Three oxidants have been evaluated for use as alternative chemical pretreatments for Fena Lake, a surface water that supplies the U.S. Navy’s Public Water System (PWS) on the volcanic island of Guam. The study consisted of two investigative components. The first and primary component included a bench-scale evaluation to study the effects of different pre-oxidant conditions on the formation of chlorinated disinfection by-products (DBPs). The second and ancillary component included a series of water treatment and distribution system management studies that analyzed DBP formation within the treatment plant and water distribution system. The goal of this research was to reduce total trihalomethane (TTHM) and haloacetic acid (HAA5) formation in the PWS.

In the primary component of the research, raw surface water from Fena Lake was collected by U.S. Navy personnel and shipped to University of Central Florida (UCF) laboratories for experimentation. Bench-scale tests that simulated the coagulation, flocculation, sedimentation and filtration (CSF) that comprises the Navy Water Treatment Plant (NWTP) were used to evaluate the use of two alternative pre-oxidants, potassium permanganate (KMnO4) and chlorine dioxide (ClO2) in lieu of gaseous chlorine (Cl2). The research assessed DBP formation by comparing several pretreatment scenarios, namely: (1) no pretreatment, (2) chlorine pretreatment, and (3) alternative oxidant pretreatment. KMnO4 pretreatment resulted in the lowest percent reduction of TTHMs and HAA5, at 5.7% and 22.7%, respectively; however, this amount was still a reduction from the results demonstrated for the chlorine pretreatment condition. Without using a pre-oxidant, TTHM and HAA5 formation were reduced by 22.8% and 37.3%, respectively. Chlorine dioxide demonstrated the greatest TTHM and HAA5 reduction at 34.4% and 53.3%, respectively.

The second component of research consisted of a series of studies that evaluated distribution system operations and management alternatives to identify opportunities that could achieve DBP reduction within the PWS. Three concerns that were addressed were the NWTP’s compliance with the U.S. Environmental Protection Agency’s Stage 2 Disinfectants/Disinfection By-products (D/DBP) Rule, variable hydraulic detention times within a small subdivision in the distribution system, and severe weather. It was determined that: (1) A decision based on in-plant studies to cease pre-chlorination at the NWTP resulted in a decrease in TTHMs and HAA5s throughout the distribution system by 62% and 75%, respectively; (2) A fluoride tracer study led to the discovery of a valved pipeline responsible for elevated DBPs because of excessive water age that when exercised and managed resolved intermittent DBP spikes in the PWS; and (3) when the Fena WTP’s ballasted flocculant clarifier (BFC) was operated in-series prior to the conventional CSF process during severe weather conditions the TTHM and HAA5 were below 39 ug/L and 29 ug/L, respectively, proving BFC in-series is a practical option for the plant during severe weather.

Major: Environmental Engineering

Educational Career:
Bachelor’s of Environmental Engineering, BS, 2013, University of Central Florida

Committee in Charge:
Dr. Steven Duranceau, Chair, CECE
Andrew Randall, UCF CECE Professor
Woo Hyoung Lee, UCF CECE Professor

Approved for distribution by Dr. Steven Duranceau, Committee Chair, on June 20, 2014.

The public is welcome to attend.