WASHINGTON AQUEDUCT
Future Treatment Alternatives Study
Stakeholder Workshop #1

MEETING MINUTES
October 14, 2009

On Wednesday, October 14, 2009, an expert and stakeholder workshop was convened in the visitor center of the Washington Aqueduct Dalecarlia Water Treatment Plant.

Members Present:
Dr. Dana Best, M.D., Children's National Medical Center
Joel Bluestein, ICF International
Erica Brown, Association of Metropolitan Water Agencies (AMWA)
Plato Chen, Washington Suburban Sanitary Commission (WSSC)
Andrew Fellows, Clean Water Action
Mike Hotaling, Newport News Water Works
Dr. Steve Hrudey, University of Alberta
Dr. Kimberly Jones, Howard University
Brian Kane, The Kane Group
Dr. Yanna Lambrinidou, Parents for Nontoxic Alternatives
Dr. Audrey Levine, USEPA
Ed Means, Malcolm Pirnie
Dr. Kirk Nowack, Malcolm Pirnie
Dr. Alexa Obolensky, Philadelphia Water Department (PWD)
Alan Roberson, American Water Works Association (AWWA) Regulatory Affairs and Fairfax Water Board
Dr. Philip Singer, University of North Carolina
Dr. Vern Snoeyink, University of Illinois
Dr. Vanessa Speight, Malcolm Pirnie
Dr. Scott Summers, University of Colorado
Mae Wu, Natural Resources Defense Council (NRDC)

Observers Present:
Saskia Alonso, Malcolm Pirnie
Vicky Binetti, EPA Region III
Nicole Brown, Malcolm Pirnie
Miranda Brown, Washington Aqueduct (WA)
Paul Castro, WA
Mike Chicoine, WA
Shabir Choudhary, WA
Nathan Cole, WA
Rodney Collins, City of Falls Church
Beth Craig, Arlington County
Brenda Creel, City of Falls Church
Robert Edelman, Virginia Department of Health (VDH)
Bob Etris, City of Falls Church
Dennis Fisher, WA

Marlee Franzen, Arlington County
Ashraf Gendy, WA
Kerry Hamilton, Association of Schools of Public Health (ASPH) / EPA Environmental Health Fellowship Program
Robert Hoffa, WA
Dave Hundelt, Arlington County
Ron Hunter, ASPH/EPA
Tom Jacobus, WA
Laura Khouvilay, Malcolm Pirnie
Eric Lindheimer, WA
Jennifer Lynette, EPA
Tomlyne Malcolm, WA
Jenna Manuszak, Malcolm Pirnie
Sara Mattie, Fairfax County Health Department
John McLaughlin, WA
Ray Moton, WA
Jay Nolan, WA
John Peterson, WA
Ralph Scott, Alliance for Healthy Homes
Anne Spiesman, WA
Lloyd Stowe, WA
Jagdish Tarpara, WA
Mel Tesema, WA
Ismael Valeri, WA
Dr. Tenkasi Viswanathan, WA
Linda Wilson, Malcolm Pirnie

Call to Order: Mr. Means, Malcolm Pirnie called the meeting to order at 8:40 a.m.

8:40 a.m. Introductory Remarks were made by Mr. Jacobus, General Manager of Washington Aqueduct.

8:45-9:00 a.m. **Welcome and Introductions**
Mr. Ed Means, Malcolm Pirnie - Session Moderator
Means welcomed the audience and introductions were made. He also noted that additional information, following this meeting, may be found on the Washington Aqueduct website.

9:00-9:10 a.m. **Presentation #1: Background and Objectives of the Future Treatment Alternatives Study**
Dr. Vanessa Speight, Malcolm Pirnie

Dr. Speight gave a short presentation on the background and objectives of the Future Treatment Alternatives Study. She discussed the timeline of this project, and plans to hold two additional workshops; one in early 2010 and one 3-4 months later (slides follow).

Presentation 1: Background and Objectives of Future Treatment Alternatives Study

Dr. Vanessa L. Speight
Malcolm Pirnie

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Future Treatment Alternatives Study

- Water utilities are dealing with the challenge of providing the best possible drinking water in the face of uncertainty regarding:
  - Contaminants
  - Health Effects
  - Treatment Effectiveness
- Washington Aqueduct is undertaking a process involving stakeholders and experts to address these challenges through the Future Treatment Alternatives Study
- Need a process to compile, synthesize and prioritize information in the face of this uncertainty
  - When funding becomes available, this process can be used to make sound decisions

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Goals

- Consider water quality issues beyond regulations
- Obtain Stakeholder input to understand community values
- Develop a framework that incorporates potential health risks to synthesize and prioritize water quality issues
- Applying this framework, identify water quality objectives that can be used to develop:
  - Treatment alternatives
  - Other options for water quality improvement

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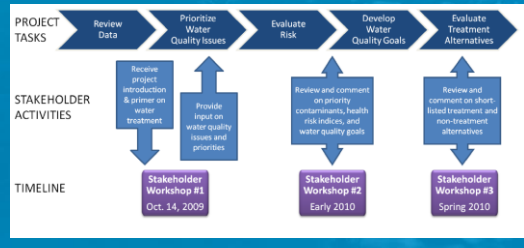
Summary of Project Activities



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Role of Stakeholders and Experts

- A panel of experts will be providing input throughout the project
- Stakeholder representatives will help to identify:
  - Priority issues
  - Community values
  - Other factors to consider
- Opportunities for input include:
  - Public comment at scheduled workshops
  - Additional written comments

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Water Quality Issues to be Considered

- Microbial water quality issues
  - Pathogens
  - Algae and algal by-products
- Water quality issues resulting from treatment and distribution
  - Disinfection by-products
  - Corrosion by-products
  - Trace contaminants in treatment chemicals
- Chemicals introduced into drinking water sources through human activities in the watershed
  - Sodium
  - Perchlorate
  - Pesticides
  - Pharmaceuticals and personal care products
  - Other persistent organic / inorganic chemicals
  - Endocrine-disrupting compounds
  - Nanomaterials

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Initial Factors that May Influence Decisions

- Human health protection (including sensitive subpopulations)
- Affordability
- Local ecosystem impacts
- Energy impacts
  - Greenhouse gas / carbon footprint
  - Future cost and availability of energy
- Sustainability
- Security considerations
- Watershed changes
- Climate change

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9:10-9:55 a.m. **Presentation #2: Overview of the Washington Aqueduct Treatment Process**

Dr. Kirk Nowack, Malcolm Pirnie

Dr. Nowack described the current process employed at WA's two water treatment plants and the plants' performance (slides follow).

Presentation 2: Overview of Washington Aqueduct Treatment Process

Dr. Kirk O. Nowack
Malcolm Pirnie

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WA System Overview

- WA operates two water treatment plants:
  - Dalecarlia Plant: 220 MGD
  - McMillan Plant: 120 MGD
- WA supplies water to 3 wholesale costumers:
  - DC WASA
  - Arlington County
  - City of Falls Church

~1 Million people

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Managing Drinking Water Quality

- Drinking water quality depends on more than just treatment…
  - Watershed protection
  - Distribution system management practices

Watershed | Treatment | Distribution

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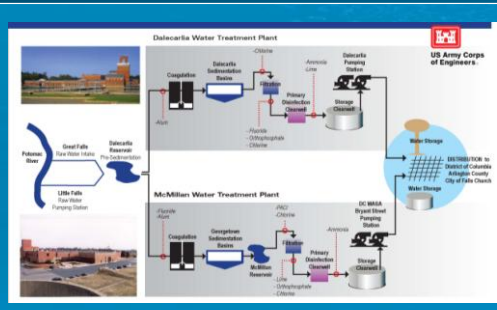
WA Treatment Plants



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Primary Goals of Water Treatment

- Turbidity (particle) removal
  - Removing particles reduces the likelihood that pathogens are present; particle removal processes remove pathogens
  - Particle removal important for aesthetic reasons
- Disinfection
  - Inactivates pathogens that remain in the water following particle removal steps

Requirements specified in the Surface Water Treatment Rule (SWTR), the Interim Enhanced Surface Water Treatment Rule (IESWTR), and the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

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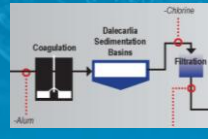
Turbidity (Particle) Removal at WA

- Particle removal occurs via three sequential processes:
  - Coagulation – causes particles to stick together
  - Sedimentation – large particles settle out
  - Filtration – small particles captured in filter media
- These processes (collectively) also remove natural organic material



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Turbidity (Particle) Removal at WA

- Influent turbidity ranges from 2 to 100+ NTU (water leaving Dalecarlia Reservoir)
- Coagulation and settling processes typically reduce turbidity to < 1 NTU
- Filtered water turbidity is < 0.1 NTU 95% of the time (regulatory requirement: < 0.3 NTU 95% of the time)

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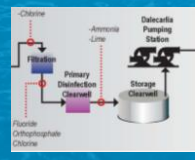
Disinfection at WA

- Free chlorine applied upstream of filters and primary disinfection (first) clearwell
  - Powerful disinfectant
  - Rapidly inactivates pathogens
- Ammonia added after first clearwell to convert free chlorine to monochloramine
  - More persistent than free chlorine
  - Forms fewer disinfection by-products than free chlorine



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Disinfection at WA

- High level of inactivation achieved with current disinfection practices
  - Exceeds inactivation requirements set forth in the Surface Water Treatment Rule
- Current system provides for considerable redundancy; inactivation occurs in filters, first and second clearwells

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Other Regulatory Considerations

- In addition to turbidity removal and disinfection, water treatment regulations also cover specific contaminants that may appear in the raw water or are formed in the distribution system:
  - Disinfection by-products
  - Corrosion by-products
  - Other regulated contaminants

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Disinfection By-Products (DBPs)

- DBPs are formed when free chlorine reacts with natural organic matter
- Two groups of DBPs are regulated:
  - Trihalomethanes (THMs) – 4 species
  - Haloacetic acids (HAAs) – 5 species
- Conversion to monochloramine essentially halts THM and HAA formation
- Since WA began utilizing monochloramine for secondary disinfection, running annual average concentrations of THMs and HAAs have consistently been less than 80 / 60 µg/L (Stage 1 DBP Rule requirements)
- Well-positioned for compliance with Stage 2 DBP Rule

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DBP Precursor Removal at WA

- Stage 1 DBP Rule also includes requirements for removing DBP precursors (natural organic matter) prior to chlorination
- DBP precursor levels measured as total organic carbon (TOC)
- TOC removal rates for both WA plants consistently exceed the Stage 1 requirements

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Corrosion Control at WA

- Treated drinking water can be corrosive and cause metals such as lead, copper and iron to be released from distribution system pipes
- WA employs the following corrosion control practices to limit the impacts of corrosion:
  - Orthophosphate addition – orthoposphate coats the inner walls of dist. system pipes, thereby reducing corrosion rates
  - pH control – pH maintained within a range that corresponds to low corrosion rates (via lime addition)

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Other Regulated Contaminants

- There are 87 primary drinking water standards (set by EPA) that regulate…
  - Volatile organic chemicals (VOCs)
  - Synthetic organic chemicals (SOCs)
  - Inorganics
  - Radionuclides
- WA consistently complies with all these standards

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Regulatory Compliance

- Washington Aqueduct consistently complies with all of the requirements set forth in the Safe Drinking Water Act regulations

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Unregulated Contaminants

- EPA has the authority to set drinking water standards under Safe Drinking Water Act
- Two programs help EPA make determinations about unregulated contaminants:
  - Contaminants Candidate List (CCL): EPA periodically publishes a list of unregulated contaminants present in drinking water that may impact public health to prioritize research and data collection
  - Unregulated Contaminant Monitoring Rule (UCMR) program: its purpose is to collect data for contaminants suspected to be present in drinking water
    - WA participates in the UCMR program

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During the discussion period that followed **Presentation #2: Overview of the Washington Aqueduct Treatment Process**, the following comments were made:

Mr. Roberson inquired as to whether WA currently uses activated carbon or pre-oxidants in their treatment strategy. Nowack responded that WA has the capability to feed powdered activated carbon (PAC) to the water leaving the Dalecarlia Reservoir, and that it is used intermittently in the summer and fall, for control of taste and odor in the finished water. PAC is not fed every year; WA has experienced two significant taste and odor events over the last 5-6 years. Chen added that WSSC did not see any of these taste and odor events for the reason that they obtain the water directly from the Potomac River and WA has raw water reservoirs. WA also has the capability to use potassium permanganate, at either the influent to the Dalecarlia or McMillan Reservoir, and copper sulfate in the middle of the Georgetown Reservoir, for algae control.

Roberson further inquired as to whether any of the VOCs, SOCs, inorganics, or radionuclides for which there are primary drinking water standards have been detected in the raw or treated water, and which specific contaminants were regularly detected (e.g., atrazine, perchlorate). Nowack responded that he could not recall which contaminants had been detected and which had not, but that any detections were well below the associated Maximum Contaminant Levels (MCLs) established by EPA. Chen supported this statement, saying that WSSC data collected from the Potomac River were all below the MCLs. He also added that the compounds detected are mainly related to agricultural activities.

Mr. Fellows inquired as to why WA chose to switch from chlorine as a secondary disinfectant to chloramines. Nowack responded that this was done to suppress the formation of disinfection byproducts, which are more prevalent with chlorine as a secondary disinfectant. He commented that while there is a potential for adverse impacts of chloramines on lead corrosion, chloramines can be managed carefully to reduce this risk.

Dr. Obolensky asked Nowack to comment on WA's use of real-time water quality monitoring of the Potomac River. Nowack responded that most of WA's raw water monitoring is done through the use of "grab" samples; however they are considering the use of on-line instrumentation.

9:55-10:40 a.m. **Presentation #3: Disinfection and Pathogen Considerations**
Dr. Steve Hrudey, University of Alberta

Dr. Hrudey gave a presentation on overarching disinfection practices employed at water treatment plants, and various pathogen considerations (slides follow).

Presentation 3: Disinfection and Pathogen Considerations

Dr. Steve E. Hrudey
University of Alberta

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Water Quality Issues to be Considered

- **Microbial water quality issues**
  - **Pathogens**
  - **Algae and algal by-products**
- Water quality issues resulting from treatment and distribution
  - Disinfection by-products
  - Corrosion by-products
  - Trace contaminants in treatment chemicals
- Chemicals introduced into drinking water sources through human activities in the watershed
  - Sodium
  - Perchlorate
  - Pesticides
  - Pharmaceuticals and personal care products
  - Other persistent organic / inorganic chemicals
  - Endocrine-disrupting compounds
  - Nanomaterials

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Pathogens

- Bacteria, viruses, and parasites are organisms of primary concern in drinking water treatment
- Pathogen inactivation is regulated for indicator organisms and pathogens including:
  - Viruses
  - Total coliform
  - *Giardia*
  - *Cryptosporidium* (future requirement)
- Regulations include a combination of direct measurements and treatment requirements

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Additional Pathogens Recommended for Further Regulatory Evaluation (CCL 3)

Pathogen	Description & Rationale
Adenovirus	Virus most commonly causing respiratory illness, and occasionally gastrointestinal illness
Caliciviruses	Virus (includes Norovirus) causing mild self-limiting gastrointestinal illness
Campylobacter jejuni	Bacterium causing self-limiting gastroentestinal illness
Enterovirus	Group of viruses including polioviruses, coxsackieviruses and echoviruses that can cause mild respiratory illness
Escherichia coli (0157)	Toxin-producing bacterium causing bloody diarrea and kidney failure in extreme cases
Helicobacter pylori	Bacterium sometimes found in the environment capable of colonizing human gut that can cause ulcers and cancer

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Additional Pathogens Recommended for Further Regulatory Evaluation (CCL 3)

Pathogen	Description & Rationale
Hepatitis A virus	Virus that causes a liver disease and jaundice
Legionella pneumophila	Bacterium found in the environment including hot water systems causing lung diseases when inhaled
Mycobacterium avium	Bacterium causing lung infection in those with underlying lung disease, and disseminated infection in the severely immunpcompromised
Naegleria fowleri	Protozoan parasite found in shallow, warm surface and ground water causing primary amebic meningoencephalitis via nasal inhalation
Salmonella enterica	Bacterium causing self-limiting gastrointestinal illness
Shigella sonnei	Bacterium causing self-limiting gastrointestinal illness and bloody diarrhea

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Pathogen Summary

Pathogen	Health Significance	Persistence in water	Resistance to chlorine	Relative infectivity	Important animal source
Norovirus	High	Long	Moderate	High	Potentially
Campylo-bacter	High	Moderate	Low	Moderate	Yes
E.H. *E.coli*	High	Moderate	Low	High	Yes
Giardia	High	Moderate	Moderate	High	Yes
Crypto-sporidium	High	Long	High	High	Yes

Source: World Health Organization, Drinking Water Guidelines 2004

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Issues Related to Pathogens

- Immuno-compromised and sensitive populations may be susceptible to different pathogens
  - For example, immune-compromised individuals can be fatally infected by *Cryptosporidium*
- Changes in the watershed may lead to higher pathogen concentrations in the source water
  - Climate change could reduce river flows or cause severe storms
  - Increase urbanization could introduce pathogens through runoff and wastewater treatment effluent
- Conventional treatment process may be ineffective for some pathogens (e.g., chlorination for *Cryptosporidium*)

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Disinfection at WA

- High level of inactivation achieved with current disinfection practices
  - Exceeds inactivation requirements set forth in the Surface Water Treatment Rule
- Free chlorine applied upstream of filters and primary disinfection (first) clearwell
- Ammonia added after first clearwell to convert free chlorine to monochloramine
  - More persistent than free chlorine
  - Forms fewer disinfection by-products than free chlorine
- Current system provides for considerable redundancy; inactivation occurs in filters, first and second clearwells

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Algae and Algal By-products

- This category includes algae, by-products produced by algae and algal toxins
  - A few compounds can be highly toxic
  - Most are not harmful but some have unpleasant tastes and odors
  - None are currently regulated
- 3 “cyanotoxins” are on CCL3 for further regulatory evaluation
- WHO, Canada, and Australia have suggested limits for several compounds

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Algae monitoring by WA

Algae Species Monitored by Washington Aqueduct

Asterionella	*Microcystis*	*Cymbella*	*Navicula*	*Synedra*	*Uroglenopsis*
Anabaena	*Chrysococcus*	*Diatoma*	*Nitzschia*	*Meridion*	*Zygnema*
Ankistrodesmus	*Closterium*	*Euglena*	*Dinobryon*	*Ulothrix*	*Spirogyra*
Fragilaria	*Tetrahedron*	*Oscillatoria*	*Scenedesmus*	*Tabellaria*	*Agmenellum*
Chlorella	*Cyclotella*	*Staurastrum*	*Tribonema*	*Gyrosigma*	

- WA monitors twice a week April-Sept, weekly for rest of the year
- Many different species have been detected in source water and reservoirs
- *Anabaena, Microcystis, Oscillatoria (Planktothrix)*

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Issues Related to Algae

- Taste and odor episodes have occurred in the Potomac River
  - Contribute to poor public perception of water
  - No public health impact for known odor agents
- Climate change and watershed redevelopment could increase algae concentrations in the source water

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Risk-Based Approaches to Address Microbial Water Quality Issues

- Strategic monitoring focus on raw water and high pathogen loading events
- Know your system (the sanitary survey)
  - What pathogens may be a threat?
  - Where and how do they pose a threat?
  - How well does your treatment train deal with them, especially under non-steady state conditions?
- Understand how to balance risks effectively
  - If you do not control pathogens, it is only a matter of time and circumstances until someone falls ill
  - Most other contaminants are controlled on a largely precautionary basis

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Risk-Based Approaches to Address Microbial Water Quality Issues

- An emphasis on **monitoring of treated water** for pathogens is insufficient to assure safe water
  - Results are generally only available after water has been delivered and likely consumed
  - Practical frequency of monitoring provides inadequate coverage of intermittent contamination
  - Practical scope of monitoring for pathogens is not encouraging
- An emphasis on process monitoring assuring treatment performance is the best approach to assure safe water

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A discussion period followed **Presentation #3: Disinfection and Pathogen Considerations.** The following summarizes the key comments and questions that were posed.

Fellows inquired as to whether re-development in the watershed is the same as development? Hrudey clarified that he meant to say development with regards to urbanization. Fellows also asked what the geographic range of concern was in considering upstream watershed activities. Hrudey responded that generally water treatment plants are most concerned with activities occurring within 50-100 miles upstream.

Chen commented that the Potomac Drinking Water Source Protection Partnership (DWSPP) regularly deals with watershed issues, and has performed a *Cryptosporidium* source-tracking study. The Potomac River watershed upstream of the DC area water supply intakes is approximately 10,000 square miles, and within that watershed there is a great deal of agricultural, and specifically cattle operations. The study included targeted monitoring of five sites (two agricultural/cattle influenced, one wastewater treatment plant (WWTP) effluent influenced, and two water treatment plants (WTPs) intakes), and results indicated the presence of cattle-derived *Cryptosporidium* in several local water treatment plant intakes. He noted that *Cryptosporidium* is a particularly hardy pathogen, and can survive a long time in raw water supplies. Speaking on behalf of WSSC, *Cryptosporidium* is the pathogen of greatest concern and for this reason WSSC implemented ultraviolet (UV) disinfection at their treatment plants. These UV facilities provide added protection against *Cryptosporidium*, beyond what is required for WSSC by the current water treatment regulations.

Hrudey further noted that over the last 15 years, the most common cause of human health outbreaks related to drinking water has been from *Cryptosporidium*.

Fellows inquired as to whether there have been any studies related to the cost-benefit of watershed control versus treatment technologies for *Cryptosporidium*. Hrudey responded that generally watershed control measures are preferred to providing additional treatment at the plant.

Obolensky asked whether concerns associated with urbanization are related more to increasing WWTP discharges, stormwater overflow, or from surface runoff. Hrudey responded that *Cryptosporidium* generally passes through the WWTP processes, and can also be found in septic tank discharge and stormwater overflows. However, modern community developments have separate sanitary and storm sewers so that wastewater overflow during storms is not a significant issue as in older cities. Also, many developments now provide retention ponds.

Ms.Erica Brown requested that someone elaborate on the source water protection work that's been done, especially with the DWSPP and any other strategic raw water monitoring programs. Chen described the *Cryptosporidium* study that was performed by the DWSPP. Since then, they have been planning some follow-up work with the agricultural community to implement best management practices (BMPs) for cattle operations. Those initiatives, though, are still in the planning stages.

Fellows asked whether there were any other regional initiatives on source water issues. Chen mentioned that the Metropolitan Washington Council of Governments (MWCOG) has

coordinated a project with many regional utilities, to install live fish bio-monitor systems for detecting chemical contamination, using bluegills (similar to the "canary in the coal mine" technique). WA participates in that program, and has a fish bio-monitor installed on their raw water intake. WSSC has fish bio-monitors on both their raw and treated water. Chen also noted that Fairfax Water has some on-line source water monitoring instruments. Chen explained that all water treatment plants routinely monitor for turbidity, which is the primary indicator for the occurrence of pathogens. Some also have on-line total organic carbon (TOC) monitors. Ms. Binetti commented that the Interstate Commission for Potomac River Basin (ICPRB) has helped organize a network of notification between upstream combined sewer overflows with downstream water treatment utilities, to notify utilities when there are treatment upsets or untreated overflow discharges into the Potomac.

Fellows inquired about the benefits of moving raw water intakes from the shoreline of a water body to the center channel, as Fairfax Water has done. Hrudey responded that locating your intake in the center stream helps with mixing and dilution of upstream contamination. Chen commented that WSSC is considering moving their intake location, mostly to mitigate the influence of the immediately upstream tributary. While the WA Great Falls intake is located along the shoreline, that particular location is not impacted by any upstream tributaries, so relocating it to the middle of the stream would not likely have any appreciable impacts on raw water quality. Furthermore, WA has a large raw water impoundment (the Dalecarlia Reservoir), which helps equalize raw water quality with respect to turbidity upsets in the Potomac.

Means posed a question to the panel, "Based on the discussion today, is it fair to state that the primary target with respect to pathogen control should be *Cryptosporidium*?" Hrudey responded that there is nothing else on the EPA Candidate Contaminant List (CCL) that would change that perspective.

Snoeyink commented that WA also has the capability to shut off their river intake, if something catastrophic were to occur upstream. Ms. Wu asked for an example of an event that would cause WA to do this. Snoeyink responded that this could be done if toxicological effects were seen in the live fish bio-monitor system. Jacobus added that there is some travel time between the WA Great Falls and Little Falls intakes. If there were a plume in the river, it may also be possible to coordinate shut down of the Great Falls intake. WA could then operate for some time with both Great Falls and Little Falls intakes shut off, by treating the water stored in the reservoirs.

Snoeyink mentioned that a recent study by Dr. Norman Pace from University of Colorado found *Mycobacterium* growth activity in showerheads and inquired as to whether Hrudey knew of any possible treatment at the water treatment plant to control the problem. Hrudey replied that *Mycobacterium* is resistant to chlorine. He added that *Mycobacterium* also grows in swimming pools.

Singer inquired as to whether Fairfax Water installed their ozone system for *Cryptosporidium* removal, which was the reason why WSSC installed their UV system. Roberson explained that the ozone system is normally run at low dosages for taste and odor control and not at the dosages that would be required for *Cryptosporidium* inactivation. He does not know the capacity of the system to meet *Cryptosporidium* log removal requirements. He will find out.

As a follow up to Ms. Brown's question about raw water monitoring programs, Singer asked whether WSSC or Fairfax Water have on-line particle counters. Chen replied that WSSC does have on-line particle counters.

Dr. Levine added that during the Potomac River source tracking study that Chen mentioned earlier, molecular methods were used for microbial source tracking which helped differentiate *Cryptosporidium* from humans from the ones from animal sources. She also indicated that chloramines are effective against *Legionella* but not so much against *Mycobacterium*. Both *Legionella* and *Mycobacterium* warrant further study and are on the CCL3.

Mr. Hotaling indicated that Newport News operates their ozone system to achieve 4-log inactivation for *Giardia*, which also gives them 0.5-log inactivation for *Cryptosporidium*; therefore Fairfax Water should get some similar log inactivation, if they operate at similar doses.

Chen indicated that WSSC has an aging distribution system, where breaks occur frequently, creating opportunities for contamination. For this reason, free chlorine provides them with a better barrier against contamination within the distribution system than chloramines. Hotaling added that free chlorine is less stable in the distribution system and it can be difficult to maintain a residual. Chloramines are more stable.

10:40-11:45 a.m. **Presentation #4: Disinfection By-Products**
Dr. Philip Singer, University of North Carolina

Singer gave a 15-minute presentation on considerations related to disinfection by-products (DBPs), including both current regulations and regulated and unregulated DBPs (slides follow).

Presentation 4: Disinfection By-Product Considerations

Dr. Philip C. Singer
University of North Carolina

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Water Quality Issues to be Considered

- Microbial water quality issues
  - Pathogens
  - Algae and algal by-products
- **Water quality issues resulting from treatment and distribution**
  - **Disinfection by-products**
  - Corrosion by-products
  - Trace contaminants in treatment chemicals
- Chemicals introduced into drinking water sources through human activities in the watershed
  - Sodium
  - Perchlorate
  - Pesticides
  - Pharmaceuticals and personal care products
  - Other persistent organic / inorganic chemicals
  - Endocrine-disrupting compounds
  - Nanomaterials

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Disinfection By-Products

- Disinfection by-products (DBPs) are a group of compounds formed when free chlorine and other disinfectants react with natural organic matter present in the raw water
- Two regulated groups of chlorination DBPs:
  - Trihalomethanes (THMs) – 4 species (80 ppb)
  - Haloacetic acids (HAAs) – 5 species (60 ppb)

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DBP Regulatory Requirements

- DBPs are regulated as a running annual average of quarterly measurements taken at various locations in the respective distribution systems.
  - The system-wide annual average must be below the regulatory maximum contaminant level.
  - Beginning in 2012, the annual average at each location must be below the regulatory level.

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Disinfection By-Products at WA

- Current management strategy for DBP compliance is:
  - Precursor removal by coagulation prior to chlorine addition
  - Use of chloramines (combined chlorine) for final disinfection
  - Use of a combined chorine residual essentially stops continuing formation of THMs and HAAs in the distribution system.
  - WA levels are, and have historically been, below regulatory limits

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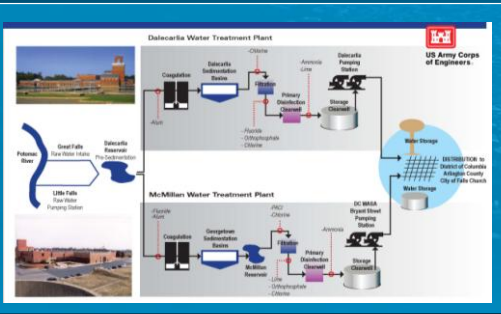
WA Treatment Plants



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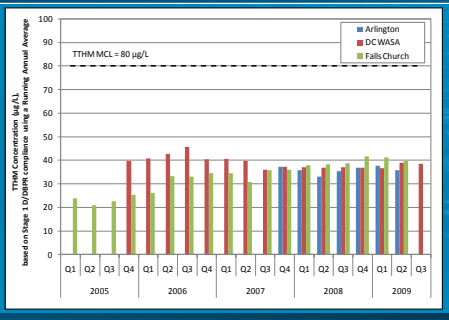
Running Annual Average for THMs in the Distribution System



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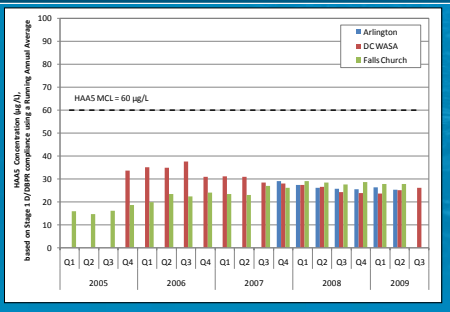
Running Annual Average for HAAs in the Distribution System



48

DBPs Continued

- Brominated species tend to be more hazardous than their fully chlorinated counterparts
  - Potomac River bromide levels are low (<50 ppb)
  - Bromide levels could increase in the future due to climate change and watershed activities.

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Issues Related to Disinfection By-Products

- Balance between disinfectant addition for pathogen inactivation and disinfection by-product formation.
- In evaluating different disinfection options (e.g. chlorine, ozone, chlorine dioxide, UV irradiation), DBPs associated with each alternative need be considered.
- Potential for undesirable unintended consequences need to be assessed.
- Potential risks associated with unregulated DBPs.

50

Unregulated DBPs

- Hundreds of DBPs have been identified in chlorinated drinking water.
- A number of “emerging” DBPs appear on CCL3.
  - Occurrence and health effects studies underway

51

Unregulated DBPs

- Iodinated species are known to occur
  - More hazardous than their chlorinated and brominated counterparts.
  - More likely to be produced by chloramines.
  - Iodide is likely to be very low in Potomac River water.
- Nitrogenous DBPs
  - NDMA likely to occur because of chloramination.
  - Upstream wastewater impacts to Potomac could increase possibility of NDMA formation.

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DBP Summary

- WA made treatment changes to comply with MCLs
  - Move point of chlorination
  - Switch to secondary chloramination
- Currently in compliance with MCLs
- Impact of emerging DBPs?
- Impact of changes in watershed

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During the discussion period that followed **Presentation #4: Disinfection By-Products**, the following comments were made:

Dr. Lambrinidou asked what NDMA stands for. Singer replied that it stands for nitrosodimethyl amine. He added that drinking water is only one potential source of exposure. NDMA is also found in cured meats like bacon and sausage.

Lambrinidou also inquired about the national landscape of disinfection practices. Singer explained that in 1974 THMs were discovered in Holland and in the US, which led to studies by the National Cancer Institute and the promulgation of the first DBP regulation in 1979. The most common means of controlling DBP formation are to move the point of chlorination downstream in the treatment process, and to remove organic material by coagulation before adding chlorine. Another common practice is to use chloramines for secondary disinfection (instead of free chlorine) which greatly reduces further formation of DBPs in the distribution system. A lesser used method of controlling DBPs has been to employ alternative primary disinfectants such as ozone and UV irradiation. Speight added that in addition to using different disinfectants to control DBPs, many utilities are looking at increased removal of organic matter, using processes such as activated carbon.

Singer went on to explain that under the Stage 2 Disinfectants / Disinfection By-products Rule (Stage 2 D/DBPR), every location in the distribution system is required to have DBP levels below the MCLs (rather than averaging all the locations). Singer believes that currently on the order of 30-40% of all water systems in the US employ chloramines for DBP control, and that after the Stage 2 D/DBPR comes into effect (in 2012), as many as two-thirds of water systems will have converted to chloramines as a way to comply with the new regulations at each location. Roberson stated that he believes it's currently unclear if that percentage will be reached due to the results of a survey performed around 5 years ago where only one third of utilities used chloramines. In terms of the percentage of the US population served by systems using chloramines, appreciably more than one third of people receive chloraminated water because many large cities use chloramines.

Dr. Summers also disagreed with the projection that two thirds of utilities will operate using chloramines by 2012, for the reasons that States like Ohio have banned them, that small systems without adequate resources will likely have operational problems like nitrification and issues around the formation of nitrosamines. He also stated that their use is not legal in Europe. He believes that utilities are hesitating about using chloramines and are evaluating other options like activated carbon for removal of DBP precursors. Singer added that chloramination is the lowest cost option and is easy to implement to comply with the Stage 2 D/DBPR. He also pointed out that the main reason why some States do not allow chloramination at utilities under their jurisdiction is because their source water is good and the State believes those systems ought to be able to achieve better coagulation performance to be able to comply with the Stage 2 D/DBPR without changing their disinfection practices. Singer pointed out that Georgia discourages the use of chloramines. However, everybody agreed that other options tend to be much more expensive.

Hrudey explained that the decision made in the 1970s to regulate THMs is an example of a precautionary regulation. After more than sixty studies on health effects of DBPs, there is only consistent evidence related to increased occurrence of bladder cancer, and that risk is associated with very high exposure to THMs, well beyond what is formed in normal drinking water treatment today. A few years ago Hrudey served on a panel in Canada to discuss whether the Canadian MCLs for THMs and HAAs should be reduced (Canadian regulations are similar to the US regulations). The Canadian panel agreed that there is not adequate evidence to justify lowering the MCLs for THMs and HAAs. Hrudey also pointed out that although there is uncertainty on human health effects of THMs themselves, they are a surrogate for other DBPs that may cause health effects.

Dr. Best inquired about HAA health effects. Hrudey replied that there is less evidence of their health effects than for THMs, basically because less data has been collected. Singer added that in the past utilities had a tendency to over-chlorinate as a precautionary measure against pathogens. The earliest epidemiological studies on DBP health effects focused on communities that were actually exposed to very high THM levels, prior to the 1979 Rule. Some utilities had THM levels in the range of 2000 ug/L (over 25 times higher than the current regulation), and few studies since that time have examined populations exposed to current levels of DBPs. Levine pointed out that research should focus on the health effects of a combination of DBPs, and less on the individual compounds, and that there is also a great research need for data on the reproductive health effects and health effects on children.

Obolensky asked which parameters Singer would recommend monitoring for, in order to better understand DBP issues, given the shifting landscape, new regulations, and new findings on health effects. She also inquired whether Singer felt that total organic halogen (TOX) is a good measurement for understanding DBP formation. Singer replied that the best way of approaching DBPs is to remove the precursors as much as possible, even though some approaches may be costly. He also believes that monitoring of DBP precursors is more important than monitoring the formation of individual compounds or subgroups of DBPs. He does not consider measurement of TOC to be the best indicator of reactive precursors; it is better to optimize treatment with respect to UV 254 absorbance (the measure of organic matter that absorbs light at a wavelength of 254 nanometers). With respect to TOX, Singer believes that it is difficult to interpret the meaning of TOX data as TOX represents a mixture of halogenated compounds and cannot provide information on the contribution of each individual compound and its potential health effects.

Roberson mentioned that according to data presented in the Information Collection Rule, exposure to THMs have been reduced by about a half since the 1970s. Singer commented that THM exposure has actually been reduced by much more, maybe by as much as 95%, from a high of 2000 ug/L down to 100 ug/L in the 1970s and then to 80 ug/L more recently. He reiterated that the first reduction, from about 2000 to 100 ug/L, was the important change, and that reducing THM levels from 100 to 80 ug/L does not necessarily represent a significant reduction in health risk. Roberson added that is not clear what EPA will do in the future, if there will be a Stage 3 D/DBPR. It appears that NDMA may be the next biggest issue related to DBPs and that nitrosamines are included in the current UCMR. However, human exposure to nitrosamines from food is 10 to 100 times greater than the exposure from drinking water.

Dr. Jones asked how seriously utilities are considering DBP precursor removal via activated carbon, ion exchange, and membranes, as these technologies can remove other contaminants of concern like endocrine disrupting compounds. Obolensky explained that at PWD their ideal goal is to remove precursors before chlorine addition, although there are competing treatment issues that have to be considered. For example, chlorine provides benefits for pre-oxidation, improved filterability, and manganese control. The most critical consideration is maintaining redundancy with respect to points of disinfectant addition in order to safeguard against any accidental loss of disinfection at one location, and consequent acute public health risks. Thus, for example, it may be necessary to construct post-contactors before eliminating prechlorination. PWD is considering magnetic ion exchange resins (MIEX) and other advanced treatment options , but those technologies are very costly and chlorine would still need to be added. Hotaling pointed out these processes (MIEX and membranes) all produce a concentrated waste stream, which must be disposed of, and this is an issue, especially in water scarce areas. Singer added that these technologies are also energy intensive, and that carbon footprint must be considered.

Chen commented that WSSC's approach is to maximize organics removal by enhanced coagulation at low pH as well as optimizing free chlorine dosing to minimize excess free chlorine in the distribution system. Using this strategy they have been able to avoid switching to chloramines, and even though they have a much more geographically dispersed distribution system than WA's wholesale customer systems, they have been able to maintain free chlorine residual and meet DBP regulations with this approach. He suggested WA consider the option of returning to free chlorine as part of this project.

Chen commented that bromide levels in the Potomac River are low and for that reason not too many brominated DBPs are formed; WSSC's experience is that 70-80% of the total THMs consist of chloroform which is less toxic than the brominated compounds. He also pointed out that one unintended consequence of organics removal is an increase in problems with copper pin-hole leaks. Chen also shared the results of a study performed by WSSC to assist them in formulating their disinfection strategy. In that study, they found that simulated NDMA formation in the treated water from WSSC's Potomac Water Treatment Plant was about 2-5 ng/L, similar to the value of 2.5 ng/L detected by WA when monitoring for NDMA. These values are lower than the notification level of 10 ng/L adopted by California, but are still higher than the 10^{-6} excess cancer risk level. Chen also pointed out that EPA research has shown that free chlorine is helpful for security monitoring whereas chloramines are less reactive and not effective an indicator to detect challenges to the system.

Best agreed that no one could have anticipated the consequences of WA switching to chloramines, but she asked why there was relatively little regulatory progress with respect to DBPs between 1979 and 2000; she asked Singer to outline what occurred during that time. Best further asked what EPA's reasons were to implement the Stage 1 D/DBPR given that epidemiology studies were not strong, and there was great uncertainty about the health effects and occurrence of DBPs. Singer described the EPA decision process to promulgate the Stage 1 D/DBPR. Best stated that it is her belief that the incremental benefit of reducing THM regulations from 100 to 80 ug/L was greatly overshadowed by the increase in lead corrosion which resulted from the switch to chloramines for compliance, and that it caused more harm than

good. However it is important to note that the Stage 1 D/DBPR also 1) brought into compliance, for the first time, utilities serving less than 10,000 people (which were previously unregulated); and 2) established a MCL for HAAs. Singer clarified that when EPA was drafting the initial Stage 1 D/DBPR, utilities were expecting that future regulations would eventually regulate THMs to concentrations as low 40 ug/L (HAAs at 30 ug/l), so therefore they were focused on finding solutions which would meet the long-term goal, rather than the immediate regulation of 80 ug/L for THMs and 60 ug/L for HAAs. This is why many utilities chose a more aggressive means of DBP control (such as moving to chloramines), rather than looking for ways to optimize their existing treatment processes. Best asked why WA decided to convert to chloramines. Jacobus replied that WA did everything they could to lower DBP levels (e.g., by changing the point of chlorination within the treatment plant, and by optimizing coagulation) before converting to chloramines.

Summers clarified that the median exposure to THMs dropped much more than 20% with the MCL shift from 100 to 80 ug/L and the movement to a locational running annual average (LRAA) over a system averaged running annual average (RAA). Summers mentioned that the City of Cincinnati has over 20 years of experience with granular activated carbon (GAC). Cincinnati decided to put in GAC because of their concern over industrial contamination in the Ohio River, but in the long term they have benefited from DBP control.

Lambrinidou asked about additional drawbacks associated with chloramination aside from those already mentioned during the workshop (e.g., security issues, NDMA, corrosion). Singer reiterated that the reason why some States banned chloramines was not because of any undesirable effects, but rather because those States have extremely high water quality source water and that the water treatment plants should be able to remove DBP precursors and simply modify their primary disinfection practices. Chen made clear that he thinks chloramines are a good option but probably not the best for WSSC given inherent nitrification issues and difficultly managing their very large distribution system. It would have required significantly more money (especially in yearly operations) for them to switch to chloramines and establish a regular flushing program, than to expend the upfront capital for enhanced coagulation facilities (including sulfuric acid and ferric chloride feed systems). DC doesn't have the large distribution system that WSSC has and can thus manage nitrification better. Summers agreed with Chen that large systems have resources to go out to control nitrification. But small systems do not have resources, staff, and understanding of their distribution systems so chloramines could present a problem. This was the main reason why Ohio was reluctant to allow chloramination.

11:45-12:50 p.m. **Presentation #5 – Corrosion Control Considerations**
Dr. Vernon Snoeyink, University of Illinois

Snoeyink gave a presentation on the issues related to corrosion control, lead and copper and metal release (slides follow).

Presentation 5: Corrosion Control Considerations

Dr. Vern L. Snoeyink
University of Illinois

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Water Quality Issues to be Considered

- **Microbial water quality issues**
  - **Pathogens**
  - **Algae and algal by-products**
- Water quality issues resulting from treatment and distribution
  - Disinfection by-products
  - Corrosion by-products
  - Trace contaminants in treatment chemicals
- Chemicals introduced into drinking water sources through human activities in the watershed
  - Sodium
  - Perchlorate
  - Pesticides
  - Pharmaceuticals and personal care products
  - Other persistent organic / inorganic chemicals
  - Endocrine-disrupting compounds
  - Nanomaterials

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Historical Background on Corrosion Issues in Washington, DC

- Washington DC has homes that were built with lead service lines but Arlington County and City of Falls Church do not have them
- In 2000, Washington Aqueduct implemented chloramine disinfection
  - Change in chemistry led to high lead levels at some homes
  - Action level of 15 ug/L was exceeded

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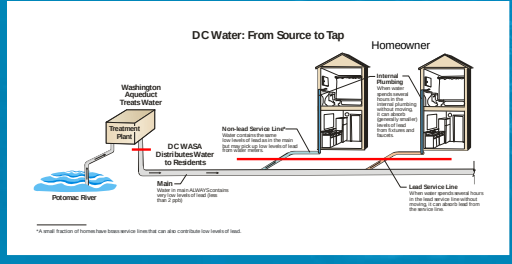
DC Lead Compliance History



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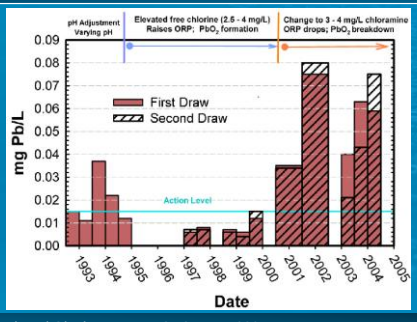
DC Lead Compliance History



Source: Schock and Giani, AWWA, WQTC Proc., 2004

58

Approach to Controlling Lead

- In August 2004, WA began addition of orthophosphate to create a low-solubility lead-orthophosphate scale, together with pH control
- Since these changes, tap water lead levels have dramatically decreased

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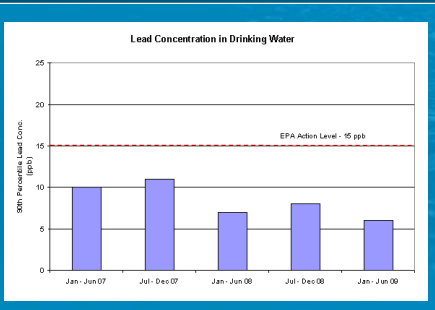
Lead Service Line Scale

60

Recent Lead Compliance Data for DC WASA



Source: http://www.dcwasa.com/waterquality/lead_copper.cfm

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Current Corrosion Control Study at Washington Aqueduct

- Ongoing project:
  - Pipe loop constructed of harvested lead pipes from DC WASA system
  - Optimize orthophosphate dose
  - In-plant determination of the effect of water quality changes on lead

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Current Corrosion Control Study at Washington Aqueduct

- Important considerations:
  - What level of lead below the action level is a reasonable plant goal?
  - What is the relationship between tap water lead level and blood lead level?
  - Orthophosphate dose vs. distribution system turbidity
  - Orthophosphate dose vs. lead and environmental impact

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Issues Related to Corrosion Control and Metal Release

- Chloride to sulfate mass ratio vs. lead release from lead-tin solder
  - Related to chemicals used in treatment process so should be considered with any future changes
- Microbial activity vs. corrosion-related issues
- Should lead service lines be replaced?
- How should lead in fixtures be dealt with?
- Release of other metals, such as iron and copper could become a greater concern
- For example, consider iron (see next slides)

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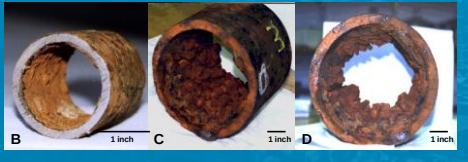
Iron scales can cause colored water, consume chlorine, and promote biofilm growth



B) inside surface cast iron pipes from Champaign
C) external appearance , Boston
D) x-section, Boston

65

Colored and Turbid Water: Lake Erie Source, Al Coagulated, Phosphate Inhibitor

66

Treatment for Distribution

- Evaluation of new or modified treatment processes must consider their impact on the various materials in the distribution system
- Water treatment must be done in a way that minimizes water quality deterioration in the distribution system

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A discussion period was held during lunch following **Presentation #5 – Corrosion Control Considerations**, and is summarized below.

Mr. Kane inquired about the percentage of homes in Washington DC that have lead pipe and as to whether there have been studies to define the areas where they are located. Snoeyink responded that there are approximately 25,000 lead service lines in DC; while he believes these lines have all been located, he could not comment on the geographic distribution of them. Best commented that DC WASA has a map of the areas, but that the map is not very accurate. She believes the highest concentration of lead services lines is located in the Petworth neighborhood, near the McMillan Plant and the Children's Hospital. Ms. Binetti explained that utilities are required to maintain records of the service areas. DC records indicated the presence of approximately 23,000 lead services lines, and successive investigations have discovered more. She pointed out that the location of the lead pipes has more to do with the age of the house than the area.

Wu inquired as to whether the lead problem was something that could have been foreseen and whether other systems have encountered similar problems when switching to chloramines. Snoeyink is not aware of any other systems experiencing similar lead corrosion problems and that nobody could have anticipated what happened in DC. He explained that the situation in DC is unique due to the type of scale present in the distribution system. In other cities like Chicago, lead dioxide (PbO_2) is surrounded by other materials, like calcium carbonate or aluminum silicate, which have precluded the lead from becoming soluble.

Fellows asked why there were also high lead levels prior to the 1995 conversion to chloramines. Snoeyink believes that it was caused by the testing of different treatment schemes at the treatment plant (for example, varying the coagulation pH), and that the system was not yet stabilized.

Fellows also asked several questions related to lead service replacement, the wisdom of it, and the DC WASA partial replacement program. Snoeyink explained that pipe replacement needs to be done correctly; otherwise when the cut is made lead particles can be released. Currently, DC WASA only replaces lead pipes in conjunction with other construction work.

Fellows asked why data indicating lead had exceeded the action level was not released to the public in a timely manner. Snoeyink replied that he could not speak for DC WASA, and that WA was not involved in the collection of lead data from the distribution system.

Levine asked Snoeyink for his opinion on the best way to monitor for lead to get a true exposure level. Snoeyink replied that Canada and Europe use different monitoring protocols than the US. He believes that the protocol itself is not the most important factor, rather a better understanding is needed of the relationship between the method and the health effects, and that it is not known. Lambrinidou stated that she believes there are serious questions about the validity of DC WASA's data and that DC WASA, with the complicity of EPA, is using a sampling protocol that is known to hide lead in the tap. She believes that based on the information available, different entities are responsible for the lead problem in DC and that the best way to address it is probably a holistic approach, having all the parties involved. She is also concerned that because of the

way the Lead and Copper Rule is written, the public is brought into the picture only when there is an action level exceedance, and people have already been exposed. She would like to see WA take a more visionary role in addressing lead corrosion and involve the public on a more regular basis, perhaps providing them with information on what consumers can do in their homes (e.g. use home water filters) to reduce exposure.

Best asked for clarification on the actual cause of lead corrosion in DC, because she had previously understood it was a direct result of the conversion to chloramines. Snoeyink replied that the problem was more complex and linked to interactions between lead dioxide and the lead pipe, and the absence of other scale components; thus, the lead dioxide particles were not adequately "shielded" from the lead pipe. Jacobus explained that pH control (maintaining finished water pH between 7.6 and 8.4) for compliance with the Lead and Copper Rule (LCR) was satisfactory until the switch to chloramines. WA was prepared for potential nitrification problems resulting from the conversion to chloramines; however the lead issue was unexpected. Future treatment changes will be pilot-tested, where possible, prior to full-scale implementation to try to avoid future unexpected outcomes. Dana commented that there is limited toxicity data available for lead; however new evidence suggests there is no safe exposure level for lead. Therefore the best approach is to be proactive.

Chen pointed out that fluctuations in raw water pH are a contributor to copper pitting corrosion (i.e., pinhole leaks) in WSSC's system. During the summer, pH in the Potomac River can increase to 9.0 to 9.5, resulting in dissolved aluminum (from the aluminum-based coagulant) pass-through in the filters unless the coagulation pH is lowered to below 7.5. The dissolved aluminum that passes through the filters will post-precipitate upon chlorination and post-pH adjustment, and these aluminum particles that pass into the distribution system have been associated with copper pitting corrosion. WSSC's solution to this issue was to lower the pH during coagulation. Chen asked as to whether WA adds acid at any point of their treatment. Speight explained that WA raw water pH levels are not as high and that acid can be added to the finished water at the McMillan Plant, but not during coagulation. Snoeyink commented that aluminum control and post precipitation are important issues and that enhanced coagulation is a good way to remove DBP precursors.

Fellows inquired as to whether Arlington County or Falls Church have experienced any type of corrosion. Mr. Hundeldt from Arlington County explained that they have not had any particular reaction to chloramines. However, they have seen some white precipitate, mostly in recirculated water in community buildings, which they believe is aluminum but are not sure of the source.

12:50 - 1:45 p.m. **Presentation #6: Other Issues to be Considered**
Dr. Scott Summers, University of Colorado

Summers gave a presentation on other water quality issues of concern, such as taste and odor, pesticides, perchlorate, endocrine disrupting compounds (EDCs), pharmaceutical and personal care products (PPCPs), and other trace contaminants (slides follow).

Presentation 6: Other Issues to be Considered

Dr. R. Scott Summers
University of Colorado

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Water Quality Issues to be Considered

- Microbial water quality issues
  - Pathogens
  - Algae and algal by-products
- Water quality issues resulting from treatment and distribution
  - Disinfection by-products
  - Corrosion by-products
  - Trace contaminants in treatment chemicals
- Chemicals introduced into drinking water sources through human activities in the watershed
  - Sodium
  - Perchlorate
  - Pesticides
  - Pharmaceuticals and personal care products
  - Other persistent organic / inorganic chemicals
  - Endocrine-disrupting compounds
  - Nanomaterials

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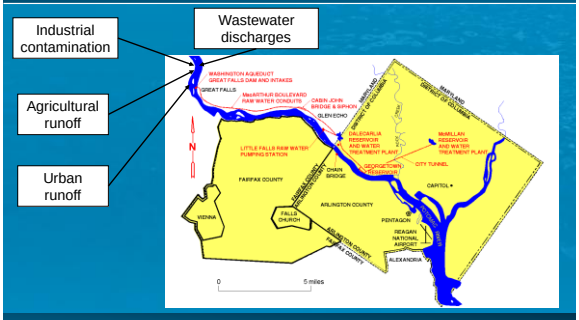
Potomac River Watershed



70

Sodium

- Potomac River sodium levels have tended to increase over the last 15 years
- Deicing salts contribute to increase in sodium
- WA current finished water levels fluctuate from 15-25 mg/L
- EPA guidance level for sodium is 20 mg/L
  - Based on a restricted sodium diet with 500 mg/day
- Treatment modifications, currently under construction, may increase sodium by 5-10 mg/L
- Deicing salts could also contain bromide and iodide, with impacts on DBPs

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Perchlorate

- Both naturally occurring and manufactured
- Dissolves easily in water (soluble)
- Detected in Potomac River and in the groundwater in the Spring Valley neighborhood in DC (near the Dalecarlia Reservoir)
- Exposure to perchlorate can adversely affect thyroid function
- Regulatory limits are under discussion

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Pesticides

- Can be classified according to:
  - Chemical class (organochlorine, carbamate, organophosphorus, chlorophenoxy compounds)
  - Type of pest they are intended to control (fungicide, herbicide, algacide)
- 24 pesticides regulated under SDWA and many more listed in CCL3 and UCMR
- Trace concentrations found in drinking water supplies
- Occurrence may be seasonal

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Chemicals Introduced into Source Waters through Human Activities in the Watershed

- Occurrence is at very low levels, only recently possible to measure many of them
- All current drinking water regulations are being met
  - Several are not currently regulated
- More information is needed about human health effects
  - long term exposure at low levels
  - mixtures

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Pharmaceuticals and Personal Care Products (PPCPs)

- Personal care products include:
  - fragrances, skin creams, sunscreens
  - antimicrobial
  - laundry products
- Pharmaceuticals include:
  - contraceptives
  - antibiotics
  - pain medications
  - anti-depressants
  - anti-epileptics
  - cholesterol lowering drugs

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Other Persistent Contaminants

- Persistent organic pollutants include flame retardants, plasticizers, surfactants, perfluorinated compounds (PFOA , PFOS)
- Persistent inorganic pollutants include heavy metals (arsenic and mercury)

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Endocrine Disrupting Compounds (EDCs)

- Defined by effect on body rather than chemical type
- EDCs include natural and manufactured compounds
  - hormones excreted by humans and animals,
  - phytoestrogens and mycoestrogens,
  - pesticides, industrial chemicals, metals,
  - naturally-occurring ions such as nitrate,
  - some food products

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Nanomaterials

- Materials with size from 1 – 100 nanometers
  - Engineered for unique properties and high surface area to volume ratio
  - Examples include sunscreens and silver particles in washing machines
- One of the fastest growing industries in US including applications for water treatment
- Health effects can include cytotoxicity, bioconcentration, and alteration of biochemical functions
  - Little is known about these compounds, their analysis, and their specific health effects
  - Active area of research

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Occurrence at WA

- Routine compliance data
- Unregulated Contaminant Monitoring Rule
- Expanded monitoring program for some compounds
  - Perchlorate
- Participation in national monitoring studies
  - USGS
  - USDA

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Unregulated Contaminant Monitoring Rule (UCMR)

- UCMR 1
  - 36 compounds – 12 on the assessment list
  - None detected in WA 2002 finished waters
- UCMR 2
  - 25 compounds
  - None detected in WA 2008 quarterly monitoring

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USGS Monitoring Data

- 2 years of monthly to bimonthly sampling in source and finished water
- Out of 277 compounds monitored (pesticides, personal care products, solvents, hydrocarbons, DBPs), 85 detected at least once
- Levels were below Acceptable Daily Intake (ADI) or therapeutic dose where these limits were available

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USDA Monitoring Data

- 1-2 years of monthly source and finished water monitoring for 173 pesticides and 25 PPCPs.
- 53 compounds were detected at least once
- Potomac River Watershed is impacted by agricultural, industrial, and human activity so the occurrence of these compounds is to be expected
- Research consensus is building on monitoring approaches for water utilities

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Issues Related to Other Water Quality Considerations

- Certain compounds currently occur and will continue to occur:
  - Sodium
  - Perchlorate
  - Trace levels of pesticides and PPCPs
- Many unknowns related to occurrence including analytical methods and variability
- Large degree of uncertainty regarding health effects of long term exposure to mixtures of low doses of EDCs, PPCPs, and nanomaterials

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Issues Related to Other Water Quality Considerations

- Given that all drinking water regulations are being met,
- How does WA move forward when facing this high level of uncertainty?

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The following section captures the key comments and questions that were posed during the discussion period following **Presentation #6: Other Issues to be Considered**:

Wu expressed that the main concern of EDCs is the timing of exposure; sensitive populations would include pregnant women and children. She concedes that there are hundreds of thousands of chemicals that we all use that are included in this category, limited data on toxicity, and that there is not one treatment process that is going to treat all of them. For these reasons, she believes that efforts should be focused on proactive solutions, such as preventing these chemicals from entering the watershed. Utilities should talk to EPA, FDA, and other regulatory agencies about controlling how much is released into the environment. Perhaps regulations should move towards regulating the use of these products. For example, tests have shown that using antibacterial soaps, which contain triclosan, is no more effective than using regular soap and water. With adequate education, Wu feels that the public probably wouldn't use these products. Best supported Wu's comments; preventing the presence of these compounds upstream is a far better solution than treating these compounds after some detrimental health impact has been discovered.

Fellows commented that it would be useful to know the top 20 contaminants of concern for WA and whether there are trends in the research that indicate low levels of these compounds are harmful. Fellows added that since pesticides are known to be used in the watershed, efforts should focus on application practices, especially where there are viable alternatives. Levine replied that the top 20 contaminants may not be consistent over time and that the combination of risks and occurrence also need to be considered; currently, there is uncertainty as to those related items. Dr. Summers added that lawn and personal care products also need to be considered, not just those used in agriculture.

Best asked about whether WA is allowed to work or support proactive initiatives such as drug disposal alternatives, or other community efforts. Roberson responded that pharmaceuticals are designed to be excreted by the human body and that flushing is not the major contributor to drugs in the environment. Perhaps drugs should be designed with less potential for excretion. Roberson also explained that he has been involved in an AWWA project aimed at developing a simple index to score the contaminants contained in the CCL3, based on health effects and occurrence data. He thinks pursuing a similar effort as part of this project will be very hard because of the variety of data sources.

Chen elaborated further on the area's source water protection efforts. He said that this region is very active in addressing these issues through the DWSPP, of which WA is an active member. The DWSPP has organized several symposia, workshops, and implemented educational programs in certain areas. He is still not certain how much of an impact a utility can have, because in most instances they do not have the power to enact regulations or control upstream sources. He explained that utilities need to be careful about being pulled into responsibilities that are not appropriate for a water utility (e.g., research on health effects and risk assessments, setting of regulatory levels, etc.). Also, due to the uncertainty surrounding many of the topics regarding emerging contaminants, it is difficult for utilities to focus their efforts. Utilities have to carefully balance their funding and weigh the importance of using money for treatment upgrades with unknown benefits, or for replacements and upgrades in their aging distribution

systems and infrastructure with known outcomes.

Fellows said that jurisdiction poses a problem for sharing the cost to treat these compounds and that this area (DC) does not have control over upstream operations, as States like New York have. He posed the question about what needs to be done to get the community and elected officials involved in the debate. Brown believes that people need to be brought into the process. The public needs to be educated because in many cases, people do not have a concept of where their water comes from, or how it is treated. She believes that if people had a better understanding of the whole cycle, they might be more engaged and would be able to comment intelligently on where to focus funding. She also believes that many of these compounds are already removed by existing treatments. However, the public needs authoritative sources of information about public health risks. She feels that utilities are sometimes viewed by the public as less credible, because they have been portrayed by the media as covering things up. She suggested that EPA, research agencies, professors, and the scientific community could perhaps play an important role in providing this information to the public. Water utilities can talk about treatment and treatment effectiveness, but the public needs to hear from agencies with authority to speak about public health risks, particularly with respect to emerging contaminants.

Jones pointed out that there needs to be a balance of funds between researchers and utilities; research funding is necessary to find long-term innovative solutions.

Obolensky believes that utilities are the "end of the line" and that a holistic approach is required to solve this issue. She also said that analytical methods evolve rapidly and that all the information generated needs to be put into perspective to make decisions. She believes that utilities need to develop more skills in risk communication and collaboration efforts. She added that emerging contaminants are an active area of research of the Water Research Foundation (WRF), but that the responsibility of funding some of these projects should be shared with the manufacturers who put those products on the market and therefore, into the environment. In particular, she expressed frustration that water utilities have had to use scarce research dollars to fund development of analytical methods to measure trace contaminants in water and suggested that at the very least such costs should be borne by entities that profit from commerce in these products.

Singer posed the question: Is it better to invest limited monies on research related to trace contaminants or in schools and hospitals for protecting public health?

Hrudey suggested that we should better use what we already know and apply that knowledge more effectively. Roberson asked as to whether there are any decision support tools to make decisions related to trace contaminants and risk trade-offs simpler. Hrudey is not aware of any off-the-shelf software that does this.

1:45 - 2:20 p.m. **Public Comment Period**

Means opened the floor for public comment from the invited observers. The following questions and statements were posed:

Mr. Scott from the Alliance for Healthy Homes commented that the meeting thus far has assumed that utilities are honest in reporting their data. He inquired as to whether it is possible to cheat when sampling for these other contaminants (e.g. by selecting the most appropriate sites and/or timing of tests). He believes that there is a lot of motivation for utilities not to detect these contaminants, and the public need to be able to rely on the data. He also asked if there are ways to prevent dishonest reporting of data.

Singer answered that yes, it is possible to cheat, and that sometimes it is intentional and sometimes unintentional. However, he believes that a very small number of systems do this and that there are many more that sample beyond the requirements, to serve and protect the public. He added that very few systems resort to that, because generally the operators, general managers, and their families and friends all drink the water that they treat. In addition, there are groups who serve as watchdogs and perform independent analyses.

Obolensky commented that the data itself is not always the source of disagreement. The problem is that there are many different ways to interpret or summarize the same set of data. She added that in the case of emerging contaminants, the data is complicated and includes significant uncertainties and it needs to be interpreted in an appropriate context. Often the public or media's desire for a very simple summary of information is in conflict with the inherent complexity of the information. She agrees that the challenge for utilities has to do with maintaining or gaining back public trust.

Roberson agreed that it is possible to falsify records, however the sampling plans that utilities develop are approved and overseen by the State, and then by EPA; and that some States also get audited. Generally utilities are being monitored over the long-term and eventually they will get caught if they falsify their records.

Fellows commented that risk communication is part of the problem. He believes that utilities feel compelled to say their water is safe and that, on occasion, utilities are driven to cover up issues that would raise their rates. Fellows feels that there should be fair allocation of costs (e.g., polluters should pay, and drug manufacturers should contribute to research) and for that to happen there must be some level of federal involvement.

Best concurred that risk communication is part of the problem; trust is a two way street, and utilities and the government don't trust the public either. For that reason, utilities need to implement risk communication programs. The public needs to hear the bad news as well as the good. She believes that if DC WASA had communicated the lead problem to the public and reacted, it would not have been the issue that it is. However, she conceded that the DC WASA situation was compounded by problems with regulators, and that it was not just their fault.

Best also commented that utility oversight is not always effective - who's watching the watchdogs? Summers added that the regulatory development and review process devotes a large effort towards defining monitoring provisions such that "gaming the system" and "cheating" is minimized. He also expressed that utility management and operator ignorance of the rationale behind the monitoring provisions is likely the leading cause of gaming / cheating.

Obolensky encouraged consumers to call their utility for information. Utilities depend on their customers and their phone calls; in many cases it is the first sign that there is a problem in the distribution system. Obolensky added that the media is a third player in the communication process, and that they have a separate agenda. Media reports are written to tell a story, and not always to present facts within appropriate context. However, Lambrinidou disagreed; she feels that the public might never have known about the DC lead problems without support from the media. She believes that the people of DC depend more on the media for information regarding the safety of their water, than on the utilities.

Hrudey commented that in the Walkerton Ontario *E. coli* outbreak, the general manager and operators who entered false results were convicted. However, during the testimony it was discovered that the operators were largely ignorant of the consequences of their actions. They had no idea they could kill their neighbors by not doing their jobs; they were even drinking the water themselves. He believes that operator training is still heavily biased towards how to make a treatment plant run, rather than gearing it towards public health protection.

Roberson pointed out the importance of the linkage between water quality and water quantity, especially during droughts and high runoff situations. Currently the Potomac River watershed is good, but climate change could change the ability to dilute contamination and increase risk from compounds that are currently at low levels.

Fellows asked about sources of contamination of Dalecarlia and McMillan Reservoirs specifically related to direct runoff (e.g., microbial contaminants from geese).

Best asked if there are any other locations in the distribution system where *Legionella* and *Mycobacterium* can collect or enter the system, similar to the showerhead. Hrudey replied that cooling towers have also been a location for *Legionella* growth. Levine added that methodology to measure for *Mycobacterium* is cutting edge and that the CCL process gives an opportunity to answer these types of question.

Best also inquired as to whether the pipe loop study that WA is currently performing mimics the water stagnation times in the distribution system. Jacobus replied that a lot of thought was put into that pipe loop study and that it does try to mimic the conditions in the distribution system.

Lambrinidou inquired as to whether it is part of the vision and purpose of this process to incorporate the idea of an integrated water system and sustainability components (e.g., reuse, conservation). Speight replied that the scope of this project is focused on water quality, and that some of those ideas apply more to the distribution system. Also, because in this area water scarcity is not a problem, conservation and reuse are not a detailed part of the project but will be considered. Means added that some solutions will require different entities to participate, and that he is certain that opportunities exist but it is a complex process.

Kane asked that affordability be included in the analysis because many customers cannot absorb the additional cost. In the programs that his group administers, the water bill is the second highest bill, after property taxes. Best seemed surprised about this fact and asked about how much the energy bill was. Kane answered that energy is paid by the individual owners.

Levine said that EPA has a program to prioritize research and that this is a collaborative effort.

2:20 p.m. **Wrap-up**

Speight explained that the next steps in this project will include compiling water quality issues and prioritizing them, incorporating the feedback received today. She added that participants are requested to call or email the following contacts with any further questions or comments.

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