Bio-P, Digestion and Dewatering: Unexpected Consequences?

IWEA/CSWEA
Biosolids Seminar
November 20, 2013

Bill Marten
Leon Downing
Eric Lynne
Donohue & Associates

Presentation Outline

- History/Background Information
- Supporting Evidence
- Suspected Causative Factors
- What the Future May Hold
- déjà vu?

History/Background Information

Sun Prairie WPCF

- **Major Plant Upgrade 2006**
  - RBC to Bio-P Nitrifying Activated Sludge
  - Anaerobic Digestion Improvements
  - Belt Filter Press Dewatering
    > Pilot Testing Before Construction =>Dewatered Cake ~ 22% TS
- **Startup Last Quarter 2006/Early 2007**
  - Initial Dewatered Cake ~ 17-18% TS
  - Cake Solids Decreased Over Several Month Period
    > Currently Achieving 12-13% TS

Sun Prairie WPCF

Beloit WPCF

- **Bio-P & Anaerobic Digestion Since 1992**
- **Added BFP in 2012**
- **Dewatered Cake Characteristics**
  - Good Release From Belt
  - No Free Water (Appears Typical of 18% TS +/-)
  - 10-12% TS Typical
- **Plant Staff Worked to Optimize Performance**

Beloit WPCF

- **Dewatering Optimization Efforts**
  - Moved Polymer Injection & Mixing Valve Location
  - Added Belt Spray Bars in Washboxes
  - Increased Belt Hydraulic Pressure
  - Added PRV to Eliminate Gas Binding in Feed Line
  - Put Second Digester Online to Increase VS Destruction
- **Results: Currently Achieving ~ 15% TS**
  - At Similar Polymer Dosage & Sludge Feed Rate

Marquette (MI) WWTF

- **Major Plant Upgrade 2009**
  - RBC to Bio-P Nitrifying Activated Sludge
  - Anaerobic Digestion Improvements
  - Belt Filter Press Dewatering
- **Startup**
  - Bio-P: April 2009/BFP: December 2009
  - Initial Dewatered Cake ~ 12-14% TS
  - Changed Polymer Spring 2011
    > Currently Achieving 14-18% TS

Kiel WWTP

- **Activated Sludge, Anaerobic Digestion, BFP Dewatering & RDP EnVessel Pasteurization**
  - Dewatered Cake 15-19% TS
- **Converted to Bio-P ~ April 2012**
  - Dewatered Cake 15-16% TS
- **What's Different Than Sun Prairie, Beloit, Marquette???**

  =>Only Primary Sludge Goes to Anaerobic Digestion

However, there have been consequences…

=>

Significant Reduction in Stack Height

Ok, Is This Real or Not???

Others Are Also Seeing This, Including:

- Hampton Roads Sanitary District Atlantic & Nansemond Plants
- Met Council Environmental Services Empire & Blue Lake Plants
- Metro Denver, CO

A number of plants in Europe as well…

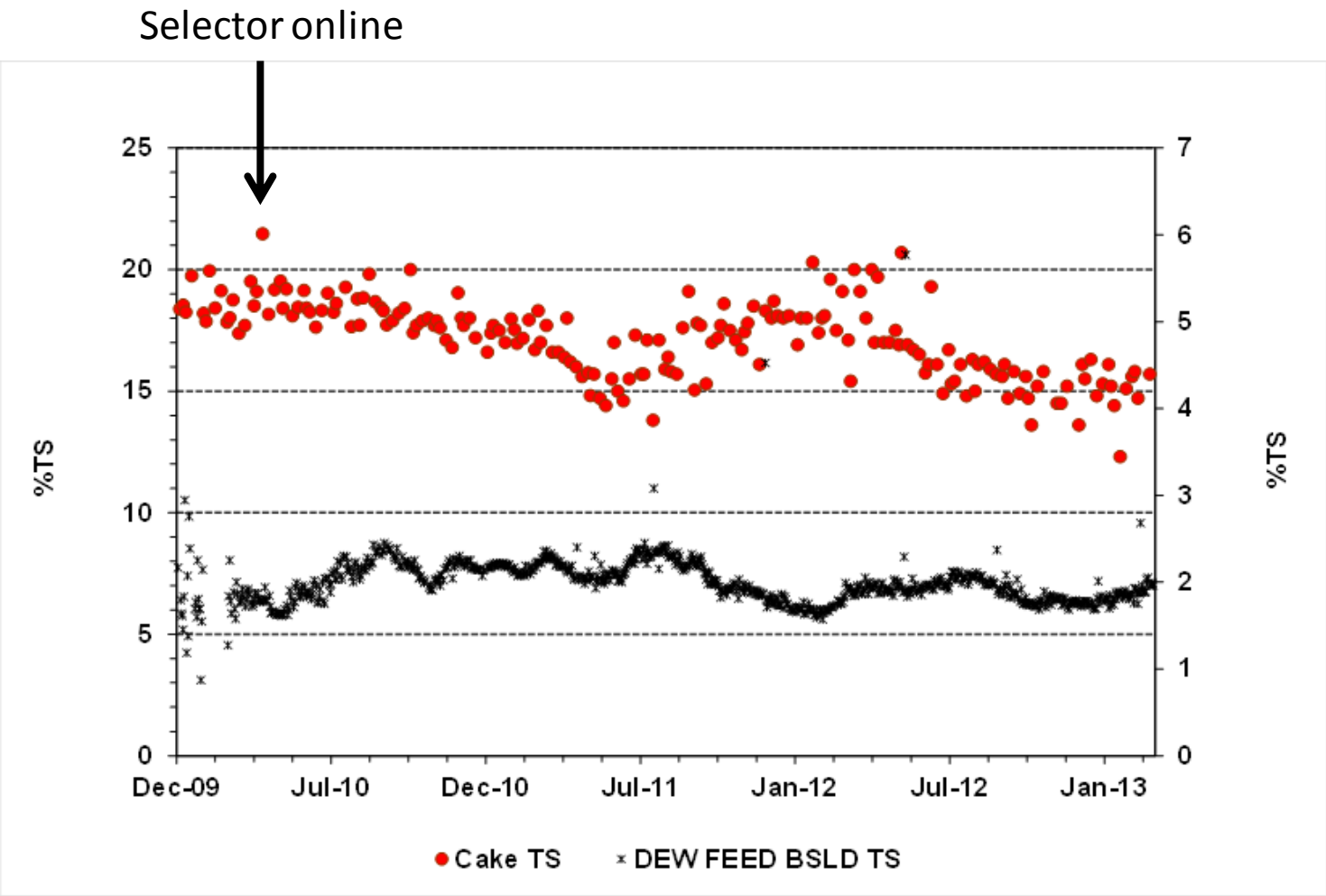
HRSD Plants

- **Nansemond**
  - Anaerobic Digestion & High Solids Centrifuges
  - Originally VIP/MUCT With Supplemental Ferric
    > Dewatered Cake 22-24% TS Consistently
  - Conversion to 5 Stage Bardenpho, Ostara & No Ferric
    > Dewatered Cake 18-18.5% Solids
  - Was Ferric Addition Making a Difference, or Did Ostara Have an Impact?

HRSD Plants

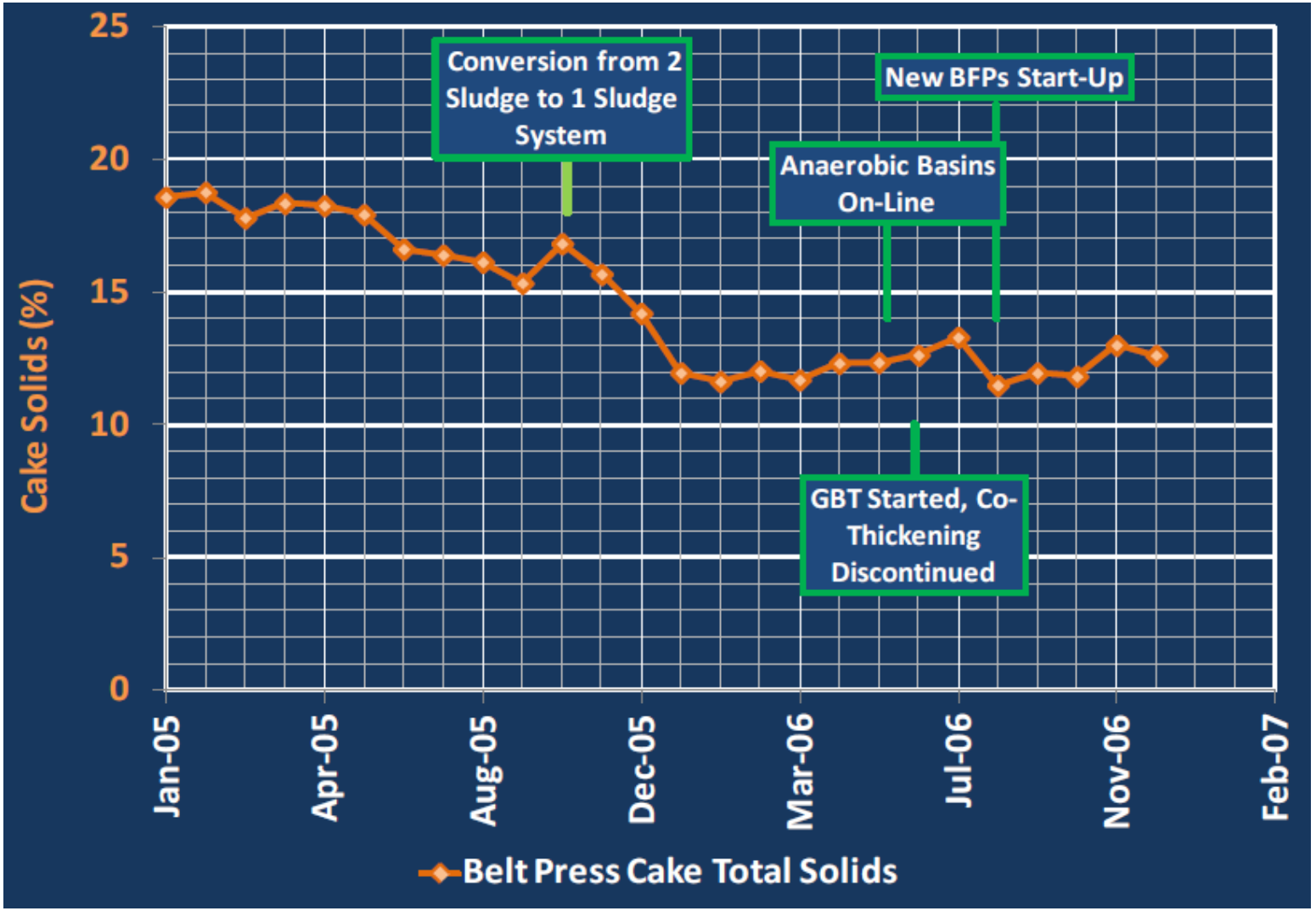
- **Atlantic**
  - Originally HPO With CEPT (using Ferric & Polymer), Anaerobic Digestion, Centrifuge Dewatering
    - > Poor Settleability Mixed Liquor
    - > Dewatered Cake ~ 19% TS
  - Converted HPO to A/O, Eliminated CEPT, Acid/Methane Digestion
    - > Bio-P & Struvite Formation
    - > Excellent Settleability Mixed Liquor
    - > Dewatered Cake 15-17% TS
  - Was Deterioration Related to Elimination of Ferric, Formation of Struvite, or Combination?

HRSD Atlantic Plant



Courtesy of Neethling, Benisch, 2013

MCES Empire Plant



Courtesy of Sprouse, 2013

MCES Thoughts to Date

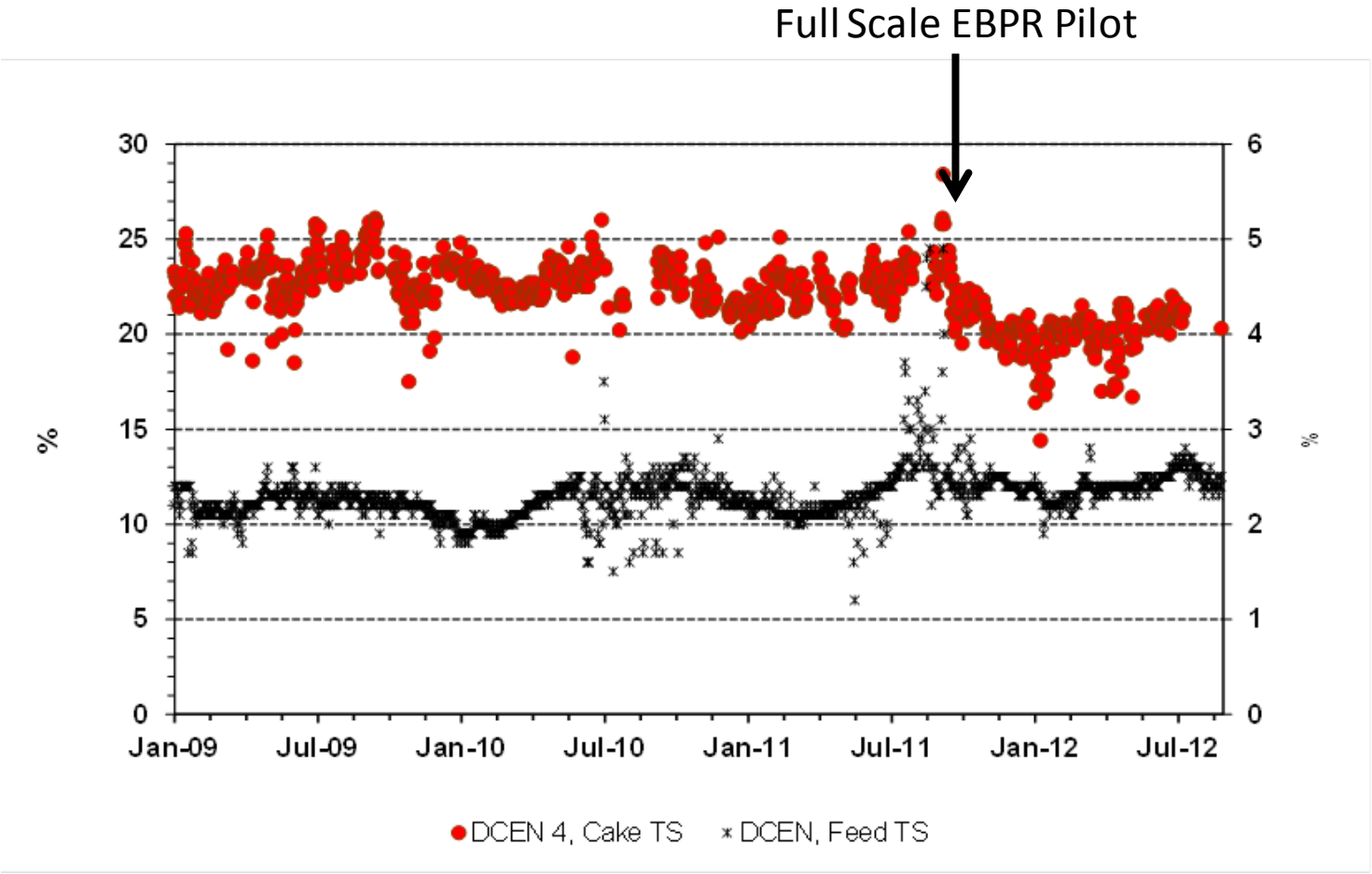
Empire

- **Was Deterioration in Dewatering Due to:**
  - Going from two-stage to single stage activated sludge?
  - Bio-P?
  - New soluble waste streams increasing WAS/PSD ratio to digestion?
  - Combination?

Blue Lake

- **Bio-P, Dewatering, Added Anaerobic Digestion**
- **Dewatering Has Deteriorated Since Digestion Added**

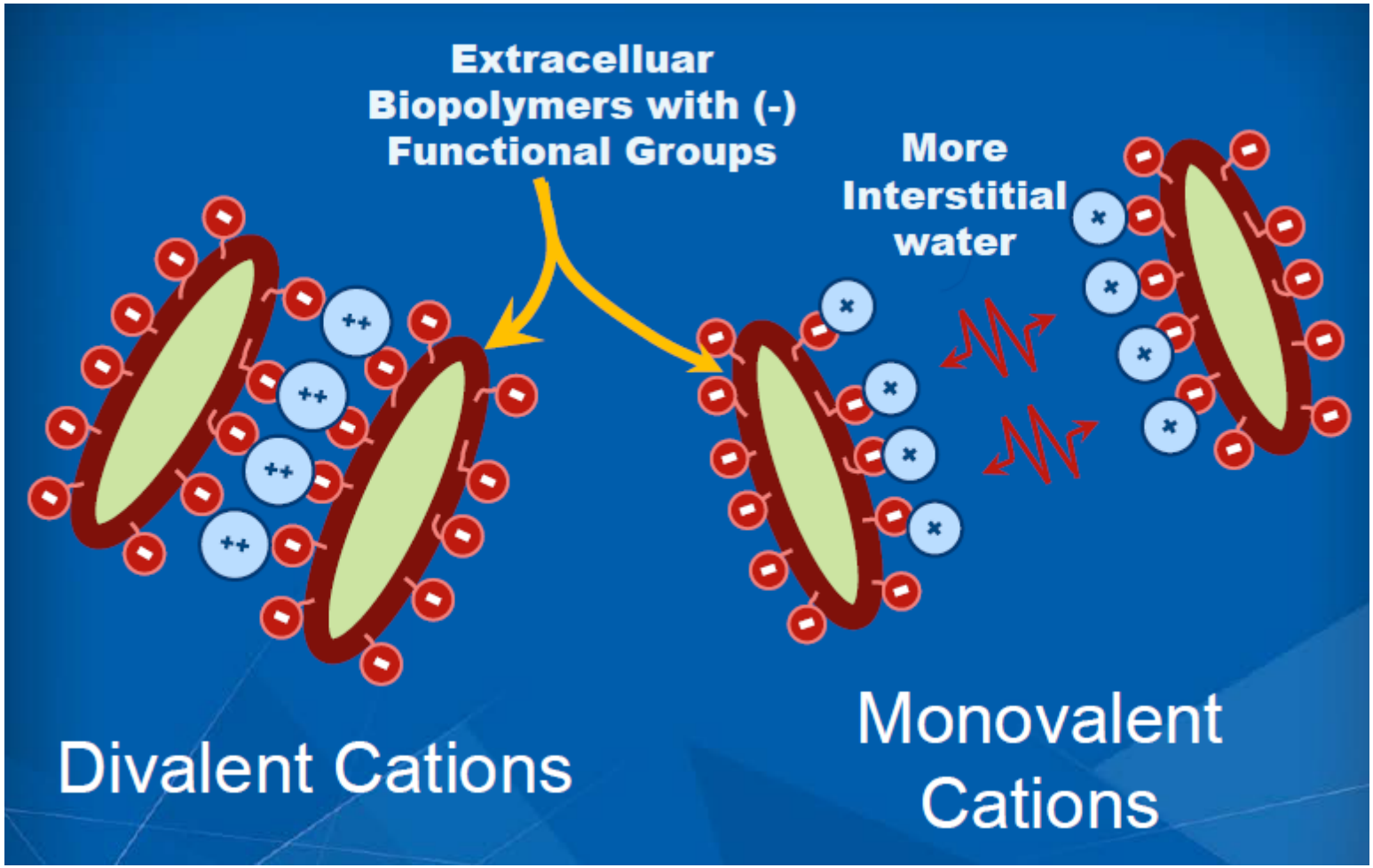
Metro Denver, CO Robert Hite WWTF



Suspected Causative Factors

- **Divalent Cation Bridging is Primary Theory**
  - Prominent Divalent Cations Are Mg^{2+}, Ca^{2+} and Fe^{2+}
  - Prominent Monovalent Cations are Na^{+} and K^{+}
  - Post Digestion Struvite Formation Lowers Divalent Cation Concentration While Not Affecting Monovalent Cations
- **Alternate Theory: Soluble P Concentration of Digested Sludge**
  - Evidence that soluble Ortho-P binds water to solids

Divalent Cation Bridging Theory



Courtesy of Sprouse, 2013

What's The Future Look Like? Focused Research Efforts Currently Underway…

- **Bucknell University, HRSD & Clean Water Services**
  - Lab Scale Digesters (M/D Cation Ratio & Concentrations, Effect of Specific Cations – Particularly K^+)
  - National Survey (With Cooperation From Many)
- **MCES**
  - Role of Cations on Dewatering, & Impacts of Bio-P and Digestion
  - Other Factors Such As Belt Blinding, Dewatering Aids, Etc.

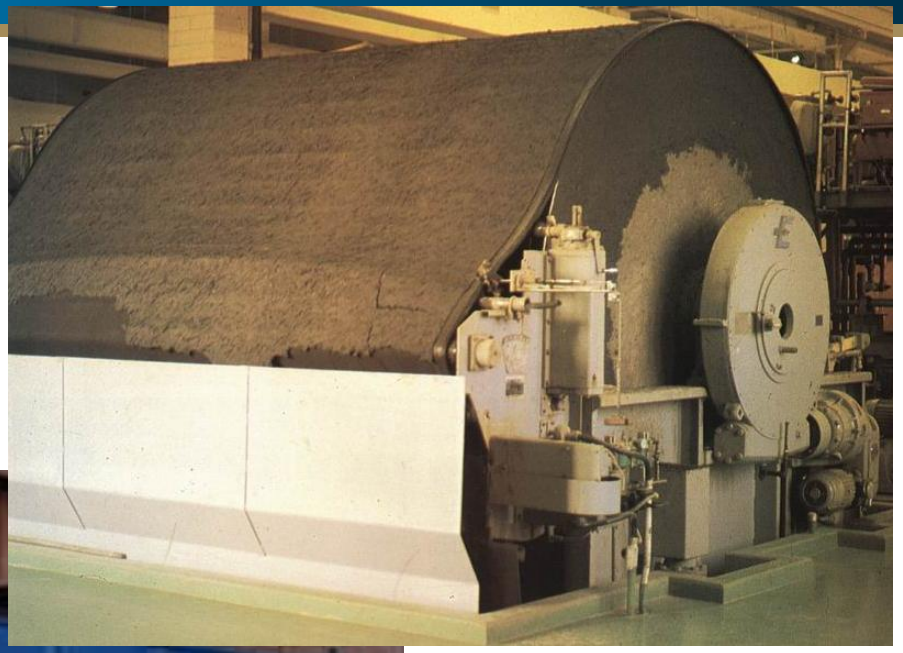
We're on a learning curve, similar to struvite a couple decades ago.

Early Returns…MCES

- **Unaerated Bio-P WAS Storage (3 Days HRT) with Ferric Addition**
  - Cake Solids Increases of 0.5-4% TS
  - Soluble P in Digested Sludge Appears to Matter – Less Soluble P Results in Higher Cake Solids
- **Digested Sludge Pre-Dewatering Treatment**
  - CO2 Stripping Followed by Addition of Divalent/Trivalent Cations (Mg, Fe, Ca)
  - Cake Solids Increases of 2-3% Attained

MCES continues to experiment…

A Final Thought…



As with many issues in our industry – are we simply re-learning the past?

Acknowledgements

- **Hampton Roads Sanitary District, Virginia Beach, VA**
  - Charles Bott
- **Metropolitan Council Environmental Services, St. Paul, MN**
  - George Sprouse
- **Metro Wastewater Reclamation District, Denver, CO**
- **HDR, Inc.**
  - JB Neethling, Mario Benisch

Acknowledgements

- **Sun Prairie WPCF**
  - John Krug, Lee Graves
- **Beloit WPCF**
  - Harry Mathos, Nate Tillis
- **Marquette WWTF**
  - Curt Goodman, Tom Asmus
- **Kiel WWTP**
  - Kris August

Thanks for your attention!

Bill Marten, PE, BCEE
731 N. Jackson Street, Suite 610
Milwaukee, WI 53202
Phone: 414-217-6909
Email: wmarten@donohue-associate.com

DONOHUE® & ASSOCIATES