



**HUNGERFORD & TERRY, INC**

Arsenic Removal  
with  
GreensandPlus

# Arsenic Species

- Arsenate (As V) required for precipitation or ion exchange
- Determination of species not necessary
  - Determination by analysis is expensive
  - Few facilities capable of species determination
  - Determination can be made empirically
  - Feasible treatment regardless of species

# Empirical Determination of Arsenic

- Strong Base Anion Resin (SBA)
- Arsenate (As V) readily exchanges; Arsenite (III) passes
- Test for total Arsenic in effluent
- Iron can interfere with determination of removal efficiencies

# Treatment for Arsenic

- Several technologies exist
  - Reverse Osmosis
  - Activated Alumina
  - Ion Exchange
  - Co-Precipitation and Filtration

# Reverse Osmosis for Arsenic Removal

- Generally costly
- Often requires pretreatment
- Treatment is very comprehensive
- Waste is difficult to dispose of

# Activated Alumina for Arsenic Removal

- O & M costs significant
- Regeneration with acid and caustic required
- Waste volume and disposal can be difficult
- Downtime for regenerations

# Ion Exchange for Arsenic Removal

- May require pretreatment
- O & M costs significant
- Downtime for regeneration
- Waste volume and disposal

# Co-Precipitation for Arsenic Removal

- Arsenic co-precipitated with iron
- Arsenic often present in iron bearing waters
- Single treatment process for iron and arsenic
- Iron treatment process well established
- Waste often readily accepted by sewer authority



# Co-Precipitation Principals

- Arsenate (V) required
- Arsenite (III) must be converted
- Conversion of As III easily done with chlorine
- Metal hydroxide formed with naturally occurring iron
- Ferric chloride can be added if iron not naturally occurring
- Arsenic backwashed out of filter with iron

# Particulate Filtration

- GreensandPlus is an effective media
  - Filters down to 10 microns
  - Offers oxidation capability in the event of lost oxidant feed
  - An established treatment method for iron and manganese
  - Allows the use of potassium permanganate
  - Shown to reduce arsenic well below current and proposed limits
- Effluent arsenic can be correlated to effluent iron quality
- Arsenic test kits available

# Monitoring Quality

- Effluent arsenic can be correlated to iron quality
- Test kits are available
- Test kits are strictly qualitative, but reliable

# Studies Conducted with GreensandPlus

- Village of Kelliher, Canada
- Grand Blanc, MI (Knollwood)
- Grand Blanc, MI (Stockbridge)
- Otisville, MI
- Hartland, MI
- New Mexico State University

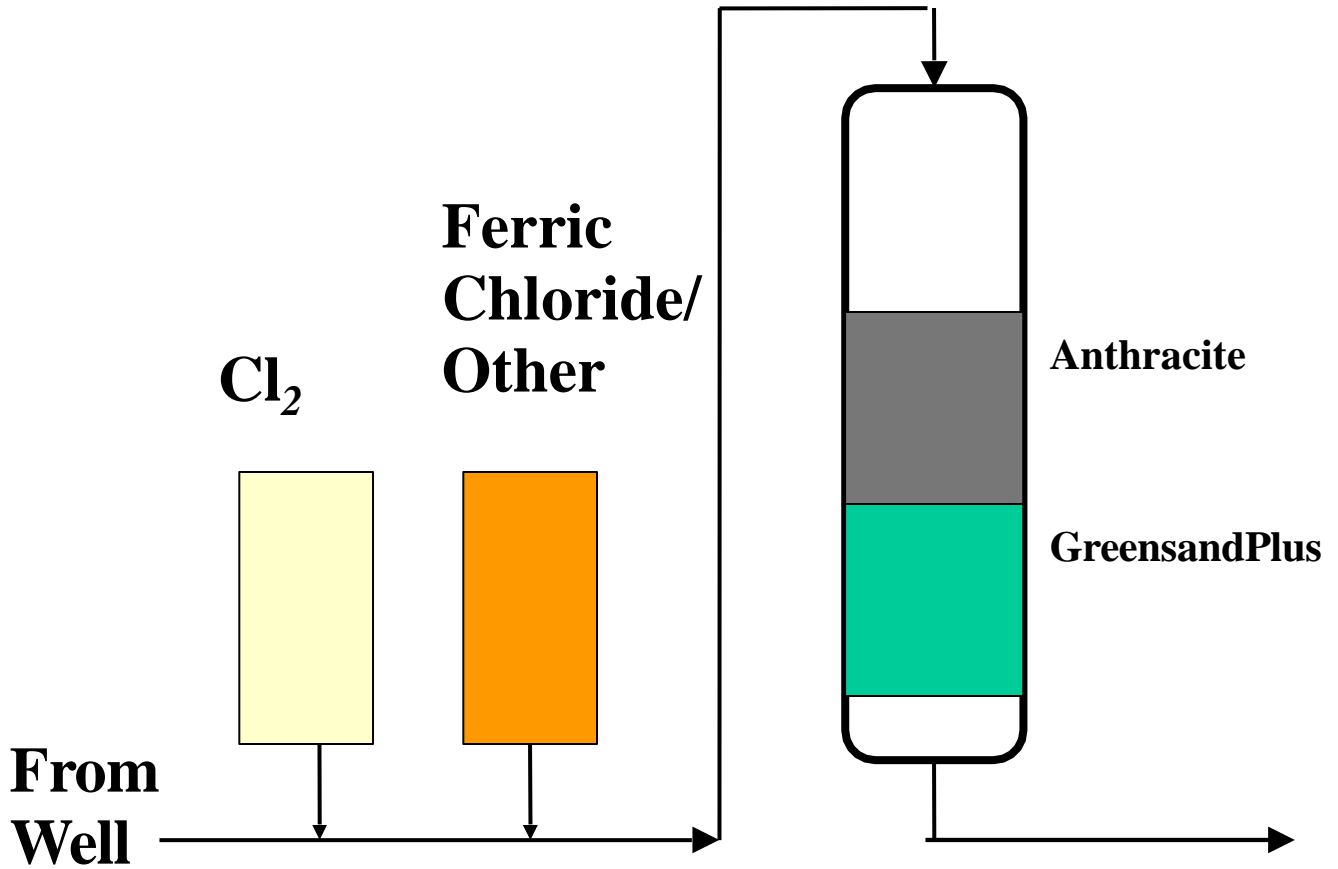
# Kelliher Study

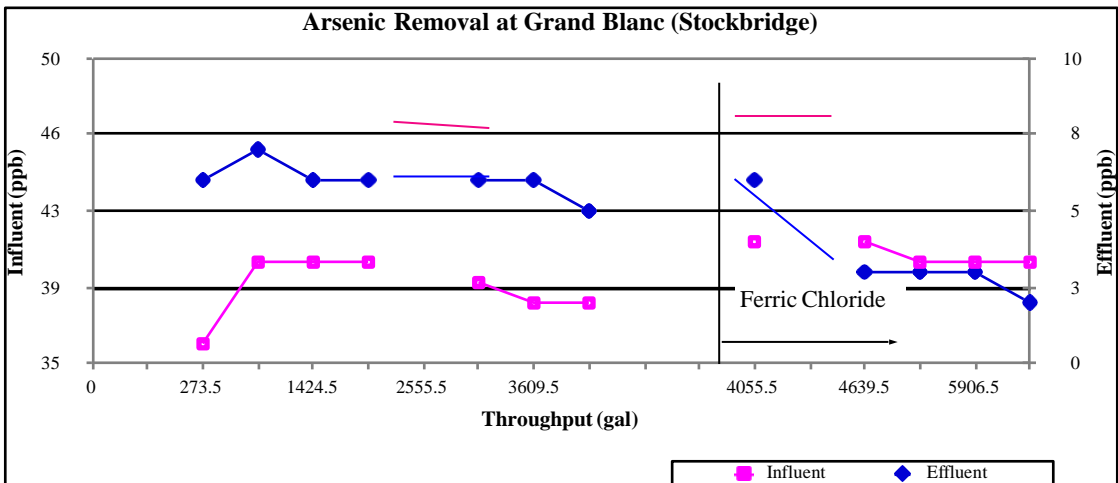
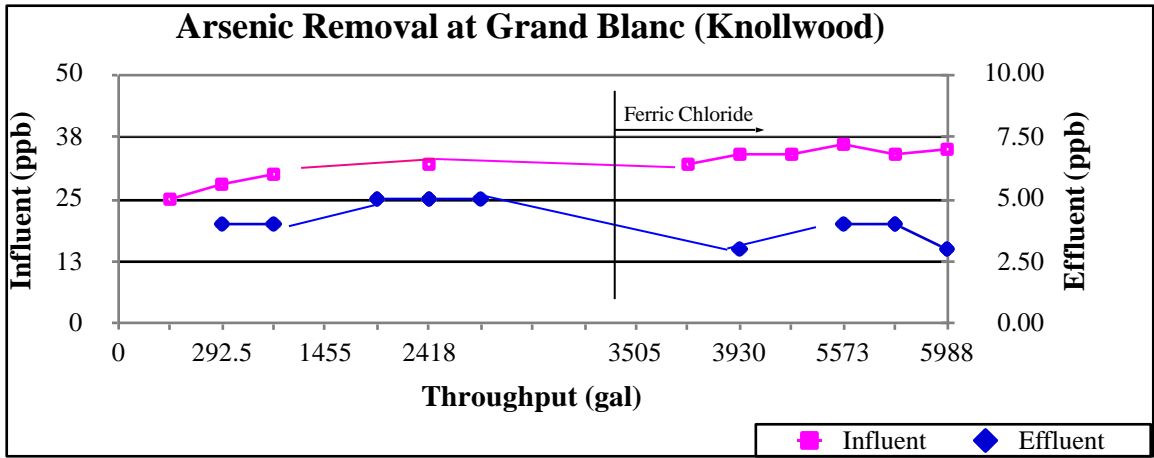
- No ferric chloride required
- Excellent treatment of iron, manganese and arsenic
- Developed correlation of iron and arsenic break
- Consistent and reliable performance
- Facility is well established and studied.

# Other GreensandPlus Studies

- Effluent arsenic exceed the current and proposed MCL's
- Arsenite (III) predominant at Grand Blanc sites
- Results were consistent
- Arsenic breakthrough not experienced
- Ferric chloride impact can be quantified
- Test kit results correlated well with certified results

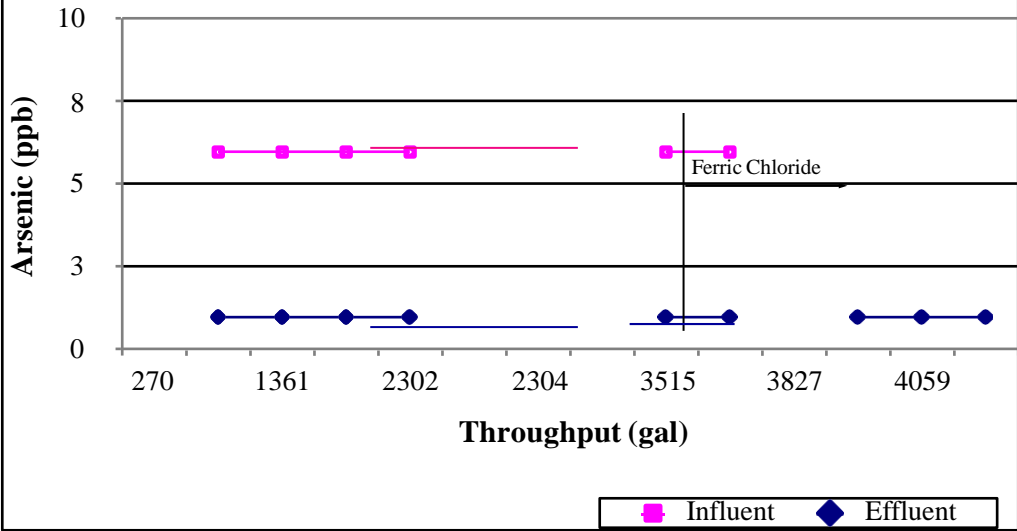
# Pilot Plant Diagram







### Arsenic Removal at Otisville, MI



# NM University Study

- Experimented to determine GreensandPlus's optimum operating conditions under IR conditions
- Arsenic was removed
- Physical operating conditions proved this to be impractical
- Experimental conclusions were outside of those recommended