<u>Field Trip # 1</u>: <u>To Greater Cincinnati Water Works – Miller Treatment Plant</u>

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Report Prepare By:
Ms. Melissa Stoltz, R A Jones Middle School, Florence, KY
Mr. Kurt Whitford, Glen Este High School, Cincinnati, OH

Greater Cincinnati Water Works (GCWW) supplies more than 48 billion gallons of water a year (220 million gallons per day) to nearly a quarter of a million residential and commercial accounts. The corporation, which has been treating Ohio River water since its beginnings as the Front Street Pumping Station in 1821, uses over 3,000 water mains to deliver drinkable water. Amazingly, many of the pipes used to this day have been carrying water for over 100 years. On July 8th, the RET 2009 group, along with Dr. Goerge Sorial and Mr. Hafiz Salih, visited the Miller Treatment Plant component of GCWW. Mr. Richard Pohlman, Treatment Supervisor of Water and Quality Treatment Division, met the RET group and presented a history of the plant as well as a concise, informative overview of the nationally-recognized processes the state-of-the art facility conducts every day.

Mr. Pohlman explained that in the 19th century, water quality, or lack there-of, was of high public significance because of the prevalence of typhoid, cholera, gastroenteritis, and other water-borne illnesses. In 1907, Louisville and Cincinnati were the first cities in the nation to utilize rapid sand filtration and alum coagulation as means of treating water. The California Waste Treatment Plant, as it used to be called, could pump 112 million gallons of water to the surrounding city nearly every day. In 1916, the plant began adding chlorine as a means of disinfecting the water. In the 1960’s, a second pumping station was added to meet the growing population’s need for water. Throughout the years, several reservoirs were built to store and protect water during times of emergency, such as in the case of an oil spill along the river. These reservoirs can hold 380 million gallons of water and supply the area with 2-4 days of water in times of need. The crowning jewel of the facility was added in 1992 and provides Cincinnati’s with the best available treatment of the water they use, Granular Activated Carbon (GAC). GAC was originally used in columns at the facility, before engineers developed the system of 12 contactors filled with GAC, which is still in use today. The GAC facility remains one of the largest of its type in the country.

Mr. Pohlman introduced the process of water treatment before we toured the facility so that we could connect the equipment we would be viewing with the functions they perform. Figure 1 below is a diagram of these processes.

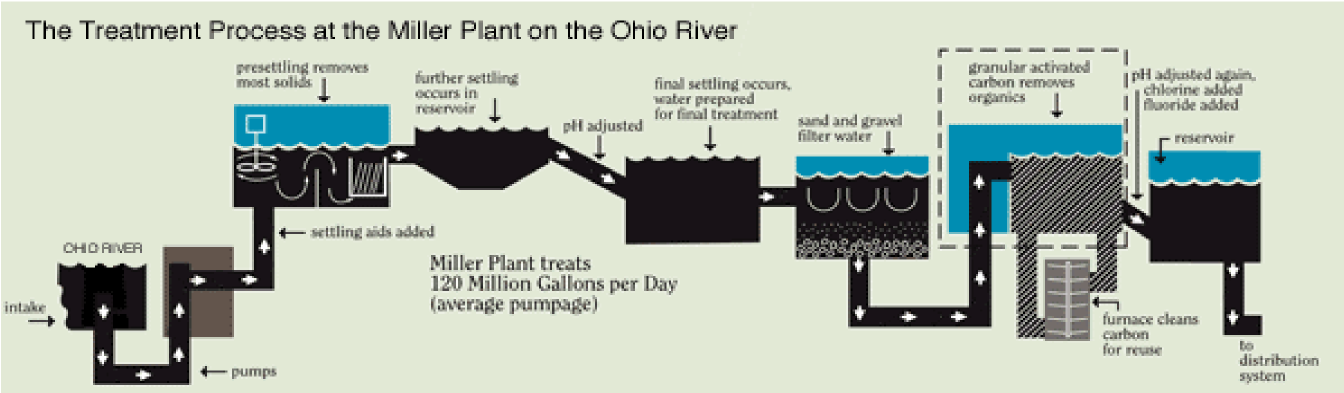

Figure 1. The Treatment Process at the Miller Plant on the Ohio River

In order to make the Ohio River water safe for human consumption, the natural organic matter must be removed, which Mr. Pohlman referred to as TOC. To do so, GCWW moves the water through a series of four processes: Coagulation, Flocculation, Sedimentation, and Filtration. Coagulation has its basis in the electrical charges found in the very small particles of chemicals, alum at GCWW, that are added to raw water as it enters the treatment facility. The chemical charges cause the particles to aggregate, making them denser so that they separate out from the water and sink to the bottom. The coagulants are rapidly mixed with the water using a surface sweep, and the particles are collected on the bottom using devices called Lamella plates (see Figure 2). These plates are slanted so that the particles do not have as far to travel through the water before they settle. This process results in a 23% reduction in TOC.

Figure 2. RET Participant Investigating the Lamella Plates

Water that has gone through coagulation, flocculation, and sedimentation must then be filtered to continue removing TOC. The different units seen by the teachers are shown in Figures 3 to 5. A total of 47 sand filters are utilized to trap particles. Each of these water filters can process 3 gallons per minute per square foot of surface, with a total of 1400 square feet per filter. When these filters fill up, GCWW uses a backwashing technique to break up the particles, expand the sand, and flush dirt and mud out. The solids from this backwashing are discharged daily so that the environment is not shocked.

Figure 3. The RET Group Observes Surface Sweeping and Sedimentation

Figure 4. Surface Sweeping

Figure 5. Model of a Sand Filter

After going through sand filtration, there is another 10% reduction in TOC level. A final measure of removing organics is conducting through adsorption by GAC as the water comes into contact 12 carbon contactors for 15 minutes (see Figure 6). Each contactor contains 600,000 pounds of granular activated carbon. The organic matter left in the water is trapped in the small pores of the carbon, reducing the TOC level by another 50%. Mr. Pohlman described the process for reactivating the carbon, which must occur when the pores are completely filled with particles. Using a large hearth furnace (see Figure 7), the carbon is heated, which releases the organic matter as gas and leaves the carbon “clean” and ready to be used for adsorption again. Each year, 9,600,000 pounds of GAC are reactivated.

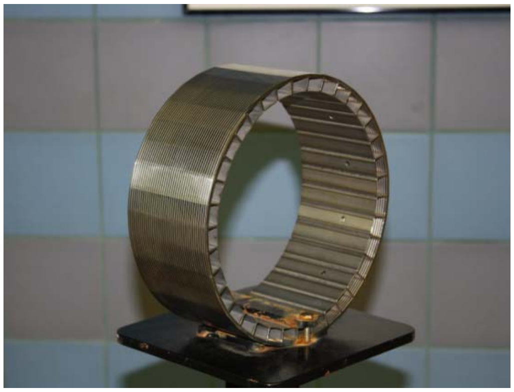

Figure 6. Model of a GAC Contactor

Figure 7. The Carbon Reactivation Hearth

Mr. Pohlman further informed that, as a final measurement of treatment, the GCWW adds a chlorine disinfectant and fluoride (see Figure 8). The water is then pumped to clear wells and distribution stations which will serve the community.

Figure 8. The Chlorine Treatment Building

Following the PowerPoint presentation, Mr. Pohlman directed the teachers through a tour of the treatment plant. The walking tour of the plant started with the museum area. Mr. Pohlman started by discussing early water pipe technology. He pointed out several examples of wooden pipes that were used in the 1800s. Mr. Pohlman clarified answers to previous questions by showing an example of a service connection between the distribution system and the end user. The museum contained other examples of drinking water pipes. Figure 9 shows several exhibits.

Figure 9. Museum Exhibits

The museum contained several posters and schematics detailing the water treatment process at the Miller Plant (see Figure 10)

Figure 10. Museum Posters and Displays

Prior to entering the filtration room, Mr. Pohlman explained how the rapid sand filters work. Using a model in the museum (see Figure 11), Mr. Pohlman showed how the filter is built by adding successive layers of progressively smaller diameter inorganic media (i.e., gravel, large diameter sand and small diameter sand) to make the filter bed. Finally, the participants entered the filtration room (see Figures 12 and 13), a secure area, where he further explained the filtering and backwash processes. Operating filters are covered with water that filters down through the media and then is collected by pipes that connect to further treatment processes.

Figure 11. Filter Model

Figure 12. View to the Filtration Room

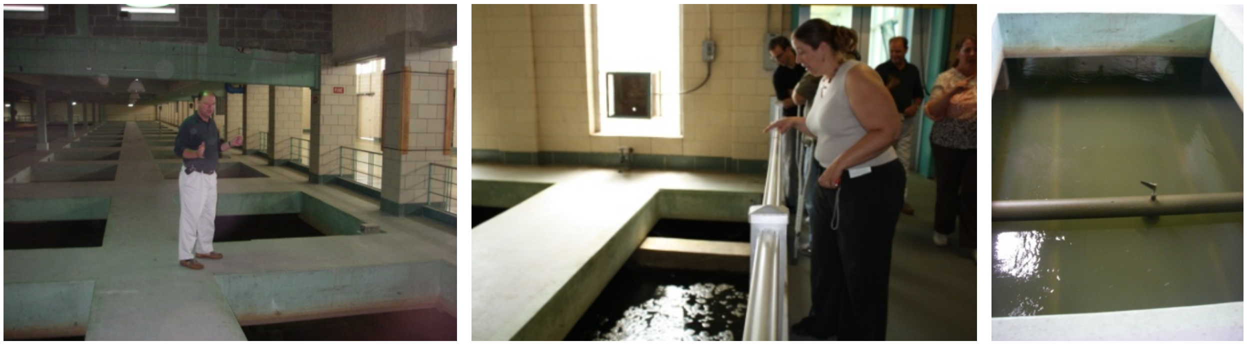

Figure 13. Filtration Room

On average, each filter (see Figure 14) must be backwashed after 30-35 hours of operation. During backwashing, the influent to the filter is turned off and the overlying water allowed to drain through the media. Water is then applied to the top of the filter through an “S-shaped” tube that performs a surface sweep, which breaks up coalesced solids. Next, water is added to the bottom of the filter. This counter flow “raises” the bed (spreads the media particles) and flushes filter contaminants out of the top. This dirt and sediment then are collected and discharged to the Ohio river. The backflow then is sequentially reduced to allow the heavier media particles to settle first, relayering the bed. The clean filter is then ready to be put back into service.

Figure 14. View of a Filter

After witnessing a complete backwash cycle, Mr. Pohlman escorted the teachers to a hallway where they could see the structure where the filtered water is collected prior to treatment with GAC. He also identified the building where treated water is chlorinated prior to distribution (see Figure 15). The building is located away from other structures due to the safety concerns with handling chlorine. Mr. Pohlman indicated that ultraviolet (UV) disinfection equipment, added to address chlorine-resistant microorganisms, will go online in 2015. (Chlorine will still be added to water prior to distribution in order to kill viruses and provide residual disinfection in distribution lines.)

Figure 15. Chlorination Units

The teachers then entered the GAC treatment building. The facility has 12 GAC contactors, each with an average residence time of 15 minutes. Each contactor is underlain with stainless steel porous pipes through which the water is collected (see Figure 16).

Figure 16. Inside the GAC Building

The teachers then toured the GAC regeneration part of the building (see Figure 17). On average, the GAC must be regenerated every 8-10 days. The turnaround time for bringing a contactor back on line is 14 days. The process involves transfer of spent carbon, as a slurry, to the GAC storage bins. These bins are close to the two multiple hearth furnaces used for carbon regeneration. The GAC-water slurry travels up a dewatering screw, which lowers the water content to an average of 55 percent, prior to entering the furnace. (Pilot testing of a vibrator-dewaterer capable of lowering water content to an average of 47 percent was taking place during the tour.) After the GAC is heated to drive off water and organic contaminants, it is cooled and placed into storage bins prior to being returned to the contactor.
Mr. Pohlman guided the group back to the museum, where the tour concluded.

Figure 17. GAC Regeneration Part of the Building