



Saddle Creek High-Rate Treatment Basin Advances Water Quality Protection in Omaha

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The Saddle Creek High Rate Treatment Basin (HRTB) is a milestone achievement in the City of Omaha's \$2-billion Clean Solutions for Omaha program, a mandated response to reduce the impacts of combined sewer overflows (CSO) on local waterways by 2037. As the first remote HRTB built in Nebraska, the facility captures combined sewage from the CSO 205 outfall and stores and treats it during wet weather events. The project is expected to reduce the annual volume of untreated CSO discharged into the Little Papillion Creek (LPC) by more than 90%, as well as total suspended solids (TSS) and E. coli bacteria.

During major storm events, the three-million-gallon, underground, concrete basin is capable of providing "equivalent

to primary" treatment of flows up to 160 million gallons per day (MGD) before discharging to the LPC. During extreme storm events, the HRTB can screen, remove grit, and disinfect flows up to 320 MGD. Lower volume flows are captured and later pumped into the LPC Interceptor and conveyed to the Papillion Creek Water Resource Recovery Facility for full secondary treatment.

Major facility components include a diversion chamber that directs flows from the combined sewer into either a 60-inch diversion sewer or the HRTB; a headworks/screening area that removes grit, material, and suspended solids; a disinfection channel that mixes sodium hypochlorite into the flow; a basin with baffles where flows are detained and settling occurs; and a dechlorination area where sodium

bisulfite is mixed into the flow before discharging to the LPC. A dewatering pump station and flushing gate system drain and clean the basin to help prevent debris accumulation and odour formation between storm events.

Since wet weather is highly variable, the Saddle Creek HRTB was designed to operate efficiently and effectively over a wide range of conditions without adversely affecting the collection and treatment system. Extensive hydraulic modeling and development of process control strategies enabled the use of real time controls and smart sewer technology to optimize flow management. The HRTB's innovative gravity-flow-through design moves flow in and out of the facility without major pumping. Sited on a former construction debris landfill, the HRTB's

excavation and deep foundation system challenges were overcome to deliver a facility that met consent order and budgetary requirements, demonstrates new wet weather storage and treatment technology to Nebraska, and aesthetically complements the highly developed surrounding area.

First High-Rate Treatment Technology Use in Nebraska

High-rate treatment (HRT) technology has been used to treat CSOs during wet weather events throughout the U.S. A combination of efficient contact times, high mixing intensity, and increased disinfection dosage are used to remove pollutants, including pathogens and bacteria, which may adversely impact the receiving water body. The Saddle Creek HRTB is the first facility to use HRT in the State of Nebraska. This required working closely with the Nebraska Department of Water, Energy, and Environment (formerly Nebraska Department of Environment and Energy) to prove the design would meet “equivalent to primary” treatment requirements in compliance with the City of Omaha’s CSO Long Term Control Plan (LTCP).

A “Presumptive Approach” was followed wherein hydraulic modeling was performed to verify that the improvements

provided a minimum of 85% volumetric capture for the Representative Year rainfall. As defined in the LTCP, “equivalent to primary” treatment provides solids and floatables control, and disinfection with a minimum of 30 minutes of detention of the peak design flow within the settling basin. Solids and floatables control were achieved through the addition of grit settling pits, mechanical screening equipment, and a settling basin. The 30-minute settling time was validated in design through computational fluid dynamics (CFD) modeling.

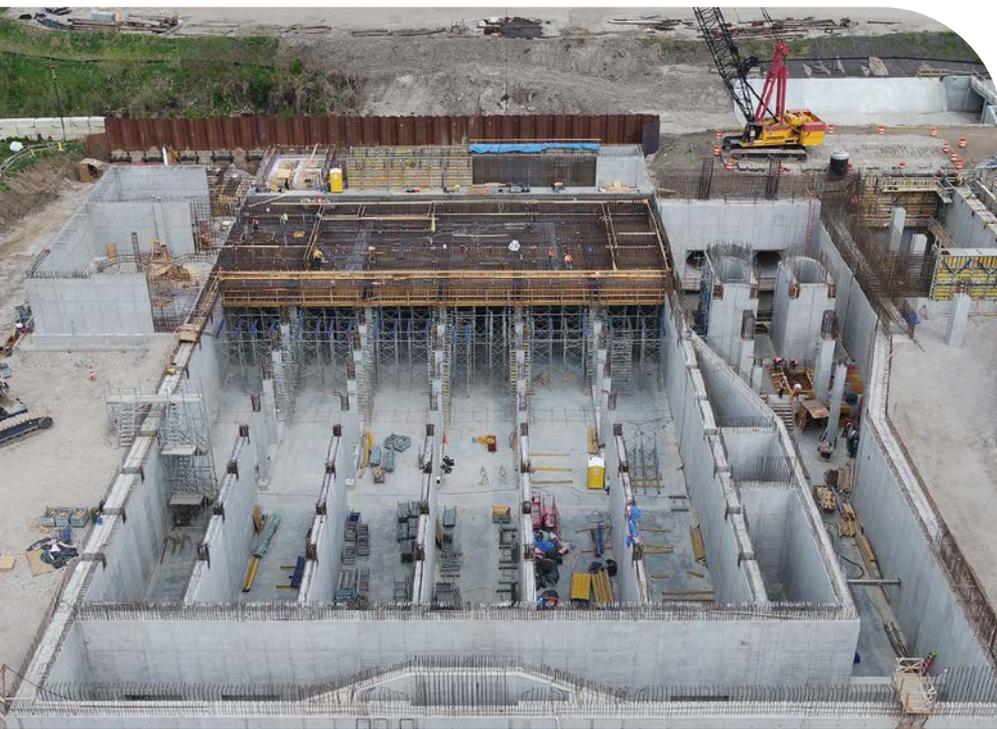
During predesign, extensive bench scale testing was performed to confirm appropriate chemical dosing for representative overflows from the CSO 205 outfall. Based on disinfection approach study results, it was recommended that sodium hypochlorite be added to influent flows for disinfection, and sodium bisulfite be injected into the effluent flows to achieve stringent limits for removal of residual chlorine before discharging to the LPC. Dosing of sodium hypochlorite uses a volumetric-based dosing formula, with flow measurement into the HRTB via various methods ensuring that the appropriate quantity of chemical is delivered via a series of chemical pumps and chemical induction mixers.

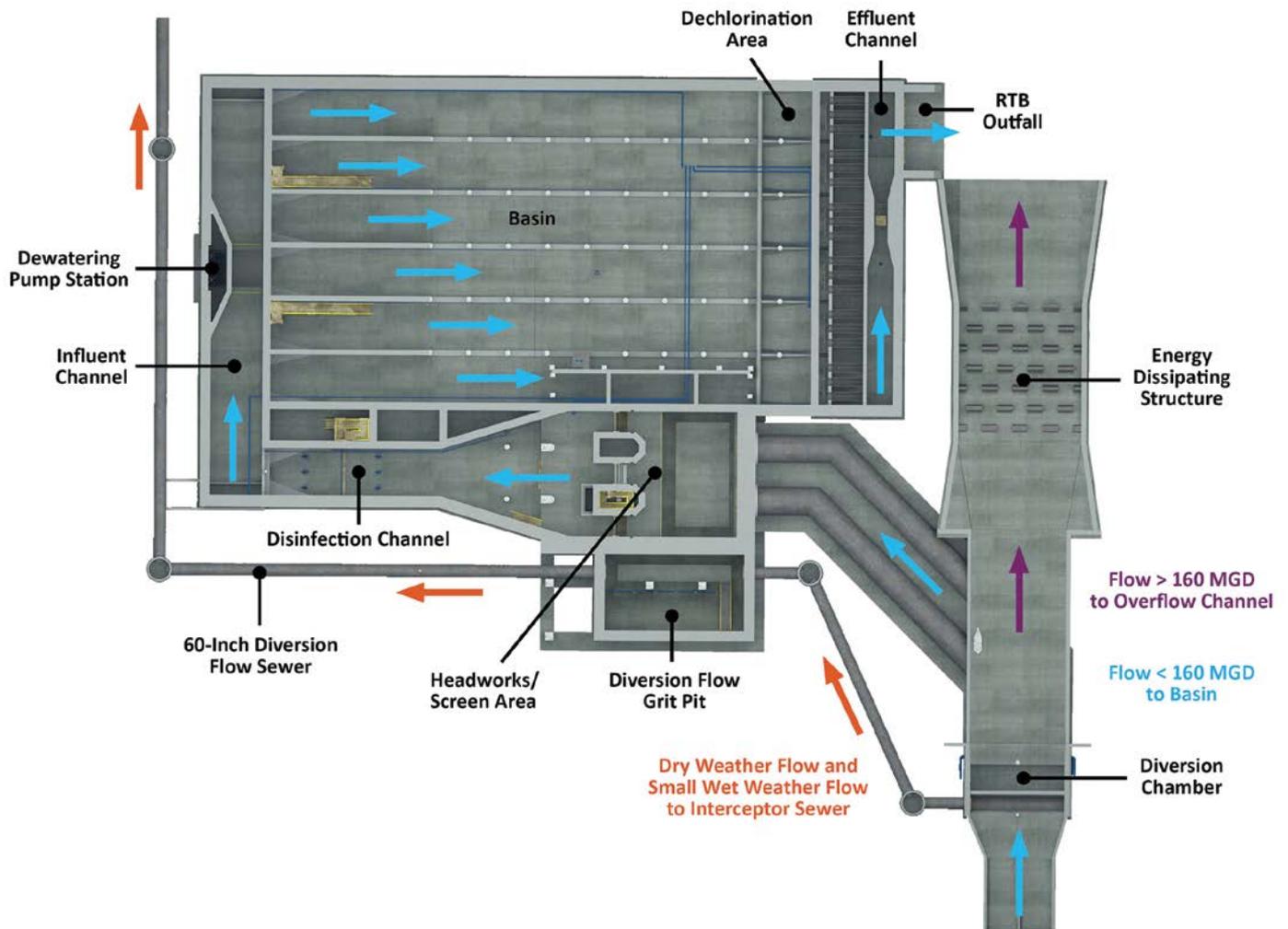
Likewise, sodium bisulfite is dosed via chemical pumps and diffusers to the effluent weirs based on flow rate to ensure the residual chlorine is eliminated within acceptable levels and validated through a system of analyzers.

Innovative Facility Design Optimizes Performance and Cost

The Saddle Creek HRTB’s innovative gravity-flow-through design was achieved through the facility’s configuration, siting, hydraulic design, flow measurement techniques, and control processes. The diversion structure, constructed over dual 10-foot by 12-foot box sewers which convey over one billion gallons per day (BGD) of flow, was configured with weirs that direct flows by gravity. Low flows are conveyed through a 60-inch diversion sewer directly to the downstream LPC Interceptor. High flows are conveyed into the HRTB for storage and high rate treatment via dual, 108-inch-diameter pipes. Flows exceeding the HRTB’s design capacity overflow from the diversion structure to the outfall channel without treatment. In addition, the CSO 205 overflow channel was reconfigured, providing a concrete trapezoidal channel with energy dissipating concrete baffles to address the erosive forces of overflows in significant rainfall events, and natural channel improvements at the downstream end of the channel. Detailed flow and flood risk plans were developed for constructing the diversion structure and influent pipes within an active flood channel.

Modeling tools were used to optimize facility design. Based on CFD modeling analysis results, baffles were installed to promote even flow distribution and mixing within the basin to achieve the minimum 30 minutes of detention time. Physical hydraulic modeling was performed to demonstrate that the diversion chamber flow could be routed to the appropriate pipes under different flow conditions without increasing water level problems in the upstream collection system. Extensive Building Information Modeling (BIM) and 3D visualizations helped reduce conflicts, promote stakeholder understanding, and support project bidding.





The complexity of designing a treatment facility at the end of a combined sewer outfall that discharges over 1 BGD during extreme storms placed a premium on the ability to operate without increasing the risk of upstream basement flooding. Advanced hydraulic modeling of the intake structure and basin layout was essential to meeting all required treatment needs while streamlining flows through the tank. Sophisticated real-time control technology and instrumentation were used to maximize flows to the downstream sewer system. This prevented unnecessary operation of the HRTB during smaller storms while ensuring the downstream interceptor sewer had adequate capacity. Flow is managed in real time by measuring water levels and flow at the facility and within the collection system. This enables process control of influent gates to the 60-inch diversion sewer and the HRTB.

Sustainability was considered throughout design to amplify the project's

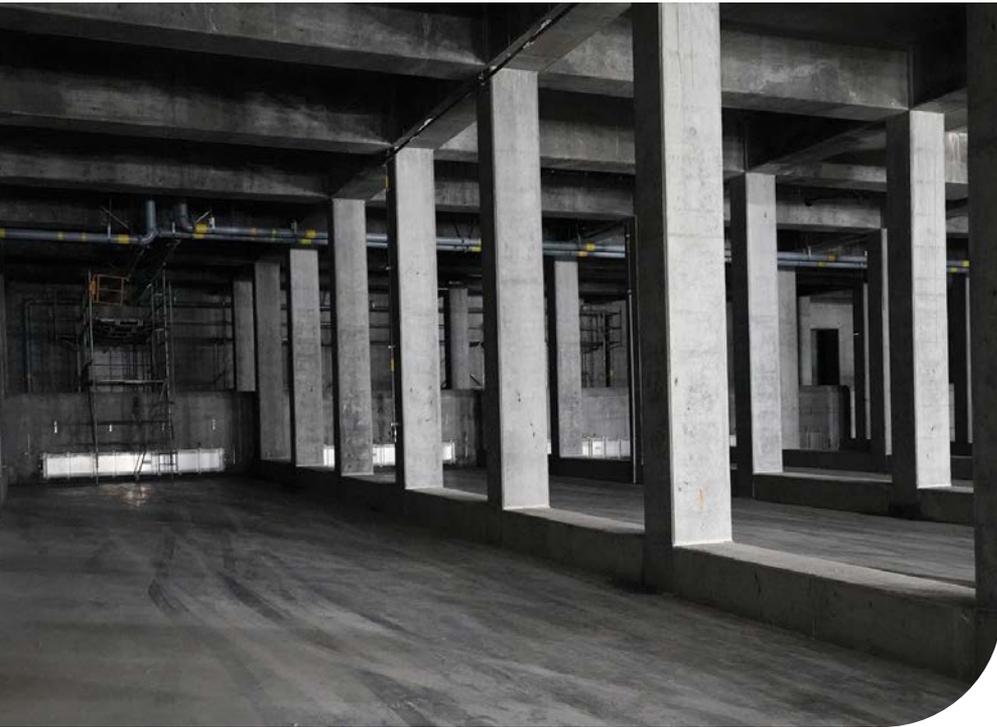
long-term benefits. A new bioretention system was incorporated to manage on-site stormwater detention. Captured stormwater is diverted to a cistern for use as process water for flushing the tank after storm events, reducing potable water use. Lastly, the CSO 205 overflow channel's restoration was designed based on US Army Corps of Engineers requirements to promote biodiversity and enhance wildlife habitat along the banks of the new facility.

Multiple aspects of design yielded cost savings to maximize the value of Omaha's investment. The facility's gravity-flow-through design eliminated the need for an estimated \$50-million pump station, along with its long-term operations and maintenance (O&M) and massive on-site generator needs. To provide office space for additional City department staff, a second floor was added on top of the HRTB's operational rooms and mechanical areas instead of building a separate office facility. When metered and predicted

flows from modeling simulations in the LPC Interceptor were reviewed, it was determined that the interceptor had additional capacity to take on flow during wet weather before the HRTB had to go into operation. A 60-inch diversion sewer was constructed to convey these flows to the downstream sewer system, reducing the overall frequency of HRTB operation and associated O&M costs. Value engineering helped optimize the HRTB's site configuration, and contractor outreach support was provided to generate interest and competition among bidders.

Landfill Site Transformed

Originally a construction debris landfill, the project site was remediated to remove over 330,000 tons of piping, street debris, and fill material from the demolition of aging water and gas pipes in the City. An adjacent CSO 205 overflow channel was eroding and filled with sections of sheet piling that would trap sewage and trash



During facility start-up, the digital twin enabled simulated operation for a range of conditions to test performance.

CSO Program Milestone Achieved

Completion of the Saddle Creek HRTB marks the Clean Solutions for Omaha program's halfway point and a total 60% of CSOs eliminated to improve water quality. This is significant progress toward reaching the overall program goal of capturing or treating 85% of CSO for the Representative Year rainfall by 2037. In addition, the project received recognition on the national level from the American Council of Engineering Companies (ACEC) and the state level from ACEC Nebraska and the American Public Works Association Nebraska Chapter.

The Saddle Creek HRTB project was one of the first projects in the United States to receive Water Infrastructure Financing and Innovation Act (WIFIA) funding assistance, amounting to a low interest loan amount of approximately \$70 Million, saving the City of Omaha approximately \$20 Million in interest costs. Administration of the WIFIA loan and associated requirements were closely coordinated with the Nebraska Department of Water, Energy, and Environment (NDWEE).

A visible amenity and educational resource, this public works facility has been toured by the head of the Environmental Protection Agency, NDWEE representatives, Mayor of Omaha, City Council members, and other dignitaries. In addition, collaboration sessions and tours have been held with University of Nebraska at Omaha civil and environmental engineering students and local engineering clubs to help them better understand water quality issues and high-rate treatment technologies.

In addition to being the largest public works project ever undertaken by the City of Omaha at the time of project bidding, this milestone achievement established the use of high-rate treatment technology to treat CSOs during wet weather events in the region. By significantly reducing the volume of CSO entering the Little Papillion Creek and ultimately the Missouri River, the facility will better protect people from potential exposure to pollutants and improve water quality. [o](#)

during overflows. The overflow channel was stabilized with a concrete lining system to efficiently control erosion, and the lower portion of the channel was restored to a natural stream. With the University of Nebraska at Omaha (UNO)'s Baxter Arena directly to the north and new residential development in the area, extensive collaboration was undertaken to make the HRTB's exterior blend with the arena's color scheme and design. An aging grit removal facility with poor aesthetics and odor problems during maintenance operations was also removed, with grit management from the combined sewer system now handled by the Saddle Creek HRTB.

A two-phased construction approach was used to address challenges and reduce risk. Soil conditions are soft to very soft wet clay, and the site is crossed by numerous utilities and bordered by an open drain, the LPC, high-pressure natural gas lines, and a natural gas vehicle fill facility. During the first phase of site preparation, excavation activities yielded a better understanding of landfill contents and reduced the risk of encountering unknown materials during HRTB construction. Excavation and hauling continued during the second phase to construct the HRTB. An extensive support of the excavation system consisting of a

three-sided vertical wall with pile, lagging, and tiebacks, and a fourth side sloped back with an earthen ramp was used to enable the excavation to be completed within the tight confines of the site. Deep foundation support systems were used to address soil conditions and support the underground, reinforced concrete structure. This consisted of 200-T steel H-piles and permanent rock anchors to resist buoyant uplift in critical areas of the facility. Nearly one quarter of the construction budget relates to excavation and deep foundation support systems.

An extensive program of monitoring groundwater and ground movement was implemented during construction using geotechnical instrumentation. A groundwater management plan was developed to ensure that groundwater levels were maintained within an acceptable range to allow for proper backfill placement within suitable moisture conditions. A Microsoft Power BI virtual dashboard enabled the engineer and contractor to monitor these levels in real time, utilizing data from the groundwater wells as transmitted via telemetry. Drones, webcams, and reality capture technology were used to create a 3D digital twin model of the basin and capture construction progress in real time.