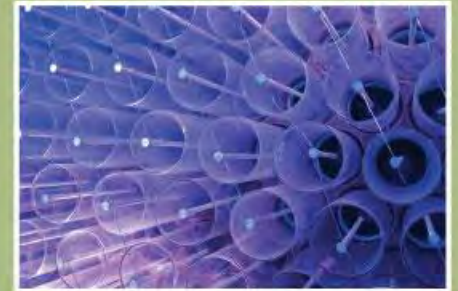




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AMERICAN WATER

**Disinfection By-Product reduction
strategy in Surface Water Plants utilizing
Sodium Permanganate**

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Learning Objectives

- Define how disinfection by-products are formed
- Identify treatment processes that promote formation
- Identify effective options that limit by-product formation and growth

Disinfection Defined



- Disinfectants used to inactivate or kill disease causing organisms
- Disinfectants also react with bromide or natural organic matter to form by-products
- By-product regulations for: trihalomethanes, haloacetic acids, bromate, and chlorite

Disinfection By-Products Formed

- Chlorine by-products:
 - **Trihalomethanes (TTHM)**: chloroform, bromodichloromethane, dibromochloromethane, and bromoform.
 - **Haloacetic Acids (HAA5)**: monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid.
- Ozone by-product → **Bromate**
- Chlorine dioxide by-product → **Chlorite**

Source Water Quality

- Organic precursors – natural make-up
- Total Organic Carbon (TOC)
- Seasonal changes (water temp)
- Multiple source water options



Reasons for disinfection

- **Protect drinking water – make it safe**
- **Inactivate (or kill) microbial pathogens: bacteria, viruses and protozoa**
- **Regulatory compliance – minimum entry point chlorine residuals**
- **Contact Time (CT)**
- **Oxidize source water metals (Fe, Mn)**

Treatment Plant Process – control formation

- **Primary Disinfectants**
 - Free Chlorine (most common)
 - Chlorine Dioxide
 - Ozone
- **All form unwanted regulated by-products**
- **By-products are part of disinfection process**

Treatment Plant Process – control formation

- **Reduce levels of Total Organic Carbon (TOC)**
 - Enhanced coagulation
 - Process pH levels ↓ the better for organics
 - Powdered Activated Carbon (PAC)
- **Reduce organics available to react and form by-products**



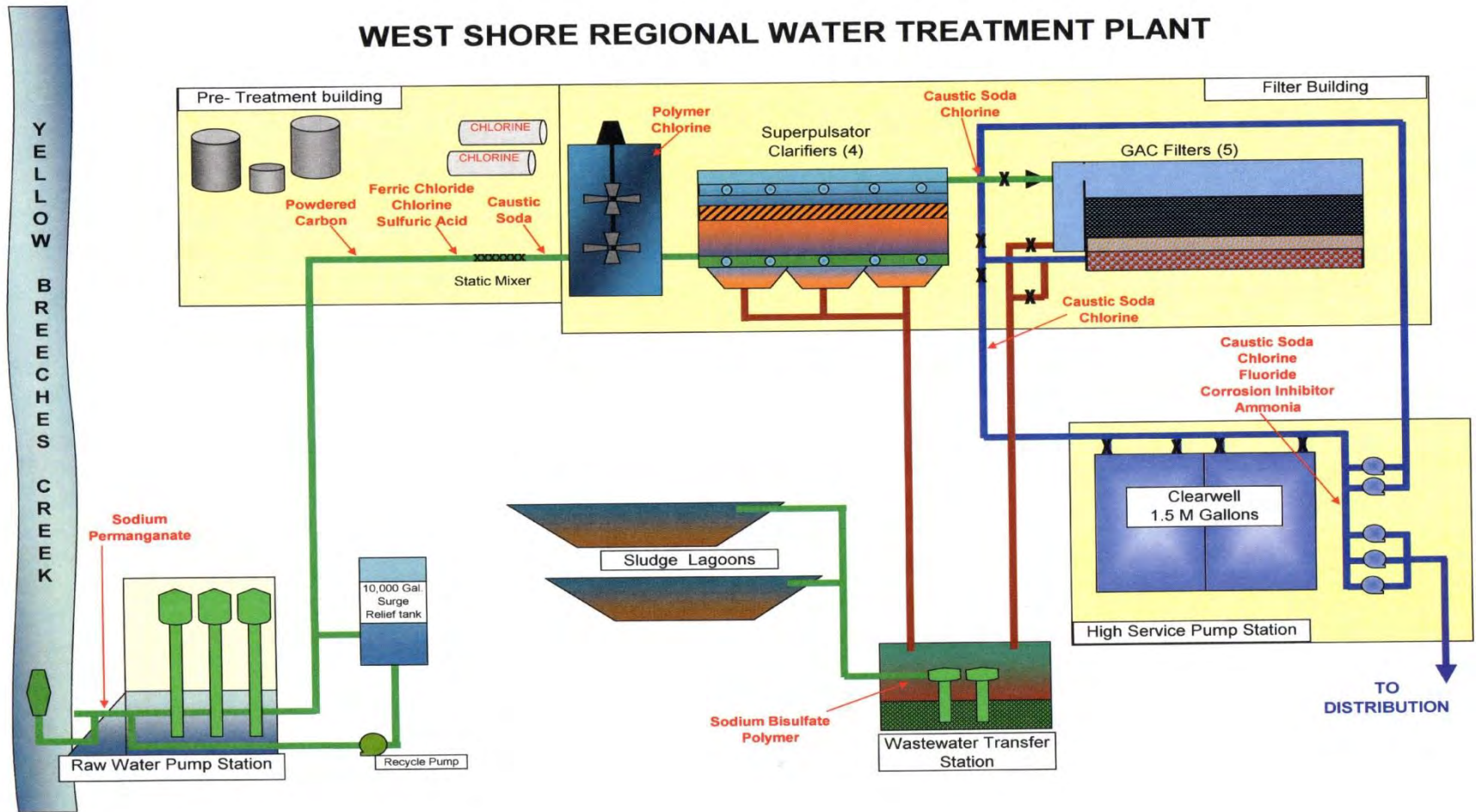
Treatment Plant Process – control formation

- **Evaluate and Modify Treatment**
 - Understand process TTHM/HAA sampling
 - Determine problem areas (clarifiers/sed basins)
 - Relocate disinfectant injection points
 - ◆ Reduce (eliminate?) detention time with organics
 - ◆ Low capital expense
 - ◆ Verify compliance with CT requirements
 - **Alternate Oxidizers**
 - ◆ **NaMnO₄**

Plant Trial - West Shore Regional WTP

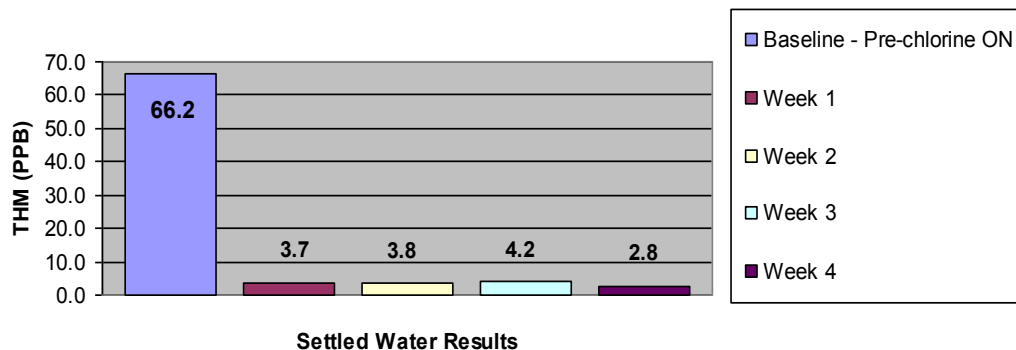
- **NaMnO₄** addition at Raw Water Bldg
- Relocate pre-treatment chlorine feed
- Sedimentation oxidized solely by **NaMnO₄**
- **Remove the chlorine – organic interaction!**
- Sufficient CT from existing clearwell storage
- **THM/HAA concentrations plummet!!**

WEST SHORE REGIONAL WATER TREATMENT PLANT



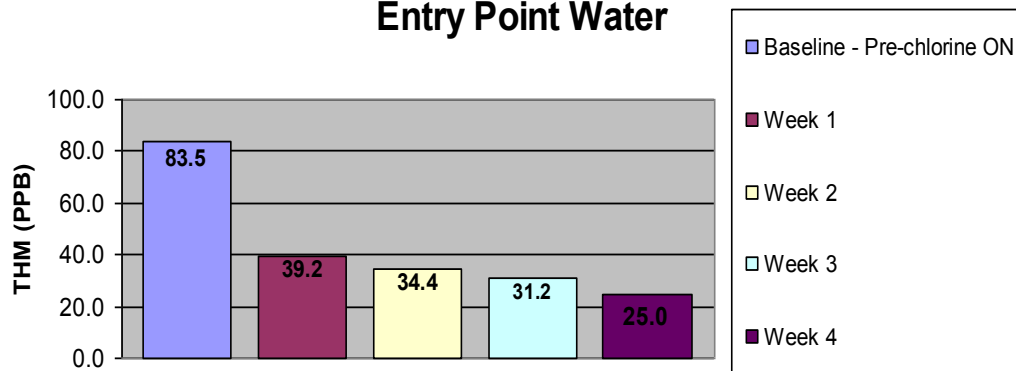
Treatment Plant Process – control formation

**WSRWTP - NaMnO4 results
Settled Water**



Settled Water Results

**WSRWTP - NaMnO4 results
Entry Point Water**



Entry Point Water Results

Reduction % from Baseline Data

Settled	96%
CFE	64%
Entry Point	70%

Distribution System – limit growth

- **Chloramination**

- Secondary disinfectant for maintaining stable, long lasting residual
- ‘Ammonia + chlorine’ at entry point
- Not as reactive with organics in forming DBPs
- Less incidence of taste and odor complaints
- **Vigilant monitoring – Nitrogen risks**

Distribution System – limit growth

- Evaluate areas of concern – detention time
- Monitor areas low turnover – improve?
- System-wide sampling to verify WQ
- Active flushing program – free chlorine
- Newer strategies - aeration of storage tanks



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