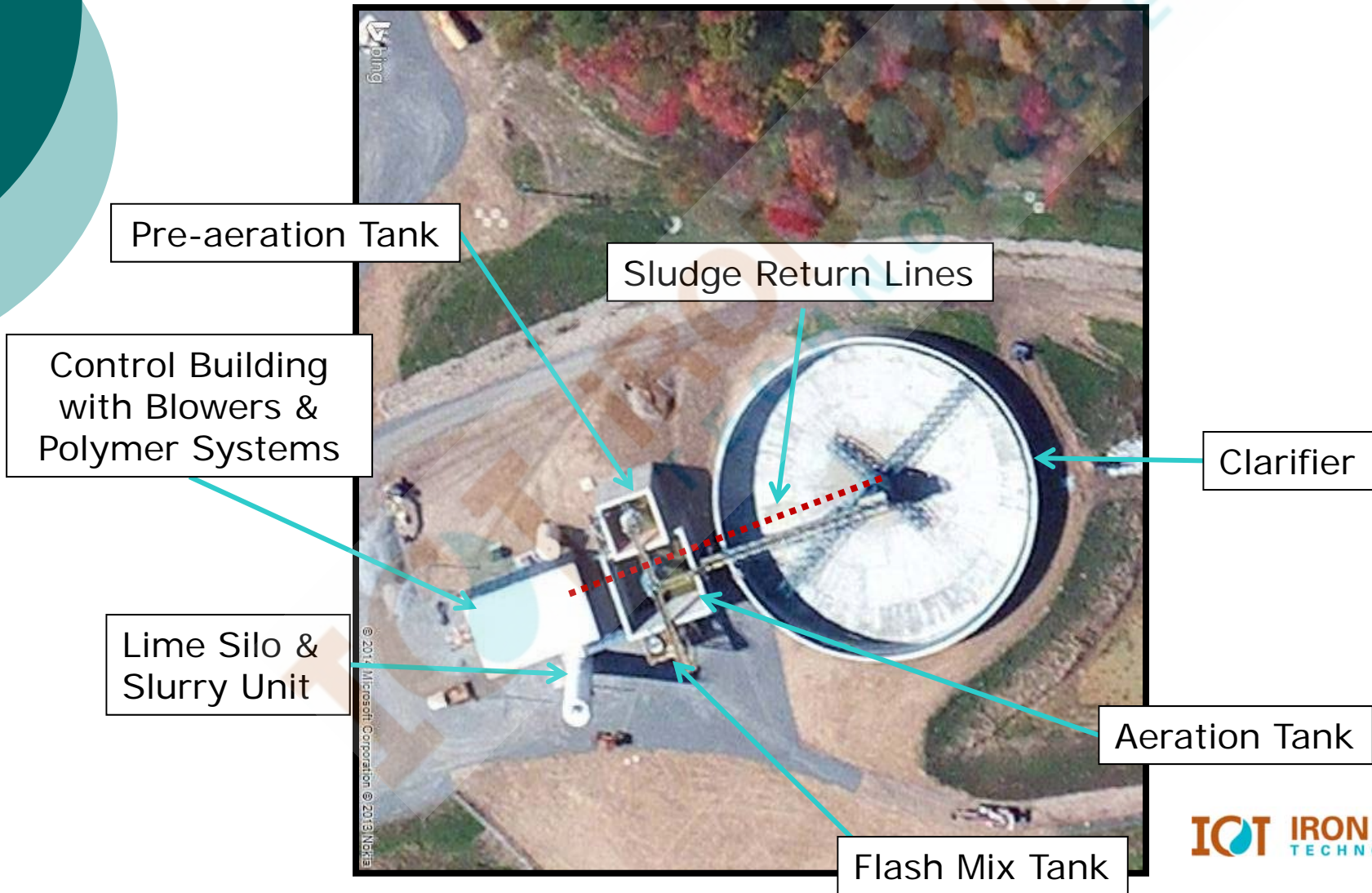
Scotts Deep Mine Discharge

pH = 5.75 Ferrous Iron = 25 mg/L, Flow = 12 MGD



Potential Conversion of Existing HDS Systems

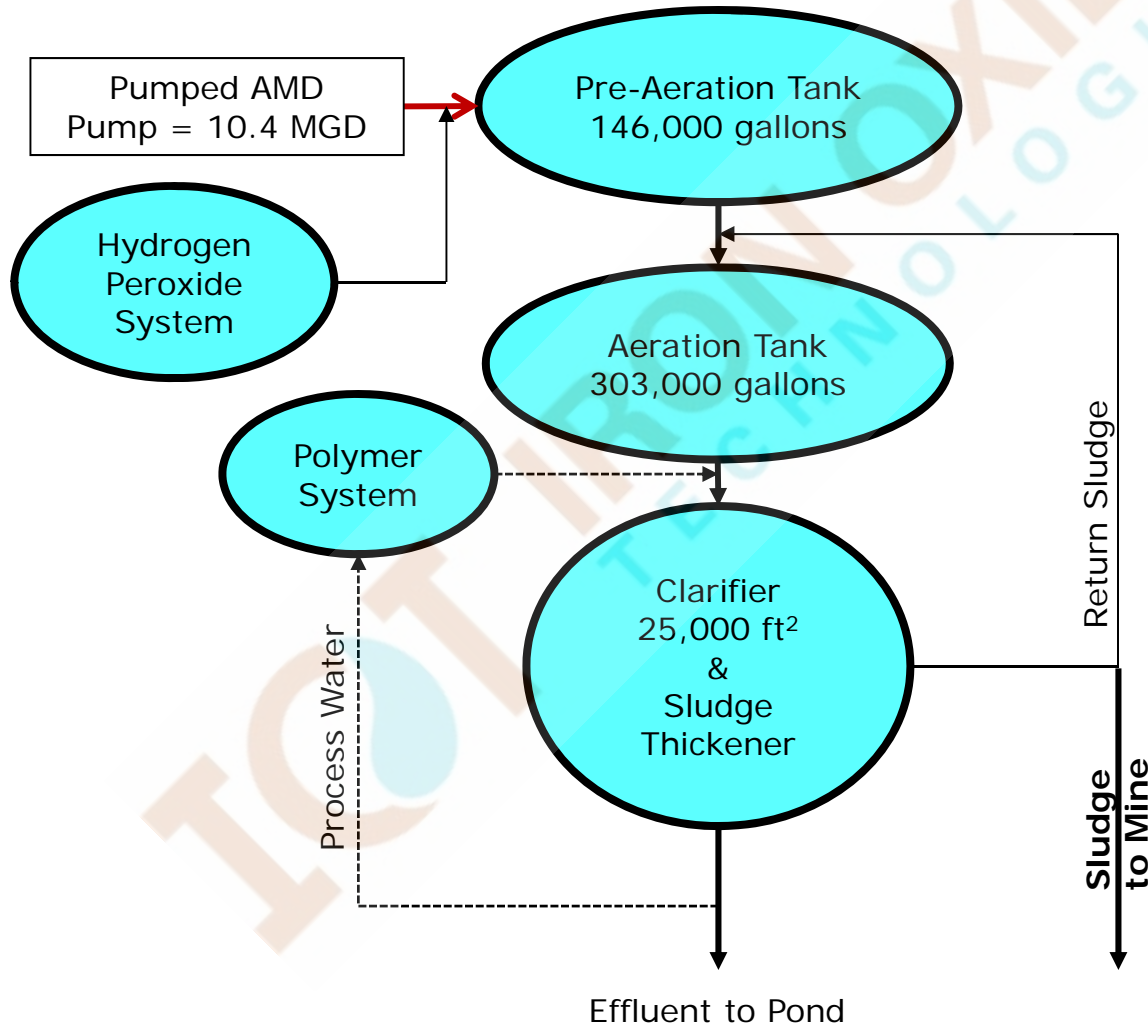
Lancashire Treatment System



Water Quality Analysis Lancashire AMD

Parameter	Units	Field	Laboratory
Flow	gpm	4,000-5,000	NA
pH	--	6.25	6.50
Temperature	°C	12.5	NA
Alkalinity	mg/L as CaCO ₃	127	115
“Hot” Acidity	mg/L as CaCO ₃	<i>Not Measured</i>	-70
Total Iron	mg/L	24.4	25.3
Dissolved (Ferrous) Iron	mg/L	24.5	21.6
Total Manganese	mg/L	<i>Not Measured</i>	1.23
Dissolved Manganese	mg/L	<i>Not Measured</i>	1.17
Total Aluminum	mg/L	<i>Not Measured</i>	0.45
Dissolved Aluminum	mg/L	<i>Not Measured</i>	<0.10
Sulfate	mg/L	<i>Not Measured</i>	282
Calculated CO ₂ Acidity	mg/L as CaCO ₃	180	

Hydrogen Peroxide Treatment Flow Path



Lancashire AIS Bench Testing



Gang Mixer Used in AIS Testing of the Lancashire AMD.



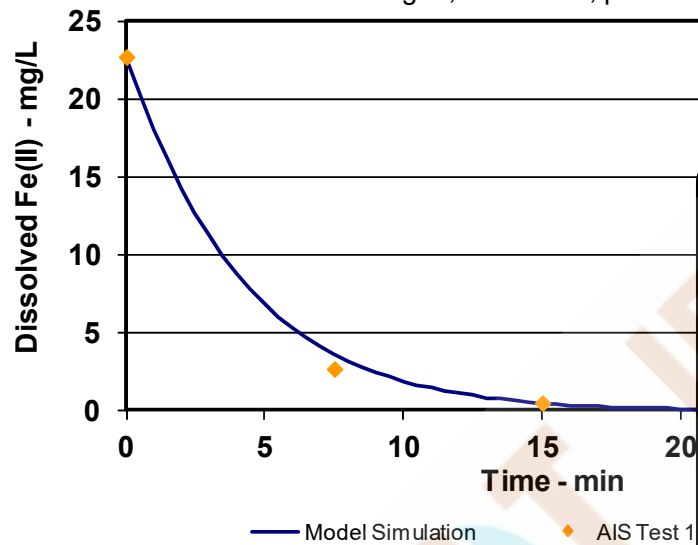
Small-scale mixing system used to evaluate changes in sludge properties

AIS Bench Testing Results

Pre-aeration Tank Conditions

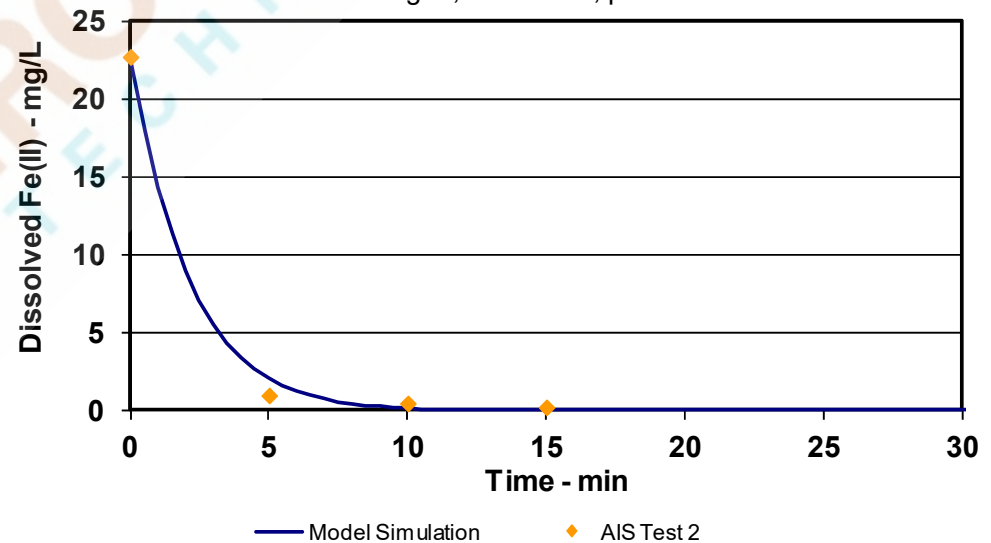
Lancashire AIS Test 1

AIS = 1.7 gr/L, DO = 95%, pH = 6.55



Lancashire AIS Test 2

AIS = 3.4 gr/L, DO = 95%, pH = 6.55

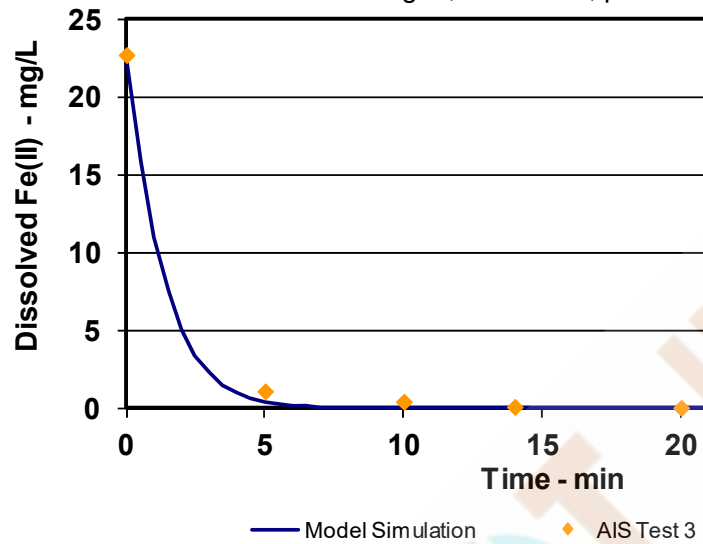


AIS Bench Testing Results

Aeration Tank Conditions

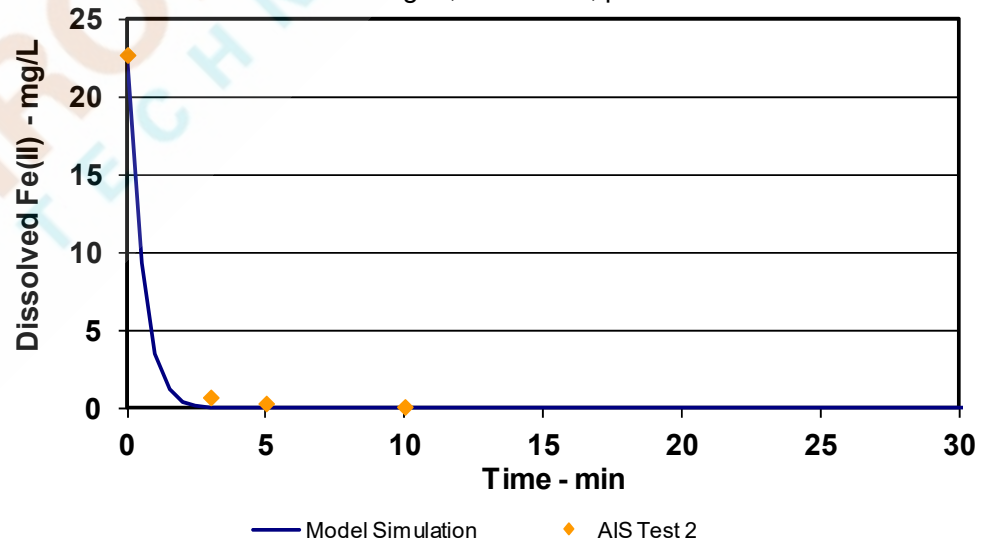
Lancashire AIS Test 3

AIS = 1.7 gr/L, DO = 95%, pH = 6.80



Lancashire AIS Test 4

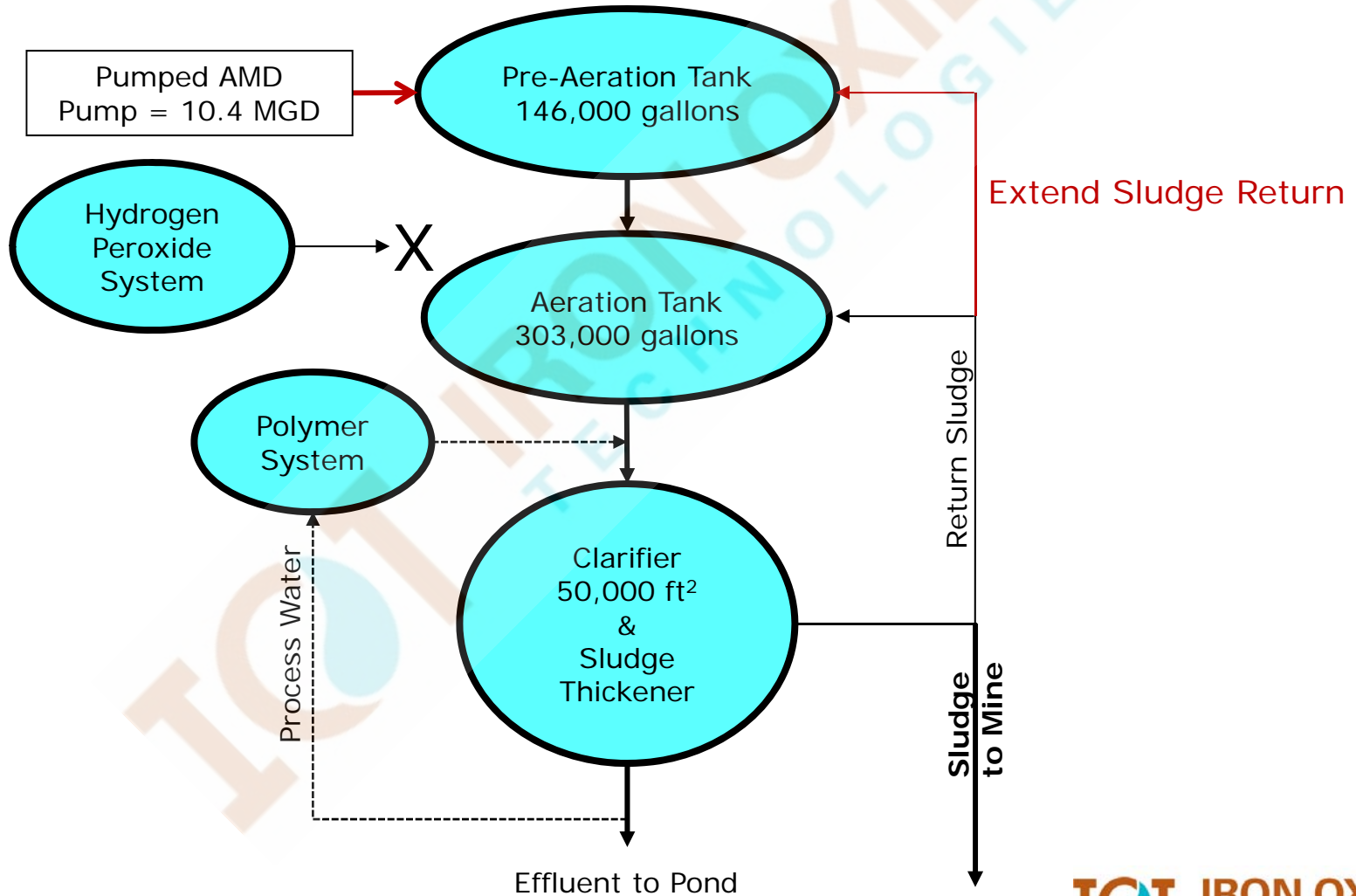
AIS = 3.4 gr/L, DO = 95%, pH = 6.85



Lancashire AMD Treatment Plant Predicted Effluent Quality With Conversion to AIS Treatment

AMD Flow gpm	Reactor AIS g/L	Reactor 1			Reactor 2			Effluent Total Iron mg/L
		Theor. Detention Time min	Modeled pH	Modeled Ferrous mg/L	Theor. Detention Time min	Modeled pH	Modeled Ferrous mg/L	
Average 4,000	2.0	35.9	6.82	3.5	74.4	7.05	0.07	< 1
	2.5	35.7	6.83	2.9	74.2	7.06	0.05	< 1
Maximum 7,200	2.0	19.9	6.45	11.5	41.4	6.87	0.65	~ 1
	2.5	19.8	6.46	10.3	41.2	6.89	0.45	~ 1

AIS Treatment Flow Path





St. Joseph's Water Treatment

A Public Water Groundwater Source,
Treatment Plant & Distribution System

AMERICA

Contaminated Water In St. Joseph, La., Leads To Public Health Emergency

December 16, 2016 · 6:40 PM ET



REBECCA HERSHER



St. Joseph, La., a town of about 1,100 people in northern Louisiana.
Courtesy of Garrett Boyte

Louisiana Gov. John Bel Edwards has declared a Public Health Emergency for the town of St. Joseph, after officials found water going to three buildings — one of them the town hall — was contaminated with lead or copper.

The governor said state testing showed elevated levels of lead at a private residence as well as the town hall building, on Thursday. The tests also showed "elevated levels of copper" at two private homes.

The governor's office issued a statement warning residents of St. Joseph, which is home to about 1,100 people, not to use tap water:

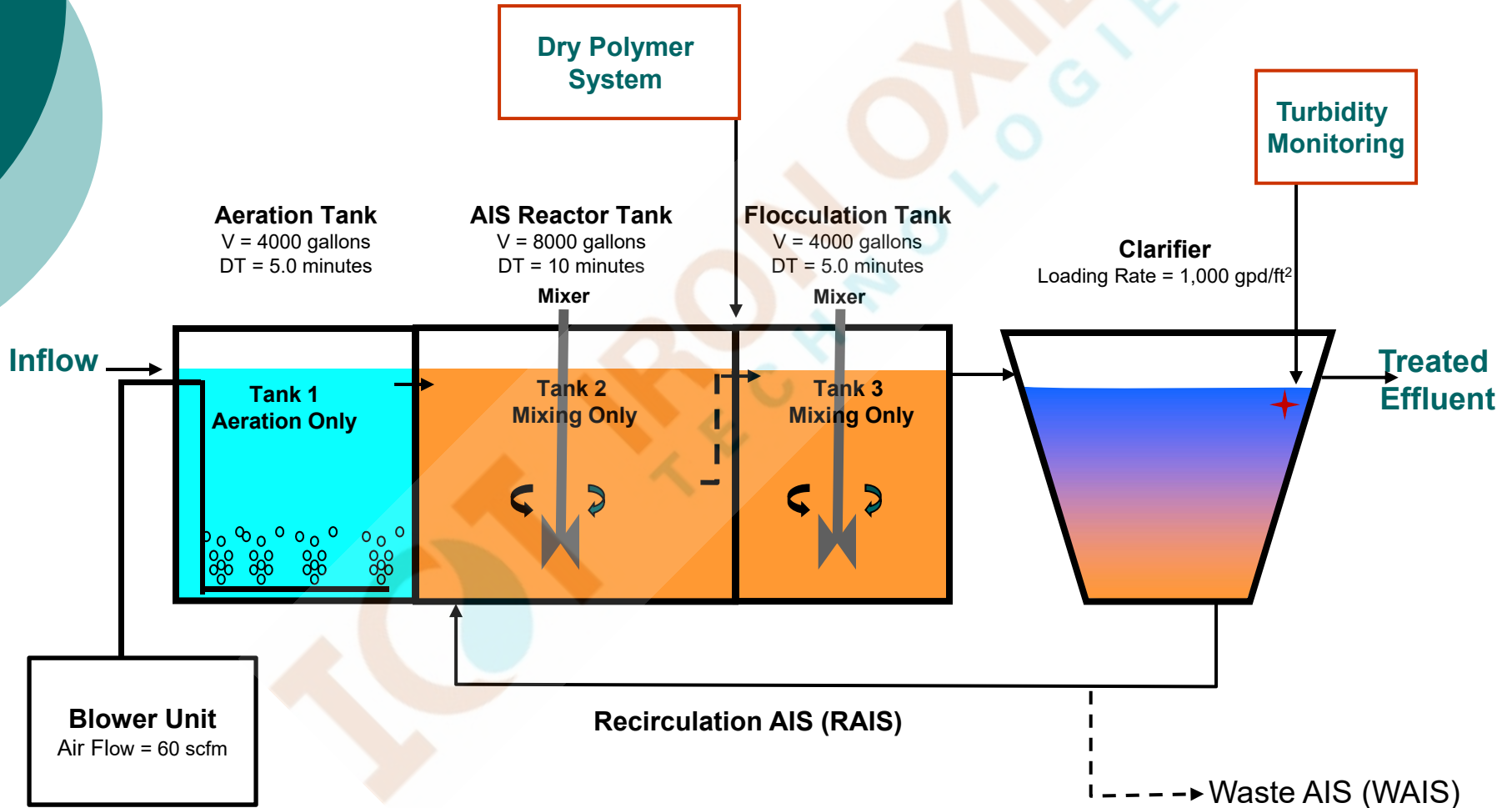
St. Joseph Well Water Chemistry

Well	pH	Alkalinity	CO ₂ Acidity	Total Iron	Dissolved Iron	Total Mn	Sulfate	TDS	Total Ca
	s.u.	mg/L as CaCO ₃	mg/L as CaCO ₃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
#1	6.90	436	120	19.6	19.0	0.7	10	500	130

Package AIS Treatment System

For Iron Removal at the St. Josephs Water Treatment Plant

Design Flow = 800 gallon per minute (1.1 MGD)



Not-to-Scale
Tank Volumes Shown



Treatment System Partners

- Purestream
- WESCO
- Excelsior Blower Systems
- SPX Sales – Lightnin Mixers
- Prominent Fluid Controls
- **Bryant-Hammett & Associates**

Reactor Tank System



Clarifier (Lamella Type)



Mixer Units



Blower System



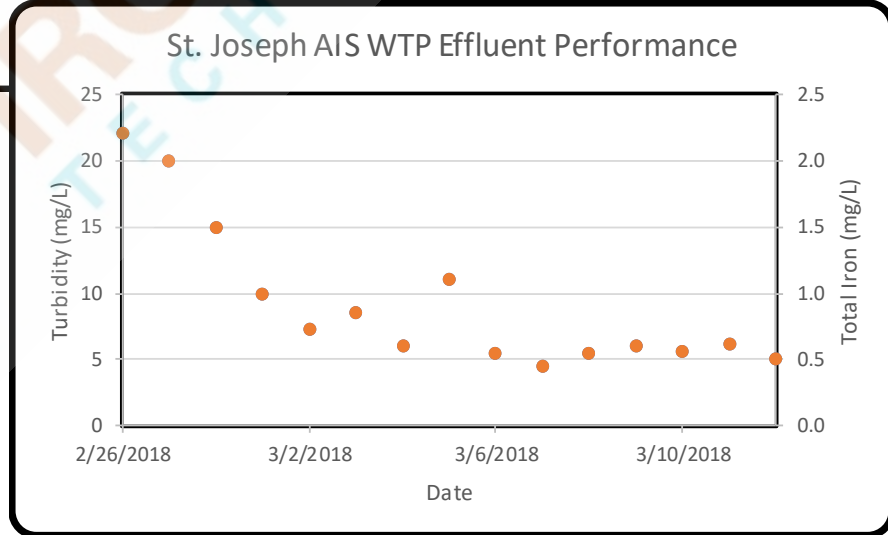
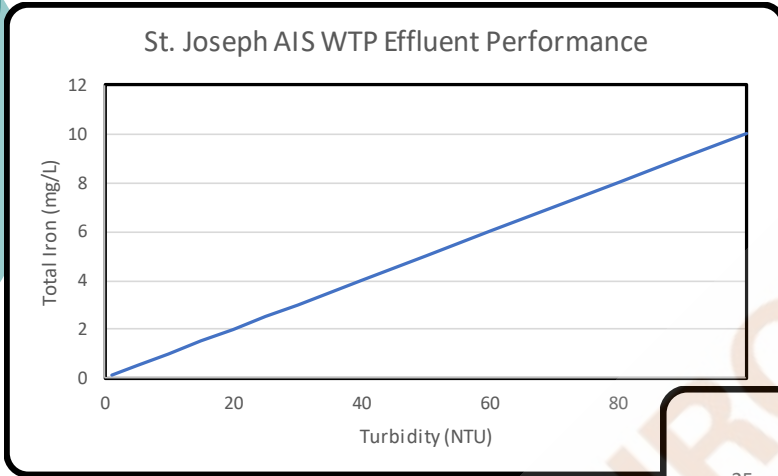
Sludge Return/Waste Pumps



Polymer System (Dry Powder)



St. Josephs AIS System Performance



St. Josephs AIS Operating Costs

(non-labor)

- Electricity ~ \$5,750/yr
 - Mixers (3Hp + 1Hp)
 - Blower (3 Hp)
 - Sludge Pump (7.5 Hp @20%)
 - Polymer System (~0.25 Hp)
- Polymer ~ \$650/yr
 - 0.3 mg/L Dose
 - \$3.50/lb
- Materials ~ \$700/yr
 - Pump Hoses
 - Gear Oil
 - Miscellaneous

Cost per 1,000 gallons Treated = \$0.11

A Picture of Performance!

