



**16th Annual  
Central States Water Environment Association  
Education Seminar  
Emerging Activated Sludge Technologies  
and Operational Strategies**

**Monona Terrace Convention Center  
Madison, Wisconsin**

**Ken Rutt, City and County  
of Broomfield, Colorado  
April 5, 2011**

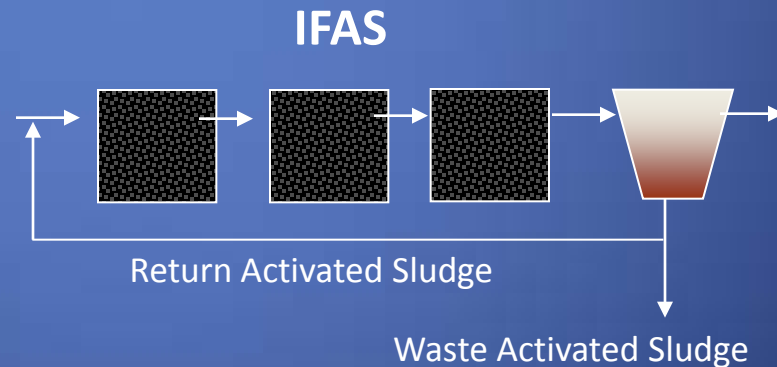
# Co-Authors and Contributors

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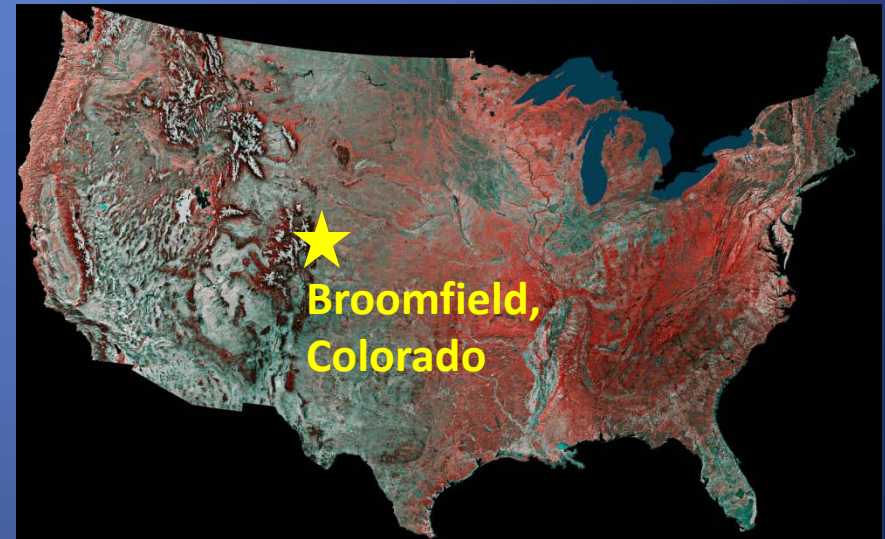
# Outline

- Broomfield WRF (IFAS)
  - Process Selection
  - Operational Considerations
  - Performance Data
  - What's next
  - Conclusions



# Broomfield Wastewater Reclamation Facility

- First IFAS facility in North America to utilize buoyant plastic media
- Phase 1 came online in 2003 (8 mgd)
- Phase 2 came online in 2010 (12 mgd)
- Did we change anything between the Phase 1 and Phase 2 designs?
  - Media fill?
  - Zone sizes?
  - Aeration?



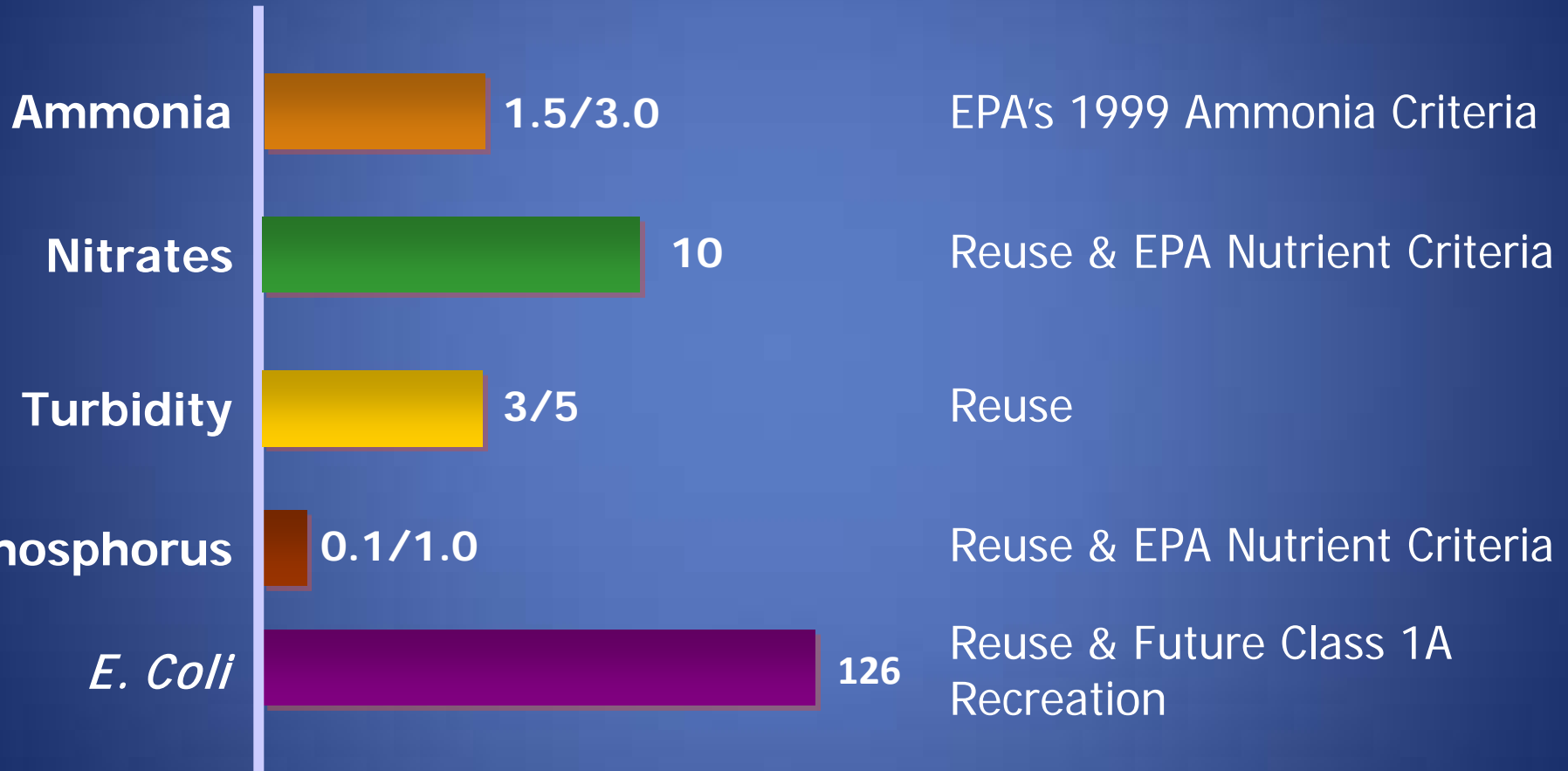


# Broomfield Process Selection

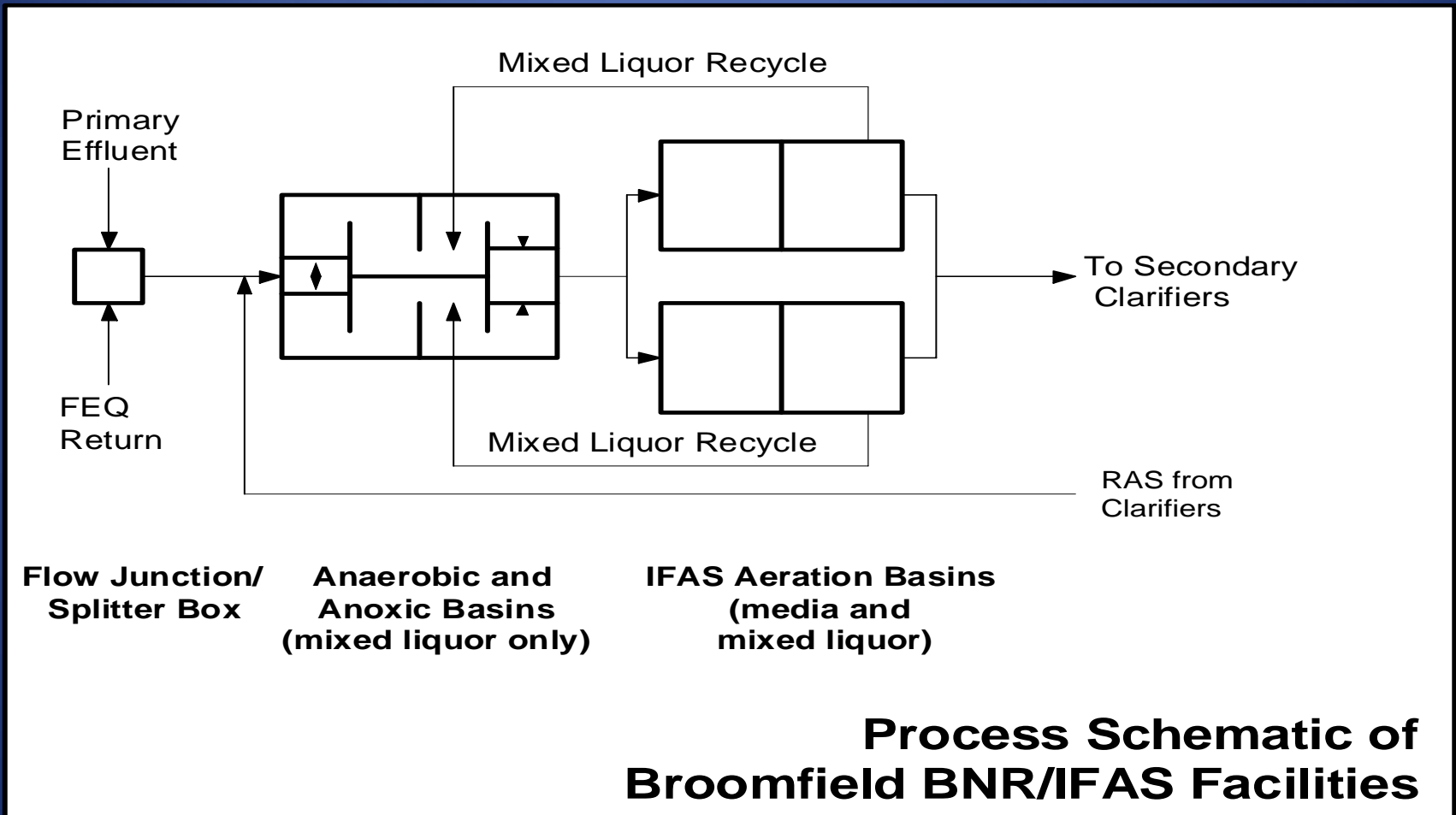
- Enhance and expand nitrification capacity with a “hybrid” approach.
- Incorporate pre-denitrification to (a) reduce nitrates, (b) lower BOD load to IFAS basins, and (3) improve process stability.
- Incorporate Bio-P, chemical feed, and polishing filters to reduce potential for excessive algae in reuse water reservoirs.
- Site constraints...need media to reduce the size of new aeration basins.

# Broomfield Effluent Objectives

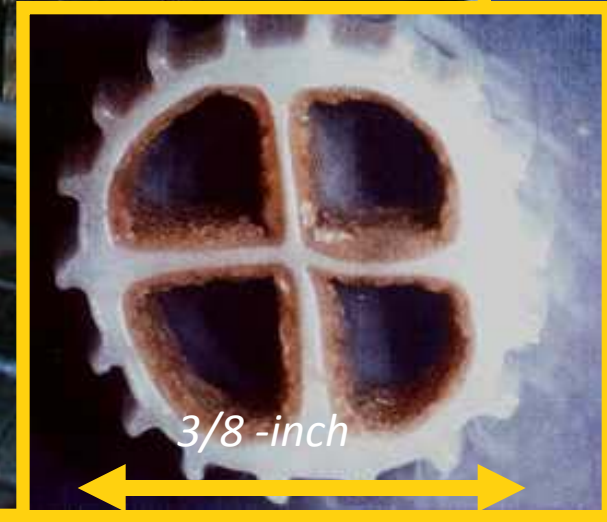
## Basic Secondary Treatment Standards Plus:



# Broomfield Process Selection



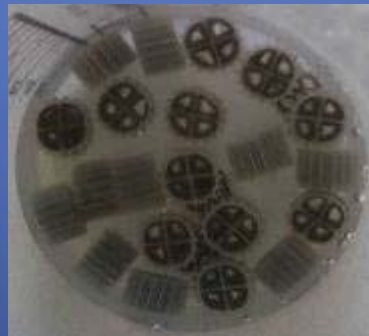
# Broomfield Phase 1 Construction





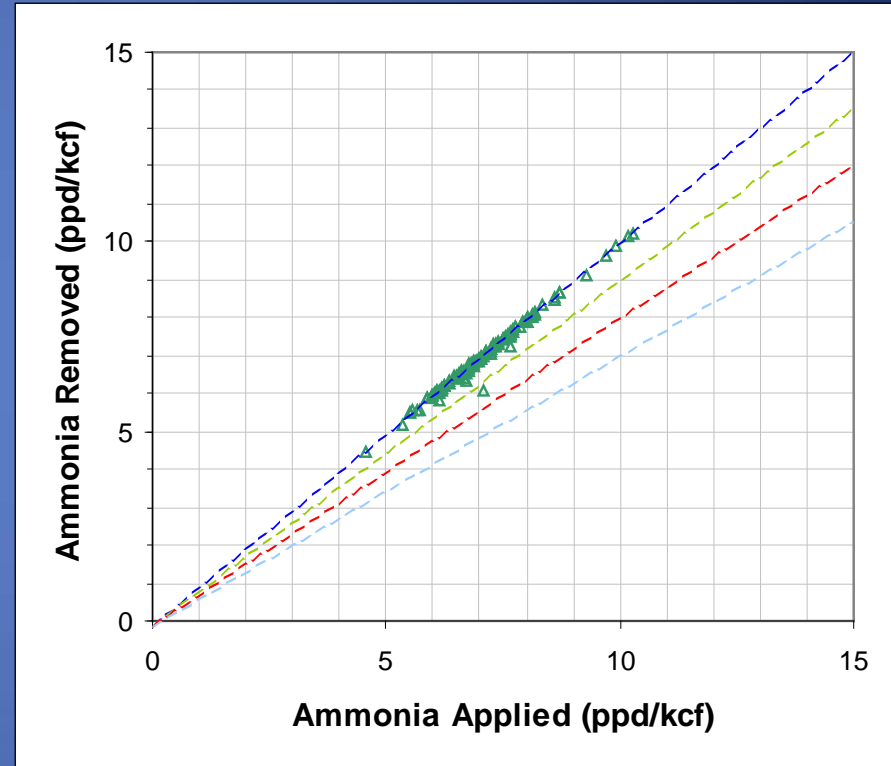
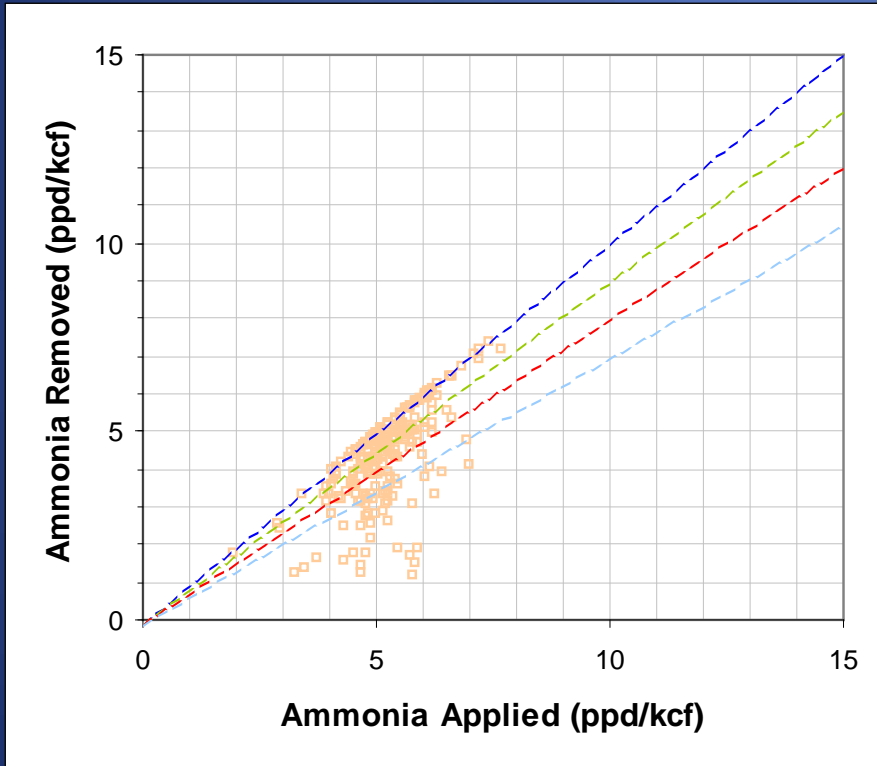
# Broomfield Phase 1 Process Control

- Operators control the process with the same parameters as conventional activated sludge:
  - RAS flowrate
  - WAS flowrate (solids retention time)
  - DO (min of 4.0 DO concentration)
  - Internal mixed liquor recycle rate
  - SVI
- One additional analysis: attached biomass



1. Collect 20-30 pieces
2. Dry and weigh
3. Remove biomass by heating in dilute bleach solution
4. Dry and weigh again

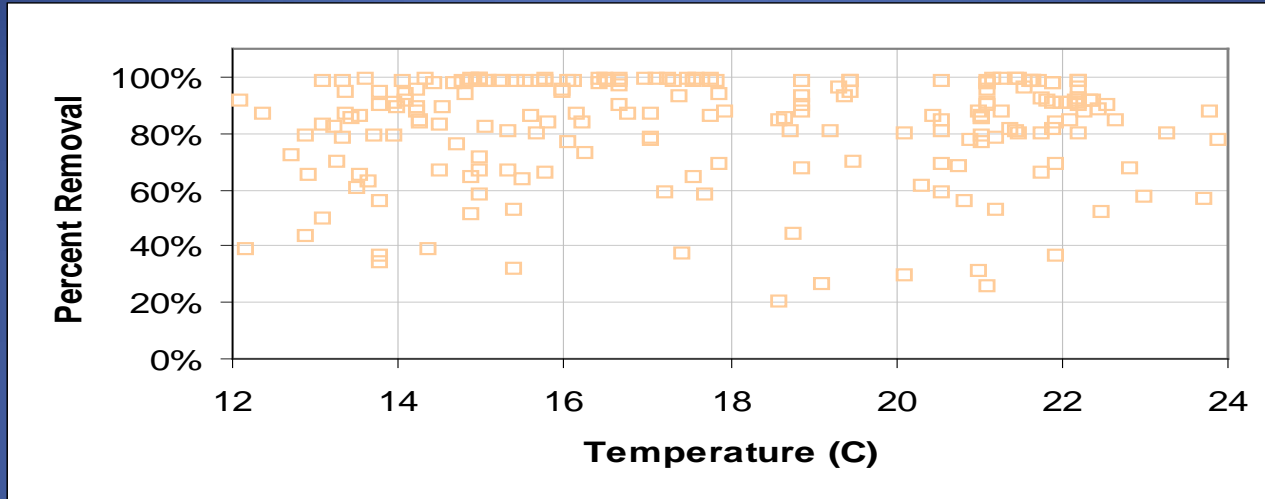
# Ammonia Removal - Before IFAS & with IFAS After



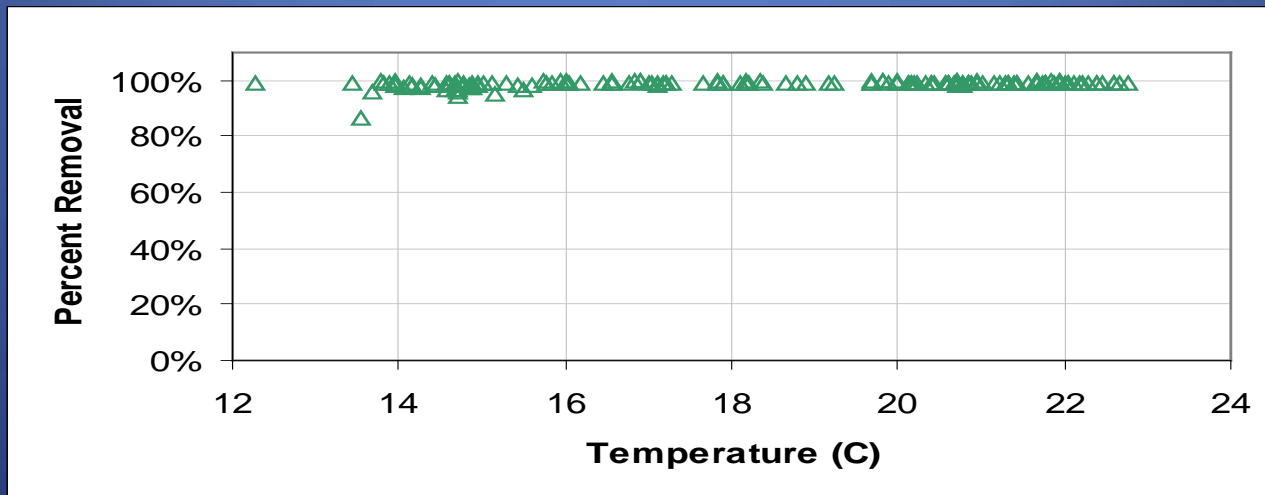
AS-Only (left) and IFAS (right)

# Ammonia Removal Performance Paired with Mixed Liquor Temperature

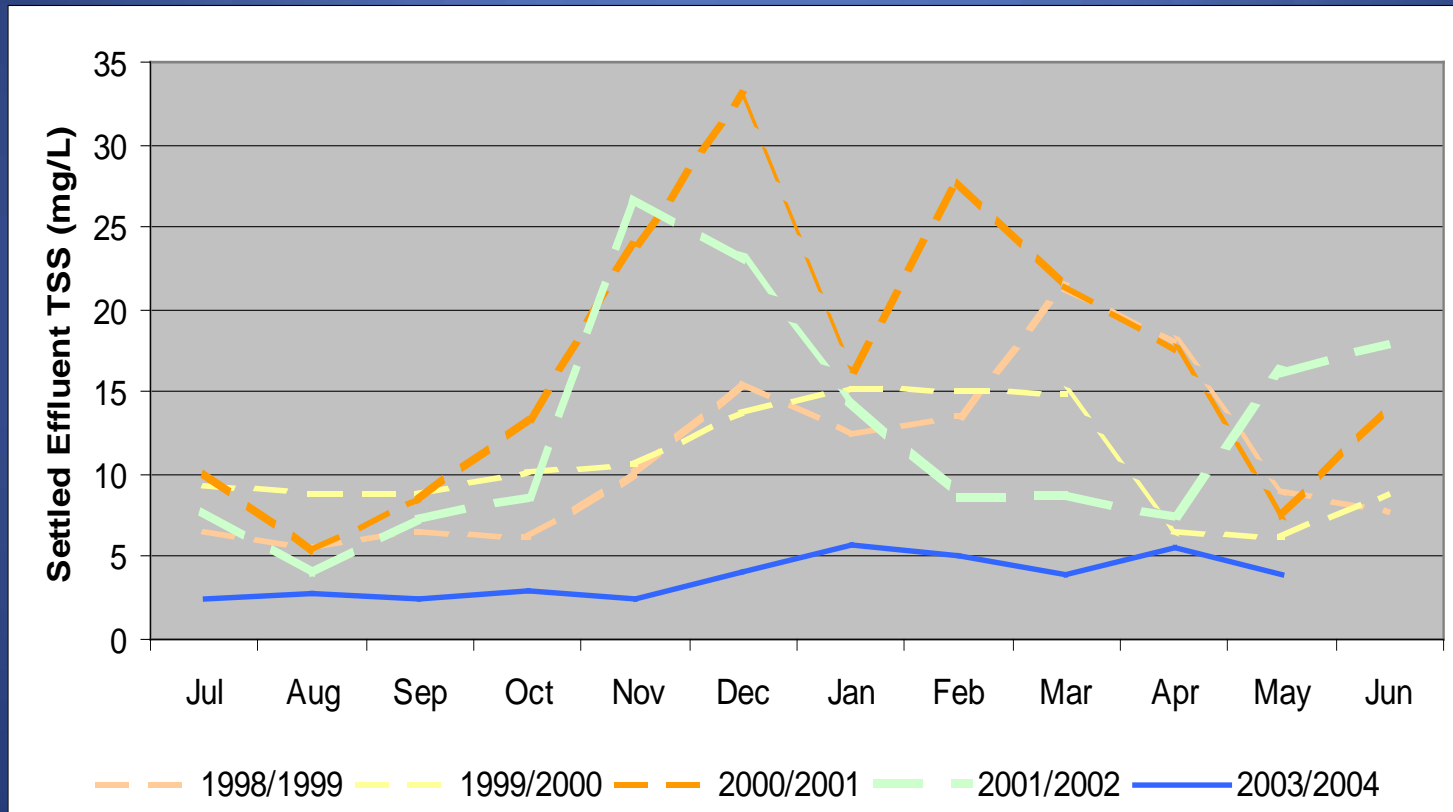
AS



IFAS



# Comparison of Monthly Average Effluent TSS





# Broomfield Model Calibration

December 2006 Calibration	BioWin Results	Plant Data
<b>IFAS Process</b>		
MLSS, mg/l	1673	1633
MLVSS, mg/l	1028	1334
DO (First Cell), mg/l	4.2	4.2
DO (Second Cell) mg/l	5.6	5.6
MLSS SRT (Oxic), days	3.3	3.3
Fixed Biomass (Cell 1), g/m2	12.4	13.7
Fixed Biomass (Cell 2), g/m2	12.6	7.4
WAS TS, lb/day	4739	4800
<b>Secondary Effluent</b>		
BOD, mg/l	2.6	1.7
TSS, mg/l	4.5	4.5
TKN, mg/l	2.6	-
NH3,N, mg/l	0.4	0.45
NO3N, mg/l	14.9	14.4
TP, mg/l	1	-
PO4P, mg/l	0.6	0.6

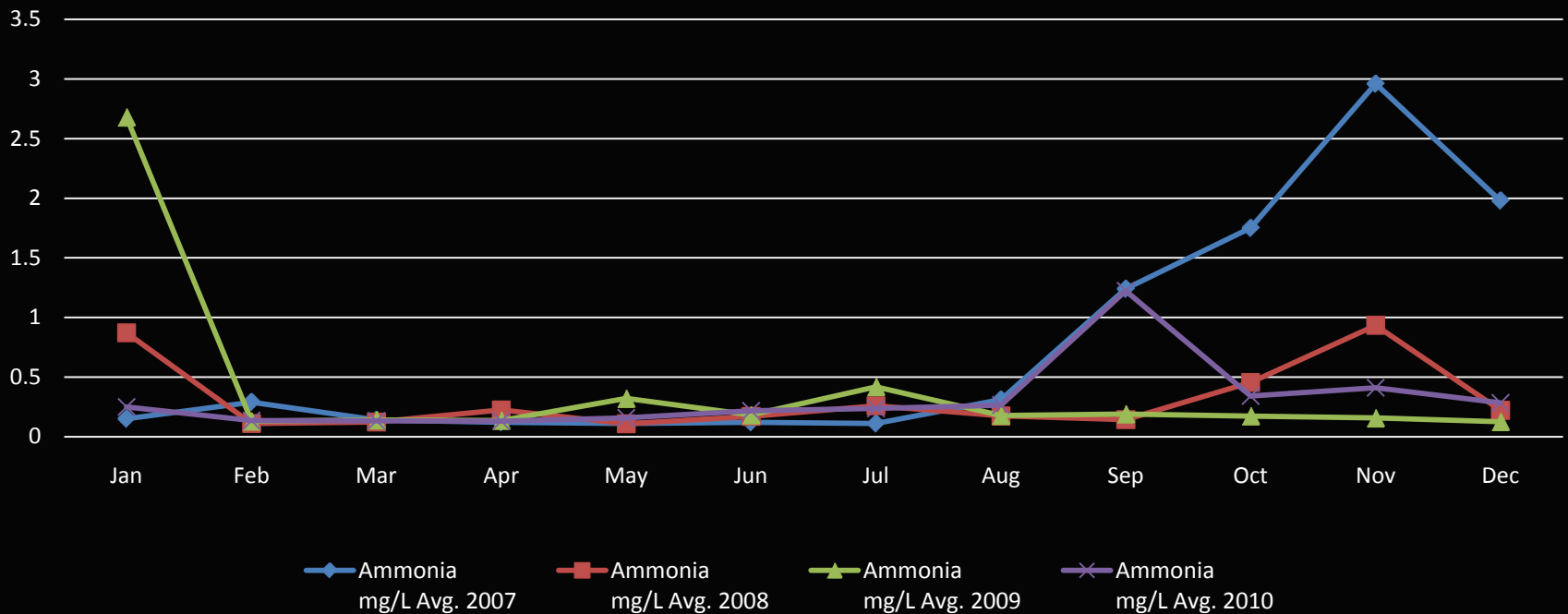


# Did We Change Anything in the Phase 2 Design?

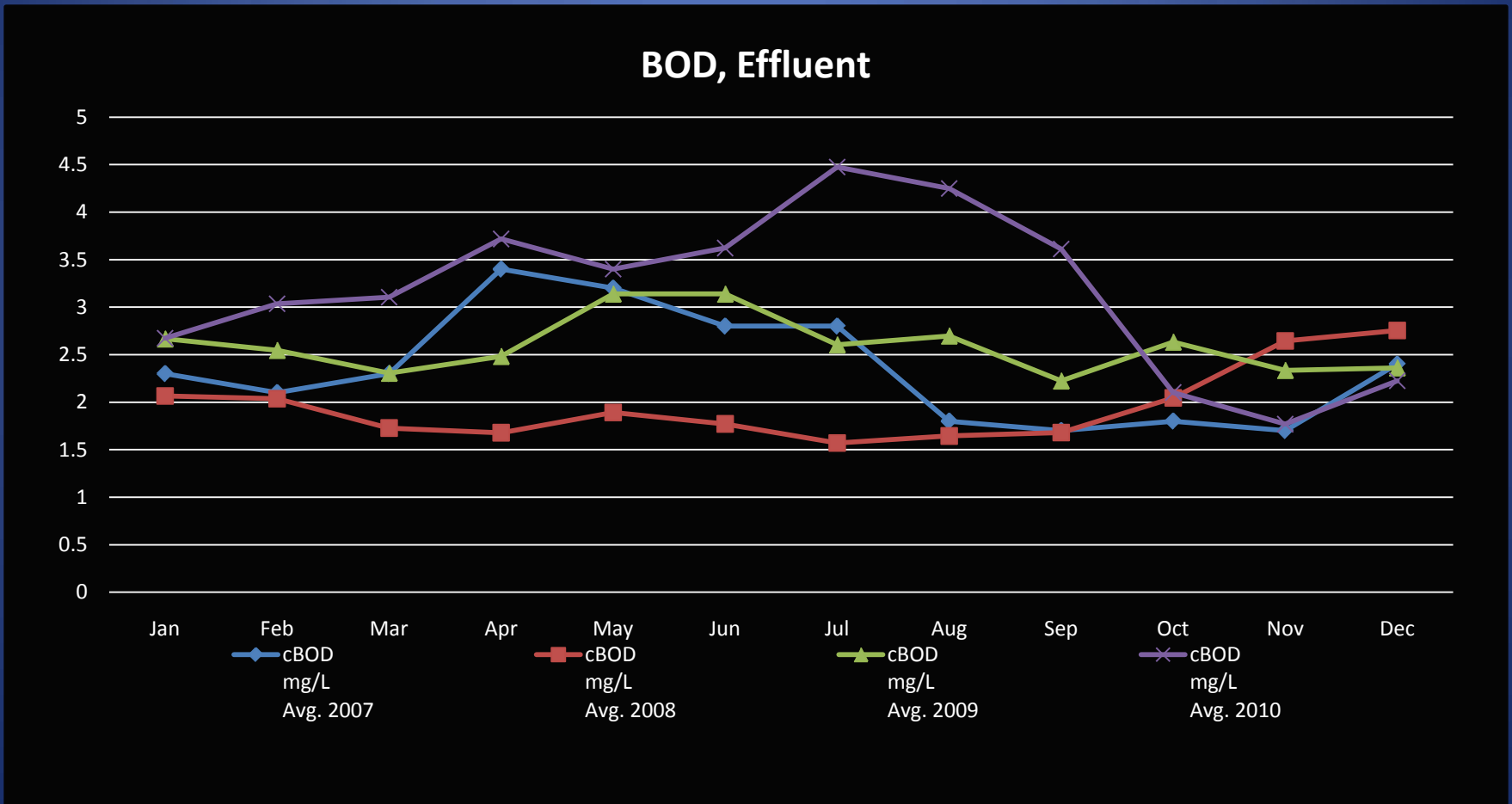
- ✓ **Updated Flow and Load Projections**
- BNR Basins
  - ✓ Pre-anoxic HRT = 24 min (at MM flow)
  - ✓ Anaerobic HRT = 45 min (at MM flow)
  - ✓ Anoxic HRT = 90 min total (at MM flow); two in series
  - ✓ Mixed liquor recycle = 350% of MM flow
- IFAS Basins
  - ✓ Oxidic HRT = 3.7 hours total (at MM flow); two in series
  - ✓ 10 day total SRT
    - ➔ **30% media fill fraction (decrease from 48%)**
    - ➔ **Two new multi-stage centrifugal blowers (decrease from 3)**
- Two new 80-foot clarifiers

# Effluent Ammonia 2007 - 2010

## Ammonia, Effluent



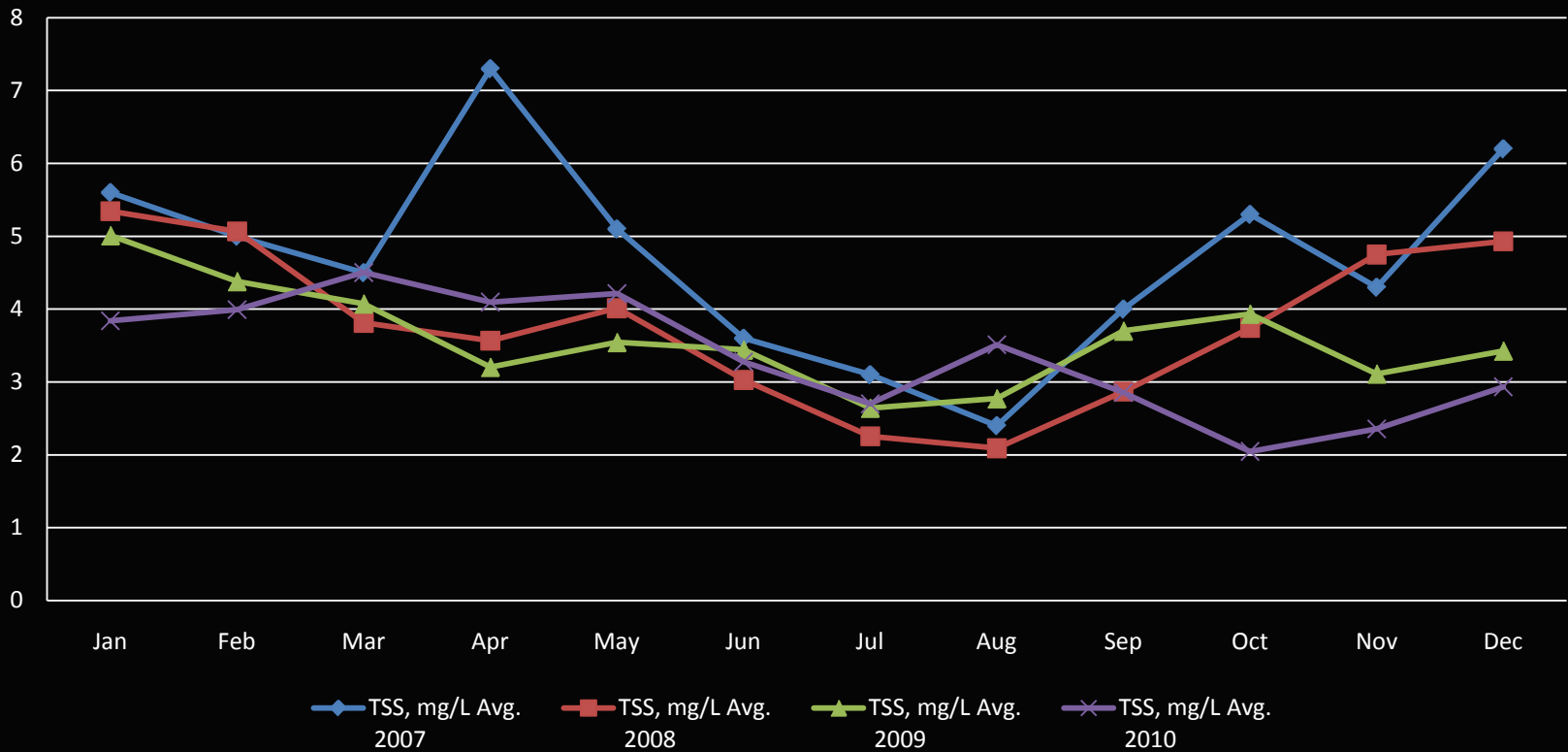
# Effluent, BOD 2007 - 2010





# Effluent, TSS 2007 - 2010

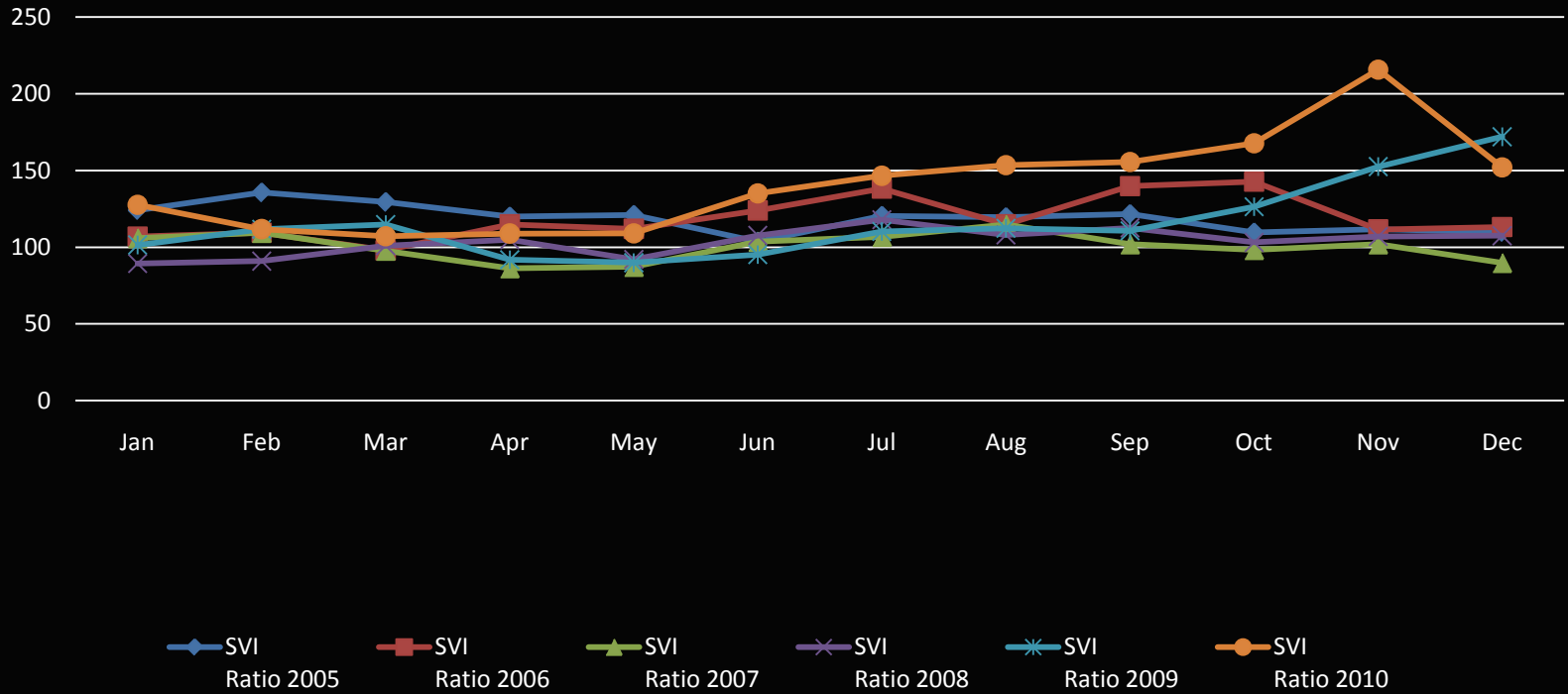
Effluent TSS, mg/L



# SVI

## 2005 - 2010

### SVI Summary



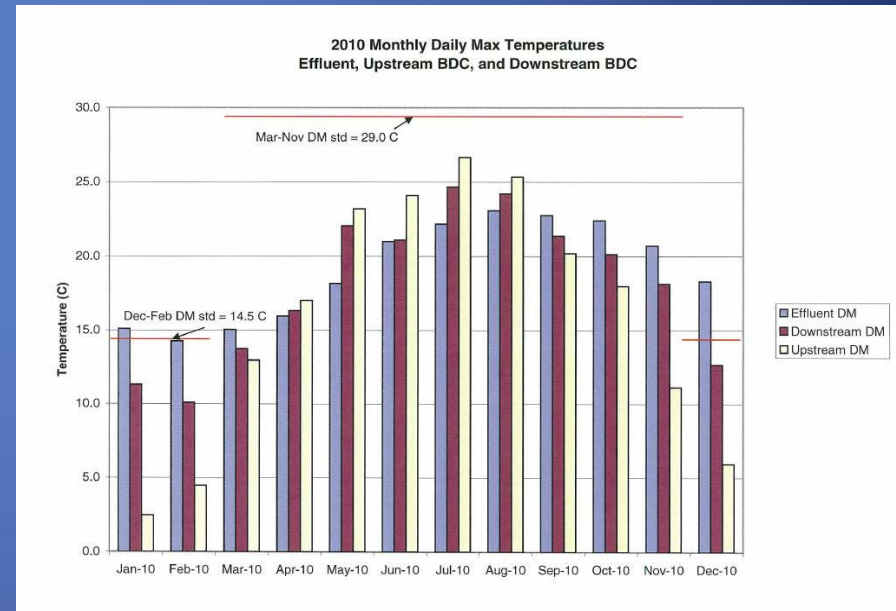
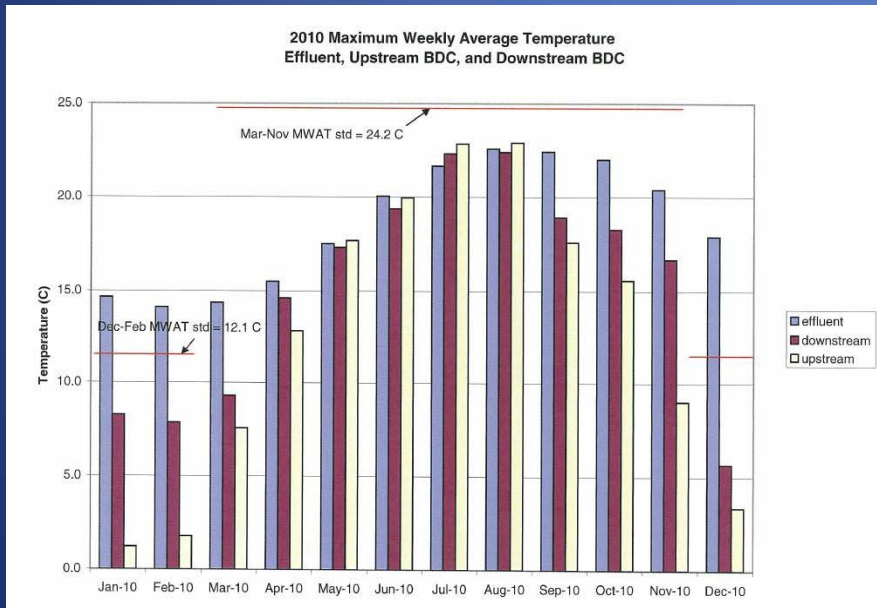
# What's Next

- New Nutrient Standards – New Proposed Discharge Limits

PARAMETER	LIMITS FOR EXISTING DISCHARGERS		LIMITS FOR NEW DISCHARGERS	
	Annual Average	Quarterly Average	Annual Average	Quarterly Average
Total phosphorus	0.7 mg/l	1.0 mg/l	0.43 mg/l	0.65 mg/l
Total Inorganic Nitrogen as N	5.7 mg/l	9.0 mg/l	3.0 mg/l	5.0 mg/l

# What's Next

- Temperature





# Conclusions

- Calibrating models with full-scale data *saves money*.
  - Broomfield: 15,000 ft<sup>3</sup> (400 m<sup>3</sup>) of media = \$375,000
- With the *right design*, IFAS and MBBR are cost-competitive with conventional technologies, *especially if you're re-using existing facilities*.

# Q/A

