Ina Road Bench Testing and Field Data Collection Results for Disinfection, THMs, and NDMA formation

January 2010

CH2MHILL

Outline

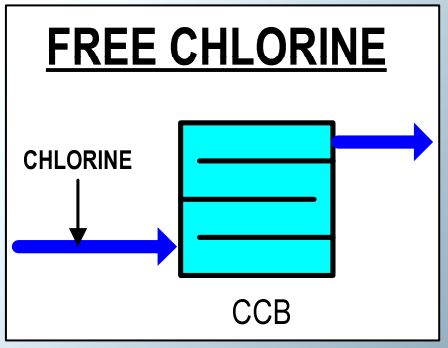
- Background
- Proposed chlorination approaches
- Bench Testing Results
- Field Data Collection Results
- Recommendations

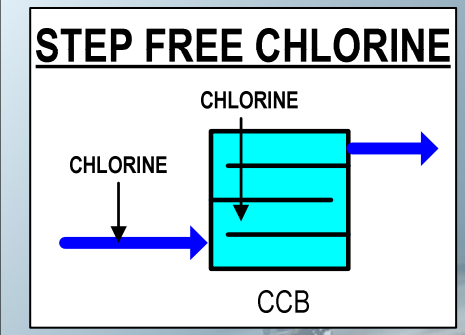
Applicable Effluent Limits

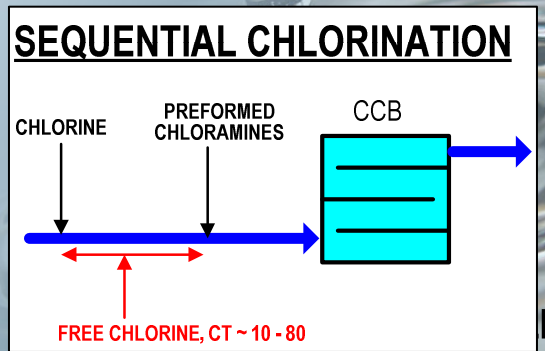
- E. Coli:
  - Four out of seven samples, non-detect
  - Maximum single sample: 15 cfu/100mL
- Total Trihalomethanes (TTHM)
  - Current: 100 ug/L (Reporting limit of 80 ug/L)
  - Future: 80 ug/L (Reporting limit of 64 ug/L)
- N-nitrosodimethylamine (NDMA):
  - 30 ng/L

Managing Disinfection, THMs, and NDMA:
Potential Chlorination Approaches

Disinfection Approach	Disinfecting Power	TTHM Formation Potential	NDMA Formation Potential
Free Chlorine (target CT of 100 per ROMP)	High	**High**	Low
Step Free Chlorine (target CT of 100 per ROMP)	High	**High?**	Low
Sequential Chlorination (target CT of 30 for free Cl2 followed by monochloramine)	Medium / High	Low / Medium	Low / Medium







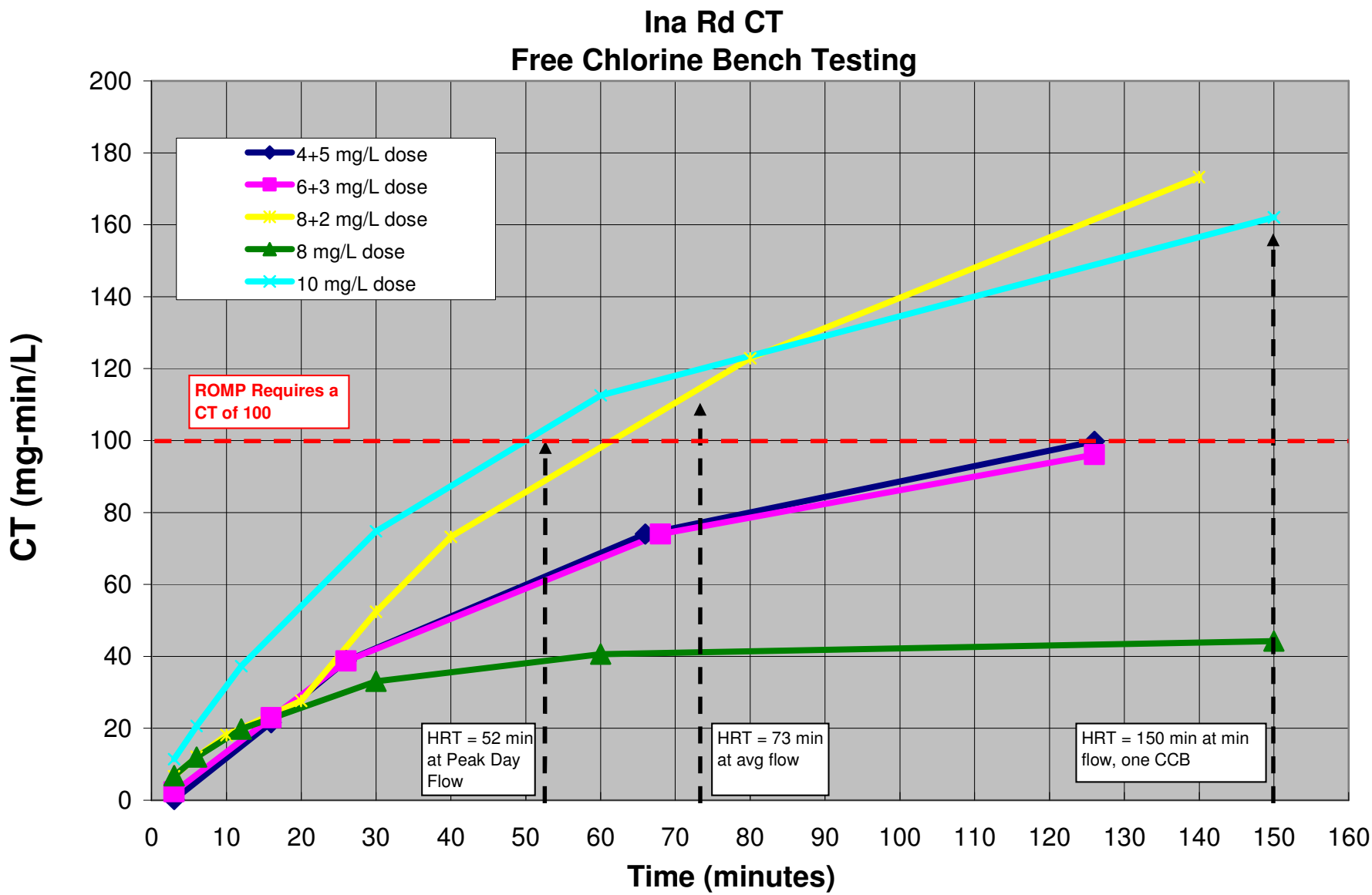
Bench Testing and Field Data Collection

- Bench Testing
  - Primary Goal: Evaluate TTHM and NDMA formation for three chlorination approaches
  - Secondary Goal: Evaluate disinfection efficacy of E. Coli

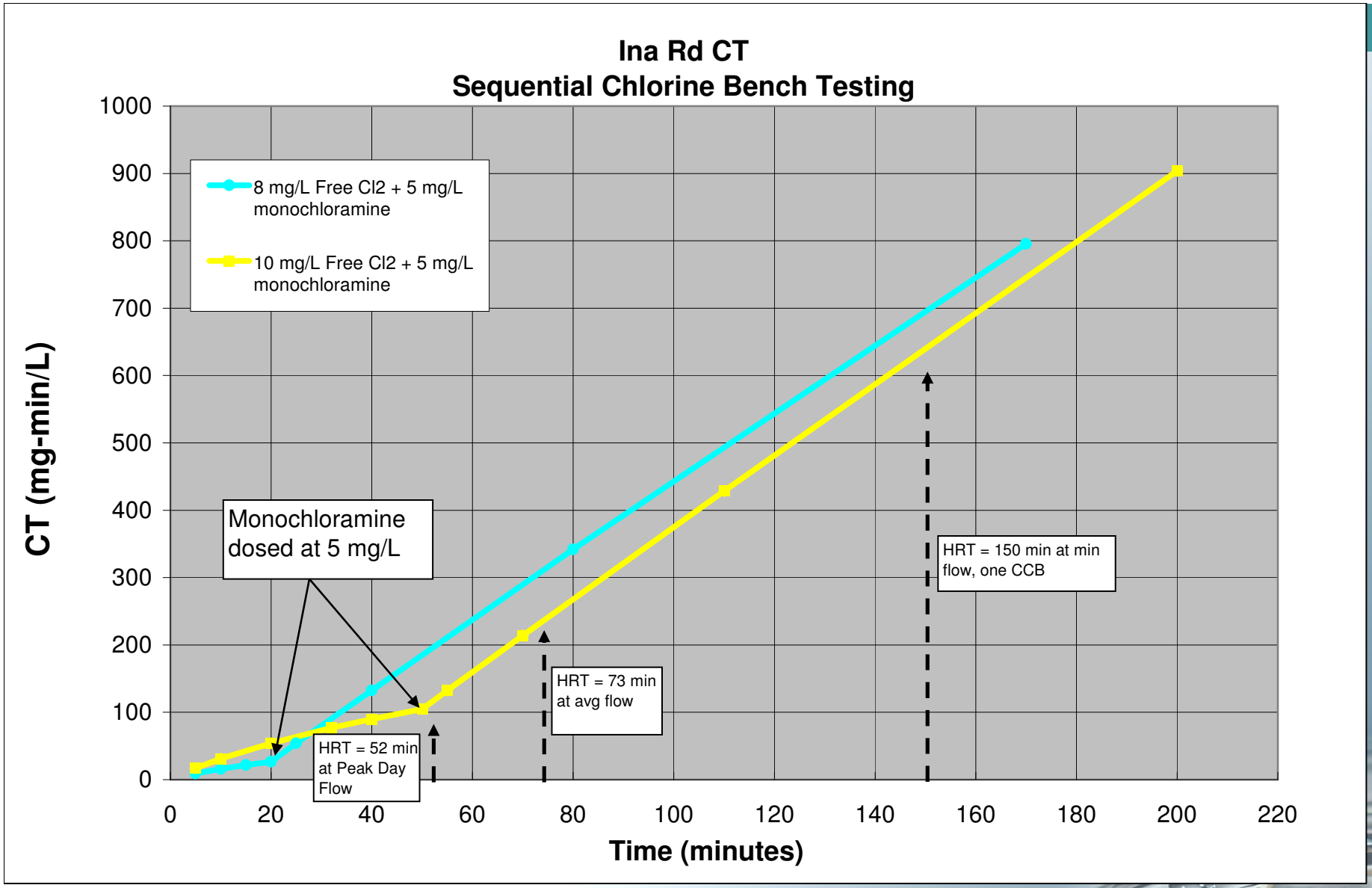
- Field Data Collection
  - Primary Goals:
    - Evaluate disinfection efficacy of E. Coli during full-scale chlorination at East Plant
    - Observe effluent ammonia variation and its impact on chlorination
  - Secondary Goal: Evaluate TTHM and NDMA formation during full-scale chlorination at East Plant

Bench Testing Results

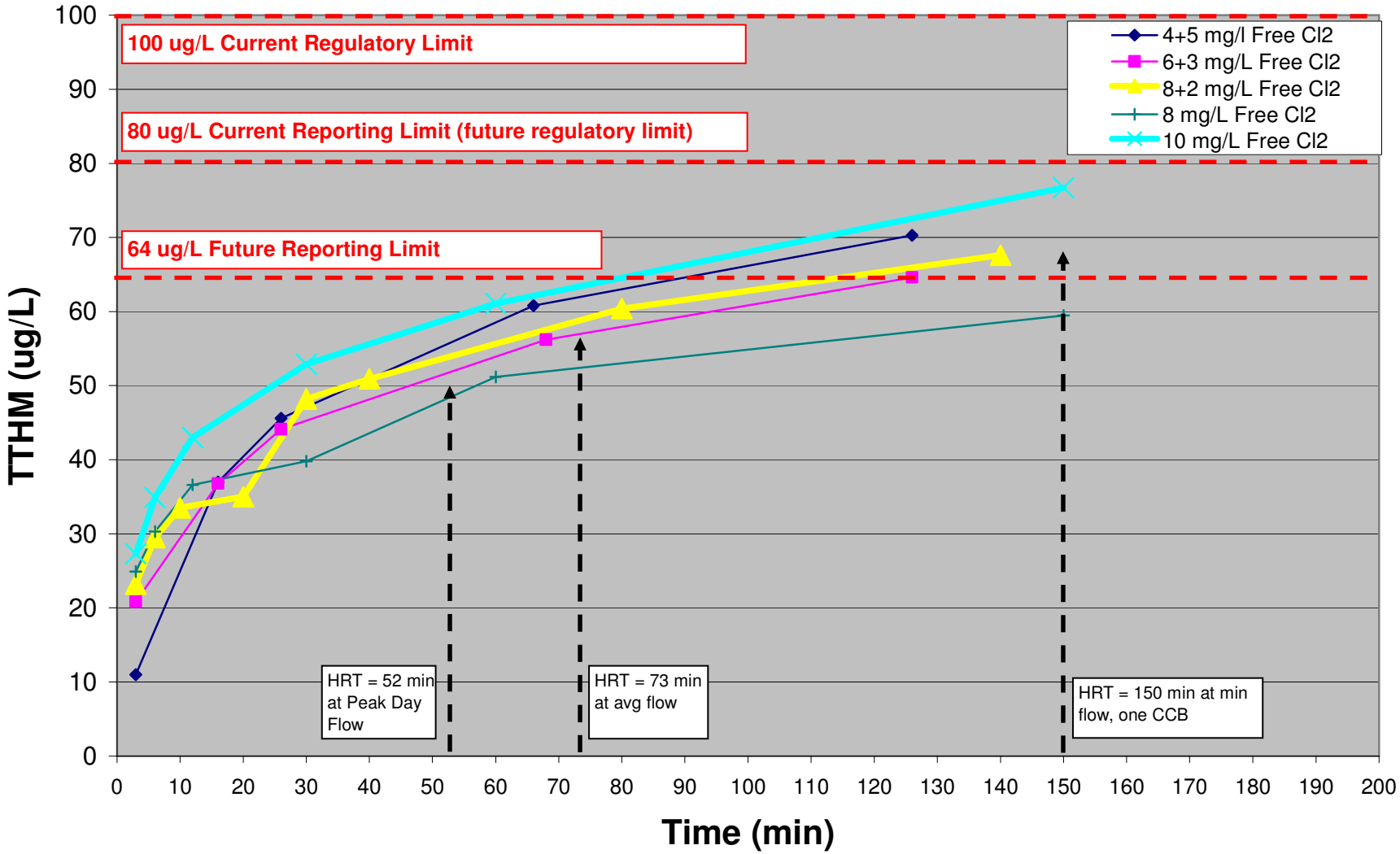
- Sample water quality:
  - Low ammonia: <0.1 mg/L NH3-N
  - Low TSS: 5.6 mg/L
  - DOC: 5.76 mg/L
  - Total coliform: 67,000 cfu/100mL
  - E. Coli: 4,200 cfu/100mL
- Free chlorine, step chlorine, and sequential chlorination testing conducted over 2-day period



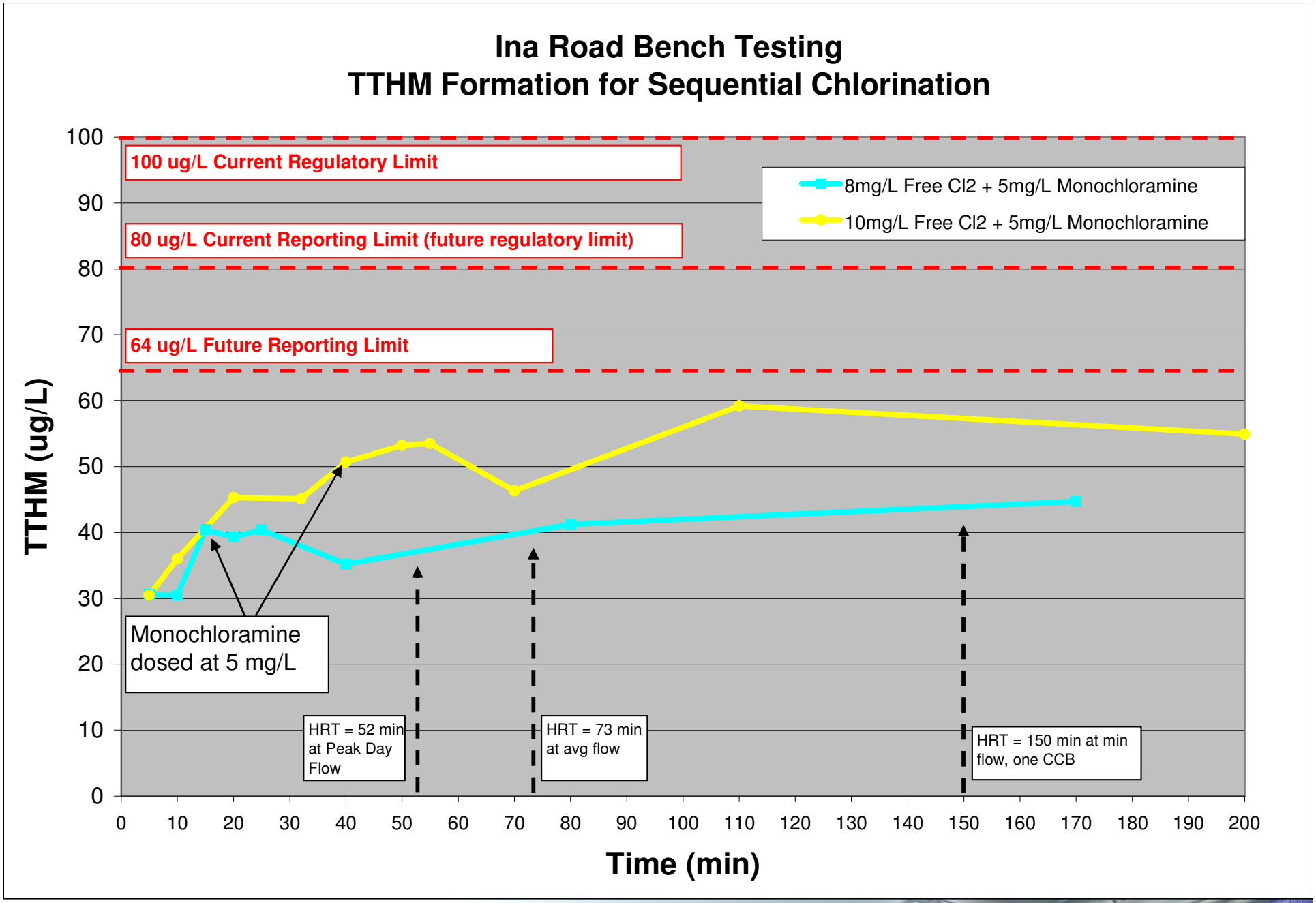
- Conclusions: Free chlorine dose of at least 10 mg/L (one dose or step chlorine dose) required to achieve CT of 100 mg-min/L



- Conclusions: Targeting ~30 mg-min/L CT for free chlorine followed by monochloramine; 8 mg/L free plus 5 mg/L monochloramine closer to target

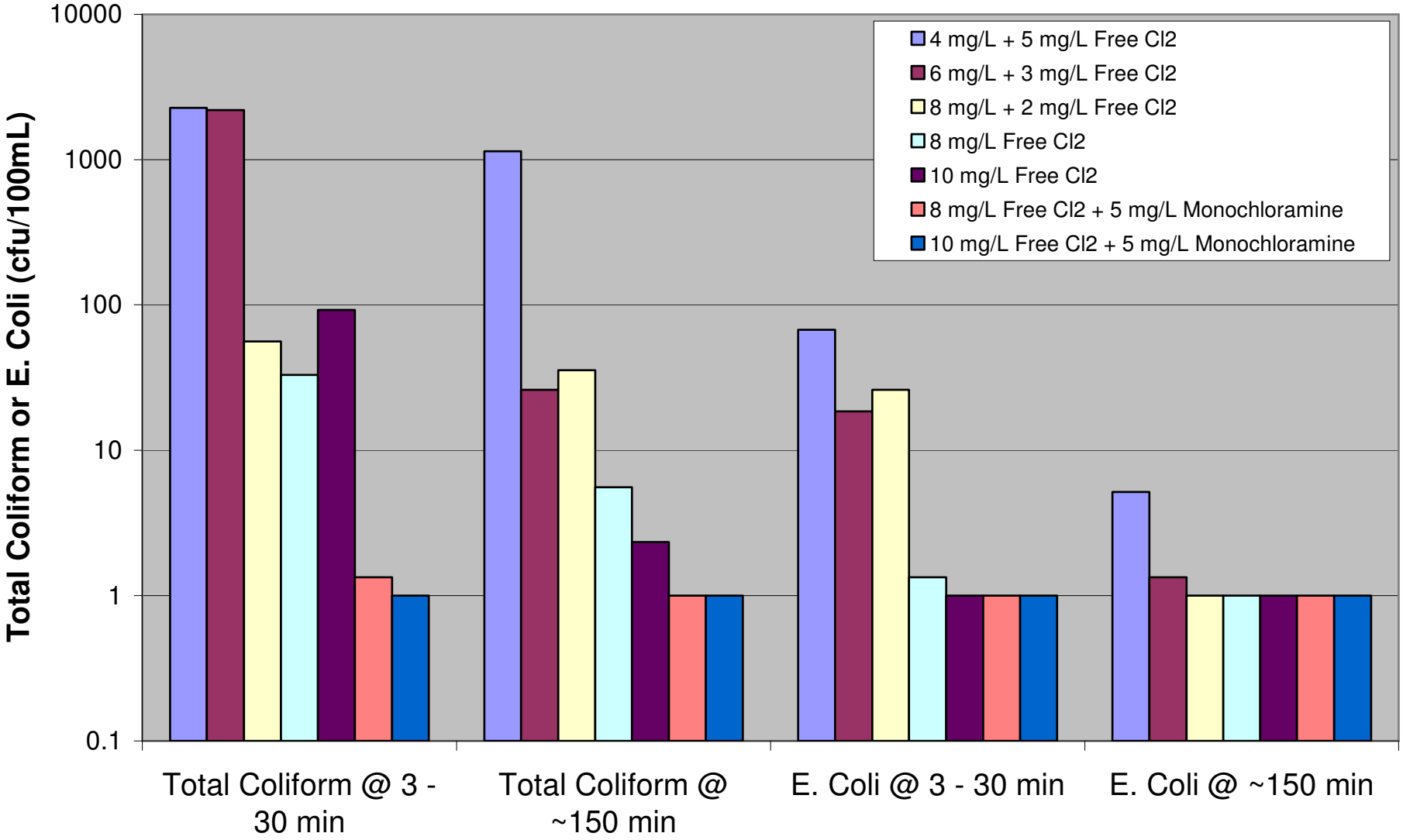


- Meeting current reporting limit and future regulatory and reporting limits may be challenging at average and minimum flows



- Sequential chlorination results in lower THM formation

Ina Road Bench Testing: Disinfection Results



- Sequential chlorination provided best disinfection

NDMA Bench Testing Results

- NDMA sampled at 30 minutes and 150 minutes for each chlorination approach
- NDMA was below detection limit (1 ng/L) for all samples
- Conclusion
  - Free chlorine and preformed monochloramines produce very little NDMA (consistent with literature)
  - If form chloramines in bulk water, NDMA formation would likely be significant

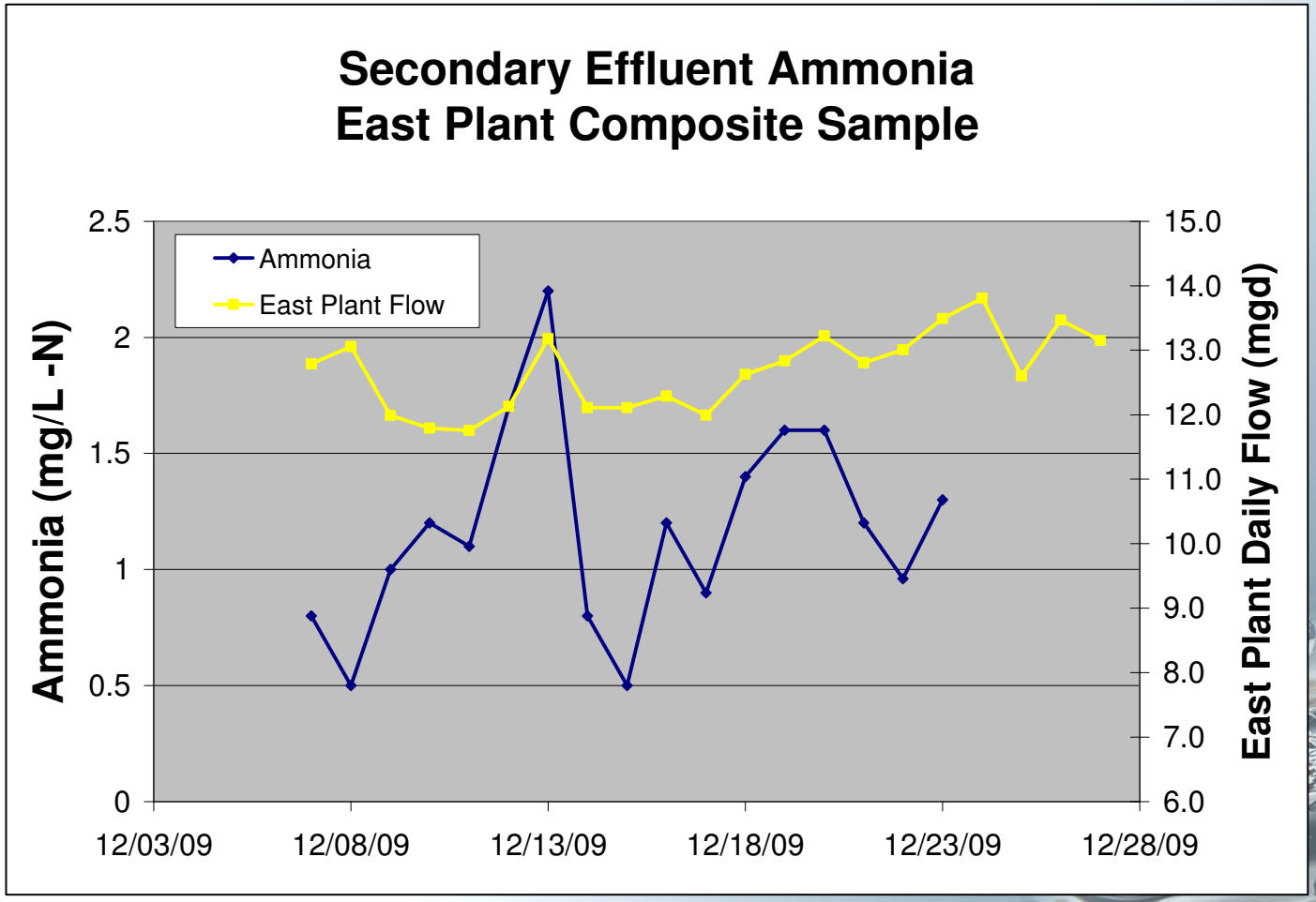
Bench Test Conclusions

- Free Chlorine or Step Free Chlorine
  - THMs: Meeting current reporting limit and future regulatory and reporting limits may be challenging at average and minimum flows
  - NDMA: none formed
  - Chlorine Dose: Free chlorine dose of at least 10 mg/L (one dose or step chlorine dose) required to achieve CT of 100 mg-min/L
- Sequential Chlorination:
  - THMs: Sequential chlorination results in lower THM formation than free chlorine
  - NDMA: none formed
  - Disinfection: sequential chlorination outperformed free chlorine in inactivating total coliform and E. Coli
  - Chlorine Dose: 8 mg/L free chlorine followed by 5 mg/L monochloramine appear adequate with low THM formation; lower doses may be possible

East Plant Field Data Collection

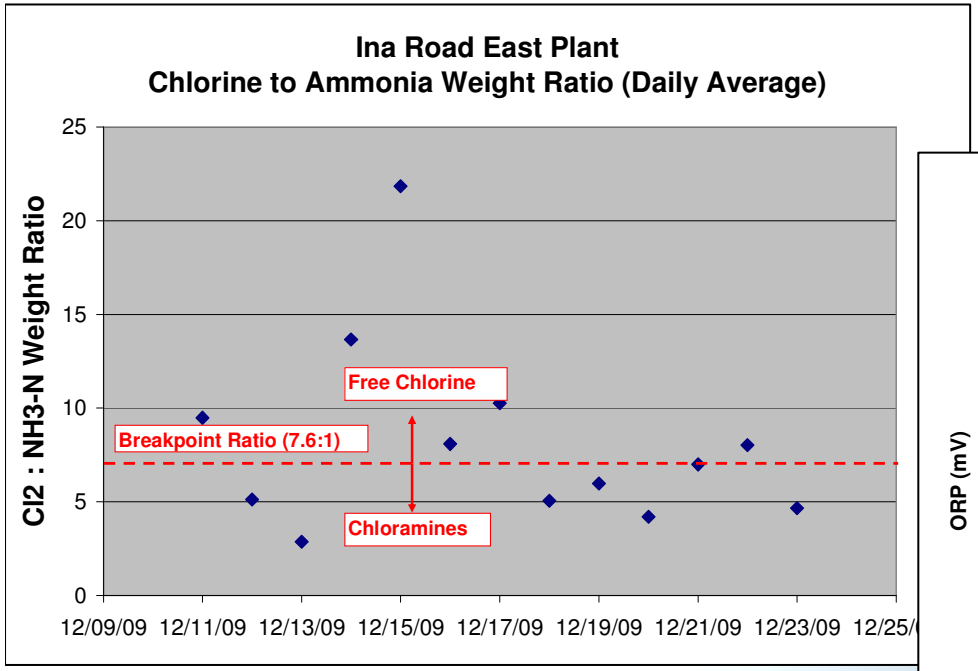
East Plant Ammonia

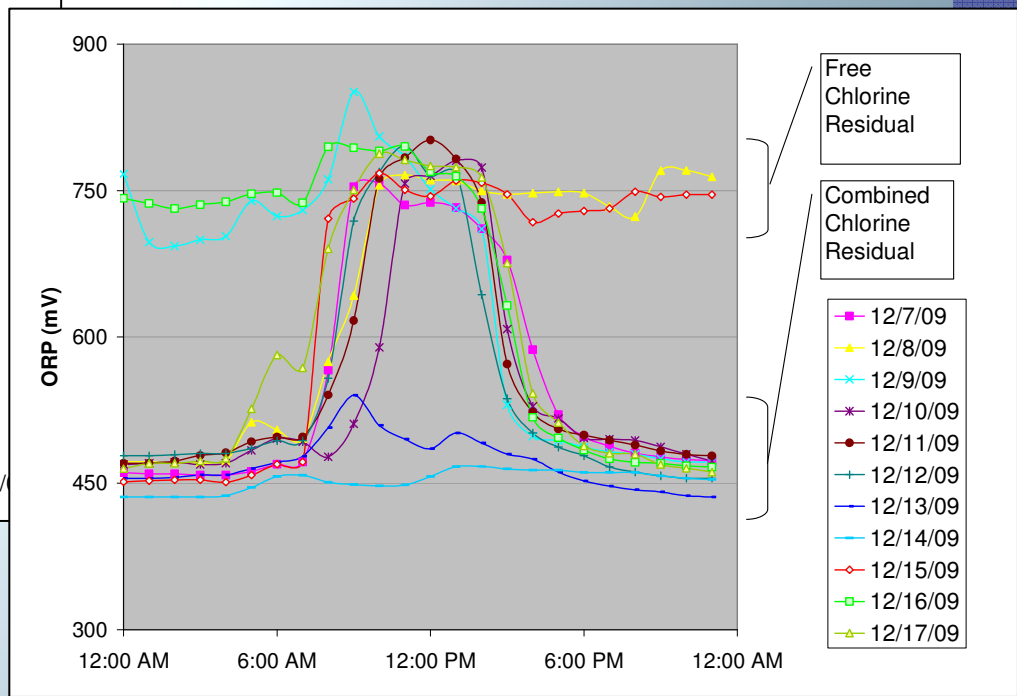
- Significant daily variation in effluent ammonia results in cycling between free chlorine residual and chloramine residual



Ammonia and Chlorine – East Plant

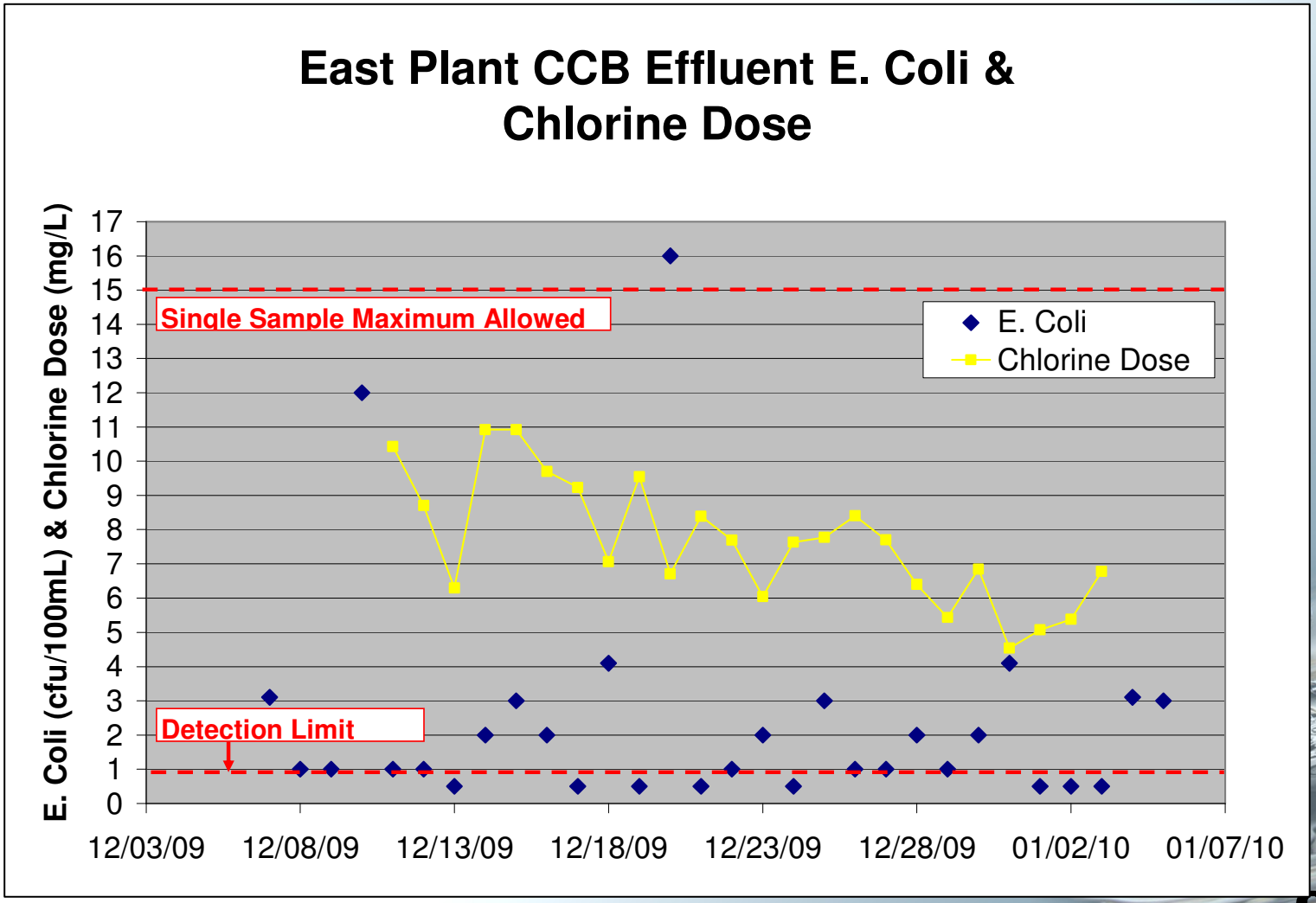
- Significant variation in effluent ammonia results in cycling between free chlorine residual and chloramine residual
  - Free chlorine often forms in the middle of the day, suggesting low ammonia levels at that time
- This will result in varying levels of disinfection and varying levels of NDMA and THM formation
  - NDMA will form when chloramines are present
  - THMs will form when free chlorine is present





East Plant Disinfection of E. Coli

- Single Sample Maximum (15 cfu/100mL) exceeded once
- Have not yet met 4 out of 7 non-detect requirement



East Plant THMs and NDMA

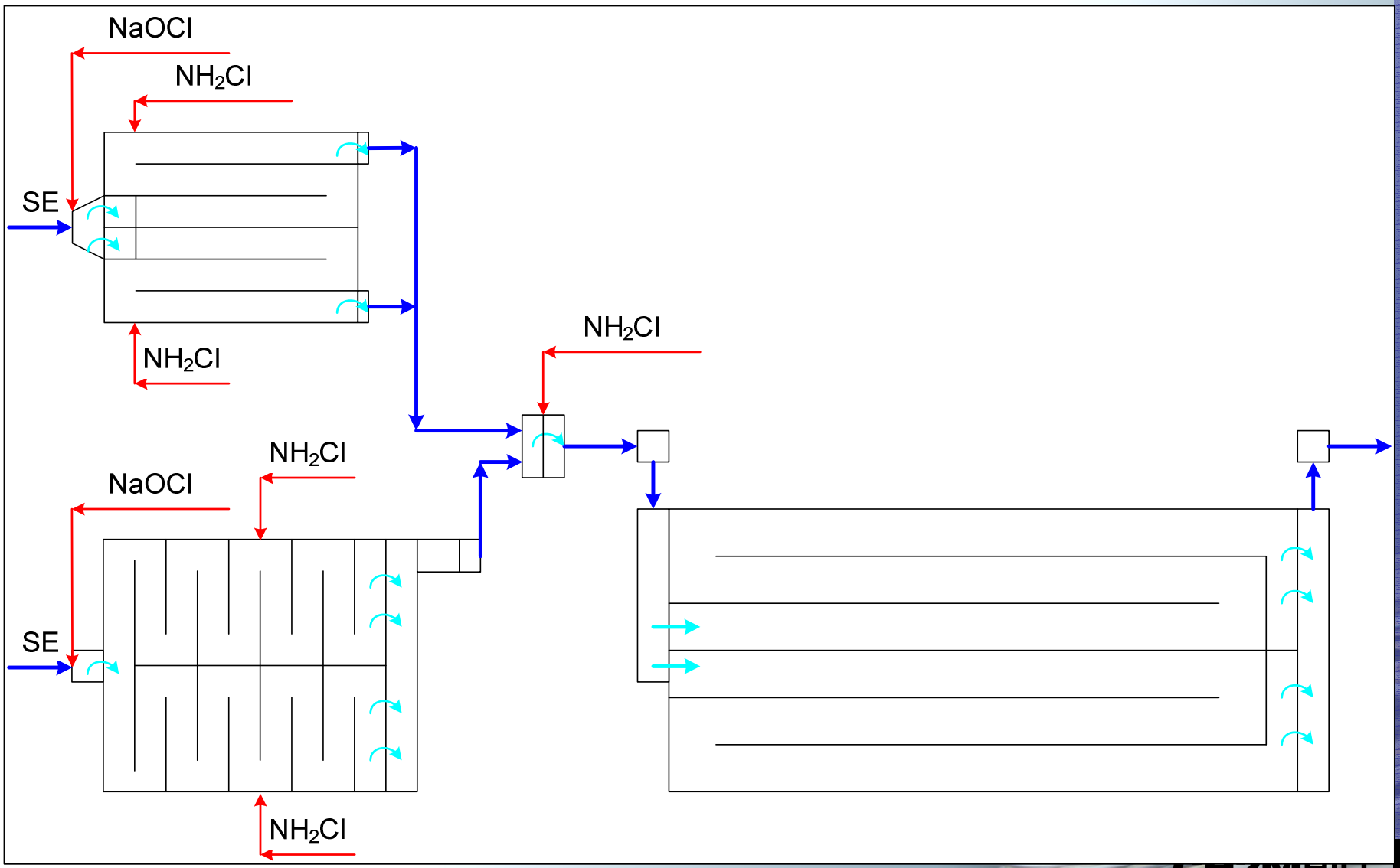
- No data yet

Recommendations

- Discuss full-scale testing of sequential chlorination
  - automated chlorine feed control (ammonia feedback loop); preformed chloramine mixing and injection

- Proceed with sequential chlorination approach
  - Free chlorine dose (4 – 12 mg/L); wide range allows implementation of free chlorine approach if so desired
  - Monochloramine dose (2 – 8 mg/L); provide multiple chloramine application points to maximize disinfection while minimizing NDMA and THM formation
    - Aqueous ammonia storage and feed system required
    - Preformed chloramine mixing facilities required

Chlorine (NaOCl) and Monochloramine (NH2Cl) Dosing Locations



Recommendations (continued)

- Continue collecting and analyzing full-scale data from East Plant
- Model effluent ammonia to determine daily variation