

**To Everything There is a
Season: *Lessons from 3 +
Seasons of Phosphorus
Removal at Greene County
Sugarcreek WRRF***

Ohio WEA
Annual Conference
Columbus
June 16, 2010

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Outline

- Concepts and keywords
- Introducing the Sugarcreek Water Resource Reclamation Facility (WRRF)
- It's phosphorus (P) season in the ULMR watershed
- Basis of design
- 2007 – baseline P removal
- 2008 – chemical P removal
- 2009 – Enhanced Biological P Removal (EBPR)
- 2010 – EBPR 2nd season

Concepts and keywords

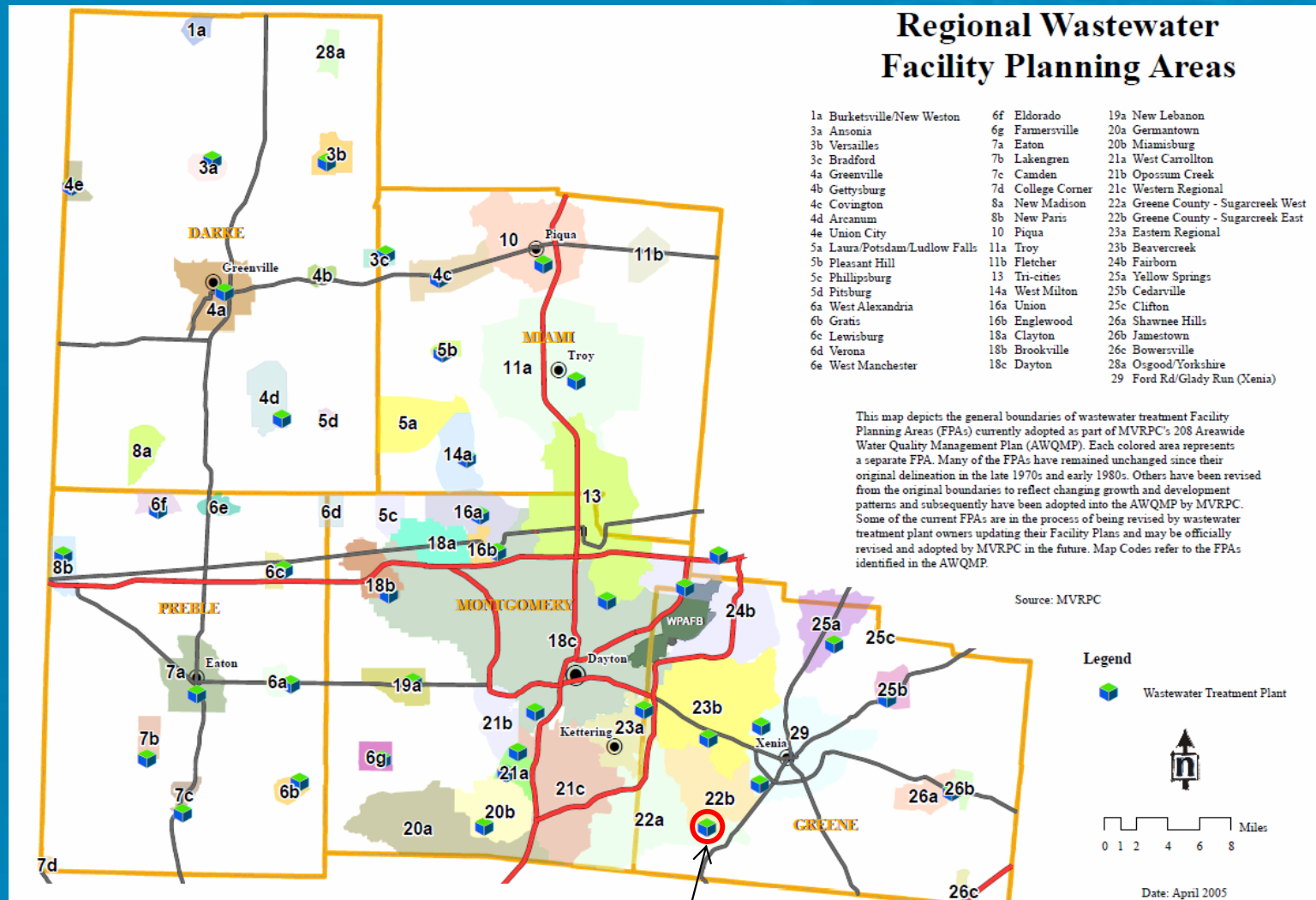
- Total Phosphorus (TP)
- Chemical precipitation
- Continuously Sequencing Reactor (CSR)
- Biological phosphorus removal

Concepts and Keywords

Enhanced Biological Phosphorus Removal

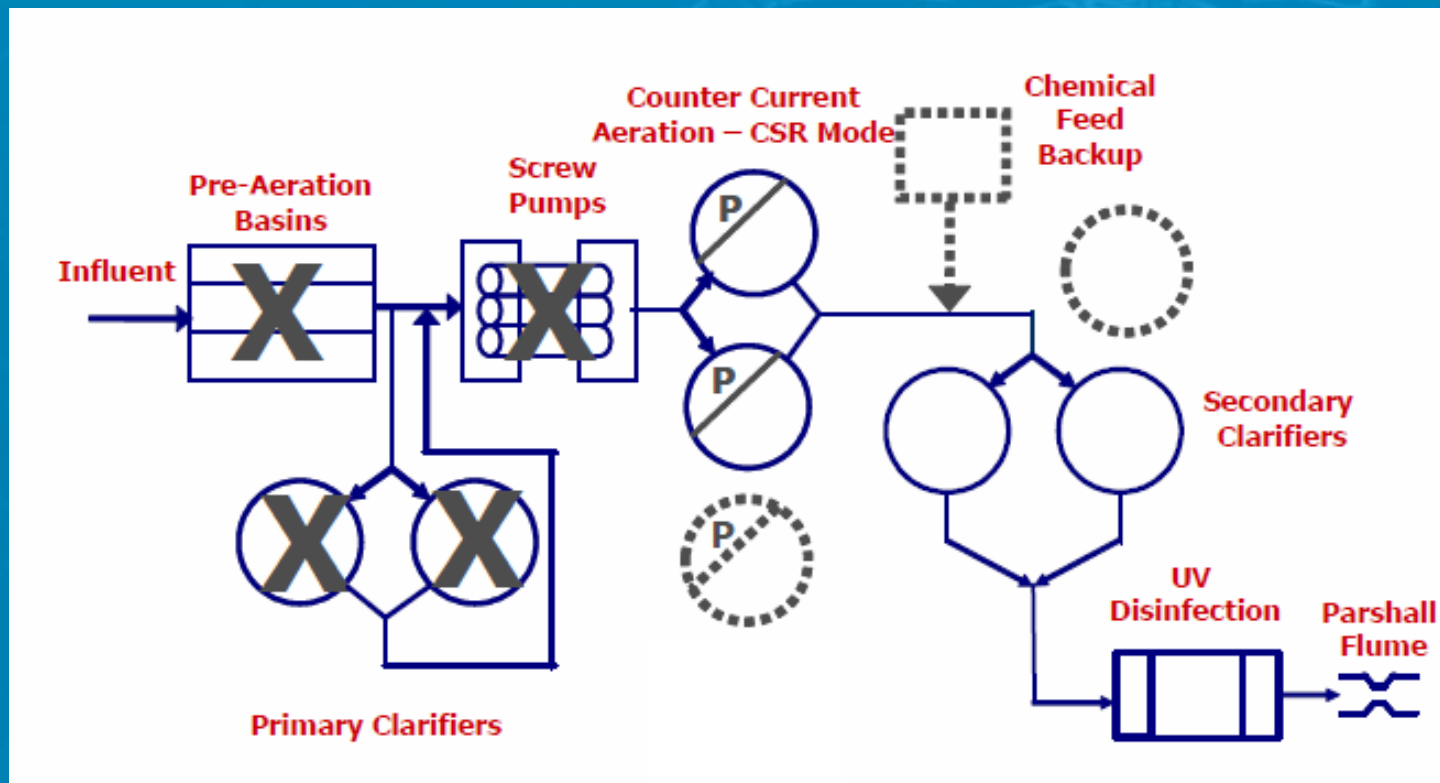
- **Polyphosphate accumulating organisms (PAO)** have the ability to store Phosphorus in excess of metabolic requirements:
 - MLVSS ~ 3 to 8% P (compared w/ 1.5 -2.0%)
- Requires cycling of oxic, anoxic, and anaerobic conditions

Introducing the Sugarcreek WRRF



Sugarcreek WRRF

SCWRRF flow sheet

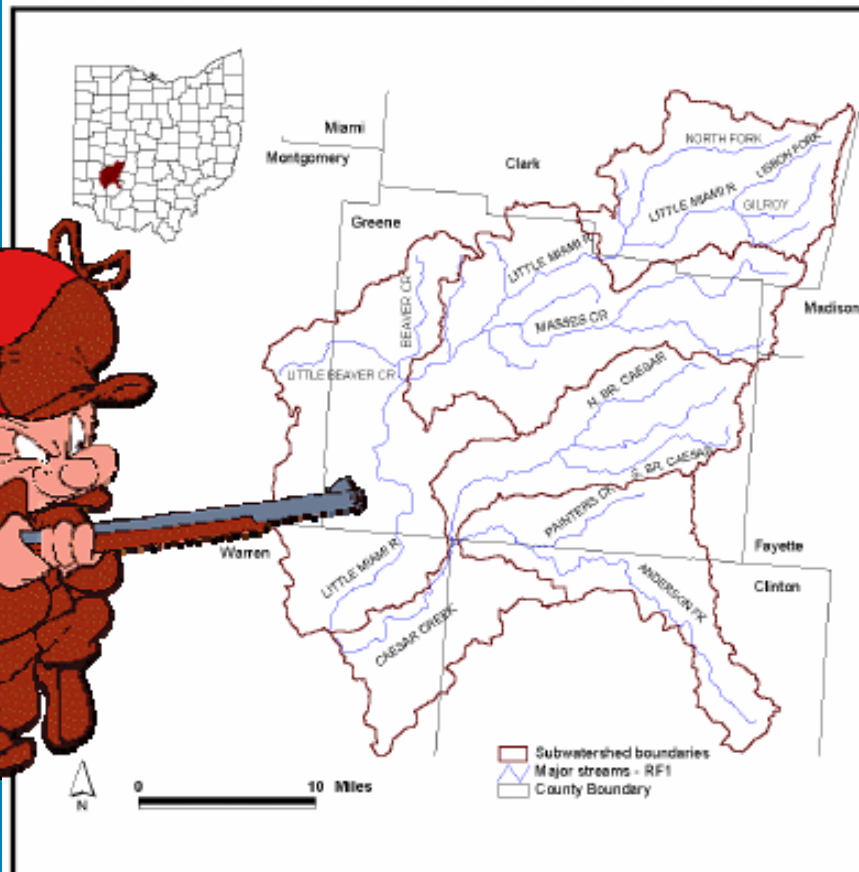


Introducing the Sugarcreek Water Resource Reclamation Facility



It's Phosphorus season – ULMR TMDL

The TMDL in Brief:



Basin:

The Little Miami River in the Ohio River Basin

Study Area:

Upper portion of the Little Miami River watershed and the Caesar Creek watershed; approximately 657 mi²

Goal:

Attainment of the appropriate Aquatic Life Use

Major Causes:

Nutrient enrichment, low dissolved oxygen, habitat alteration

Major Sources:

Agricultural and urban runoff and municipal discharges.

Measures:

Phosphorus, dissolved oxygen, biological and habitat indices

Restoration Targets:

60% reduction in phosphorus; 30% reduction in sediment; average instream D.O. of 6 mg/l; habitat indices (QHEI) >60

Restoration Options:

Agricultural and urban runoff controls, habitat protection and restoration, septic system improvements, point source controls, and public education

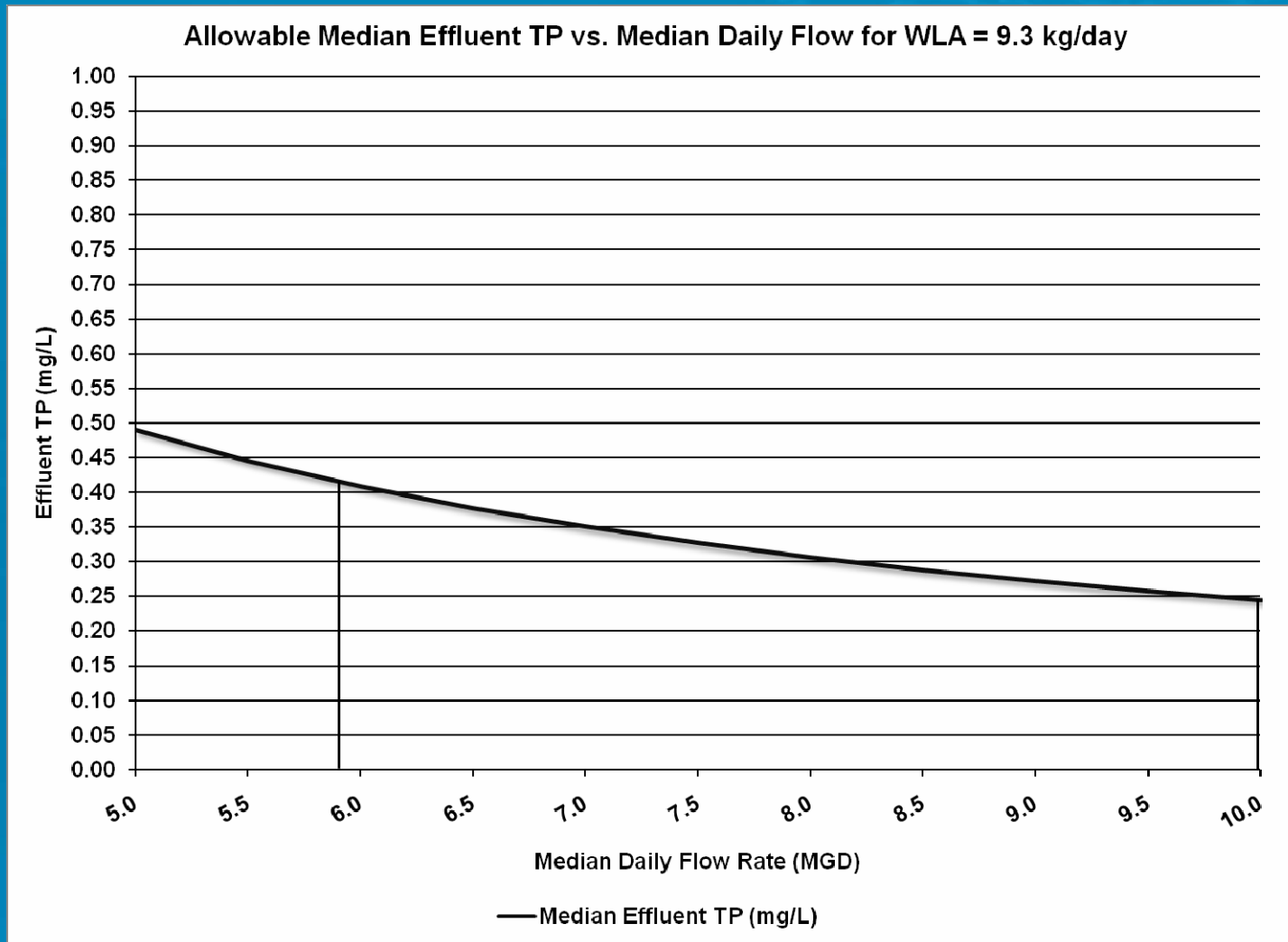
TMDL point source limits

- 2008: Basin-wide effluent TP concentration limit = 1.0 mg/l (monthly average) for NPDES dischargers;
- 2013: SCWRRF load limit based on WLA
 - Allowable Load = $(Q_{med} \times P_{med}) \times F - LR = 9.3 \text{ kg/day}$
 - Where
 - Q_{med} = 5-year median daily effluent flow rate during May - October (MGD),
 - P_{med} = median daily effluent total phosphorus concentration during May – October (mg/l),
 - LR = water quality credits accrued through participation in a water quality trading program,
 - $F = 3.7854$.

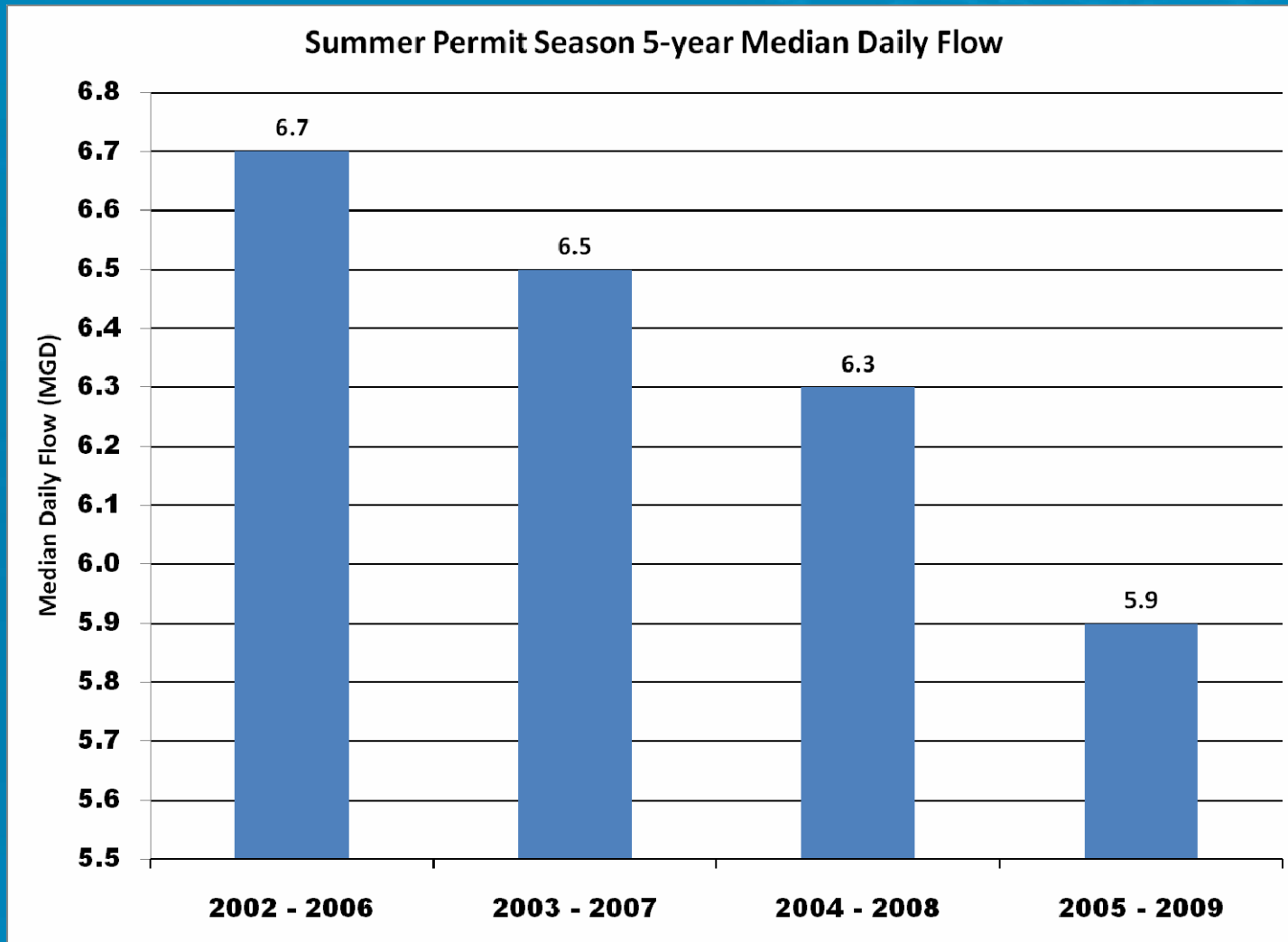
Basis of design

| Parameter | Design Average Influent | Effluent Limit |
|---------------------------|-------------------------|------------------|
| Flow (mgd) | 9.9 | |
| CBOD ₅ (mg/L) | 105 | 10 (May – Oct) |
| TKN (mg/L) | 19.2 | |
| NH ₃ -N (mg/L) | 9.6 | 1.25 (May – Oct) |
| TP (mg/L) | 3.6 | 1.0 (2008) |
| TP (kg/day) | 135 | 9.3 (2013) |

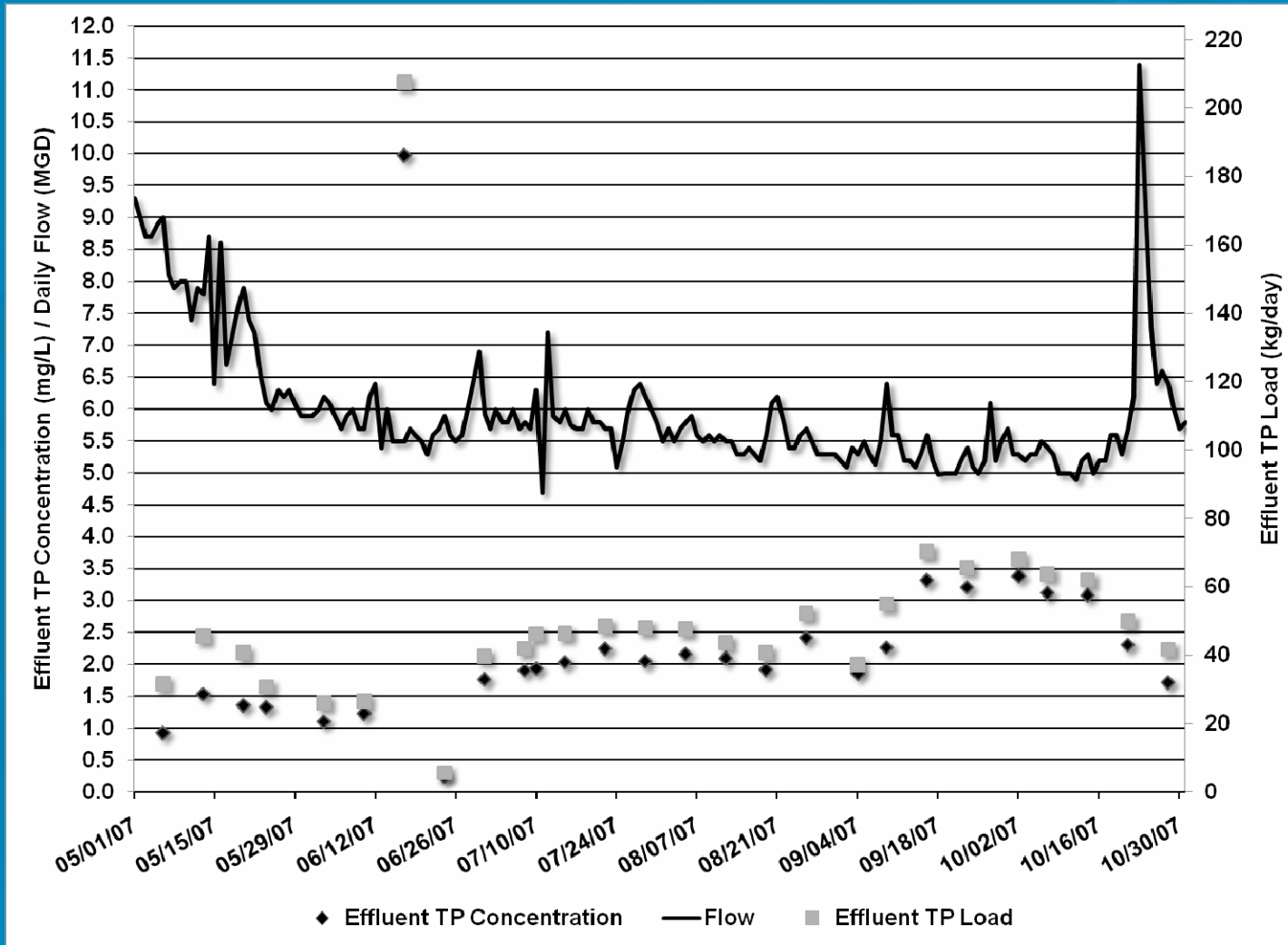
Allowable Effluent TP - SCWRRF



Median flow rate



2007 - Before TP limits



TMDL Calculation:
 $2.40 \times 6.50 \times 3.785$
 $= 59.05 \text{ kg/day}$

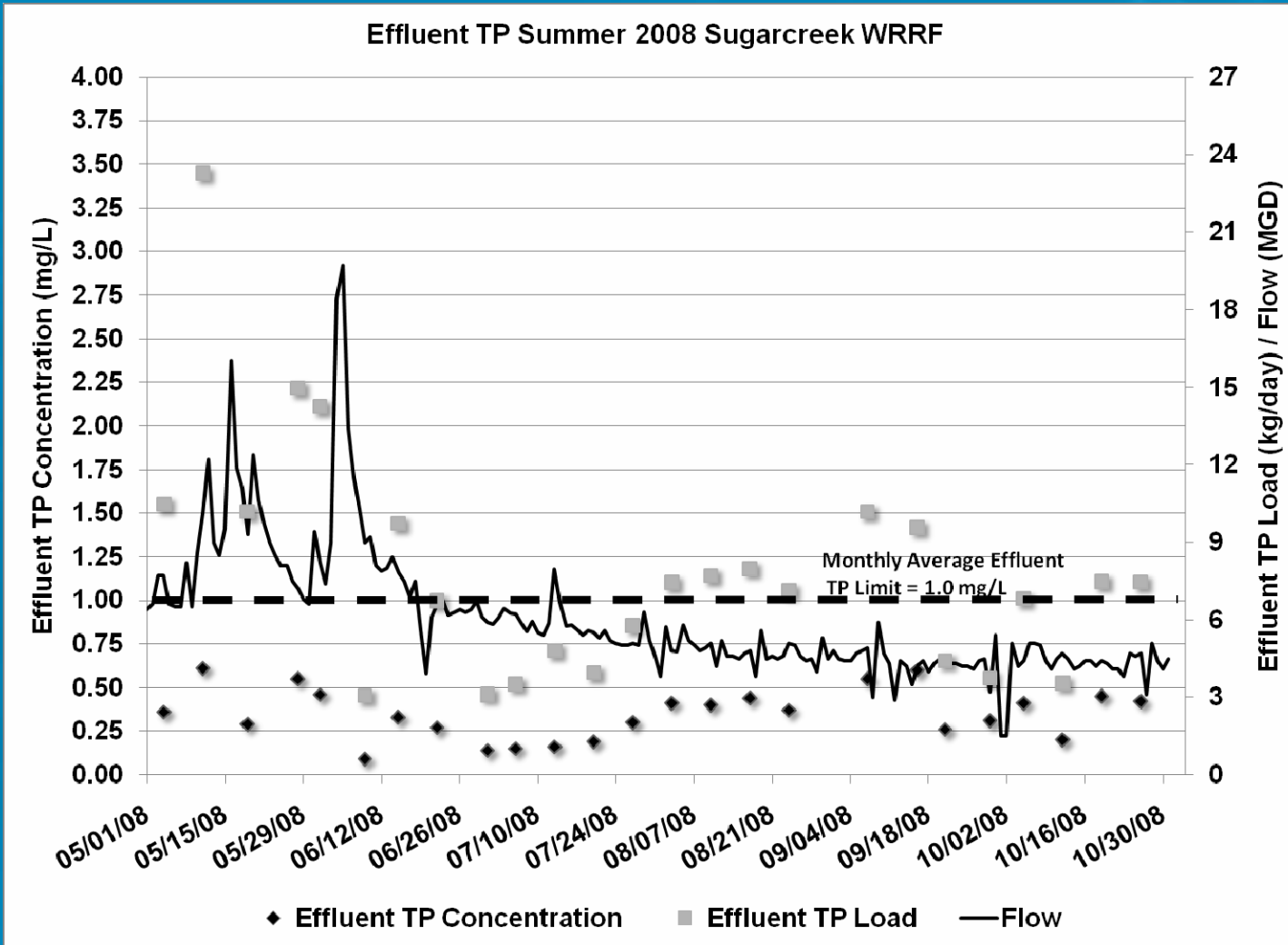
2007 season (Baseline) - no supplemental removal of TP

- Raw wastewater ~ 5.5 mg TP / L (Average)
- Final Effluent ~ 1.8 mg TP / L (Average)
 - 3.7 mg/L TP removed
 - Biological – 1.0 mg sol P / L removed
 - VSS 1.5 – 2% P
 - 100 mg/L BOD removed
 - Physical - 2.7 mg part P / L removed
 - Influent TP ~ 50% particulate

Lessons learned

- Effluent TP strongly influenced by Flow
- Supplemental P removal required to meet effluent requirements

2008 – 1.0 mg/L TP limit with chemical treatment

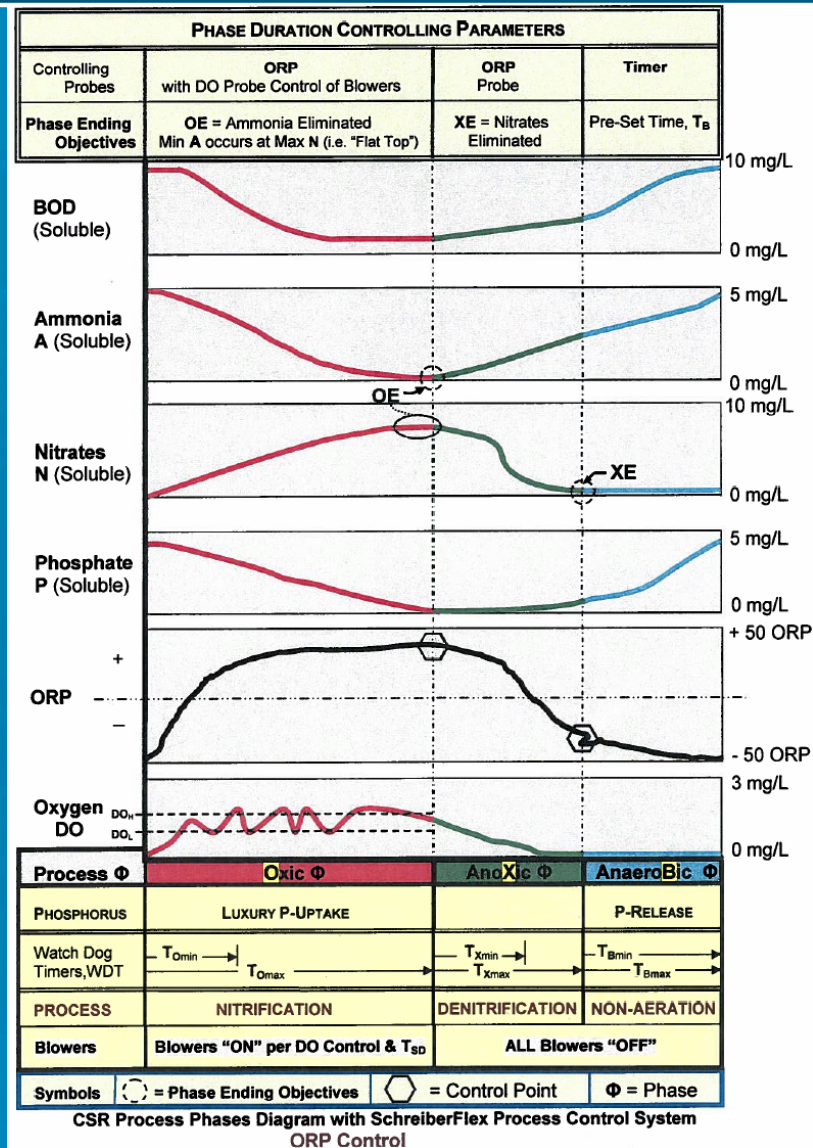


TMDL Calculation:
 $0.36 \times 6.30 \times 3.785$
 $= 8.58 \text{ kg/day}$

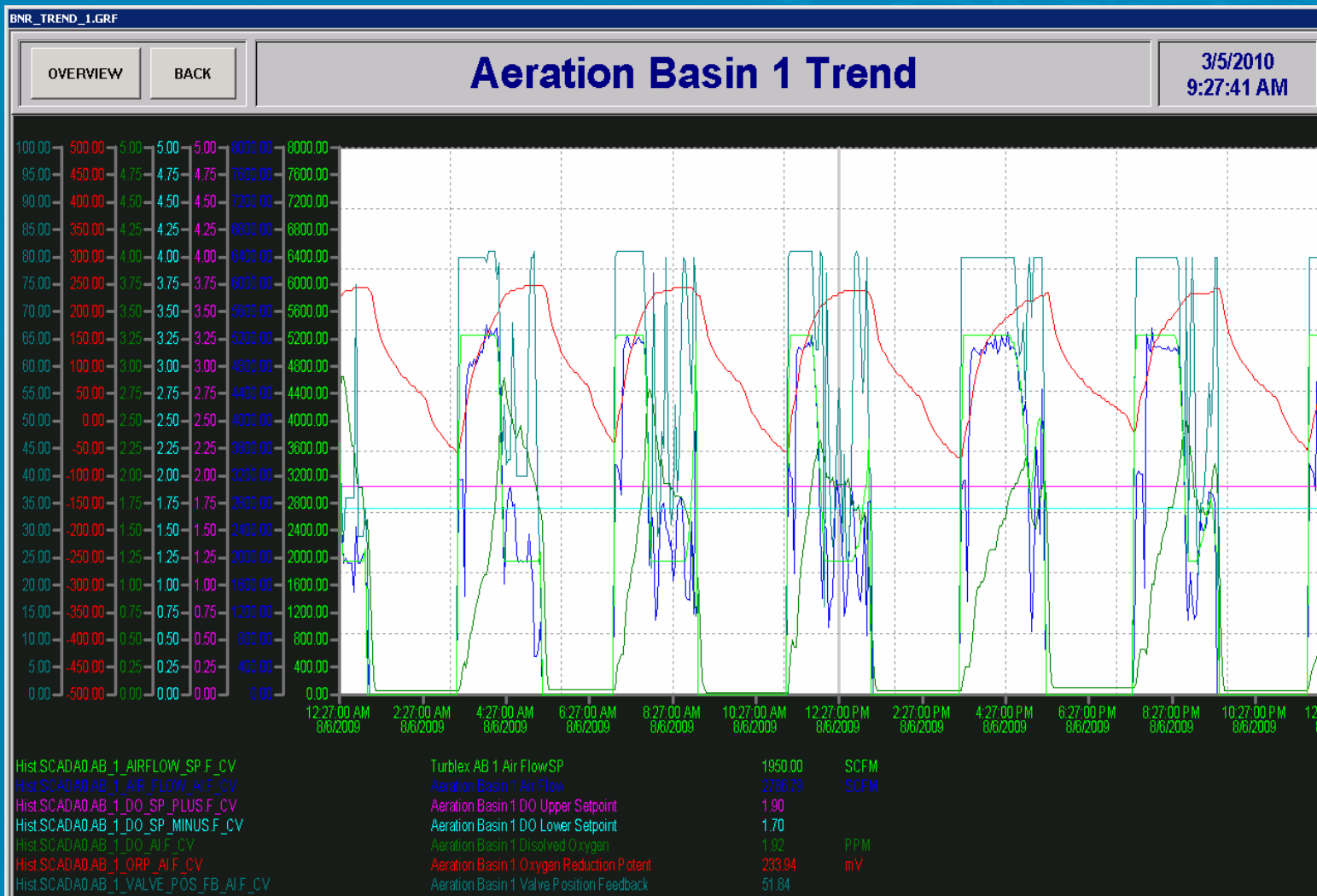
Chemical precipitation – lessons learned

- Effluent TP < 0.5 mg/L consistently
- Metering pumps at lowest setting provided more chemical than required
 - Turndown is critical particularly for growth projects that may not meet design loads for many years
 - Intermittent operation (optional)
 - Inadvertent Alum release

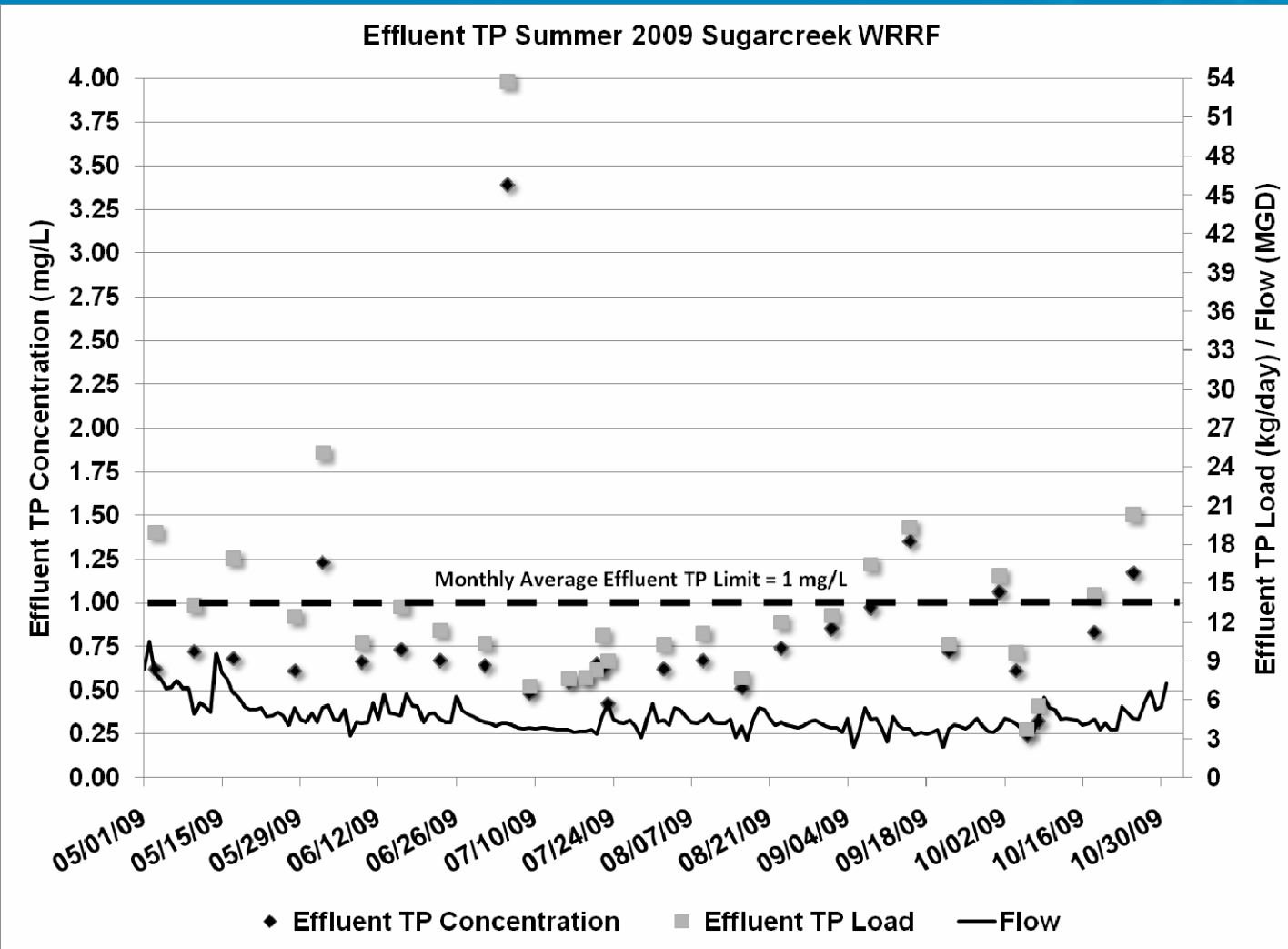
Schreiber CSR process



Sugarcreek operation



2009 – 1.0 mg/L TP Limit with EBPR

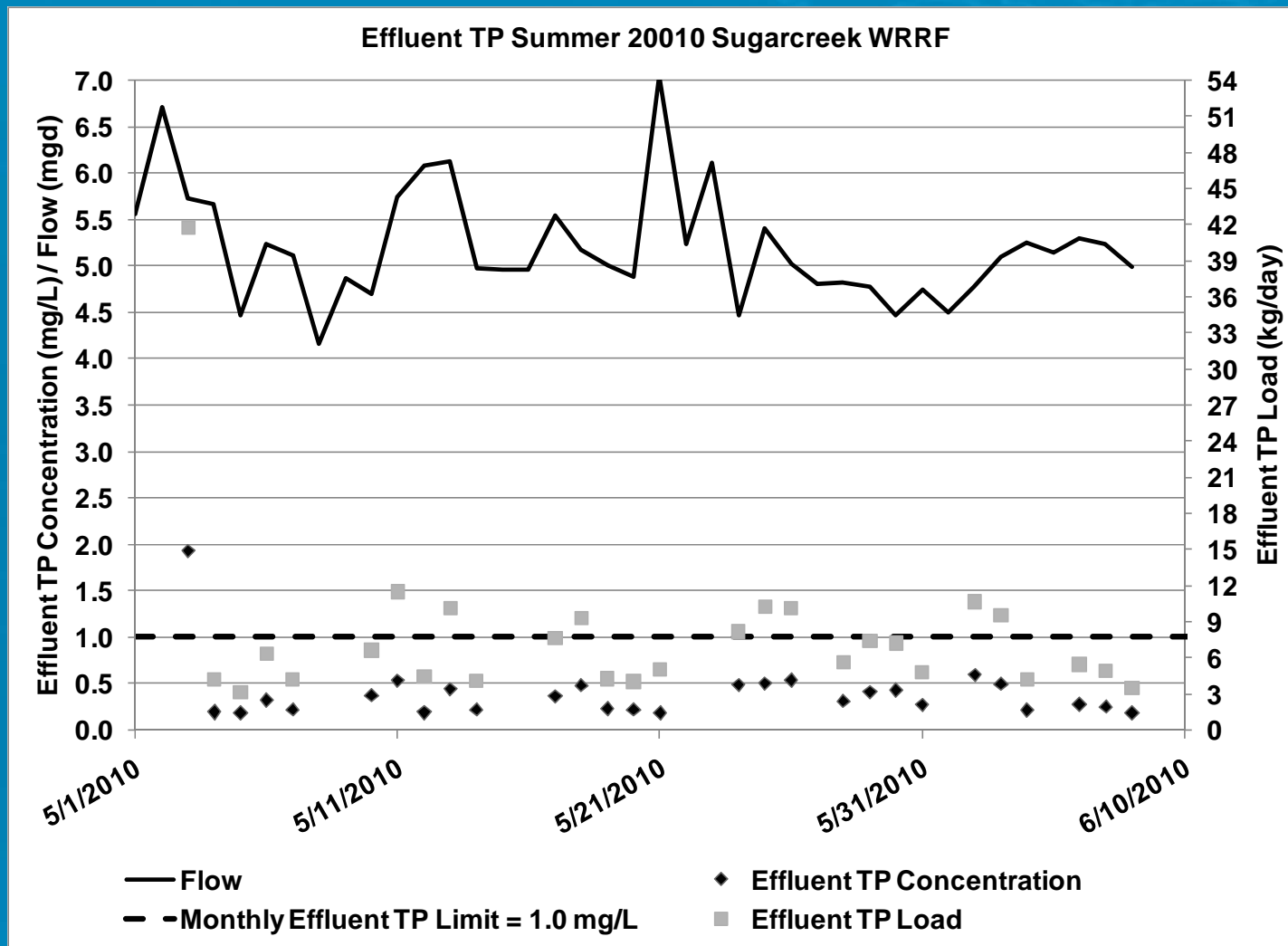


TMDL Calculation:
 $0.66 \times 5.90 \times 3.785$
 $= 14.74 \text{ kg/day}$

EBPR – lessons learned

- Effluent TP > 0.5 mg/L consistently
 - Some soluble P lost during anaerobic stage
 - Supplemental alum required.
- Schreiber CSR + Turblex = robust control system
 - Oxidic-anoxic-anaerobic
 - D.O. setpoint – High-low vs. deadband
 - Rotating aeration bridge
 - Data conditioning
 - Multiple basins functioning independently
 - Blower control – not instantaneous
 - Response time
 - Valve position
- Higher F:M

2010 – Lessons Learned?



Acknowledgements

- Larry Goble, Sugarcreek Operations Supervisor
- Shawn Hollon, Wastewater Superintendent
- Schreiber
- Turblex

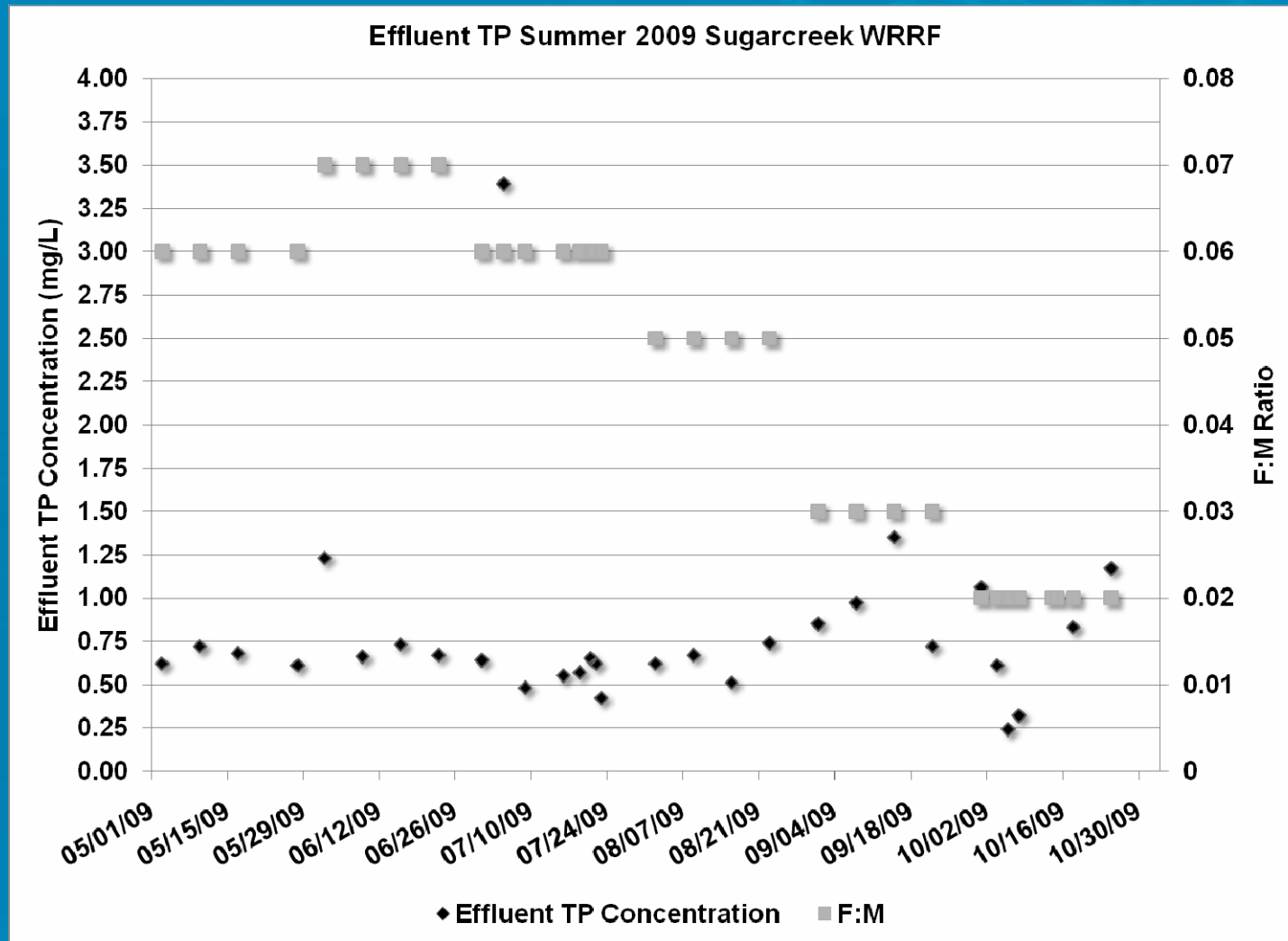
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Effluent TP and F:M 2009



BACK-UP SLIDES

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EBPR – The primary means of effluent TP compliance

Minimum Requirements:

- Anaerobic - Aerobic Cycling
- Readily degradable organic carbon (BOD)
- Excess Phosphorus

Contributing Factors:

- Wastewater characteristics
- Anaerobic zone integrity
- Aeration rate and duration
- Final clarifier solids capture
- Secondary release and recycle

Chemical precipitation – equilibrium model

- Conversion of soluble P to insoluble P.
- Al and Fe coagulants are typically used.

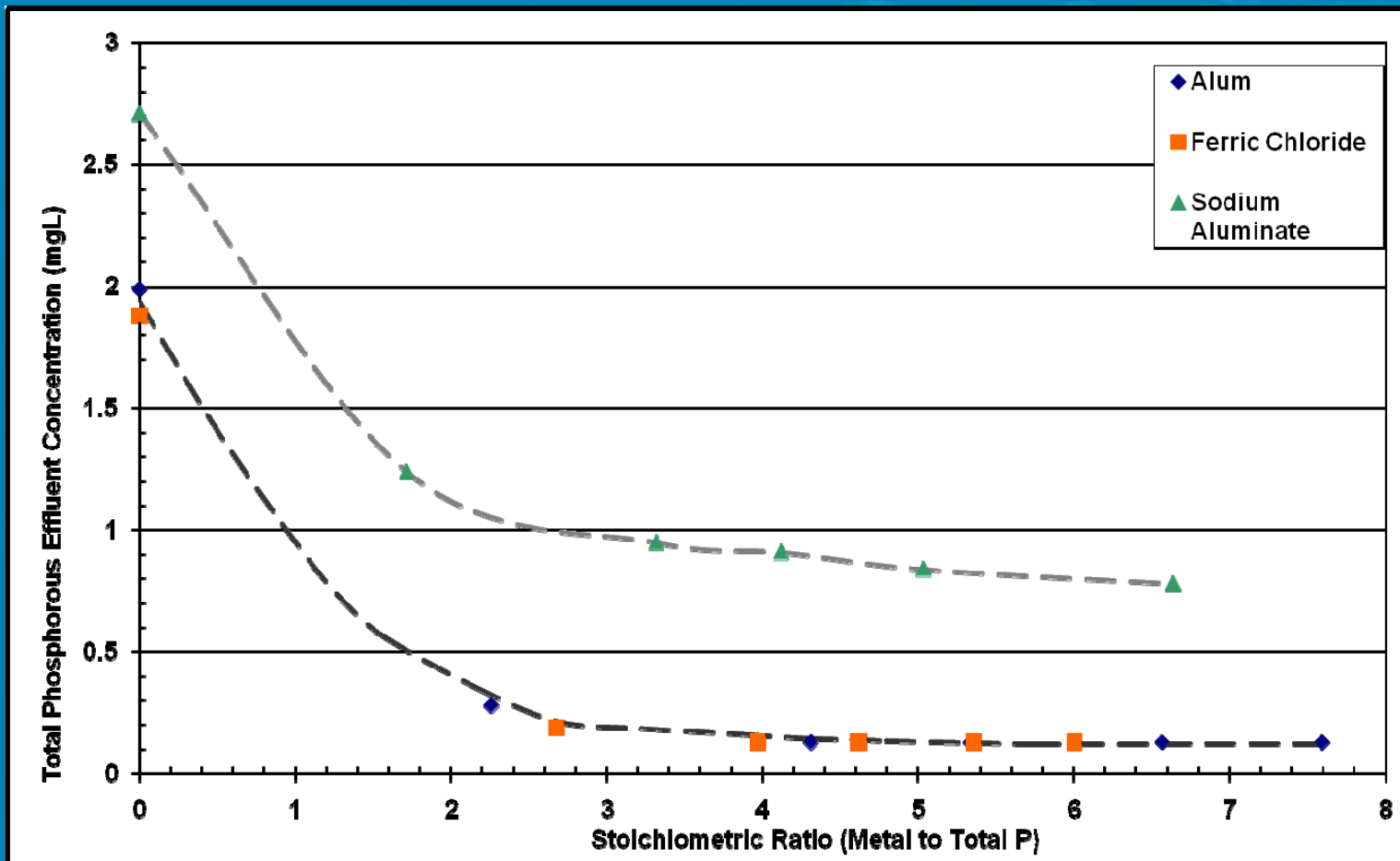


- Reaction is with soluble P ($\text{PO}_4\text{-P}$)
- 2 moles Al : 2 moles P
 - 0.87 mg Al : mg P
 - 10 mg Alum : mg P



- 0.5 mg alkalinity consumed / mg Alum
- 0.3 – 0.5 mg chemical solids / mg Alum

Chemical treatment design: jar testing

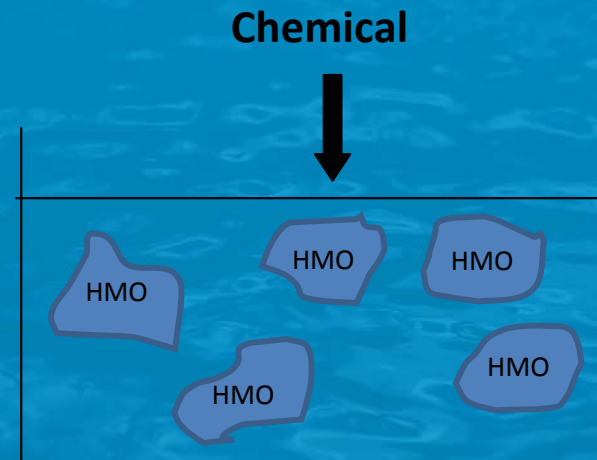


Chemical Treatment Design

| | 2009 | 2025 |
|--|--------------|---------------|
| Average Wastewater Flow (MGD) | 6.0 | 9.9 |
| Target Effluent Total Phosphorus (mg/L) | 1.0 | 0.25 |
| Average Phosphorus Removal (mg/L) | 1.6 | 2.3 |
| Average Phosphorus Removal (lbs./day) | 79 | 190 |
| Maximum Chemical Demand (gal/day) | 139 | 1,292 |
| Chemical Storage Required (gal) | 7,500 | 38,750 |
| Average Chemical Sludge Production (lbs./day) | 312 | 2,103 |

Surface complexation model

Hydrous Metal Oxide
Precipitation



Soluble P Adsorption &
Co-Precipitation

