USEPA Webinar Series

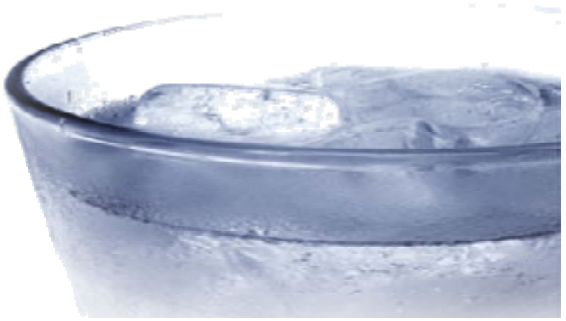
Best Practices for Drinking Water Compliance

Office of Ground Water and Drinking Water

Source/Treatment Changes

What Primacy Agencies Should Consider

OGWDW Contract No. EP-CI-08-018
Work Assignment 06



This Webinar Series:

- **Source/Treatment Changes**
  - What Primacy Agencies Should Consider
- Simultaneous Compliance Planning Issues for Ground Water PWS
- Simultaneous Compliance Planning Issues for Surface Water PWS
- Water Quality Management in Distribution Systems
  - Simultaneous Compliance and Unintended Consequences

Outline of Today's Discussion

Source/Treatment Changes & What Primacy Agencies Should Consider

- Defining Simultaneous Compliance
- What Constitutes a "Change?"
- Discussion of Specific Changes
- Once a change has been proposed...
- Wrap-Up

Key Acronyms – SDWA Regulations

SDWA – Safe Drinking Water Act
TCR – Total Coliform Rule
LCR – Lead & Copper Rule
SWTR – Surface Water Treatment Rule
IESWTR –"Interim" Enhanced Surface Water Treatment Rule
D/DBP Rule – Disinfectant/Disinfection Byproduct Rule
LT1-ESWTR – Long-Term 1 Enhanced Surface Water Treatment Rule
LT2-ESWTR – Long Term 2 Enhanced Surface Water Treatment Rule
FBR – Filter Backwash Rule
GWR – Groundwater Rule

Key Acronyms – Water Quality

AOC - biologically-assimilatible organic carbon
CCT – corrosion control treatment under LCR
DBP – disinfection by-product
Fe/Mn – iron/manganese
IOC – inorganic chemical
NOM – naturally-occurring organic material
ORP – oxidation reduction potential (redox)
SOC – synthetic organic chemical
TOC - total organic carbon
T&O – taste & odor
VOC - volatile organic chemical
NO_3 – nitrate
PO_4 – phosphate
SO_4 – sulfate

Misc Acronyms

GAC – granular activated carbon
IX – ion exchange
MF/UF – microfiltration/ultrafiltration
RO – reverse osmosis
NF – nanofiltration (loose RO)

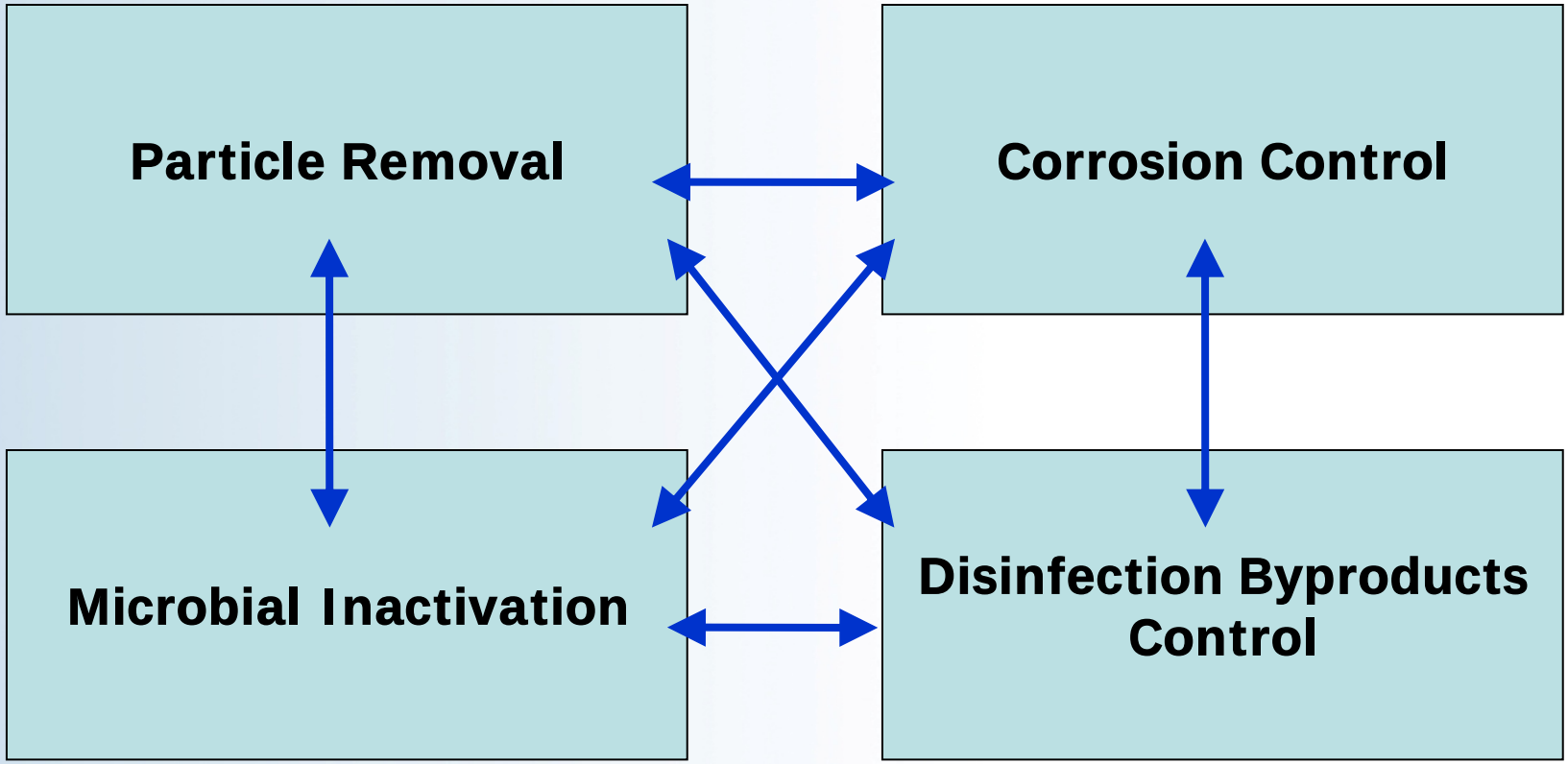
PWS – public water system
WTP – water treatment plant
WWTP – wastewater treatment plant
POTW – publicly-owned treatment works

Defining Simultaneous Compliance

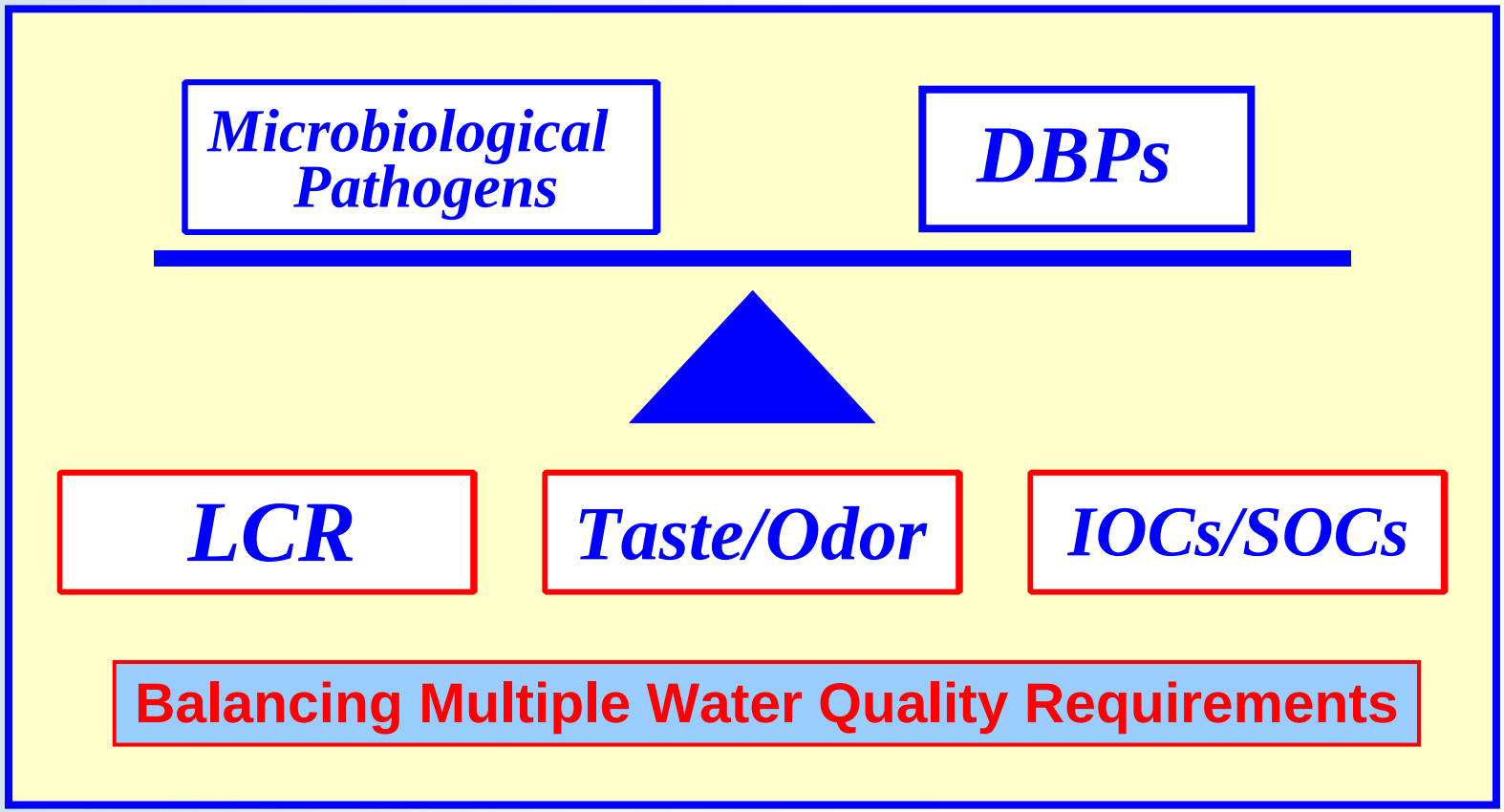
Without careful planning and proper implementation, actions intended to improve one aspect of regulatory compliance can produce serious conflicts (or at least post challenges) in other areas of water quality performance.

Simultaneous Compliance planning is the holistic assessment and evaluation of regulatory compliance actions prior to their implementation.

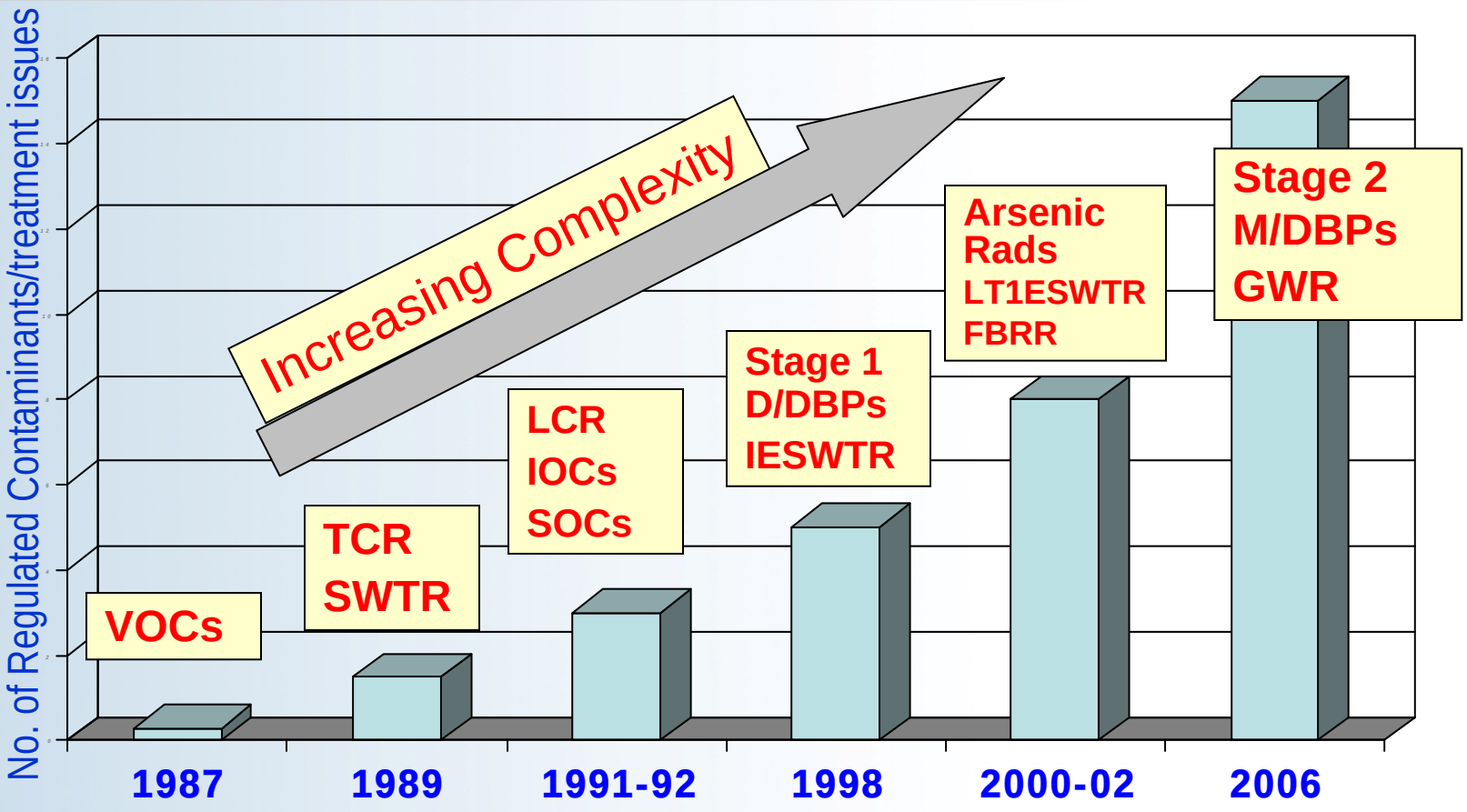
Simultaneous Compliance Interactions Challenges and Conflicts



PWS Increasingly are Required to Balance Competing Regulatory Water Quality Requirements

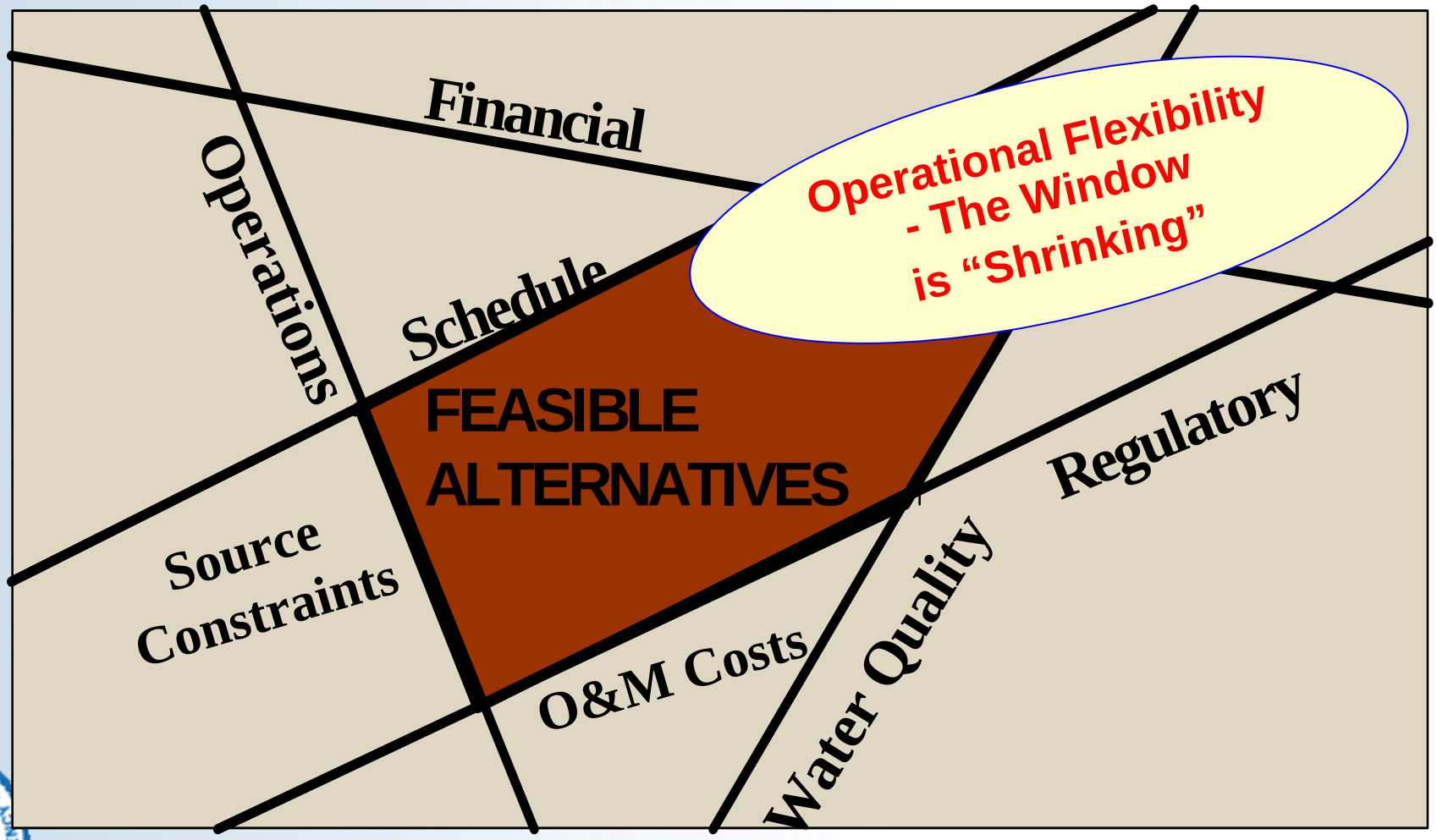


Simultaneous Compliance Complexity has Increased Significantly in 20 Years



Many "secondary water quality impacts" are also related to SDWA regulatory compliance

PWS Operations are Increasingly Complex and Flexibility is Shrinking



Source: Balancing Multiple Water Quality Objectives, AWWARF, 1998

Primacy Enforcement Responsibility

40 CFR 142.10.b.5

By virtue of being designated a primacy agency by EPA, states must create procedures to include:

"… *establishment and maintenance of an activity to assure that the design and construction of new or substantially modified public water facilities will be capable of compliance with the State primary drinking water regulations.*"

Required LCR Notification

40 CFR 141.90 (a) (3)

*"… as early as possible prior to the **addition of a new source or any long-term change** in water treatment, a water system deemed to have optimized corrosion control… shall **submit written documentation** to the State describing the change or addition.*

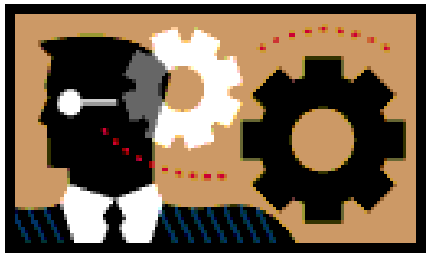
*The State must **review and approve** the addition of a new source or long-term change in treatment **before it is implemented**…*

Examples of long-term treatment changes include the addition of a new treatment process or modification of an existing treatment process. ."

SDWA Primacy Agencies Need to Anticipate Conflicts/Interactions//Challenges

- Direct SDWA-driven Rule conflicts
- Treatment process interactions/impacts
  - Coagulation/Softening
  - Filtration performance
  - Disinfection efficacy
  - Residuals

- Distribution system impacts
  - Microbial/regrowth
  - Chemistry/Corrosion/Pipe-scale
  - Secondary/Aesthetics/Operations



So….

What constitutes a “Change?”

What Constitutes a "Change?"

- Long-term changes in existing unit process operation
- New technology implementation for regulatory compliance
- New sources of supply or modified use/blending of existing sources
- Any of the above even when primarily driven by **secondary** water quality standards/issues

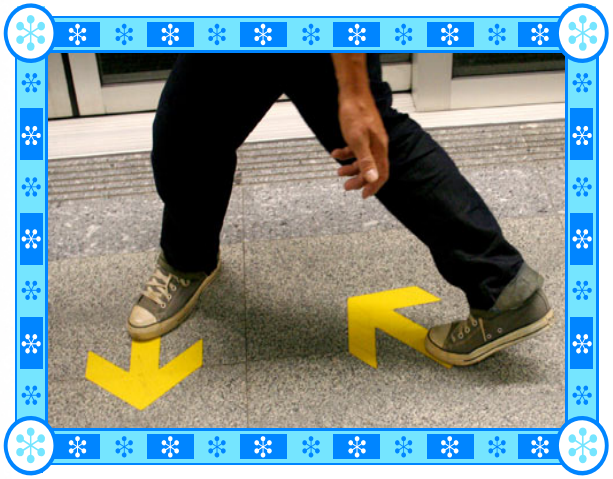
Changes Often are Mandated by New Regulatory Requirements

- SWTR/TCR
- LCR
- IOCs/SOCs
- IESWTR
- FBR
- Stage 1 D/DBP Rule / LT1-ESWTR
- Stage 2 D/DBP Rule / LT2-ESWTR
- GWR

Changes also Undertaken to Meet Aesthetics Secondary Water Quality Goals

- Hardness
- Dirty water
- Taste & odor
- Scale stability
- Fe/Mn
- Other Secondary MCLs

Framing the Universe of Change

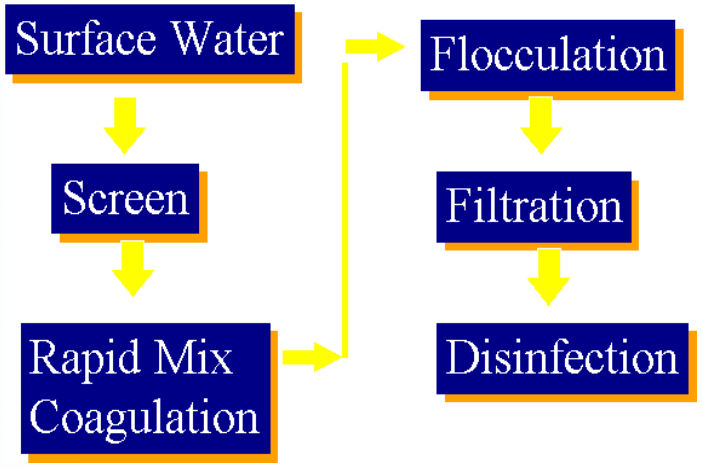


- Source of Supply Changes
- Increased Capacity
- Changes to Existing Unit Processes/Treatment
- New Unit Process(es)
- Discontinue Existing Treatment Process
- Long-term change vs. Short-term Optimization

Source/Capacity Changes

- New Source of Supply
- New Blending Scenarios for Existing Sources
- New or Multiple System “Entry Points”
- Increasing/Decreasing Pumping Capacity
- Shifts in CCT Chemistry (pH, alkalinity, ORP, PO_4, Chlorides)

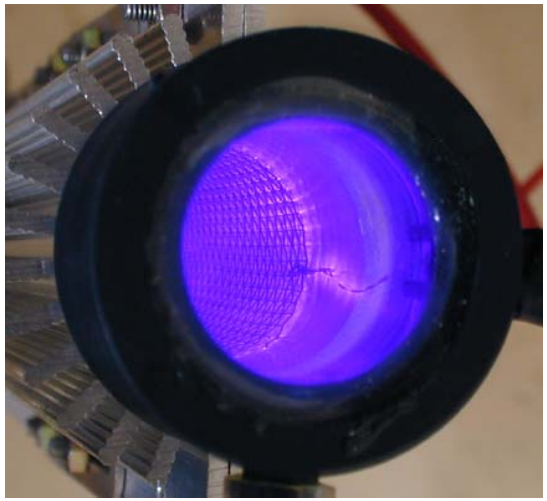
Changes to Existing Unit Processes/Treatment



- Modified Coagulation
- Mixing Improvements
- High-Rate Clarification
- Filtration Rate Increase
- Filtration Media Replacement
- Moving Point of Disinfection
- Change of Treatment Chemicals
- Increase/Decrease Finished Water Storage

Implementing New Unit Process

- Additional Chemical Feed Systems (PAC, SO_2, etc.)
- GAC Adsorption
- New Oxidants
- Start/stop Softening
- Membrane Filtration Technologies (MF/UF)
- Ion Exchange



Suspending an Existing Treatment Process May Create Compliance Problems

- Seasonal Variation in Source Water Quality
- Discontinue Softening
- Taste & Odor Control
- Filter Backwash Recycle
- Primary Disinfection CT upstream of Filtration
- Source Water Blending

Long-Term v. Short-Term Changes

Long-Term Changes

- New treatment process
- Modification of existing treatment process
- Switching secondary disinfectants
- Switching coagulants
- Switching corrosion inhibitors

Short-Term Changes
(generally not subject to pre-approval)

- Adjust chemical feed rates to match variations in source water quality
- Other “optimization” of existing unit processes
- Distribution system BMPs

"Optimization" Efforts may be Short-Term or Long-Term Changes

- Water quality enhancement
- Reduce O&M costs
- Simplify operations

- Source water management
- Adjusting pH
- Chemical feed rates
- Distribution system BMPs
  - Flushing
  - Nitrification control, etc.

Discussion of Some Specific Changes

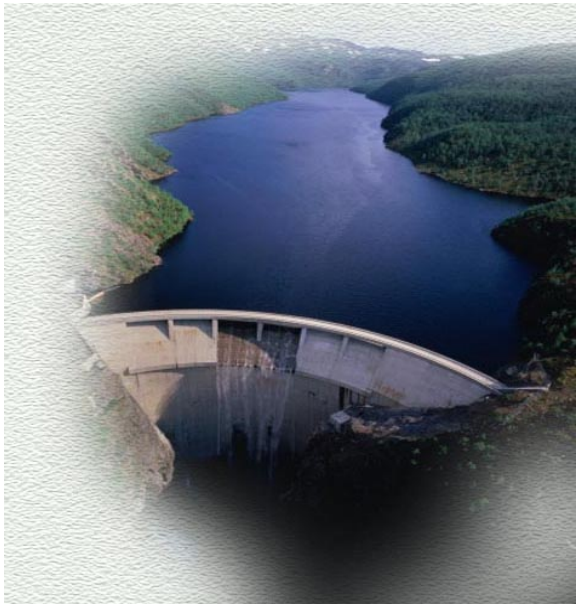
Some Specific Changes

- Source of Supply Changes
- Disinfection Practices
- Enhanced Coagulation/Softening
- Corrosion Control Treatment (CCT)
- Distribution System Operations

More detailed examples and discussion will be presented in Webinars 2, 3 & 4

Some Specific Changes

Source of Supply Changes



- Adding new source(s)
- Blending multiple sources
- Modifications to existing sources of supply to reduce O&M costs

Most source changes will impact treatment requirements and/or distribution system chemistry.

Source of Supply Changes

Why Change Source Water?

To Increase Capacity!!

To Improve Quality/Consistency:

- DBP precursors
- Turbidity/pathogen levels
- Disinfectant demand
- IOCs/SOCs/VOCs
- Residuals production

In general - to improve raw water treatability for turbidity, microbials and/or DBP precursors

Source of Supply Changes
Possible Conflicts/Challenges

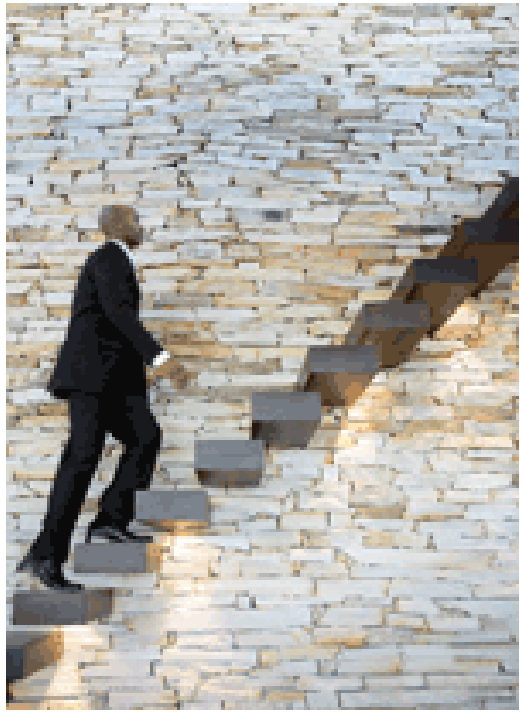
- LCR CCT issues with shift in pH, ORP, alkalinity and/or NOM
- Stage 2 DBPR issues with shift in TOC, NOM, chlorine demand, temperature
- LT2ESWTR issues due to changes in source quality, TSS and temperature
- Finished water aesthetics; regrowth potential, scale stability

Source Water Change
Mitigating Potential Conflicts/Challenges

- Identify/evaluate potential conflicts/interactions
- Recognize potential for source changes to impact existing treatment/distribution system chemistry
  - Exercise positive control over coagulation and softening chemical treatment/dosages
  - Maintain pH and alkalinity targets in both plant and distribution system
  - Monitor TOC and shifts in disinfectant demand

Source Water Change
Mitigating Potential Conflicts/Challenges

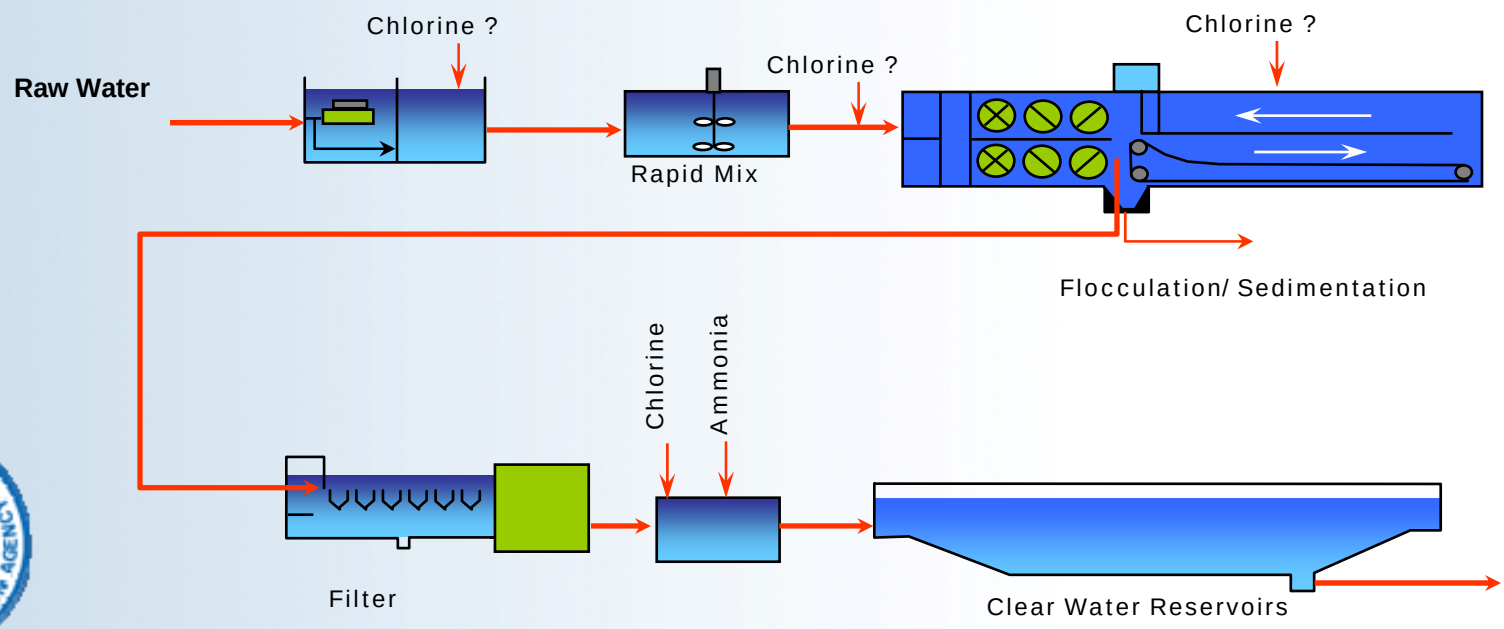
- Collect data! Evaluate!
- Re-optimize CCT as needed to ensure effectiveness over full range of conditions
- Keep distribution system chemistry consistent



Some Specific Changes

Disinfection Changes

- Dosage changes
- Relocating disinfectant application point
- Switching to a new disinfectant
- Applying multiple disinfectants



Disinfection Changes
Why Change Disinfection Practices?

- Meet CT criteria under changing source water conditions
- Control/reduce DBP formation
- Improve “secondary” disinfectant residual in distribution system
- Optimize disinfectant consumption
- Control microbial regrowth
- Oxidation of iron and manganese
- Protection from Asiatic clams, zebra mussels and algal growth
- Aesthetics (taste & odor)

Disinfection Changes

New Disinfectant Combinations Often Pose Unique Challenges

Existing Disinfection Scheme	New Disinfectant Combination
Chlorine/Chlorine	Chlorine Dioxide/Chlorine Chlorine/Chloramine Chloramine/Chloramine Chlorine Dioxide/Chloramine Ozone/Chlorine Ozone/Chloramine
Chlorine/Chloramine	Chlorine Dioxide/Chloramine Ozone/Chloramine
Chloramine/Chloramine Ozone/Chlorine	Ozone/Chloramine

Disinfection scenario listed as "primary/secondary" disinfectant chemicals.

Disinfection Changes
Possible Conflicts/Challenges

- DBP formation/speciation shifts with change in TOC, NOM and temperature
- Coagulation and filtration implications
- Interactions with adsorptive processes
- Impacts to downstream treatment processes (bio-regrowth; fouling of membranes)
- LCR CCT issues (pH, alkalinity, ORP)
- Changes in residuals production and characteristics

Disinfection Changes
Mitigating Potential Conflicts/Challenges

- Identify/evaluate potential conflicts/interactions
- Control chlorine/ammonia ratio, water age and other factors to avoid nitrification
- Evaluate ozone impacts on downstream treatment processes
  - AOC & bio-regrowth potential
  - Biological filtration may be needed
  - Membrane fouling potential

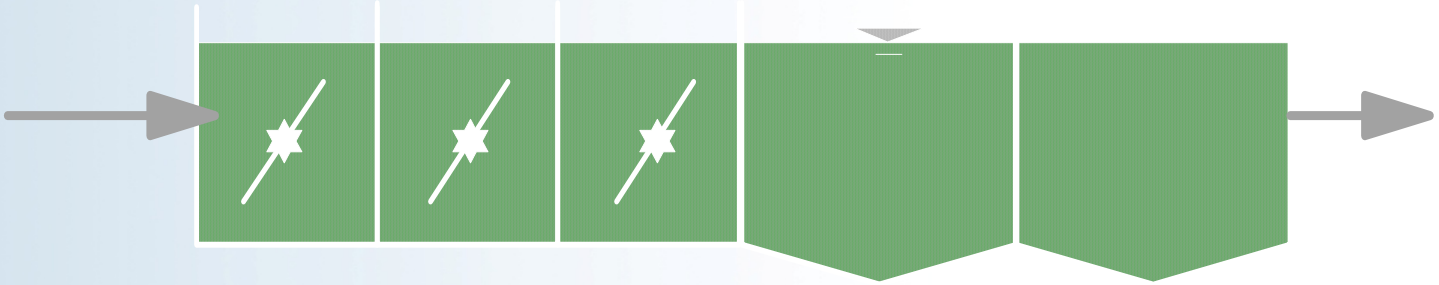
Disinfection Changes
Mitigating Potential Conflicts/Challenges

- Conduct site-specific treatability testing to establish how new oxidation conditions impact:
  - DBP speciation, bromate, chlorides/chlorates, etc.
  - Primary Disinfection/CT
  - Coagulation/softening/Corrosion
- Re-optimize CCT (if needed)
- Keep distribution system chemistry as consistent as possible to promote scale stability - and avoid AL exceedences or aesthetics problems

Some Specific Changes

Coagulation/Softening Changes

- Enhanced Coagulation
  - Consumes alkalinity
  - Lower coagulation pH
  - Increasing coagulant dose
  - Switch coagulant
  - Adding a coagulant aid polymer
- Enhanced Softening



Coagulation/Softening Changes

Why Enhanced Coagulation or Softening?

- Reduce DBP formation
- Improve disinfection effectiveness by:
  - Reducing NOM
  - Allow increased disinfectant dosages for pathogen inactivation
- Reduce bromate formation
- Improve arsenic and rad removal
- Improve GAC adsorption performance

Coagulation/Softening Changes

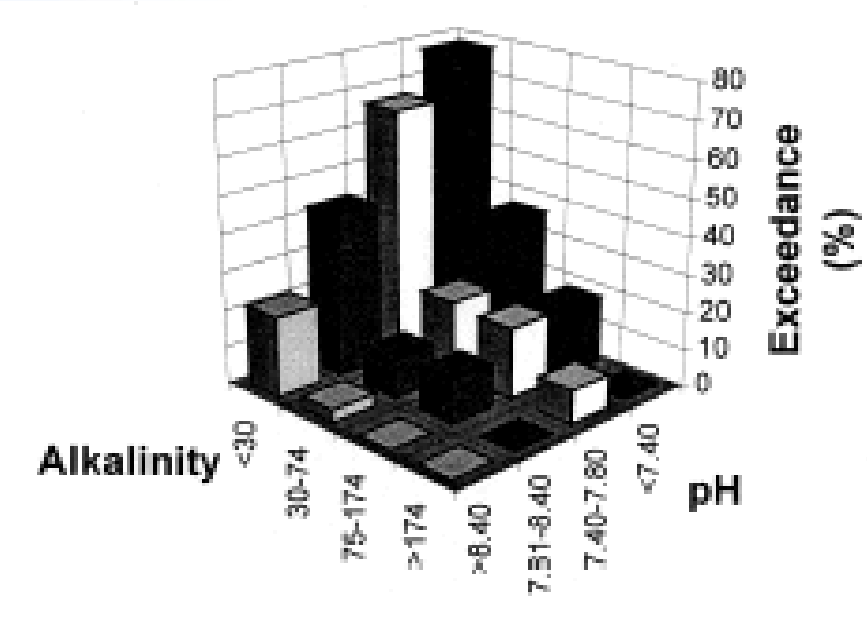
Recognize Potential Conflicts/Challenges

- Flocculation/Sedimentation performance
- Filter performance - shift in particle size distribution and character
- Increase in soluble aluminum may create post-precipitation problems
- Shifts in pH, Cl^-/SO^{-2} ratio, TOC, and alkalinity may impact LCR-CCT
- Changes in residuals quantity or characteristics

Some Specific Changes

LCR Corrosion Control Treatment

- Carbonate Passivation
- Carbonate Precipitation
- Passivation using PO_4 corrosion inhibitor



LCR Corrosion Control Treatment

Why Optimize/Re-Optimize CCT?

- CCT required by LCR, and to avoid:
  - AL exceedance/Public Education
  - LSL Replacement
- Maintain CCT effectiveness in conjunction with process modifications
- Address Fe/Mn/dirty water/aesthetics
- Mitigate/manage POTW Issues
  - Zinc
  - Phosphorus

LCR Corrosion Control Treatment

Managing CCT Frequently about Consistency

- pH, alkalinity, orthophosphate, ORP, NOM, TDS, nitrifying bacteria, etc. etc.
- Solubility (Pb, Cu, Ca, Cd, ??)
- Scale "Stability"
  - Deposition, permeability and scale hardness

Poor Scale Stability → Particulates → Higher Tap Lead Levels

LCR Corrosion Control Treatment

Possible Conflicts/Challenges

- Secondary disinfection efficacy
- Maintaining consistent target pH/alkalinity under reduced buffering
- Scale stability/release
- Shift in $Cl:SO_4$ ratio
- Bio-regrowth potential
- Red water / “dirty water” / aesthetics
- POTW Impacts (phosphorus, zinc)

LCR Corrosion Control Treatment
Mitigating Potential Conflicts/Challenges

- Critically examine changes or responses with potential to impact CCT
- Maintain consistent WQ in distribution system
- Carefully re-optimize CCT if needed
  - *Final Revised Guidance Manual for Selecting Lead and Copper Control Strategies. EPA 816-R-03-001 March 2003*
  - *"Managing Lead and Copper Rule Corrosion Control Practices to Avoid Unintended Consequences," AWWA, 2005.*

Some Specific Changes

Distribution System O&M Changes

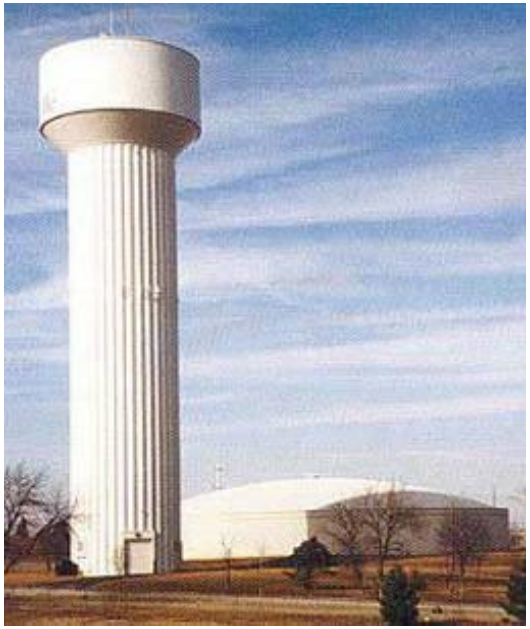
- Addition of booster disinfection
- Increase or decrease in water age
- Reservoir storage tank maintenance
- LSL Replacement under LCR
- Meter change-out programs
- Flushing

Distribution System O&M Changes

Why Implement Distribution System Changes?

- Improve secondary disinfection
- Increase disinfectant residual in periphery of system
- Reduce water age to lower DBPs
- Reduce nitrification / regrowth
- Improve bio-stability of water
- LCR ALs or compliance

Distribution System O&M Changes
Possible Conflicts/Challenges



- Negative impact on CCT effectiveness
- Nitrification/regrowth spikes
- Release/re-suspension of sediments
- Dirty water complaints
- Reduced storage for emergencies (e.g., fire protection)

Distribution System O&M Changes

Mitigating Potential Conflicts/Challenges

- Cycle/recirculate storage tanks
- Carefully re-optimize CCT
- Maintain consistent WQ in distribution system
- Loop distribution pipelines to minimize dead-ends
- Unidirectional flushing plan/program

Once a change has been proposed…

Once a Change is Under Consideration/Review...

- Characterize response "why, what, how?"
- Why was this response selected over another?
- Were alternatives compared?
- Is this compatible with existing treatment?
- How may this alter dist. system WQ?

Once a Change is Under Consideration/Review… cont.

Identify possible system conflicts/challenges

- Weigh impacts on existing treatment
- Hydraulic grade line impacts
- Wholesale or consecutive system issues
- WWTP Impacts (P, Zn)
- Residuals production/disposal
- Need to re-optimize CCT?
- Sufficient operator training/skill set in place?

How Did PWS Arrive at the Recommended Change?

Did PWS perform/complete:

- Water quality monitoring
- Disinfection Profiling/Benchmarking
- Hydraulic modeling
- Desktop evaluations
- Analogous System Study
- Bench-scale testing
- Pilot Plant testing
- Engineering report

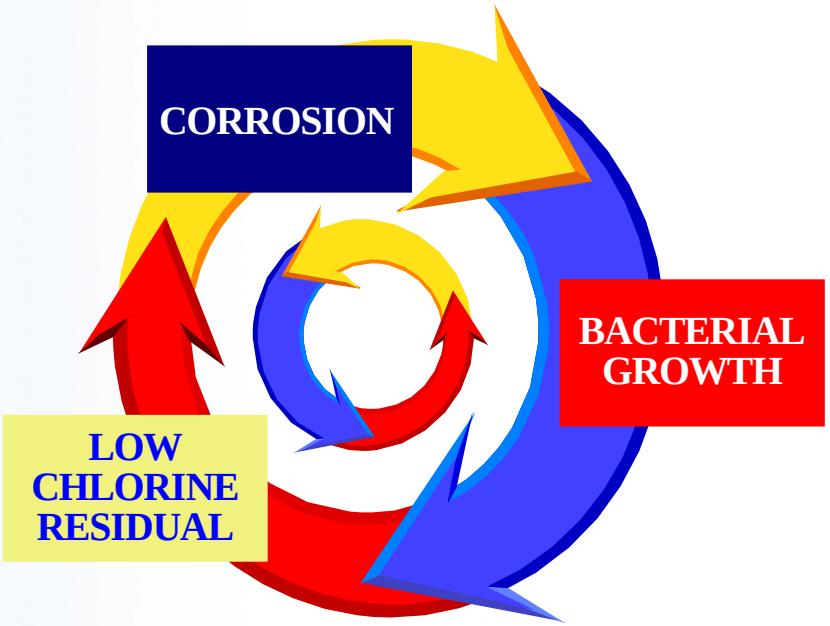
Did PWS Evaluate Impacts of Change in Terms Of...

- All primary and secondary WQ goals
- Compatibility/interactions with existing unit process operations
- Overall facility capacity
  - redundancy, reliability
- Impact on residuals quantity/characteristics
- Compatibility with distribution system operations
- Consecutive system requirements

Wrap-Up

Negative Water Quality Impacts Can Result from a Diverse Array of Changes

- Source Water
  - New Source
  - Blending of sources
- Treatment
  - Major unit process modifications/additions
  - Oxidants/disinfectants
  - Shifts in ORP, dose
  - O_3, chlorine dioxide, or UV
  - Enhanced/modified coagulation
  - Modified CCT
- Distribution System
  - Conversion to chloramines
  - Switch from Cl_2 gas to NaOCl
  - Nitrification
  - Nitrification control



Numerous and Subtle *Secondary Impacts* Increasingly Challenge Water System Operations

Taste & Odor
Iron/manganese
"Dirty Water"
Degradation of Filter Performance

Scale Stability & Metals Release
Nutrients and Regrowth Problems
POTW conflicts
Residuals Issues (As, Rads)

Blending of source/finished waters
Changes in flow, direction and pressure
Cleaning and other maintenance activities

Take Away

- Primacy agencies need to recognize and review <u>any change</u> which impacts:
  - *water quality performance*
  - *treatment process effectiveness, or*
  - *distribution system chemistry*

  ….<u>this is “simultaneous compliance.”</u>
- Utility compliance responses are sometimes constrained by “aesthetics/secondary” issues.
- Webinars 2, 3 & 4 will delve deeper into specific challenges.
- Technical resources are available.

Resources

- USEPA Simultaneous Compliance Guidance Manual for The LT2/Stage 2 DBP Rules, March 2007(EPA 815-R-07-017)
  http://www.epa.gov/ogwdw/disinfection/stage2/pdfs/guide_st2_pws_simultaneous-compliance.pdf
- "Simultaneous Compliance Tool," WRF 3115, 2009 (coming soon).
- "Managing Lead and Copper Rule Corrosion Control Practices to Avoid Unintended Consequences," AWWA, 2005.
  http://www.awwa.org/files/Advocacy/Govtaff/Documents/Lead_And_Copper_Managing_Change.pdf
- USEPA Microbial and Disinfection Byproduct Rules Simultaneous Compliance Manual, 1999. EPA 815-R-99-015
- "Balancing Multiple Water Quality Objectives," WRF, 1998.
- USEPA Regulations & Guidance Manuals
  http://www.epa.gov/safewater/regs.html

Discussion

Q&A