Recent Developments in the Removal of Phosphorus from the Solids Stream

Tim Shea, PE, PhD, BCEE | Dewberry

March 22, 2018

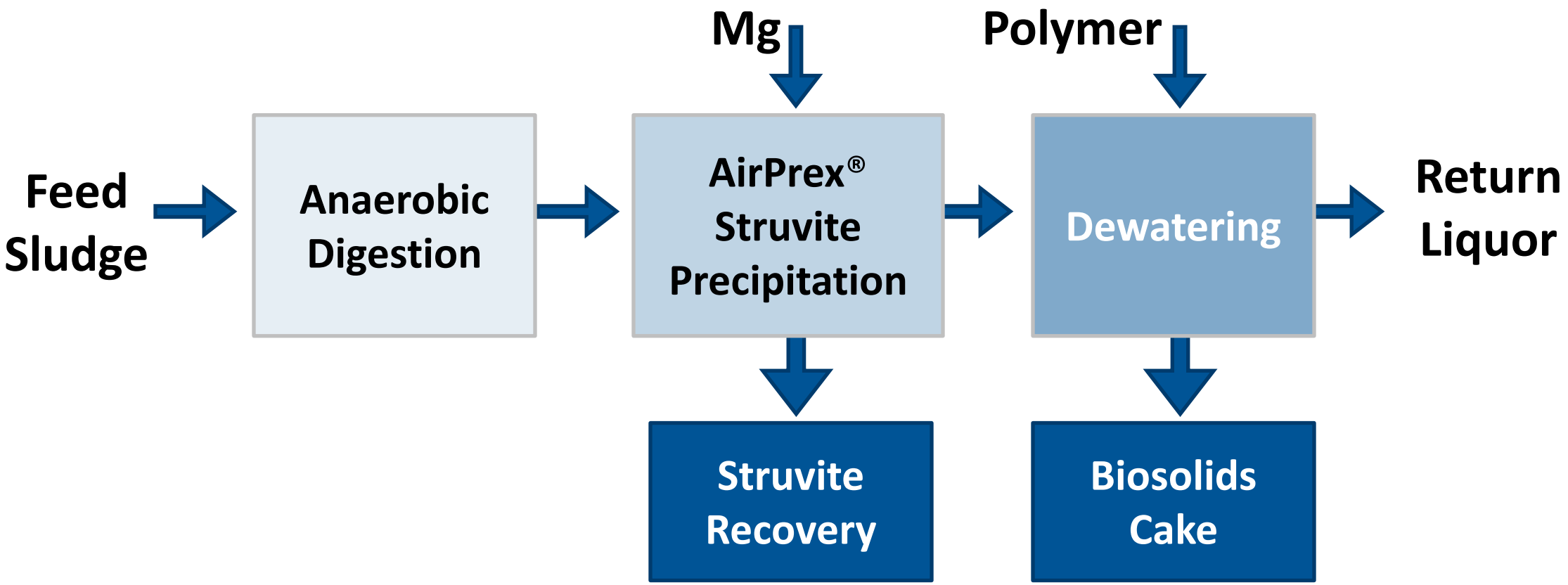
Acknowledgements

- Menachem Tabanpour
  CNP –Technology Water and Biosolids Corporation
- James McQuarrie and Blair Wisdom
  Metro Water Reclamation District, Denver, CO

Why Remove Phosphorus from Solids Stream?

- Phosphorus Recycle Control
- Biosolids Dewatering
- Struvite Reduction
- Phosphorus Index
- Product Recovery

Post-Digestion Pre-Dewatering Phosphorus Recovery



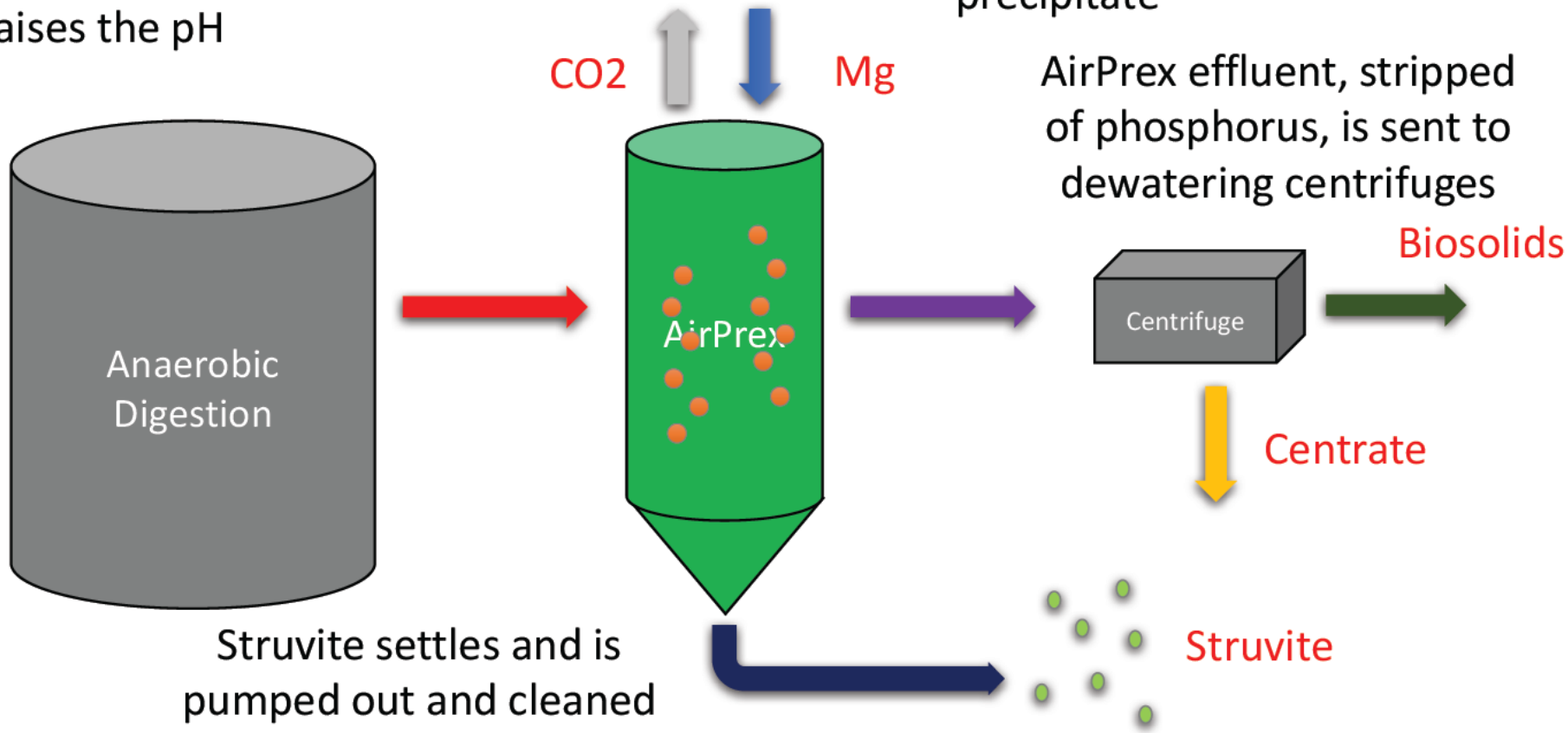
Struvite: Magnesium Ammonium Phosphate (MAP)
($NH_4MgPO_4 \cdot 6H_2O$)

How Air Prex® Works

Digester effluent is fed to AirPrex reactor

Reactor is aerated which strips the CO_2 from the reactor and raises the pH

Magnesium is dosed to the reactor causing struvite to precipitate



AirPrex effluent, stripped of phosphorus, is sent to dewatering centrifuges

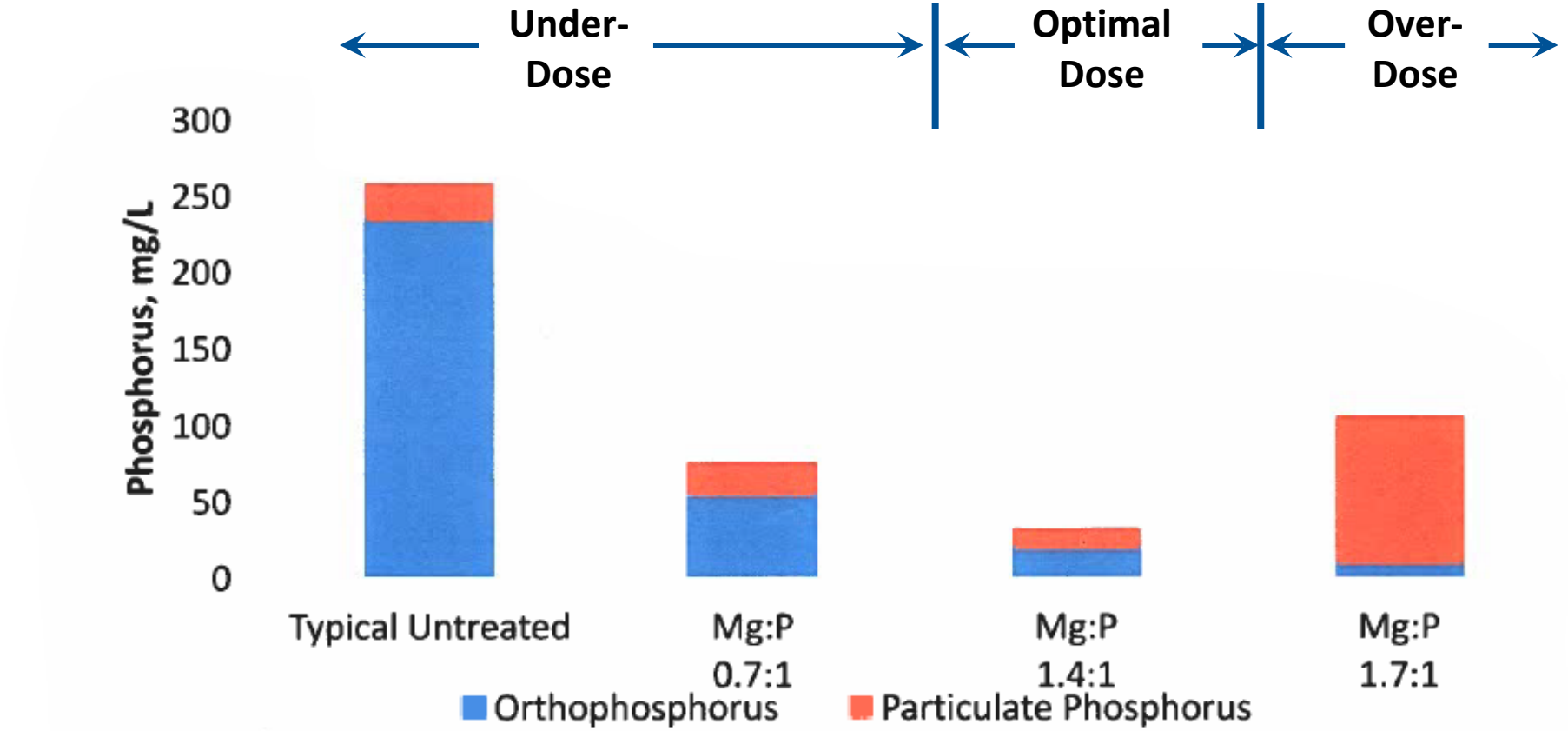
Struvite settles and is pumped out and cleaned

Dewberry

Operations and Testing at Denver Metro

- Pilot unit onsite for two months (2016)
- Reactor operation at flow of 11 gpm
- Mg:P molar dosing in range 0.7:1 to 1.7:1
- Dewatering centrifuge operated 6-8 hours a day
- ~3,000 water and solids samples analyzed
- Thermodynamic modeling to estimate nuisance struvite formation before/after AirPrex® reactor
- Biowin modeling – effects of P recycle

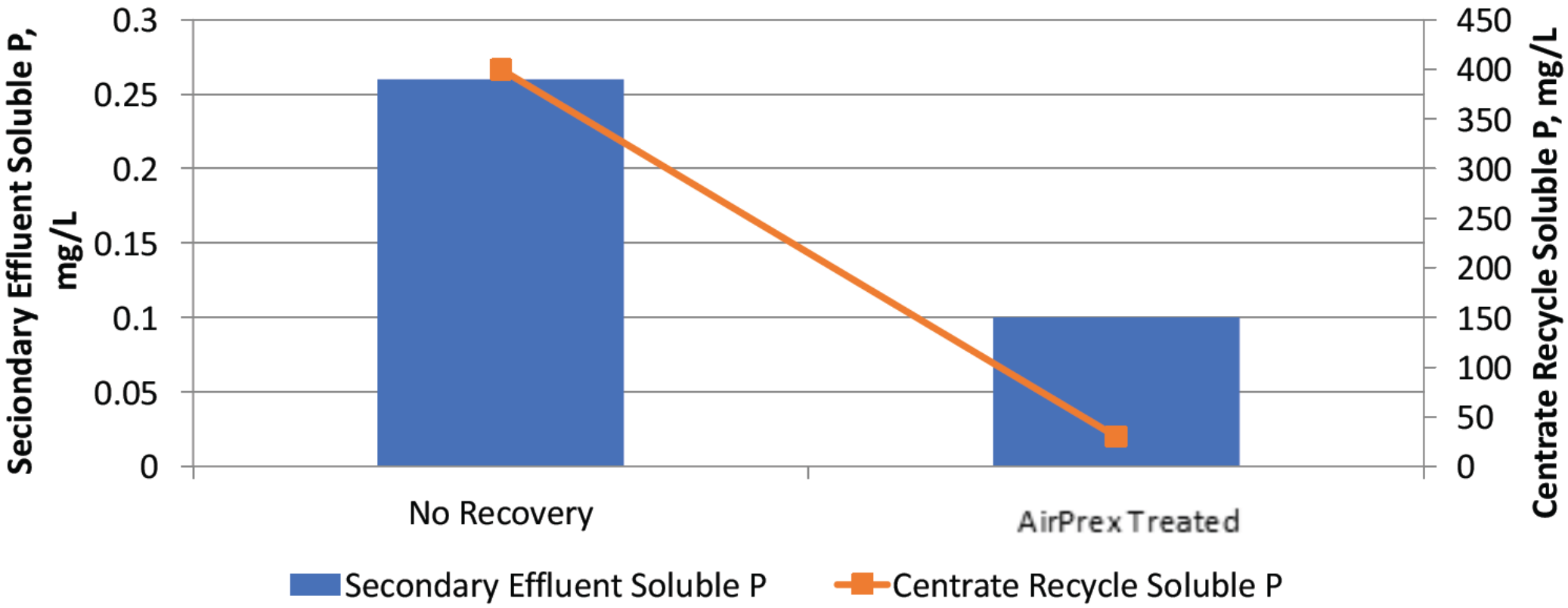
P Recycle Load Control – Centrate



- OP and TP were observed to decrease in the centrate as the Mg:P molar dosing ratio increased to 1.4:1
- At 1.7:1 Mg:P molar ratio, OP was lowest, while TP increased – potentially due to fines loss

Source: Denver Metro

P Recycle Load Control – Secondary Effluent Soluble P



- Reducing recycle soluble phosphorus concentrations from 400 mg P/L to 30 mg P/L would result in a decrease in secondary effluent OP.

Source: Denver Metro

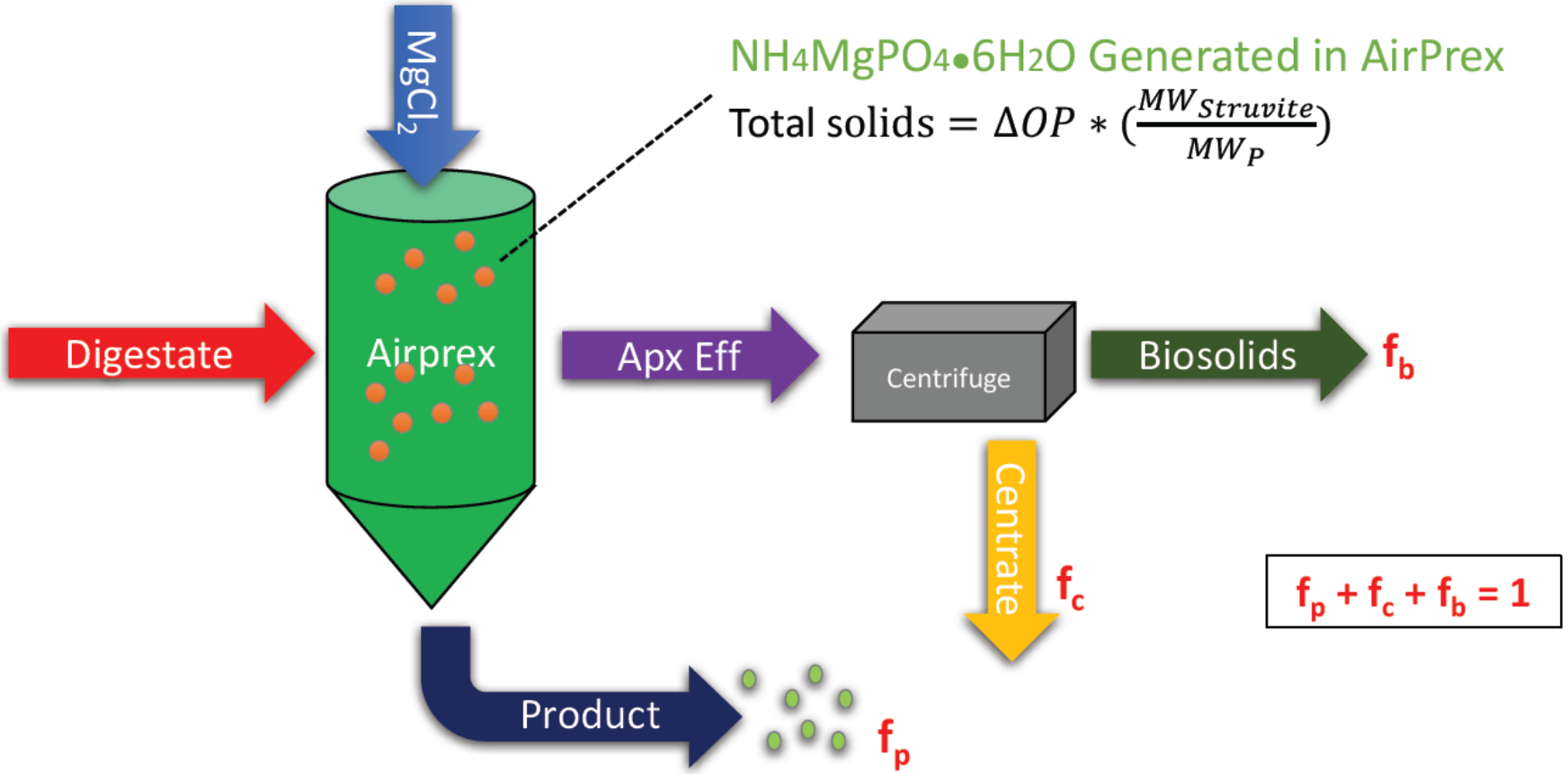
Dewberry

Dewaterability Impacts

- Cost Centers:
  - $ Polymer consumption
  - $ Wet mass of biosolids for hauling and dispersal
- Tracked cake total solids and polymer consumption
  - Polymer dose varied in 5 active pound/dry ton increments
  - Higher average centrifuge hydraulic pressures for AirPrex® treated digested biosolids

Source: Denver Metro

Solids Correction – Dry Mass



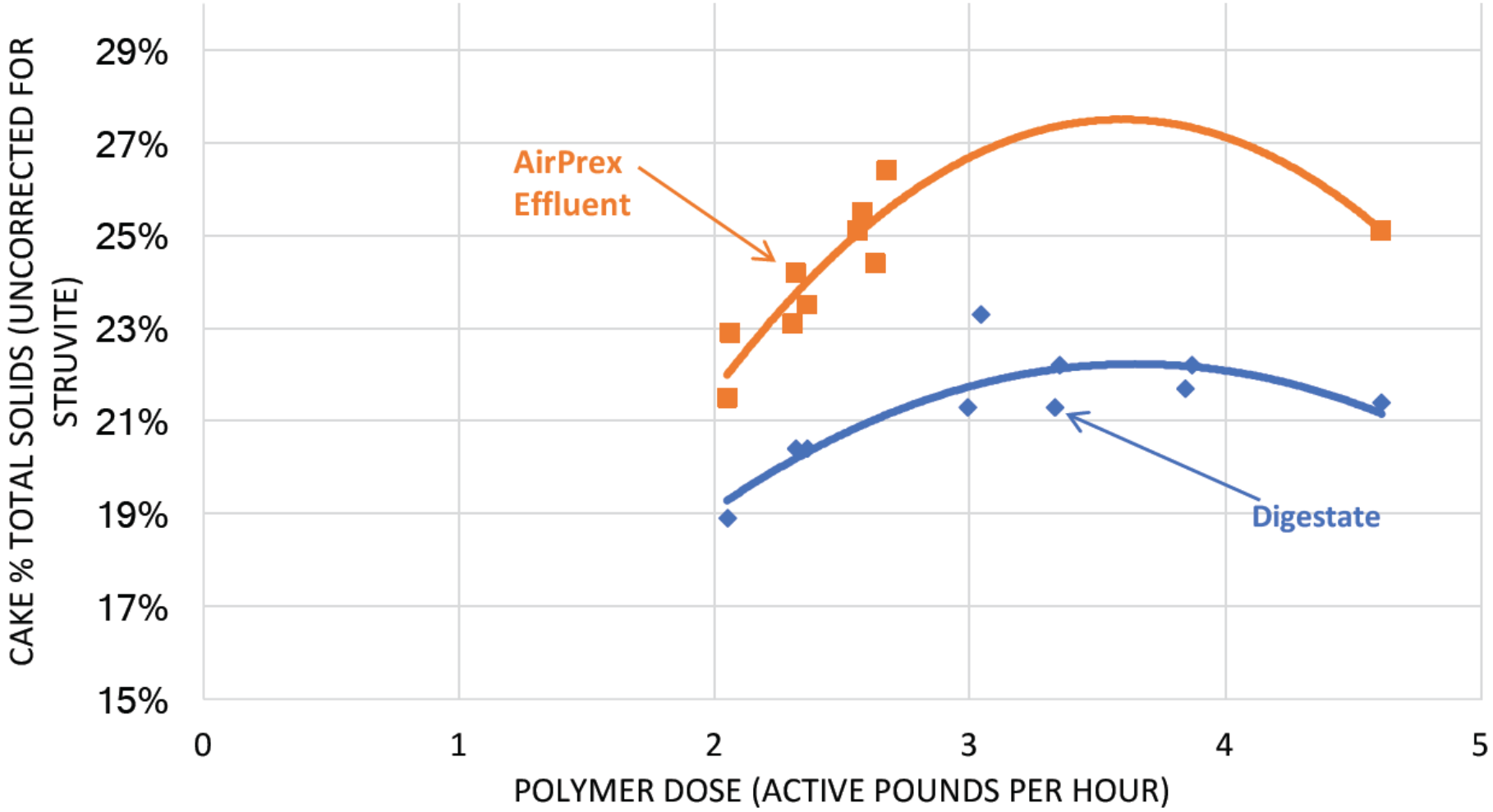
- Fraction of struvite in biosolids matrix - f_b~80%
- Fraction of struvite fines in centrate - f_c~0%
- Fraction of struvite that settles and is pumped out as product - f_p~20%

Source: Denver Metro

Dewberry

AirPrex® – Dewaterability

- 20 data points analyzed
- 8.7% reduction in wet tons hauled
- **17.6% decrease in polymer consumption**



Source: Denver Metro

Dewberry

Biosolids Dewatering Cost Impacts

- 8.7% reduction of biosolids hauled

Untreated Biosolids
21 Hauled Truckloads

After AirPrex Treatment
19 Hauled Truckloads

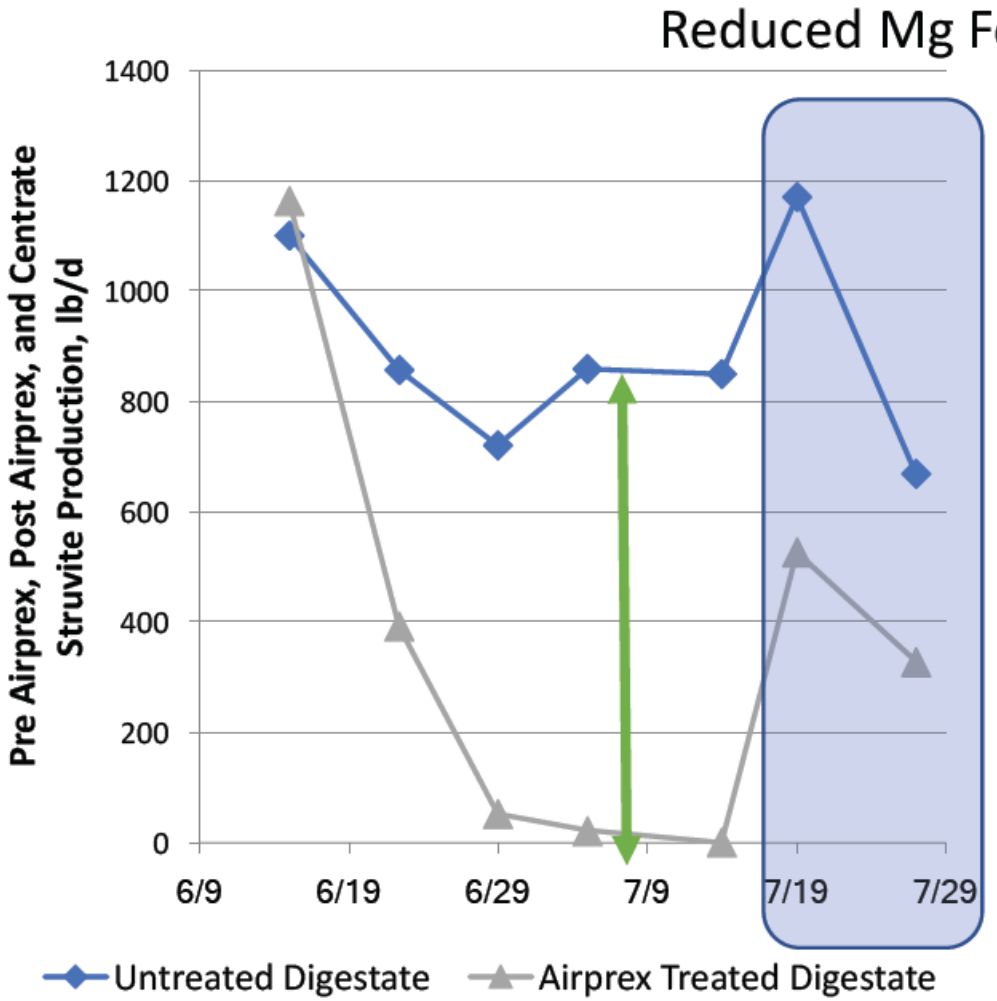
Difference of 2 truckloads per day or 730 truckloads per year!

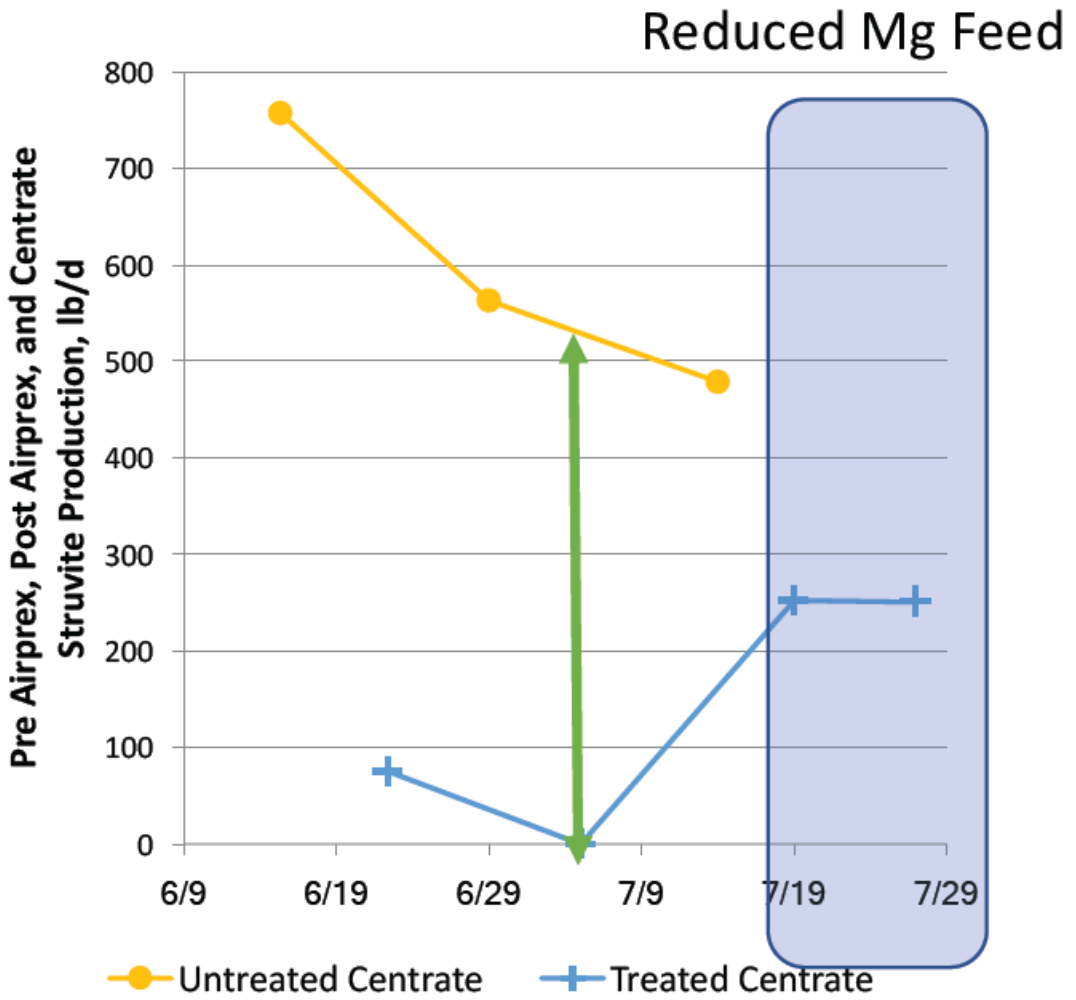
- Approximately 15–20% decrease in polymer use

Source: Denver Metro

Dewberry

Struvite Reduction Estimates





Significant reduction of struvite mass predicted between untreated and AirPrex® treated

Source: Denver Metro

Dewberry

AirPrex® Pilot Testing Results

•Phosphorus Recycle Control		↑	Reliable OP and TP Reduction
•Biosolids Dewaterability	Polymer	↑	~17% polymer reduction
	Truck Hauls	↑	~8.7% reduction hauled mass
•Struvite Reduction	Digesters	↔	~25% reduction digester struvite
	Dewatering	↑	Significant reduction in dewatering nuisance struvite
•Phosphorus Index		↔	Accumulation of phosphorus in biosolids
•Product Recovery		↔	Low recovery of product

Source: Denver Metro

Conclusion

- Testing Essential to Estimate Performance
- Questions?