

**Rideau Canal Pedestrian Bridge  
– 20 years from conception to construction -**

Ronald Jack (Presenter and Author), Delcan Corporation  
Vice-President, Ottawa Office Manager  
and Transportation Division Head

Sylvain Montminy (Co-Author), Delcan Corporation  
Senior Principal, Structures Division Manager, Ottawa

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**Paper Title:** Rideau Canal Pedestrian Bridge – 20 years from Conception to Construction (City of Ottawa)

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**Author's Name:** Ronald Jack, Delcan Vice-President  
Ottawa Office Manager and Transportation Division Head  
Sylvain Montminy (Co-Author), Delcan Senior Principal  
Structures Division Manager

**Contact Information:** Delcan Corporation  
Suite 100, 1223 Michael Street  
Ottawa, ON K1J 7T2  
Phone: 613-738-4160 Fax: 613-739-7105  
Email: [r.jack@delcan.com](mailto:r.jack@delcan.com)

The historic Rideau Canal, 202km long, links the Ottawa River at the National Capital Region with Lake Ontario at Kingston. Constructed as an alternative to the St. Lawrence River in the event of war, it is North America's oldest continuously operated waterway. Since its construction, the Rideau Canal has always played an important transportation function. Within the centre of Ottawa, this 7.8km-long section of Canal attracts tourists and locals alike, who make multi-modal use of the waterway and the adjacent pathways and parkways. For all its magnificence and functional diversity, the Rideau Canal Corridor has one major shortcoming – it poses a barrier to mobility across it.

Outside the City Core, but within the Central Area, there are only three bridges within a 4.5 km distance. This separation is manageable by motorized vehicle, but is significant when considering other modes of transportation, and the natural desire to link neighbourhoods, amenities and services on either side of the Canal.

For decades, the City realized the need for improving non-motorized vehicle linkages across the Canal. As early as 1984, with initial development of the bus rapid transit system, there was agreement to provide a pedestrian crossing linking the Sandy Hill community, University of Ottawa and the Campus Transitway Station east of the Canal, with the Centretown employment, residential and retail areas west of the Canal. The benefits being both economic and social.

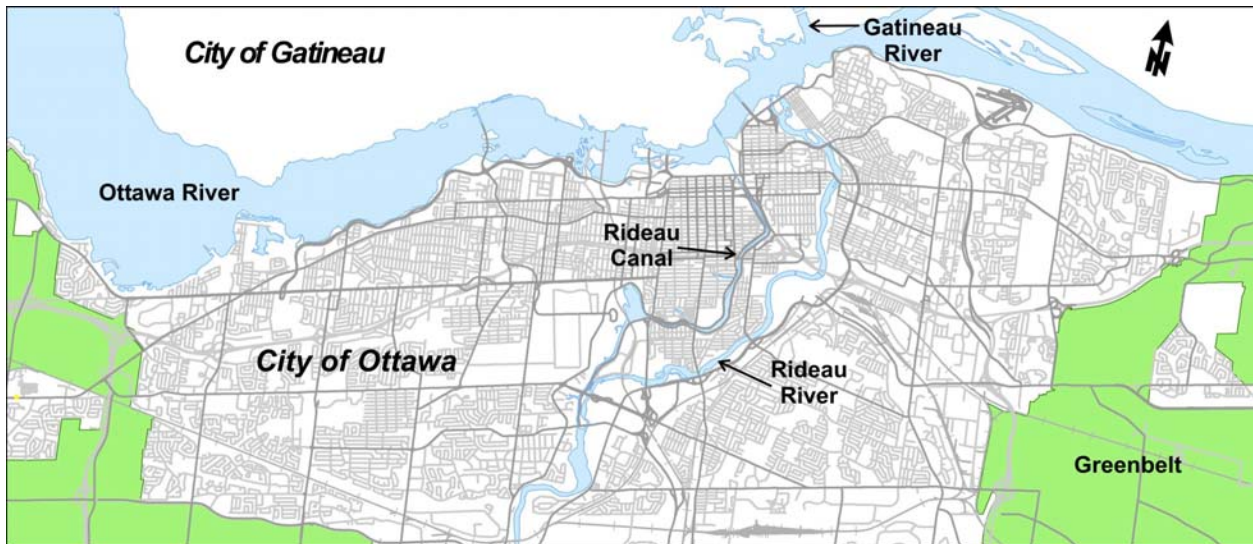
It would take another 20 years to achieve this pedestrian connection because of the divergent views and objectives of the *City*, *Parks Canada* (owners of the Canal) and the National Capital Commission (*owners of adjacent land*). Ultimately, the City of Ottawa undertook a *Planning and Environmental Assessment Study: Rideau Canal Pedestrian Crossing* (2000-02) that was approved by all levels of government. Nevertheless, local political support was not unanimous, as there were concerns relating to the need for the pedestrian bridge and its cost.

From the onset, the Study objective was to develop a safe, functional bridge that would provide economic and social benefit, and would visually enhance the historic setting without overwhelming the landscape. It was to provide a link between Sandy Hill, the University and Centretown, improve accessibility to rapid transit, increase connectivity within the existing recreational pathway system, and provide a convenient and attractive route for downtown walking tourists. Key considerations in determining the location, elevation, structure type and design of the crossing included: integration with the existing road, pathway and transit networks; maintaining minimum navigational clearances; integration with the existing cultural landscape and social environment; respect for Canal and Parliament Hill protected views; barrier free access; and sufficient space for the landing requirements at either end of the structure. Daytime and nighttime images of numerous design options assisted in the final selection.

It was a long journey from inception to completion. The Rideau Canal Pedestrian Bridge opened in September 2006 and received broad public endorsement as attested by numerous media reports, and its 2000 to 3000 pedestrian crossings per day. With its social and economic objectives achieved, all it needs now is a name.

## CONTEXT

The National Capital Region of Canada, which is comprised primarily of the City of Ottawa and the City of Gatineau, is bisected by four major waterways; the Ottawa River which forms the border between Ontario and Quebec and flows into the St. Lawrence River, the Gatineau River in the Outaouais region which flows into the Ottawa River, the Rideau River which extends from the Kingston area and flows north to the Ottawa River; and the scenic Rideau Canal waterway which links the lakes and rivers between Ottawa and Kingston to the Ottawa River. Within the National Capital Region's urban area there are currently a total of twenty-nine bridges that cross these waterways in order to provide the mobility necessary to ensure the economic and social health of the City of Ottawa (812,129, population) and the City of Gatineau (242,124, population).



With regard to the historic Rideau Canal system, it links the Ottawa River with Lake Ontario near its confluence with the St. Lawrence River. The system comprises both lengthy sections of the Rideau River and Cataraqui River where navigable, and sections of canals and locks where the rivers are not navigable. The result is a continuous 202 km long system of navigable waterway that was built as an alternative to using more circuitous navigable river system routes in the event of war. It is North America's oldest continuously operated waterway and this year marks the Canal's 175<sup>th</sup> anniversary.

Today, the Canal remains a vital transportation route, especially for boaters who use the Rideau River/Canal to travel from one end to the other and to places in between. The system is bounded by many unique and historic communities (Manotick, Merrickville, Smiths Falls, Westport, Chaffey's Locks and Kingston) which have varying degrees of daytime and overnight facilities catering to the Canal system's



**The Rideau Canal in Provincial Context<sup>1</sup>**

<sup>1</sup> Rideau Canal, 175 Anniversary Web Site

users. In 2006, nearly 70,000 boats pass through its locks, over 1 million land-based visitors walk, drive or bike to the locks, and over 1.4 million use the Canal during Ottawa's Winterlude celebrations.

Within the Central Area of the City of Ottawa, the Rideau Canal continues to accommodate this important boating function during the summer months, but the corridor within which it exists provides for and accommodates many more diverse functions that help to define the City. These include:

- two scenic parkways (Colonel By Drive and Queen Elizabeth Drive which are owned by the National Capital Commission) which border the Canal on both sides within the City's Central Area and provide an important tourist and commuter function;
- two-way paved recreation pathways located between the Canal and the Parkway on both sides of the Canal, and which accommodate thousands of pedestrians, joggers and cyclists daily;
- in the winter months, the water level is dropped and the Canal is transformed into a 7.8 km long skating facility which extends from approximately the Parliament Buildings south to Carleton University. Along the way it passes the downtown core, the University of Ottawa, Dow's Lake and numerous inner-city communities; and
- the whole corridor comprising the Canal, the parkways and the pathways are lined or bounded by varying degrees of tree planting, large gardens and landscaped parks which accommodate family outings and the City's seasonal festivals.



Summer view of downtown Canal section



Winter skating in view of Parliament Hill



Pathway, Parkway, Canal and the Bank Street Bridge



Adjacent Pathway, Parkway and Park

The combination of the multi-modal nature and beauty of the Rideau Canal corridor through central Ottawa makes it a very well used, multi-seasonal and world-renowned facility. It provides an important transportation function, and has become a highly valued recreational and social amenity. However, for all its magnificence and functional diversity, the Rideau Canal, like most waterways through cities, has one major shortcoming – it provides a barrier to community integration and mobility for those with trip origins and destinations on either side of it.

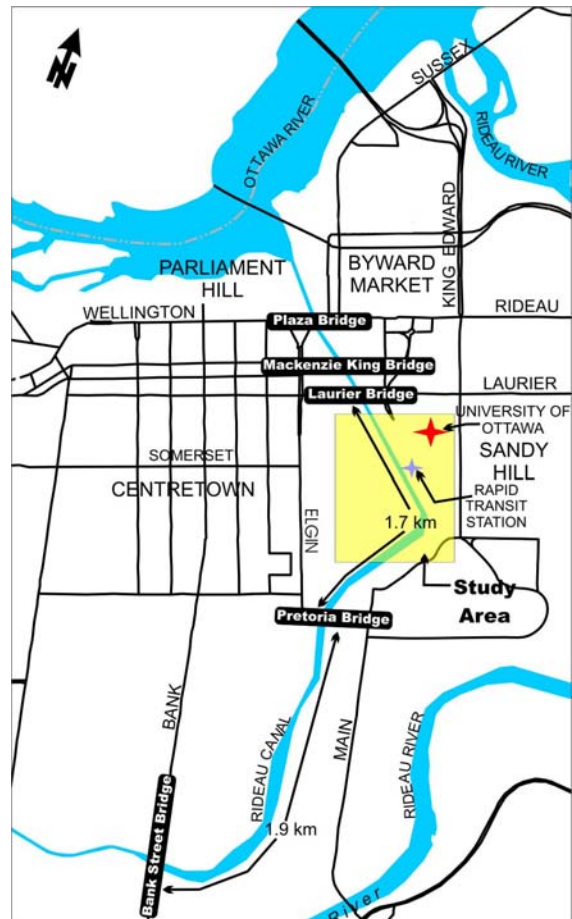


So while there is a significant volume of multi-modal traffic travelling along or parallel to the Canal as it extends through the Central Area of the City, crossing the Canal can be problematic. For example, outside of the Core Area, but within the immediately adjacent Central Area, there are only three (3) bridges crossing the Canal located within a 4.5 km distance. This separation is manageable by motorized vehicle, but is significant when considering other modes of transportation (walk, run, cycle) and the natural desire to link neighbourhoods, amenities and services on either side of the Canal.

## PROJECT HISTORY

For decades there was interest by many to improve the pedestrian connectivity across the Rideau Canal within Ottawa's Central Area. Over the years momentum developed due to a combination of the following:

- the growth of recreational activity in the City and in particular walking, running and cycling and the use of the Canal Corridor for these activities;
- the maturing of the Elgin Street corridor, located three blocks to the west of the Canal, as a trendy and successful restaurant, bar, coffee shop and retail strip;
- residential intensification in the Centretown, Golden Triangle and Sandy Hill neighbourhoods which are located adjacent to, or in close proximity to, the west and east sides of the Canal, respectively;
- significant growth and expansion of the University of Ottawa campus which is located on the east side of the Canal; and
- the development of the City's rapid transit (Transitway) system in a corridor located between the Canal and the University of Ottawa, and which has two stations located on Campus.



**The Rideau Canal Within the Ottawa Central Area**

The natural location for a new bridge was always assumed to be the east-west Somerset Street corridor, as it is an important roadway and cycle route that extends east-west through the City, and as the University's primary rapid transit station is located directly on the alignment of a potential Somerset Street linkage. As well, in this corridor on the east side of the Canal, there is an existing pedestrian underpass of Nicholas Street (a four-lane connecting link to Highway 417) and a pedestrian activated traffic signal on Colonel By Drive that currently provides a safe and direct link from the University to the Canal corridor, and from the Canal corridor (east side) to the Campus Rapid Transit Station.

All of the foregoing factors contributed to the building of momentum for a new Central Area Canal crossing, but the primary trigger was the development of the Transitway (bus rapid

transit) and its University of Ottawa stations. In the early 1980's, the former Regional Municipality of Ottawa-Carleton (the Region) realized the economic and social value of improving the City's pedestrian and cycling system and of maximizing transit ridership by providing improved connections to the transit stations. As a result, in 1984 an agreement was developed between the Region and the National Capital Commission which outlined several areas in the City for improved transit linkages, including a pedestrian linkage across the Rideau Canal, to better link the adjacent communities with the transit station, the Canal corridor and the University.

Subsequent to this agreement, it took a number of years for agency issues to be resolved, for funds to be allocated, and for study Terms of Reference to be approved. Ultimately, in the Spring of 2000, all was in place, the consultant selection process was conducted. Delcan Corporation was retained by the former Region (now City of Ottawa), in collaboration with the National Capital Commission and Parks Canada, to conduct the Planning and Environmental Assessment Study of a proposed non-vehicular crossing of the Rideau Canal in the Central Area of Ottawa.

## **PROJECT OBJECTIVES AND THE RESULT**

In simplest terms, the goal of the proposed non-vehicular bridge over the Rideau Canal was to encourage alternative modes of transportation in the City in keeping with their move towards Smart Growth. Specific project objectives were to develop a safe, functional bridge that would provide economic and social benefit, and would visually enhance the historic setting without overwhelming the landscape. It was to provide a link between Sandy Hill, the University of Ottawa and Centretown, improve accessibility to rapid transit, increase connectivity with the existing recreational pathway system, and provide a convenient and attractive route for downtown walking tourists.

In the initial stages of the study, approximately 3000 pedestrians/cyclists were projected to use the proposed bridge daily based on the following:

- the number of daily users of the Canal's parallel pathways;
- the number of daily pedestrians and cyclists using the adjacent bridges to cross the Canal;
- ongoing development on either side of the Canal;
- the inherent value of improved connectivity; and
- the City's Official Plan objective "to promote walking, cycling and the use of public transit" and their increased target for each.

It took two decades from conception to construction of the Rideau Canal Pedestrian Bridge to become a reality. During this period, there were many issues and concerns that needed to be resolved between the owner of the Canal (Parks Canada), the owner of the adjacent land (National Capital Commission), the local municipality (City of Ottawa) and area residents. Even at the final stage of approving the preferred design solution, the political support was not unanimous and there were continued concerns about the bridge's need and its cost. Ultimately, however, the approval of all affected agencies and governments was obtained, the bridge was constructed in 2005/06, and it opened in September 2006. The total cost of the project, including the Environmental Assessment Study, Design and Construction, was approximately \$5.5M.

With its opening and subsequent use, the Rideau Canal Pedestrian Bridge has received only accolades, and many of them. The following are excerpts from various recent publications which typify the feeling of the public and elected officials towards the new facility:

*“Bridge Works: a big hit with bikers, bladers, boarders and especially pedestrians”<sup>1</sup>*

*“safe, fabulous, modern, wonderful and convenient”<sup>1</sup>*

*“the landscaping is just wonderful”<sup>1</sup>*

*“aesthetically pleasing and transparent structure enhancing the Rideau Canal precinct with minimal intrusion into the views along the Canal”<sup>2</sup>*

*“greatest pedestrian bridge I have seen in years...particularly impressed by the night time lighting”<sup>1</sup>*

*“people are going onto the bridge to get a beautiful new view of Ottawa, and it is bound to become a tourist attraction”<sup>3</sup>*

*“pedestrians are using bridge to travel to/from the University of Ottawa Rapid Transit Station in numbers higher than expected”<sup>3</sup>*

*“nothing but positive feedback - University of Ottawa”<sup>3</sup>*

*“one small step towards creating a more walkable city, less dominated by cars, smog and noise”<sup>4</sup>*

*“bridges can divide people or connect them depending on where they are placed and how attractive they are to use. This bridge is most definitely “connecting”<sup>4</sup>*

*“one of the City’s most popular projects...so cool the local Councillor wants to see another foot bridge over the Canal”<sup>3</sup>*

So how was the Planning and Environmental Assessment Study conducted and the design undertaken, such that the aforementioned objectives were met and the finished product prompted these accolades? Read on.

## **THE PROCESS**

The Planning and Environmental Assessment Study for the Rideau Canal Pedestrian Crossing was conducted within the framework of a Harmonized Environmental Assessment. As the City was the proponent, and as Parks Canada and the National Capital Commission own the Canal and adjacent lands and pathways respectively, the project was subject to the requirements of a Schedule “C” project in the provincial Municipal Class Environmental Assessment process, the Canadian Environmental Assessment Act and the National Capital Commission Environmental

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<sup>1</sup> Ottawa Sun, 21 October 2006

<sup>2</sup> Councillor Newsletter, 11 January 2007

<sup>3</sup> Ottawa Citizen, 25 November 2006

<sup>4</sup> Ottawa Citizen, 3 December, 2006

Assessment Policy. Hence the harmonized approach. Within this framework, the study was conducted in the following manner:

- confirmation of the rationale and need for a new Canal crossing;
- establishment of the study area;
- identification of existing conditions with regard to:
  - land ownership
  - planning status
  - transportation
  - heritage resources
  - archaeological resources
  - views and vistas
  - noise and vibration
  - lighting
  - utilities
  - geotechnical
  - biological
- evaluation of alternative Canal crossing solutions and locations;
- identification of planning and design parameters;
- development of alternative bridge design concepts;
- refinement and evaluation of the short-listed design concepts;
- selection of the preferred design;
- assessment of the preferred design; and
- conduct of the appropriate consultation with the public, the advisory committees and the elected officials at key decision points during the study.

With regard to consultation, this was a key aspect to the success of the project due to the combination of multi-agency involvement, the number of communities affected and the high-profile of the study. Consultation was extensive and included:

- Technical Advisory Committee meetings (5)
- Public Advisory Committee meetings (4)
- Presentations to the National Capital Commission Advisory Committee and Planning, Design and Realty (3)
- Public Open Houses (3)
- Presentation to the City's Transportation and Transit Committee (1)

In addition to the thoroughness and transparency of both the planning and public process, key to obtaining public and political support for the project, and specifically for the preferred design solution, was the quality of graphics used to present the design alternatives. With the use of computer generated graphics, the alternative bridge design concepts (twelve) were developed electronically and digitally superimposed onto photographs of the preferred crossing location. Both day-time and night-time visuals were developed so that the alternative designs could be effectively explained and evaluated against all the key criteria including views and vistas, contextual environment and architectural expression. The resulting presentation material created great interest from those to whom they were presented, as they discussed which design they preferred and why, and it provided comfort that there would be a very good solution amongst the design concepts developed and presented. The night-time graphics were of particular interest, as bridge lighting and its effects are a key decision-making factor. Many viewers initially thought the bridge locations were real and wanted to know where they were located.



## ALTERNATIVE DESIGN CONCEPTS AND EVALUATION CRITERIA

Once the preferred crossing location was confirmed as the Somerset Street corridor, as depicted in Figure 4, it was then necessary to develop and assess alternative bridge design concepts. This process included the development and evaluation of twelve design concepts including; a low-level swing bridge (one alternative), mid-level lift bridges (three alternatives) and high-level fixed bridges (eight alternatives).



**Canal Crossing Location**

To assist in the design and evaluation of the bridge concepts a comprehensive list of planning and design parameters were developed. The parameters were grouped by heading, and each design parameter was accompanied by a number of “planning and design features” which quantified or qualified the parameter. The design parameters were:

### **Views and Vistas**

- View protection of national symbols
- View sequences
- Neighbourhood view corridors
- Views from a new crossing

### **Contextual Environment**

- Built form
- Response to setting

### **Cultural Landscape**

- Topography and plant material

### **Architectural Expression**

- Form
- Scale
- Assertiveness
- Integrity
- Detailing and quality
- User experience

### **Functional Requirements**

- User compatibility
- Accessibility
- Connectivity
- Year round use
- Navigational clearance
- Safety
- Utility location

**Physical Design**

- Width
- Grades
- Cross-slope
- Design speed
- Horizontal curvature and sight distances
- Clearances

- Design loads
- Signage and pavement markings
- Bollards
- Lighting
- Design code
- Structural spans
- Historic reference

**Construction Materials**

- Construction materials
- Abutments

- Railings

**Economic Considerations**

- Capital cost

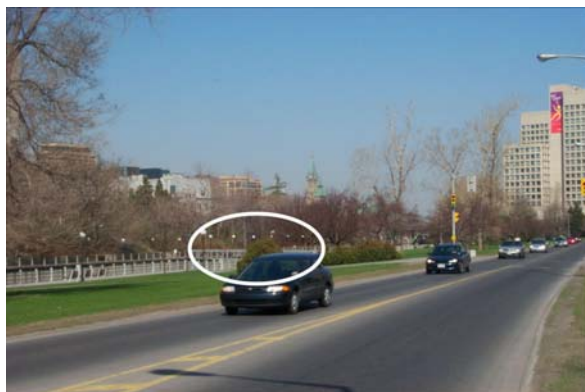
- Operational and maintenance costs

These criteria/parameters were grouped under six headings and assigned the following weights to assist in evaluating the alternatives.

• Natural Environment	5
• Views and Vistas	25
• Contextual Environment	10
• Architectural Expression	25
• Functional Requirements	25
• Economic	10
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	100

These groupings and weightings were approved by all of the project's Advisory Committees, the City and by the affected agencies, and were deemed reflective of their values related to this project in its specific prominent location.

As a result of the initial evaluation, eight bridge design concepts were eliminated from further consideration and four were carried forward for refinement and a second round of evaluation and assessment. Those carried forward were fixed, high-level bridges which provided the necessary navigation clearance. Some of the design concepts not carried forward are depicted in the following figures.



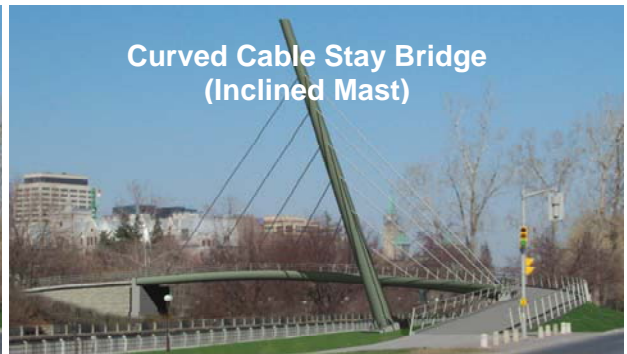
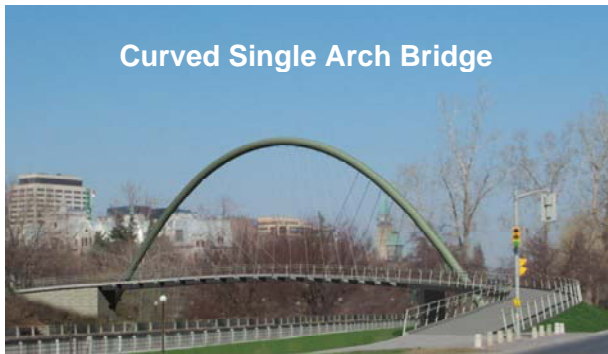
**Bridge Design Concepts Not Carried Forward**



**Bridge Design Concepts Not Carried Forward**

### **SHORT-LISTED BRIDGE DESIGN CONCEPTS**

The following figures depict electronic generated visuals of four of the distinctly different design alternatives carried forward for further refinement and assessment. Depicted are; a Through Arch Bridge, a Curved Cable Stay Bridge (single mast), a Curved Single Arch Bridge and a Curved Cable Stay Bridge (Inclined Mast). It is noteworthy that while some of these design concepts received a lot of attention, none of them were ultimately selected as the preferred design concept.



**Short-Listed Design Concepts**

To advance the four short-listed design concepts and to facilitate selection of the preferred design, the following list of refinements were applied:



- possible deck width reduction;
- reduction of the visual effects of abutments;
- day and night lighting treatment;
- enhancing user experience;
- examination of an asymmetrical configuration for the rigid frame bridge;
- exploration of alternative tower configurations for the cable stay bridges;
- investigation of providing access to the north from the east approach;
- examination of a partially structured and/or switch back east ramp; and
- examination of the possibility of a carved deck and approach for the cable stay bridges.

## **THE PREFERRED DESIGN**

The preferred design concept for the Rideau Canal Pedestrian Bridge was a rigid frame bridge with double inclined legs and with its key characteristics being high-level, low profile and understated. This concept best met the evaluation criteria and was considered to be visually light, elegant, unobtrusive and respectful of its contextual environment. Like all of the other bridge structures along the Canal, it was considered to be expressive of the structural technology of its time, yet sensitive to the local context. Renderings of the preferred design concept, prepared at the time of the Planning and Environmental Assessment Study, follow.

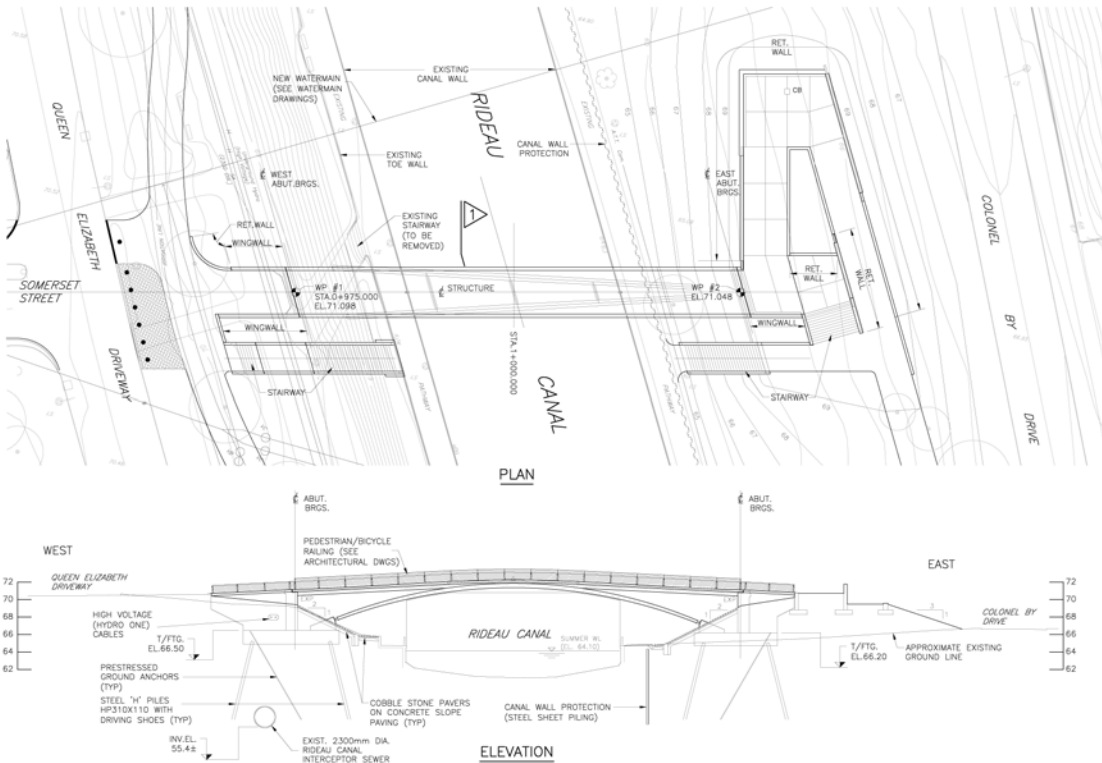


**Initial Renderings of the Preferred Design Concept**

Fundamental elements of the preferred design concept include:

- steel framing to enhance the aesthetics and architectural expression so as to give the structure a more graceful, arch-like appearance;
- the individual pier legs are angled at 20°;
- the girder depth of the main span ranges from 1.9 m at the pier leg to 0.5 m at the east abutment;
- three girders with the two exterior girders are canted or slanted outward in a 10V:3H plane so the inclined legs splay outward;
- lighting treatment of the structure to enhance the appearance of the bridge at night; and
- the abutments are set farther back into the west Canal bank and into the east approach fill so as to be less visually exposed.

The Structural General Arrangements for the preferred design concept are depicted as follows.



### Structural General Arrangements Preferred Design Concept

In advancing the preferred concept through to preliminary and detailed design, the following design recommendations were also made.

- Below deck structure
  - single span steel girder/arch structural approach;
  - explore further asymmetrical structural approaches that could achieve better overall visual balance in elevation profile;

- explore minimizing the lateral bracing depth to help achieve visual primacy of the longitudinal beams as viewed from below the structure;
- minimize dimensions and scale of structural elements to achieve lightness;
- maximize openness between elements; and
- provide visual interest in underside detailing to enhance Canal pathway walking experience.
- Abutments
  - minimize visual weight of abutments by keeping abutment structure below deck and set back from deck alignment in plan; and
  - explore further design refinements that could work with the structure to respond to site asymmetry, especially east side solutions that are compatible with landscaping approach.
- Deck
  - deck width 5.0 m maximum; and
  - functional surface that (to the extent possible) responds to pedestrian/cyclist use and scale.
- Handrails
  - open metal railings that maximize transparency and invite viewing from the bridge; and
  - meet reasonable safety requirements and discourage easy climbability.
- Lighting
  - concealed lighting to illuminate curved lines of primary structural members; and
  - discrete lighting integrated into railing to illuminate pathway surface.
- Materials/Detailing
  - high quality, durable, compatible materials and finishes to provide premium appearance over time and minimize ongoing maintenance;
  - consistent and rigorous detailing approach to elements and connections that exhibits design and structural integrity;
  - contemporary detailing approach that expresses current technology and best industry practices; and
  - avoid gimmicky design devices or overtly historicist references that may soon appear dated. The design should "age gracefully".
- East Approach
  - ramp gradient of 5% minimum;
  - approach path width of 4.0m;
  - a handrail on at least the Colonel By Drive side to aid pedestrians and to contain users thus reducing potential conflicts with vehicles on the roadway; and
  - the ramp pathway alignment should be visually compatible with the elegant bridge and abutment character, particularly when viewed from the Colonel By crosswalk.
- West Approach
  - ramp gradients of 5% maximum;
  - bridge approach width of 5.0m (extension of bridge); and
  - lower ramp approximately 2.0m wide with handrails on both ramps.
- Landscaping
  - replace tree groupings in the lower east Canal plateau in combination and repositioned to complement the approach embankments;
  - re-vegetate the west Canal embankment within the limits of the project;
  - use vegetative types which correspond to the planting guidelines for the Canal corridor as recommended by the National Capital Commission;



- embankment gradients should be 1:3 or less to facilitate grass cutting and promote gentle grade transitions; and
- seat walls or abutment walls should be considered as a compositional extension of the bridge structure and embankments in scale, material and finish.
- **Lighting Treatment**
  - provide safe levels of illumination for the bridge crossing, approaches and Canal pathways;
  - lighting of the structure should be complementary to the context and not upstage views to the Peace Tower and other National Symbols; and
  - use indirect source contemporary fixtures compatible with the bridge architecture.

Application to these design recommendations to the preferred design concept lead to the design and construction of the Rideau Canal Pedestrian Bridge as depicted by the seasonal photographs of the actual bridge in the ensuing figures.

As can be seen by these pictures, and as confirmed by the aforementioned public accolades, the Rideau Canal Pedestrian Bridge is a major success. It has met or exceeded its initial social and economic objectives as follows:

- successfully links employment and residential communities;
- provides improved community access to the City's rapid transit system;
- links the University of Ottawa to additional housing and to retail amenities;
- provides continuity of the City's east-west pedestrian and bicycle network;
- has barrier-free integration with the recreation located pathways located on both sides of the Canal;
- completes an attractive and manageable walking route for tourists staying in the downtown area;
- meets the navigable waterway clearance requirements; and
- daily use is in the range of 1500 to 3000 persons.

In addition, the design objectives were met as follows:

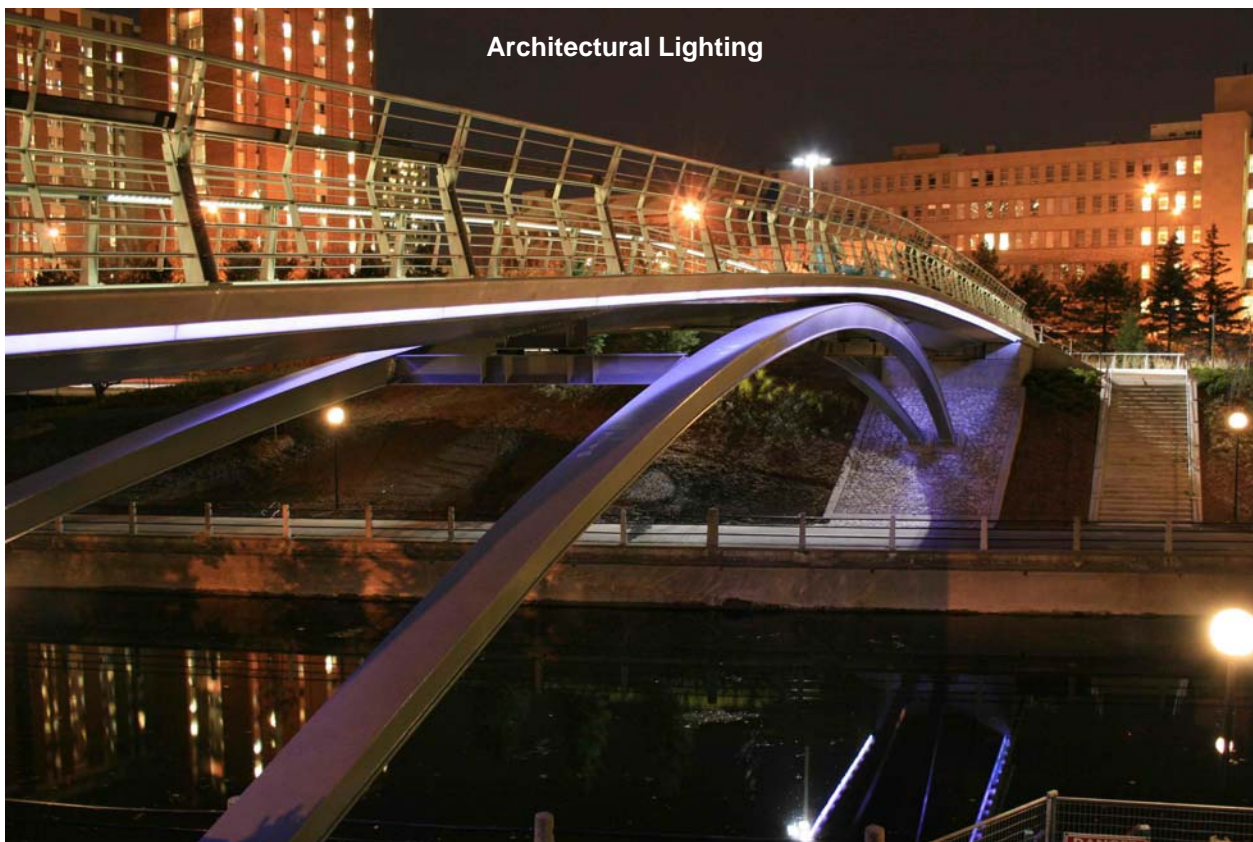
- the bridge is elegant, light and visually unobstructive;
- it enhances critical views and vistas;
- its lighting is complementary to the local context, subtly highlights the structure's key elements and does not upstage views to National Symbols in the area;
- it is expressive of the structural technology of its time yet sensitive to the local context; and
- the landscaping at the abutments and approaches looks natural to its setting and successfully integrates the bridge structure with its local cultural environment.



**Fall Boating**



**Winter Skating**



## DESIGN INNOVATION

As with the majority of high profile transportation infrastructure projects, the technical complexities in the planning, design and construction of the project are not usually obvious when viewing the final product. For the Rideau Canal Pedestrian Bridge this is certainly true with regard to the bridge's substructure design, and with regard to a major watermain replacement across the Canal within the bridge crossing corridor. The following is a brief summary of the more technical aspects of these components of the overall project.

**Innovative Substructure Design** – The preferred bridge included a pair of very light and shallow steel arches. The elegance of these thin steel arches was one of the main reasons this concept was selected. The arching principle permits these steel members to act almost solely in compression and not be subjected to large bending moments like beams. This principle is what permits the slenderness of these arches, but it is very dependent on the stability of the end supports and their capability of resisting both the vertical and horizontal components of the arch thrust. This was a significant problem at this site, as existing soils at both ends of the bridge were comprised of very weak clays not suitable for resisting the thrust from the arches. These loads, therefore, needed to be resisted through battered piles, oversized heavy abutments, and a series of post-tensioned rock anchors angled precisely. An added complication was the presence of both a large interceptor sewer and several high voltage hydro cables, which were in direct conflict with the west abutment. To resolve these conflicts, the abutment footing was lengthened to ensure that the battered piles would avoid the sewer, and the high voltage cables were supported and protected throughout the construction and then incorporated through the wingwalls of the abutment.

Equilibrium of forces and the overall stability of the abutments were not only critical once the bridge was completed, but also throughout the entire construction process as weight was added to the arches and the associated thrust increases. A detailed construction procedure was developed to ensure the stability of the abutments throughout construction. This procedure included staged construction of the abutments themselves, staged backfilling of the abutments and sequential stressing of the rock anchors.

The east abutment had its own technical challenges. Due to its low and flat nature, the east approach required the addition of a significant fill embankment with a switch back ramp to reach the required navigation clearance height for the bridge. This meant that the existing native soils would experience a significant surcharge, which in turn would increase the lateral earth pressures being applied to the historic Rideau Canal walls. Since construction information for this section of the historic retaining walls could not be found and their existing condition was fair, it was decided that deep permanent sheet piling would be designed and installed between the embankment and the Rideau Canal to essentially resist the new lateral earth pressures and prevent them from affecting the canal walls.

The east approach had also historically been traversed by multiple railway lines going to and from the old downtown Central Rail Station. This past usage had left the soils contaminated, which posed a high corrosion risk to any buried steel in this area. As the use of steel H-piles and steel sheet piling was critical, special sacrificial anodes were designed and attached to all buried steel in this location.

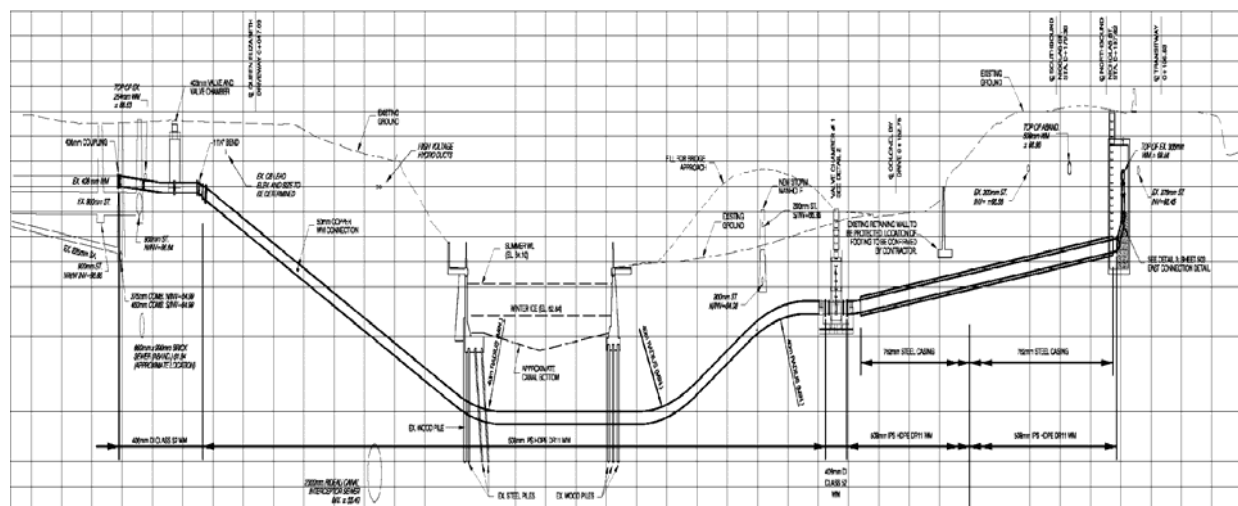
**Innovative Trenchless Watermain Replacement** – The construction of a new watermain, to replace the two existing watermains, was included as part of the contract for the Rideau Canal Pedestrian Bridge Project. The reliability of drinking water supply from the City's two Water Purification Plants, across the Rideau Canal, to the eastern part of the City was a major concern. The two existing watermains consisted of 381mm diameter unlined cast iron pipes and had been abandoned. The new watermain is a 400mm (I.D. 16" and O.D. 20") high density polyethylene pipe (HDPE).

Due to the multiple and unique physical/social/environmental issues within the project corridor, many different rehabilitation/replacement options were evaluated. Issues that required special attention included:



- Future watermain construction activities and associated disturbances in the vicinity of the Rideau Canal, the new Pedestrian Bridge and adjacent streets could be eliminated by including this component in the Pedestrian Bridge contract.
- As construction of the Pedestrian Bridge project was scheduled to start in the Spring of 2005, it was necessary to expedite approvals so that the watermain component could be incorporated with the bridge contract.
- The walls of the Rideau Canal were problematic. The east wall, constructed in 1912, is supported by three rows of timber piles, while the west wall, reconstructed in 1969, includes three rows of steel piles and one row of timber piles. Horizontal Directional Drilling was used to probe and locate the piles in both walls. Knowing pile location and spacing, the design team could then determine the watermain alignment.
- Soil stability issues associated with the steep slope on the west side of the canal, were not well suited for open cut excavation.
- The east end connection point of the new watermain also required careful consideration. The new 400mm watermain had to connect to an existing 305mm diameter located beneath Nicholas Street, which is the City's highest volume on/off ramp from the Central Area to Highway 417. Approximately 30,000 vehicles use Nicholas Street daily. Ground surface elevation differential between the east side of the Rideau Canal and Nicholas Street's critical traffic carrying function were determining factors in the selection of the trenchless replacement technology.

Following review of these issues and evaluation of many technologies, the preferred solution to implement the replacement water main within the Pedestrian Bridge corridor was a combination of two trenchless methods: i) Horizontal Directional Drilling; and ii) Jacking and Boring. This successful approach mitigated adverse traffic impact and social disruption, while minimizing construction and social costs. Public/community support for combining the construction schedules for the projects was received during the EA consultation undertaken for the watermain project.



## PROJECT RECOGNITION

In addition to the documented public support for the Rideau Canal Pedestrian Bridge, and the Transportation Association of Canada's approval of this paper's presentation at its October 2007 Annual Conference, the following is also noteworthy:

- the Rideau Canal Pedestrian Crossing was selected to be presented at the 2002 World Canal Conference in Montréal, Quebec.
- the Rideau Canal Pedestrian Crossing Project, and its Planning and Environmental Assessment Report, was the *Recipient of the Canadian Institute of Planners Award of Planning Excellence*, 2003.

## SUMMARY

As summarized herein, the planning of the Rideau Canal Pedestrian Bridge was time consuming and thorough, the evaluation of the alternative design concepts and the selection and refinement of the preferred concept was rigorous, and the design of the preferred concept was complex. The end product is a simple and elegant bridge structure, the success of which can be measured by its daily use, its effortless integration into its local context, and the accolades it has received from its users and admirers.

As well, the multiple linkage functions it performs between the residential neighbourhoods, employment centres, transit facilities, institutions, amenities and recreational facilities located on either side of the Canal attest to its significant economic and social benefits.

Now that the bridge is built, functioning as envisioned, and delighting those that use it, all it requires is a name.