

# Water Master Plan

City of Delaware, OH, USA

Over the next 20 years, Delaware faces two main challenges in providing an exemplary level of service for finished water.

- Meeting Customer Demands. Because of population growth and development in the service area, more finished water capacity will be needed. System capacity and reliability requirements will therefore increase.
- Meeting Regulatory Requirements. Recently promulgated federal SWDA drinking water regulations including the LT2ESWTR, Stage 2 DDBPR, and contaminants listed in the CCL2 require higher levels of treatment.

Specifically with regard to compliance with the **Stage 1 and Stage 2 Disinfectant/Disinfectant By-products Rule** regulatory requirements.

The City currently draws its water supply from the Olentangy River, supplemented with groundwater from wells located adjacent to the water treatment plant. The Olentangy River water quality issues are: turbidity, hardness, algae, total organic carbon (TOC), disinfection by-products (total trihalomethanes), pathogens (Giardia and Cryptosporidium), Atrazine, nitrate, taste and odor, and thermal variation (gradients). Significant levels of filamentous algae have been an observed water quality issue. Nitrate and atrazine occur as seasonal peaks due to spring-season run-off.

As a part of the planning effort, it was determined that the City will continue to rely on the Olentangy River for its water supply, along with its two existing well fields. However, an upground reservoir will be added to increase available capacity and improve the quality of water to be treated.

The addition of the reservoir is part of the strategy to control DBP formation in the City’s water distribution system by reducing DBP precursors. However, the reservoir alone will not be sufficient to assume compliance with DBP regulatory requirements.

The second aspect of the plan is to upgrade water treatment technology to further reduce DBP precursors, new treatment technologies were investigated with particular attention to the removal of Total Organic Carbon (TOC).

Total organic carbon (TOC) is the amount of carbon covalently bonded in organic molecules. TOC removal is of interest due to the disinfection by-products formed in chlorination and ozonation reactions. TOC also is used as a surrogate measurement for DBPs. Under Stage 1 DBPR, most systems with average raw water TOC exceeding 2.0 mg/L will be required to operate in enhanced coagulation/enhanced softening mode to achieve specified TOC removals.

Regulatory compliance can be achieved in two ways:

- Enhancing removal of TOC; or
- Using alternative disinfection.

Enhanced removal of TOC can be achieved by enhanced coagulation, enhanced softening, granular activated carbon adsorption (GAC), nanofiltration (membrane softening), or reverse osmosis (RO).

Alternative disinfection methods include: moving the point of chlorination to later in the treatment process after TOC has been removed by coagulation and clarification; or using alternative disinfectants such as

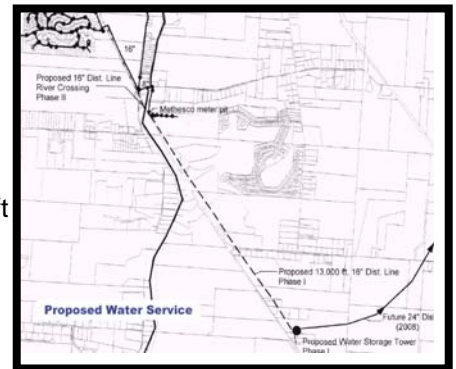


intermediate ozonation between clarification and filtration, chlorine dioxide, UV, membrane filtration (MF or UF), or chloramination. Chlorine dioxide can also be used as an alternative to free chlorine for primary disinfection thus reducing DBP formation to some extent.

The City of Delaware has already taken steps to reduce DBP formation. The application point for chlorination has been moved. The coagulation and softening processes have been optimized to achieve compliance with the Stage 1 D/DBP rule. Further enhancement of coagulation and softening, even if possible, would not be expected to provide the necessary additional removal of DBP precursors to achieve regulatory compliance. Chlorine dioxide is not expected to be feasible for achieving compliance due to the dosage limitation and chlorite by-product formation. Intermediate ozonation and BACF would also not provide sufficient reduction of DBP formation. While UV or membrane filtration could be used for alternative disinfection, chloramination would still be required for distribution system residual disinfection to achieve DBP compliance.

Future treatment upgrades must include technologies to provide addition removal of TOC in order to achieve future regulatory compliance within the distribution system. Conventional coagulation and softening will not achieve this alone. Thus, GAC adsorption or membrane treatment using NF or RO membranes must be considered to provide additional TOC removal and DBP compliance.

**GAC adsorption** would be applied as a post filtration pressure filtration process. Adsorption sites within the GAC would remove TOC to low levels until the adsorption capacity is exhausted. Once exhaustion has occurred the GAC must be regenerated or replaced. The regeneration or replacement frequency is dependent on the influent TOC levels after coagulation, softening, and filtration. With the expected high TOC that is left after conventional coagulation and softening, the frequency of replacement of GAC may be on the order of 1-2 months. The operations and maintenance cost of GAC replacement is of course the most important consideration affecting the choice of GAC adsorption for DBP control.



**Nanofiltration (NF)** can serve two primary treatment objectives: replacing lime softening clarification for removal of hardness by membrane softening; and providing enhanced TOC removal. NF will remove > 95% of the TOC. RO can remove slightly greater amounts of TOC than NF.

To address TOC concerns, three basic alternatives were developed and estimated for comparison:

- Alternative 1 Conventional treatment with lime softening granular activated carbon for TOC and Atrazine removal and ion exchange for Nitrate removal;
- Alternative 2 Conventional treatment with nanofiltration (NF) membrane treatment for removal of TOC Atrazine and Nitrates as well as softening; and
- Alternative 3 Advanced treatment with microfiltration (MF), high-rate dissolved air flotation (DAF), and nanofiltration (NF).

The third and final aspect of the plan is improvements and management of the water distribution system to control water age and disinfectant residual levels to reduce the peak levels of DBP that develop over time. This aspect of the plan includes computerized hydraulic modeling of the water distribution system to simulate water quality factors, and identify critical locations subject to potentially high DBP levels (either TTHM or HAA5). These critical locations can then be monitored routinely to assure water quality compliance. Also, proposed system improvements and operational strategies can be tested to determine their effectiveness in controlling DBP levels.

The City of Delaware Water Master Plan then, based on a comprehensive analysis of the City's water source of supply, treatment and distribution systems and facilities, provides a comprehensive, integrated approach for meeting existing and future water quantity and quality requirements, especially upcoming Disinfectant/Disinfectant By-Product regulations.