Mitchell Water Treatment Plant

Greensboro, North Carolina, USA

Completion Date
2019

Owner
CITY OF GREENSBORO

Engineer
SKA CONSULTING ENGINEERS

Contractor
FREYSSINET USA, STIRLING VA

Products
MEGAMIX II

Project Type
STRUCTURAL REHABILITATION

Fig 1 -- Xypex Megamix II was used to repair and protect the flocculation and sedimentation basins at the Mitchell Water Treatment Plant in Greensboro, North Carolina, USA. The cost to repair the structures is estimated to be 5-10 times less than the cost to rebuild and is expected to provide up to 40 years of additional service life.

The City of Greensboro, North Carolina, USA, made access to water its earliest public service when in 1810 it enclosed the town well and provided a bucket on a chain. Since those days, the city has come a long way and today produces and distributes more than 33 million gallons of drinking water per day to more than 285,000 residents.

Both of the city's main water treatment plants (WTPs)—the Mitchell and Townsend plants—are regularly upgraded to achieve improved efficiency and the highest possible water quality. The Mitchell plant, located in central Greensboro, was built in 1958 and draws its raw water from Lake Brandt, located about nine miles away.

Over the last few years, the city has spent more than $14 million to rehabilitate and rejuvenate the Mitchell WTP with the installation of a new one-million-gallon clear well and the renovation of the plant's filter house and sedimentation / flocculation basins (fig 1&2).

Fig 2 -- The Mitchell WTP is located in central Greensboro and provides up to 24 million gallons per day of potable water. The filter house (shown here) was renovated in 2017, including new concrete slab floors, some steel beams, and certain equipment.

Fig 3 -- Exposed aggregate and missing chunks of concrete are the result of more than 60 years of concrete paste erosion due to exposure to water containing harsh chemicals and fine abrasives. Xypex Megamix II repair mortar was used to resurface and repair more than two acres of basins.

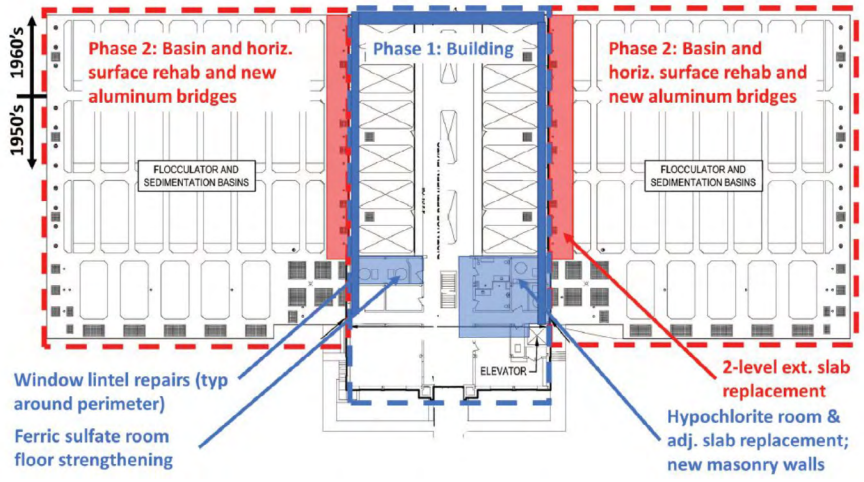

Fig 4 -- The City of Greensboro, N.C., USA invested more than $14 million to rebuild the main structures at the Mitchell Water Treatment Plant. The work on the filter house and flocculation / sedimentation basins (shown here) had to be conducted in the winter months during lower water demand. Each section of basins could function independently, which allowed one side to be shut down but not impact water production.

Local Engineering Support

According to project engineers SKA Consulting Engineers Inc., based in Greensboro, many of Mitchell's concrete structures, indoors and out, were badly deteriorated having been built before modern concrete standards had been widely adopted. For instance, a lack of air entrainment, abrasion, and the attack of various chemicals over many decades had resulted in serious damage.

Chemicals such as ferric sulfate, Lime slurry, sodium hypochlorite, and deicing chemicals had taken their toll on the more than 60-year-old structure (fig 3). "Pretty much all of the concrete paste was missing from the surfaces of the flocculation and sedimentation basins located outdoors," notes SKA project engineer David Keatts, PE. "Paste erosion and freeze thaw damage left nearly two acres of basins with exposed aggregate and some isolated large pieces missing."

Following the successful rehabilitation of the filter building in Phase 1, the city undertook restoration of the basins in Phase 2 (fig 4). Keatts explains, "We needed a repair mortar to not only replace the missing concrete paste and cover the aggregate, but also provide waterproofing, vapor permeability, chemical protection, low shrinkage, freeze/thaw protection and it we had to be able to be spray applied."

Crystalline Protection Selected

While SKA and the city considered several alternatives, the design group ultimately chose Megamix II repair mortar from Xypex due to its successful use in many water and wastewater treatment plants around the world, as well as excellent on-site bond test results and mock-ups (fig 5). It was also important that Megamix is certified to NSF/ANSI/CAN 61 for products that will come in contact with drinking water.

Fig 5 -- Conducting early test of spray applied Xypex Megamix II in order to bond test later. Exposed aggregate within basins can be seen. Deteriorated concrete on overhead beams is also visible.

Fig 6 -- Skilled applicators used lightweight magnesium floats to smooth the Xypex Megamix II repair mortar once it has been spray applied. Light finishing was required in order to preserve the surface bond.

Fig 7 -- Extensive tests using vertical and horizontal mockups were conducted according to ASTM C1583 in order to ensure that the Xypex Megamix II repair mortar would provide sufficient bond with the substrate. This test core—one of two dozen—achieved 316 psi before breaking, well above the 200 psi target goal.

Like all Xypex coating and repair products, Megamix II contains proprietary chemicals in powdered form that react with the water in concrete and with the byproducts of cement hydration to generate a non-soluble crystalline formation in the pores and capillaries of concrete. Megamix is resistant to chemical attack, fiber reinforced to reduce shrinkage, and develops up to 7700 psi in compressive strength at 28 days.

Technical Team Makes a Difference

"Along with meeting all of performance requirements," Keatts says, "another key factor in our choice of Xypex Megamix was the local

Fig 8 -- A key focus of the rehabilitation program were the filter house and adjoining banks of flocculation and sedimentation basins to either side. The new one million gallon clear well can be seen the upper left. It was recently painted by a world-renowned mural artist.

Xypex technical team. Paul Derby and George Arnold were very helpful in directing us on proper prep, application and finishing techniques. Megamix does not like to be over worked by the finishers, so that was a situation where Paul helped us understand how we could level it just enough and then finish it with a magnesium float (fig 6) to achieve the optimal surface without overworking it."

The surface preparation process was carried out by the project contractor and applicator, Freyssinet USA, and included hydrodemolition using water jet equipment capable of producing at least 35,000 psi to remove any unsound or contaminated concrete substrate. Bond tests were then conducted on certain prepared concrete substrates with a 200 psi bond strength required for all core samples. While most bond samples were 200 psi or greater, some fell below the minimum level (fig 7).

"The Xypex technical team also helped us evaluate our bond samples when we had failures," Keatts explains. "They helped us troubleshoot the situation and preparation and determine where we could improve or use a different type of finishing technique, which ultimately made it work really well."

Work When Water Demand is Low

Approximately 600 tons of Xypex Megamix II repair mortar was applied throughout all the basins on both vertical and horizontal surfaces. The application crew was required to work during the late fall, winter and early spring, during low water demand periods. Only half the basins could be finished during one winter season, requiring the project be carried out during the winters of 2017-2018 and 2018-2019.

The prepared concrete substrate was kept saturated surface dry (SSD) by using a network of fine water mist nozzles. The nozzle network also aided in helping to cure the repair mortar. Trained applicators applied the Xypex Megamix with low pressure spray equipment where possible and by hand in very tight spaces.

The final finish included a light broom treatment on horizontal surfaces to make them slip resistant. Vertical basin walls and floors received a smooth finish with magnesium floats to prevent the trapping of flocculation particles.

Temporary tents were erected over most of the basins as work progressed in order to protect the workers and keep the Megamix repair mortar warm during the cold winter months to aid curing. A network of aluminum walkways and platforms were also installed over the basins to minimize wear and improve safety.

"Ultimately, the city chose to extend the life of the existing structures at the Mitchell plant," SKA's Keatts observes. It's estimated that the cost to rebuild the two acres of flocculation and sedimentation basins (fig 8) would have been 5-10 times the cost to repair and resurface them.

"We believe that the service life for the basins where Megamix was used to restore them will be an additional 40 years. The waterproofing provided by Megamix is critical because these basins are continually filled with water that has been treated with various chemicals like ferric sulfate and Lime slurry that cause a variation in pH levels (fig 9). Everything tends to move to equilibrium so it causes the concrete to leach out calcium hydroxide which weakens the concrete over time. Megamix prevents that from occurring."

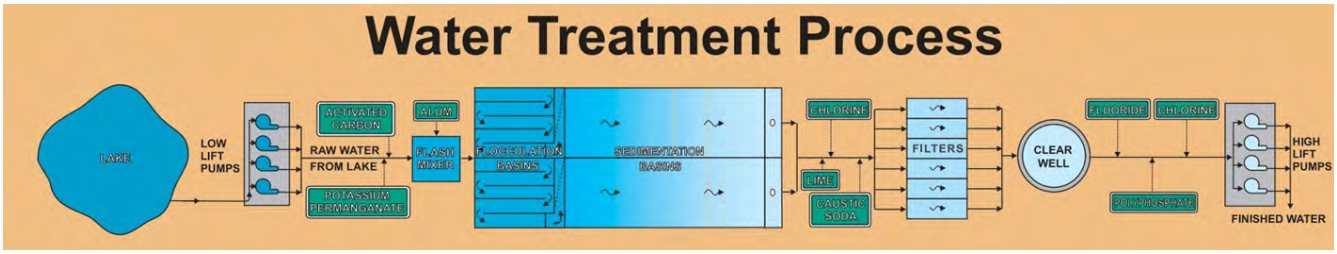

Fig 9 -- A simplified view of the water treatment process taking place at the Mitchell Water Treatment Plant in Greensboro. Chemicals detrimental to concrete are used in the process and caused significant damage to the structures over the decades.