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Water 4.0

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History of Willamette River

- Typhoid 1936, 6 cases linked to swimming. City board of health outlaws swimming.
- Early color film records scenes of spewing waste into river
- 1962 deemed “dirtiest river in pacific northwest
- 1962 documentary “pollution in paradise” documents state of river.
- 1966 governor McCall institutes clean river program
- 1972 National Geographic describes Willamette “River Restored”
- Persistent public perception river is polluted

Source: Willamette River: Currents of Change 1998 KGW documentary
Willamette River: Currents of Change
1998 KGW
History of Willamette River Water Treatment Plant

- City of Wilsonville used wells to provide drinking water
- Wells began to diminish in the 1990’s
- Building moratorium put in place due to lack of drinking water
- Choice between buying Bull Run water from Portland or Build treatment for nearby Willamette river
- Less expensive to build treatment facility then built pipe from Bull Run.
- Serious objections from residence due to legacy of pollution in river.
What about Pesticides?

- No positive detects recorded
- What is sensitivity of test?
- “Dilution is the solution to pollution”

Is the EPA Being Pressured on Atrazine? New Findings of Environmental Concerns about Syngenta's Crop Chemical Removed from EPA Site

Submitted by Lisa Graves (user/3526/lisa-graves) on May 11, 2016 - 12:01am

https://www.prwatch.org/news/2016/05/13104/epa-atrazine-likely-harming-most-species-plants-and-animals
Water Flow
(Greatly Simplified)
Coagulation/Flocculation

ACTIFLO ballasted flocculation

- Alum $\text{Al}_2(\text{SO}_4)_3$
- Polymer ?
- Microsand
Primary disinfection

Ozone

- Highly effective disinfection
- Secondary benefit of chemical contaminate degradation
- Kills chlorine resistant microorganisms
- Produces Bromate DBP
Bromate (Ozone bi-product)
B2 (IRIS: Probable human carcinogen - based on sufficient evidence of carcinogenicity in animals)

Source: https://yourwater.oregon.gov
Filtration
deep bed granular activated carbon

- Broad spectrum contaminant removal
- Taste and Odor control
- Biologically active?
Corrosion control

- NaOH addition
- Raise pH (higher pH reduced metal corrosion)
Secondary disinfection (residual)

Sodium hypochlorite

• hypochlorite anion OCl– production
• Considered safer than chlorine gas
**Situation:** In a perfect storm of failing/aging water infrastructure and climate induced extreme weather over 100,000 Americans have died in past year as a direct result of poor water quality (broad spectrum organic/inorganic contaminate & water born disease). You have been chosen by the president and unanimously confirmed by the Senate to be head of a new cabinet level drinking water agency. You have vast emergency powers and a 100-billion-dollar budget.

**Mission:** Transform Flint Michigan into the world leader for water infrastructure and model to be emulated nation wide. Design the next generation surface water treatment facility and replace all mains and service lines with best available technology. Adapt and improve upon Willamette River Water Treatment Plant using public health “Precautionary Principle”.

**Execution:** (Brainstorm)
Coagulation/flocculation (water 4.0)

- Replace Aluminum based coagulant (possible neurotoxin) with **Electrocoagulation**
- Replace petroleum-based polymer (possible endocrine disruptor) with non-toxic **Tannins**
Primary disinfection (water 4.0)

• Replace Ozone with UV disinfection.
• Operates chemical free (green technology)
• No Disinfection Bi-Products? (in absence of chlorine)
• Advanced UV oxidation through Hydrogen Peroxide addition option depending on seasonal water quality
Filtration (water 4.0)

- Keep GAC (highly effective and no known downside besides cost of operation)
- Add biologically active mixed media silos with potential to engage as anoxic bioreactors as needed (addition of acetic acid)
- Add membrane polishing step
Corrosion control (water 4.0)

- Stop NaOH addition
- Use Limestone contactor
- “Chemical free”
- Raises both pH and Alkalinity
- Calcium ion has corrosion control interaction

\[
\begin{align*}
\text{Ca}^{2+} \cdot \text{O} \cdot \text{C} \cdot \text{O}^{-} \cdot \text{O}^{-}
\end{align*}
\]
Secondary disinfection (water 4.0)

• No chlorine residual by default
• Replace old mains with High Density Polyethylene
• Reduce retention times in distribution system
• Do regular testing in distribution system using modern high-speed SNP-chip gene sequencing
• Only add chlorine residual backup if hazard identified in system
Quantitative contaminate analysis
Portland vs Wilsonville
Total Organic Carbon

Source: https://yourwater.oregon.gov/
Total Trihalomethanes (TTHM) 2002-2019
B2 (IRIS: Probable human carcinogen - based on sufficient evidence of carcinogenicity in animals)

Source: https://yourwater.oregon.gov
Haloacetic acids (HAA5) 2002-2019
(IRIS: Likely to be carcinogenic to humans)

Source: https://yourwater.oregon.gov/

Lead in water

• 2019 Portland tested 215 homes for the presence of lead.
• All locations produced positive results > 1 ppb.

• 2018 Wilsonville tested 34 homes for the presence of lead.
• Only 2 homes tested positive for lead >1 ppb; 4 and 6 ppb respectively.
• Are all homes truly tier 1? (suspicious)

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Proposed Revisions to the Lead and Copper Rule

EPA’s proposed Lead and Copper Rule (LCR) includes a suite of actions to reduce lead exposure in drinking water where it is needed the most. The proposed rule will identify the most at-risk communities and ensure systems have plans in place to rapidly respond by taking actions to reduce elevated levels of lead in drinking water.

The agency’s proposal takes a proactive and holistic approach to improving the current rule —from testing to treatment to telling the public about the levels and risks of lead in drinking water. This approach focuses on six key areas:

https://www.epa.gov/ground-water-and-drinking-water/proposed-revisions-lead-and-copper-rule
Lead in water (continued)

LCR Sampling History

[Diagram showing Portland Joint Monitoring 90th Percentile Lead Levels Tier 1 Homes with pH levels and sampling data over years from 1992 to 2016.]
Questions?