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NYC Environmental Protection

Chloramination: an alternative disinfection method to achieve discharge permit limits

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Outline

- Introduction
- Objectives
- Pilot Setup
- Influent characterization
- Performance and discussion
- Conclusions
- Full-Scale Application at the Hunts Point WRRF

Introduction

HP pilot study drivers:

- **Proposed HP WRRF TRC discharge target is 0.57 mg as Cl_2/ L.**
- **SPDES permit: Fecal Coliform 30-day geometric mean is not to exceed 200 CFU/100mL.**
- **DEC Proposed enterococcus concentration is not to exceed 35 CFU/100 ml geometric mean.**
- **Reduction in hypo consumption**

HP pilot study definition:

Chlorination: hypo addition

Chloramination: hypo addition & supplement ammonia-N

OBJECTIVES

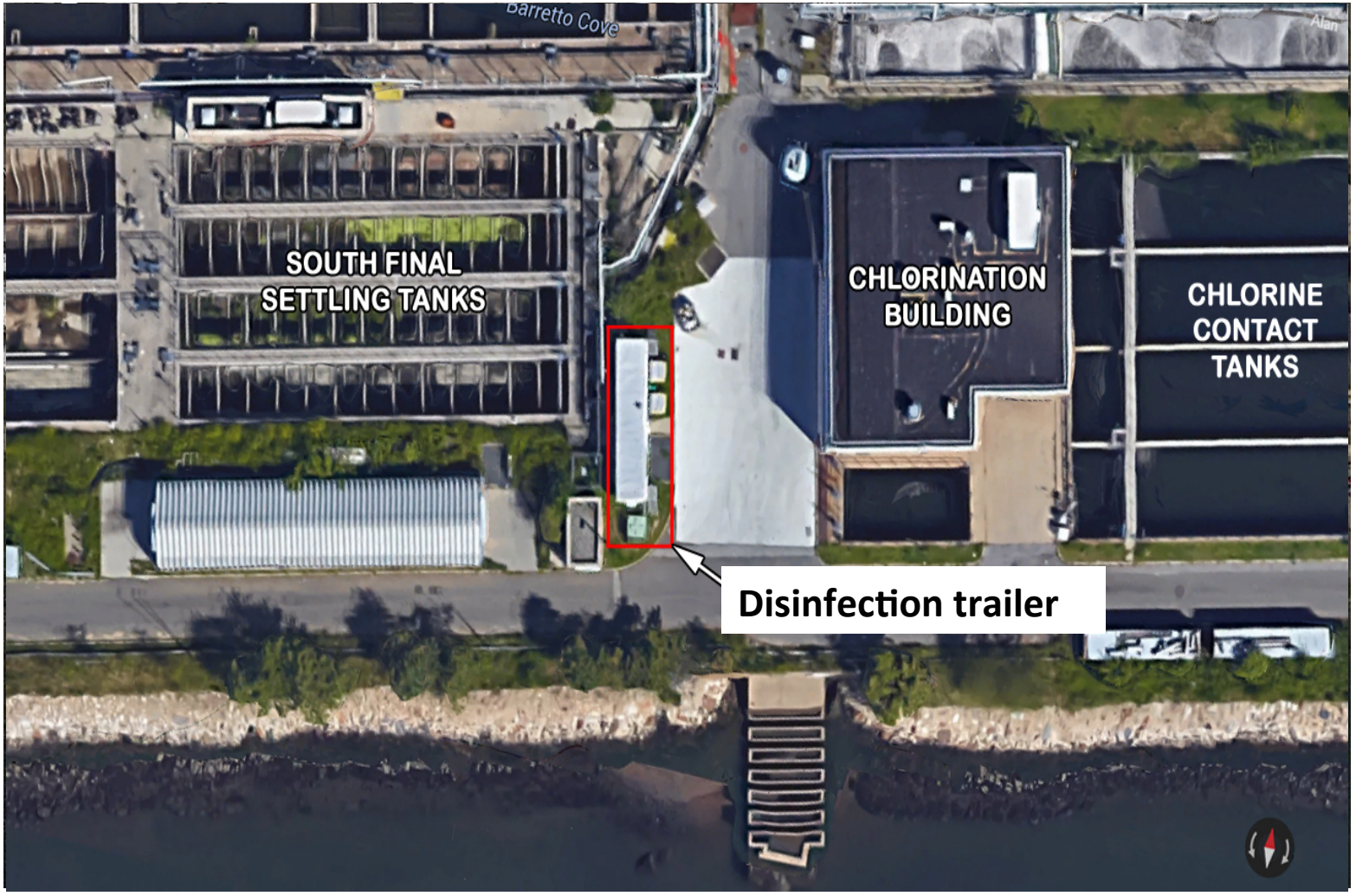
- Evaluate the impact of Nitrogen species on disinfection in BNR plants.

- Reduce chlorine demand by
  - Controlling the NO_2-N/NH_3-N by addition of Ammonia-N
  - Minimizing the hypo dosage

- Compare the use of enterococcus to the traditional fecal coliform bacteria as the indicator for effective disinfection.

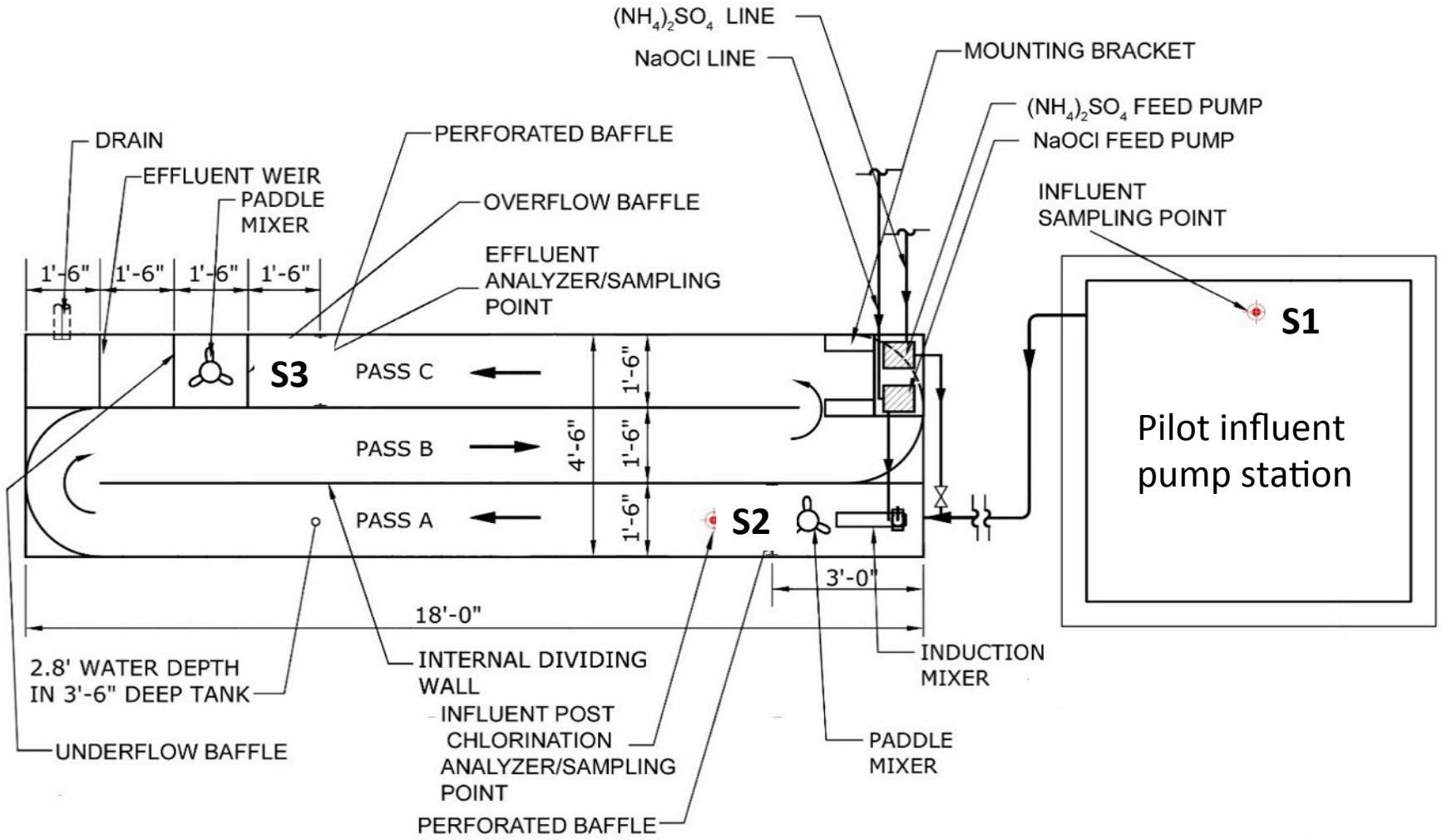
- Determine the minimum value of “CT” required to comply with the discharge permit limits.

Location of the Pilot Facility



Copy from google map

Pilot Facility layout



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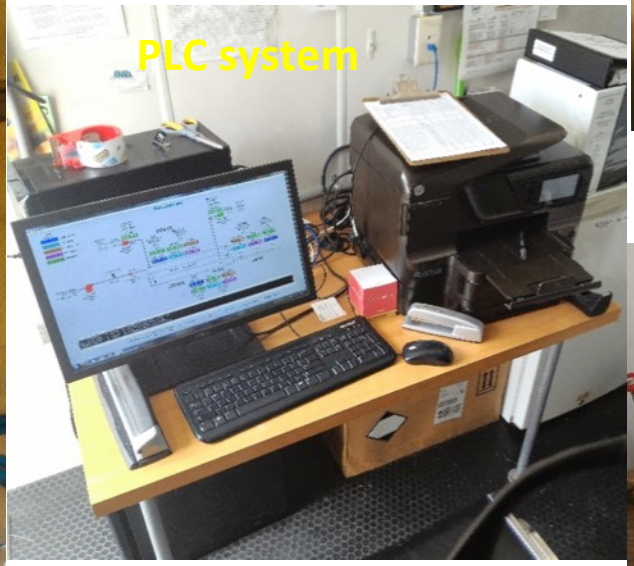
Instrumentation Available



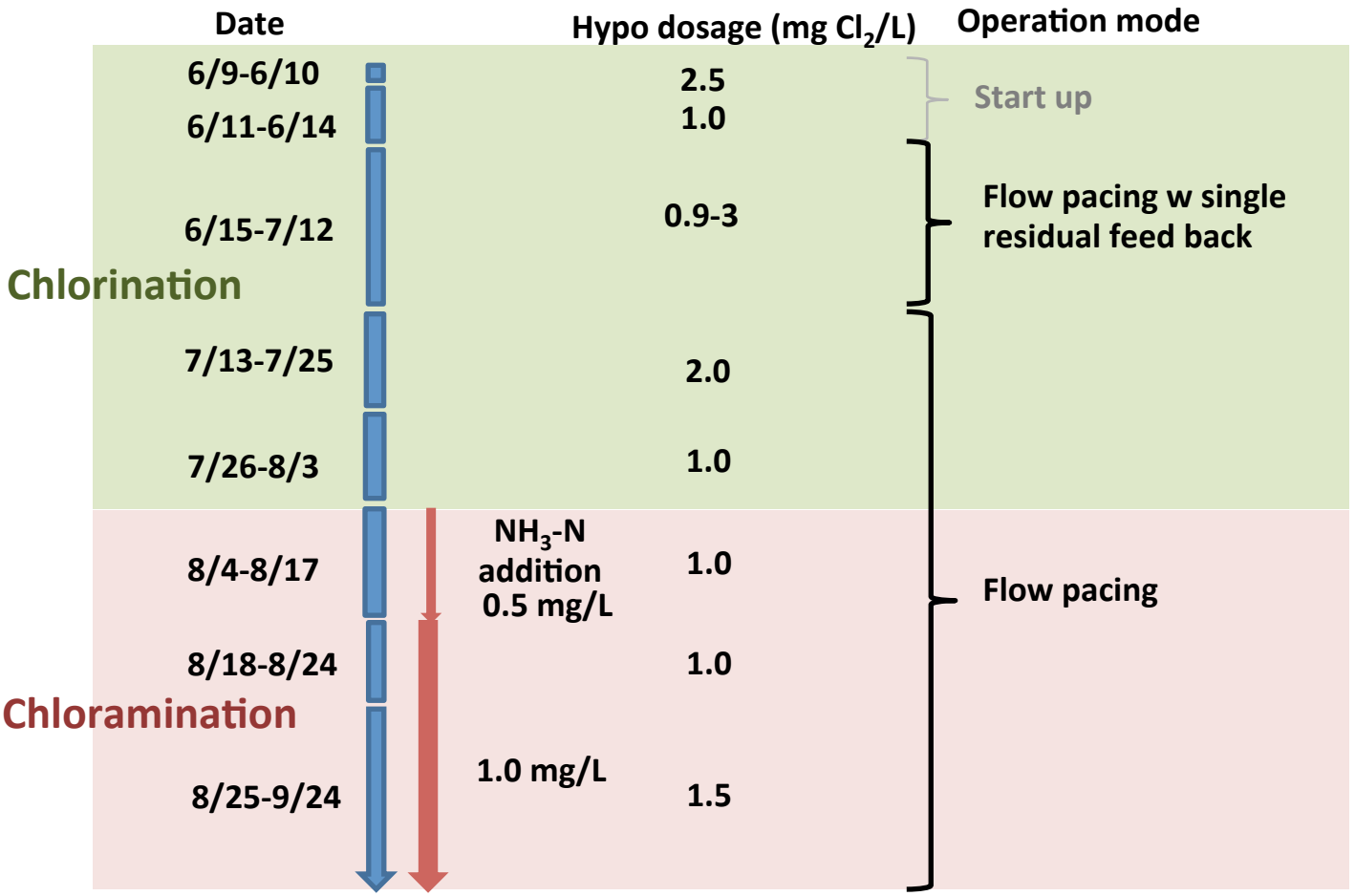
Prominent HACH

Analytical methods

Parameters	Sampling frequency
Free Chlorine (mg Cl_2/L)	Twice a day (10AM & 2PM)
Total chlorine(mg Cl_2/L)	
Monochloramine (mg Cl_2/L)	
Ammonia (mg N/L)	
Nitrite (mg N/L)	
Enterococci (CFU/100mL)	
Fecal coliforms (CFU/100mL)	
COD (mg/L)	Weekly or rain event
Total alkalinity (mg/L as $CaCO_3$)	
TSS (mg/L)	
pH	Spot Checks

Note: All methods are adapted from EPA or Standard methods.

Pilot Timeline



Pilot Influent characterization

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Pilot Influent nitrogen species characterization

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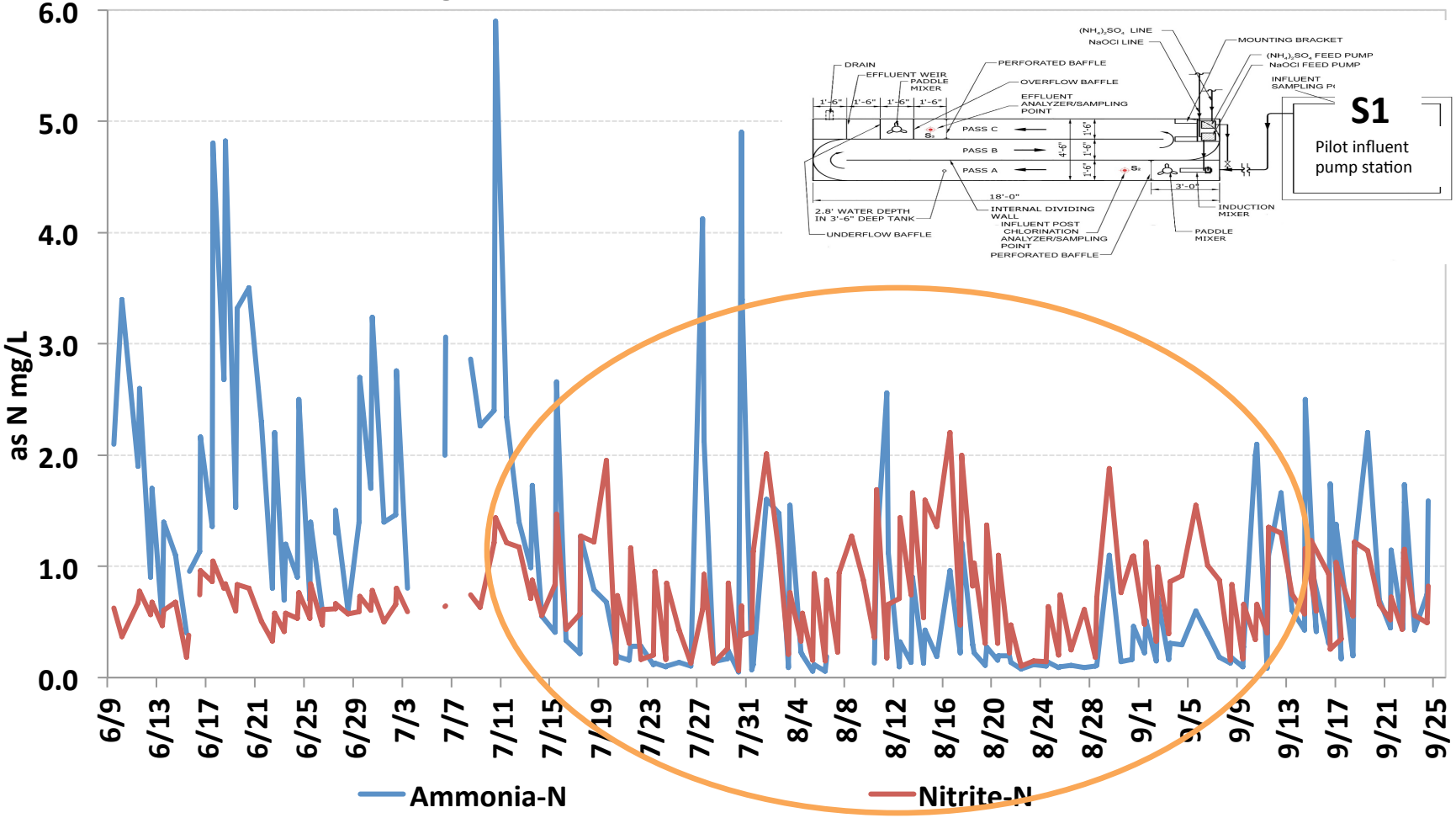

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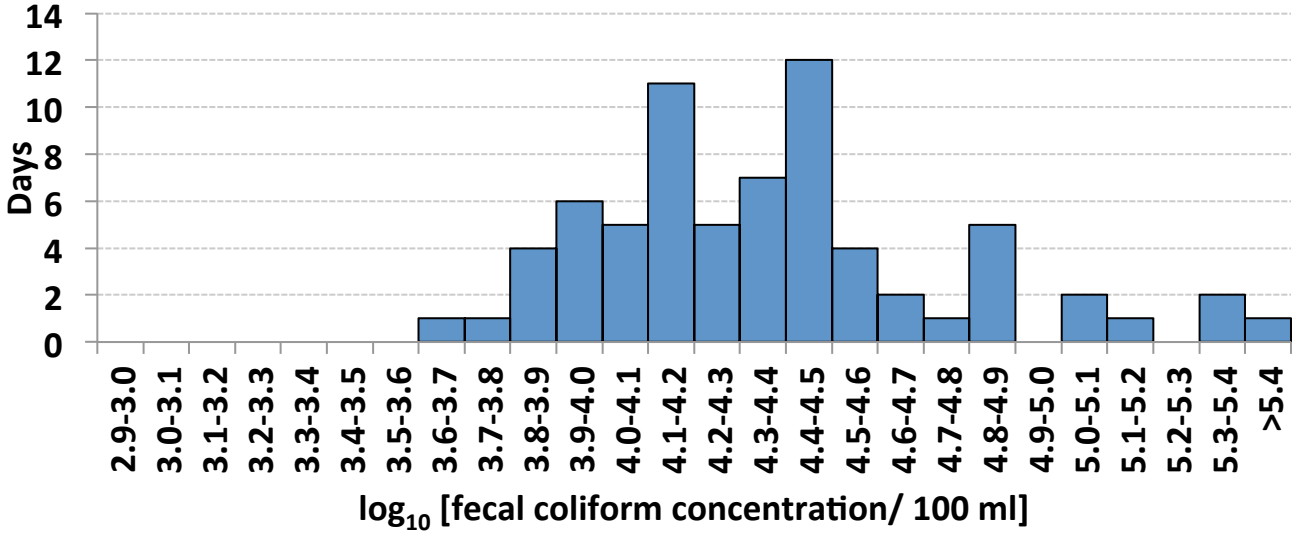
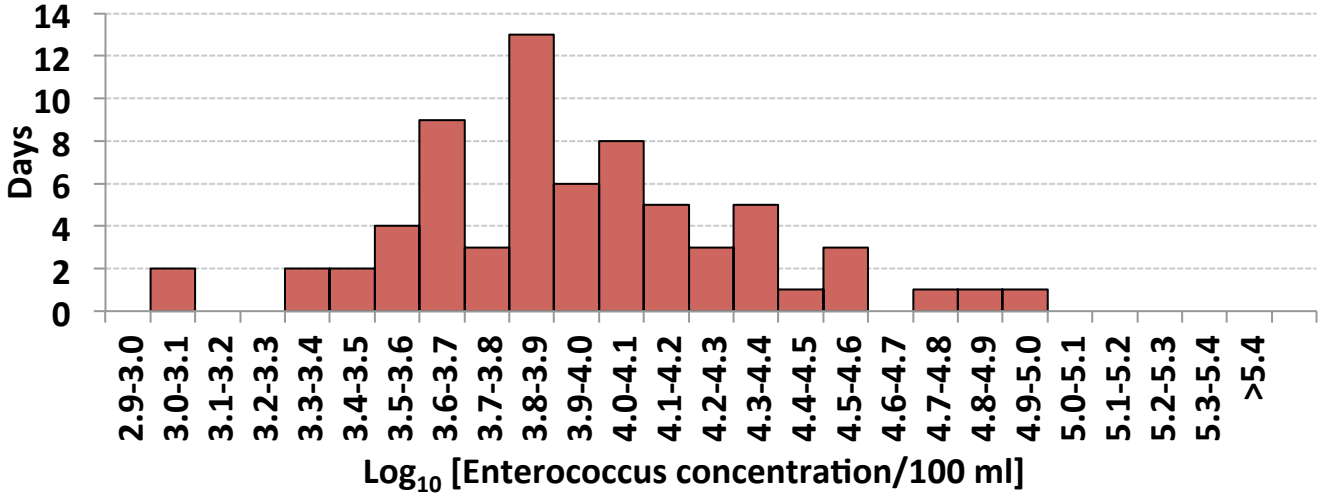
Characterization of pilot influent bacteria indicators



CFU/100mL	FC	Entero.
Ave.	4.14E+04	1.06E+04
stdev	7.92E+04	1.22E+04
Min.	4.00E+03	3.00E+02
Max.	6.00E+05	7.06E+04



Summary: Pilot Influent characterization

	NH_3-N (mg N/L)	NO_2-N (mg N/L)	F. C. (CFU/100mL)	Entero. (CFU/100mL)
Ave.± stdev	1.05±1.12	0.74±0.42	$4.14x10^4±7.92x10^4$	$1.06x10^4±1.22x10^4$

- Ammonia-N has large variance. On many occasions, nitrite-N is higher than ammonia-N.
- The Fecal coliform population is about 4 times that of the enterococcus in the final settling tank effluent.

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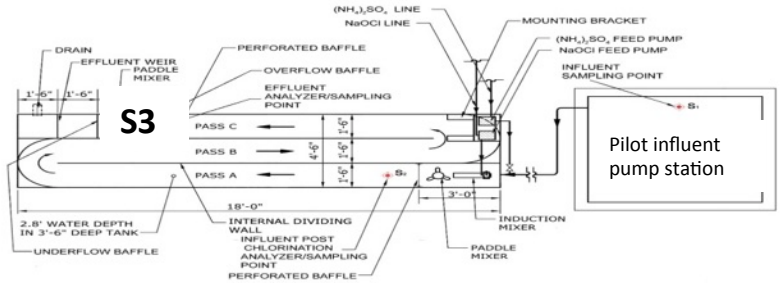
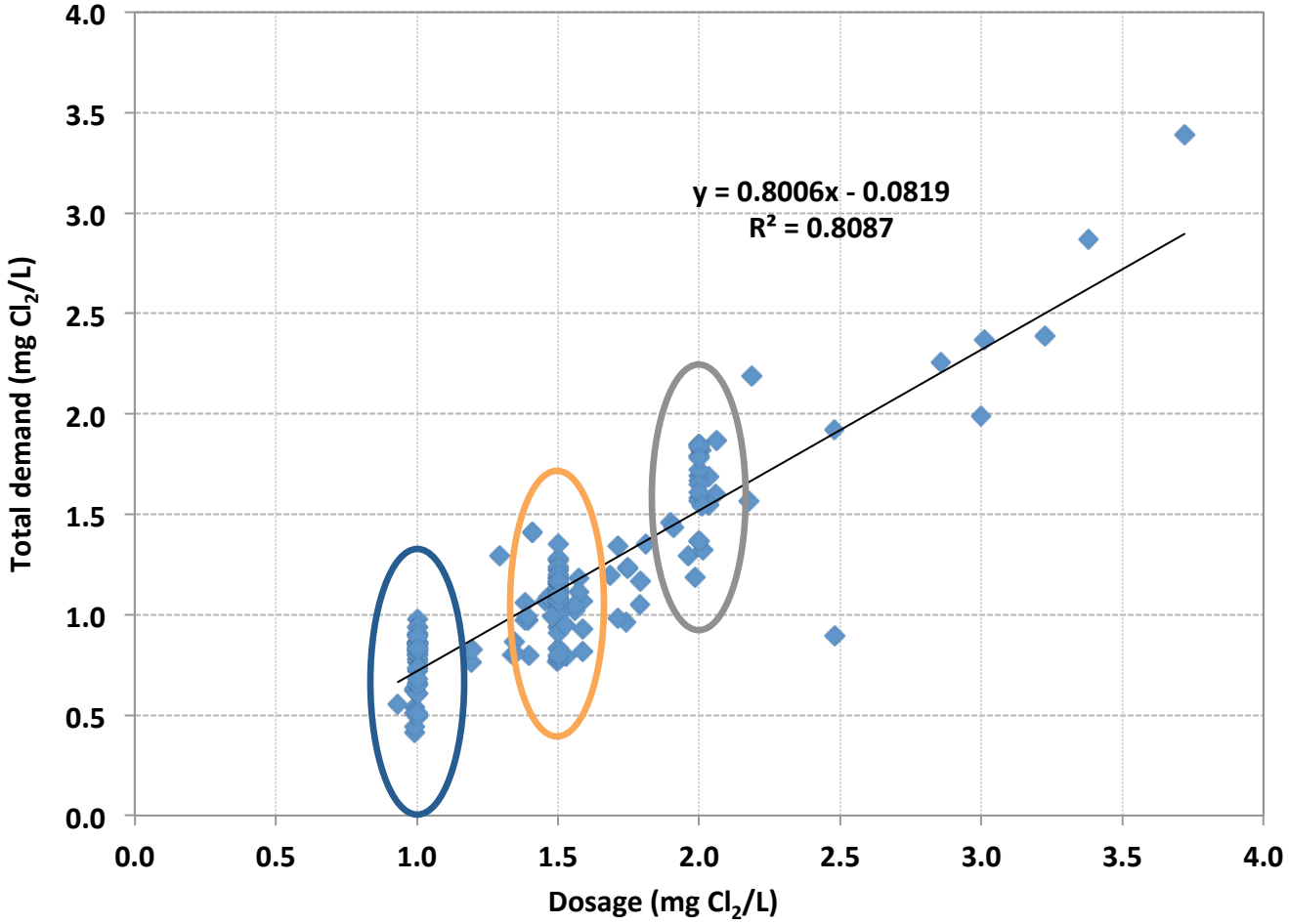
Pilot Performance minimum TRC experiment

Performance as measured against Target TRC



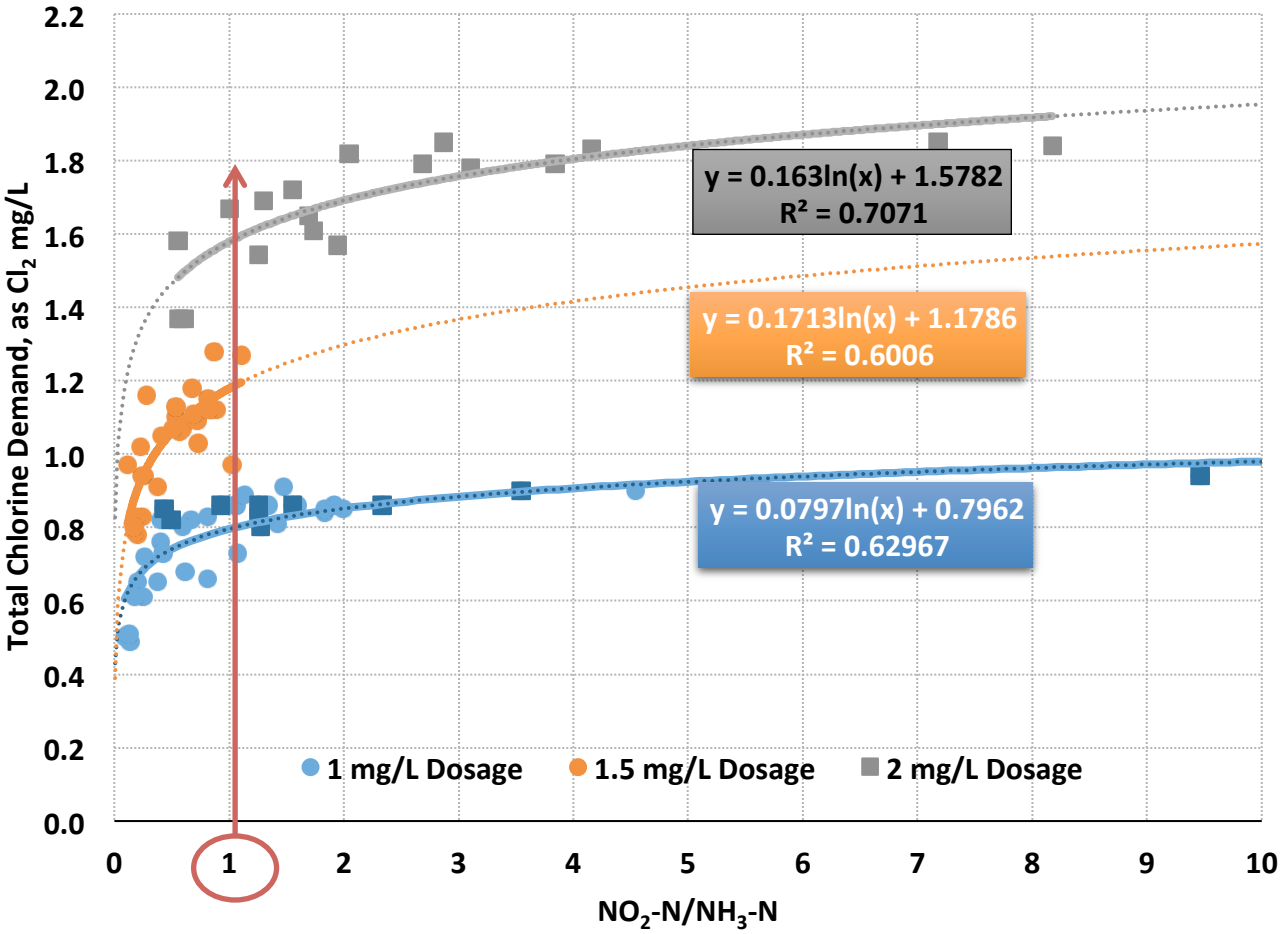
Note: grab sample for TRC and NH_2Cl.

Chlorine demand recorded during the study period



Note: Data based on daily grab samples.

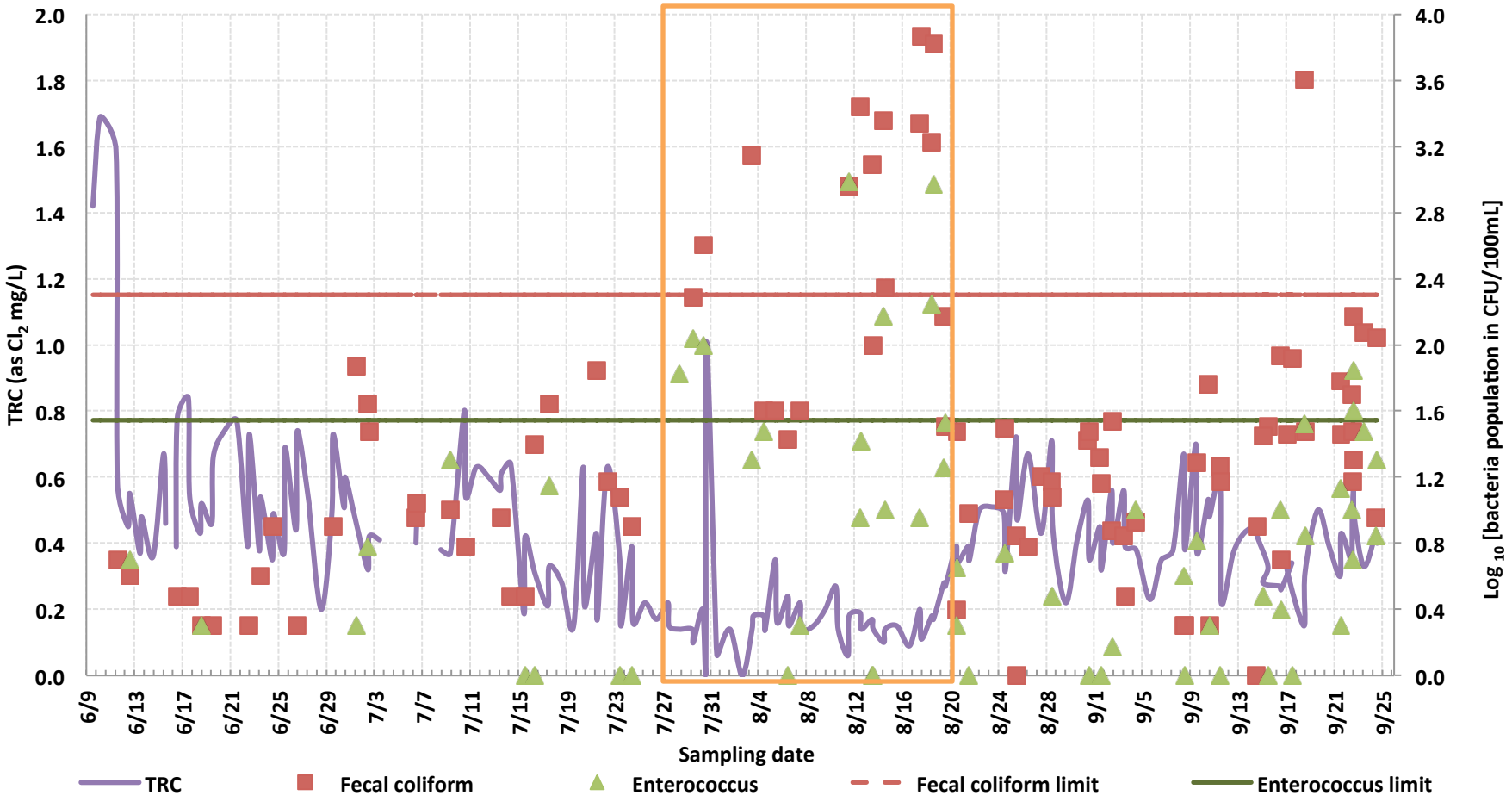
Factors impacting total chlorine demand



- Hypo dosage
- Nitrite-N/ammonia-N

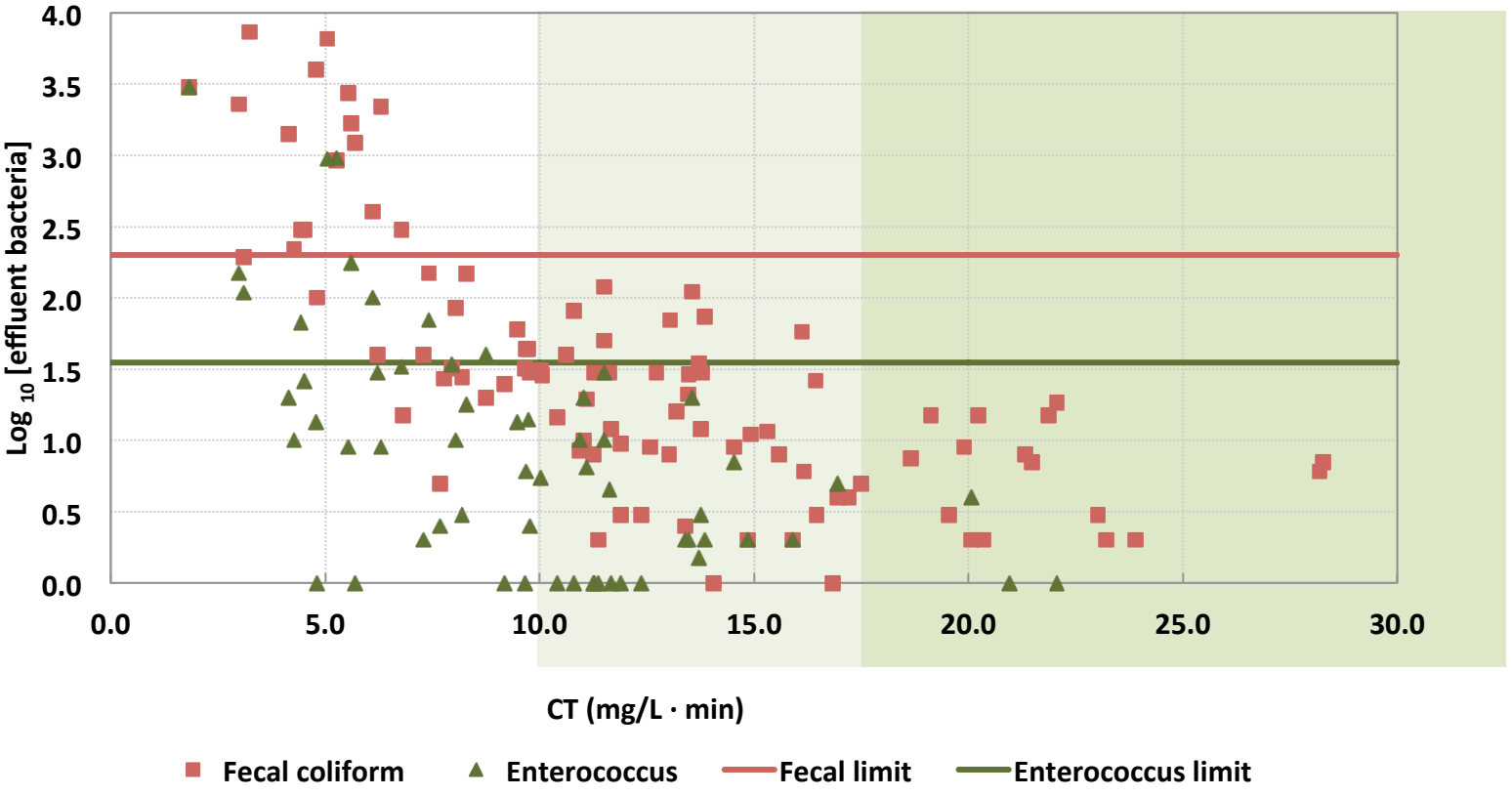
Disinfection performance

Disinfection performance based on bacteria indicators



Both indicators, F.C and enter., show exceedances during the same period when TRC ave. = 0.15 mg Cl_2/L. Disinfection criteria satisfied when TRC is above 0.3 mg Cl_2/L.

Optimum CT

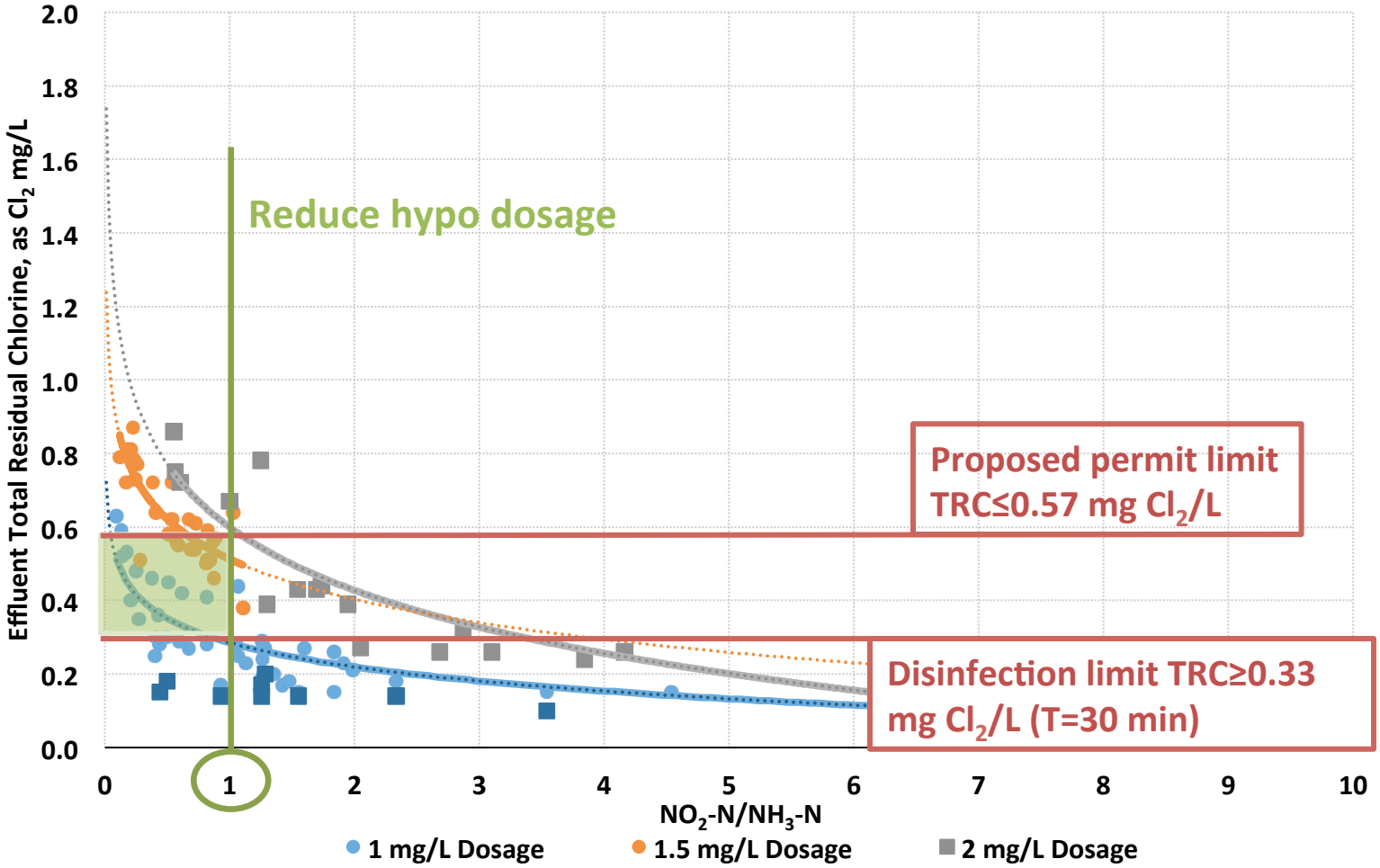


Minimum CT required for efficient disinfection is 10 mg/L · min.

CT=10 mg Cl_2/L ·min T= 30 min, TRC=0.33 mg Cl_2/L

Proposed TRC=0.57 mg Cl_2/L, T= 30 min, CT=17.1 mg/L ·min

Strategy to optimize hypo dosage



Conclusions

- Chloramination by supplementing ammonia-N is a successful method to disinfect the effluent from BNR plants.
- To reduce chlorine demand, the ratio of NO_2-N to NH_3-N to be maintained at 1 or less by supplementing ammonia-N and with this the hypo dosage could be in the range of 1-1.5 mg Cl_2/L.
- Both fecal coliform and enterococcus bacteria can be used as indicators of effective disinfection.
- To achieve the proposed TRC=0.57 mg Cl_2/L, CT=17.1 mg Cl_2/L · min is required with a detention time of 30 minutes. However, the minimum value of CT to assure compliance of the discharge permit limits was determined to be 10 mg/L · min.

Lessons Learned from Pilot Operation And applied to main plant

- Chlorine residual between 0.25 mg/l and 0.40 mg/l is sufficient to provide bacterial kill

- Ratio NO_2/NH_3 has large impact on performance

Lessons Learned from Pilot Operation And applied to main plant

SYSTEM

- New accurate metering system
- Tuning of automatic controls

PROCESS

- Control aeration and step-feed to limit nitrification
- Operators Training

From pilot to full scale

New Metering Pumps – Chemical Induction Mixers – Automatic Controls

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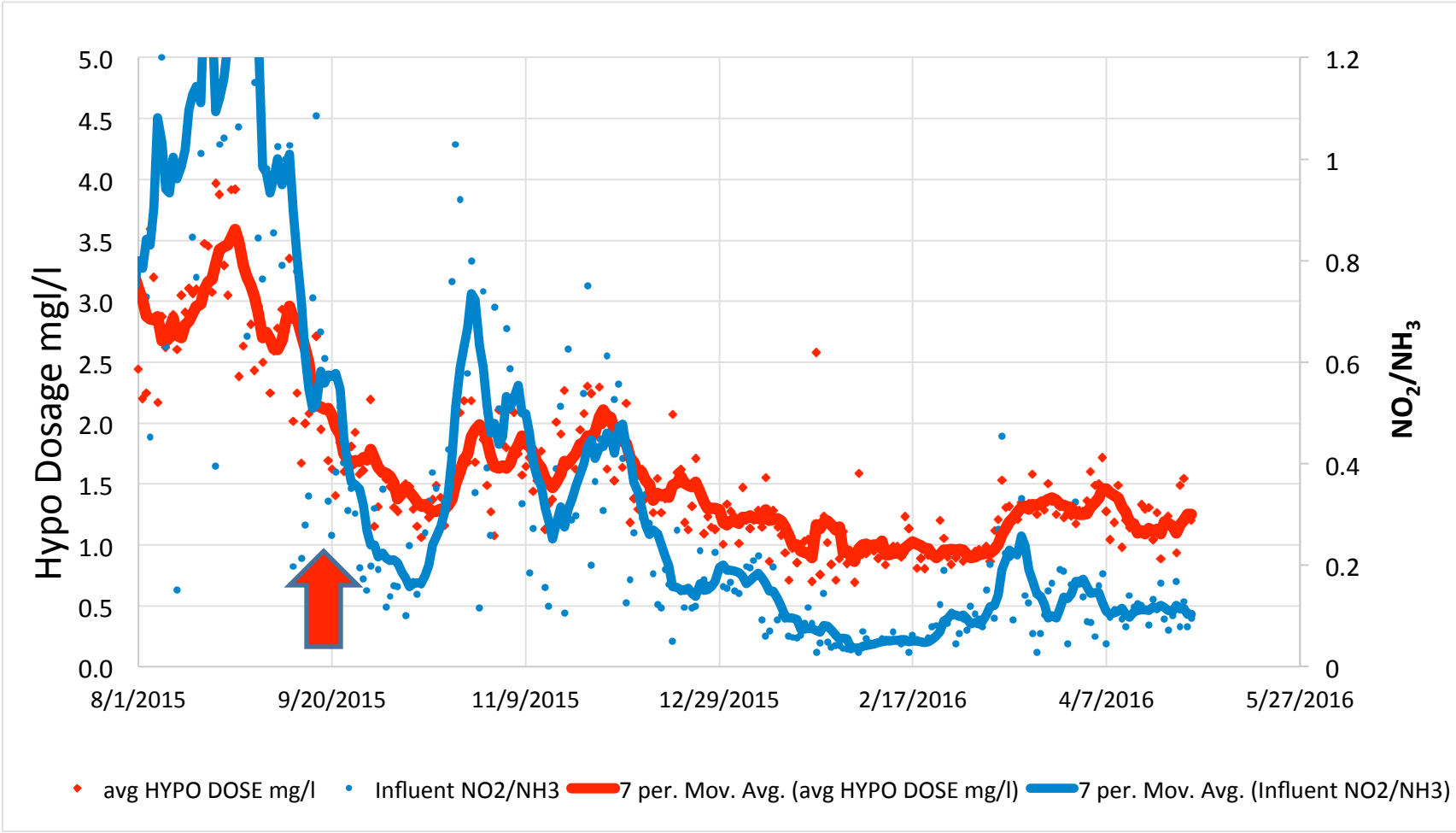
NO_2-N/NH_3-N affects hypo consumption at HP WWTP



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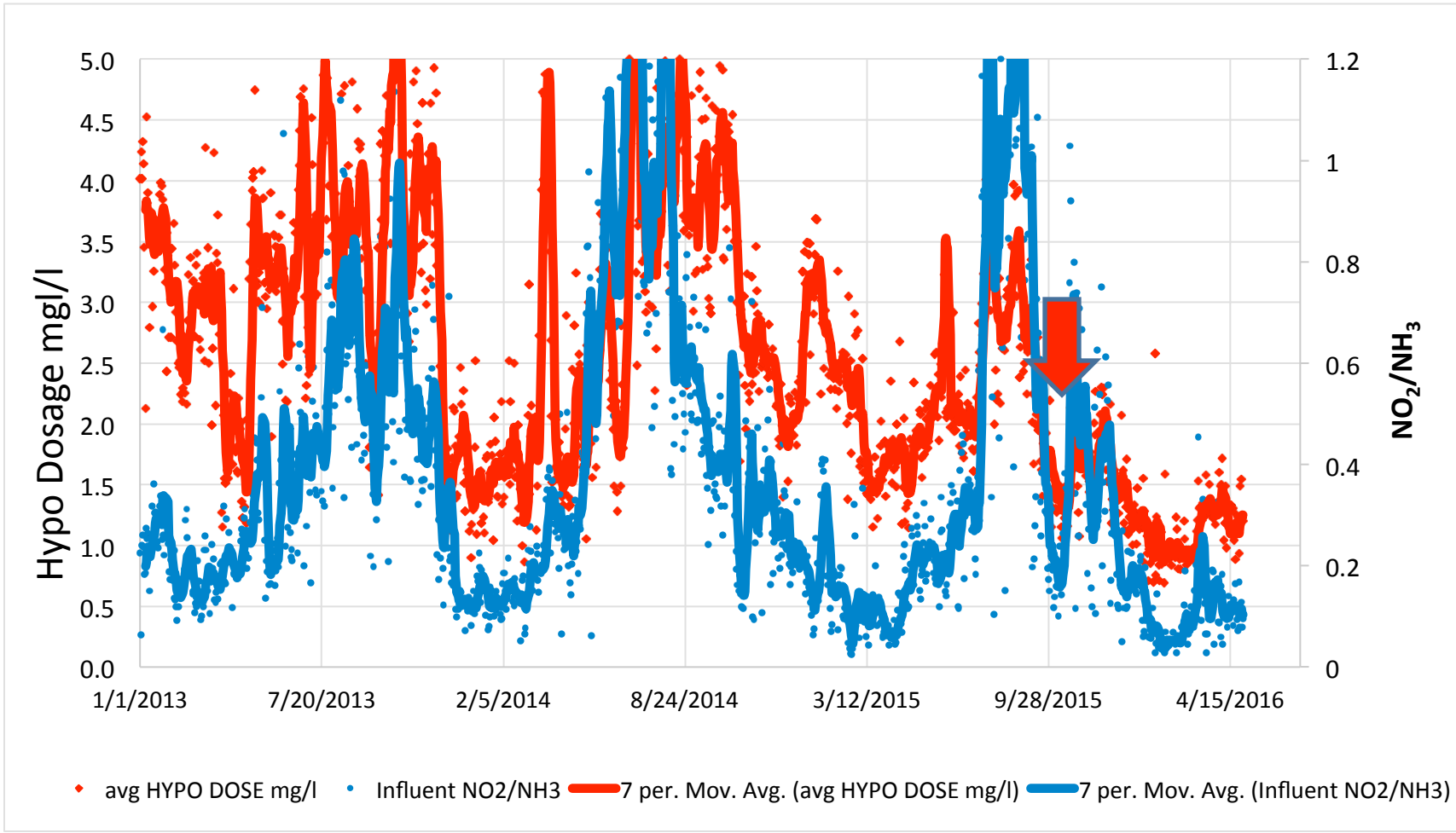
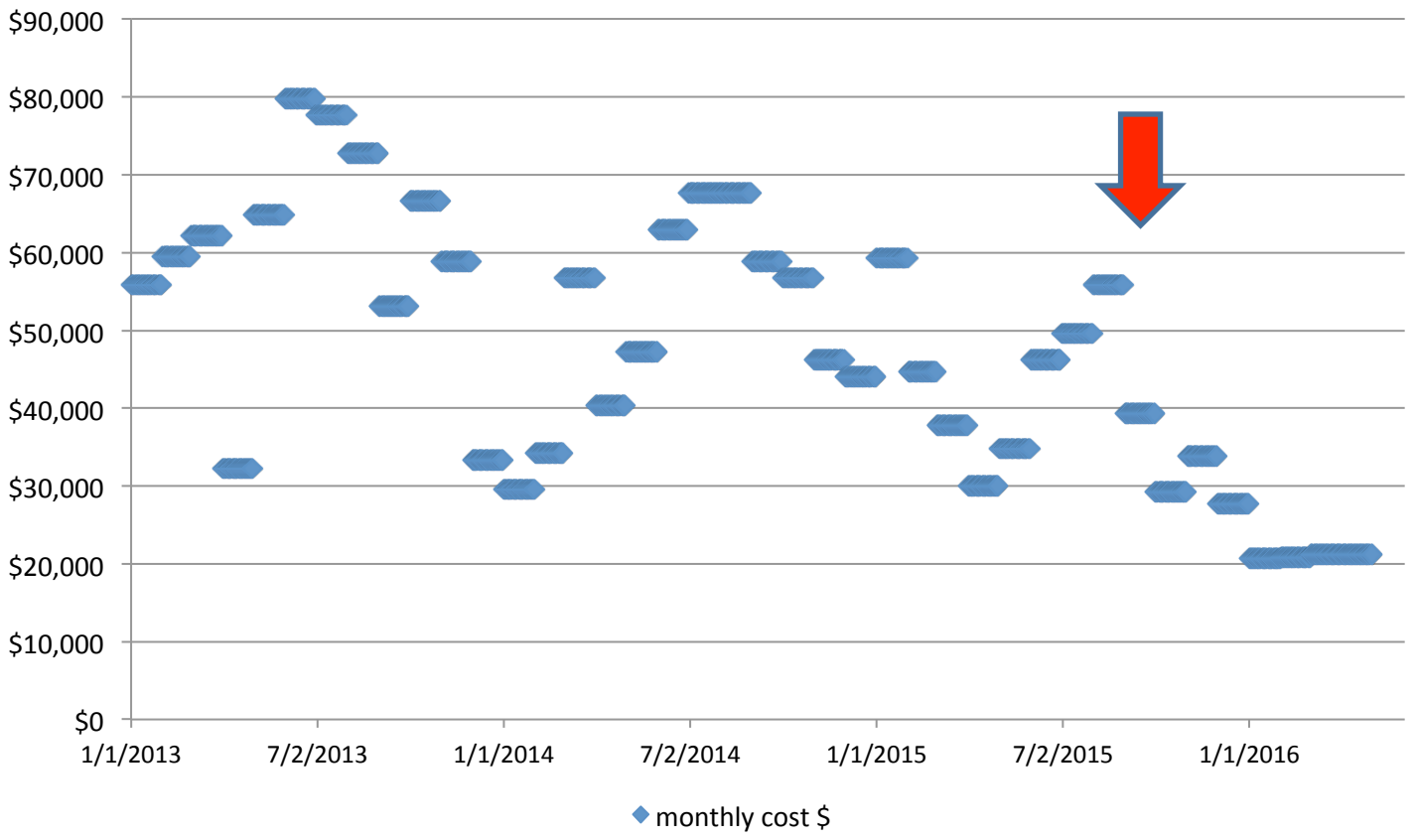


Monthly Cost $



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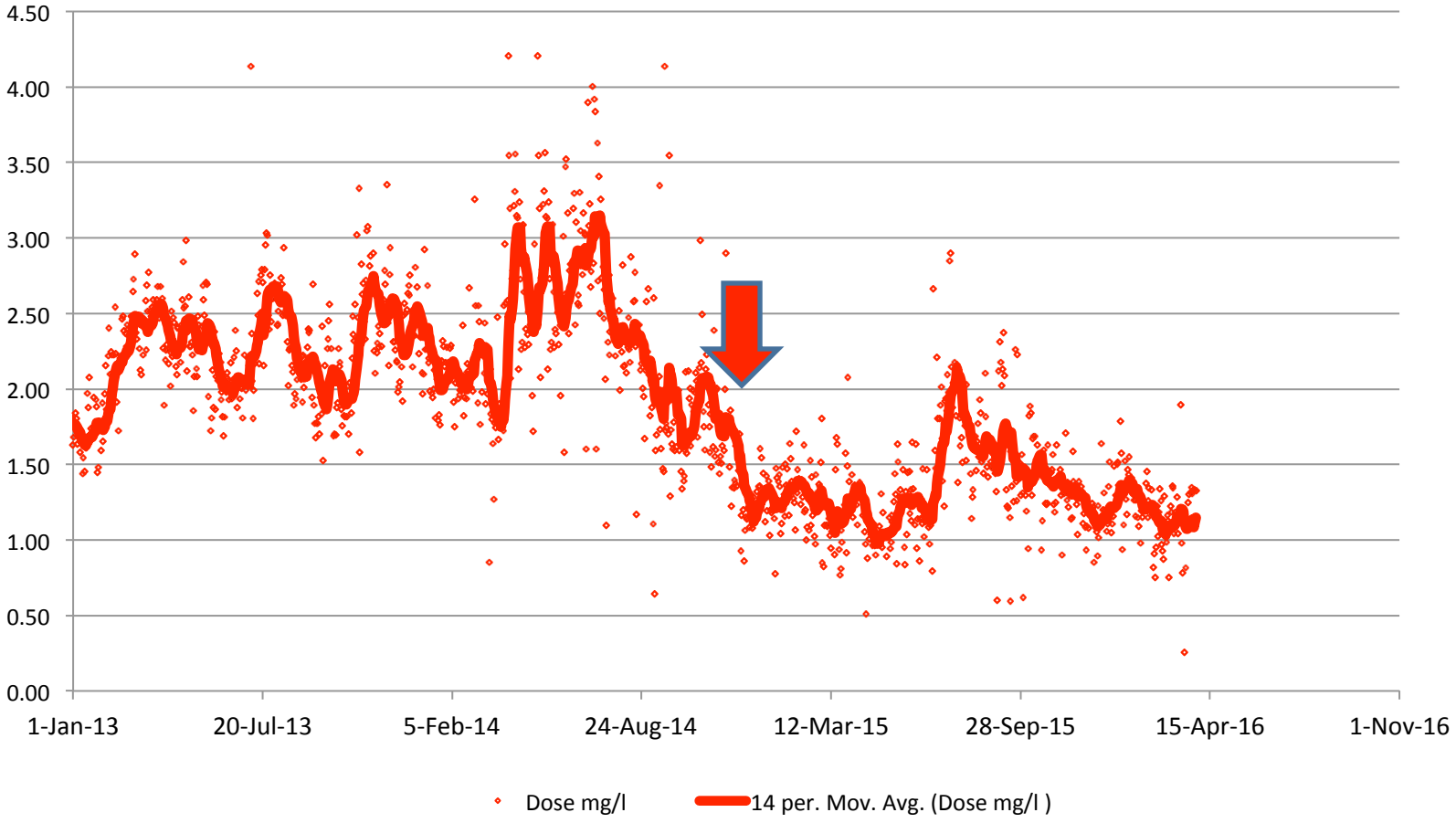
Wards Island mg/l



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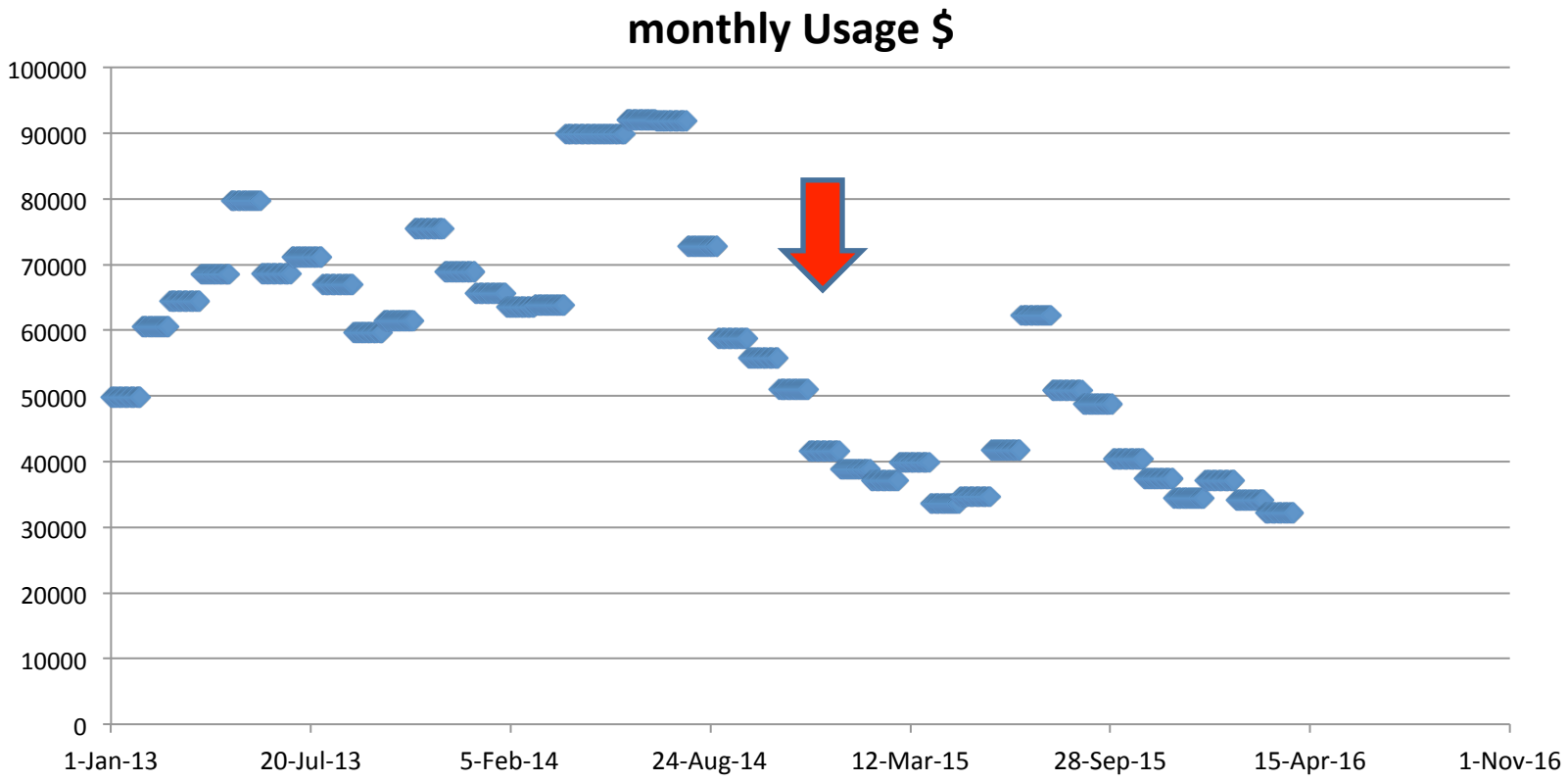


Challenges

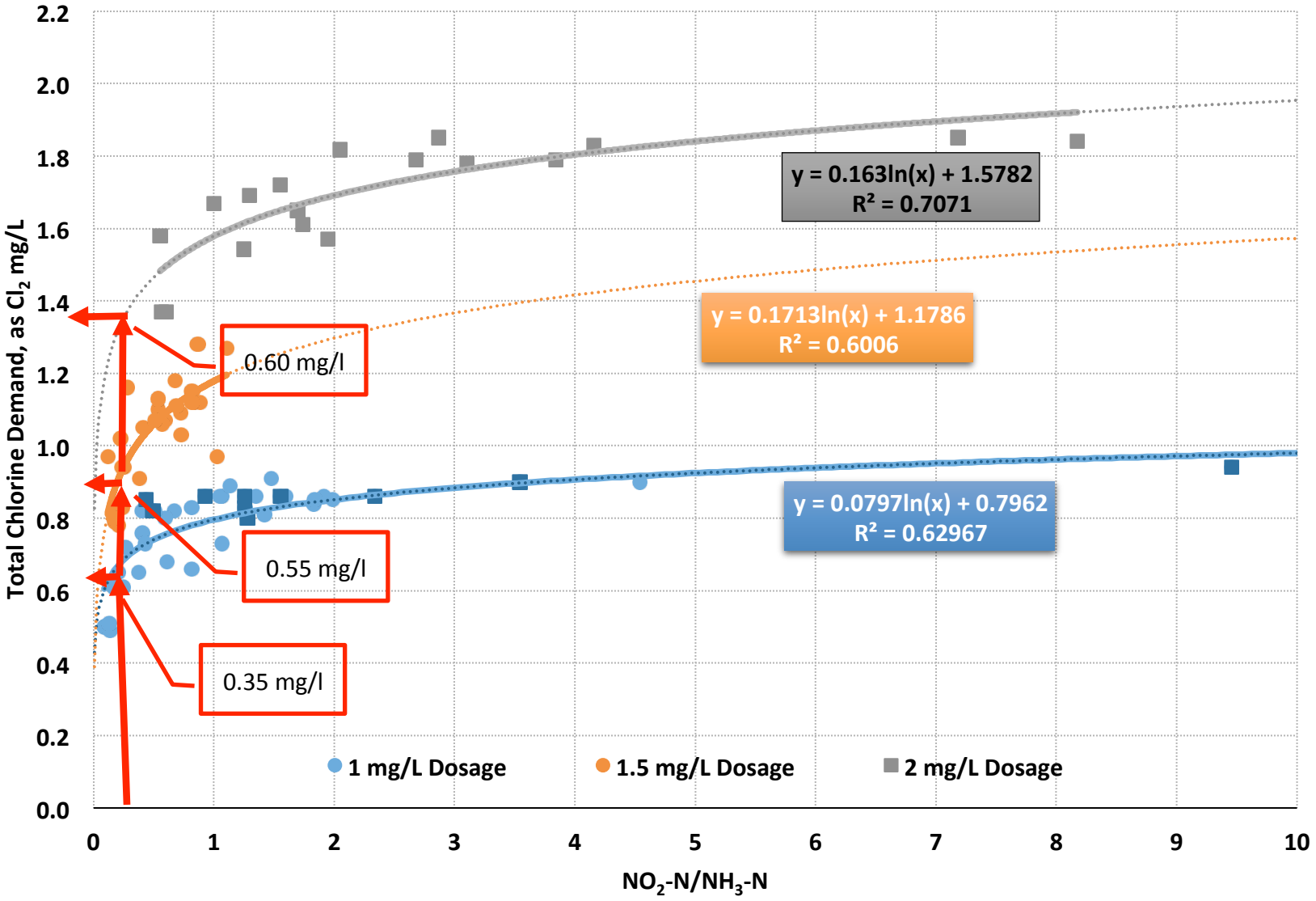
- Operators training
  - Maintain Constant Dose instead of constant residual

- Operation
  - Set lower residual target – disinfect, not sanitize
  - Limit Nitrification in pass D to control ratio of NO_2/NH_3
  - Tune automatic dosage controls, preference to Flow-Pacing

Challenges

DOSE = Demand + Residual

?


Total Chlorine Demand, as Cl_2 mg/L
NO_2-N/NH_3-N
y = 0.163ln(x) + 1.5782
R² = 0.7071
y = 0.1713ln(x) + 1.1786
R² = 0.6006
y = 0.0797ln(x) + 0.7962
R² = 0.62967
0.60 mg/l
0.55 mg/l
0.35 mg/l
1 mg/L Dosage
1.5 mg/L Dosage
2 mg/L Dosage

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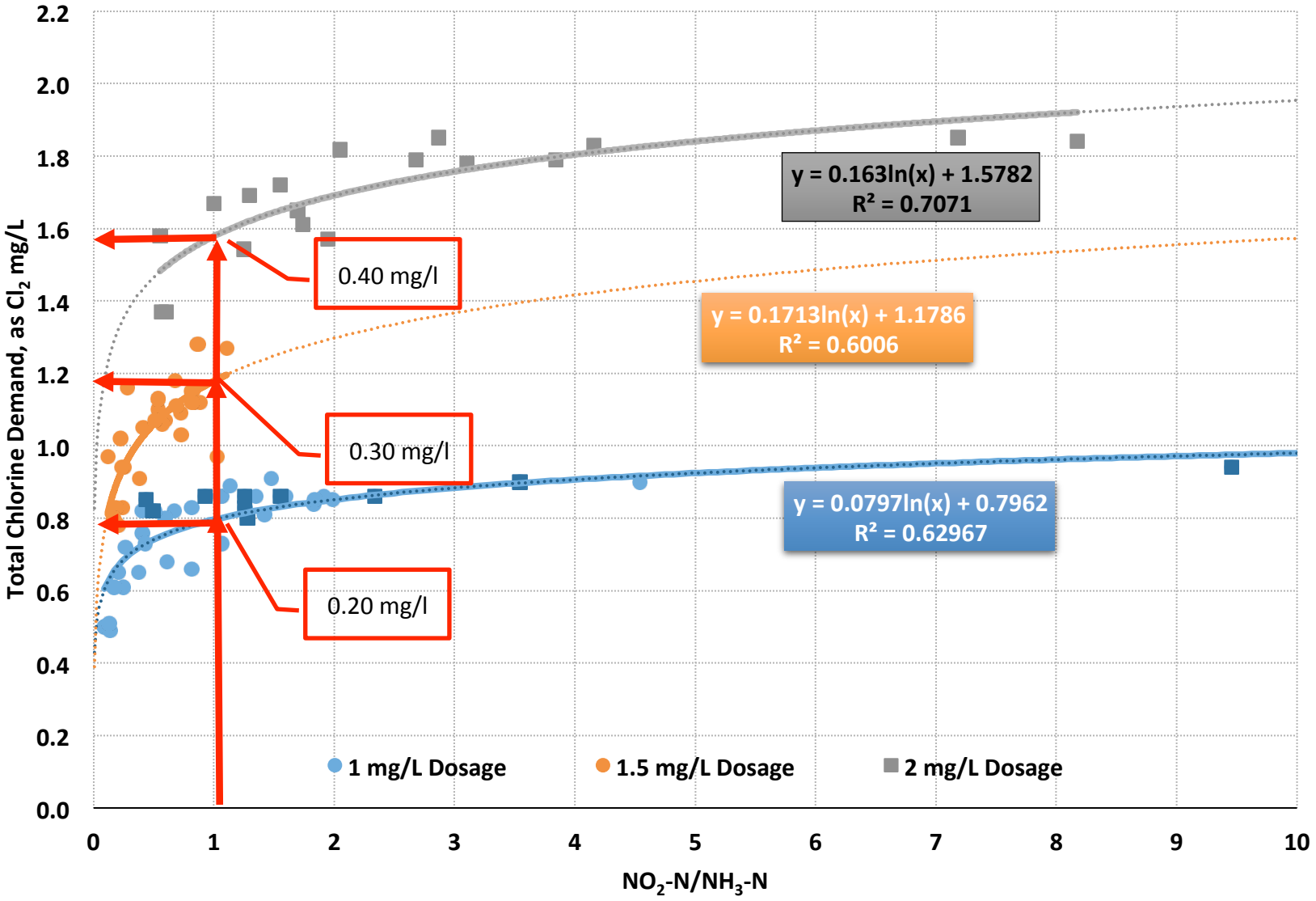

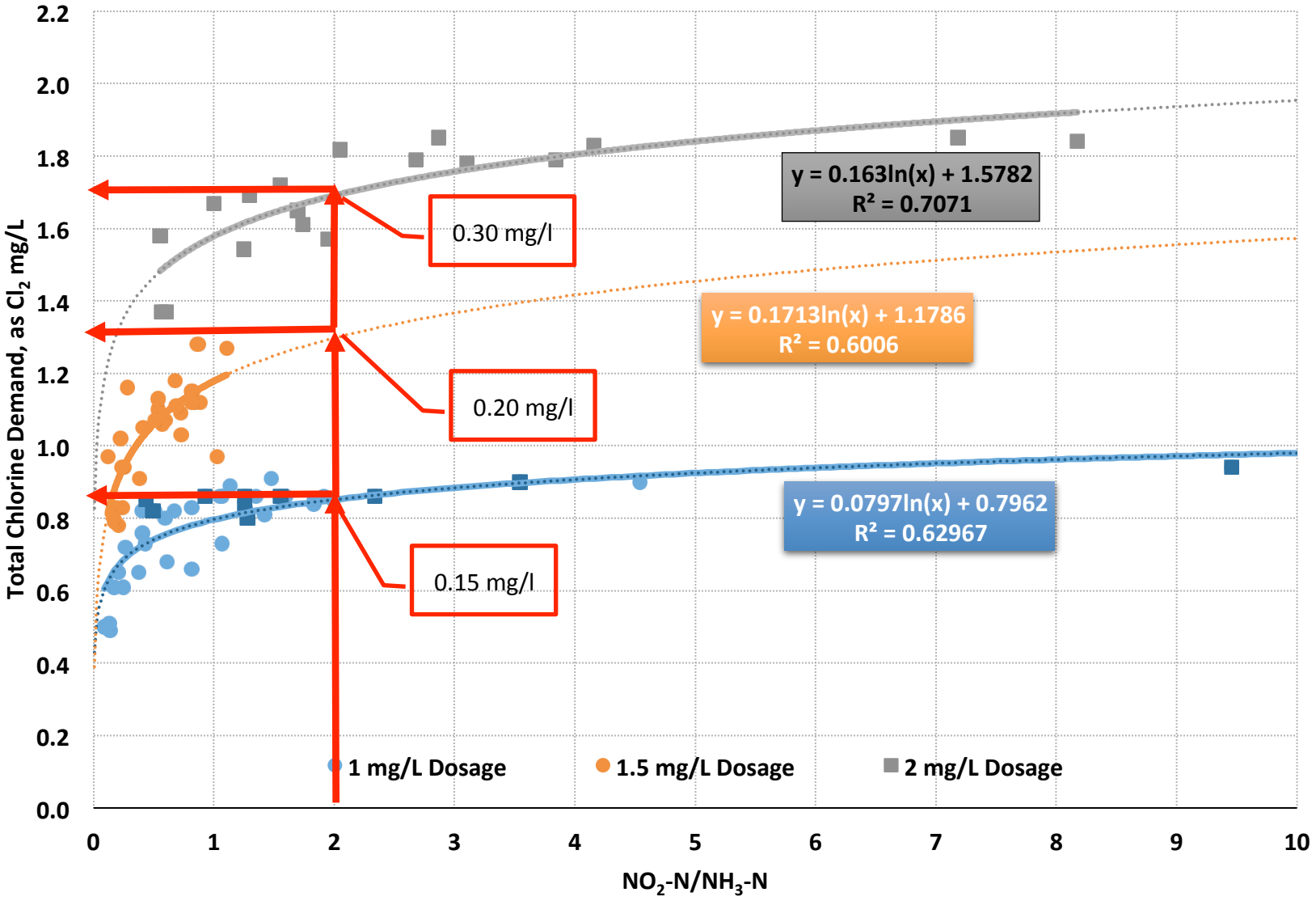
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R² = 0.6006
y = 0.0797ln(x) + 0.7962
R² = 0.62967
0.30 mg/l
0.20 mg/l
0.15 mg/l
1 mg/L Dosage
1.5 mg/L Dosage
2 mg/L Dosage

Effect of NO2/NH3 on demand and Residual

NO2/NH3 →	0.2	1.0	2.0
Dose (mg/l)	TRC (mg/l)	TRC (mg/l)	TRC (mg/l)
1.0	0.35	0.20	0.15
1.5	0.55	0.30	0.20
2.0	0.60	0.40	0.30

Conclusions

- An accurate metering system, mixers, and some form of automation are necessary to achieve reliable disinfection.
- Dose control is more efficient than Residual control.
- Residual trimming, when the NO_2-N to NH_3-N ratio changes during the day, causes waste of chemical.
- In BNR plants, operators understanding of the process is fundamental.