# WALTERDALE BRIDGE

CANADIAN CONSULTING ENGINEERING AWARDS

ISL Engineering and Land Services

DIALOG

# The new Walterdale Bridge offers Edmonton a striking new entrance into the downtown and river valley.

The new bridge is a gracious, single span arch–a functional, signature structure that blends with its natural setting and creates a landmark gateway to Downtown.

Walterdale Bridge creates a public space on the river, where the duality of the city and nature are experienced and celebrated at a pivotal location. The approaches to the bridge on the north and south banks not only satisfy mobility requirements but also reinforce the signature quality of the bridge through evocative land form and planting. Pedestrians and cyclists feel closer than ever to the river when using the new bridge. There are places on the bridge to linger and watch the river go by.

This seamless integration between engineering, architecture and the public realm is considered at all levels of scale, from the overall global level of the structure and roads down to the pedestrian domain.

The consultant teams and their scopes:
ISL Engineering and Land Services Ltd. (Prime Consultant, Project Management, Roadway Design), DIALOG (Bridge Design team leader, Architectural, Landscape Architecture and Electrical Design), COWI North America Ltd. (Bridge Design Sub-consultant), Al-Terra Engineering Ltd. (Roadway Design Sub-Consultant), Thurber Engineering Ltd. (Geotechnical and Materials Testing), Spencer Environmental Services (Environmental Assessment and Permitting), Turtle Island Cultural Resource Management (Historical Resources Impact Assessment and Aboriginal Consultation), Northwest Hydraulic Consultants Ltd. (Hydrotechnical Evaluation), HLB Lighting Design (Lighting Design), Acuren (Structural Steel Inspection and Testing), SMA Consulting Ltd. (Risk and Value Analysis).

## Project Summary

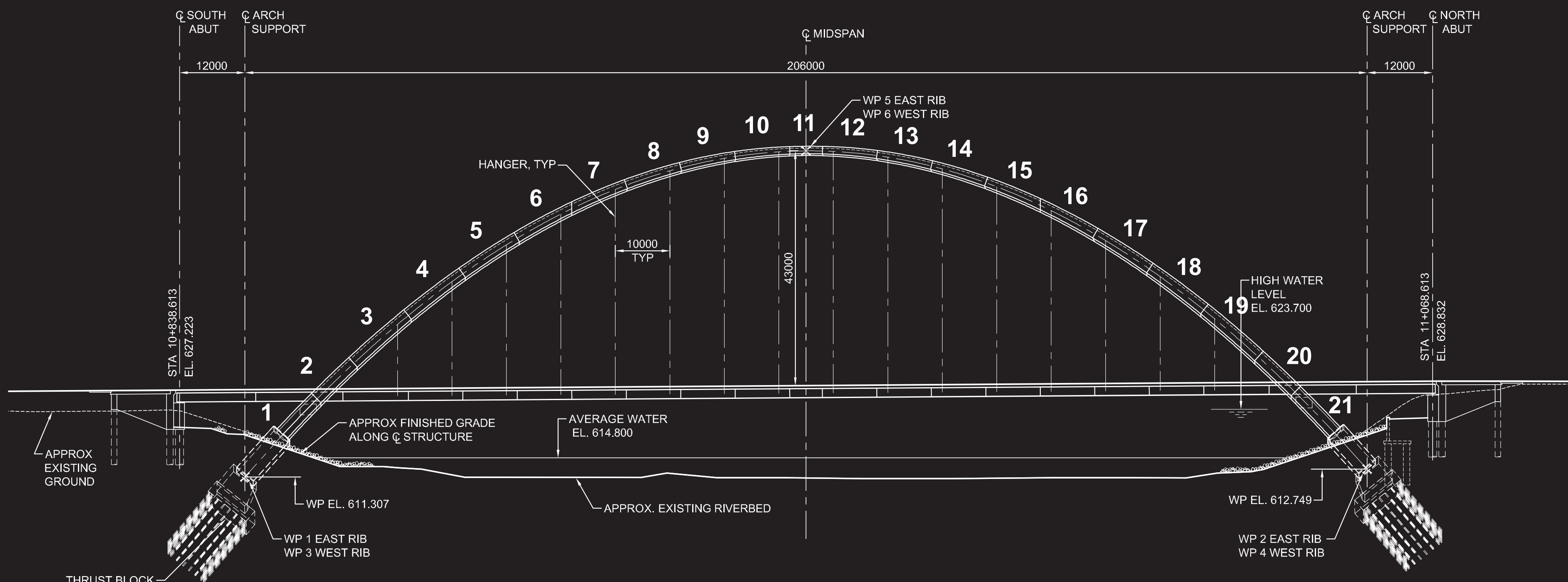
The Walterdale Bridge Replacement project involved the construction of a new bridge over the North Saskatchewan River. The bridge is a twin through-arch steel structure, spanning 206 m (greater than the length of two football fields) from bank to bank. It carries three lanes of northbound vehicle traffic, a sidewalk to the west of the roadway and a separated footbridge (shared use path) for pedestrians and cyclists to the east. The project also included the realignment of sections of Queen Elizabeth Park Road and Walterdale Hill Road to connect to the new river bridge alignment. The congruence of the city's growing skyline and nearby greenspace inevitably creates seamless integration of shared use paths, land forms, plantings and public spaces.

## Project Management

Considered one of the most complex infrastructure projects undertaken by the City, it required a rigorous yet all-inclusive management approach to balance the desires of the stakeholders, design requirements and construction circumstances. Each 'area of knowledge' within the project management realm of expertise was implemented to ensure the project delivered value for the City of Edmonton and all users.

The approach included:

- A series of design charrettes in the initial project stages with representation from the City and the design team, and input from local contractors to develop design concepts. *(Scope Management)*
- An extensive public consultation program to obtain input from stakeholders into the design of the project. *(Communication and Stakeholder Management)*
- A comprehensive design phase to develop complete contract documents, with extensive quality reviews and checks. *(Scope, Quality and Risk Management)*
- A thorough program by a specialty archaeological consultant to ensure the important historical aspects of the site were respected through all phases of the design and construction. *(Scope, Environment and Stakeholder Management)*
- A rigorous program of monitoring the fabrication of structural steel elements overseas and construction activities on site to ascertain that the contractor delivered a product that does not just meet the requirements of the contract documents, but will also stand the test of time. *(Quality and Risk Management)*
- The selected design spans the river from bank to bank eliminating bridge piers from the river. Temporary instream works were minimized and thoroughly monitored to ensure construction duration impacts were managed. *(Environmental Management)*
- Direct, frank, reliable and regular reporting to the City on project activities, including a sophisticated secure project data Sharepoint site that ensured all project communications, quality documents, design and construction changes were accurately tracked for all parties. *(Scope, Quality, Schedule, Resources, Communication, Cost Management)*
- Prequalification and early contracts were implemented to advance time sensitive project activities *(Schedule and Procurement Management)*
- Regular project communications were issued through the project website, social media, newsletters, print and media outlets to keep the public updated on project progress *(Communication Management)*
- The overseas fabricator encountered some production issues that led to schedule challenges. Although the project took longer to complete than expected, there was no impact to the citizens of Edmonton as our team planned the new bridge location and construction staging to leave the existing bridge open to vehicular and pedestrian traffic for the duration of construction. (Risk and Stakeholder Management)
- As a result of the far-reaching construction documents and because an experienced team of project managers and resident engineers was assigned to administer the contract, the project was completed within the City's budget of $155 M. (Cost Management)



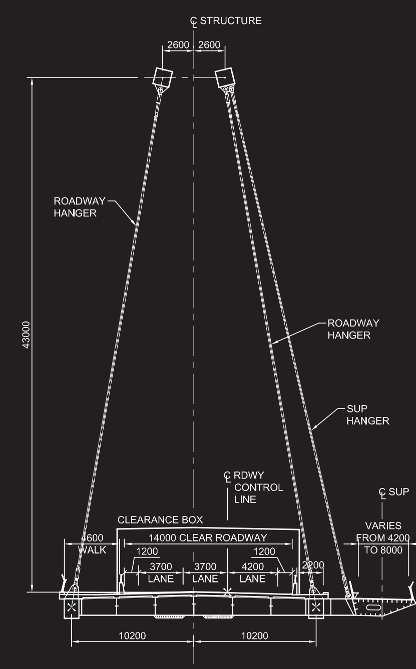

ELEVATION
LOOKING WEST 1:500

## Arch Structure

With a total length of 230 m between abutment centrelines, the bridge deck is suspended by cables from two arch ribs rising 40 m above the roadway that are fabricated from structural steel plate into box-shaped sections. The arch ribs span between thrust blocks that are founded in clay shale bedrock on the riverbanks, and vary in cross-sectional sizes from approximately 2.5 m by 2.5 m with 100 mm plate thicknesses at the base to 1.4 m by 1.4 m with 75 mm plate thicknesses at the crown. The arch ribs are connected together by struts above the roadway and by deck support beams. The deck is a concrete slab supported by structural steel wide-flange stringers, varying depth plate girder floor beams and box-shaped edge girders. The deck has an asphaltic concrete pavement wearing surface complete with a waterproof membrane adhered to the slab to protect the structure.

For the design of the arch rib members, global buckling was accounted for using the standard axial force biaxial bending interaction equation where moments are magnified to account for the increase due to P-Delta effects. In sizing the arch ribs, an allowance was made for the out-of-plane bending stresses induced in the flanges owing to member curvature.

In addition to stresses from externally applied moments, the stresses in a compression member as it approaches failure are higher than those produced by the buckling load because of “buckling” moments, moments induced by initial imperfections, and residual stresses. To justify these effects, the connections of the arch ribs to the thrust blocks and arch rib splices are designed to resist the total stresses.




A
SECTION
1:200


## Foundation

The arch ribs are founded on thrust blocks resting in clay shale bedrock. Each thrust block resists axial forces and moments by the combined action of an inclined footing with plan dimensions of 9 m by 10.5 m in bearing and 44-200 mm diameter micropile anchors embedded 18 m into the bedrock. Although described as extremely weak to very weak in rock mechanics terminology (compressive strength of intact rock is less than 5 MPa), the predicted foundation movements are small, as the clay shale was heavily overly consolidated during the Ice Age.

The thrust blocks were constructed below the water table in a braced excavation that is 18 m deep (about the same depth as a six-storey underground parking garage) with plan dimensions of approximately 16 m by 14 m. Each heavily reinforced thrust block is attached to the structural steel arch rib above grade through a cast-in-place concrete support leg, stressed to the rib with 58-65 mm diameter high-strength threaded bars.

## Shared Use Path

A generous shared use path is supported by the top flange of a 1.4 m deep trapezoidal-shaped, curved box girder fabricated from structural steel plate. The girder is supported on abutments at the north and south river banks, on Delta piers near the water’s edge, and by cable hangers from the east arch rib and floor beam extensions from the main bridge deck near mid-span. Concrete ballast is placed in the girder sections over the Delta piers and near the abutments to avoid uplift under unbalanced live loading. To enhance the journey of pedestrians and cyclists across the river, the shared use path has a clear width of 8 m at the banks and 4.2 m near mid-span. With a view to make it a citywide point of attraction, materials and finishes on the shared use path were chosen to respond to the nature and character of the valley with opportunities to sit, enjoy the river, watch Canada Day fireworks and more.

## Arch Lifts, Navigation Procedure and Shared Use Path Erection

Each arch rib is made up of 21 segments, numbered sequentially from 1 through 21 starting at the south concrete support leg. The arch ribs were assembled and lifted into their final position in two stages. For the first lift, the central sections of both arch ribs (Segments 7 through 15) were assembled on intermediate towers on the south bank of the river and connected together with struts.

The ends of these sections were joined with temporary tension ties, and supported on skids resting on rails. Once the tension ties were stressed, the intermediate towers were removed and the sections were skidded on the rails to barges in the river. Because the level of the water was low, the river bed was dredged to allow the barges to be pulled into position by cables connected to temporary anchors and to the piers of the existing bridge.

At the same time as the assembly of the central sections on the south bank, Segments 4, 5 and 6, and Segments 18, 17 and 16 were erected on temporary towers resting on berms, respectively, extending from the south and north banks into the river. With the berms in place, approximately 50 percent of the channel was open to flow.

The contractor successfully completed this operation, which required extremely careful risk control planning, as ice was starting to form on the river in the late fall of 2015.

1st lift – 990 tonnes

2nd lift – 2020 tonnes

Shared Use Path

In the first lift, the central sections of the arch ribs (Segments 7 through 15) with a weight of 9700 kN (990 tonnes) were hoisted into position using lifting towers that were supported on the edges of the berms. Once in position, the central sections were connected to Segments 4, 5 and 6, and Segments 18, 17 and 16 on the south and north berms, respectively.

After the bolted connections were made between Segments 6 and 7, and Segments 15 and 16, new lower tension ties were placed between the ends of Segments 4 and 18. The upper tension ties required for navigation and the first lift were then removed.

For the second lift, Segments 1, 2 and 3, and Segments 21, 20 and 19 were first assembled on temporary towers resting on the south and north berms, respectively. The lifting towers were repositioned to Segments 3 and 19. Segments 4 through 18 with a weight of 19800 kN (2020 tonnes) were then hoisted into position for connection to Segments 1, 2 and 3, and Segments 21, 20 and 19 resting on the concrete support legs. Finally, welded connections were completed between Segments 3 and 4, and between 18 and 19, and the lower tension tie was removed.

The shared use path was erected sequentially, starting from the abutments and moving towards the centre. The end segments were supported from temporary scaffolding on the berms, and the mid-span segments were erected from cranes on the berms in the river. All the connections between shared use path segments were welded.

## Roads

The project included the realignment of sections of Queen Elizabeth Park Road and Walterdale Hill Road to connect to the new river bridge alignment, and the narrowing of Walterdale Hill Road (three lanes to two lanes) from 109 Street northward to facilitate the construction of a separate shared use path along the north side of Walterdale Hill Road. Upgrades to the City's stormwater management system and utility relocation work were also completed.

To avoid disturbance to the historical site on the north side of the river, in the initial planning stages, the bridge replacement was to be positioned in the same location as the existing bridge. This would have required one of the main roadways to downtown Edmonton to be closed for the duration of construction. As the concept planning progressed, the roads were carefully relocated so that north abutment of the bridge replacement was positioned to allow the existing structure to remain open to traffic during construction, while at the same time respecting the historical site constraints.

Although the bridge is currently designed to carry three lanes of northbound traffic across the river, the structure is designed so that in the future, a fourth lane can be located on the west side, with a new sidewalk constructed outside the plane of the cables supporting the deck.

## River Valley Trails, Landscape and Lighting

The project sets in place river bank and valley facilities that both make the bridge a destination and provide a framework for the future development of connections and destinations. With plazas on each bank terminating the shared use path from the bridge, the project is integrated within the context of valley trails, resting places and ecologies.

With the potential for repurposing of the Rossdale Generating Station and Pump Houses, the north bank is designed for a future active mode promenade extending up and down stream. As a high point gently sloping to the buildings, the north plaza overlooks the Generating Station and leads through stairs to a pathway with a generous 9 m width that sweeps under the bridge.

On the south bank, the project scope addresses the sculpting of Dantzer's Hill for winter sledding, as a viewpoint to downtown and to provide a landing for a future pedestrian bridge over Queen Elizabeth Road.

Views to the bridge and downtown skyline are framed with broad sweeps of aspen trees. From the south plaza, stairs and trails lead to a shared use path running under the bridge. Parallel to the path, an informal trail enables wildlife movement.

All connecting paths and routes beyond the plazas are accessible with slopes less than 5%.

At the abutments the grade change from the bridge to the riverbank is acknowledged with sweeping gabion walls and intensive plantings. Planting strategies evoke and build from the valley and aspen parkland communities. Riparian planting are inserted within the riverbank rip rap to both green the armoring and contribute to bank stabilization. Broad sweeps of shrub and tree planting set the bridge structure within the valley landscape. The gabion walls provide seating opportunities where they edge the plazas and paths.

In addition to conventional LED street lighting for motorists and pedestrian safety, aesthetic lighting is an important aspect of the new bridge design.

The arches of the bridge are illuminated by a dynamic lighting system using LED technology.

The lighting system consists of programmable fixtures along the arches connected to control cabinets located on each side of the river which are linked by a fibre optic cable. Using DMX protocol, the light fixtures can be programmed to provide white or coloured lighting of varying intensity. In addition, the arch lighting can be programmed to display kinetic lighting effects for special events during the year.

To encourage people to cross the river using non-motorized modes of transportation, LED lighting is mounted inside the handrails along the shared-used footbridge to the east of the bridge. This lighting is designed to provide a safe, dynamic environment for pedestrians and cyclists to cross, congregate and enjoy the river valley.

“This bridge clearly demonstrates that this city is not afraid to build the kind of iconic infrastructure and architecture typical in the world’s finest cities.”
-Don Iveson, Mayor of Edmonton

**5500 tonnes**
STRUCTURAL STEEL

**800 000 kgs**
REINFORCING STEEL

**7000 m$^3$**
CONCRETE

**950 tonnes**
FLOATED SECTION