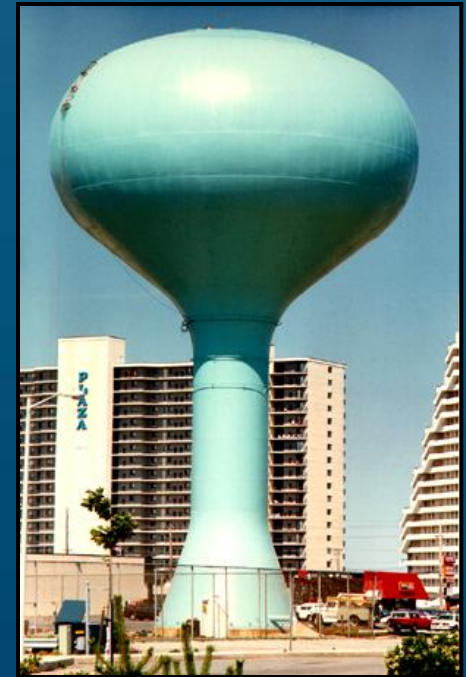


Balancing Microbial Control and Stage 2 DBP Rule Compliance (at Ocean City, Maryland)



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Pennsylvania
Section

American Water Works Association

May 4, 2012

Acknowledgements

- Town of Ocean City, MD DPW
 - Jim Parsons, PE
 - Bud Iman
- NCS Engineers – Bench-Scale Testing
 - Harish Arora, PhD, PE
 - Ashish Agrawal

Presentation Outline

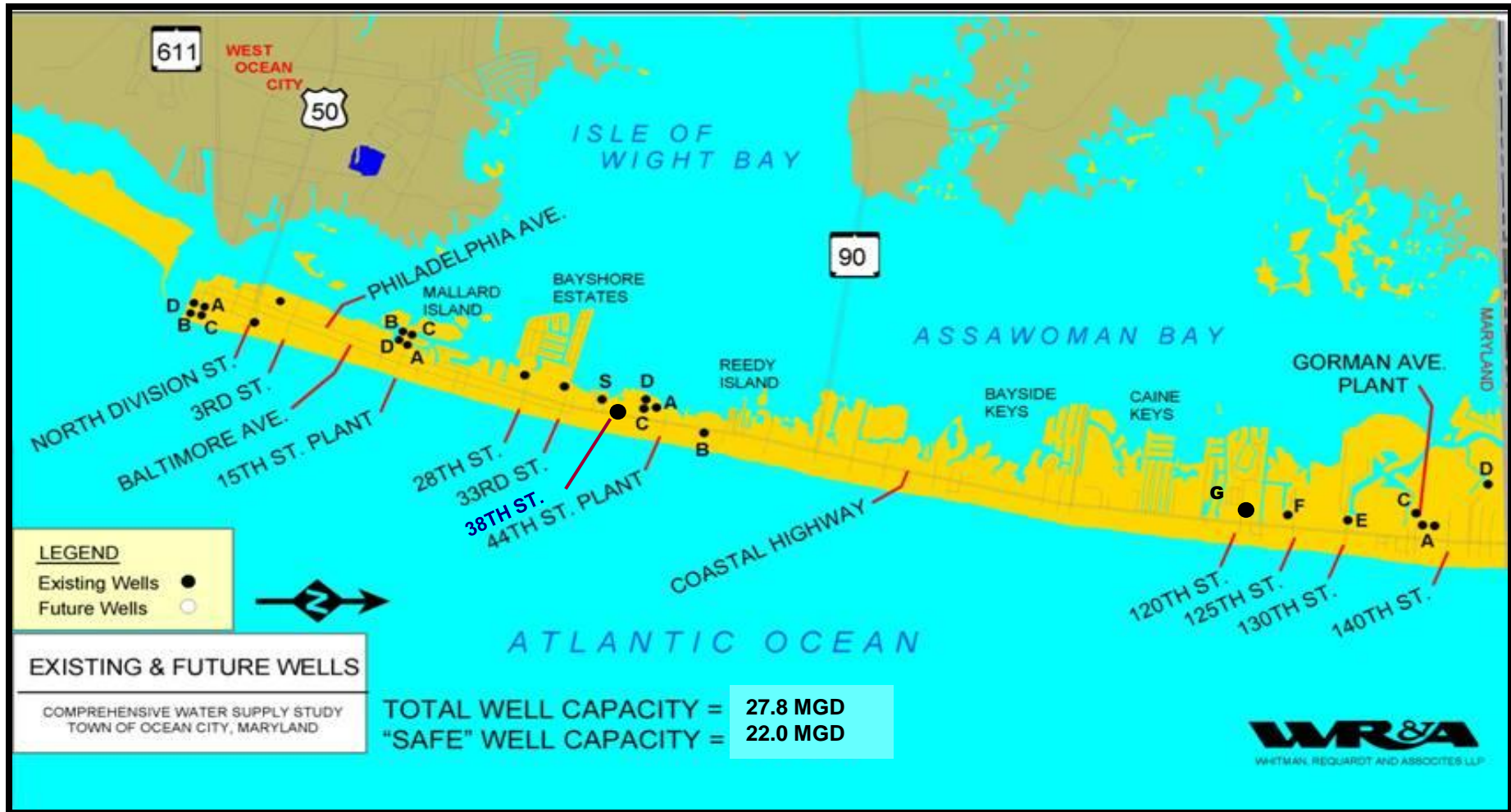
- Unique Water System Issues
- Source Water Quality Issues
- Distribution System Assessment
- Disinfection Byproducts
- Bench-Scale Testing
- Recommendations

Water System Issues

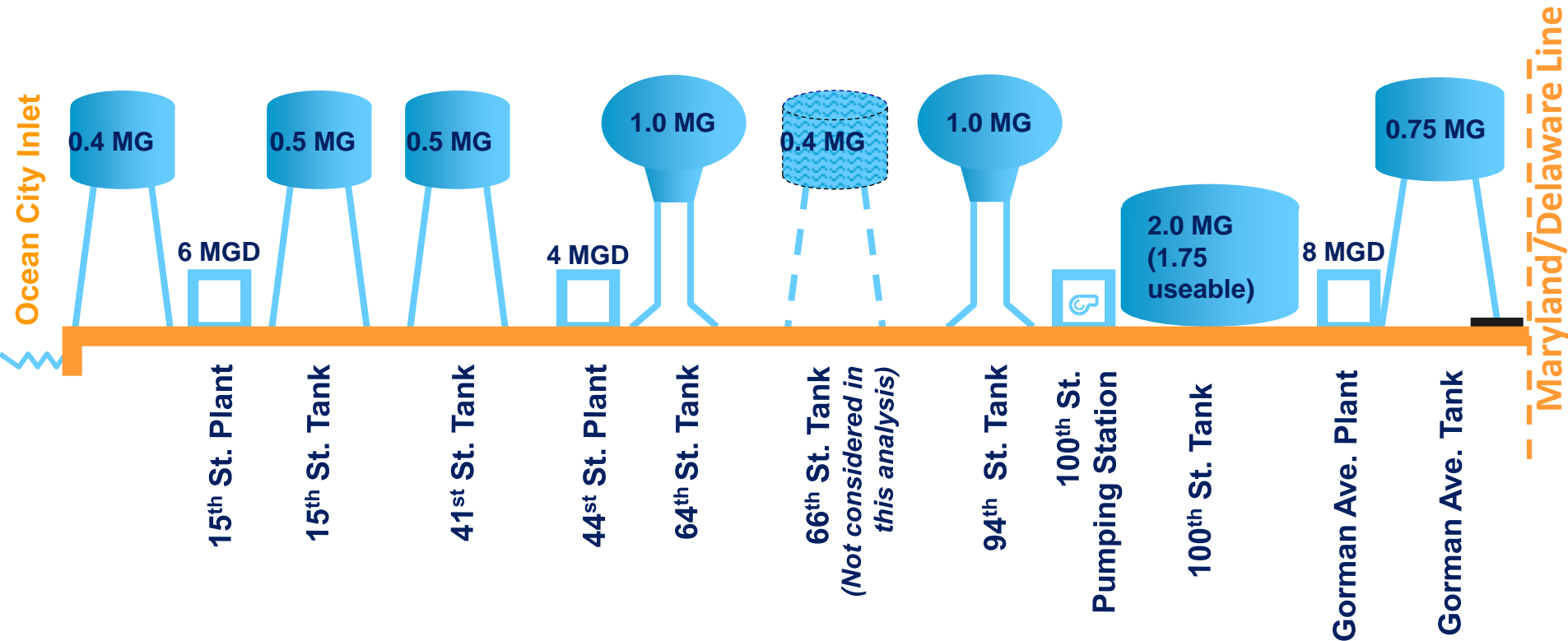
Town of Ocean City, Maryland

- Narrow system
 - 10 miles in length ; Dead-ends north & south
- Variable Water Demand
 - Off-season averages 2-4 mgd
 - Seasonal peak projected demand is 16.8 mgd
- Water Storage & Piping
 - Sized for maximum day demands & fire flow
- Water Treatment Plants
 - 3 separate plants operational during summer
 - 1 plant in service during off-season
 - 3 different WTP processes & 2 different aquifers

Ocean City Water System



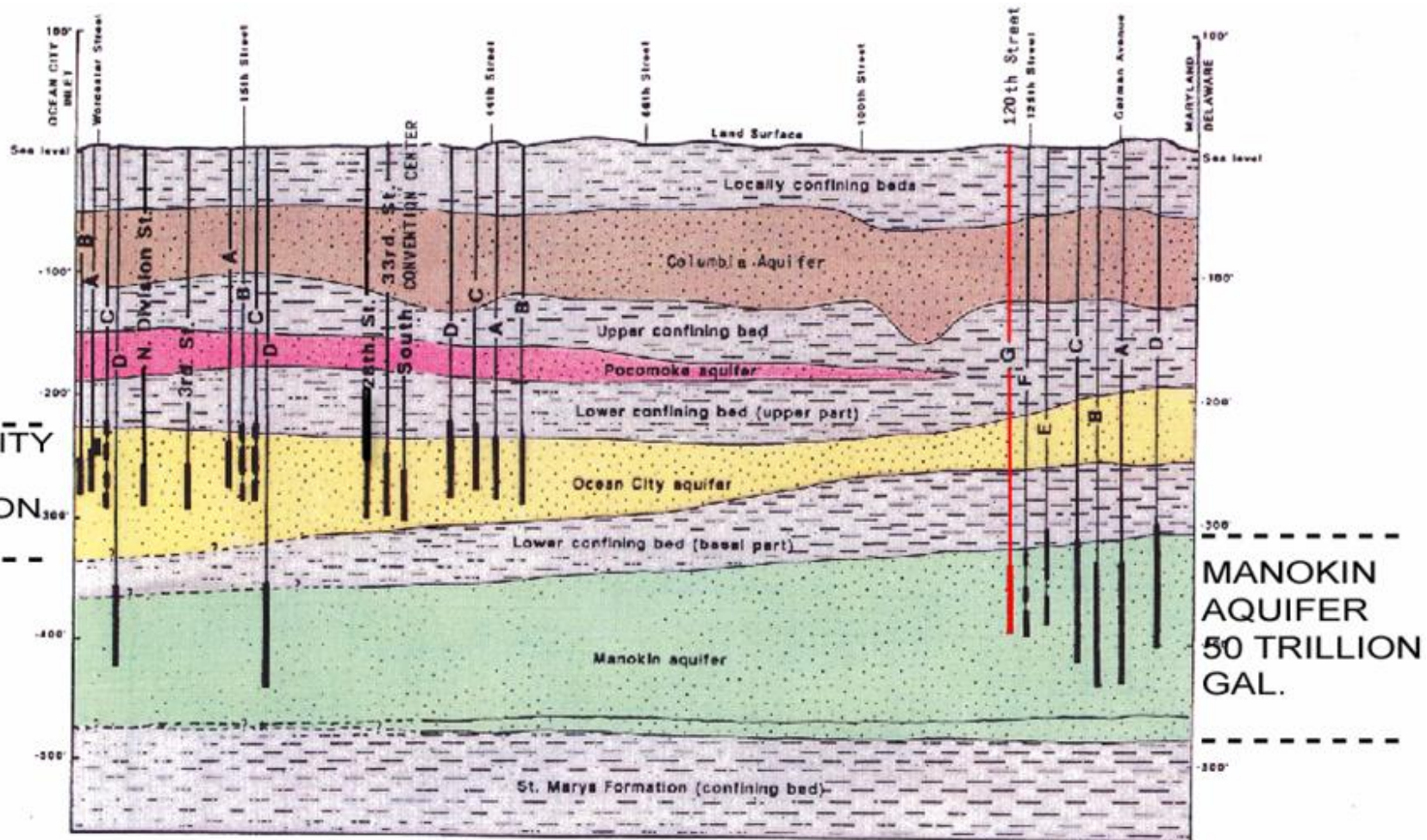
Ocean City Water System Profile



Total Usable Water Storage = 5.9 Million Gallons

Equivalent to : 8 hours during maximum day / 70 hours during minimum day

Ocean City Wells



Water Treatment Plants



**Gorman Avenue
Water Treatment
Plant - 8 MGD**

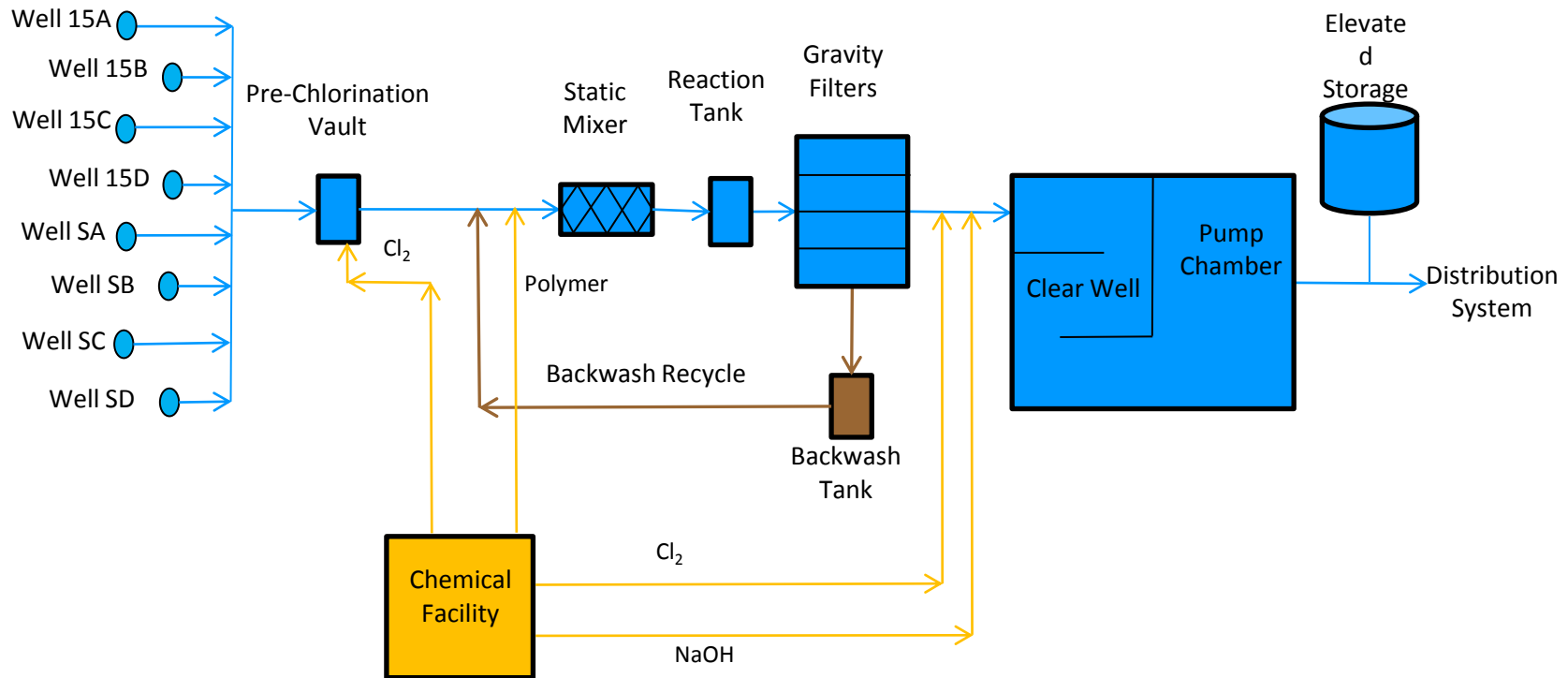


**44th Street Water
Treatment Plant
- 4 MGD**



15th Street Water Treatment Plant - 6 MGD

15th Street WTP



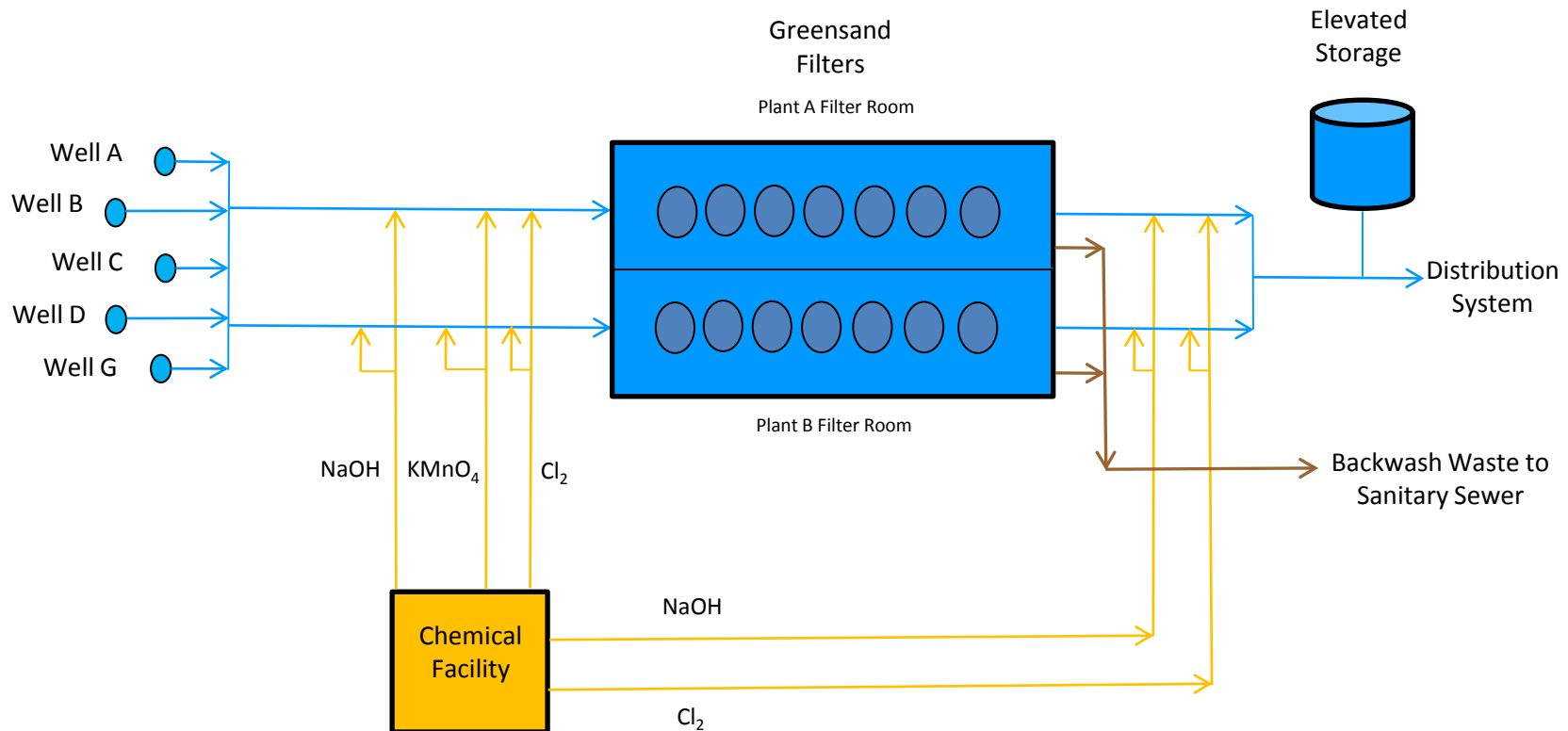
Source Water Quality:

Iron 1-3 mg/L

Ammonia: 0.3 – 0.4 mg/L

TOC: 1.2 – 5.3 mg/L

44th Street WTP



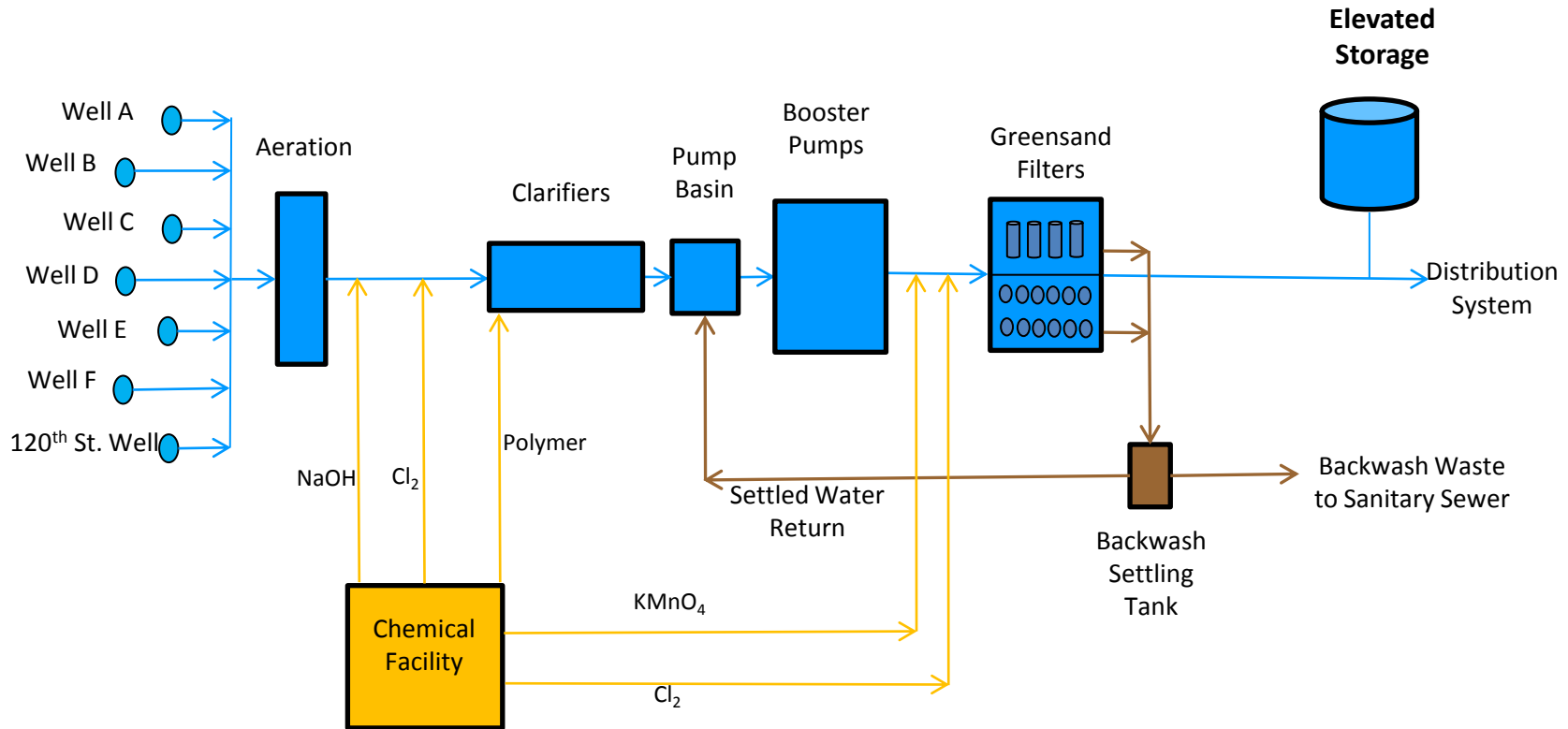
Source Water Quality:

Iron 3 - 7 mg/L

Ammonia: 0.4 – 0.8 mg/L

TOC: 1.3 – 4.5 mg/L

Gorman Avenue WTP



Source Water Quality:

Iron 4 - 13 mg/L

Ammonia: 0.8 – 1.4 mg/L

TOC: 3 – 10.7 mg/L

Distribution System Water Quality

Distribution System Water Quality Assessment performed in 2005 in response to several incidences of waterborne microbial contamination (primarily related to degradation of water quality within various buildings), recommending:

- Conduct an Enhanced Water Quality Monitoring Program
- Loop dead-ends & incorporate automatic flushing devices
- Consider unidirectional flushing program
- Formalize cross-connection control program
- Consider proactive community outreach

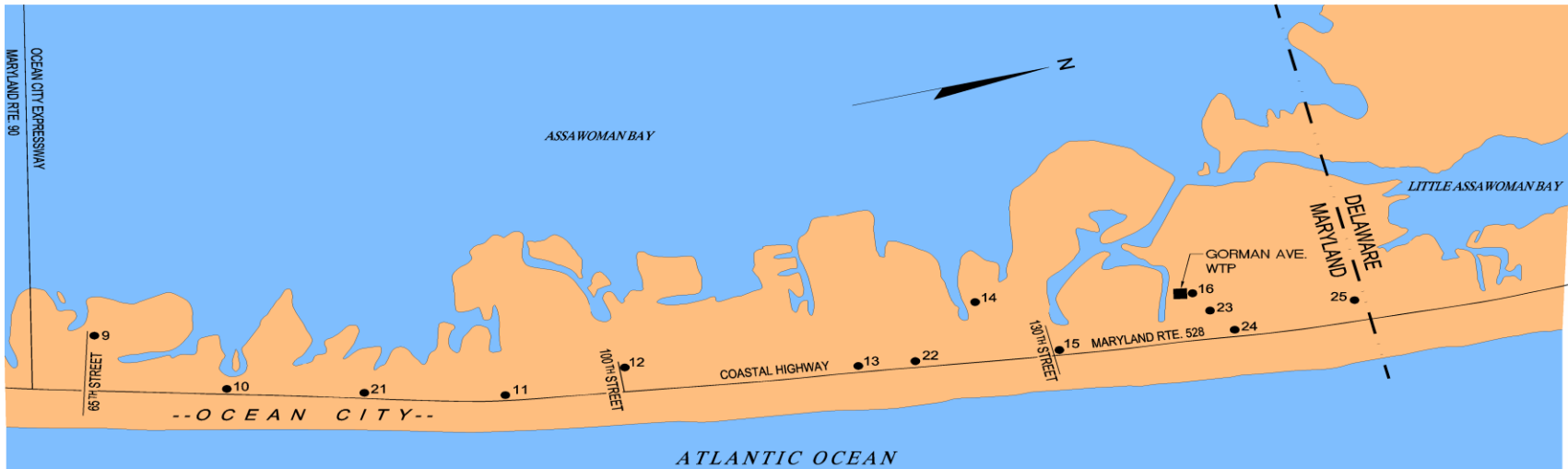
Enhanced Water Quality Monitoring

- Increased number of sampling sites (to 25) for weekly sampling with number adjusted monthly to be proportional to estimated customers served
- Analytical parameters included: Free & Total Chlorine, Total Coliforms, pH, Heterotrophic Plate Count (HPC)
- Data entry into electronic database
- Monitoring began October 2005 & will continue indefinitely

Ammonia Monitoring

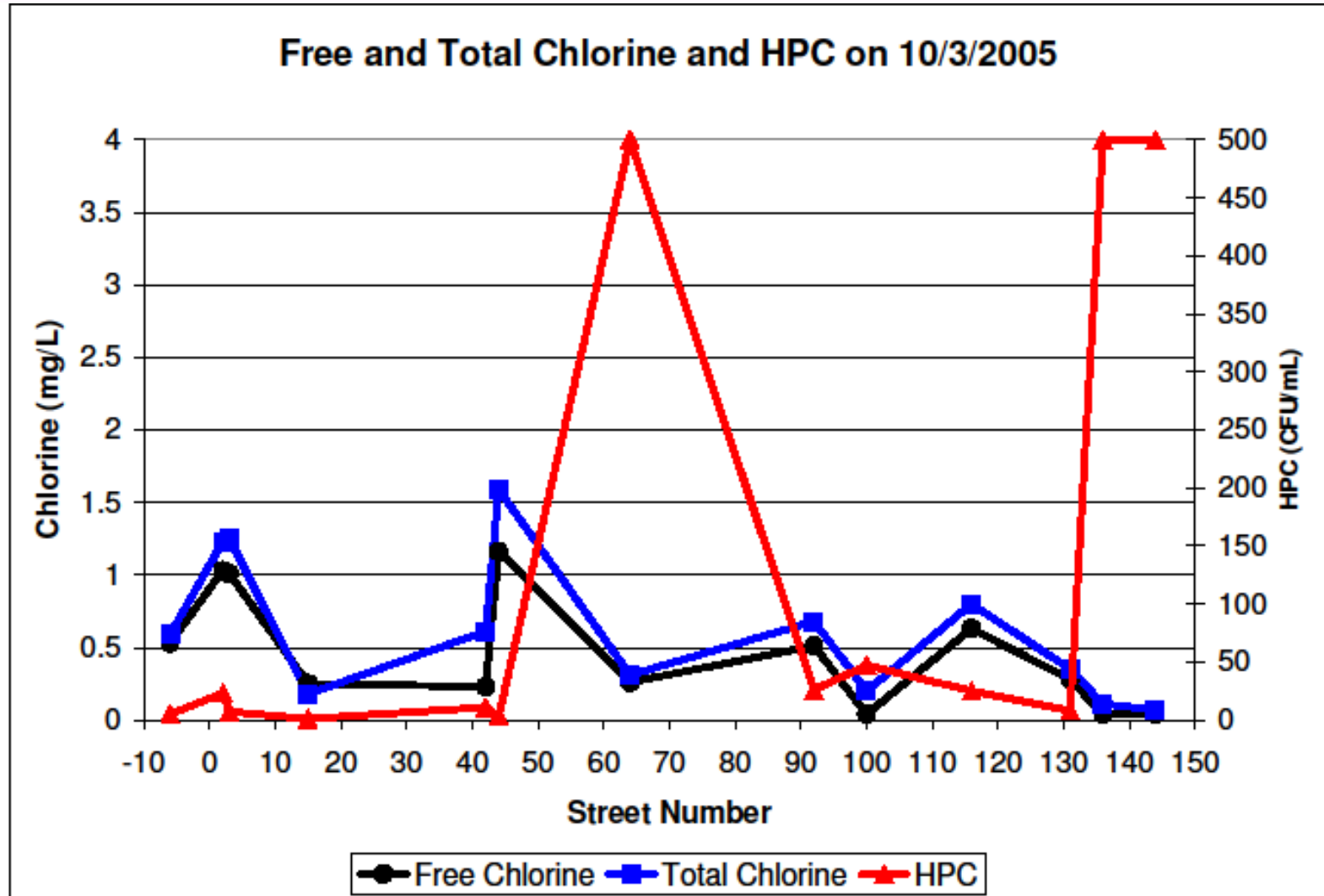
- Raw water & finished water sampled for ammonia & chloramines subsequent to observation of large difference between free chlorine & total chlorine
- High proportion of monochloramines (up to 90% of total) especially in northern portions of the system with the Gorman Ave. WTP in service
- Resulting in sporadic instances of inadvertent chloramination
- Ammonia concentrations vary from 0.3 – 1.7 mg/L

Sample Site Map

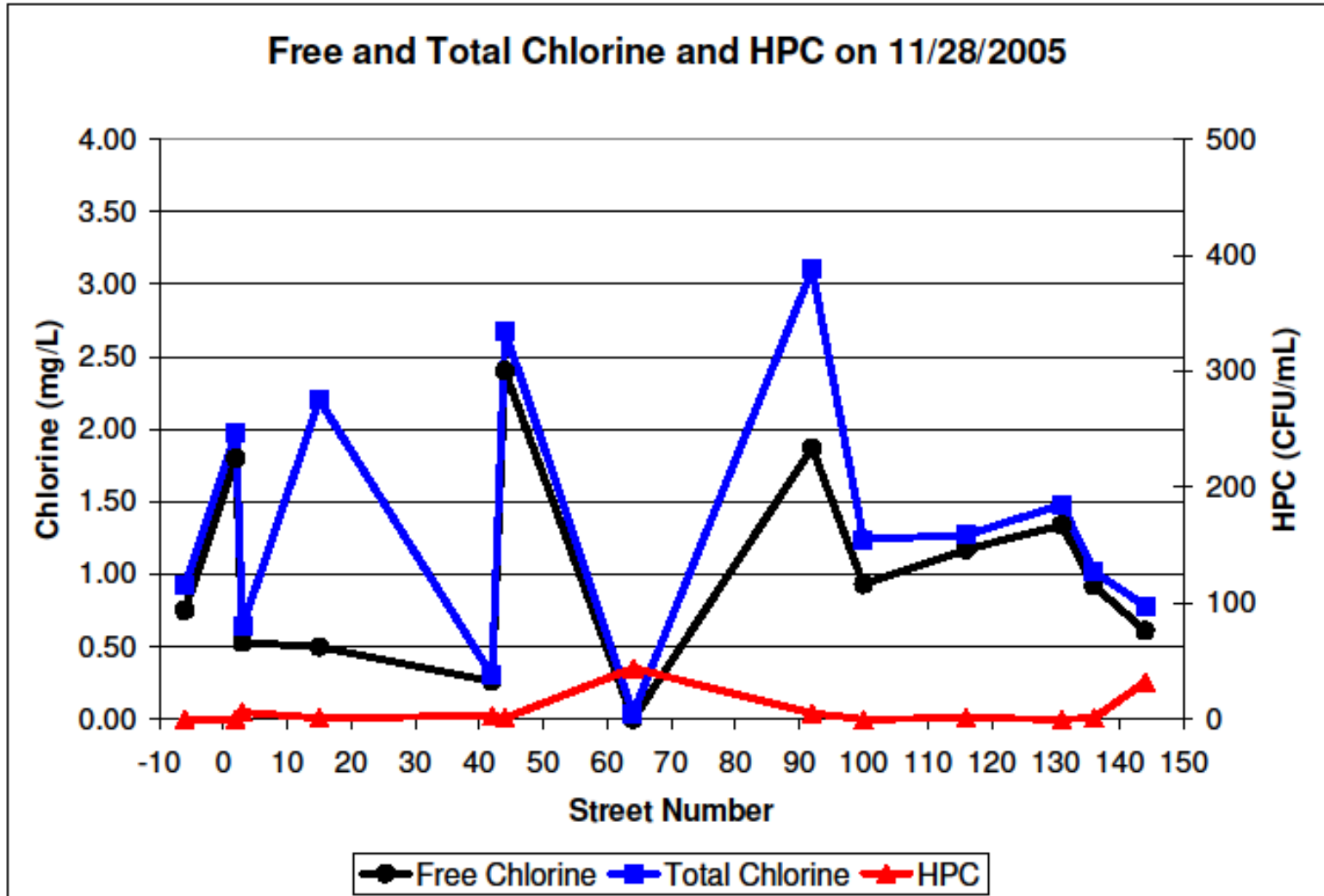


Distribution System Monitoring

First Sample Data – October 2005

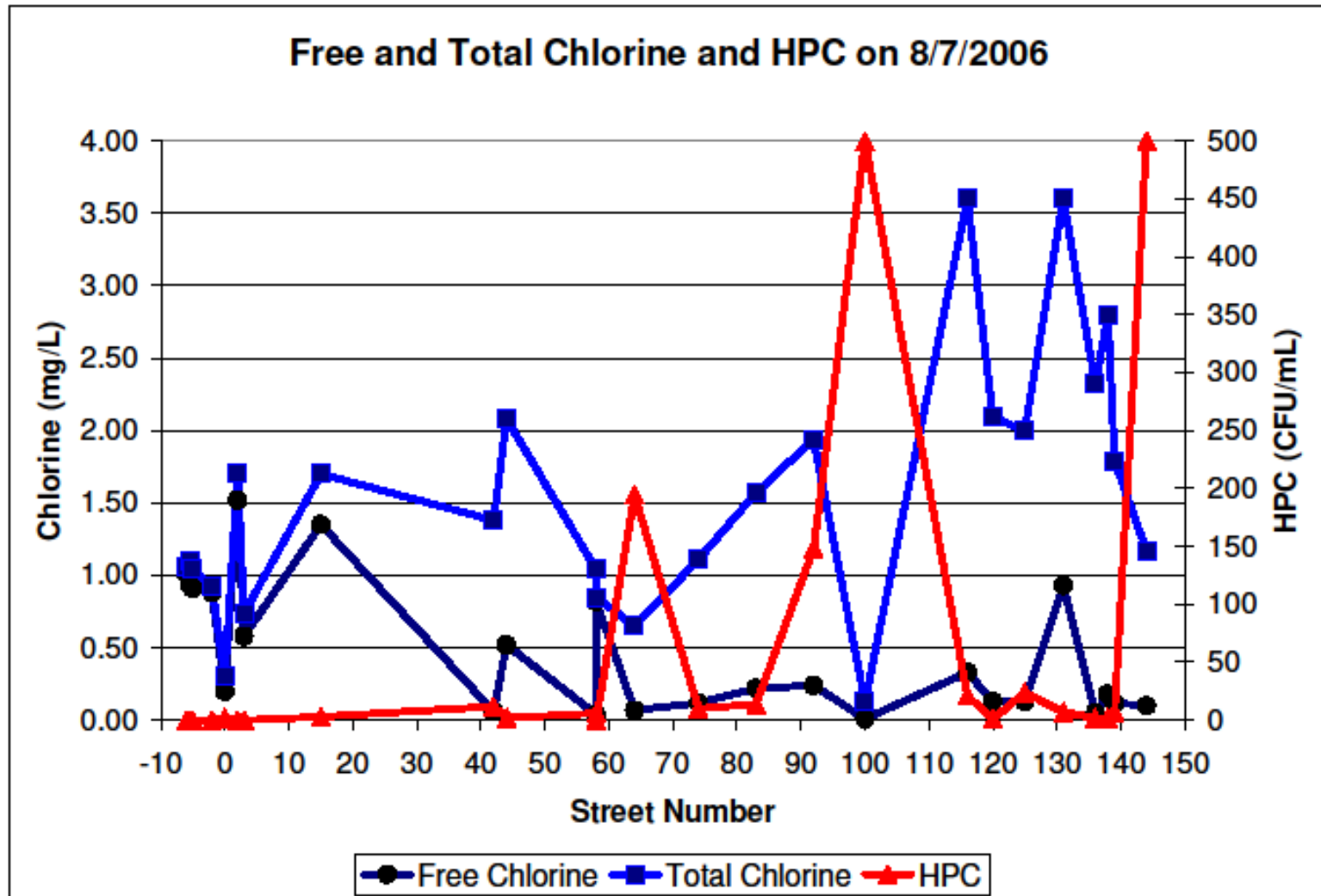


Distribution System Monitoring One Month Later



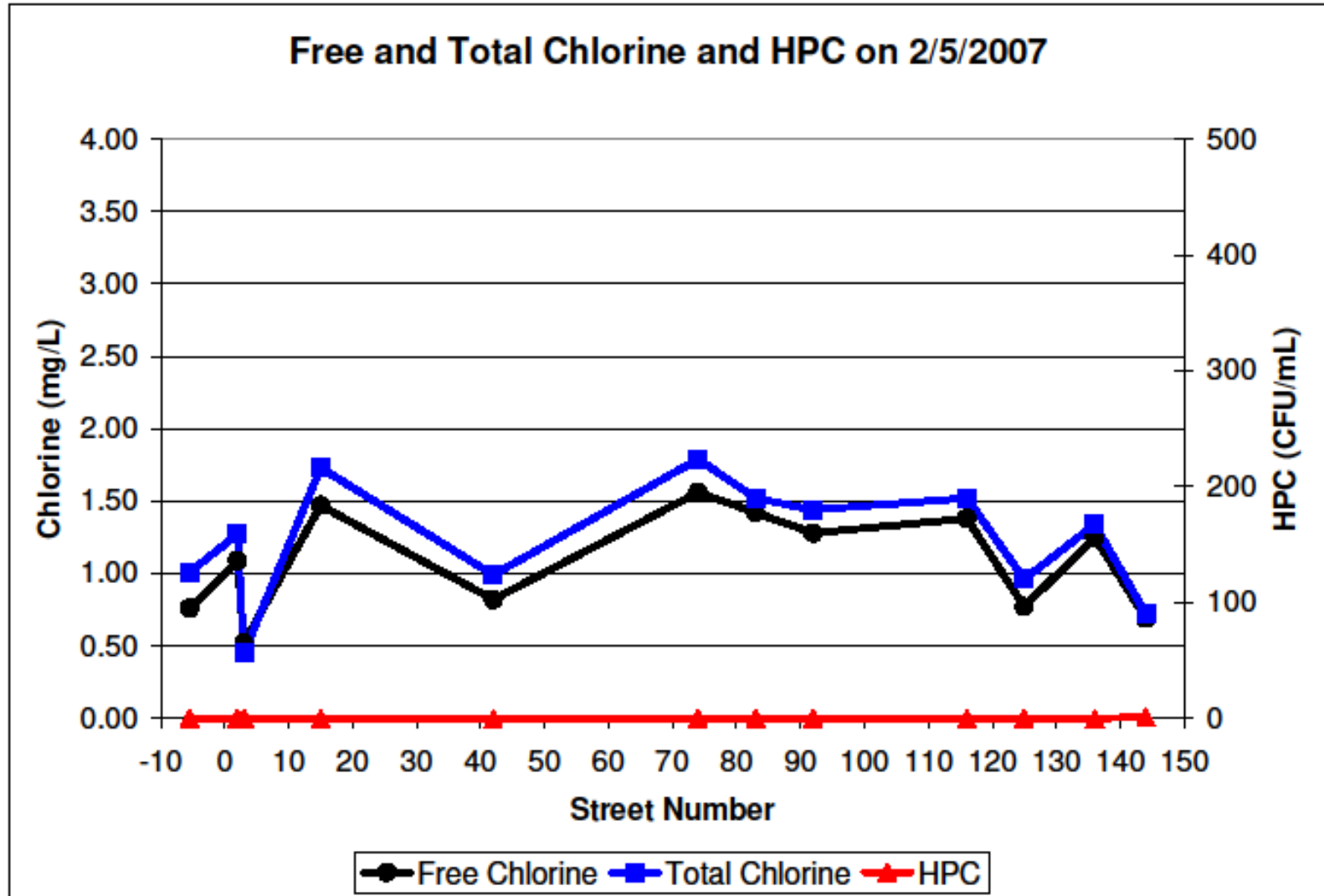
Distribution System Monitoring

Typical Summer 2006



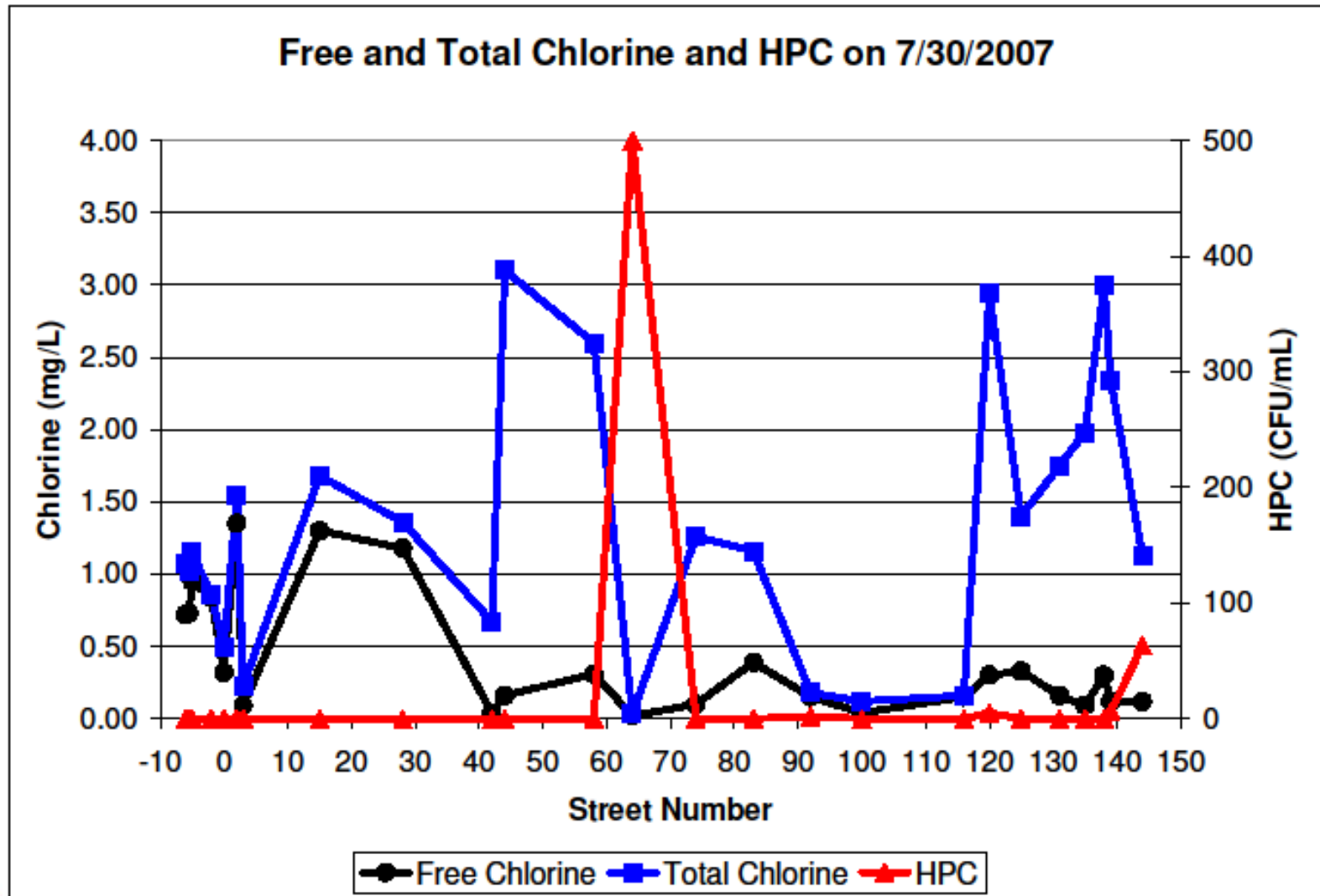
Distribution System Monitoring

Typical Winter 2007



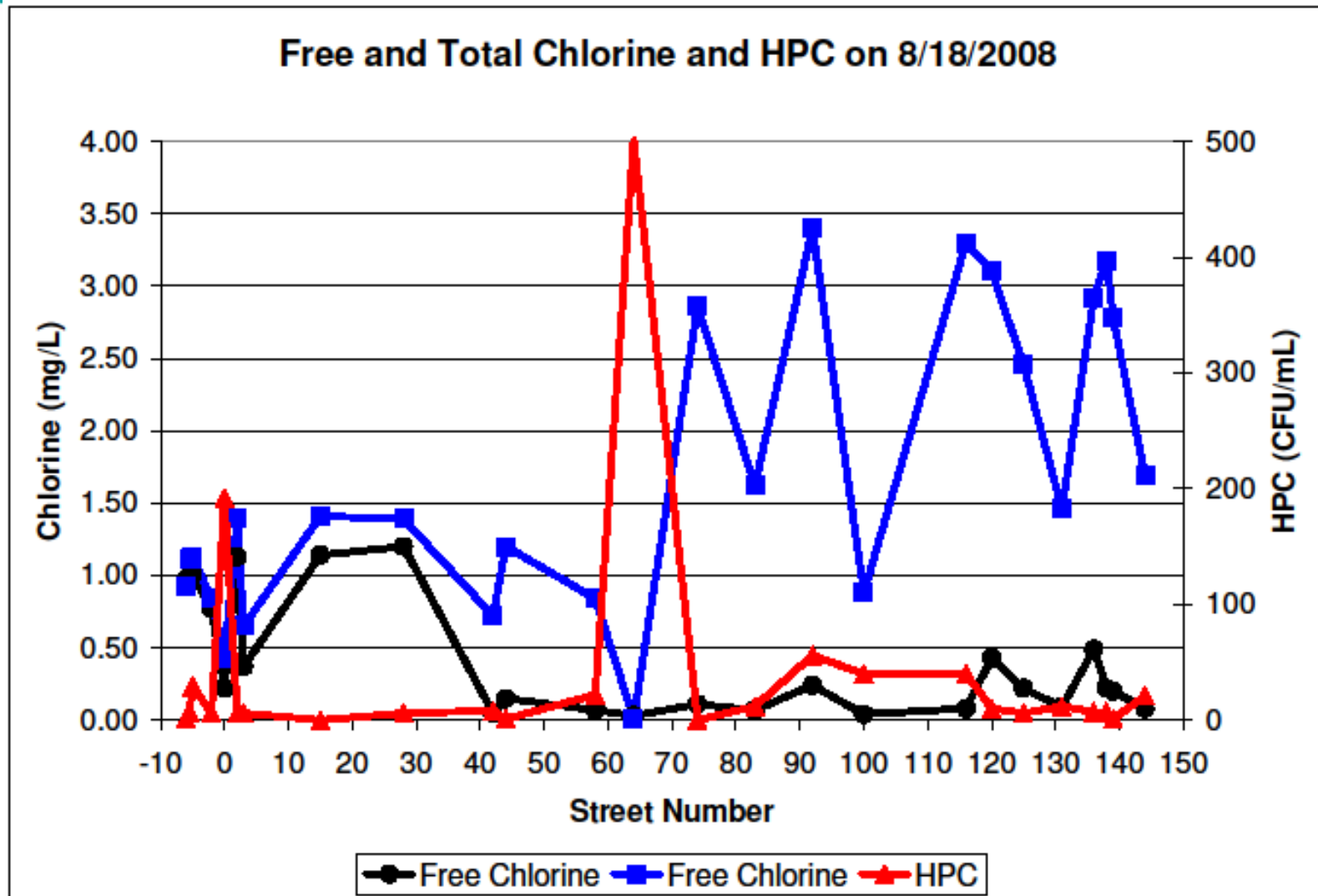
Distribution System Monitoring

Typical Summer 2007



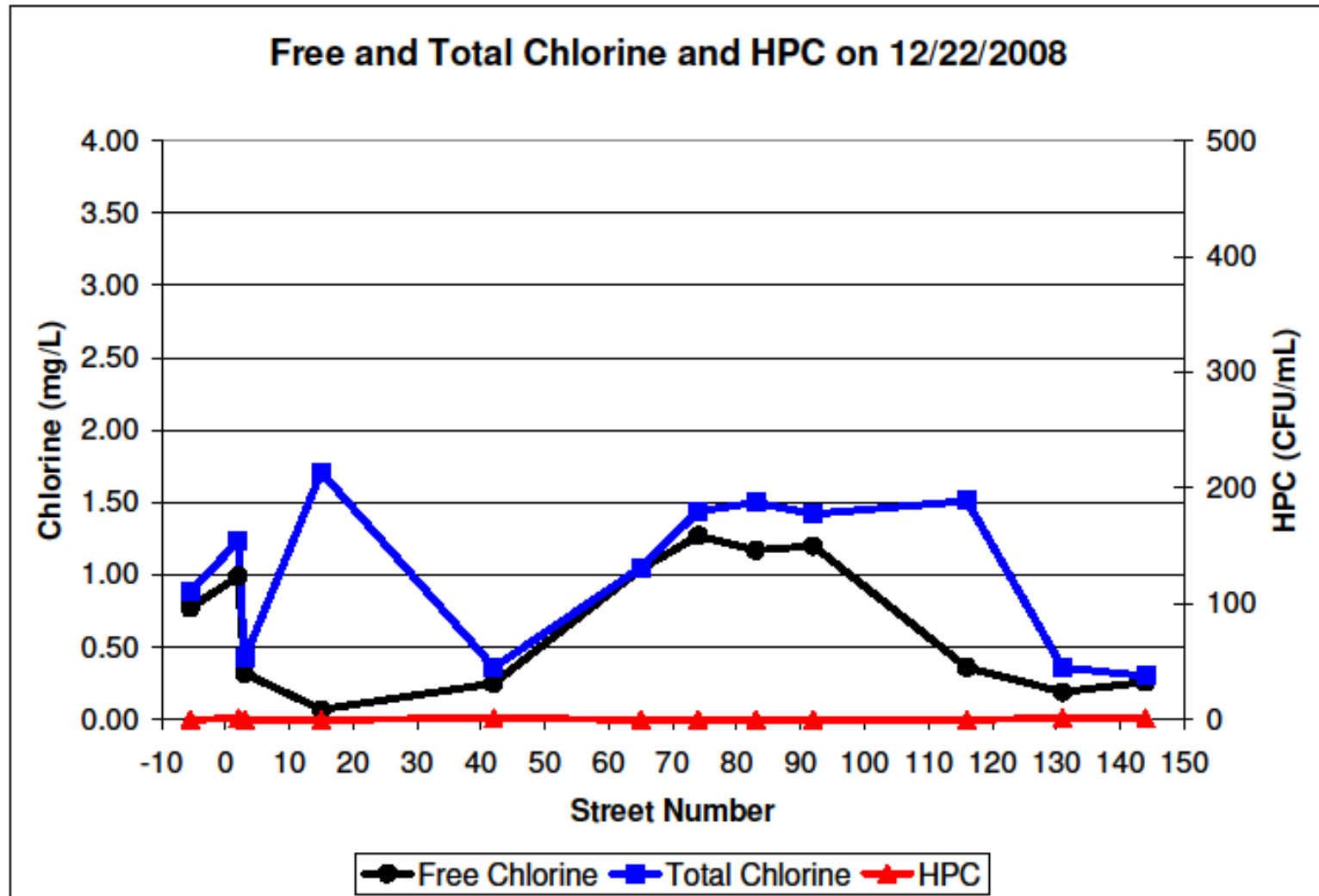
Distribution System Monitoring

Typical Summer 2008



Distribution System Monitoring

Typical Winter 2008-09



Distribution System Water Quality Monitoring Summary

- Certain areas more prone to loss of chlorine residual
- Low free chlorine residual ($< .2$ mg/l) typically results in increased HPC levels
- Higher proportions of “combined chlorine” (total chlorine – free chlorine) in certain areas due to ammonia in source water.
- Combined chlorine shown to be effective in maintaining low HPC
- Presence of ammonia probably enhances DBP reduction
- Increased chlorine dosage implemented to oxidize ammonia in source water

Operational Revisions

- Maintain higher free chlorine residual (>0.2 mg/l)
- Reviewing WTP operations to optimize disinfection performance
- Modify operations to promote greater cycling of water level in tanks
- Meetings with hotel/ condo associations to educate about importance of flushing program
- Installed tank mixing systems

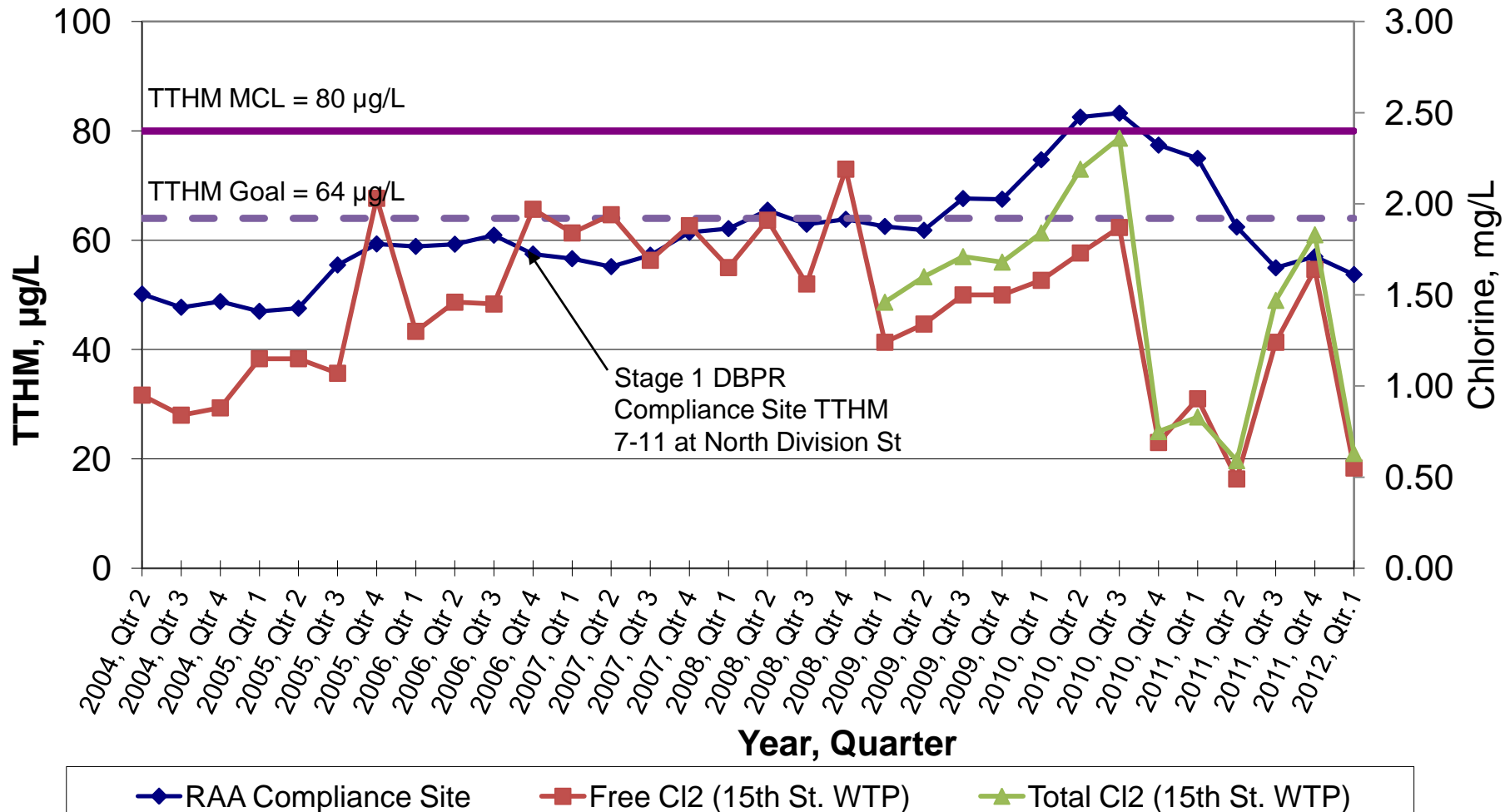
Ocean City DBP Control Issues

- Relatively high organics in source water
- High iron concentrations require strong oxidant to enable removal by filtration
- High “water age” (10+ days) during the off-season
- Relatively high concentrations of ammonia requires larger doses of chlorine to obtain free chlorine residual for disinfection

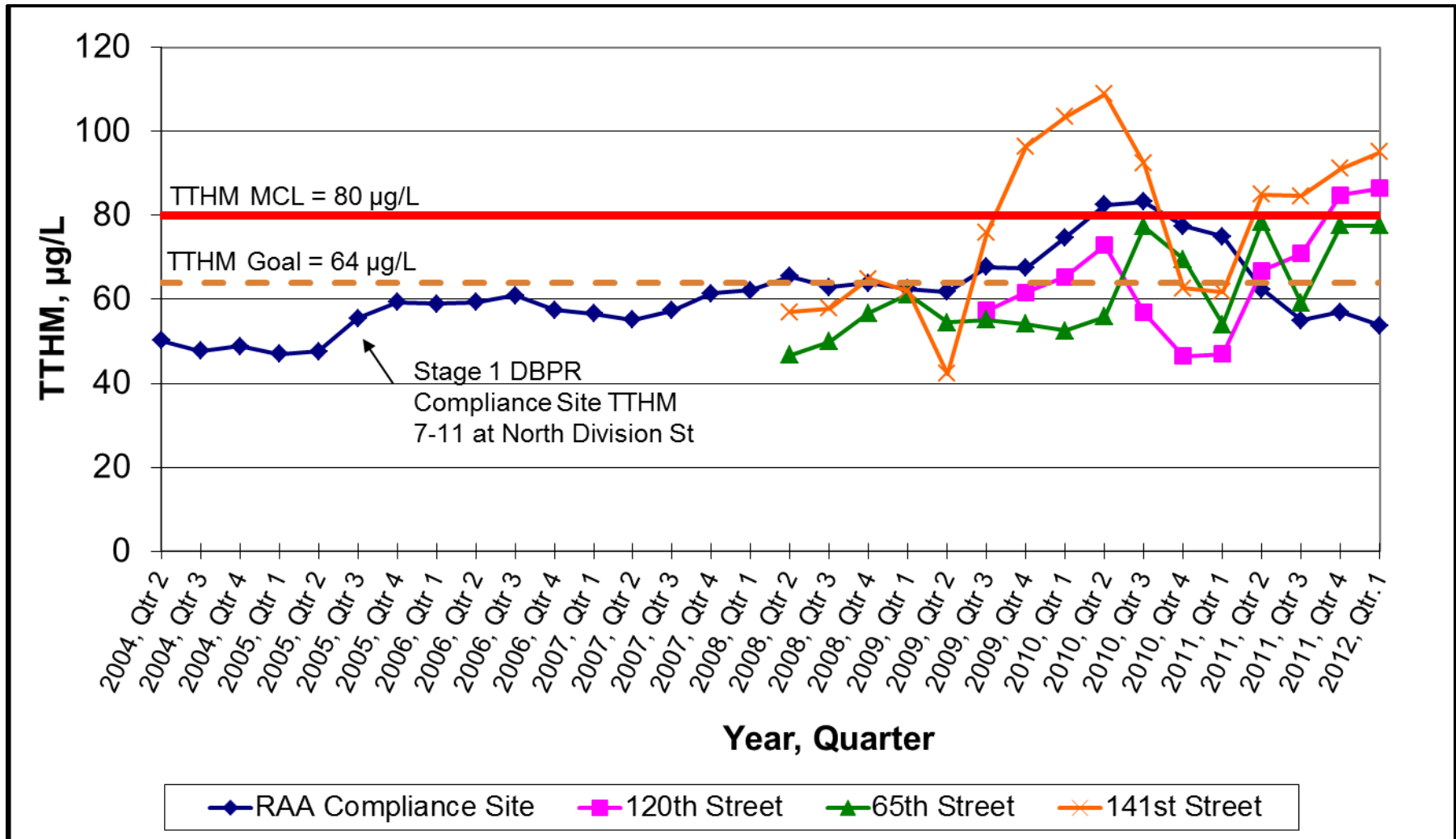
Disinfection Byproducts (DBPs)

- DBPs: Trihalomethanes and Haloacetic Acids
- Currently Compliant with Stage 1 DBP Rule
 - TTHM RAA must be < 80 ppb
 - HAA5 RAA must be < 60 ppb
- Stage 2 DBP Rule
 - Requires selection of new monitoring sites (Total of 4 sites for Ocean City)
 - Each site must comply with limits
 - Compliance monitoring begins November 2013

Historical TTHM vs. Chlorine Residual for Stage 1 Compliance



Historical TTHM at Stage 1 and Stage 2 Compliance Sites



Simultaneous Compliance Disinfection vs. DBPs

Apply enough
disinfectant to
control
pathogens



Implement
strategies to
reduce
concentrations of
DBPs

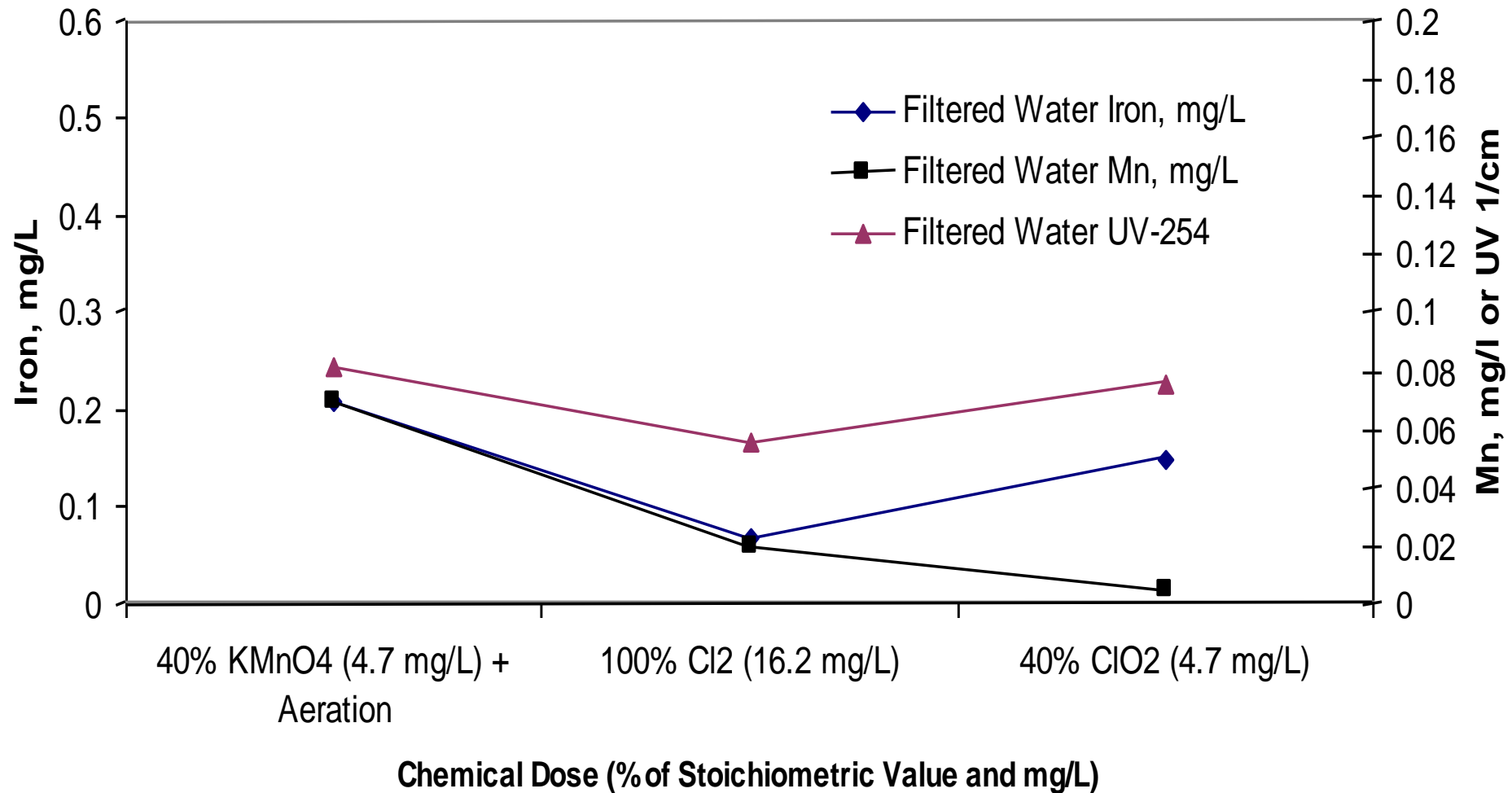
Ocean City WTP Optimization Study

- Goals: Optimize oxidation and removal of iron and manganese while minimizing THM formation
- Bench-Scale Testing: Alternate oxidants and disinfectants

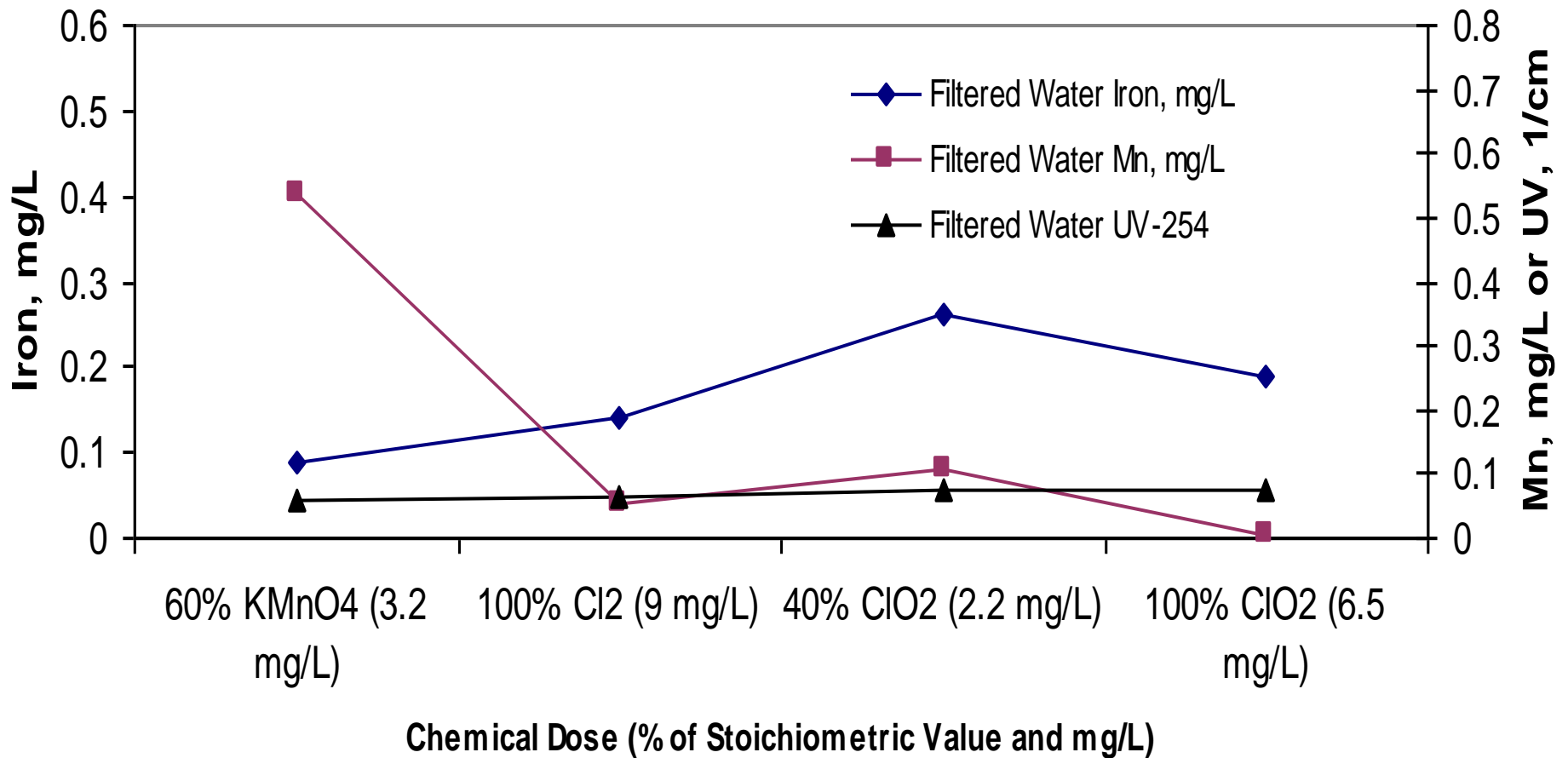


Aeration,
KMnO₄,
ClO₂,
Cl₂,
Chloramines

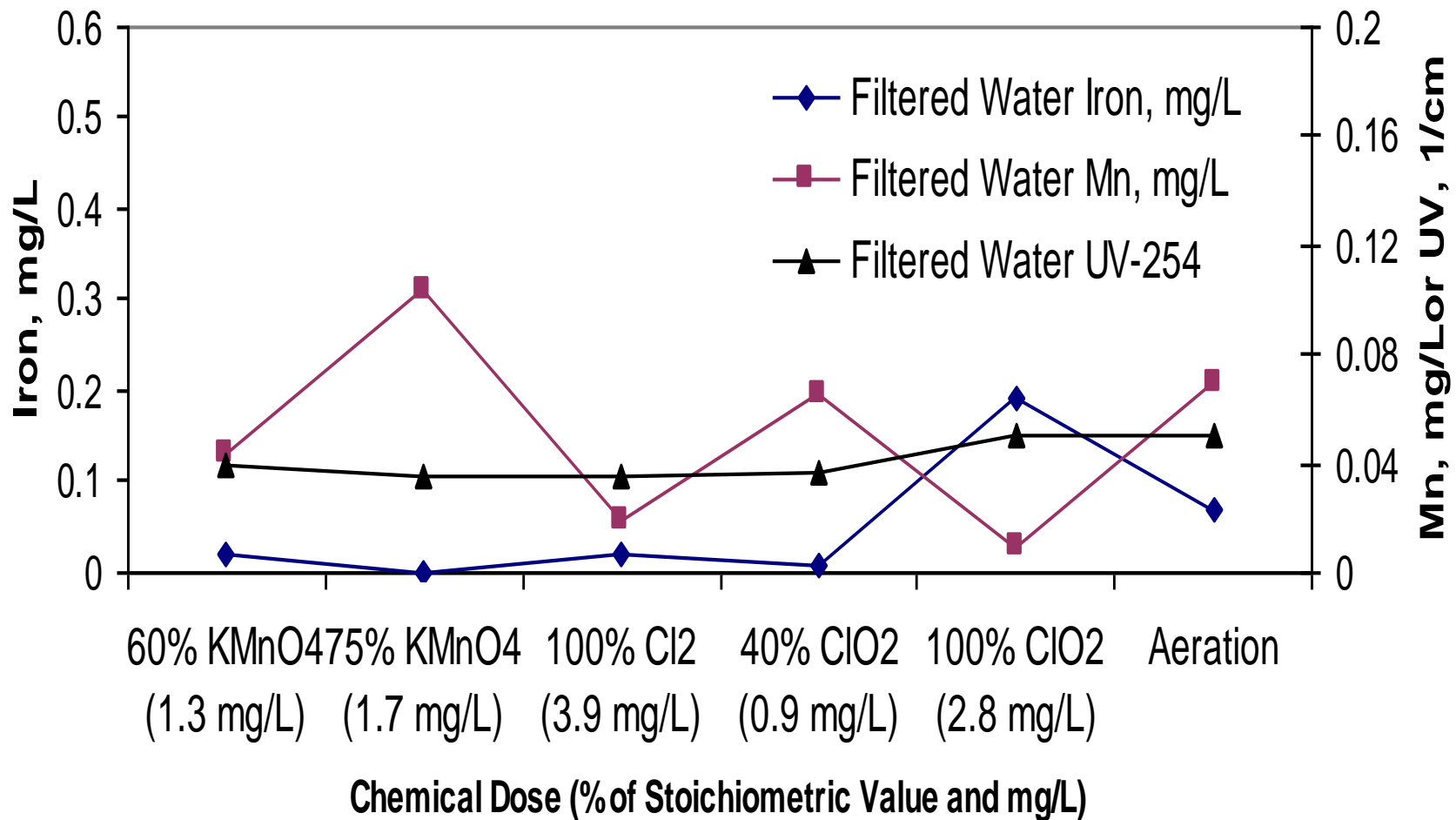
Gorman WTP Oxidation Testing



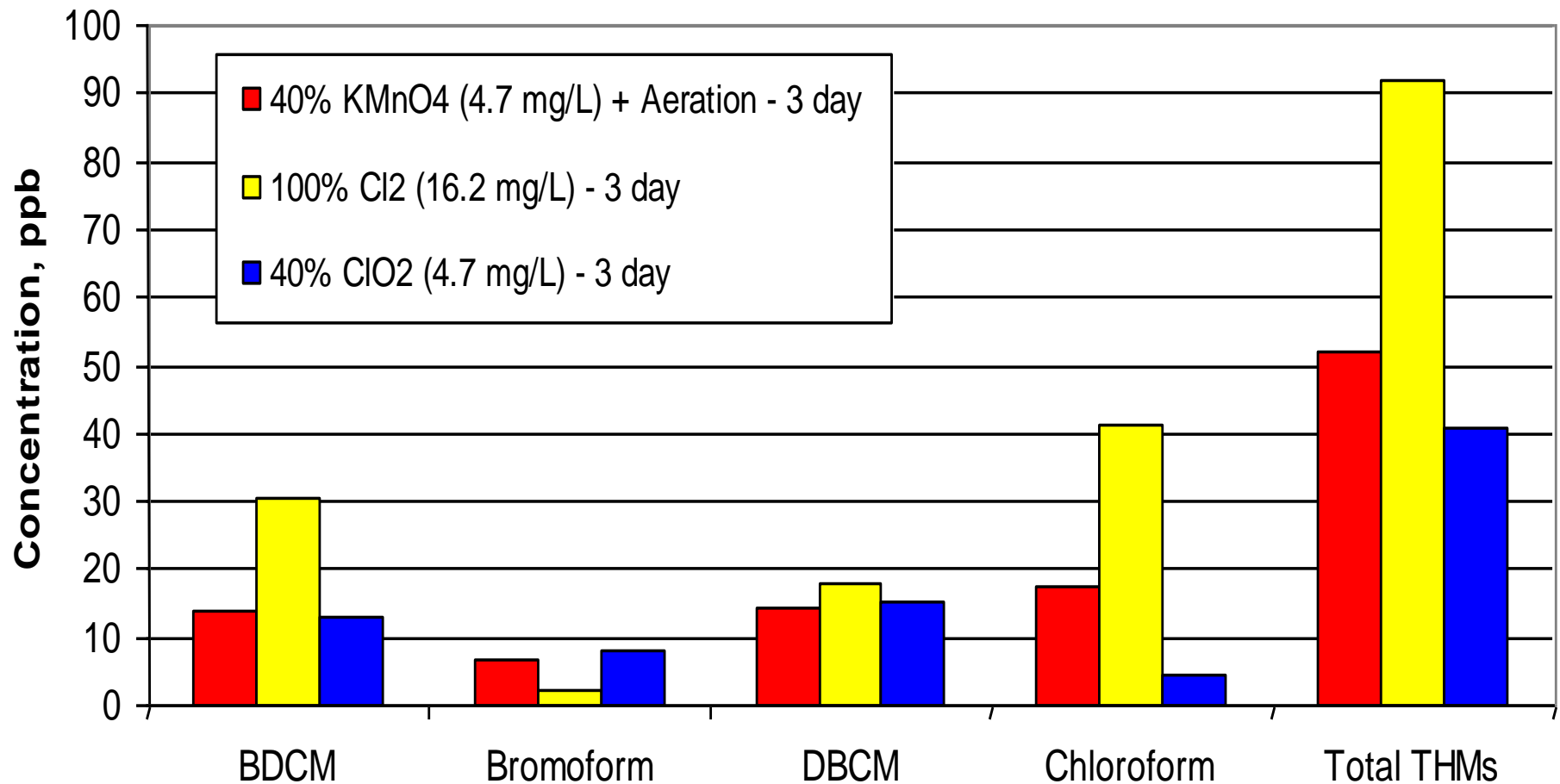
44th Street WTP Oxidation Testing



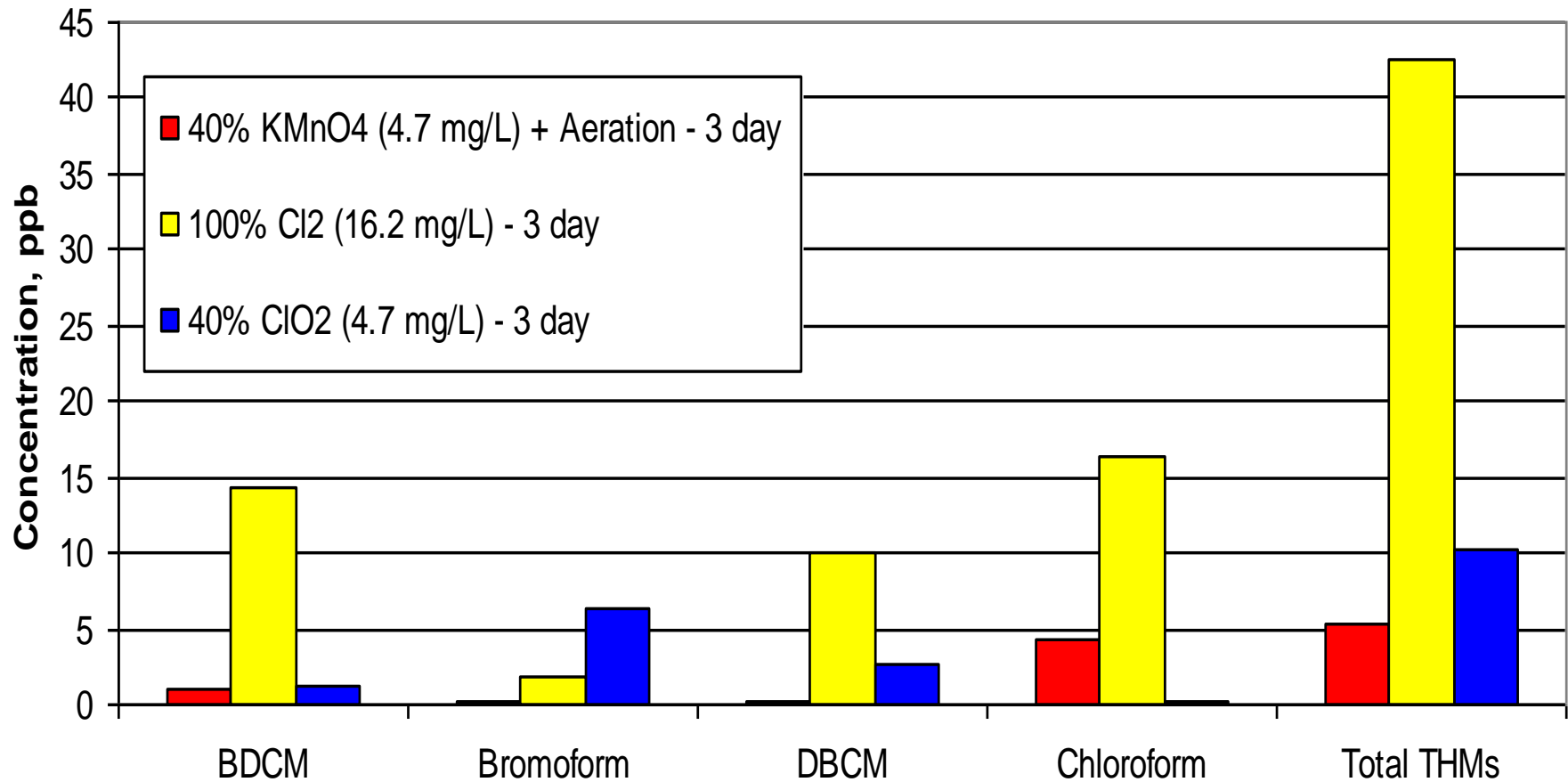
15th Street WTP Oxidation Testing



Gorman Avenue WTP THM Testing (THM after 3 days with free chlorine residual)

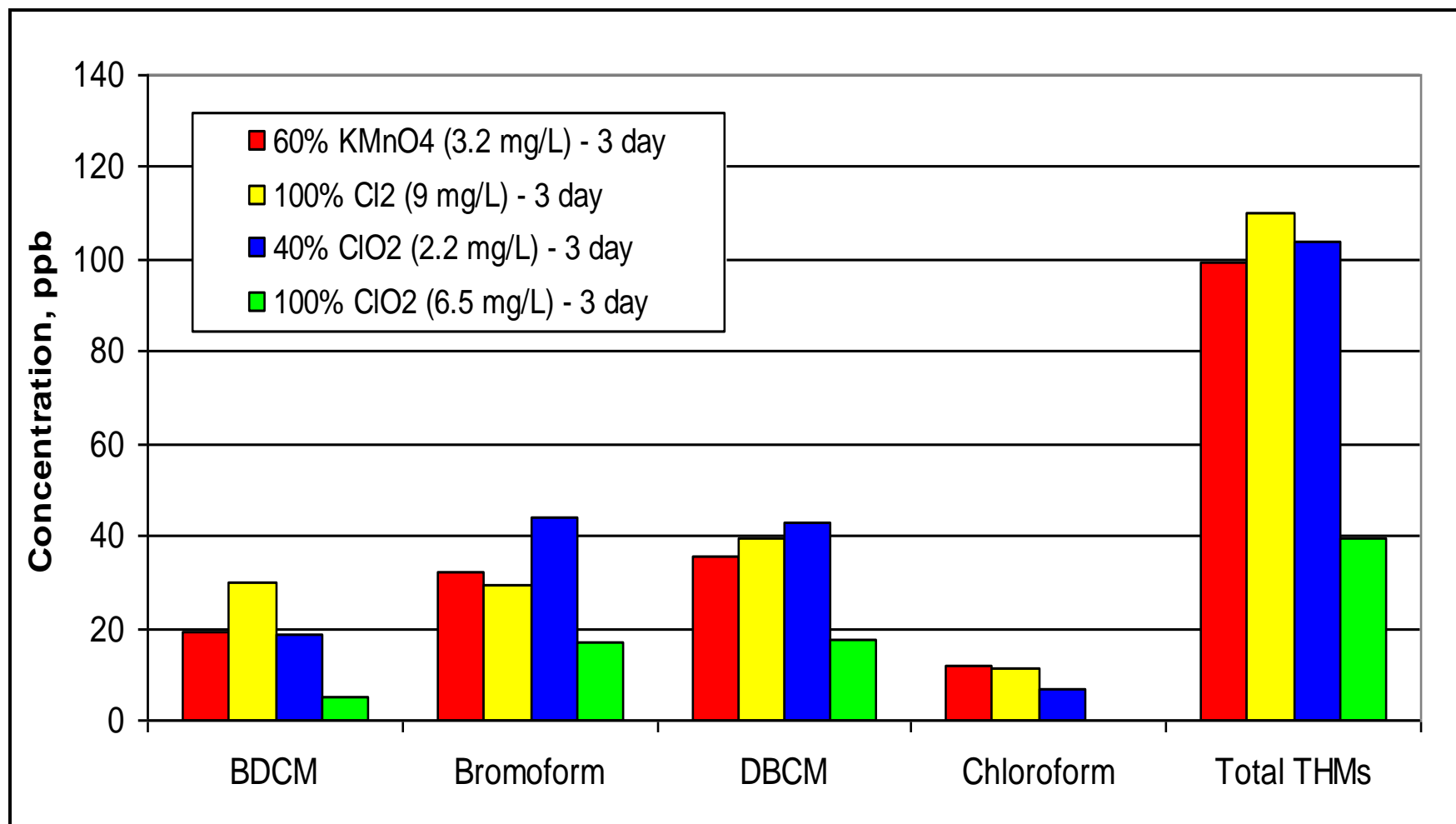


Gorman Avenue WTP THM Testing (THM after 3 days with chloramine residual)



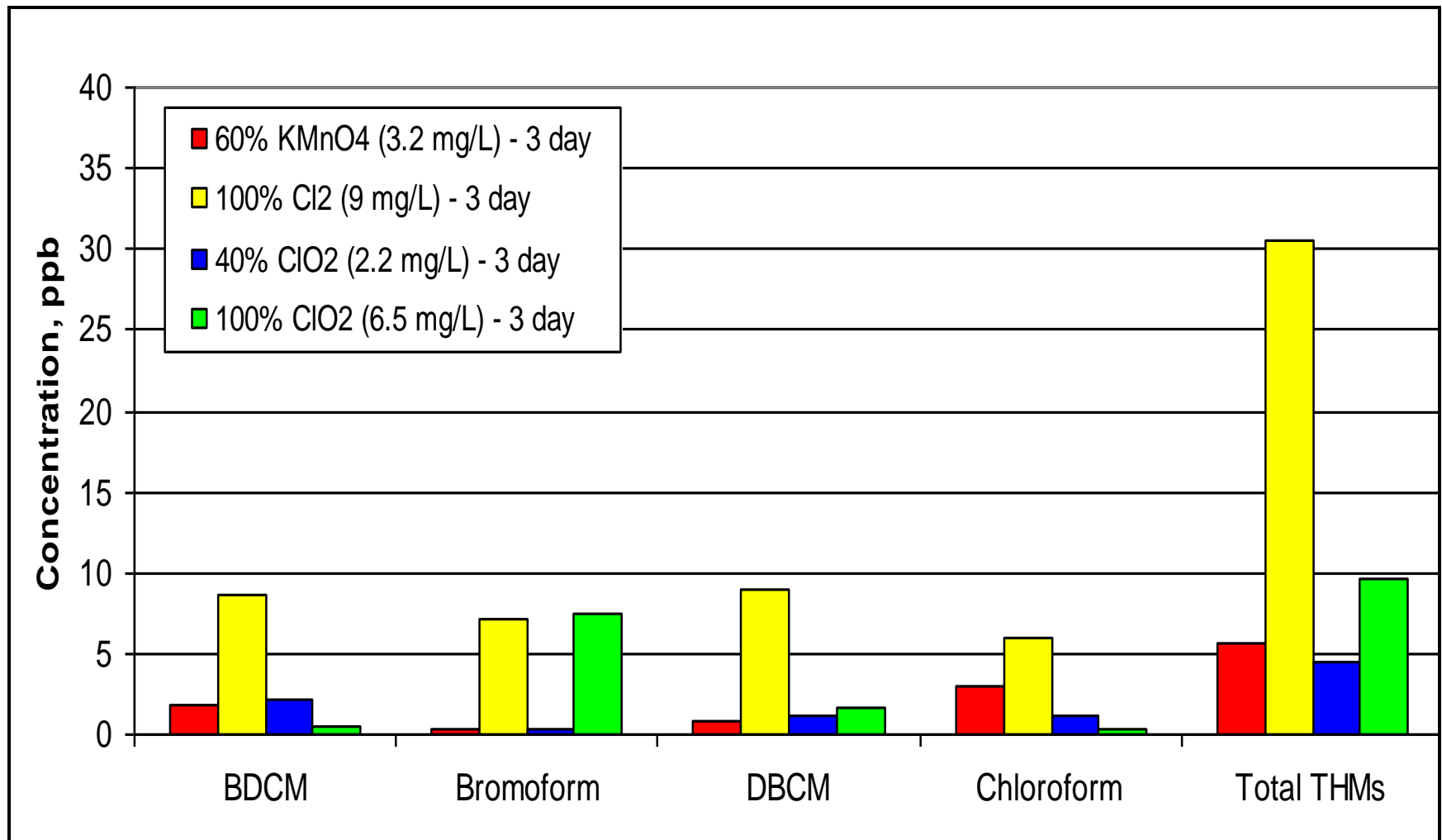
44th Street WTP THM Testing

(THM after 3 days with free chlorine residual)



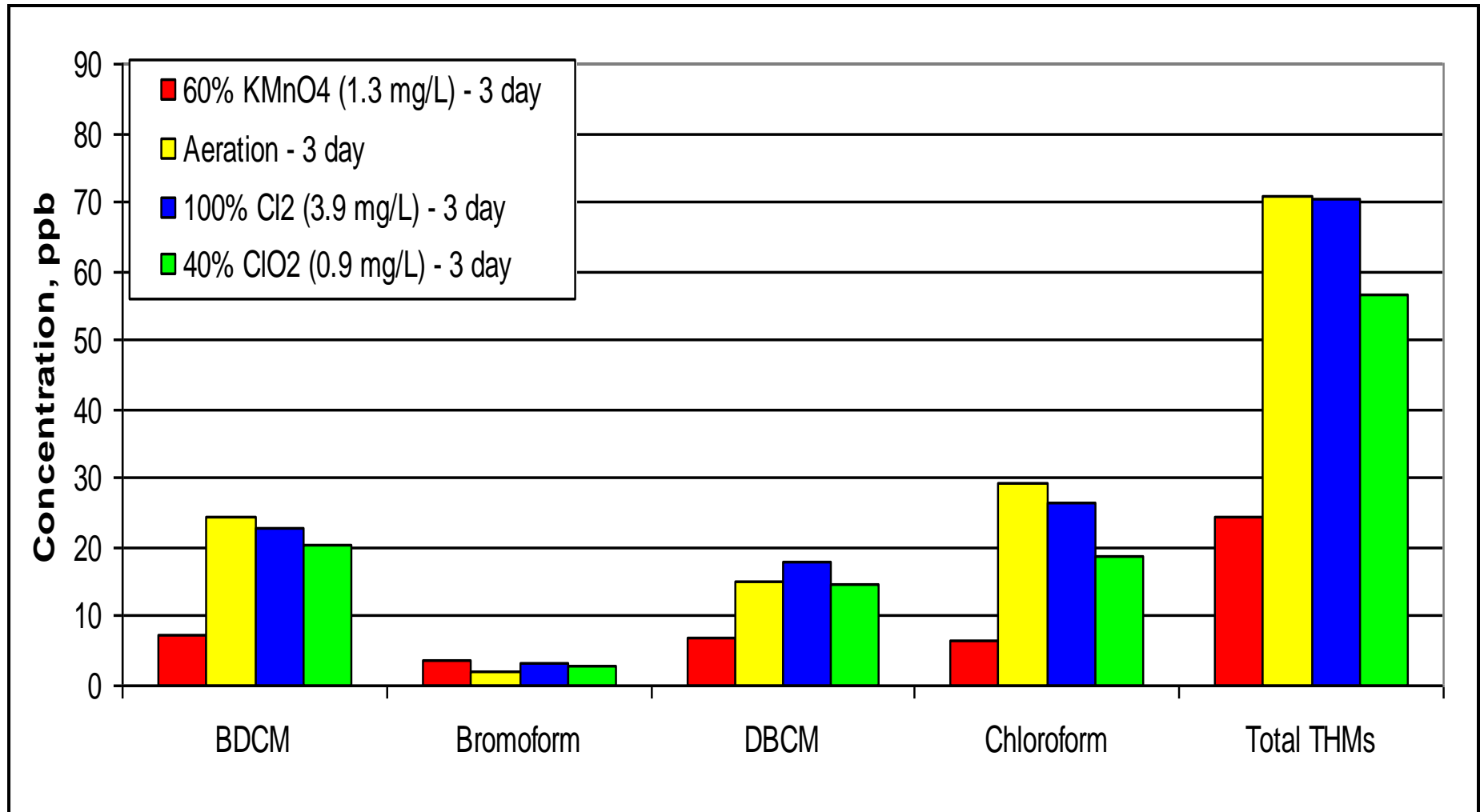
44th Street WTP THM Testing

(THM after 3 days with chloramine residual)



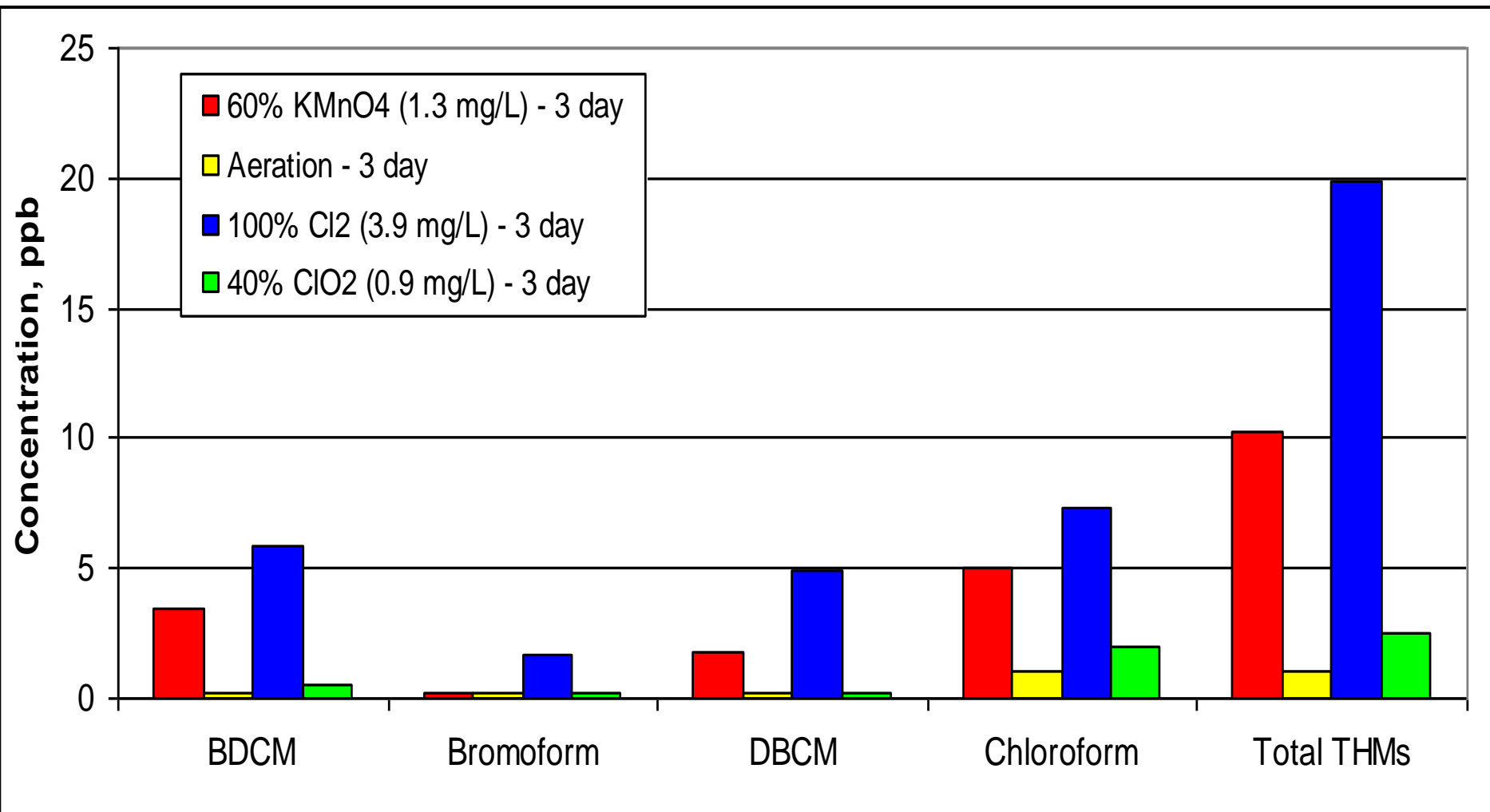
15th Street WTP THM Testing

(THM after 3 days with free chlorine residual)



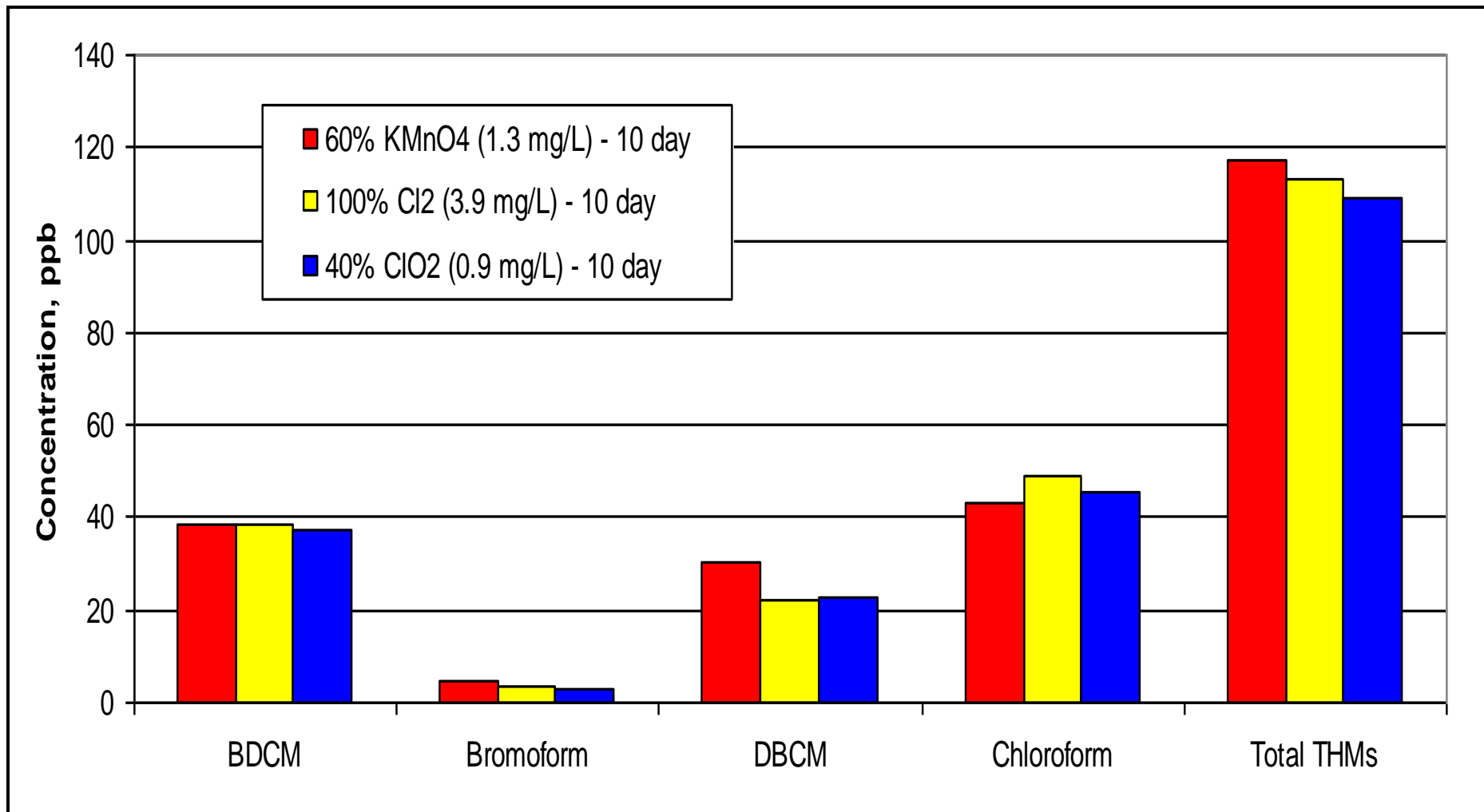
15th Street WTP THM Testing

(THM after 3 days with chloramine residual)



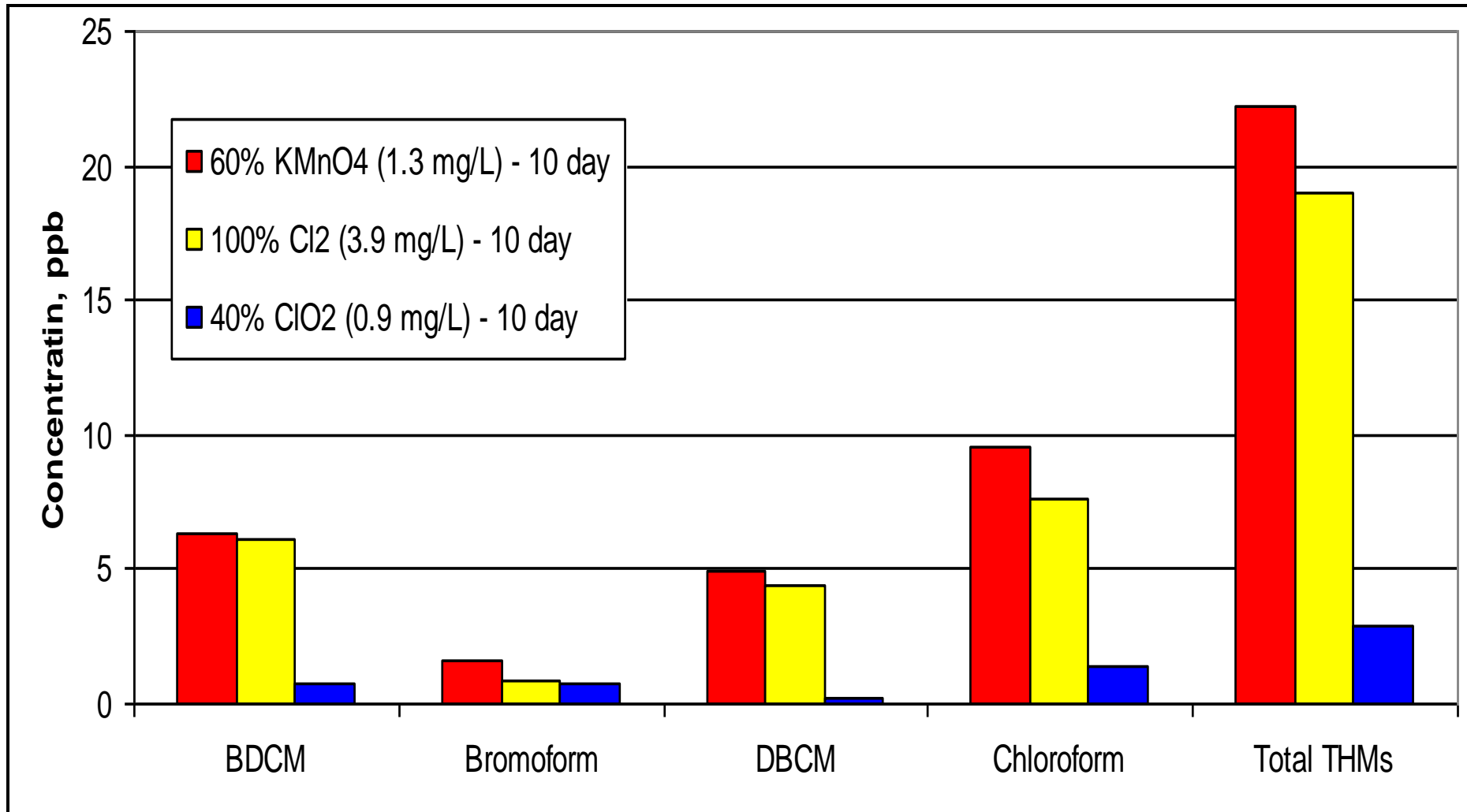
15th Street WTP THM Testing

(THM after 10 days with free chlorine residual)



15th Street WTP THM Testing

(THM after 10 days with chloramine residual)



Bench Testing Conclusions

Oxidation: Aeration, Potassium Permanganate
Chlorine Dioxide all proven effective

THM Control:

- Chloramines treatment resulted in lowest formation of THMs, even after 10 days simulated water age
- Alternate oxidants (other than chlorine) reduced THMs in system, although not as effective at longer than 3 days water age



Microbial Control / DBP Compliance

- Alternate oxidants
- Possible sequential oxidation



- Reduce water age
- Flushing
- Consider chloramination

Recommendations for Ocean City

- 1) Town prefers to exhaust other oxidation and disinfection alternatives prior to implementing chloramination due to potential byproducts (NDMA and others?) plus other issues (added ammonia to wastewater and corrosion issues)
- 2) Conduct additional bench testing
 - Confirm previous results
 - Test multiple wells
 - Test combinations of oxidants



Recommendations for Ocean City

- 3) Conduct desktop analysis comparing economic and qualitative factors for the strategies considered acceptable to the Town
- 4) Pilot/demonstration testing and develop design criteria for Maryland Department of Environment (MDE) approval
- 5) Likely will apply for Stage 2 compliance extension while implementing selected alternative

Questions?

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