DILLON CONSULTING

75 YEARS

CITY OF LONDON

REHABILITATION OF HISTORIC BLACKFRIARS BRIDGE

Category B: Transportation

CANADIAN CONSULTING engineer

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA

ASSOCIATION DES FIRMES DE GÉNIE-CONSEIL | CANADA

Project Summary

Constructed in 1875, Blackfriars Bridge is one of the oldest surviving wrought-iron bowstring arch-truss bridges in North America.

The City of London retained Dillon to help address the challenge of rehabilitating this heritage bridge to give added strength while preserving aesthetic character. Classic hot-riveting methods were combined with modern technologies.

Roadway engineering, landscape architecture, park enhancements and climate change challenges were addressed across the environmental assessment, detailed design and construction phases to reinvigorate the community.

PROJECT HIGHLIGHTS

Innovation

Since the days of horse and buggy in 1875, Blackfriars Bridge has served the City of London as an iconic community symbol for the community, an unforgettable marriage of form and function. This heritage bridge spans the Thames River connecting the London Ontario Central Business District to the Blackfriars Heritage Conservation District.

Constructed before the invention of the lightbulb, the graceful arch-truss represents the peak of wrought iron metal construction, just before the emergence of steel as the dominant material, and it continues into its third century as a crossing for the vehicles of today.

Dillon was first engaged back in 1948 to repair and strengthen the bridge, giving it a second service life of over 70 years. The repair methods of that era led to details that detracted somewhat from its original appearance.

In 2010, as the bridge approached ***twice the normal expected lifespan*** of a typical bridge, the City faced new challenges: Could the bridge survive any longer? Was it time to replace it? Once again, the City called on Dillon to deliver an innovative, big-picture approach.

Dillon started with a ***multi-faceted risk assessment*** of the bridge and its role in the transportation network. Two facilitated workshops were held, drawing on subject matter experts from many perspectives, along with City staff including the City Engineer. An acknowledged expert on Blackfriars Bridge, Michael Bartlett, Ph.D., was engaged for advice and guidance on its history and rehabilitation.

The next phase of the project involved completion of a detailed arms-length ***inspection and evaluation***, followed by immediate short-term repairs.

These initiatives provided critical insight for Dillon to lead a Schedule ‘C’ Municipal Class Environmental Assessment (EA), considering a wide range of options from ***replacement*** to ***removal*** to a ***replica*** strategy. Competing public interests about the future of the bridge ranged from demolition to museum-like, non-functional treatments. With careful guidance by Dillon and the City, the public embraced an ***innovative rehabilitation strategy to restore much of its original 1875 form, appearance and character***. This involved removal of much of the 1950s overlaid plates to reveal the original forms beneath.

It was clear that an operational bridge was the best way to preserve the character and identity of the bridge as a living focal-point for the community in everyday life.

In 2016, the subsequent detailed design and construction strategy faced many challenges to revive such an old and iconic structure, involving a combination of almost-forgotten techniques and modern technologies. Hot riveting methods from the mid-1900s were brought back. Replica members were fabricated, and integrated into the original.

Central to success, Dillon made a ***bold recommendation***: to lift the bridge off its bearings, disassemble it, ship it to a fabrication facility for rehabilitation, then return the bridge to the site for assembly and erection back in place. To accomplish such a substantial lift required the largest crane ever used on a City project.

The successful construction phase was accomplished in 18 months, with the bridge reopened to the public on December 1, 2018.

Complexity

The Dillon team had to overcome a wide range of complex problems not commonly encountered.

Wrought-iron is a heterogeneous material with impurities that severely limited fabrication options and eliminated most welding approaches.

Old-world hot riveting techniques were brought back by engaging an international expert for guidance on the use of thousands of rivets in the design. Where needed, modern button-headed tension control bolts were used for an historic appearance without compromising performance.

Computerized machining was used to create replicas of the smoothly rounded wrought iron cruciform members distinctive to the original 1875 forging methods.

Finite element analysis was applied to the critical arch-to-tie connection at the bearing.

Customized, member-by-member adjustments were required to address extensive dimensional inconsistencies of the original 1875 members.

The ***logistics*** of removing the bridge, reassembly and erection required a custom field-assembly table, field welding of tension ties, tilt-up erection methods, temporary shoring for cross-members and a 45 m radius erection scheme using a massive crane.

Many components required a ***careful merging of original details with modern code requirements***. For example, the 1875 latticed members required batten plates for load-sharing, and the original railing required permission of the Regulatory Authority to preserve its original lattice infill.

The original stone masonry ***abutments were stabilized*** using lightweight cellular concrete backfill and refined analysis methods.

Viewing contractor selection as critical, Dillon initiated an ***innovative prequalification phase*** to ensure all final construction bidders were experienced and qualified for heritage rehabilitation work, leading to a highly-collaborative construction phase that was instrumental to the successful completion of the project.

Social and/or Economic Benefits

The bridge ***has survived generations of users***, and has become the oldest and longest-spanning arch-truss bridge of its type in North America. It is the oldest metal bridge on the *Ontario Heritage Bridge List* and is included in the *Canadian Register of Historic Places*.

Since the early 1980s, the bridge has been a focal point of many artists, including a series of stained glass images at the City of London's Centennial Hall, sealing its significance as a ***deeply-ingrained part of the community identity***.

This project was about more than just rehabilitating the structure. Many features were added to celebrate and reinforce the sense of place and community that the bridge represents:

- The ***original bridge patent signs*** commemorating innovations were lost over the years. Using photographic records, replica plaques were cast out of remnant wrought iron reclaimed from the original bridge.
- A ***viewing plaza*** was added to provide a vantage point to the bridge, integrating parks and roadway networks.
- An ***artifact of select bridge remnants*** was constructed into a public monument in the plaza, with interpretive signage.
- A ***plaque commemorating the 2016 "National Historic Civil Engineering Site"*** designation from the Canadian Society for Civil Engineering was erected.
- An ***historic gateway sign*** was erected across the roadway using letters forged from reclaimed wrought iron.

The rehabilitation of Blackfriars Bridge has renewed this iconic structure for new generations to enjoy, while providing a functional and enhanced component to the transportation network in the City's downtown core. The bridge has not only met the future needs of the City, it has become an integral part of the community identity, a gateway to the past, and a part of the shared heritage of all Ontarians.

The opening of the bridge was celebrated by Londoners in an opening ceremony, on December 1st, 2018. To match the 1875 opening, the mayor and local dignitaries were drawn by horse and carriage across the bridge at a community event featuring local musicians, artwork and fanfare.

Environmental Benefits

Rehabilitation of existing infrastructure is a central element to good asset management and sustainability practiced by consulting engineers across Canada.

At Blackfriars, the bridge was strengthened and renewed to extend its life substantially, achieving reuse of materials and minimizing waste, while simultaneously delivering one of the most economical solutions to the many design challenges at the site.

Reuse of bridges sends a dual message about our commitment to supporting cultural continuity which is consistent with the need to sustain and preserve our infrastructure and provide value for future generations.

The bridge was constructed without entering the water for temporary support at any stage of the work over the eight year period, including the use of suspended scaffolding under the bridge for inspection, and all of the work in the rehabilitation contract. This avoided undesirable impacts to the environment and demonstrated that high quality engineering solutions can be achieved while protecting the environment.

In addition, hydraulic clearance was evaluated for climate change effects on water surface elevations, ensuring the bridge would not be a constraint on the river if climate effects become more pronounced in the future.

Trail systems along each side of the river were tightly integrated into the design and multiple transportation modes, including cyclists, were accommodated to make the bridge setting sustainable for mixed usage in years to come.

Meeting the City of London's Needs

The project addressed the following key needs identified by the City of London for the project.

The advance work of undertaking a risk assessment and a broadly defined environmental assessment allowed a comprehensive solution that engaged the public in a positive and supportive way and met the needs of the City.

The project was completed with a high standard for public and worker safety throughout all phases of the work. Safety considerations were a primary focus in the decision to remove the bridge and do most of the fabrication off-site, thus minimizing working at height hazards.

The quality of workmanship and final product was maintained at a high level, in part as a by-product of the approach to fabricate the rehabilitation in shop conditions off-site.

The project achieved the goal of opening the bridge on time and within the bid price despite extremely complex and unusual challenges during construction.

The service life of the bridge was greatly extended, while avoiding costly replacements and loss of service due to bridge closure, achieving good value for money to the City and taxpayers.

The project was integrated into the community vision, with heritage aspects treated with delicacy, care and respect befitting such an iconic historical bridge, the oldest metal bridge on the *Ontario Heritage Bridge List*.

The rehabilitated Blackfriars Bridge delivers an above-average user experience that tightly integrates active transportation, parks and transportation objectives with a beautiful and functional bridge crossing and a celebrated sense of place in the community.

DILLON CONSULTING 75 YEARS

CANADIAN CONSULTING engineer

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA
ASSOCIATION DES FIRMES DE GÉNIE-CONSEIL | CANADA