Beyond Nitrification – Benefits of Higher SRT Operation

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Outline

- Introduction and Objective
  - Why operate at longer SRT?
  - What are the reasons other than nitrification?
- Enhanced removal of emerging contaminants
- Improved stability and biomass quality
- Energy conservation

Disadvantages

- Conventional Wisdom
  - Nitrification costs more, lots more, and is more difficult to operate and maintain
- Greater energy consumption due to greater oxygen uptake
- Greater aeration tank volumes
- Clarifier denitrification, nitrites interfering with disinfection

Advantages

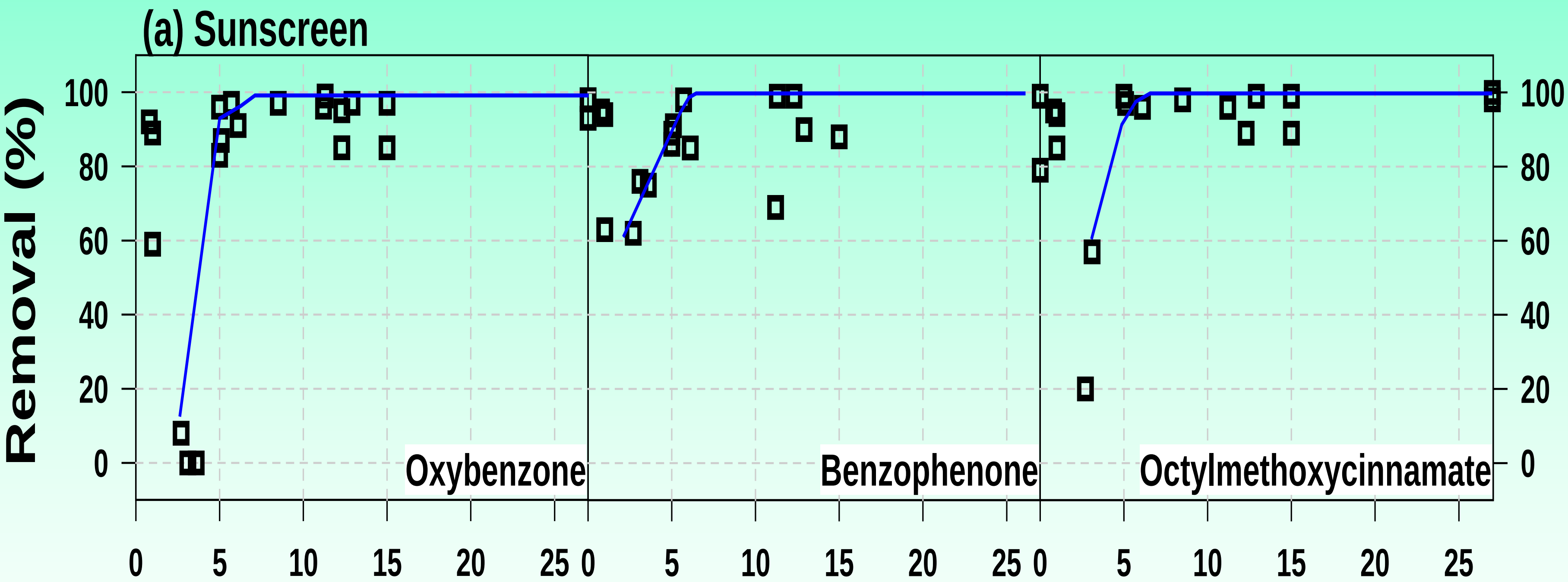
- Improved emerging contaminants removal and soluble effluent quality
- Improved microbial environment
  - Selectors with denitrification
  - Particle size distribution
- Energy consumption
  - Improved efficiency with higher SRT
  - Denitrification credit
  - Reduced diffuser fouling
- Reduced biosolids production

Removal of Emerging Contaminants

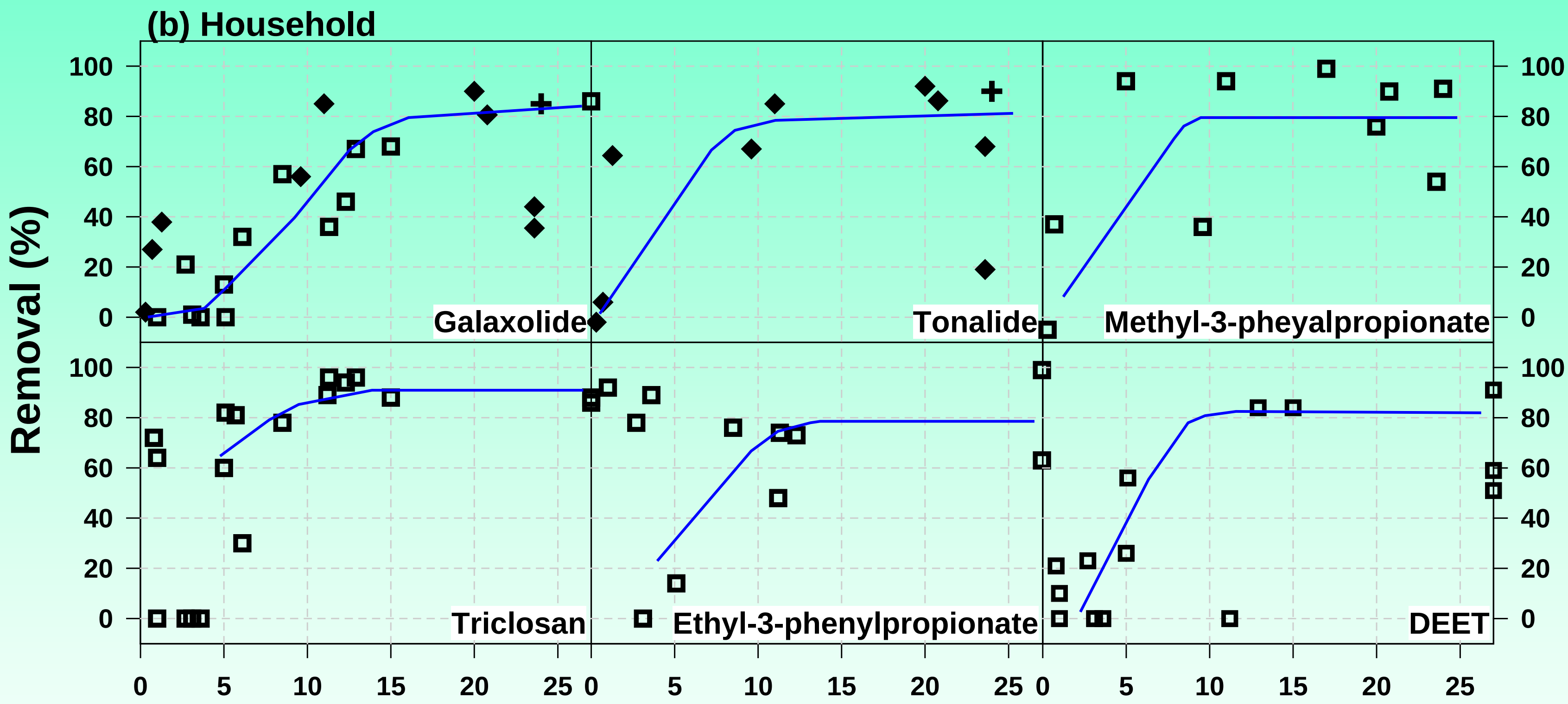
About 80% of the pharmaceuticals, endocrine disrupters, hormones are degraded at high SRT, while most are not degraded at low SRT

Some literature examples (a few from my lab!)

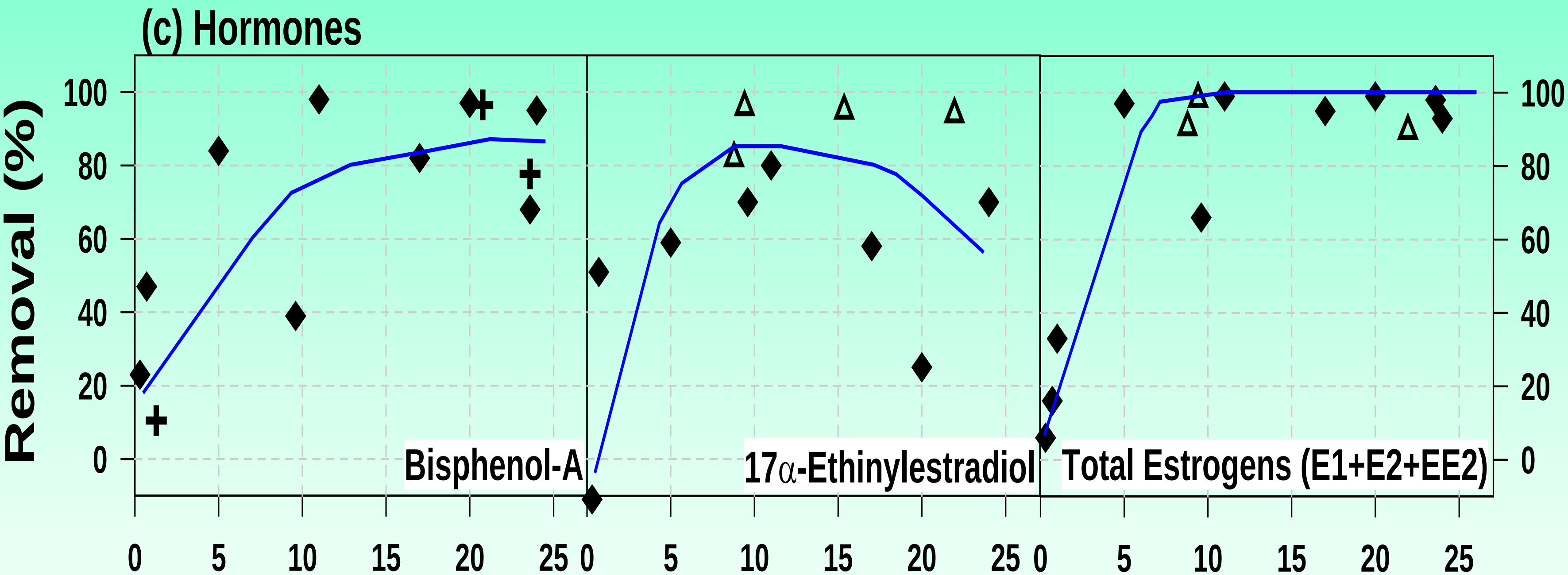
Emerging Contaminants 1



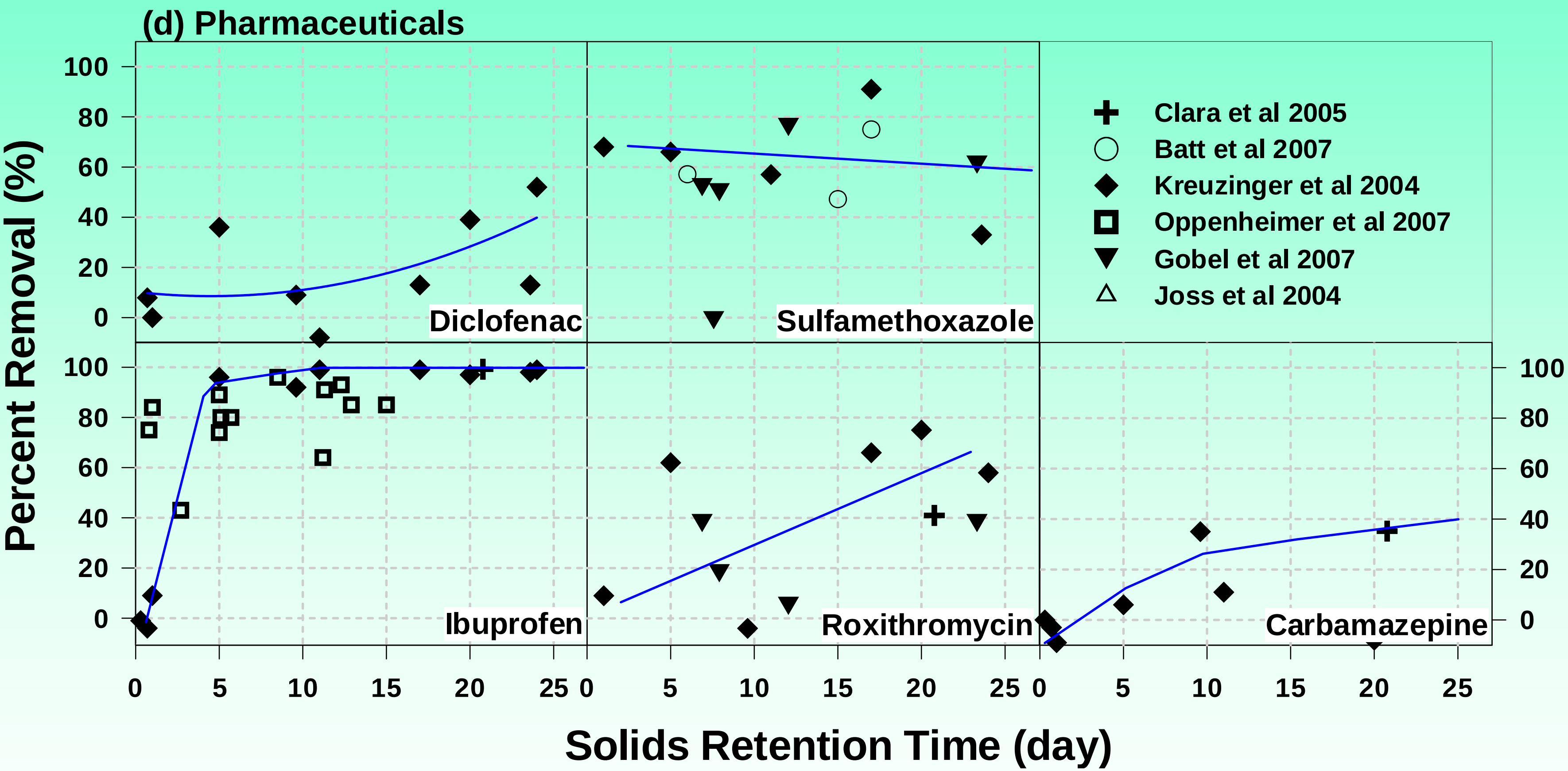
Emerging Contaminants 2



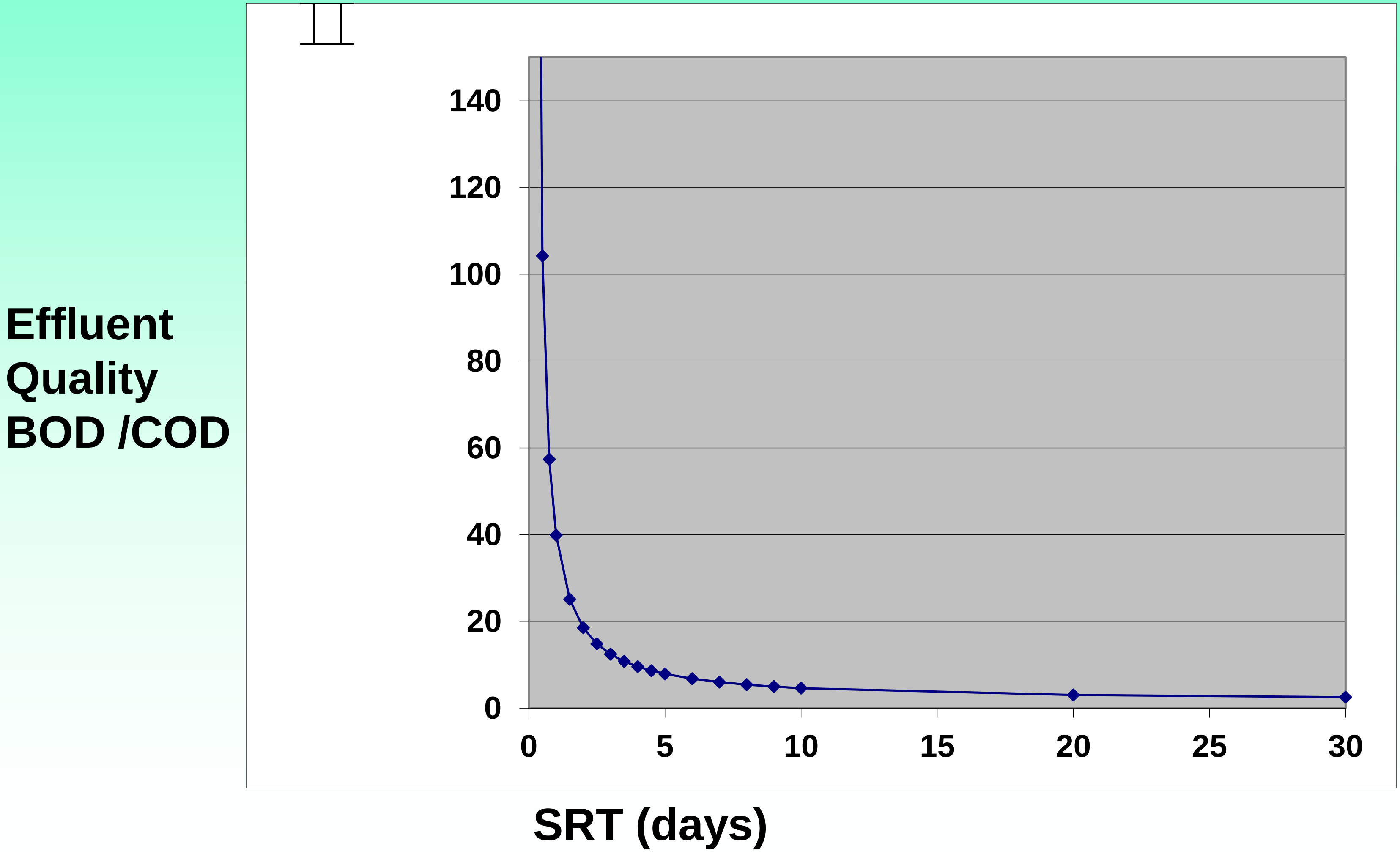
Emerging Contaminants 3



Emerging Contaminants 4

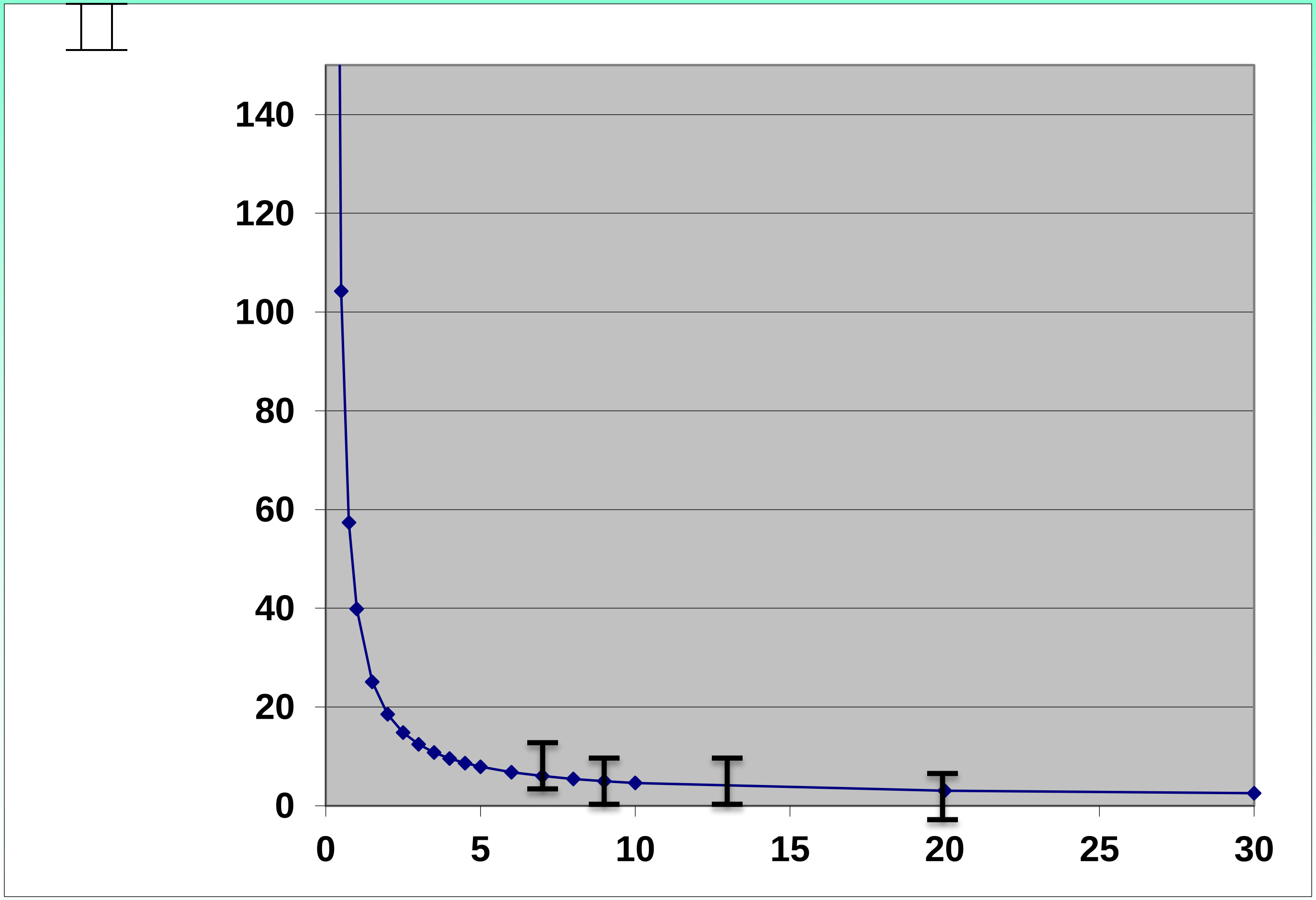


Traditional Modeling Result of Effluent Quality



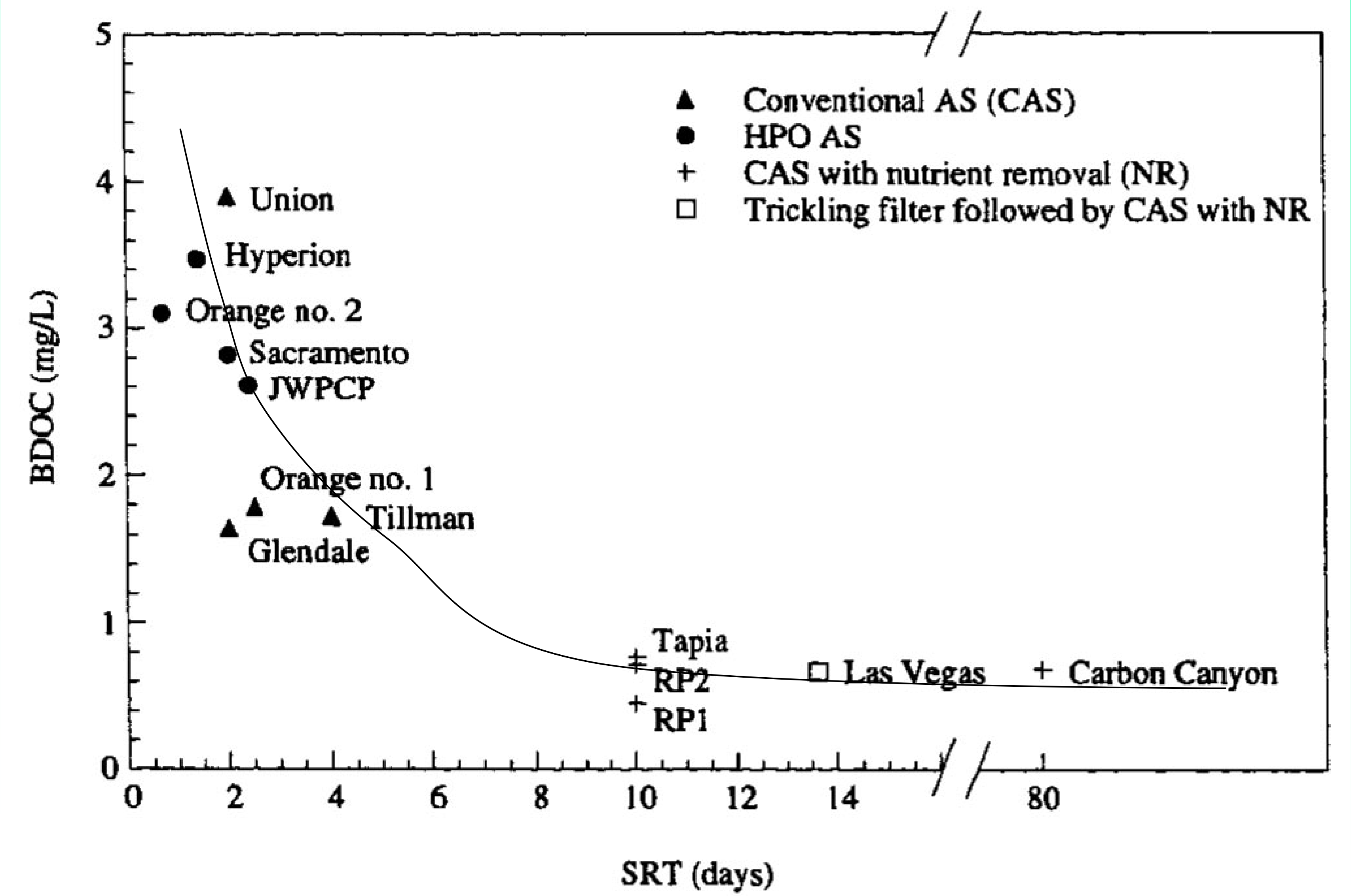
Errors associate with typical measures like BOD & COD do not show improved efficiency

Effluent
Quality
BOD /COD



SRT (days)

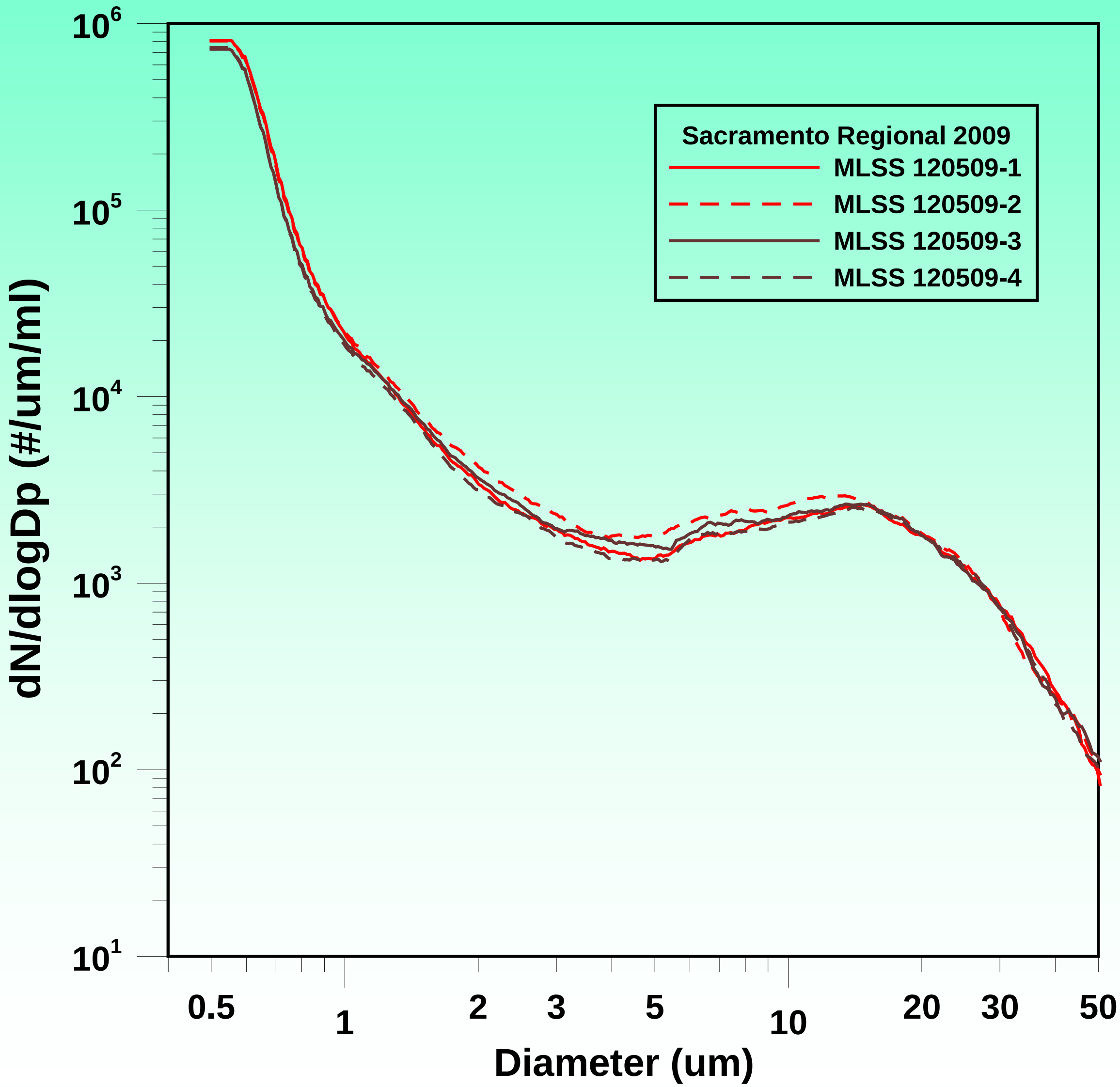
Improved BDOC Removal



Improved Biomass Quality

- Anoxic selector effect
- Reduced incidences of filamentous bulking
- Clearer, less turbid effluents

Particle Size Distribution



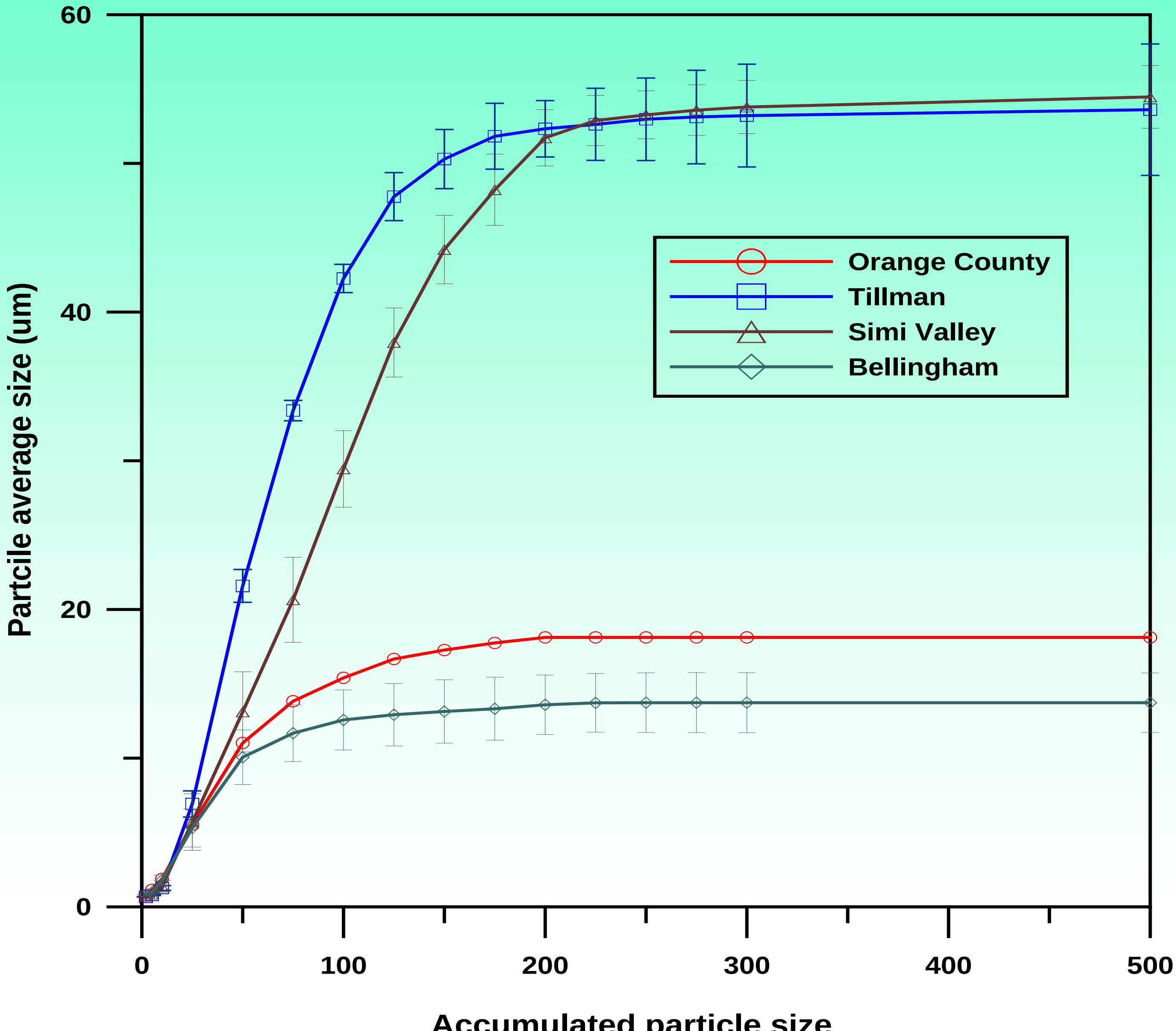
Calculating Mean Particle Size

$$\text{Total Particles} = \int_{0.5}^{M} N ds$$

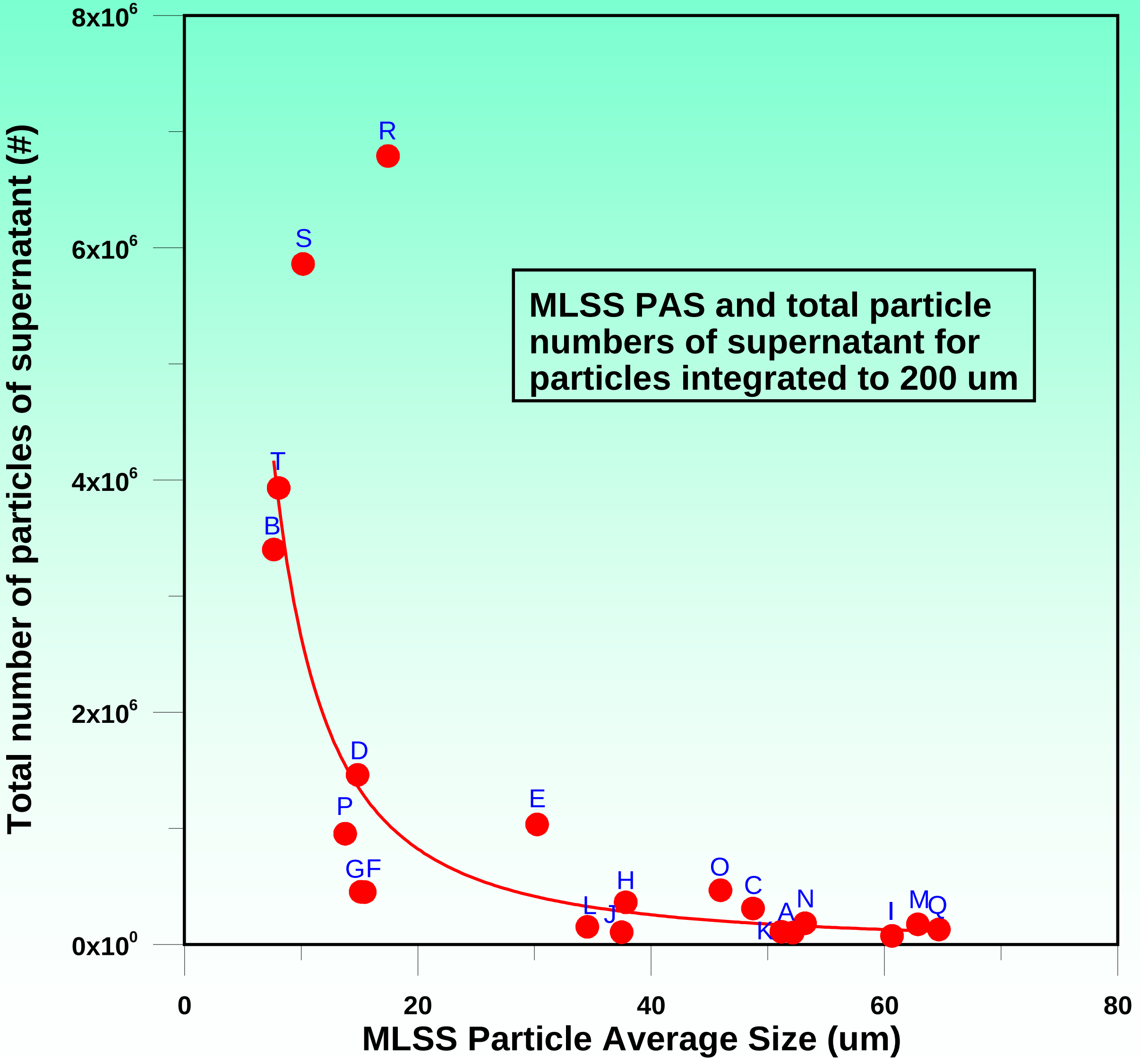
$$\text{First Moment} = \int_{0.5}^{M} S \cdot N ds$$

$$\text{PAS} = \frac{\int_{0.5}^{M} S N ds}{\int_{0.5}^{M} N ds}$$

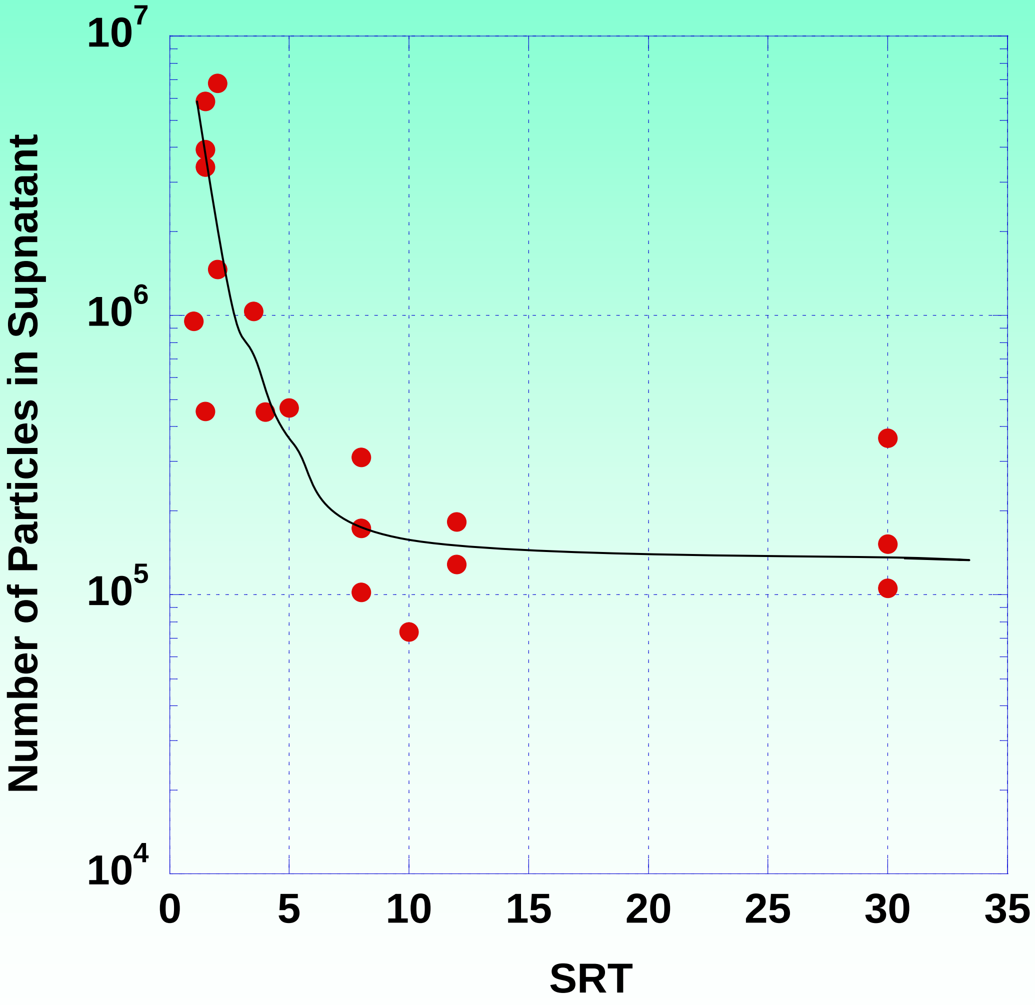
Impact of Integration Parameter



Impacts to Effluent Quality?



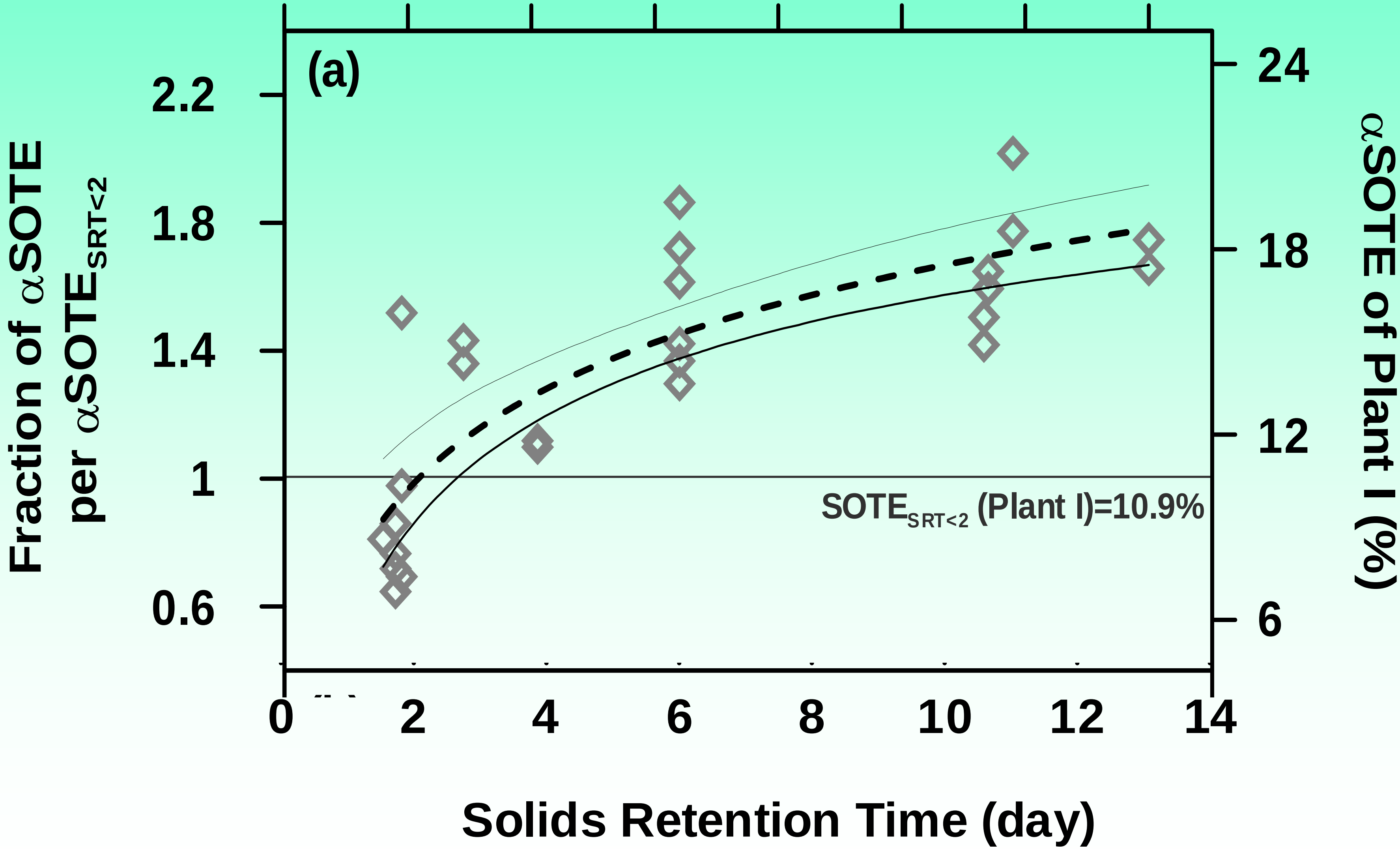
Supernatant Particles vs SRT



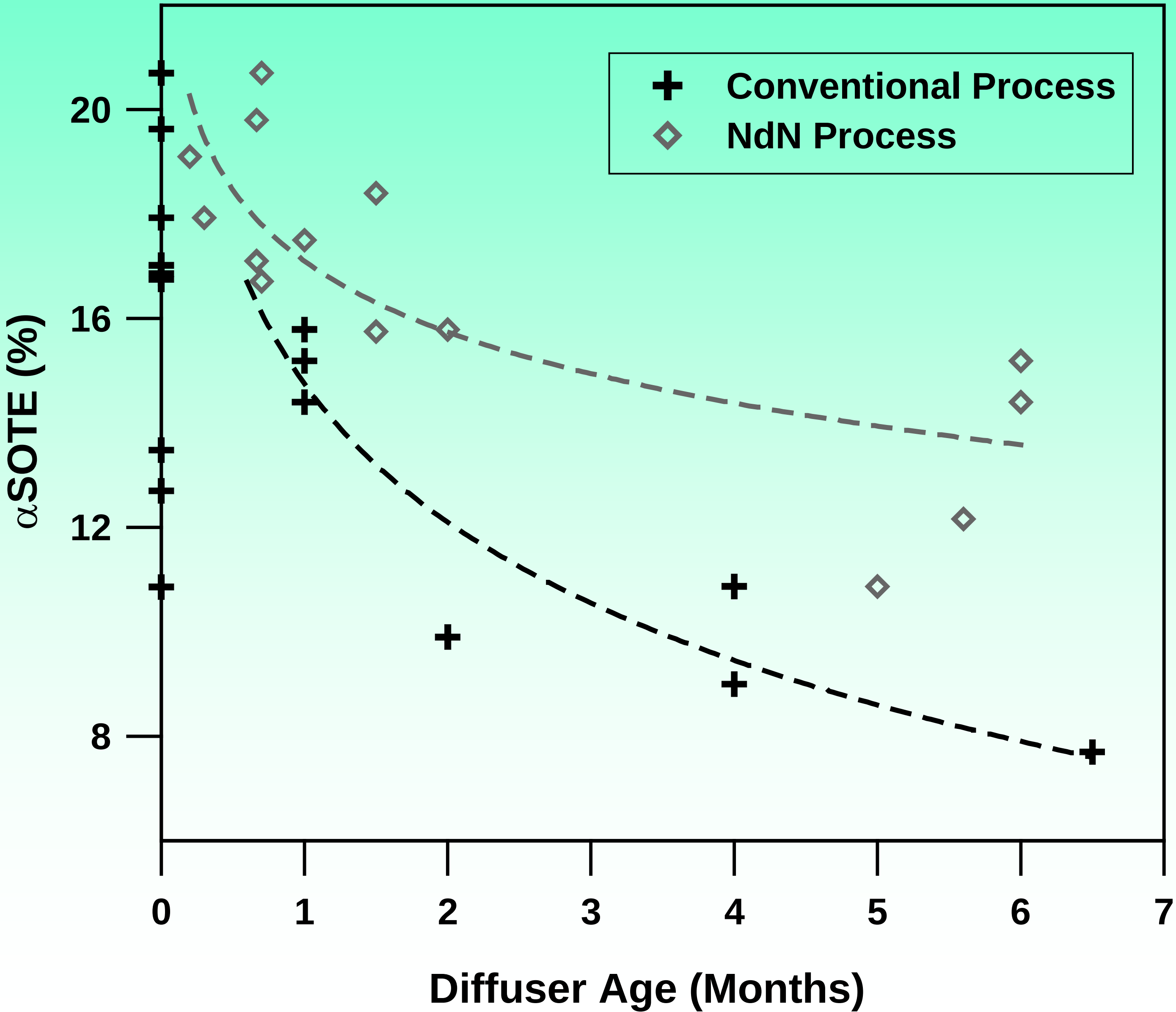
Three Plants Monitored Using Off-Gas Analysis

Test Plant	Phase	Process	SRT (day)	Flow Rate per Tank	
				($10^3 m^3$/day)	(MGD)
Plant I	1	Conventional	1.6 - 1.9	18.8	5.0
	2	Conventional	2.6 - 3.5	15.1	4.0
	3	NDN (Partial)	6.4 - 7.0	17.0	4.5
	4	NDN (Full)	11.0 - 12.2	16.3	4.3
Plant II	1	Conventional	3.1 - 4.1	15.5	4.1
	2	NDN (Full)	12.5 - 14.0	11.4	3.0
Plant III	1	Conventional	3.3 - 4.5	79.8	21.1
	2	Nitrification only	14.0 - 17.3	37.2	9.9
	3	Conventional	1.8 - 2.5	37.2	9.9

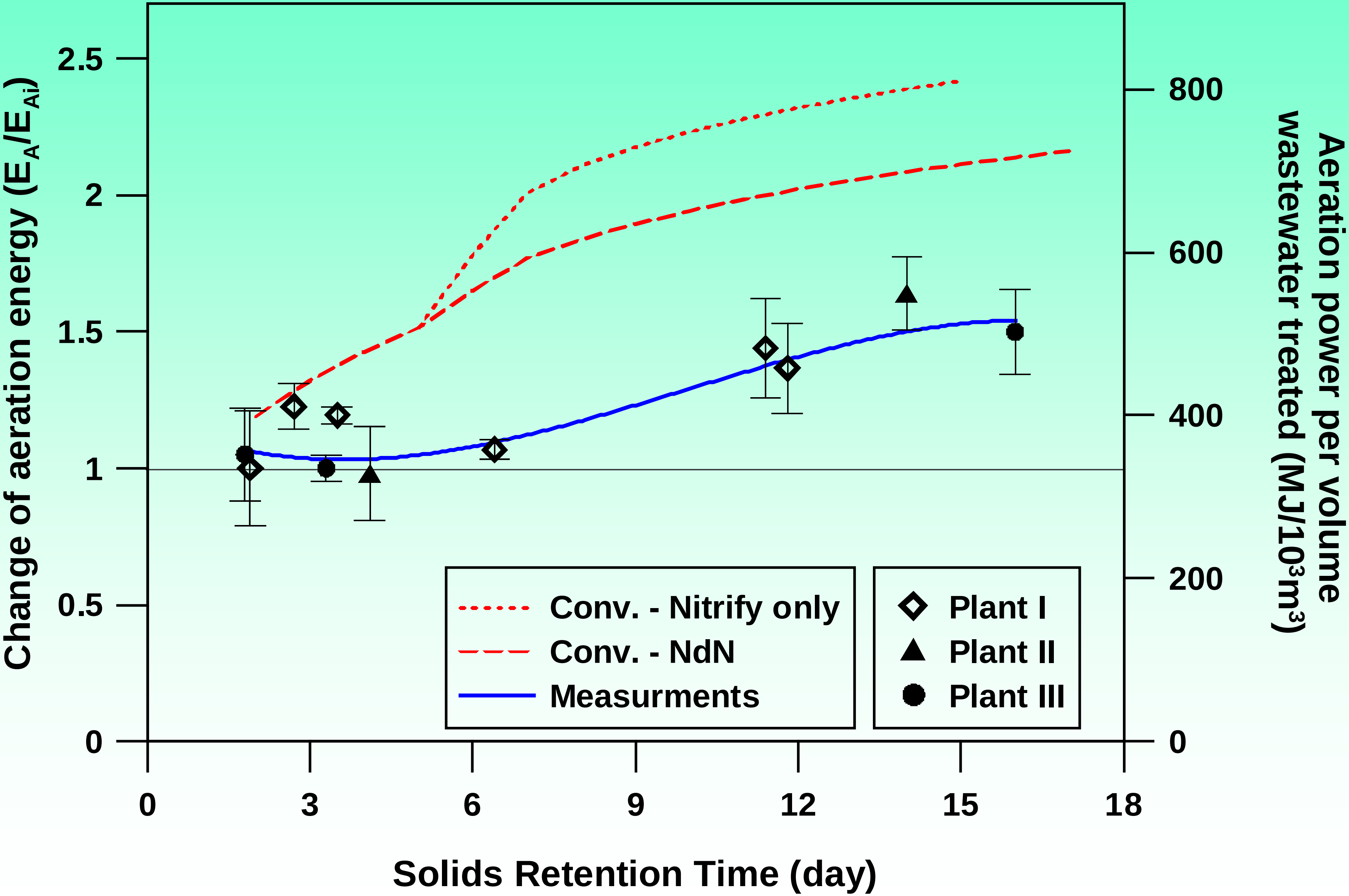
Relative Aeration Efficiency



Rate of Diffuser Fouling



Relative Cost of Aeration vs SRT



Process Modifications

- Analysis was performed for “warm” climates. Conversion to longer SRT and NDN occurred with little or no plant capacity derating
- Improved OTE confirmed in colder climates
- Increases in aeration time at colder temperatures not investigated and increased tankage should be anticipated

Conclusions

- Higher SRT produces superior quality effluent with respect to numbers and sizes of particles
- Higher SRT produces effluent lower in biodegradable organic carbon
- Literature review and some of our data show that many (~80%) of the emerging contaminants have superior removal at higher SRT. (Degradation or adsorption mechanisms)
- Improved aeration efficiency off-sets much of the energy associated with the increased OUR
- Reduced rates of diffuser fouling will improve the energy trade off to higher SRT

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