

## Project Narrative

In 1996, on a cold January morning, over 400 homes, a hospital, and other commercial businesses were flooded along Solomon Creek in Wilkes-Barre, Pennsylvania with over four feet of water. A heavy rain and a warm wind combined to melt over 10-inches of snow resulting in a sudden rise in the stream, which overtopped the existing flood protection system in this densely populated urban area of South Wilkes-Barre. In fact, residents along this stretch of Solomon Creek in Luzerne County have been plagued with flooding problems for years.



### Technical Merit

The City of Wilkes-Barre and the Pennsylvania Department of Transportation (PennDOT) sought the expertise of Borton-Lawson to design the replacement of four bridges over the Creek including portions of Franklin, Regent, Barney, and Waller Streets in South Wilkes-Barre. However; detailed Hydraulic & Hydrologic (H&H) analyses indicated that the stream capacity was less than a 10-year frequency in the area of the bridges alerting the project team that the bridge replacements alone may not put an end to the flooding. After meeting with the City to discuss the findings, the City conducted an economic survey to verify the cost of damages due to the 1996 flood event. Consultations with the Corps of Engineers led to the formation of a flood protection feasibility study team composed of Borton-Lawson and the Corps of Engineers, Baltimore District. This team would work together to determine the magnitude of this project to provide a total solution to the flooding in the community.

The Solomon Creek Channel consists of an earthen bottom, 30 feet in width, and stone masonry walls, approximately 15 feet in height. The walls and bridges were several feet higher than adjacent roadways and properties. Because of this, the team was presented with a unique challenge if they were to improve the waterway opening. The channel width was restricted by walls and parallel residential streets, while the profile grade over the bridges was restricted by the elevation of adjacent properties.

Borton-Lawson, along with PennDOT, determined that the bridges across the creek could not be raised higher due to the impact to the residential streets in the area. Coordination meetings were held to discuss the results and major constrictions, which were limiting the capacity of the stream. The solution to this was neither raising the bridges nor simply widening the channel, but a combination of reducing the already shallow superstructure depth, slightly increasing the profile grade, widening the channel by 8 feet, and installing floodgates on the bridges to convey a 100-year flood event. This combination of adjustments achieved the necessary increase in waterway opening.

Currently, the project includes four bridge replacements with three more structures scheduled for replacement by Luzerne County further downstream. All of these bridge replacements are vital to the overall project success that eventually will pass the 100-year flood with a 48-foot wide concrete lined channel 8,000 feet in length. The Bridge Replacement portion of this project is a vital step in protecting this area from a 100-year flood event. This phase of the project was innovatively designed with the future widening of the channel in mind.

## Aesthetics

Prior to the construction of these bridges, residents of this neighborhood saw bridges stained with rust, lime, and missing and discolored stone walls while looking from their homes. The newly installed bridges feature textured form liners with a stone finish, Blue Stone caps, and an anti-graffiti finish on the walls, a significant improvement from the old bridges and channel.



## Innovation

In order to acquire adequate space for widening of the channel, a small number of properties adjacent to the creek needed to be acquired, but overall the project was designed to minimize impacts on neighboring residents. The presence of major utilities buried in Brook Street, a parallel street, further complicated the design. Because the new wall is 15 feet in height, a substantial footing was required for a cantilever-style retaining wall. The installation of the footing required excavation of all of Brook Street. In order to eliminate the need for excavation of the portion of Brook Street containing the utilities and minimize right-of-way acquisitions, a precast concrete "U" channel section was designed in two segments to allow partial width construction of the channel, while maintaining stream flows.



Probably the most unique, innovative feature included the conception of a unique removable bridge parapet design to be quickly reconfigured from a bridge railing to a floodgate. A steel box railing was designed on hinges allowing the Emergency Management teams to swing the railing across the roadway to act as a floodgate. According to the U.S. Army Corps of Engineers, this system is the first of its kind in the United States. Other innovations are listed in the Significant Project Features Summary.

## Constructability

The project team worked tirelessly to ensure that each detail of this unique system would work well with the current bridge designs as well as future improvements to the channel. They even asked the fabricator of the flood gates to produce a mockup and make recommendations for improving the design concept. Minor changes were made to improve operational characteristics and reduce maintenance needs. Project team members and local emergency response personnel conducted a public training with local residents demonstrating how the three-ton swinging gates could be easily operated by the appropriate people in the event of rising waters.

The Mayor of Wilkes-Barre's major concern was disrupting and displacing area residents to complete this project. The design team exceeded expectations and was able to contain most of the excavation, shoring, and construction within the channel by developing unique solutions. U-shaped channel walls were designed to use the concrete channel bottom as the footing and to be constructed half width to minimize construction impacts. The channel and bridge were realigned to allow the new wall to be constructed in front of the old one along Brook Street thereby leaving the utilities, adjacent roadways, and residential properties undisturbed.

In conclusion, Wilkes-Barre made the national news during the extreme flooding in late June of 2006. The bridge designs along Solomon Creek passed their first test while residents watched the emergency personnel close the floodgates protecting them from the excessive damage they have come to expect during extreme storm events. Longtime residents of this region will see significant improvement of the flood protection system when the waters start to rise. They will soon say goodbye to their fears of flood waters inundating their neighborhoods once the comprehensive solution is completed.

### Significant Project Features

- The 52' span consists of 48" x 17" adjacent box beams skewed 73 degrees to the reinforced concrete abutments. It also features extreme profile grade transitions with a sharp vertical curve on the bridge deck, combined with skew created haunch variations from 0 to over 7 inches.
- Custom designed double-gate, hinged traffic barriers are at each abutment. The barriers can be swung from behind the sidewalk into the roadway to act as floodgates. The barriers are steel box beams designed for a TL-3 crash load, the required design load for these local streets. Sliding plates lock down to the roadway to complete the flood protection. Each gate is nearly 25 feet in length and weight is approximately three tons.
- An abrupt channel profile grade change occurs at the Franklin Street Bridge causing a hydraulic jump which, in turn, slows the creek flow and causes deposition of extreme bed loads and debris under the bridge diminishing channel capacity. The concrete channel lining minimized snagging of debris under the bridge and reduces the severity of the channel velocity change minimizing debris deposition. The lining also makes debris removal after the storm very simple.
- At two of the bridges, vehicular maintenance access ramps were constructed to allow for removal of flood debris from the channel. These ramps were designed as a U-shaped "bin style" wall supported on pile foundations. Because there is no bridge superstructure load on the wall, relatively small vertical loads were inadequate to develop the required lateral resistance in battered piles. The pile pattern consisted of nearly 30 piles arranged in 3 rows with the front row battered and all others vertical. Although additional battered piles were desirable, temporary sheet piling needed for construction would not permit pile leads to be battered for driving. Three-Dimensional modeling of the pile group was completed using FB Pier software to determine lateral capacity of the pile group.
- L-shaped reinforced concrete retaining walls were designed to minimize construction impacts, which would have been created if conventional cantilever wall footings were used. At the bridges where access ramps were provided, L-shaped channel walls were designed to use the concrete channel bottom as the footing and were designed to be constructed half width using concrete compression struts braced off of the access range for lateral resistance.
- In order to construct the channel walls without disturbing the major utilities buried in Brook Street behind the existing channel wall, the channel and bridge were realigned to allow the new wall to be constructed in front of the old one, thereby leaving utilities undisturbed. Flowable fill was used to grout the gap between the new and existing walls and provide positive load transfer.
- Permanent cantilever sheet pile retaining walls were designed to provide temporary wall closures between existing channel walls and the new, realigned channel walls and abutments, which will accommodate the new, 48' wide future channel, an increase of 8 feet in width over existing.
- Aesthetic treatments including Pennsylvania Blue Stone caps on channel walls, textured stone concrete finishes, and anti-graffiti coating/staining.

