Wisconsin Section – American Society of Civil Engineers

2017 Engineering Achievement Award Nomination
Category A: Construction Cost Under $2,000,000

ASCE
WISCONSIN SECTION

Mead & Hunt

Riverside Pump Station Project
Green Solutions for Separate Infrastructure and Sewer Separation
City of Milwaukee – Milwaukee Water Works
Milwaukee, Wisconsin

Overview

The Riverside Pumping Station project exemplifies engineering excellence by balancing the natural environment, cost and community enhancement while providing solutions to decrease the risk of flooding at the MWW's Riverside Pumping Station building. Using a study from 2012, MWW selected the alternative for design and construction. This project involved replacing and re-grading the north-most service road at the facility, accommodating storm flows to the property, from the west, to bypass the pumping facilities and discharge to the Milwaukee River to the east.

During design, it was determined that several MMSD Rules applied to the project that would impact the existing stormwater discharges to the combined sewer system. Primarily, stormwater discharges from a site that is riparian to the waters of the State to a combined sewer are not allowed and treatment must be provided for new stormwater discharges prior to release to a waterway.

To adhere to these requirements, MWW requested and was awarded a Green Infrastructure grant through MMSD. The MMSD awards money, through this grant, to community groups, businesses and municipalities to help pay for rain collection projects. This Green Infrastructure partnership program is an effort to keep stormwater out of sewers and prevent overflows or backups into basements. With the $415,000 grant awarded from the MMSD, MWW was able to separate the storm sewer from the combined sewer and collect and filter stormwater, which is much more cost-effective than building more sewers or deep tunnels, and better environmentally for discharging treated stormwater into water bodies such as the Milwaukee River. By incorporating Green Infrastructure into this project, we eliminated over 450 pounds of sediment and pollutants that would have entered the Milwaukee River each year.

As with any existing facility the ability to identify the various storm water connections posed many difficulties. The approach to facilitating the separation of the storm sewers from the combined sewer system included reviewing utility records for the facility, field survey and investigating the facility based on system maps and historical drawings MWW provided. These system maps and drawings indicated that revisions could be made to the roof drains for the pumping building, several inlets and two sanitary sewer laterals. In order to capture and treat these stormwater sources, a new storm sewer east of

Date of Construction

- September 2015 to May 2016

Total Cost

- $650,000

Key Project Aspects

- Replace portion of new service road pavement.
- Remove of two inlet structures that discharge to a MMSD combined sewer.
- Install new security fence.
- Replace security gate with a vertical pivot gate.
- Install a riprap lined overflow channel from the service road to the Milwaukee River across MMSD property.
- Remove stormwater drain lines from pumping station building to the combined sewer system; running lines through bioretention swales.

the pumping building was constructed and discharges to the river near the riprap-lined overflow channel planned as part of the access road replacement. A new storm sewer was also needed on the south side of the building to take storm flows around the sanitary lateral connections. The laterals on the south side of the building will remain connected to the combined sewer system. A new sanitary sewer, ultimately connected to one of the existing combined sewers, was routed along the north side of the pumping station to intercept the sanitary laterals in the area. The new storm sewer line was designed to intercept the flows from the six existing sewers directly tributary to the City's combined sewer. Two of the six connections remained as sanitary sewer discharge points. The remaining four connections were permanently bulkheaded.

Bioretention areas, existing catch basins, and newly installed catch basins were used to provide TSS and other debris-removal for the portions of the project that were disconnected from the combined sewer system (City of Milwaukee Code of Ordinances, Part 120-7-6 discusses TSS removal goals). Now constructed, this project provides for TSS removal of 45 percent, exceeding the ordinance requirement of 40 percent. Four hundred and fifty pounds of TSS are removed annually from stormwater that would otherwise enter the Milwaukee River. The bioretention areas were sited adjacent to the roadway and set at an elevation to accept gravity flow from the roadways through curb openings at the existing inlet locations. During a ten-year frequency storm event, the disconnection of the on-site storm sewers from the City's combined sewer system will result in a reduction of nearly 187,000 gallons of stormwater from the combined sewer system, and will instead be treated in bioretention basins before discharging directly to the Milwaukee River.

In addition to separating the storm sewers and adding in bioretention basins, our team provided many other noteworthy project features. A portion of the new service road was replaced with porous asphalt pavement, which will allow for proper drainage and increase the life of the roadway. Brush and overgrown vegetation was removed from the MMSD property line and a new security fence and vertical pivot gate with a control system was installed increasing safety and aesthetics to the area. A riprap-lined overflow channel was constructed to direct overflow from the service road to the Milwaukee River and a concrete multi-use path was installed and lined with butterfly seed to create a park-like feel for residents to bike or walk along the river.

Modifications to the northern portion of the service road enhanced capacity for stormwater flow to the Milwaukee River. The TSS reduction is due to the bioretention areas, porous asphalt pavement, and new catch basins. Also, removing the storm sewer connections to the existing combined sewer system was accomplished. This project accomplished and exceeded the overall goal of limiting the risk of flooding at the pumping station, while providing an environmentally-sustainable method of controlling stormwater runoff with TSS reduction.

Evaluation Criteria

Service to the Well-Being of People and Communities

Benefits to the Community

- Reduces pollutants that drain into the Milwaukee River, enhancing the environment for aquatic wildlife.
- Promotes infiltration through bioretention basins resulting in cleaner water entering the river.
- Reduces the risk of flooding at the pump station structure.
- Aesthetically-pleasing walking trail improvements.

The MWW worked in cooperation with the MMSD to promote the well-being of people and communities in Southeast Wisconsin by improving the quality of the watershed district. This project, which is partially funded by the MMSD's Green Infrastructure program, supports the MMSD's Wisconsin Pollutant Discharge Elimination Systems permit goals of:

- Increasing Green Infrastructure capture by one million gallons during each year of the permit
- Providing flood management benefits
- Reducing nonpoint source pollution

To be eligible to receive a Green Infrastructure grant, the project had to meet certain goals related to integrated watershed management consistent with the goals listed above. Under Mead & Hunt's guidance, the design and construction of the stormwater improvements satisfied these requirements. This project eliminates 450 pounds of sediment that would have entered the Milwaukee River each year, which amounts to a 45 percent reduction. Disconnecting the on-site storm sewers from the City's combined sewer system resulted in the reduction of flows treated by 8.7 cubic feet per second during a ten-year frequency storm event. Additionally, and as a condition of the MMSD's grant, MWW has agreed to maintain the project for at least ten years after construction to prove that the stormwater improvements perform their intended functions.

As part of this project, an area of scrub brush, overgrown vegetation and tangled trees on former MMSD property was enhanced by clearing and grubbing. The City acquired land needed for the stormwater overflow riprap-lined drainage channel via a property transfer from the MMSD. This work benefited the users of the Milwaukee River walking trail, because the overgrown trees and vegetation were a security concern and were aesthetically unpleasing. In addition to clearing an inclined path to a walking trail along the Milwaukee River, a new chain gate was installed across an access road for the MMSD at a location in accordance with the new property boundaries. A concrete walkway was constructed across the riprap-lined channel at the river's edge. The path promotes health and community wellness by providing a safe walking and biking route along the river. Butterfly seed mix was planted on either side of the riprap to increase natural aesthetics and attract butterflies.

Evaluation Criteria

Uniqueness

As a tribute to the uniqueness of this project, MWW was awarded a grant from the MMSD and took the opportunity to incorporate Green Infrastructure into the improvements at the project site. The following are unique aspects of this project.

Porous asphalt pavement, constructed over well-draining base material with subsurface drain pipes, was used on a portion of the northerly access road. The road was reconstructed to slope away from the pumping station, directing water flow to the porous asphalt segment. A high-flow overflow riprap-lined channel was constructed from the road to the Milwaukee River. The super-elevated roadway and high-flow riprap-lined channel were designed to convey overland storm flows, which previously impacted the pumping station's operation, past the station and into the Milwaukee River. The porous asphalt pavement provides for stormwater quality improvements. The existing storm sewer system for the site previously discharged to the City of Milwaukee's combined sewer system.

The combined sewer connections were bulkheaded and the lines abandoned. The facilities combined sewer system was separated with sanitary sewer flows directed to the combined sewer system and stormwater flows treated and discharged. A new storm sewer system was installed to convey the storm flow to the river. The stormwater runoff is treated using catch basins and five separate bioretention basins that consist of underdrains, sand filter beds, and an engineering soil stratum topped with vegetation. The combination of porous asphalt pavement, riprap-lined overflow channel, effective use of catch basins and incorporating bioretention areas collectively make the project truly unique in managing stormwater flows at the pumping station site prior to entering the Milwaukee River.

In addition, a cast-in-place concrete pad was incorporated in the design of the riprap overflow channel to be used as a walking path along the river. At the request of the Milwaukee RiverKeeper, butterfly seed mixture was added to the areas along each side of the overflow channel. This enhanced the aesthetics of the walking path in an environmentally-sensitive way.

Unique Project Features

- Access road was constructed with porous asphalt pavement over well-draining base material with subsurface drain pipes to enhance water quality with TSS removal.
- Constructed high-flow overflow riprap lined channel to the Milwaukee River to direct stormwater flow and reduce velocity.
- Stormwater runoff is now treated through the use of catch basins and five separate bioretention basins to enhance water quality.
- Bioretention basins consist of underdrains, sand filter beds, and an engineering soil stratum topped with vegetation to provide an aesthetically-pleasing feature.

Evaluation Criteria

Pioneering Aspects in Design and Construction

Pioneering Aspects

- Achieved a TSS percent reduction of 45 percent (goal of 40 percent).
- Eliminated 450 pounds of sediment that would have entered the Milwaukee River each year.
- Proactive approach to incorporate the installation of Green Solutions.
- Reconstructed a portion of road to better control stormwater flows, and new asphalt pavement was unilaterally sloped.

During the design phase, Mead & Hunt evaluated several options to achieve the project goals. The selected options were incorporated into the design and were closely monitored throughout the construction phase. Several pioneering aspects were incorporated into the design and construction with the overall goal of meeting the Green Infrastructure goals. The City of Milwaukee and Mead & Hunt took a proactive approach to incorporating the MMSD's Green Solutions into this stormwater improvement project. This enabled the City of Milwaukee to obtain the Green Infrastructure grant and apply the funds to this project.

For design, the best management practices consisted of the porous asphalt pavement, bioretention areas and catch basins were modeled for TSS removal based on an average annual rainfall using the WinSLAMM v10.0. The TSS removal includes treating stormwater using porous asphalt pavement, several bioretention areas, four existing catch basins and six new or replacement catch basins. The new bioretention areas consist of an 18-inch layer of engineered soils (70% sand and 30% compost) over a 12-inch layer of crushed stone enveloping a perforated underdrain with a geotextile fabric over the top of the underdrain. The underdrain system drains by gravity to the adjacent new or existing storm sewer. The project achieved a TSS reduction of 45%, which exceeded the goal. The total tributary area for the analysis was 3.17 acres, and the project resulted in the elimination of 450 pounds of sediment that would have entered the Milwaukee River each year.

All work was done while keeping the pumping station operational and maintaining access to the pumping station road network and associated driveways during construction. To better control and direct stormwater flows, the northern portion of the perimeter road was reconstructed and the new asphalt pavement was unilaterally sloped so rain water would flow to the north side of the road. This served two purposes, as it directed rain water to the porous asphalt segment of the roadway while directing flow during storm events to the riprap-lined overflow drainage channel and away from the pumping station structure. A perforated drain pipe was installed under the porous asphalt pavement to collect stormwater flow and direct it to the new storm sewer and ultimately to the Milwaukee River. These features took advantage of the natural slope of the site from high areas to the west near the entrance gate, to the lower areas at the base of the entrance road at the location of the riprap-lined overflow drainage channel. This project provides a new approach on updating infrastructure with an environmentally-friendly twist and provides affordable options for other communities or municipalities to explore.

Evaluation Criteria

Economy in Initial Costs and/or Operation and Maintenance Cost

With cost-savings in mind, several alternatives for controlling stormwater at the pumping station were analyzed and reviewed, before selecting the alternative described in this nomination. This project had the lowest initial and life-cycle costs and provided the necessary functions with the desired outcome. During design, we determined that only a portion of the road needed to be reconstructed with porous asphalt pavement. Only one-third of the roadway was constructed with porous asphalt pavement, and the remaining two-thirds was constructed with conventional asphalt used for roads. The bioretention areas were located on the project site to take advantage of the natural topography while allowing flow to drain by gravity into the Milwaukee River. This negated the need for pumping facilities.

Operation and maintenance of the project is very simple and cost-effective. MWW has full-time employees tasked with maintaining MWW facilities, including buildings and grounds. A conservation easement was created for the areas of Green Infrastructure. This easement allows for access for operation and maintenance, which will enhance the project components to be fully functional for a period of ten years from the date of project completion. MWW intends to use and maintain the project beyond the ten year life of the easement. The low-cost base operation and maintenance program consists of:

- Inspection of the bioretention areas and the porous asphalt pavement periodically following major rain events to provide proper infiltration.
- Periodic inspection (minimum of once every two months) of the riprap lined overflow channel and the bioretention areas, to clean and clear the areas of trash and debris as well as remove weeds and woody material for proper performance.
- Vacuum sweeping of the porous asphalt pavement twice a year, at a minimum.
- Inspection and cleaning of the catch basins and storm structures annually.
- Repair of the bioretention areas, if necessary, with engineered soil, supplemental seeding and/or supplemental aeration. Repair includes control of weeds and other nuisance plants.

This projects exemplifies this requirement by actively seeking cost-saving opportunities during design and construction and looking into future cost-effective operation and maintenance opportunities that will provide low-cost solutions for ten years and beyond.

Cost Saving Measures

- Porous pavement was only used where needed for stormwater flow.
- Bioretention areas were located on the project site, negating the need for any pumping facilities.
- MWW has full-time employees who are tasked with maintaining facilities and grounds, including the project area.
- Conservation easement was created to allow for simple and cost effective operation and maintenance.

Evaluation Criteria

Exceptional Use of Materials

Material Usage

- Bioretention areas were constructed of readily available materials to comprise the engineered soil.
- Stone riprap was placed over filter fabric material so fine material can't penetrate the fabric.
- Cast-in-place concrete pad was constructed to connect with an existing walking path.
- Butterfly seed mix was blended with the existing vegetation along the overflow channel at a very low additional cost compared to a more conventional grass seed mixture.

Balancing cost-effectiveness and longevity were key to deciding what materials to use for this project. Through a collaborative effort, researching alternatives and using cost-control measures we were able to make deliberate decisions to cut down on wasted materials and effectively use quality materials to enhance the area. Key examples of exceptional use of materials are described in the following paragraphs.

The reconstructed roadway included approximately one-third of the width with porous asphalt pavement, with a granular drainage layer and perforated drain pipe. The drainage of the roadway took advantage of the natural topography of the site to drain storm flow through the underdrain system to the Milwaukee River. The bioretention areas were constructed in location that also took advantage of the natural topography, and were constructed from readily available materials to comprise the engineered soil.

The riprap-lined overflow channel was constructed on a sloped area of the site, to drain by gravity from the roadway directly to the Milwaukee River. The stone riprap was placed over filter fabric material so that fine material is precluded from penetrating the fabric, which could compromise the drainage characteristics. A simple cast-in-place concrete pad was constructed in the riprap, near the downstream end of the channel, to connect with an existing walking path along the west side of the river.

At the request of the Milwaukee RiverKeeper, an agency with an interest in this project because of the overflow channel, a butterfly seed mix was incorporated into the project. This seed mix was used in the graded areas along each side of the riprap-lined overflow channel, and in addition to attracting butterflies, blended well with the existing vegetation, all at a very low additional cost as compared to a more conventional grass seed mixture. The underdrains, catch basins and manholes were constructed of commercially-available products, thereby decreasing the project cost.

Evaluation Criteria

Balanced Regard for Utilitarian and Aesthetic Values

This project excels at balancing utilitarian and aesthetic values by providing an environmentally-friendly and sustainable design. By incorporating Green Infrastructure initiatives into the project, the resulting environmentally-conscious and aesthetically pleasing facility enhances stormwater flow to the Milwaukee River.

The security fence along the northern property line was removed and replaced with a new security fence that meets current MWW criteria and defines the northerly border of the MWW property. The new vertical pivot gate and control system provides for smoother and more dependable operation, and compliments the new security fence. A new permanent loop detection system and optical sensor was installed with the new gate and pavement at the entrance to the pumping station property.

Old, tangled trees and unsightly underbrush were removed along the MMSD and MWW property lines in conjunction with removal of the old security fence. The area is now open, and offers an open and attractive entryway to a stairway that leads down to a walking path along the Milwaukee River. This clearing and removal results in a safer and more visible access area to the Milwaukee River, and blends in with the well-maintained yard areas for the Riverside Pumping Station property. In cooperation with the MMSD for access to one of their deep tunnel facilities, a new chain-link gate and new concrete-filled steel bollards were constructed across the MMSD's access road at a new location that better serves their facilities. The MMSD and MWW worked in an extremely cooperative manner to facilitate the property transfers that enabled the overflow channel to be constructed in the optimal location.

Additionally, new concrete curb and gutters for the reconstructed portion of the access road provides for enhanced visual guidance (contrast with the asphalt pavement) for vehicles using the access road. The bioretention areas, including the riprap-lined curb cuts from the road, blend well with the existing topography and yard areas of the pumping station site, enhancing the overall aesthetics of the site. The butterfly seed mix used on either side of the riprap-lined overflown channel provides an aesthetically pleasing and environmentally-sensitive solution to providing a vegetation seed mixture that requires little to no maintenance. The cast-in-place concrete pad constructed at the downstream end of the riprap-lined overflow channel provides a smooth transition across the riprap for the existing walking path located along the west side of the Milwaukee River.

Utilitarian & Aesthetic Balance

- A new pivot gate and control system allows for smoother and more dependable operation.
- Brush removal offers a safer and more attractive entryway to a walking path.
- New concrete curb and gutters provides enhanced visual guidance to the access road.
- Bioretention areas blend with existing topography and yard areas enhancing the aesthetics.
- Butterfly seed mix creates aesthetically pleasing landscape.
- Cast-in-place concrete pad provides a smooth transition to the existing walking path.

Why this project is an award-winner




This project demonstrates excellent cooperation and coordination between MWW and the MMSD during the design and construction phases, effective use of the Green Infrastructure grant, and maintenance of the project according to the terms of a ten-year maintenance agreement as a condition of the grant. The Riverside Pumping Station is one of MWW's vast network of pumping stations and distribution mains that provides drinking water to the City of Milwaukee and surrounding communities. Overland stormwater flows that cross through the pumping station property west of the Milwaukee River threatened flooding of the pump station during high-frequency storm events prior to this project.

Now constructed, the project controls those flows with the reconstruction of the northern portion of the on-site loop road in an effort to significantly decrease or eliminate flood impact potential to the pumping facilities. This reconstruction included changing the cross slope of the road to a unilateral cross slope to a porous asphalt pavement section with underdrains to direct flow directly to the Milwaukee River. For a high-frequency storm event, flow is directed to a riprap-lined overflow channel that discharges directly into the Milwaukee River. Where the overflow channel meets the river, a concrete multi-use path was constructed and the riprap was lined with butterfly seed. This creates an environmentally-sensitive and aesthetically-pleasing trail that can be enjoyed by bicyclists and pedestrians as they travel along the riverfront.

In addition to this unique project feature, on-site discharge points were removed from the combined sewer. The new storm sewer, constructed as part of this project, collects storm flows from the discharge points and accepts the underdrain and overflows from the bioretention areas. This project results in eliminating 450 pounds of sediment that would enter the Milwaukee River each year, which amounts to a 45 percent reduction. Disconnecting the on-site storm sewers from the City's combined sewer system results in the reduction of flows treated by 8.7 cubic feet per second during a ten-year frequency storm event.

This highly-sustainable and environmentally-friendly project clearly demonstrates how innovative ideas and interagency cooperation can deliver a project that benefits its citizens and paves the way for future stormwater projects. While this project is only one example of incentive-based funding, it is truly a viable option for other communities or municipalities in Southeast Wisconsin to explore when looking to update infrastructure with an environmentally-friendly twist. Whether considering the newly-added vertical pivot gate; simplified and cost-effective operation and maintenance; significant reduction of TSS that will provide cleaner water for the area; or any of this project's many other unique features, it is easy to see that this project truly embodies the criteria required to receive the Wisconsin Section ASCE Engineering Achievement Award.