4.0 BRIDGE CONCEPT DEVELOPMENT

4.1 INTRODUCTION

The new Walterdale Bridge will replace the existing three-span structural steel truss bridge that was constructed in 1912 to 1913 to carry two lanes of roadway traffic and a street railway across the North Saskatchewan River in Edmonton, Alberta. The existing bridge currently carries two lanes of northbound traffic, along with pedestrians and bicyclists on sidewalks on both sides, and a number of utilities across the river.

The terms of reference for the "Walterdale Bridge Replacement and Approach Roads Evaluation" indicate that the existing structure should be replaced with a functional signature bridge that will form an attractive entrance to downtown Edmonton. The replacement is to have an innovative urban design complementing the "West Rossdale Urban Design Plan", and respecting the aboriginal burial grounds on the north bank of the river.

In Phase 1 of the "Walterdale Bridge Replacement and Approach Roads Evaluation", we compared signature extradosed, arch and cable-stayed bridge replacement alternatives to a more conventional girder bridge alternative. We developed the conceptual bridge designs for the Base Road Option. The geometry and appearance of the structure will be similar for the East and West Side Road Options.

We assumed that the replacement bridge will carry three lanes of northbound traffic and possibly one lane of southbound traffic, in addition to pedestrians, bicyclists and utilities across the river.

As the study progressed in Phase 2, a through-arch bridge was selected as the preferred alternative. This alternative will carry three lanes of northbound traffic on the alignment of the approved roadway option, which is located to the east of the existing bridge.

4.2 EXISTING BRIDGE

The existing Walterdale Bridge has three curved-chord Pratt truss spans that are supported on an abutment at the south bank of the river, two piers in the river and an abutment at the north bank. The spacing from the centreline of the bearings at each abutment to the centreline of the adjacent pier, and the spacing between the centrelines of the piers, is 71.3 m resulting in a total bridge length of 214 m from bank to bank. The 7.24 m wide roadway is located between and travels through the trusses that are spaced at 8.23 m apart. The trusses are built up from structural steel plates, angles and lattice elements that are fastened together with rivets.

The deck consists of steel grating that is supported by wide flange structural steel transverse stringers resting on wide flange longitudinal stringers. The longitudinal stringers span to built-up structural steel floor beams that are supported at the truss panel points.

Timber plank sidewalks and utilities on the east and west sides of the bridge are supported from structural steel brackets that cantilever out 2.63 m from the centerline of the trusses.

The river piers and abutments are constructed from concrete. The piers have been jacketed with a layer of reinforced concrete in the past, and the south side of the north abutment has been faced with reinforced concrete. The river piers and abutments are founded on concrete footings.

In 2000 BPTEC Engineering Group Ltd. carried out a condition assessment of the existing bridge. Although the bridge was found to be in reasonable condition given its age, the following observations were made:

- The bridge deck grating had extensive wear and loss of section in the wheel paths of vehicles using the bridge. There was loss of connectivity between the grating and the supporting stringers.
- The transverse stringers had areas of extensive corrosion on the top surfaces of both the top and bottom flanges.
- There was extensive corrosion on the top flanges of the longitudinal stringers and pack rust between the flanges where the transverse stringers rest on the longitudinal stringers.
- The top flanges of the floor beams were extensively corroded.
- The trusses were in variable condition. The members exhibited extensive corrosion below the roadway level, but were in good condition above.
- The fixed bearings at the north end of each span were functioning, but the roller bearings at the south ends were no longer functioning as intended.
- The concrete piers and abutments were showing signs of their age, but were functioning well.
- Paint on the portions of the structural steel trusses above the splash line was in relatively good condition, but the top coat was reaching the end of its life. The paint on the trusses below the splash line and the structural steel floor system was in poor condition. The paint contains lead and zinc, both hazardous materials.
- The bridge is used to carry a number of utilities across the river, including water and gas pipelines, electrical, telecommunications and cables services. The total weight of the utilities is approximately 21 % of the total dead load.
- A number of the members of the bridge deck floor system had reached or exceeded their safe fatigue life. A number of bridge truss members were predicted to reach their fatigue limit prior to 2050. To extend the life of the

existing bridge for vehicular traffic, extensive and expensive rehabilitation is required.

The loads on the bridge have been limited to CS1 (two axle), CS2 (three axle) and CS3 (four axle) trucks with masses of 24 tonnes, 40 tonnes and 54 tonnes, respectively. These trucks are consistent with the CS 530 design loading (truck mass 54 tonnes). Edmonton Transit low floor buses that cross the bridge on a regular basis have a mass of 18 tonnes in a configuration that is consistent with the CS1 loading.

In their 2000 report, BPTEC Engineering Group Ltd. found the transverse stringers, longitudinal stringers and floor beams to be adequate for the CS 530 loading. Certain top chord truss members were found to be overloaded by 8 % under this loading.

The existing bridge does not have adequate structural capacity to carry legal truck loads in Alberta. The masses of legal CS1, CS2 and CS3 trucks are 28 tonnes, 49 tonnes, and 63 tonnes, respectively. As indicated in Section 4.5, new bridges in Alberta are designed for trucks with a mass of 81.5 tonnes.

A report prepared by Hydroconsult EN3 Services Ltd. indicates that there is a high risk of the footings of the bridge piers in the river being undermined by scour in the event of severe flood conditions.

In 2004 a repair program was undertaken to extend the life of the existing bridge for 10 years, allowing the structure to provide safe and relatively maintenance free service for that period. This approach allowed the bridge to “deteriorate” through the ten year period, such that replacement after ten years would be necessary. Work performed during the repair program included replacing the existing steel deck grating, replacing several transverse stringers, repainting the bottom chord truss members, replacing loose and worn deck joint components, repairing bearings, and repairing portions of the abutments.

As part of the bridge replacement evaluation, the project team has been asked to determine whether it is practical to rehabilitate the existing bridge in its current location or move it to a new location. From consideration of the costs of the recent rehabilitations of the Low Level Northbound and Dawson Bridges in Edmonton, the initial construction cost to extend the life of the existing Walterdale Bridge for an additional 50 year period will be in the range of \$8 M to \$20 M. A cost approaching the higher number will be required if the bridge continues to carry vehicular traffic, whereas the lower number may be appropriate if the bridge is used to carry pedestrian and bicyclist traffic alone.

If the bridge is rehabilitated and it remains in service, relatively high life cycle costs on a per square metre deck area basis will be required for the maintenance of the existing bridge when compared to the costs for a modern structure. Under the assumption that the bridge remains in service for an additional 50 years, we anticipate annual maintenance costs of \$25,000 for inspections and minor repairs, minor rehabilitations at years 15 and 40 with costs of \$150,000 to touch up paint and replace wood decking for

the sidewalks, and a major rehabilitation at 25 years with a cost of $10 M to repair corroded members, paint trusses, replace wood decking for the sidewalks, and repair pier and abutment concrete.

If the existing bridge is rehabilitated for use as a pedestrian facility in its current location, as a minimum the following repairs and enhancements will be required:

- Place rock rip-rap or use other means to reduce the potential for scour at the footings for the piers. This in-stream work will require environmental and Department of Fisheries and Oceans approvals.
- Rehabilitate the concrete abutments and piers by patching and jacketing with new reinforced concrete sections.
- Install new bearings.
- Repair, strengthen, or replace corroded structural steel members.
- Repair or replace damaged structural steel deck support members.
- Repaint the structural steel superstructure.
- Install a new pedestrian friendly deck.
- Install new pedestrian railings.
- Provide enhanced connections to the multi-use trails. Please note that it will be difficult to construct a pedestrian trail under the existing bridge at the north bank.
- Provide enhancements to attract pedestrians and cyclists onto the bridge.

The existing bridge, if left in place as a pedestrian facility, will detract from the appearance of the proposed signature bridge replacement. Also, views from the bridge replacement to the river valley will be impaired by the existing structure.

There may be ways to keep a portion of the existing bridge in its current location as a facility to help draw people to the river valley. For example, if the south span of the existing bridge remains in place, it could be used as an 8.2 m wide pier that extends slightly more than 70 m into the river. The pier could be used for many things, including providing a place for people to enjoy the views from the river valley at all times during the year and athletes from Kinsmen to exercise over the water in the summer months. The initial construction cost for modifying the south span to become a destination pier will be in the range of $2 to 3 M.

If the bridge is moved for reuse at another location, it will be necessary to disassemble the superstructure and reassemble it piece by piece. The cost of moving and reassembling the existing bridge at a new location would likely exceed the cost of constructing a new bridge.

It may be possible to respect history by incorporating parts of the existing bridge into the design of the multi-use trail system and promenades in the vicinity of the bridge replacement, or adjacent park pavilions.

4.3 BRIDGE EVALUATION CRITERIA

Standing the test of time, a signature bridge will become a point of pride for the citizens of Edmonton and will draw people to the river valley. In evaluating the bridge replacement alternatives, the Project Team has made reference to the following selection criteria:

- **User Experience**. Motorists should have a positive impression of the North Saskatchewan River valley and the entrance to downtown Edmonton when travelling across the bridge.

  Pedestrians and bicyclists using the trails adjacent to and under the bridge should feel that it complements the river valley trail system, and should not be intimidated by the impersonal nature of a massive structure. Pedestrians and cyclists should feel safe when using the trail system or travelling across the bridge.

  As Edmonton matures, there is the desire for people to enjoy the valley by travelling up and down the river in boats, canoes, rafts and other vessels. People should have a positive experience when approaching and travelling under the bridge on the water.

- **Views**. When viewed within the context of the river valley, the bridge should relate to the natural environment, the repurposed EPCOR site and future development on the north bank, and the Kinsmen Sports Centre on the neighbouring south bank. The bridge should complement the views of the Legislature Building, the High Level Bridge and other buildings on the tops of the banks.

  When crossing the bridge at a leisurely pace, pedestrians and bicyclists should have the opportunity to enjoy the views from the river valley and touch the water.

- **Pedestrian and Bicyclist Movement**. There should be easy access for pedestrians and cyclists to cross the river on the replacement structure.

- **Visual Lightness**. Most people find bridges to be more attractive when the decks do not obstruct views and have a light appearance.

- **Towers and Piers**. Many of the signature bridges throughout the world have towers that become design features. Depending on the alternative considered, there is the opportunity to incorporate the towers into the design of the bridge replacement.

  To reduce the potential for disturbance to the environment, it may be desirable to construct the new bridge without towers or piers within the river.

- **Utilities**. If the utilities on the existing bridge must be carried across the river, there is no doubt that they will detract from the appearance of the new structure. The replacement alternative selected should accommodate utilities without a negative impact on appearance when the bridge is viewed from the sides or below.

4.4 DOWNTOWN AND PARKS PLANS

Exhibit 4.1 shows proposed initiatives for the river valley promenades and facilities near the Walterdale Bridge replacement. The urban design and architecture of the bridge will address the common goals and objectives identified in "Edmonton - Alberta's Capital City Integrated Planning and Design Initiative" that seeks to coordinate and integrate projects in the vicinity of the Alberta Legislature Centre, West Rossdale, Downtown and the North Saskatchewan River. The bridge should enhance parks and open spaces within the river valley by connecting the north and south banks through the multi-use trail system.

4.5 STRUCTURAL DESIGN CRITERIA

The Walterdale Bridge replacement will be designed in accordance with the requirements of the CAN/CSA-S6-06 Canadian Highway Bridge Design Code, Supplement No. 1 to the Code, and the standards referenced in the Code for the CL-800 truck loading shown in **Exhibit 4.2**.

The bridge will also be designed to carry the overload vehicles shown in **Exhibit 4.2**, using the provisions of Section 14 - Evaluation of the Code. In considering overloads, we will assume that a single vehicle travels across the bridge in the central area of the roadway width under controlled conditions.

4.6 HYDROTECHNICAL CONSIDERATIONS

Northwest Hydraulic Consultants has completed a preliminary hydrotechnical assessment for the site.

They indicate that the geodetic elevation of the high water level for the flood with a 100 year return period is 623.1 m and the corresponding discharge is 5270 m^3/s. The highest recorded water level occurred in the 1915 flood, when the surface geodetic elevation and discharge were 623.7 m and 5800 m^3/s, respectively.

The new bridge will be designed with a minimum freeboard of 1.0 m above the historic high water level, so that the soffit is at or above geodetic elevation 624.7 m.

Multi-use trails for pedestrians and cyclists will be constructed under the deck of the replacement bridge on the north and south river banks. Depending on roadway geometry and the depth of the superstructure required for the various bridge alternatives, it may not be possible to have the elevation of the trails above the historic high water level. Northwest Hydraulic Consultants indicate that the geodetic elevations

of the high water levels for floods with 2, 5, 10, 20 and 50 year return periods, respectively, will be 616.9 m, 618.5 m, 619.6 m, 621.0 m and 622.2 m.

For comparison purposes, the geodetic elevation of the highest point of the multi-use trail on the south bank of the river under the existing Walterdale Bridge is 621.2 m, consistent with a 23 year flood return period.

Northwest Hydraulic Consultants recommend that bridge piers and towers in the water be designed for forces at spring break-up from ice with a thickness of 0.8 m and an effective crushing strength of 700 kPa. This is consistent with Clause 3.12.2.1(b) of the Canadian Highway Bridge Design Code for ice that breaks up at melting temperature and is somewhat disintegrated. The centre of gravity of the ice is assumed to be at a geodetic elevation of 615.5 m, which corresponds to the water level at geodetic elevation 615.9 for the break-up flow with a 100 year return period.

4.7 Geotechnical Considerations

Thurber Engineering Ltd. prepared a report titled "New Walterdale Bridge and Approach Alignments, Preliminary Geotechnical Evaluation" dated September 8, 2008 as part of a previous study.

This report indicates that the North Saskatchewan River Valley is 55 m to 60 m deep at the crossing locations, extending from geodetic elevation 671 m at the top of the south bank and elevation 666 m at the top of the north bank to elevation 613 m at the river.

The stratigraphy in the south uplands consists of layers of fill, clay, sand and clay till overlying clay shale at depths of about 10 m. The south slope material is made up of clay, sand and gravel overlying bedrock. There is evidence of ancient landside activities on the south slope.

The river channel at locations proposed for the crossing is expected to be underlain by a thin layer of gravel with a maximum thickness of about 3 m to 4 m, overlying bedrock. The top of competent bedrock is estimated to fall between elevation 605 m and 608 m.

A low level terrace is situated along the north side of the river. The terrace is expected to be underlain by clay overlying compact silt, sand and very dense gravel and bedrock close to the river level.

The north slope is expected to consist of clay, clay till and sand deposits. The north uplands are expected to consist of clay overlying clay till and bedrock.

Conventional bridges crossing the North Saskatchewan River in the Edmonton area have generally been founded on pier footings cast on competent bedrock. Abutments have been founded on steel piles driven to refusal through the sands and gravels often to bedrock or cast-in-place concrete belled piles founded on bedrock.

As part of the current evaluation, Thurber Engineering Ltd. prepared Technical Memorandum No. 2 titled "Walterdale Bridge Replacement, Arch Bridge Alternative, Preliminary Geotechnical Input" dated February 10, 2011, and Technical Memorandum No. 3 titled "Walterdale Bridge Replacement, Arch Bridge Alternative, Preliminary Geotechnical Input for Pile Foundations" dated February 16, 2011. These memoranda focus on providing recommendations for the design of the abutments of the arch bridge alternative at the river banks.

Memorandum No. 2 indicates that the arch abutments can be founded at an approximate elevation of 612 m on competent bedrock below the upper weathered and fractured zone that has a thickness of 2 to 3 m below the upper surface of bedrock. Depending on the compressive strength and degree of fracture, the ultimate bearing capacity of spread footings founded on competent Edmonton Formation bedrock could vary between 1200 and 2000 kPa. These ultimate values must be multiplied by a geotechnical resistance factor of 0.5 to obtain the factored ultimate limit state design capacity for bearing.

Memorandum No. 3 indicates that the arch abutments can be supported on straight shaft or belled, cast-in-place concrete, piles socketed a minimum of 3 m into competent bedrock below the upper weathered zone. The piles may be designed based on a combination of shaft frictional and end bearing resistances. The ultimate shaft frictional resistance and ultimate end bearing resistance for drilled concrete piles are 150 kPa and 3000 kPa, respectively. These ultimate values must be multiplied by geotechnical resistance factors of 0.4 or 0.3, respectively, to obtain the factored ultimate limit states design capacities in compression or tension. Dynamic or static pile testing can increase the compressive resistance factor to 0.5 or 0.6, respectively.

To account for weathering and fracturing, the ultimate skin friction for drilled concrete piles should be reduced to 50 kPa in the upper 2 m of bedrock. The centre to centre spacing of straight shaft piles should not be less than three pile diameters. For belled piles, the bell to shaft diameter ratio should not exceed 3:1, the pile depth should not be less than three times the bell diameter and the clear spacing between adjacent bells shall not be less than 0.5 times the bell diameter.

The arch abutments can also be supported on driven steel H-piles or open-ended pipe piles. Steel piles driven to practical refusal in the bedrock may be designed for a combination of ultimate shaft resistance and ultimate end bearing resistance of 150 kPa and 10000 kPa, respectively. These ultimate values must be multiplied by geotechnical resistance factors of 0.4 or 0.3, respectively, to obtain the factored ultimate limit states design capacities in compression or tension. Dynamic or static pile testing can increase the compressive resistance factor to 0.5 or 0.6, respectively. The ultimate skin friction for steel piles should be reduced to 50 kPa in the upper 2 m of bedrock.

The factored ultimate limit states pile capacity should be limited to the smaller of the compressive stress of 110 MPa times the cross sectional area of steel and the structural capacity of the pile section. The centre-to-centre spacing between piles should not be less than three pile diameters.

4.8 EXISTING PEDESTRIAN AND BICYCLE CIRCULATION

Exhibits 4.3 and **4.4**, respectively, show the pedestrian and bicycle network, and existing views and destinations for pedestrians in the vicinity of the Walterdale Bridge replacement.

There are multi-use trails for pedestrians and bicyclists on the south and north banks of the river. The trail that runs along the river on the south bank passes underneath the existing Walterdale Bridge. On the north bank, the trail that runs along the river detours from the river bank and crosses 105 Street at grade where Rossdale Road changes to River Valley Road.

Pedestrians and bicyclists can cross the river on narrow sidewalks on both sides of the existing bridge. Currently, there are no convenient connections between the multi-use trails that run along the river and the sidewalks on the existing bridge.

The Study team should design the bridge replacement so that it is convenient for pedestrians and bicyclists to cross the river, visit Kinsmen Sports Centre, and connect to the pedestrian network within West Rossdale and top-of-the-bank neighbourhoods. There should be lookouts or similar features on the bridge that will allow pedestrians and bicyclists to stop and enjoy the views of the valley as they cross the river.

The new bridge will be designed with the necessary clearance to allow the multi-use trail on the north side to pass underneath the structure.

4.9 ROADWAY GEOMETRY AND RELATED ISSUES

As indicated above, in Phase 1 of the study we prepared the conceptual designs for the Base Road Option plan and profile geometry. This option has a total width of 22.6 m along most of its length to accommodate three lanes of northbound traffic, a conventional sidewalk on the east side, and a multi-use trail on the west side. The deck flares out to 29.7 m wide at the north end to accommodate new lanes leading up to the River Valley Road intersection.

The City of Edmonton is interested in evaluating the pros and cons of including a southbound lane with access to Kinsmen Sports Centre on the replacement bridge. This evaluation is discussed further in Section 3.5. We included the additional width for the southbound lane when considering the bridge placement and assessing construction costs.

The bridge length on the base alignment will be approximately 240 m.

The other road options are similar to the Base Road Option from the bridge alternative perspective, with variations in horizontal and vertical alignment geometry. The East and West Side Road Options will have bridge lengths of approximately 290 m and 220 m, respectively.

The replacement bridge will be on a skew for the Base and East Side Road Options. The skew of a bridge refers to the angle between the roadway and the river being crossed. A zero-skew bridge crosses the river at a right (90 degree) angle, and is the simplest to design and construct. Depending on the roadway option, the skew of the bridge replacement may be up to thirty degrees.

River piers must be aligned with the direction of water flow to minimize ice forces and reduce hydraulic effects such as scour. Bridge alternatives that have piers in the river and are aligned on an angle other than 90 degrees to the river are therefore designed "on a skew", which introduces design and construction challenges. The bridge structures that can cross the river without in-stream piers work better in skew situations, since abutments can be rotated to be square to the bridge instead of the river.

In Phase 2 of the study, we assumed that the bridge replacement will be constructed on the alignment of the approved roadway option, which is located east of the existing bridge and on a 15 degree skew to the river. The bridge will carry three lanes of north-bound vehicular traffic across the river, and will have a sidewalk on the west side and a wider multi-use trail for pedestrians and bicyclists on the east side. The bridge will have a length of 240 m and a total width of 26.5 m.

The Team is currently undecided as to whether the multi-use trail should be placed on the west side of the bridge (as was done for Phase 1 of the Study) or on the east side (as was done for Phase 2). The west side favours urban views upstream from the bridge replacement, whereas the east side favours downstream pastoral views. We recommend that the decision as to which side is best should be made early in the detailed design phase when more information concerning multi-use trail connections and the design of the bridge is available.

4.10 BRIDGE ALTERNATIVES

4.10.1 General

There are a variety of types of bridges that have been constructed throughout the world to carry vehicles, pedestrians and bicyclists across rivers. If designed with sensitivity to the surroundings, it is our opinion that either a girder, extradosed, arch or cable stayed alternative has the potential to become a signature bridge at the Walterdale site. As part of the planning study, we have collected precedent photographs from around the world that illustrate the characteristics of signature bridges.

4.10.2 Girder Precedents

Exhibit 4.5 shows girder bridge precedents from Germany, Scotland and the USA. These bridges carry loads by the bending and shear of girders spanning parallel to the direction of travel of traffic between the abutments and piers. Girder bridges are used extensively throughout the province. Examples in the Edmonton river valley include the Anthony Henday Drive, Quesnell, Groat, James MacDonald, Capilano, Beverly and Clover Bar bridges. Conventional, constant depth structural steel plate or precast

concrete NU girder bridges with spans of up to about 70 m are economical to build in the Edmonton market place.

Haunched girders that have greater depths over the piers and shallower depths at mid-spans to match the bending moments that the members must resist are more attractive than girders with a constant depth along the span length. Trapezoidal box-shaped girders in cross section have a cleaner and more appealing appearance than I-shaped girders. Lighting at night further enhances the appearance of the bridges.

4.10.3 Extradosed Precedents

Exhibit 4.6 shows two recently constructed extradosed bridges from Vancouver and another from Slovenia. Extradosed bridges generally have prestressed concrete girders that span parallel to the direction of travel of traffic. The prestressing cables that are positioned near the bottoms of the members at mid-span run outside and are deviated by short towers located above the piers. The bending members in extradosed bridges can be shallower than those in conventional girder bridges, and often have a solid rectangular or box shaped cross section. These bridges have an appearance that is similar to a cable stayed structure, but the towers are not as high.

4.10.4 Arch Precedents

Exhibit 4.7 shows arch bridge precedents in Brazil, Spain and Slovakia. Arch bridges generally have a curved or parabolic shape when viewed in elevation, carrying the bridge deck from hangers. The arches act in compression for balanced vertical loads, but have shear and bending moments for unbalanced loads. Large horizontal thrust reactions must be resisted at the ends of the arches by using the deck structure as a tension tie or by embedment into the earth. The appearance of an arch bridge would respect the heritage of the existing Walterdale Bridge with its curved truss top chord members.

4.10.5 Cable Stayed Precedents

Cable stayed bridge precedents in Spain, Taiwan and Holland are illustrated in **Exhibit 4.8**. In this type of structure, deck loads are transferred by inclined cables to towers that in turn carry loads to the foundation. The horizontal reactions at the connections to the towers from the forestay cables that support the main span deck are generally balanced by the horizontal reactions from backstay cables that either carry a portion of the side span deck or are anchored into the foundation. If the backstay cables carry the deck, the horizontal reactions from the forestay cables at the deck connections are transferred through the deck to balance the horizontal reactions from the backstay cables. If the backstay cables are anchored into the foundation, the horizontal reactions in the deck from the forestay cables must be taken out by a separate connection to the foundation. The decks of cable stayed bridges are relatively slender when viewed in elevation.

Cable stayed bridges have been constructed in most major communities throughout the world, and if designed properly become a point of pride for the citizens. Often the towers

of these bridges, which are relatively high, become design features. **Exhibit 4.8** illustrates the dramatic appearance of the bridge in Holland when lit up at night.

4.10.6 Pedestrian and Bicyclist Precedents

As indicated above, pedestrians and bicyclists will be accommodated along with vehicular traffic on the new bridge. **Exhibit 4.9** illustrates bridges in France, Italy and the USA that successfully accommodate pedestrians and cyclists, allowing them to enjoy the surroundings when crossing.

It is desirable for pedestrians and bicyclists to feel like they are separated from vehicular traffic when crossing bridges. Also, if practical sidewalks should be wide enough so that pedestrians and bicyclists do not have to compete with each other for space when crossing the river.

4.10.7 Design Detail Precedents

Exhibit 4.10 shows detail precedents that should be considered as the Walterdale bridge project moves through conceptual to detailed design. The precedents illustrate such things as the potential for pedestrian outlooks, provision for pedestrian seating, how the structure of the bridge might be expressed as an architectural feature, the potential for incorporating the bridge into the river valley promenade, and so forth.

4.11 GIRDER ALTERNATIVE

4.11.1 Structural System

Exhibits 4.11A, 4.11B and 4.11C show the girder alternative. For this alternative, we propose to use structural steel, reinforced concrete or precast concrete box girders to carry loads in the longitudinal direction. The girders will be supported on conventional reinforced concrete abutments and piers that transfer loads into the foundations.

4.11.2 Girder Types

The girders for this alternative will be haunched when viewed in side elevation. For structural steel, the webs and lower flanges of the girders will be fabricated in the shop and installed by launching from the shore or by field erecting in sections from berms. A reinforced concrete deck slab will be cast on top of the girders to complete the boxes, and act compositely with the structural steel to resist loads in flexure.

If concrete is used, variable depth box girders will likely be constructed from cast-in-place or precast concrete segments by the balanced cantilever method. In this method the concrete boxes are cast sequentially or the precast segments are erected starting from the piers and working towards mid-span. The cantilevers on either side of each pier are balanced during erection to reduce the moments in the piers.

4.11.3 Spans

A three-span girder bridge will balance economy with aesthetics at this site. A bridge with three spans requires two piers in the water that will have less impact on the river when compared to a four-span or five-span structure. An odd number of spans is generally considered to be more aesthetically pleasing, and will allow pier placement away from the middle of the river.

A span arrangement of approximately 70 m – 100 m – 70 m will give the best balance between aesthetics, pier placement, and structural efficiency.

4.11.4 Design and Construction Considerations

A girder bridge will have the greatest structural depth when compared to the other structural alternatives. The structural depth will dictate the roadway height, since the soffit of the girder must clear the design high water mark plus a 1.0 m freeboard.

A box girder bridge can be constructed with the girder lines diverging on a curve near the bridge ends to accommodate the flared geometry that may be required there. Torsion induced into the curved girders will need to be considered. The girder box shape is efficient at resisting torsion.

A girder bridge with a significant skew needs more design consideration and will be more expensive to construct.

A girder bridge will require piers in the water, which will have an impact on the river during construction and over the life of the structure.

Girder bridges are a commonly used structural system in Alberta. Variable-depth girder bridges are less common than constant-depth girders, but contractors will be comfortable bidding on and constructing this type of bridge.

The bridge will carry utilities across the river. The utilities can be placed between girder lines so that they are hidden except when viewed from directly below the bridge.

4.12 EXTRADOSED ALTERNATIVE

4.12.1 Structural System

Exhibits 4.12A, 4.12B and 4.12C show the extradosed alternative. For this alternative, the deck will be supported on floor beams, which span transversely to the bridge centreline, and carry forces to the bridge girder/cable system. The girder/cable system will carry forces to the reinforced concrete abutments and towers, which transfer forces into the foundations.

4.12.2 Girder Types

Girders for the extradosed alternative can be fabricated from steel or concrete, and will be box-shaped in cross-section. To improve the appearance, the girders can be haunched at the piers.

Girder sections can be erected in a segmental fashion, using the cable system for temporary support.

4.12.3 Spans

A three-span extradosed bridge will balance economy with aesthetics at this site. A bridge with three spans requires two piers in the water. A symmetric cable layout was chosen for this report to show a structurally efficient form.

A span arrangement of approximately 60 m – 120 m – 60 m will give the best balance between aesthetics, pier placement, and structural efficiency.

4.12.4 Design and Construction Considerations

The extradosed bridge deck will have a shallower structural depth than the girder alternative but a greater depth than the arch and cable stayed alternatives. The structural depth will dictate the roadway height, since the soffits of the girders must clear the design high water mark plus a 1.0 m freeboard.

An extradosed bridge can be constructed with the girder lines diverging on a curve near the bridge ends to accommodate the flared geometry that may be required there. The increased width will require increased floor beam depths, which may result in a deeper girder depth. Torsion induced into the curved girders will need to be considered. The girder box shape is efficient at resisting torsion.

An extradosed bridge with a significant skew needs more design consideration and will be more expensive to construct. The towers that support the cables will be aligned with the flow of the river, which may cause them to look slightly out of alignment when viewed from the bridge deck.

An extradosed bridge will require piers in the water, which will have an impact on the river during construction and over the life of the structure.

Extradosed bridges are a relatively new structural system. Two notable extradosed bridges were built in the Vancouver area within the last few years (North Arm and Golden Ears bridges). Since the bridge is a cable/girder hybrid, contractors will be less comfortable bidding on and constructing this alternative than a girder alternative.

The bridge will carry utilities across the river. The utilities can be placed between girder lines so that they are hidden except when viewed from directly below the bridge.

4.13 ARCH ALTERNATIVE

4.13.1 Structural System

Exhibits 4.13A, 4.13B and 4.13C show the arch alternative. This alternative will use two inclined arches as the primary load-carrying members. The deck will be supported on stringers that are carried by transverse floor beams, which are in turn carried by boxed shaped girders and hanger cables suspended from the arches. The arch ribs will be "tied" by connecting the ends to the perimeter box-shaped girders, preventing the arch ends from spreading out. The arches will be supported on reinforced concrete abutments, which transfer forces into the foundations.

4.13.2 Arch Rib Types

Arch ribs can be fabricated from steel plates or pipe sections, or can be cast from reinforced concrete. Generally, above-deck arches like the proposed alternative are fabricated from steel.

Steel arch ribs can be erected in a segmental fashion, using a cable system or falsework as temporary support. They are often filled with concrete to form a composite compression member.

4.13.3 Spans

A single span arch bridge will carry pedestrians and traffic over the river without requiring piers in the river. A symmetric arch layout with vertical hanger cables was chosen for this report to show a simple, clean form.

A 240 m span was used, with a height of 40 m, giving a span to depth ratio of 6. Span to depth ratios can vary; a shallower arch will have a sleeker appearance but will be less efficient structurally.

4.13.4 Design and Construction Considerations

The arch alternative will have a slender deck section when compared to the girder and extradosed alternatives. The road profile (and not the structural depth) will dictate the roadway height in this case. The soffit of the girders and floor beams will clear the design high water mark plus a 1.0 m freeboard.

The arch alternative can be constructed with flares at the bridge ends by adjusting the placement of the arch rib ends and altering the floor beam lengths to accommodate the varying bridge width. A wider bridge will require deeper floor beams, which will dictate the deck structure depth.

An arch bridge with a significant skew can be accommodated by aligning the abutments with a perpendicular to the longitudinal axis of the bridge crossing. This will increase

the bridge length slightly, but will improve the bridge appearance, and simplify the design and construction process.

A single-span arch bridge will not require piers in the water, which will reduce the impact on the river during construction and over the life of the structure.

This bridge alternative is used around the world, but is less commonly built due to increased construction costs. The alternative will be a new structural system for most local contractors and fabricators, but good detailing and communication will streamline the construction process.

The bridge will carry utilities across the river. The utilities can be placed between girder lines so that they are hidden except when viewed from directly below the bridge.

4.14 Cable Stayed Alternative

4.14.1 Structural System

The cable stayed alternative is shown in **Exhibits 4.14A, 4.14B and 4.14C**. This alternative will use a large reinforced concrete tower on the south bank to support stay cables that carry the bridge deck. The deck will be supported on longitudinal stringers that are carried by transverse floor beams. The beams will in turn be carried by exterior girders and stay cables that are suspended from the tower. The deck superstructure will be supported on a reinforced concrete abutment at its north end and the base of the tower at the south end. The abutment and tower base will transfer forces into the foundations.

A backstay system will be used to balance the horizontal forces at the connections to the tower from the forestay cables supporting the deck. The backstays will be anchored by a separate abutment tied down using ground anchors to prevent uplift.

4.14.2 Cable Stay Tower

The reinforced concrete cable stay tower (sometimes referred to as a pylon) will be constructed using cast-in-place concrete, with either a slip-form or staged casting process.

4.14.3 Spans

A single span cable stayed bridge will carry pedestrians and traffic over the river without requiring piers in the river. An asymmetric, single-tower layout has been chosen for this report to show a simple, clean form.

A 240 m span was used, with a tower height of 120 m. A shorter tower could be used, but will be less structurally efficient.

4.14.4 Design and Construction Considerations

The cable stayed alternative will have a slender deck section when compared to the girder and extradosed alternatives. The deck will be similar to that used for an arch system. The road profile (and not the structural depth) will dictate the roadway height in this case. The soffit of the floor beams and exterior girders will clear the design high water mark plus a 1.0 m freeboard.

This alternative can be constructed with flares at the bridge ends by altering the floor beam lengths to accommodate the varying bridge width. A wider bridge will require deeper floor beams, which will dictate the deck structure depth.

A cable stayed bridge with a significant skew can be accommodated by aligning the abutment and tower with a perpendicular to the longitudinal axis of the bridge crossing. This will increase the bridge length slightly, but will improve the bridge appearance, and simplify the design and construction process.

A single-span cable stayed bridge will not require piers in the water, which will reduce the impact on the river during construction and over the life of the structure.

This bridge alternative is used around the world, but is less commonly built due to increased construction costs. This alternative will be a new structural system for some local contractors, but good detailing and communication will streamline the construction process.

The bridge will carry utilities across the river. The utilities can be placed between girder lines so that they are hidden except when viewed from directly below the bridge.

4.15 COSTS FOR BRIDGE ALTERNATIVES

4.15.1 Initial Costs

Table 4.1 tabulates preliminary cost estimates for the various bridge alternatives in 2011 dollars. The costs are for the complete construction of the bridge structures including the superstructure, towers, piers and abutments, but not including the approach fills, ramps, retaining walls or other structures required to bring the roads, pedestrians, and bicyclists to the new bridge. The costs to demolish or move the existing bridge to a new location are not included. The costs include line items for a 30 percent contingency on construction cost and a 15 percent allowance for engineering and City of Edmonton administration fees.

The estimated construction costs have been developed for competitively bid, functional signature bridge structures. The design and construction costs for the various alternatives could be 10 percent less to 40 percent more than the tabulated values. It should be appreciated that signature bridges have been constructed in other parts of world for unit costs in excess of those given in this report.

The costs in Table 4.1 were produced during the first phase of the study where the four bridge alternatives were compared. The costs include an allowance for a southbound lane to Kinsmen Sports Centre except where noted as NB only. If the southbound lane is removed from the Base Road Option, the project cost will be reduced by $14.0 M, $17.4 M, $21.8 M, and $19.4 M, respectively, for the girder, extradosed, arch and cable stayed bridge alternatives.

Table 4.1 – Phase 1 Bridge Capital Costs

BRIDGE ALTERNATIVES	BRIDGE AREA	UNIT COST	COST	30% CONTINGENCY	CONSTRUCTION COST	15% ENGINEERING AND ADMIN	PROJECT COST
	m^2	per m^2					
Girder Bridge							
Base Road	7050	$ 6,500	$ 45,800,000	$ 13,700,000	$ 59,500,000	$ 8,900,000	$ 68,400,000
Base Road - NB Only	5600	$ 6,500	$ 36,400,000	$ 10,900,000	$ 47,300,000	$ 7,100,000	$ 54,400,000
East Road Option	8700	$ 6,500	$ 56,600,000	$ 17,000,000	$ 73,600,000	$11,000,000	$ 84,600,000
West Road Option	6450	$ 6,500	$ 41,900,000	$ 12,600,000	$ 54,500,000	$ 8,200,000	$ 62,700,000
Extradosed Bridge							
Base Road	7050	$ 8,000	$ 56,400,000	$ 16,900,000	$ 73,300,000	$11,000,000	$ 84,300,000
Base Road - NB Only	5600	$ 8,000	$ 44,800,000	$ 13,400,000	$ 58,200,000	$ 8,700,000	$ 66,900,000
East Road Option	8700	$ 8,000	$ 69,600,000	$ 20,900,000	$ 90,500,000	$13,600,000	$104,100,000
West Road Option	6450	$ 8,000	$ 51,600,000	$ 15,500,000	$ 67,100,000	$10,100,000	$ 77,200,000
Arch Bridge							
Base Road	7050	$10,000	$ 70,500,000	$ 21,200,000	$ 91,700,000	$13,800,000	$105,500,000
Base Road - NB Only	5600	$10,000	$ 56,000,000	$ 16,800,000	$ 72,800,000	$10,900,000	$ 83,700,000
East Road Option	8700	$10,000	$ 87,000,000	$ 26,100,000	$113,100,000	$17,000,000	$130,100,000
West Road Option	6450	$10,000	$ 64,500,000	$ 19,400,000	$ 83,900,000	$12,600,000	$ 96,500,000
Cable Stayed Bridge							
Base Road	7200	$ 9,000	$ 64,800,000	$ 19,400,000	$ 84,200,000	$12,600,000	$ 96,800,000
Base Road - NB Only	5750	$ 9,000	$ 51,800,000	$ 15,500,000	$ 67,300,000	$10,100,000	$ 77,400,000
East Road Option	8700	$ 9,000	$ 78,300,000	$ 23,500,000	$101,800,000	$15,300,000	$117,100,000
West Road Option	6600	$ 9,000	$ 59,400,000	$ 17,800,000	$ 77,200,000	$11,600,000	$ 88,800,000

4.15.2 Life Cycle Costs

Table 4.2 tabulates the life cycle costs for the various bridge alternatives over a 50 year period (assuming a 75 year life span). The costs are calculated for the Base Road Option, NB only case where there is no southbound lane. In preparing the life cycle cost analyses, we have assumed that minor bridge maintenance will be undertaken every 5 years, and major rehabilitations will be needed every 25 years. Minor rehab will include concrete sealer and cable inspections. Major rehabs include the work completed in a minor rehabilitation plus steel coating replacement, deck rehabilitation, and cable repairs. We have assumed that the discount rate is 4 %. The total residual value includes 15% engineering and administration costs.

Table 4.2 – Phase 1 Bridge Life Cycle Costs

	BRIDGE AREA M^2	MINOR REHAB (EVERY 5 YEARS)	MAJOR REHAB (YEAR 25)	MAJOR REHAB (YEAR 50)	50 YEAR PV TOTAL + RESIDUAL
Girder	5600	$ 150,000	$ 5,000,000	$ 7,000,000	$ 55,100,000
Extradosed	5600	$ 250,000	$ 7,000,000	$ 9,000,000	$ 68,400,000
Arch Bridge	5600	$ 250,000	$ 10,000,000	$ 12,000,000	$ 86,000,000
Cable Stayed	5750	$ 250,000	$ 7,000,000	$ 9,000,000	$ 78,400,000

4.16 Discussion and Recommendation

The terms of reference for the “Walterdale Bridge Replacement and Approach Evaluation” indicate that the existing structure should be replaced with a functional signature bridge that will form an attractive entrance to downtown Edmonton. Table 4.3 compares the girder, extradosed, arch and cable-stayed alternatives to replace the existing bridge from consideration of the evaluation criteria presented in Section 4.3.

The table comments on the following:

- Technical considerations that relate to the structural design.
- Accessibility to the multi-use trail system and facilities on the north and south banks.
- Project constraints.
- Projects and initiatives that are proposed for the adjacent river banks.
- Project opportunities.
- Costs.

Table 4.3 Walterdale Bridge Alternatives Evaluation

		Bridge Type			
	CRITERIA	GIRDER	EXTRADOSED	ARCH	CABLE STAYED
TECHNICAL CONSIDERATIONS	**Profile in North Saskatchewan River Valley**	• Low profile; you would not know you were on a bridge. Girders quite deep, long span.	• Higher profile than girder; deck more slender.	• Deck very slender; arch quite prominent.	• Deck very slender; tower about 3 times higher than High Level Bridge.
	Impact on river	• Two piers in river; removal of existing piers.	• Two piers in river; removal of existing piers.	• No piers in river; removal of existing piers.	• No piers in river; removal of existing piers.
	Impact on south river bank	• New abutment, removal of existing abutment.			• New abutment and pylon on south bank. • New large tie-down block. • Removal of existing abutment.
	Impact on north river bank	• New abutment, removal of existing abutment.			
	Utilities integration	• Utilities should fit between girders.		• Utilities may be carried in box between east walk and road barrier.	
	Constructability	• Common bridge type. Segmental construction required, which is less common than usual girder construction for shorter spans.	• Less common bridge type. • More complex than girder.	• Arch erection complex. • Requires well thought out deck erection procedures.	• Very tall tower. • Requires well thought out deck erection procedures.

<table>
<tr><th></th><th>CRITERIA</th><th>GIRDER</th><th>EXTRADOSED</th><th>ARCH</th><th>CABLE STAYED</th></tr>
<tr><td rowspan="6">ACCESSIBILITY</td><td>Pedestrian experience and safety</td><td>• Minimal separation between pedestrians and vehicles.
• Higher above water unless pedestrian walkway is a separate element.</td><td>• Enhanced buffer between roadway and pedestrians due to cable structure over a portion of bridge length.
• Higher above water.</td><td>• Enhanced buffer between roadway and pedestrians due to cable structure.
• Lower to water.</td><td>• Enhanced buffer between roadway and pedestrians due to cable structure.
• Lower to water.</td></tr>
<tr><td>Bicycle experience and safety</td><td>• Minimal separation between pedestrians and vehicles.
• Higher above water unless pedestrian walkway is a separate element.</td><td>• Enhanced buffer between roadway and bicycles due to cable structure over a portion of bridge length.
• Higher above water.</td><td>• Enhanced buffer between roadway and bicycles due to cable structure.
• Lower to water.</td><td>• Enhanced buffer between roadway and bicycles due to cable structure.
• Lower to water.</td></tr>
<tr><td>Access to Kinsmen Sports Centre</td><td colspan="4">• Bridge type does not impact vehicular access.</td></tr>
<tr><td>Access to Rossdale Generating Station</td><td colspan="4">• Bridge type does not impact vehicular access.</td></tr>
<tr><td>Access/ integration with north multi-use trail system</td><td>• Structural design allows higher elevation for trail and promenade.
• Structure has potential to be split to reduce impact of bridge widths on trails below.</td><td>• Structural design allows higher elevation for trail and promenade (closer to existing elevation).</td><td colspan="2">• Structural design can have lower trail and promenade; bridge can be raised if a higher trail is warranted.</td></tr>
<tr><td>Access/ integration with south multi-use trail system</td><td colspan="2">• Bridge higher on south bank.
• Trail system can be generous and fully integrated.</td><td>• Bridge lower to river; can be raised to accommodate trail below bridge.</td><td>• Tower proximity to water's edge impacts trail.
• Bridge deck can be raised to accommodate trail below bridge.</td></tr>
</table>

	CRITERIA	GIRDER	EXTRADOSED	ARCH	CABLE STAYED
CONSTRAINTS	**Legislative**	• No significant restrictions.			• Airport height restrictions?
	Regulatory	• DFO, Navigable Waters.			
	Geotechnical	• No significant constraints.		• Since bedrock has a low strength in rock mechanics terms, a tied arch is preferred.	• Large uplift forces at tie-down anchorage will be a challenge.
	Archaeological	• Impact depends more on road alignment.			
	Environmental	• Piers in the water impact the river.			
		• Impact on valley depends more on road alignment. All options require removal of existing piers.			

<table>
<tr><th></th><th>CRITERIA</th><th>GIRDER</th><th>EXTRADOSED</th><th>ARCH</th><th>CABLE STAYED</th></tr>
<tr><td rowspan="8">ADJACENT PROJECTS/INITIATIVES</td><td rowspan="2">Kinsmen Sports Centre</td><td colspan="2"></td><td colspan="2">• May require staging area in Kinsmen parking lot during construction.</td></tr>
<tr><td colspan="4">• Depends on road alignment.</td></tr>
<tr><td>Burial Grounds</td><td>• Bridge profile has little visual impact.</td><td>• Lower profile of towers has low visual impact.</td><td>• Height of arch has strong visual impact. May reduce visual presence of burial grounds.</td><td>• Height of tower and cable system has strong vertical presence. May reduce visual presence of burial grounds.</td></tr>
<tr><td>Interpretive Belvedere</td><td colspan="4">• Bridge design has no apparent impact.
• Road alignment may require a re-location of Interpretive Belvedere.</td></tr>
<tr><td>West Rossdale Urban Design Plan</td><td colspan="2">• Good opportunity to complement strong public realm design and enhanced relationship to water’s edge.</td><td colspan="2">• Higher degree of visual presence has potential to reduce importance of public realm.</td></tr>
<tr><td>Impact on repurposing of Rossdale Generating Station including Pumphouse 1 and 2</td><td>• Low visual profile provides opportunity to open views to and from the site, and create a strong presence for the Power Station.</td><td colspan="3">• Superstructure design potentially diminishes the presence of the Power Station and obscures views to and from the site.</td></tr>
<tr><td>Impact on/relationship to Legislature Grounds</td><td>• Low visual profile provides opportunity to open views to site.</td><td>• Superstructure is below south lawn but obscures sustained views to Legislature.</td><td colspan="2">• Superstructure is above south lawn of Legislature.
• Obscures sustained view to Legislature.</td></tr>
</table>

<table>
<tr><th></th><th>CRITERIA</th><th>GIRDER</th><th>EXTRADOSED</th><th>ARCH</th><th>CABLE STAYED</th></tr>
<tr><td rowspan="3">OPPORTUNITIES</td><td>Watercraft use of river</td><td colspan="2">• Piers in water may impact watercraft.</td><td colspan="2">• No piers in water will enhance use of river by watercraft.</td></tr>
<tr><td>Wildlife passage</td><td colspan="4">• Bridge type choice has no impact.</td></tr>
<tr><td>Functional signature opportunity - point of pride</td><td>• Simple design requires an innovative approach to achieve a signature bridge.
• Common type of bridge in Alberta.</td><td>• Stronger visual statement inherent with tower and cables.
• Some people feel that this bridge type has an industrial appearance that does not fit into a river valley setting.</td><td>• Strong visual impact of bridge will be signature in and of itself.
• If properly designed, will have a contemporary and iconic quality.
• Care in design will be required to integrate this bridge into the river valley.
• Classic and visually appealing bridge form that respects the appearance of the existing Walterdale Bridge.
• Structure can be designed to have a relatively light appearance.</td><td>• Very strong visual impact of bridge may overwhelm the river valley and surrounding facilities.
• Some consider this to be an over-used bridge form.</td></tr>
</table>

	CRITERIA	GIRDER	EXTRADOSED	ARCH	CABLE STAYED
COST	**Capital cost**	• Lowest.	• Medium.	• Highest.	• Medium.
	Operating and maintenance costs	• Lowest.	• Careful detailing will be required to reduce cable maintenance costs.	• Careful detailing will be required to reduce cable maintenance costs. • Requires upkeep if paint is used for steel arch ribs.	• Careful detailing will be required to reduce cable maintenance costs. • Expensive to work at heights when maintaining bridge.
	Life cycle cost	• Lowest.	• Medium	• Highest	• Medium

The outstanding advantages and disadvantages of the four structural alternatives are as follows:

- **Girder Alternative.** The girder alternative is economical to construct in the Alberta market place, and has a low profile that will have little visual impact on the river valley and adjacent projects. Since it does not rise above the roadway, the girder alternative will do little to announce the entrance to downtown Edmonton. The girder alternative will require a deeper deck than the other alternatives, which will require the approach roadways to be higher, increasing the footprint in the river valley. Because modern bridges in Alberta are generally constructed from girders, this alternative is considered to be commonplace by most people.

- **Extradosed Alternative.** The extradosed alternative has been used successfully for bridges throughout the world, with two notable examples constructed recently in Vancouver. Since the appearance is considered to be utilitarian, many people do not believe that this alternative will become a point of pride for the citizens of Edmonton. This alternative has the disadvantage that it will require two piers in the North Saskatchewan River.

- **Arch Alternative.** The classic arch form has been used for the construction of iconic bridges since Roman times. This alternative pays homage to the existing bridge, and relates well to the river valley and the adjacent Low Level and High

Level bridges. With arches that rise above a slender deck, if properly designed this alternative will become the gateway to downtown and a point of pride for the citizens of Edmonton. To avoid piers in the river, we propose a single arch span between the south and north banks. Because the erection requires care and attention on the part of the contractor, the cost of an arch bridge will be in the range of 10 to 20 percent more than other functional signature bridges.

- **Cable-Stayed Alternative.** In the past 30 years, cable-stayed bridges have been constructed throughout the world. By virtue of a high tower on the south bank and a slender deck, this alternative has the potential to become a signature structure in and of itself. However, many people are of the opinion that this alternative will overwhelm the river valley and detract from the surrounding facilities. The backstay cables and tie down required for this alternative on the south bank have the potential to complicate the design and construction of the approach roadways.

Although any of the four alternatives considered can be designed to be a signature functional bridge, from consideration of the advantages and disadvantages of each we recommend that the arch alternative be used for the Walterdale Bridge replacement.

4.17 CONCEPTUAL DESIGN OF PREFERRED ALTERNATIVE

4.17.1 Structural Design and Details

The preferred bridge alternative, a through arch, will be constructed on the alignment of the approved roadway option, which is located to the east of the existing bridge and on a 15 degree skew to the river. The north bridge abutment will be positioned in the vicinity of the Interpretive Belvedere adjacent to the existing bridge. The bridge will carry three lanes of north bound vehicular traffic across the river, and will have a sidewalk on the west side and a wider multi-use trail for pedestrians and bicyclists on the east side.

Exhibits 4.15A and **4.15B** show the overall structural configuration for the preferred bridge alternative. This alternative will use two inclined arches as the primary load-carrying members with a span of 240 m between abutments at the north and south banks of the river. We recommend an arch rise of 40 m above the road surface giving a span to depth ratio of 6 to 1.

Exhibit 4.16A, 4.16B, and **4.17** show the configuration of the deck superstructure. The reinforced concrete deck will be supported on longitudinal stringers that are carried by transverse floor beams, which are in turn carried by boxed shaped girders and hanger cables suspended from the arches. The arch ribs will be "tied" by connecting the ends to the perimeter box-shaped girders, preventing the arch ends from spreading out.

For purposes of this Concept Planning Study we have assumed that the arch ribs and deck superstructure will be constructed from structural steel, but in the detailed design

phase it may be to the advantage of the City of Edmonton to consider both structural steel and concrete alternatives for the bridge.

There has been concern with the use of arch bridges in the USA from the middle 1970's until recently, since it was thought that the tension ties as fracture-critical members lack redundancy. We recommend that the arch tie girders be constructed from several components using bolted connections so that a fracture of one component does not propagate into another.

There have also been problems resulting from the interaction of the tie girders with the bridge deck in the past for tied arch bridges, even when the designer has assumed that the deck is separated from the ties. In detailed design, we recommend that consideration be given to proportioning the bridge so that the tie girders and deck work together to resist the additional tie forces that result from live loads. To reduce cracking, the concrete deck should be hung from the arch in sections separated by transverse pour strips along the full length of the span. The pour strips should then be cast and the deck post-tensioned longitudinally. The interaction of the tension ties with the deck will add redundancy to the arches.

Exhibit 4.15A and drawing **BWAL-111-S02** show a conceptual design for the reinforced concrete abutments that transfer forces into the foundations. The vertical reactions from the arches at the abutments will be supported by a number of belled concrete piles founded on competent bedrock.

Thurber Engineering Ltd. is of the opinion that the foundation conditions at the site are not conducive to having the arch horizontal reactions resisted by the soil.

The bridge will carry utilities across the river. The utilities can be placed between tie girder lines, under the walkways and in the concrete parapets so that they are hidden except when viewed from directly below the bridge.

4.17.2 Architectural Design and Details

The Walterdale Bridge Replacement project offers Edmonton a unique opportunity to create a striking new entrance into our downtown and the Alberta Legislature. Together with the repurposing of the Rossdale Generating Station and the West Rossdale Area Redevelopment Plan, collectively known as the North Bank Project, there is potential to create a legacy, one that is transformative not only for this neighbourhood but for all of Edmonton. Collaborative, integrated city building bringing together a bridge, a neighbourhood, and a major public facility in the heart of an established city is a rare and powerful opportunity.

Exhibits 4.18 through **4.21** illustrate our conceptual plan for the Walterdale Bridge replacement.

The plan for the new bridge is a gracious, single span arch – a functional, proud structure connecting the north and south bank at a location rich in history. It is more

than a bridge, it is architecture, it is a public realm and it is art. It is a signature element in our river valley.

Key architectural design and detail opportunities illustrated in this concept planning study and to further explore in the detailed design of the bridge include:

- Expressing the current shape of the arches as they rise above the ground at each abutment to respond to the specific character of the north and south banks.
- Expressive connection details that read at differing scales and modes of movement from vehicular to pedestrian.
- Unique, night sky friendly lighting scaled for vehicles and pedestrians.
- Universal access between the bridge walkways and the river valley trail network that is integral to the bridge architecture.
- Overlooks down the river to the High Level Bridge to the west, to the bend in the river to the east, to the Legislature Grounds, to the Rossdale Generating Station and beyond to the downtown skyline.
- A generous promenade or public realm, a city-wide destination, with materials, finishes and planting that responds to the nature and character of the valley with opportunities to sit, to enjoy the river, to watch fireworks and more.
- Display and interpretive elements that tell the story of the site and celebrate the aboriginal and civic history of the area.
- Integration with the development of the Rossdale Generating Station public gardens and plaza.
- Framing sustained views to the Alberta Legislature and the downtown skyline.

4.17.3 Urban Design and Integration

The mandate of the Walterdale Bridge Replacement for a functional signature bridge offers the opportunity to create a public space on the river; where duality of city and nature are experienced and celebrated at a pivotal point in Edmonton.

The detailed design of the project should respect and emphasize the history and archaeological significance of the site.

The existing Interpretive Belvedere will need to be relocated as part of the bridge replacement project. The design team will need to work collaboratively with the stakeholders to find an appropriate location to redevelop the Interpretive Belvedere.

The approaches to the bridge on the north and south banks offer the potential for the creation of landscape that not only satisfies mobility requirements but can reinforce the functional signature quality of the bridge through evocative land form and planting.

Pedestrians and bicyclists should feel that they can "touch the water" when using the new bridge. There should be places on the bridge to linger and watch the river go by.

The replacement should help create sustainable and complete neighbourhoods. This can be accomplished by providing access from the West Rossdale neighbourhood and

Generating Station site to larger gathering spaces at the Kinsmen Sports Centre and Queen Elizabeth Park. A key aspect of urban design will be to incorporate a multi-use trail river crossing on the bridge structure, and allow for multi-use trails to pass under the bridge adjacent to the abutments at the south and north river banks.

Exhibits 4.16A and **4.16B** show preliminary concepts for the multi-use trail that will be carried across the river, shown on the east side of the bridge. A relatively wide trail is recommended so that pedestrians and bicyclists can cross the river without conflicts occurring. There will be ample room for people to pause on the trail as they cross the river and enjoy the pastoral views to the east.

Although a relatively narrow sidewalk is proposed on the west side of the bridge, lookouts can be incorporated into the sidewalk designs to allow pedestrians crossing the bridge to view the Legislature, High Level Bridge and other urban views to the west.

Exhibit 4.15A shows the proposed geometry for the multi-use trails as they pass under the bridge at the river banks. Note that the geodetic elevations of the tops of the trails adjacent to the south and north abutments, respectively, are consistent with high water levels for floods with 9 and 36 year return periods. The geodetic elevation of the top of the trail at the south bank could be raised to achieve a longer flood return period, but the clearance between the soffit of the bridge and the trail would have to be reduced.

4.17.4 Public Art

One percent of the construction value of the bridge structure is allocated to public art. Mr. Ken Lum, a renowned artist from Vancouver, British Columbia, has been appointed to the Project Team as part of the commitment of the City of Edmonton to public art.

The Project Team has met with Mr. Lum several times as part of the Concept Planning Study. His interaction with the team will have a significant influence on the design of the bridge as the project proceeds.

As an example of his early input, Mr. Lum concurs with the suggestion of the team that the bridge have a relatively wide multi-use trail to allow pedestrians and bicyclists to cross the river. The extra width of the trail could be used by artists to display their work. Ken writes:

> "As a member of the Design Team, I am most interested in the production of public space. Given the compelling historical and geographical character of the site with its vistas of nature and various culturally significant public spaces, I think it is vital to produce a participatory space able to mediate multiple spatial practices and symbolic meanings (such as inclusion, cultural diversity, and social difference). Thus, my proposal is to create not only a pedestrian passerelle, but also a civic plaza space sited over the river. At a minimum, I agree with team members who are calling for a widened pedestrian walkway. I also believe that the site can and should be more fully activated by a public square. Such a space would be unprecedented anywhere in the world that I know of.

In terms of art components on bridges, I look to the Charles Bridge in Prague, the Bridge of Angels in Rome, and bridge statues at Preah Khan, Cambodia. My idea would be to mark the bridge or plaza at regular intervals with statuary. Rather than rendering heroic saints and historical figures, I believe a theme more aligned to the essential attributes of nature is called for in the form of statues of young children. Such statues would project futurity and growth in addition to social and ethnic hybridity. Each statue would stand atop a plinth that registers a text stating in laconic terms the child's name plus along with the ethnicity of the parents (i.e. Father: Scottish-Latvian. Mother: Lebanese-Turkish). The children statuary would traverse time and space within the constitution Edmonton's history and even pre-history. A child could be born 1896 for instance or 1996 and their years of birth would be noted on the respective child statue. No matter the year born, every statue will appear as a historically appropriate child. In so doing, the inscribed text reads in the most matter-of-fact and statistical manner. It is left to the operations of art to open up a space for thought for viewers regarding the past, present and future of their city and its inhabitants."

4.18 COSTS FOR PREFERRED ARCH ALTERNATIVE

4.18.1 Initial Costs

Table 4.4 tabulates the initial construction cost estimate for the preferred arch bridge alternative on the approved roadway plan. The assumptions used in preparing this table are the same as those used to prepare the initial capital cost estimates for the various bridge alternatives in Section 4.15.1.

Table 4.4 – Phase 2 Bridge Capital Costs

BRIDGE ALTERNATIVES	BRIDGE AREA	UNIT COST	COST	30% CONTINGENCY	CONSTRUCTION COST	15% ENGINEERING AND ADMIN	PROJECT COST
	m^2	per m^2					
Arch Bridge - Base Road	6400	$10,000	$ 64,000,000	$ 19,200,000	$ 83,200,000	$12,500,000	$ 95,700,000

4.18.2 Life Cycle Costs

Table 4.5 tabulates the life cycle costs for the recommended bridge alternative. The assumptions used in preparing this table are the same as those used to prepare the life cycle costs for the bridge alternatives in Section 4.15.2.

Table 4.5 – Phase 2 Bridge Life Cycle Costs

	BRIDGE AREA M^2	MINOR REHABILITATION (EVERY 5 YEARS)	MAJOR REHABILITATION (YEAR 25)	MAJOR REHABILITATION (YEAR 50)	50 YEAR PV TOTAL + RESIDUAL
Arch Bridge – Base Road	6400	$ 250,000	$ 10,000,000	$ 12,000,000	$ 97,400,000

4.18.3 Enhancements

The terms of reference for the Conceptual Planning Study indicate that the existing structure should be replaced with a functional signature bridge. Although the costs listed in Sections 4.18.1 and 4.18.2 will provide citizens with a bridge that will become a point of pride, the City of Edmonton may wish to consider optional enhancements to the design of the arch alternative as part of the current or future projects. Table 4.6 tabulates optional enhancements for consideration that are not included in the above initial or life cycle costs.

Table 4.6 – Optional Design Enhancements

DESCRIPTION	CONSTRUCTION COST	15% ENGINEERING AND ADMIN	PROJECT COST
Increase the width of the multi-use trail on the east side of the bridge from 4.2 m to an average width of 6.5 m.	$ 5,000,000	$ 750,000	$ 5,750,000
Separate the multi-use trail from the bridge structure so that the trail remains horizontal when it crosses the river, and to create a sense of separation between the trail and road traffic. The trail will be lower than the roadway at the south bank and at about the same elevation on the north bank.	$ 4,000,000	$ 600,000	$ 4,600,000
Enhance pedestrian connections between the bridge and existing trail system to promote increased usage and better links, especially at the north end of the bridge.	$ 2,000,000	$ 300,000	$ 2,300,000
Incorporate the Interpretive Belvedere with the new bridge, possibly on one of the lookouts. The existing Interpretive Belvedere needs to be relocated with the proposed bridge alignment.	$ 500,000	$ 75,000	$ 575,000
Enhance the lighting for the bridge, using programmable LED lights on the arch ribs and deck edge.	$ 1,200,000	$ 180,000	$ 1,380,000
Use asymmetrical ribs for arch or cross each arch rib to change the look and feel of the bridge, giving it a truly unique signature aesthetic.	Cost of this enhancement will be significant and cannot be determined without doing more detailed design work.		
Use brushed stainless rather than the painted structure steel for the arches.	$30,000,000	$4,500,000	$34,500,000
Use custom light fixtures along roadway, sidewalk, and multi-use trail.	$ 500,000	$ 75,000	$ 575,000
Provide sculpted concrete at the bridge abutments.	$ 2,000,000	$ 300,000	$ 2,300,000

DESCRIPTION	CONSTRUCTION COST	15% ENGINEERING AND ADMIN	PROJECT COST
Develop a curved pedestrian multi-use trail/ promenade on bridge based on Ken Lum's design sketch.	$ 6,000,000	$ 900,000	$ 6,900,000
Provide glass railings with stainless steel detailing and wood decking for the multi-use trail.	$ 1,800,000	$ 270,000	$ 2,070,000
Provide seating and planting along the multi-use trail.	$ 500,000	$ 75,000	$ 575,000
Enhance south bank approach road landscaping (provide, for example, land sculpting, planting, and lighting).	$ 1,500,000	$ 225,000	$ 1,725,000
Provide north bank promenade to the west of bridge (to 106 Street alignment).	$ 3,700,000	$ 555,000	$ 4,255,000
Provide north bank promenade to the east of bridge (to 104 Street alignment).	$ 4,500,000	$ 675,000	$ 5,175,000
Provide south bank promenade in vicinity of bridge.	$ 5,500,000	$ 825,000	$ 6,325,000
Provide an enhanced pedestrian walkway to the Kinsmen Sports Centre.	$ 1,600,000	$ 240,000	$ 1,840,000
Provide entrance park at 105 Street and Rossdale Road.	$ 2,000,000	$ 300,000	$ 2,300,000
Provide boat dock and access on south bank.	$ 250,000	$ 37,500	$ 287,500
Provide boat dock and access on north bank.	$ 250,000	$ 37,500	$ 287,500

4.19 CONSTRUCTABILITY

The arch bridge proposed for the Walterdale Bridge replacement will be a world class, signature structure. Although a conceptual erection scheme will be shown on the contract documents, the successful contractor for the project will be responsible for selecting the approach that is used to erect the bridge.

We expect that the arch bridge will be erected from temporary towers stayed by cables from the banks of the river. The contractor will have to coordinate the locations for the tower backstay cables so that they do not interfere with adjacent roadways, trails and other facilities on the banks of the river. The components of the arch ribs and the bridge deck could be erected from a highline that travels between the towers on the north and south sides of the river, or could be erected sequentially by cantilevering out from the towers on each bank.

There is no question that a sophisticated, well-organized contractor with experienced sub-trades will be required to construct the bridge. We have had discussions with several local contractors to ascertain the level of interest that they have in a project of this size and complexity. We believe that PCL Constructors Inc., Graham Construction and Engineering Ltd., Flatiron Construction Corp. and Peter Kiewit Infrastructure Co. have the qualifications to bid the project.

Representatives of Alberco Construction Ltd. have indicated that they will likely form a joint venture with a local structural steel fabricator to pursue the project. All of these contractors are active in the Alberta marketplace.

Since bonding requirements for a project of this size are onerous, we expect that joint ventures may be formed between other local contractors and major sub-trades to construct the bridge.

4.20 SCHEDULE

We recommend that the City of Edmonton allow a period of ten months for the design of the bridge. This will allow adequate time for the team to obtain environmental approvals, address heritage and aboriginal issues, and interact with the utility organizations affected by the project.

We expect that the bridge will be constructed in a 24 to 30 month period over the course of three construction seasons. The project should be tendered in February of 2012, with award of the construction contract coming in April. In the first construction season, the abutments, the arch ribs, and a portion of the superstructure will be erected. In the second season, the superstructure erection will be completed and part of the bridge deck will be cast. In the final season, the remainder of the bridge deck will be cast, the wearing surface will be applied and the remainder of the work will be completed. This will result in a construction completion date of mid-summer 2014.

The above schedule was developed assuming that the deck system will be cast in place concrete using traditional forming methods. If the City intends to have bridge construction completed by the end of 2013, this can be done by using a non-conventional deck system, such as partial depth precast concrete, SPS (Sandwich Plate System), or UHPC (ultra high performance concrete) precast waffle slab systems. These systems may increase costs beyond those presented in this report.

4.21 SUMMARY AND CONCLUSIONS

The design team has considered the use of girder, extradosed, arch and cable stayed alternatives to replace the existing Walterdale Bridge across the North Saskatchewan River in Edmonton with a new signature structure. From consideration of project constraints, aesthetics and integration into the urban environment, we propose that a through-arch structure be used for the bridge replacement.

The arch bridge will be constructed on the alignment of the approved roadway option, which is located to the east of the existing bridge and on a 15 degree skew to the river. The bridge will carry three lanes of north bound vehicular traffic across the river, and will have a sidewalk on the west side and wider multi-use trail for pedestrians and bicyclists on the east side.

Drawings **BWAL-111-S01** and **BWAL-111-S02** show the conceptual design of the recommended arch alternative.

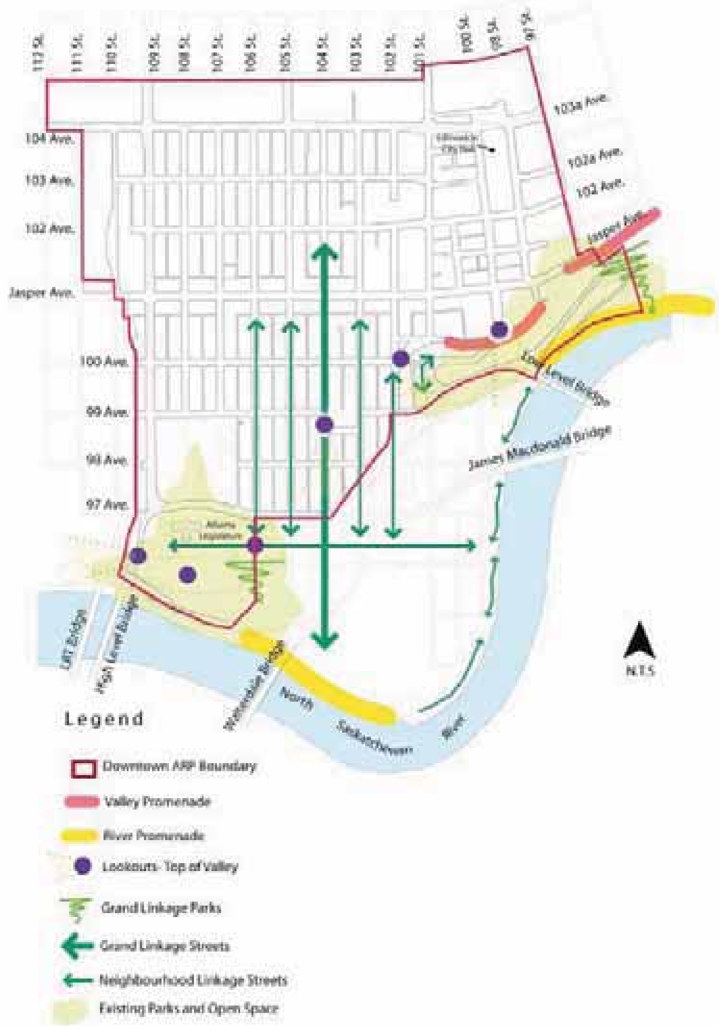
The bridge will have two inclined structural steel arches as the primary force-carrying members spanning 240 m between abutments at the north and south banks of the river, and rising 40 m above the road surface. The horizontal reactions at the ends of the arches will be resisted by structural steel tie girders that extend from one end of the superstructure to the other.

We anticipate that the superstructure will be constructed from a reinforced concrete deck supported on structural steel longitudinal stringers spanning between transverse floor beams that are in turn supported on the tie girders. The girders will be carried by cable hangers suspended from the arch ribs.

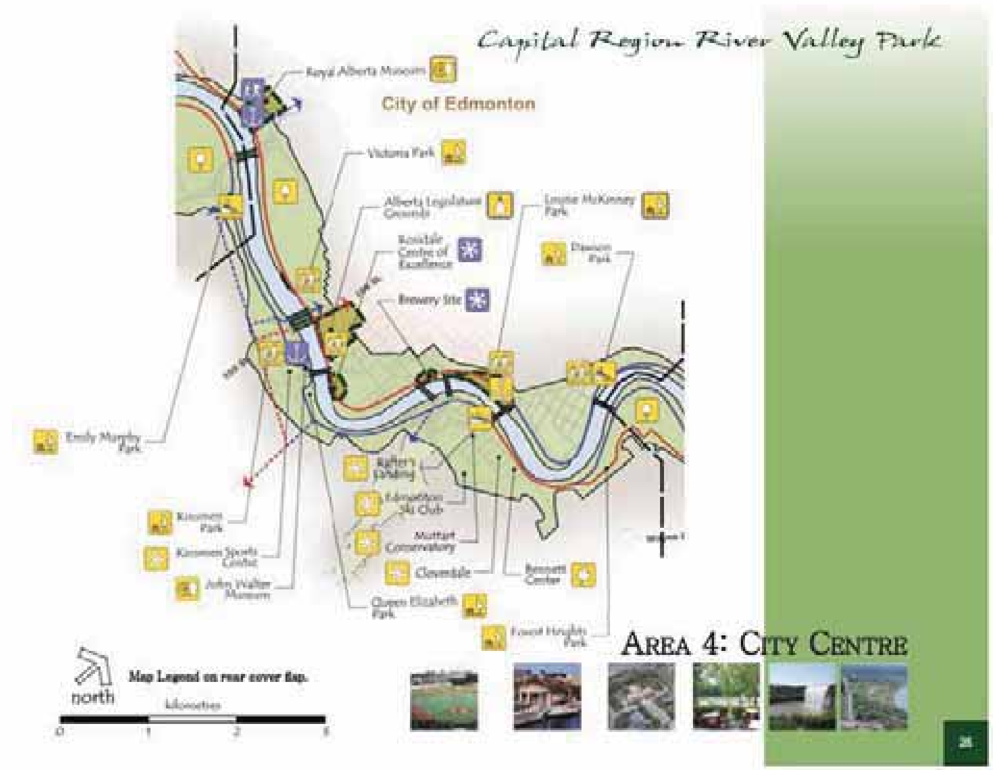
The abutments on the river banks will be constructed from reinforced concrete. The vertical reactions from the arches and the abutment loads will be supported by means of belled, cast-in-place concrete piles founded in competent bedrock.

The arch bridge can be constructed for an estimated project cost of $95,700,000 in 2011 dollars. The City of Edmonton may wish to make allowances for optional costs for some or all of the bridge enhancements listed in Section 4.18.3.

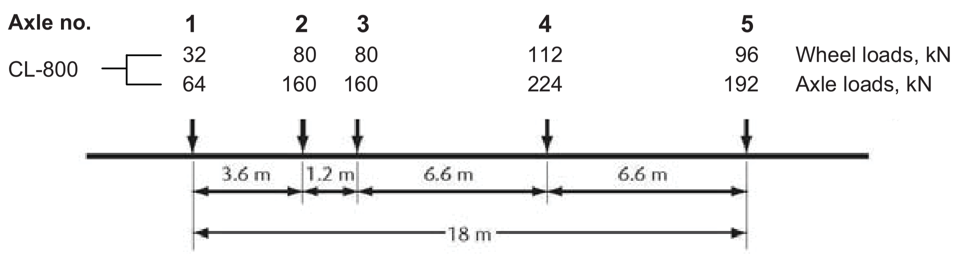
The City of Edmonton should allow ten months for design, and 24 to 30 months for the construction of the bridge.



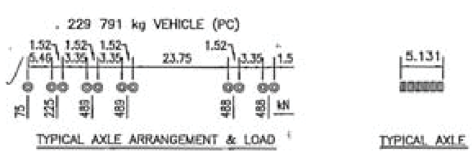
River Valley Promenades plan from Capital City Downtown Plan



River Valley Park Plan from River Valley Alliance

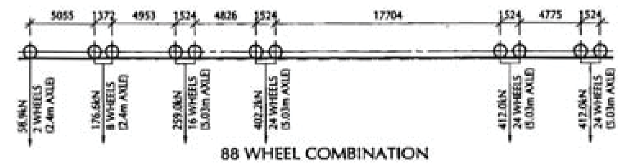


CL-800 TRUCK

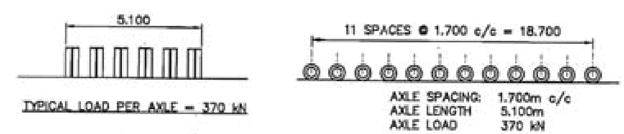


OVERLOAD TRUCK - 230 TONNE

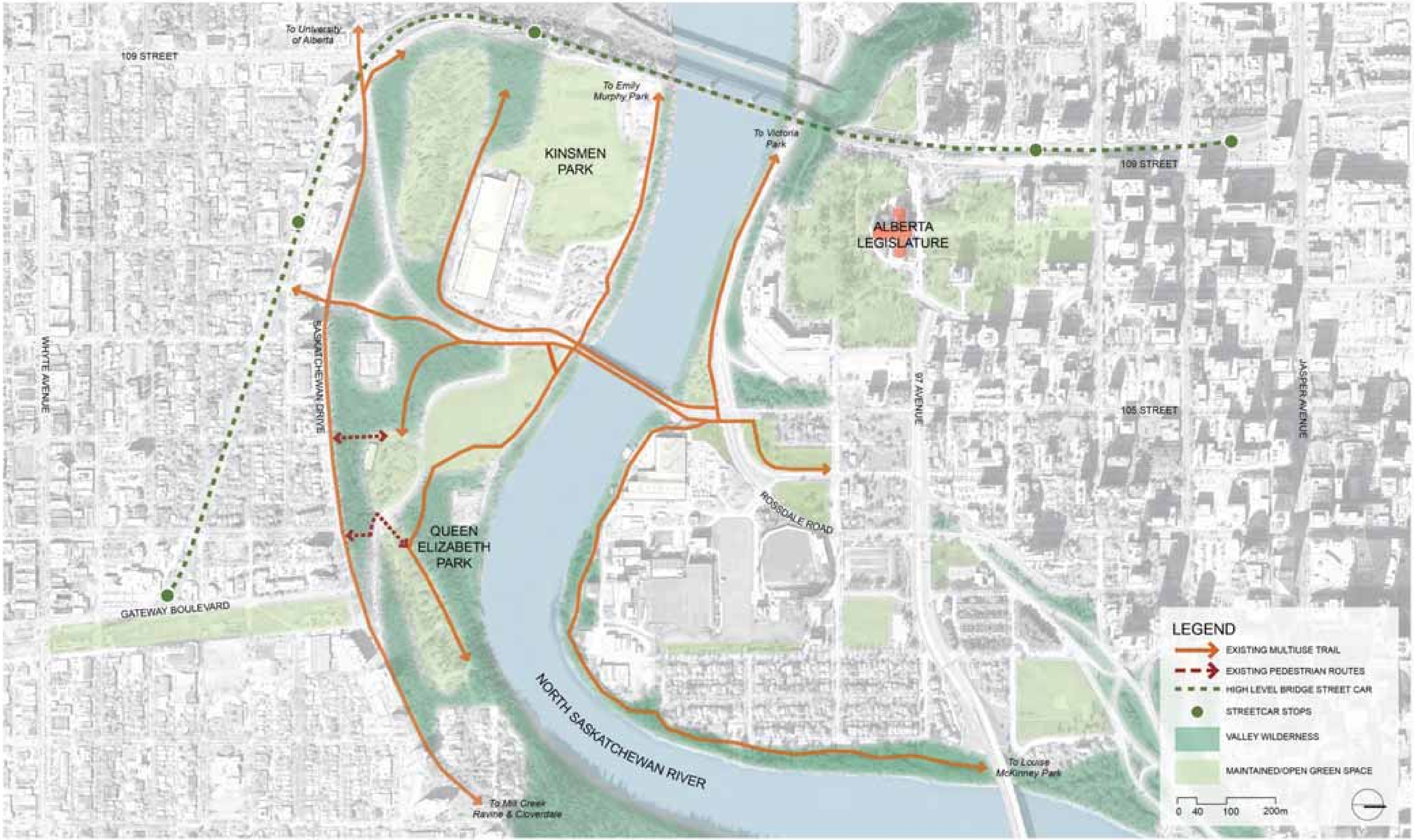
OVERSIZE LOAD: 1720.7 kN



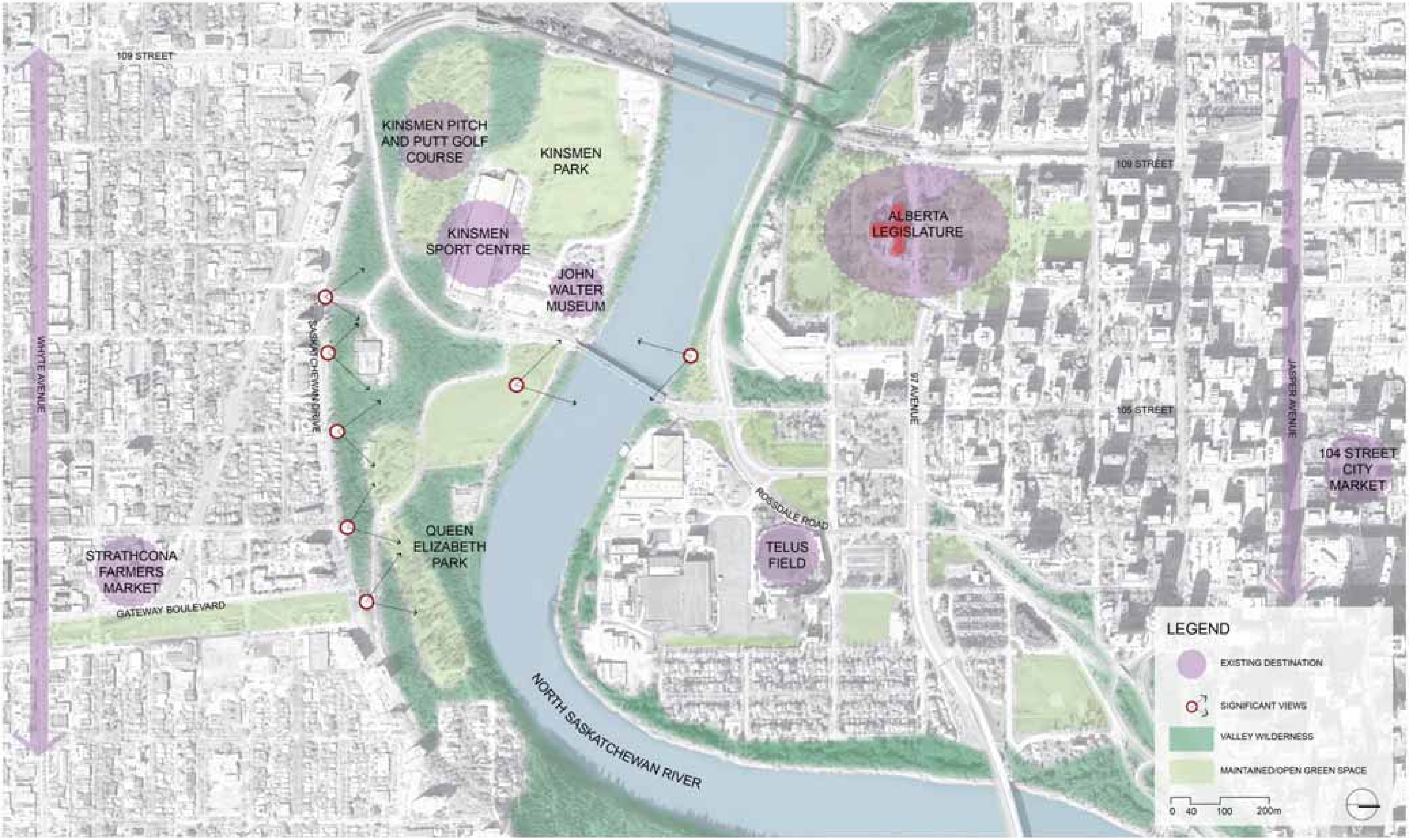
OVERLOAD TRUCK - 88 WHEEL COMBINATION



SPECIAL OVERLOAD TRUCK

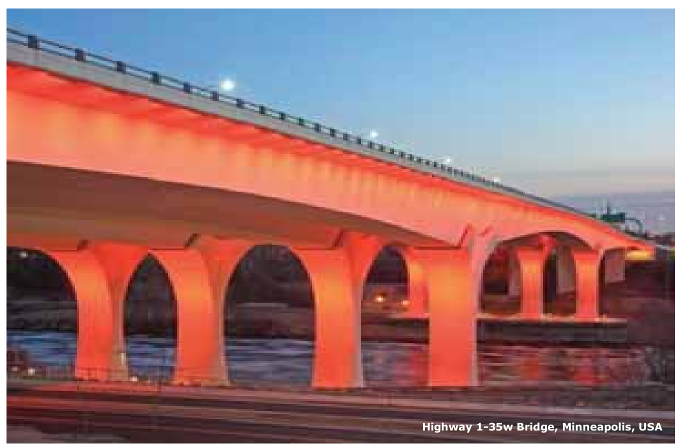


EXISTING OPEN SPACE, BICYCLE AND PEDESTRIAN NETWORK


109 STREET
WHYTE AVENUE
KINSMEN PITCH AND PUTT GOLF COURSE
KINSMEN PARK
KINSMEN SPORT CENTRE
JOHN WALTER MUSEUM
SASKATCHEWAN DRIVE
QUEEN ELIZABETH PARK
STRATHCONA FARMERS MARKET
GATEWAY BOULEVARD
NORTH SASKATCHEWAN RIVER
ALBERTA LEGISLATURE
109 STREET
105 STREET
97 AVENUE
ROSSDALE ROAD
TELUS FIELD
JASPER AVENUE
104 STREET CITY MARKET
LEGEND
EXISTING DESTINATION
SIGNIFICANT VIEWS
VALLEY WILDERNESS
MAINTAINED/OPEN GREEN SPACE
0 40 100 200m

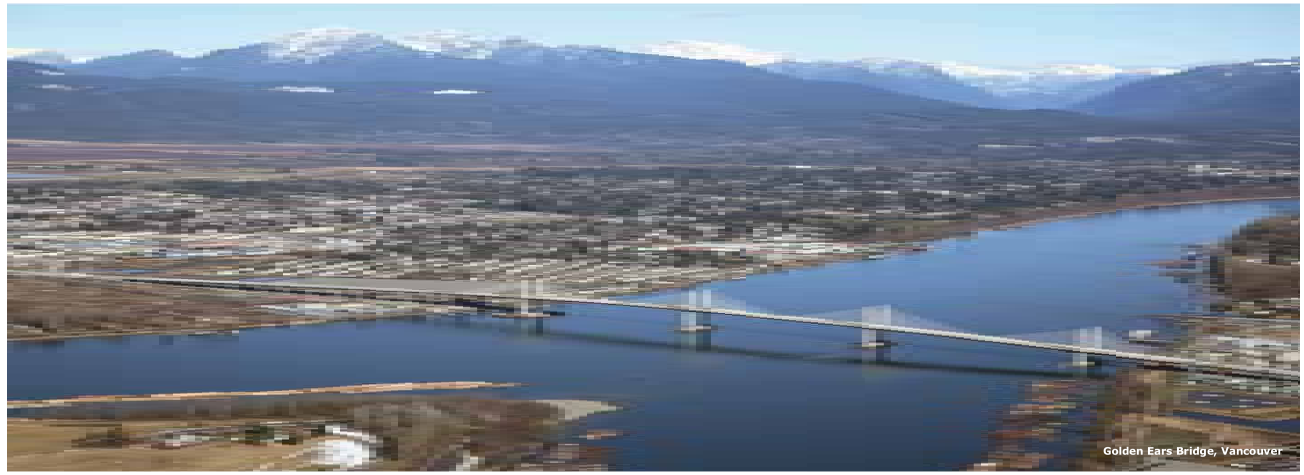

Deutz Bridge in Cologne


Kingston Bridge, Glasgow, Scotland


Highway 1-35w Bridge, Minneapolis, USA

GIRDER BRIDGE

Gird•er [n] - A large beam made out of steel or concrete. A straight or slightly curved structure designed to act primarily in flexure (bending). Sometimes tensioned with internal cables.



Golden Ears Bridge, Vancouver

North Arm Bridge, Vancouver

Puh Bridge, Slovenia

EXTRADOSED BRIDGE

Ex•tra•dosed [n] - A girder bridge in which the tension cables are installed outside and above the main girder and deviated by short towers located at supports. A hybrid between girder and cable-stayed.


Juscelino Kubitschek Bridge, Brasilia


Highway Bridge, Palmas de Gran Canaria, Spain


Apollo Bridge, Slovakia

ARCH BRIDGE

Arch [n] - A curved structure designed to act primarily in compression. Horizontal thrust reactions are resisted by a tension tie or embedment into the earth.

Alamillo Bridge, Seville, Spain

Lover's Bridge, DanShui, Taiwan

Erasmus Bridge, Rotterdam, The Netherlands

CABLE-STAYED BRIDGE

Ca•ble-stayed [n] - A slender girder system cantilevered both ways from a central tower and supported by inclined cables attached to the tower.


Passerelle Simone-de-Beauvoir, Paris, France


Ponte della Costituzione, Venice, Italy


High Line, New York, USA

PEDESTRIAN BRIDGE

Pe•des•tri•an [n] - A person who goes or travels on foot; walker.

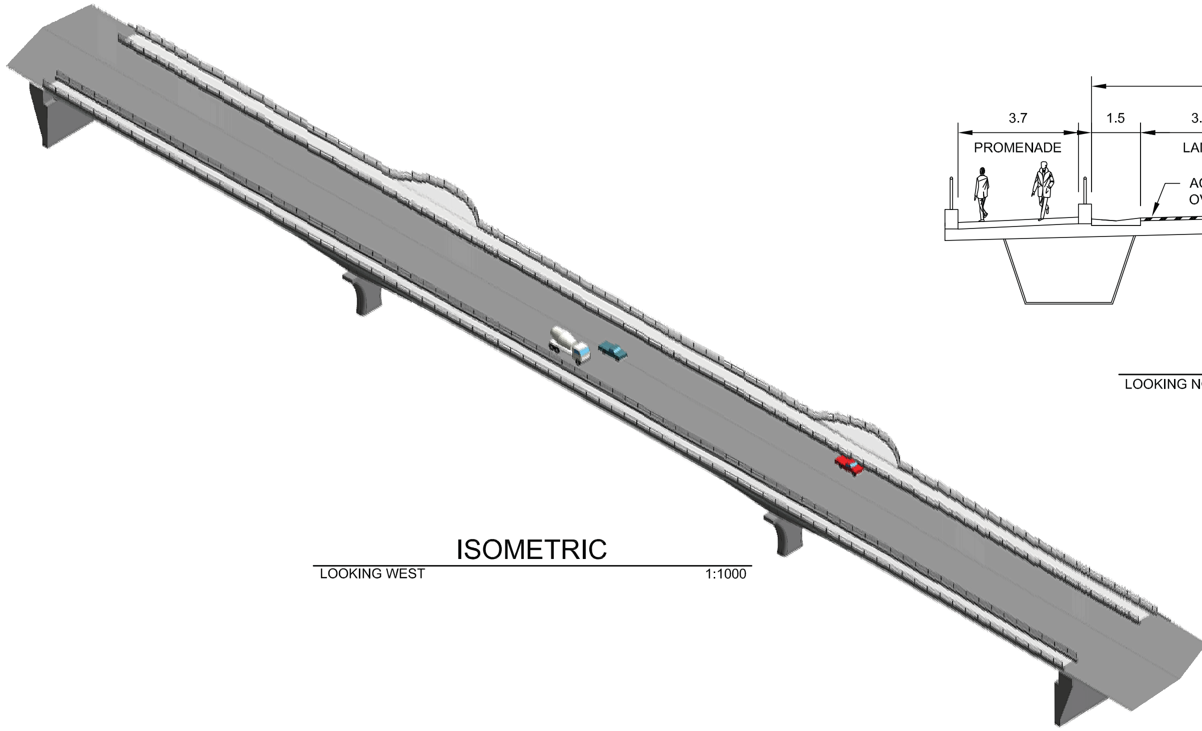
Cy•clist [n] - A person who rides or travels by bicycle.


Alamillo Bridge, Seville

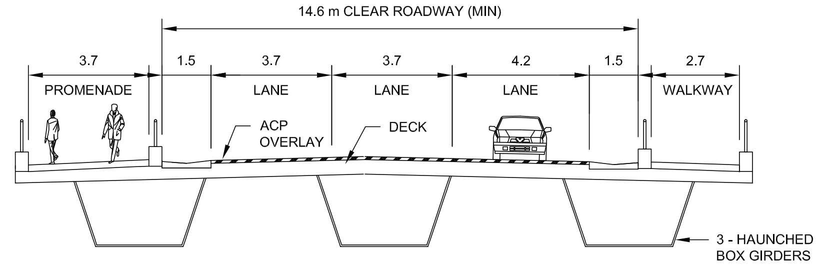

Erasmus Bridge, Rotterdam


Ponte della Costituzione, Venice


North Arm Bridge, Vancouver



ISOMETRIC
LOOKING WEST 1:1000



SECTION
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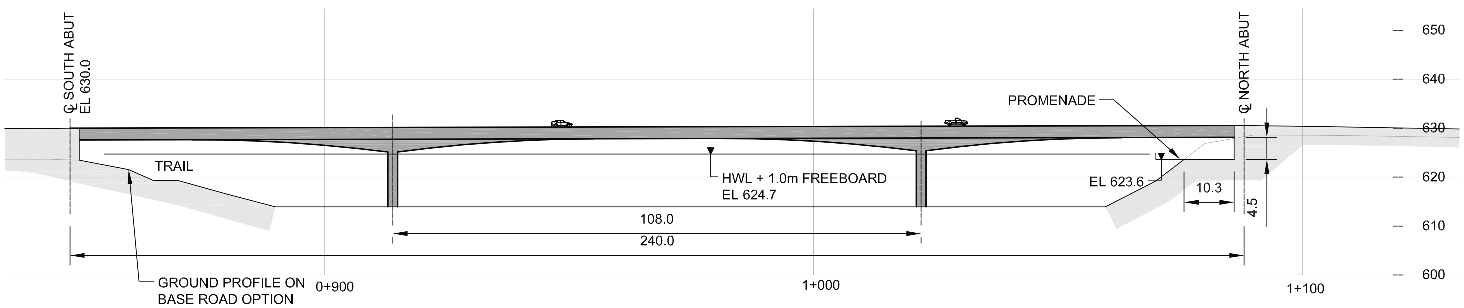
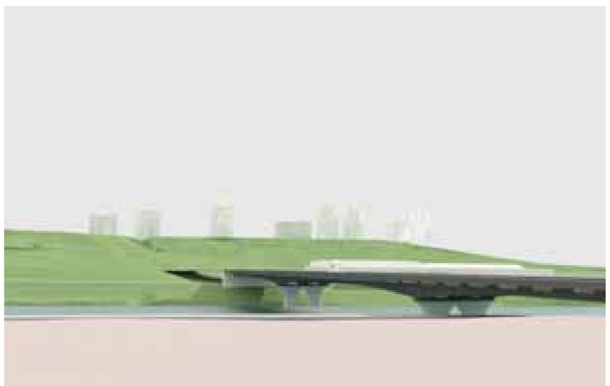
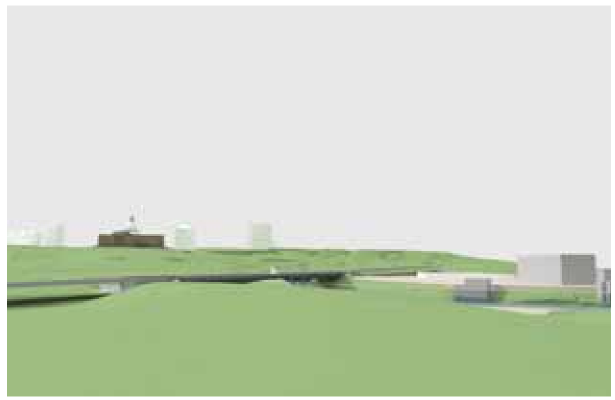


ELEVATION
LOOKING WEST 1:1000

GIRDER ALTERNATIVE SECTION IN VALLEY

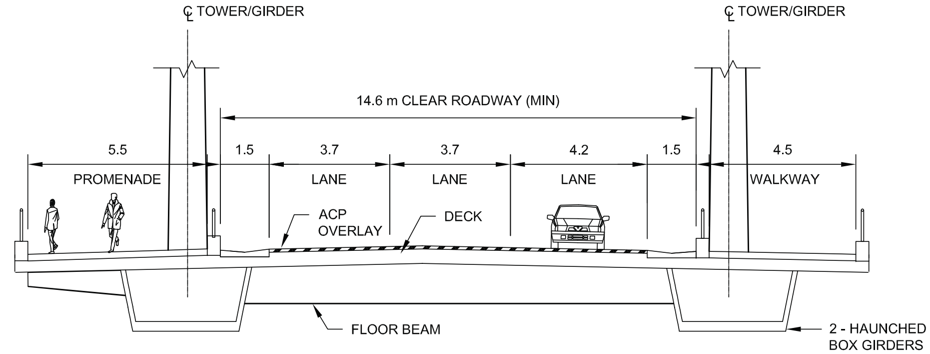


VIEW FROM NORTH BANK LOOKING SOUTH



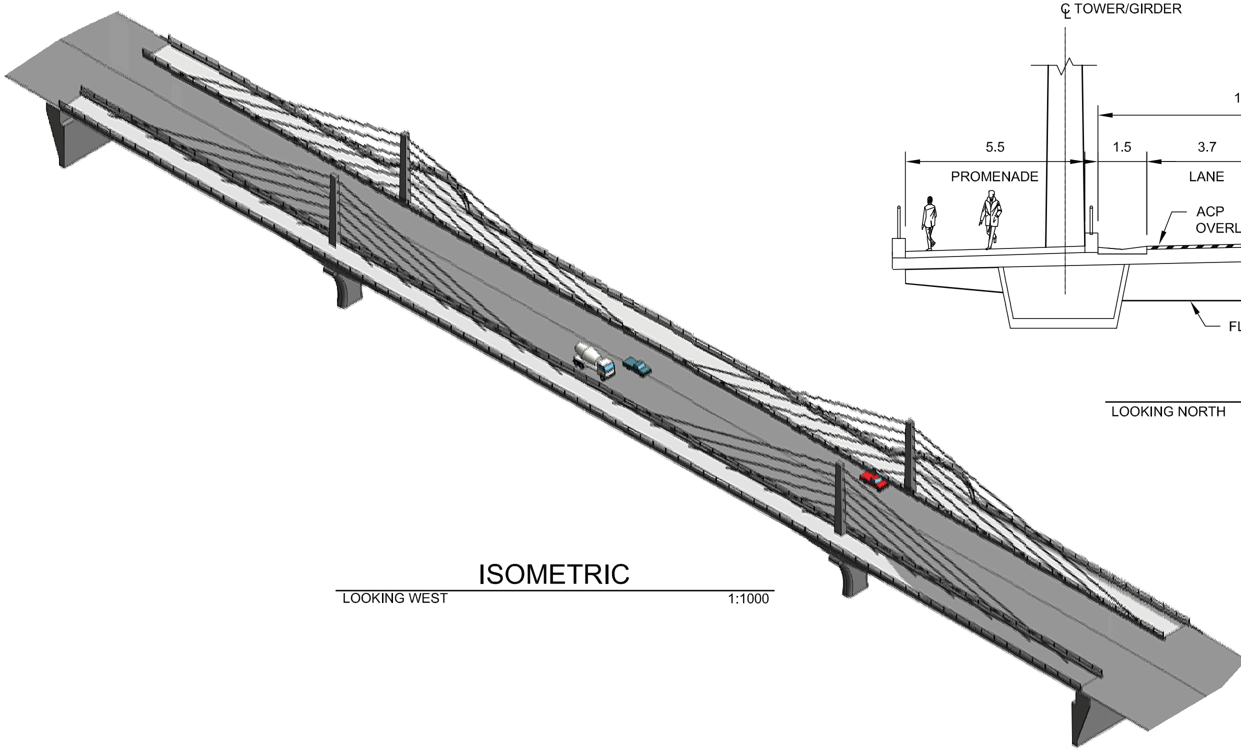
VIEW FROM SOUTH BANK LOOKING NORTH

VIEW FROM BRIDGE LOOKING NORTH



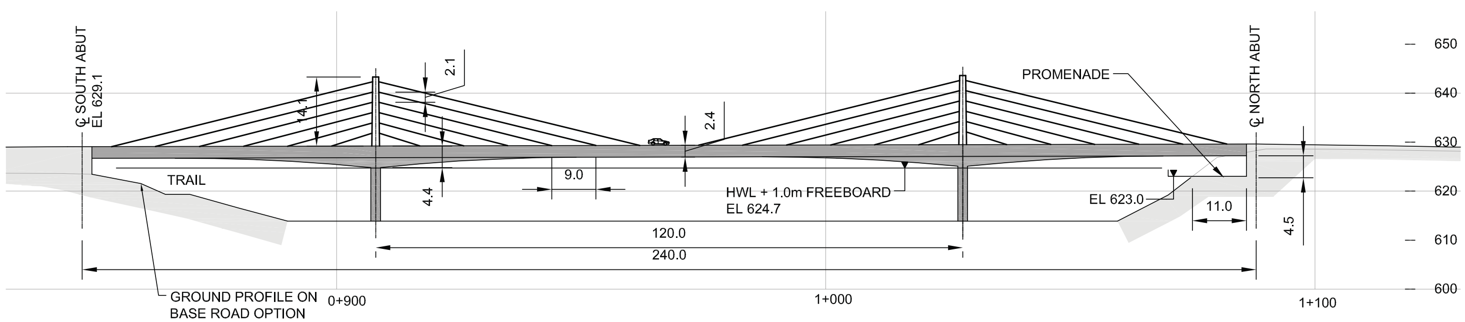
SECTION

LOOKING NORTH 1:150



ISOMETRIC

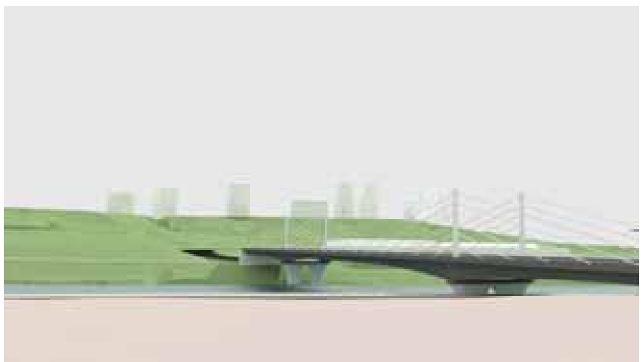
LOOKING WEST 1:1000



ELEVATION

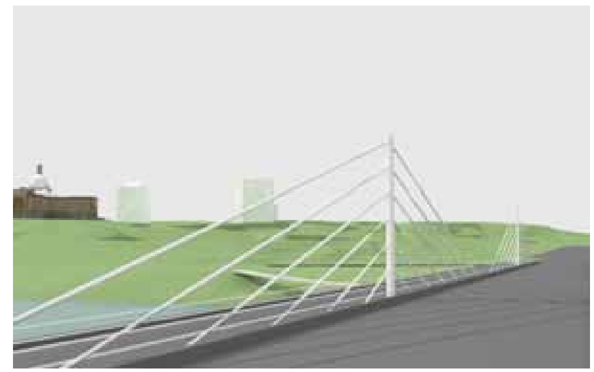
LOOKING WEST 1:1000

EXTRADOSED ALTERNATIVE SECTION IN VALLEY

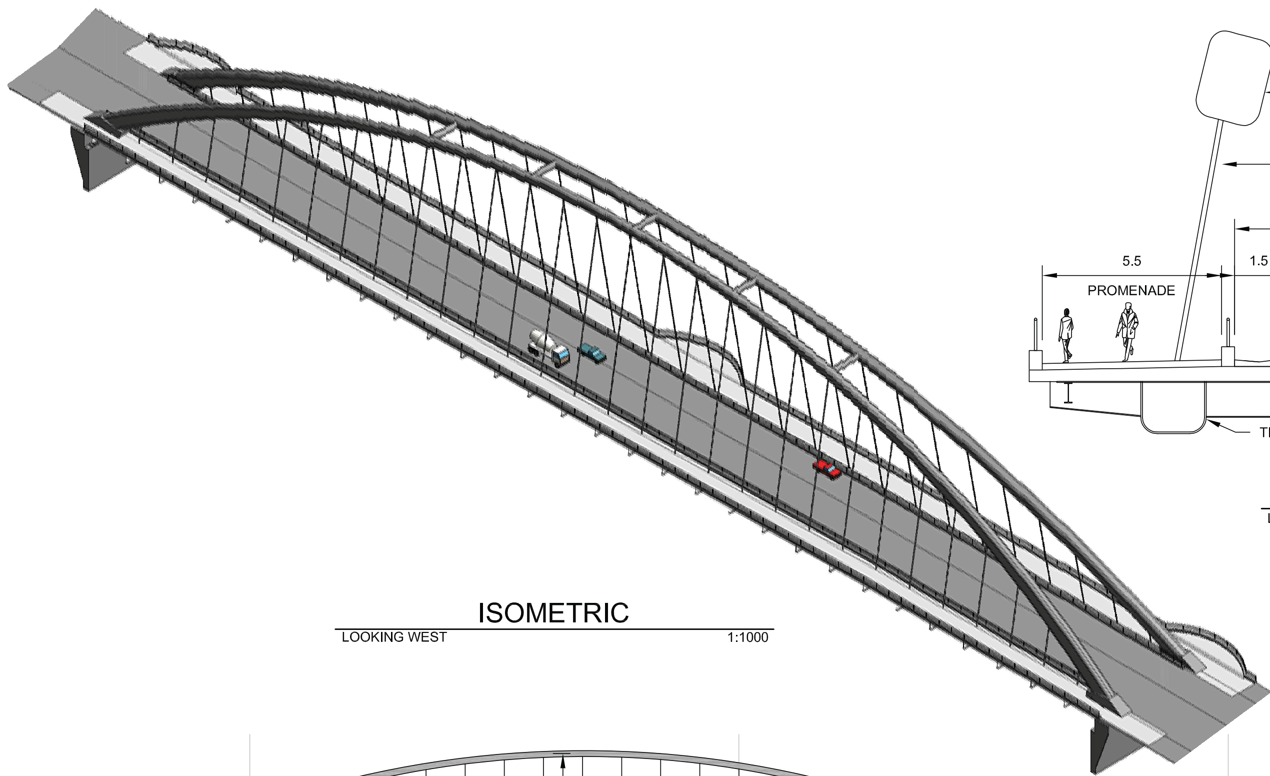


VIEW FROM NORTH BANK LOOKING SOUTH

VIEW FROM SOUTH BANK LOOKING NORTH



VIEW FROM BRIDGE LOOKING NORTH



ISOMETRIC

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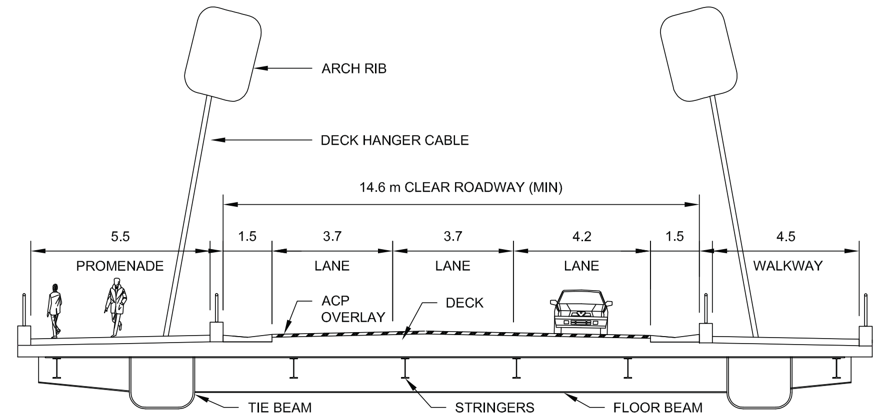

SECTION

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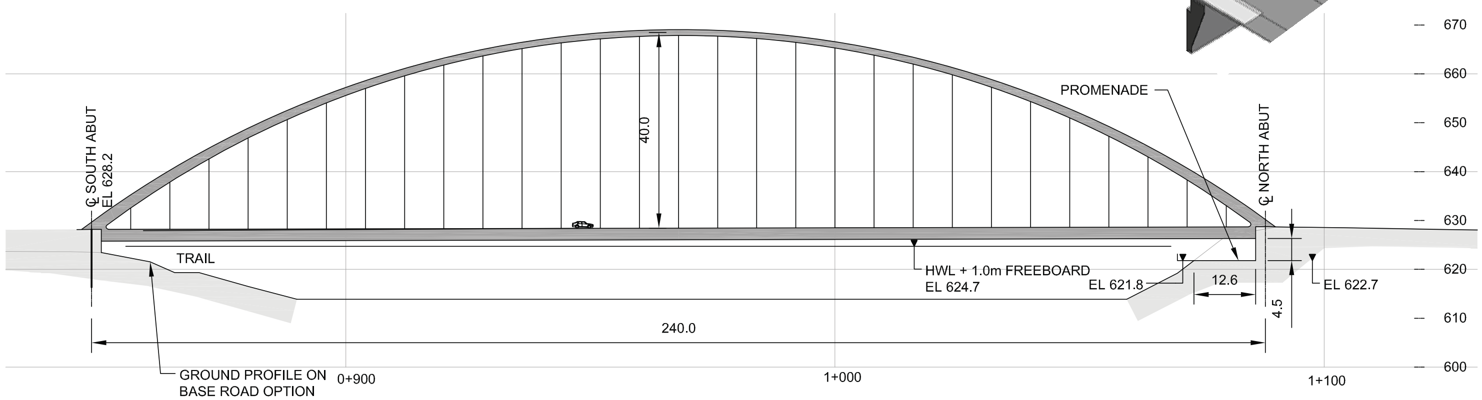


ELEVATION

LOOKING WEST 1:1000

WALTERDALE BRIDGE REPLACEMENT

CONCEPT PLANNING STUDY | FINAL REPORT | APRIL 2011

The City of Edmonton

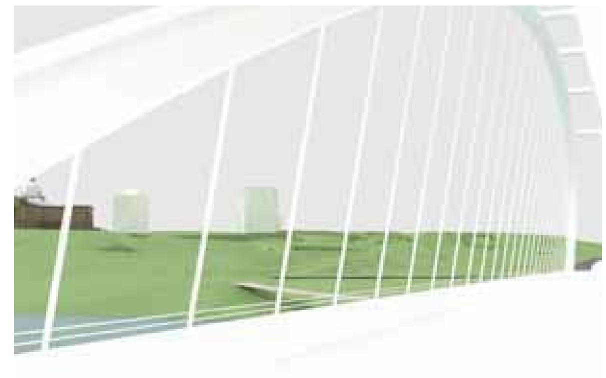
ARCH ALTERNATIVE

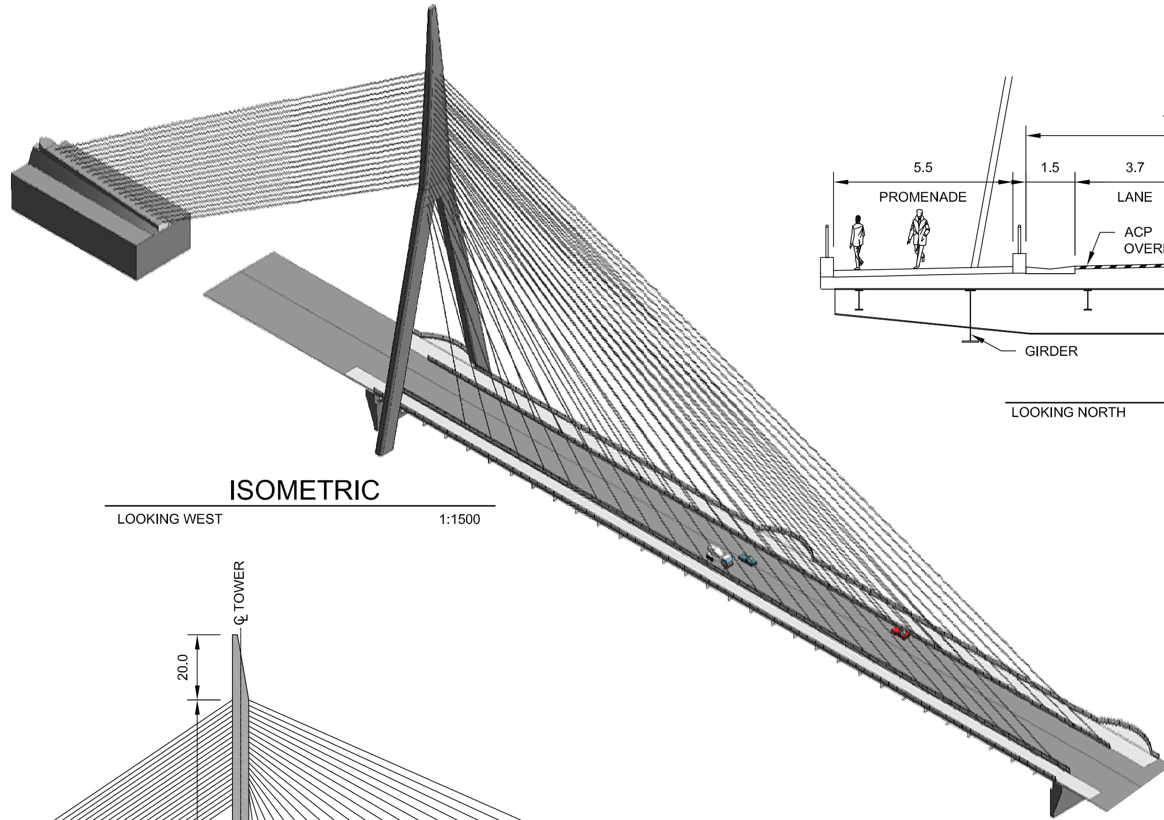
4.13A

ARCH ALTERNATIVE SECTION IN VALLEY


VIEW FROM NORTH BANK LOOKING SOUTH


VIEW FROM SOUTH BANK LOOKING NORTH


VIEW FROM BRIDGE LOOKING NORTH



ISOMETRIC
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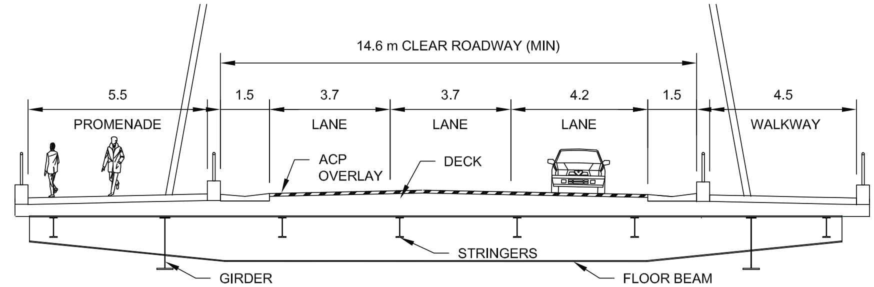

SECTION
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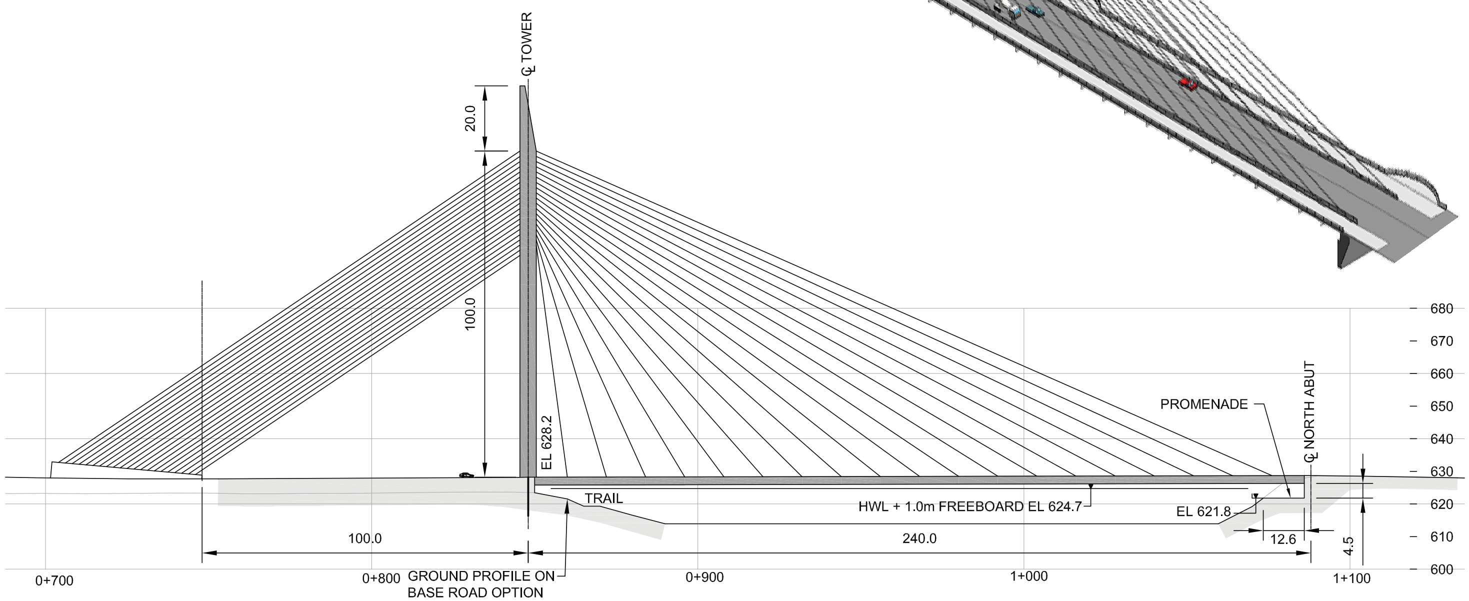
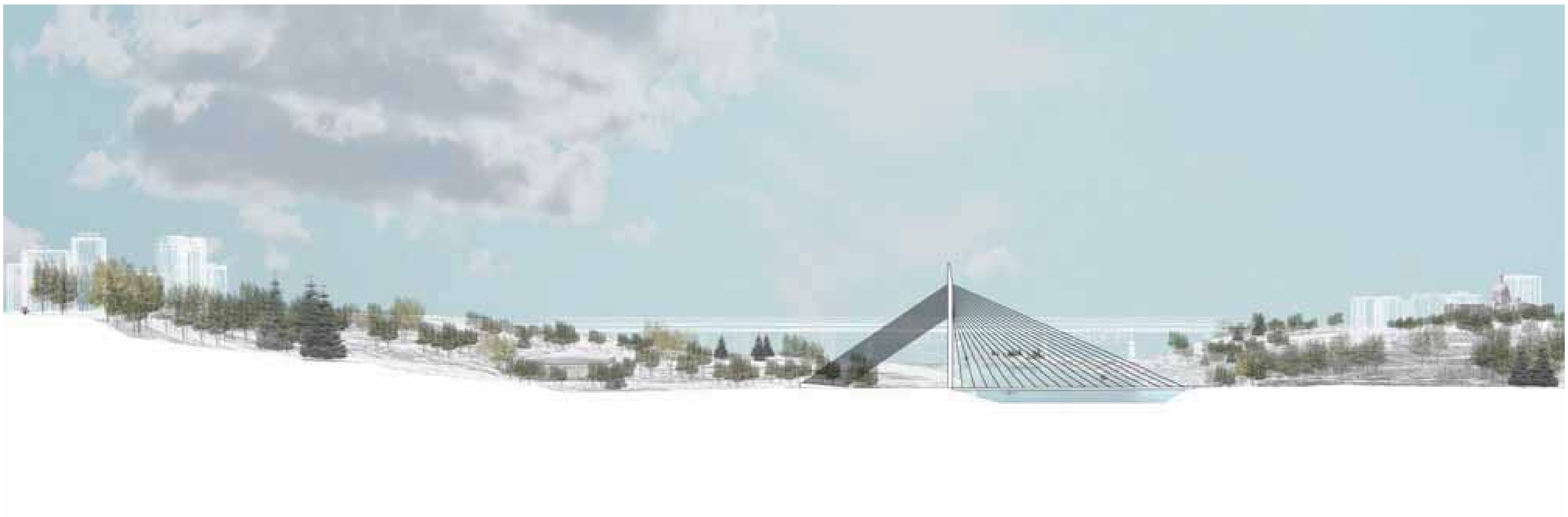
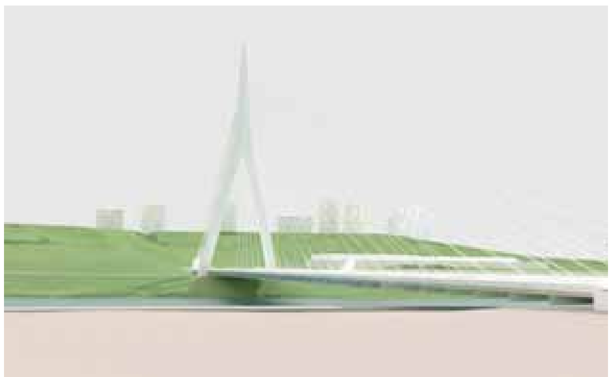


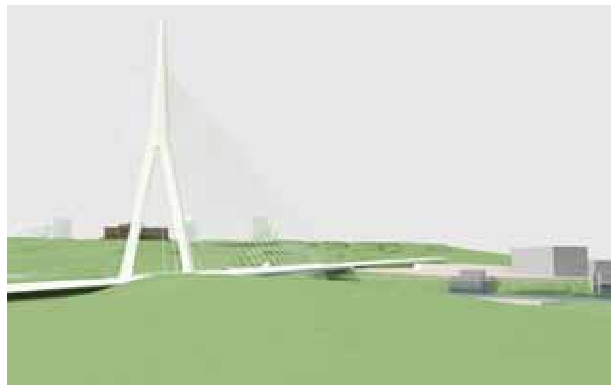
ELEVATION
LOOKING WEST 1:1500



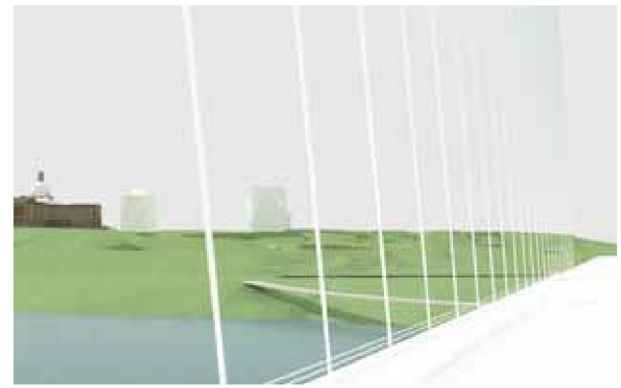
CABLE-STAYED ALTERNATIVE SECTION IN VALLEY



VIEW FROM NORTH BANK LOOKING SOUTH



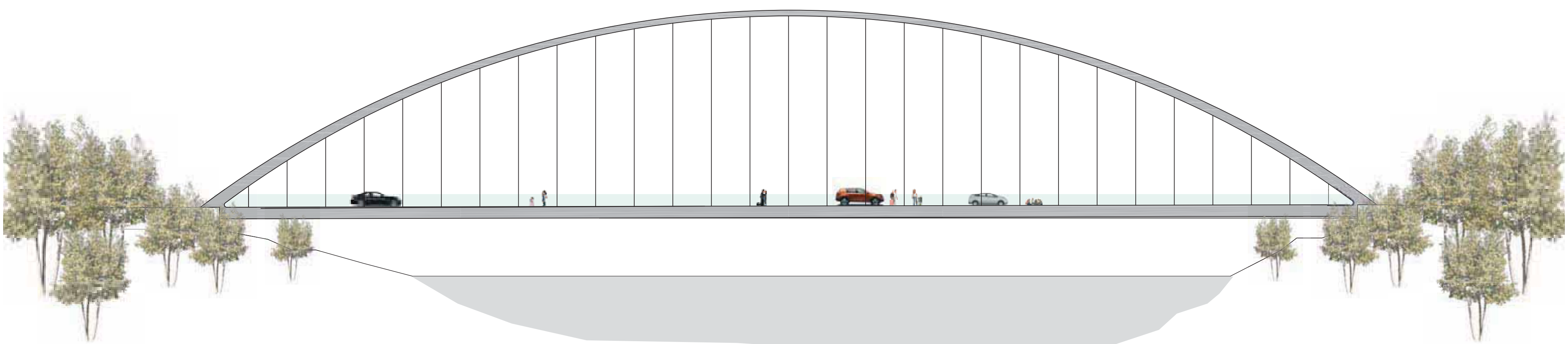
VIEW FROM SOUTH BANK LOOKING NORTH



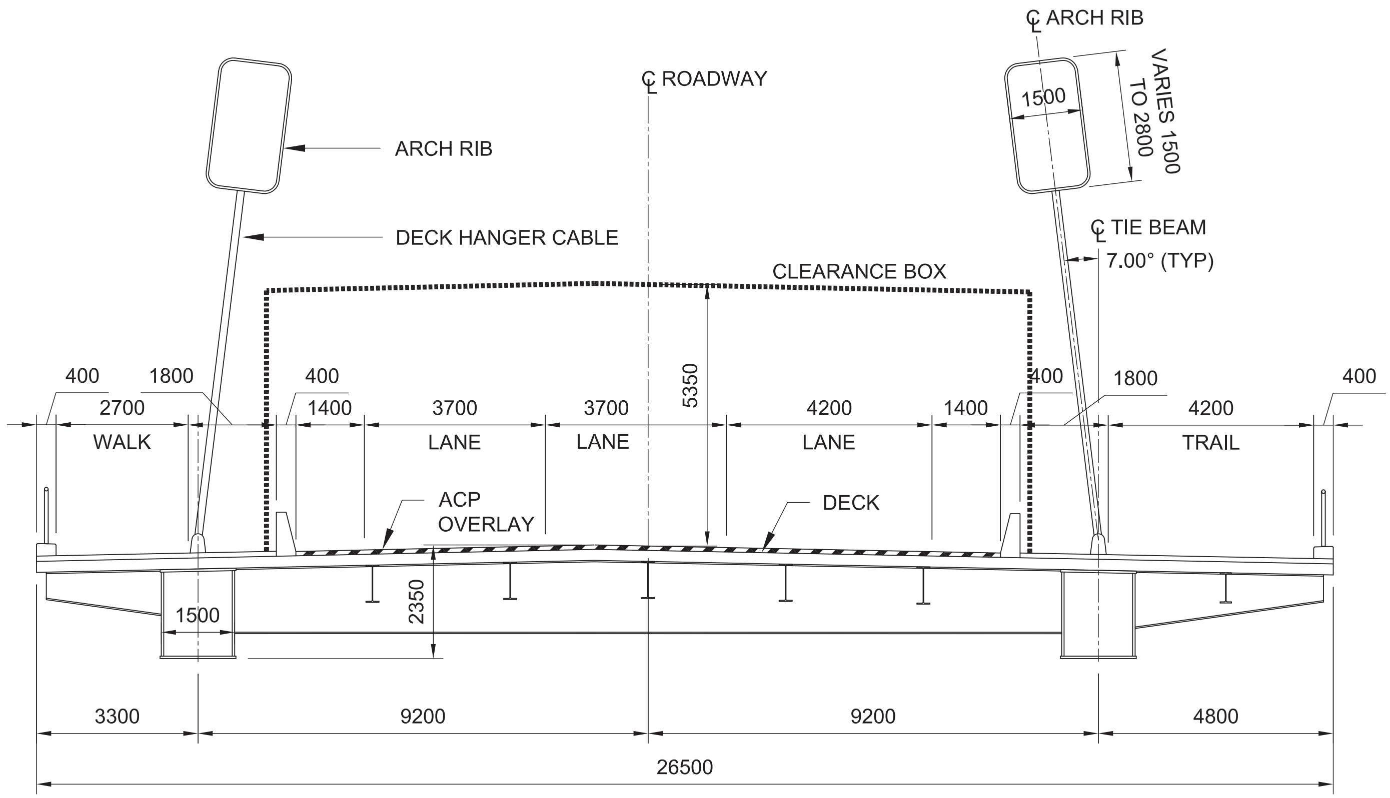
VIEW FROM BRIDGE LOOKING NORTH

ELEVATION

LOOKING WEST 1:750

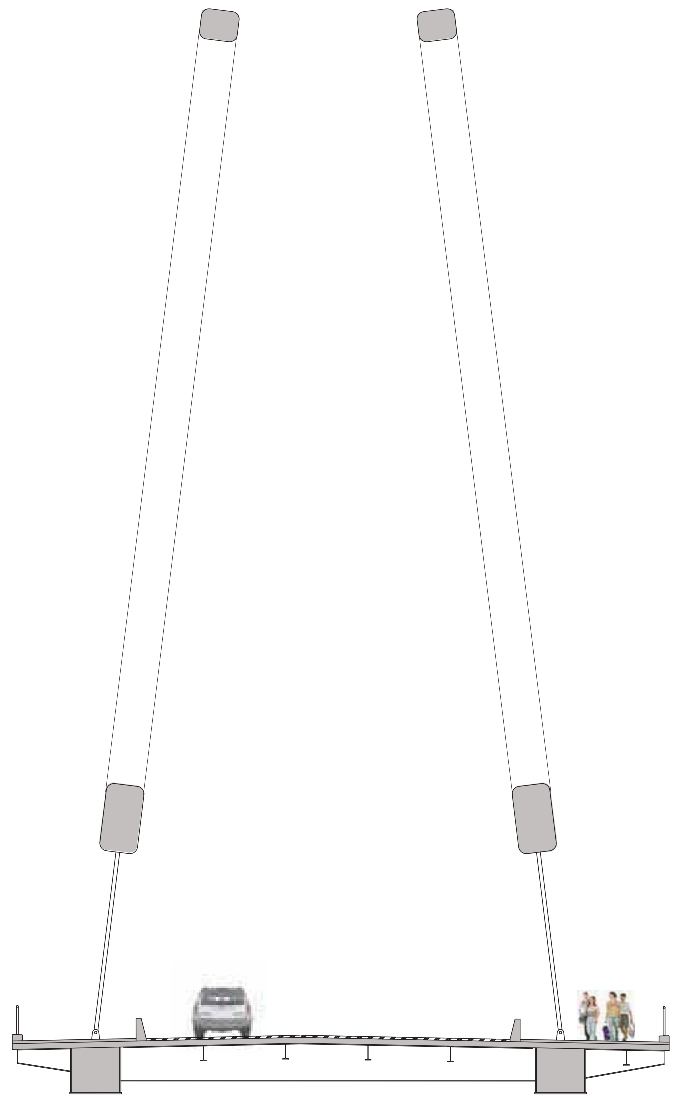


ARCHITECTURAL ELEVATION



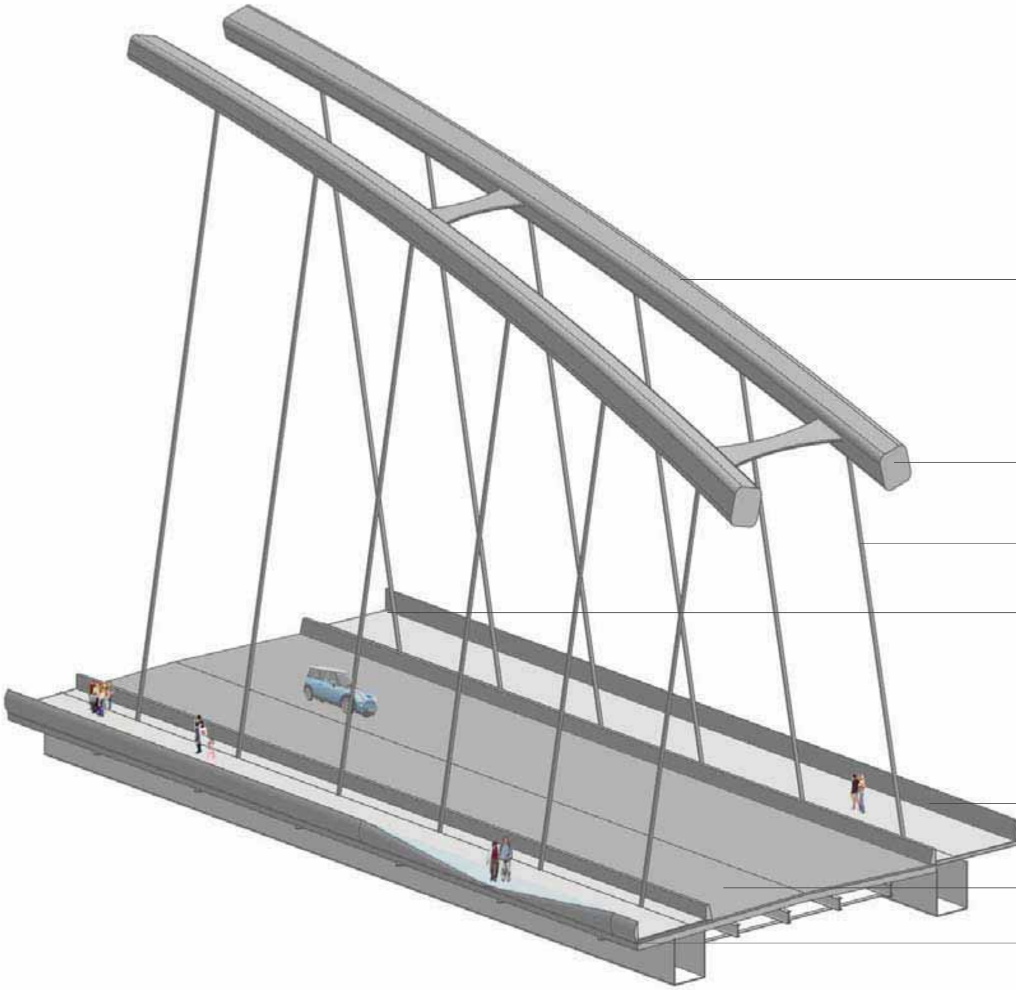
SECTION

LOOKING NORTH 1:100



ARCHITECTURAL SECTION

ISOMETRIC SECTION




dramatic evening & festival lighting


vegetation & solid surface promenade

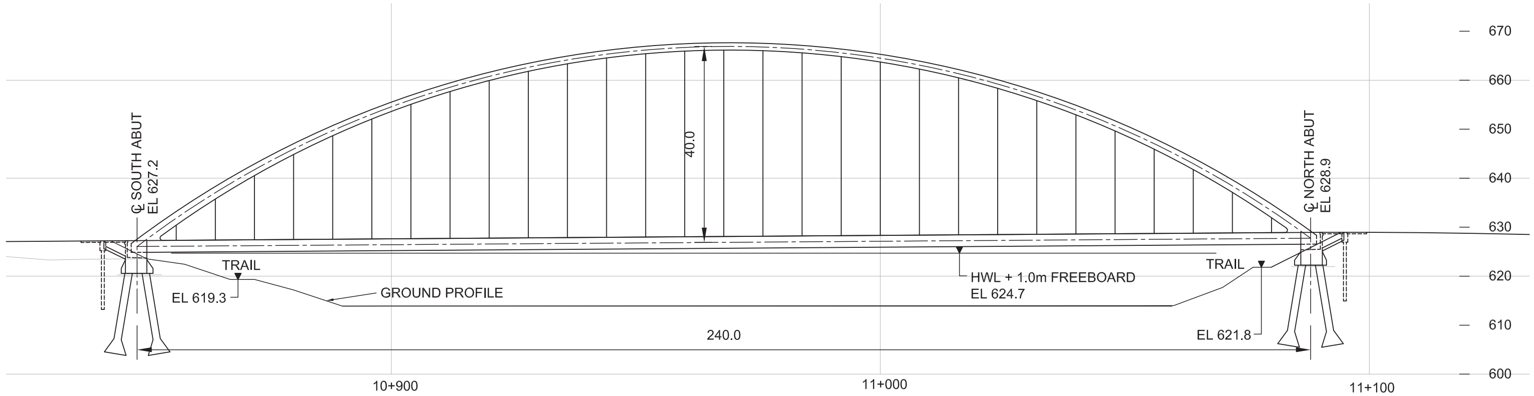

guard rail & abutment potential

RENDERING - SUMMER VIEW
LOOKING WEST ALONG RIVER

BRIDGE VIEW
STANDING ON EAST WALK LOOKING NORTH

RENDERING - NIGHT-TIME VIEW
LOOKING NORTHWEST TOWARDS LEGISLATURE

RENDERING-WINTER VIEW
LOOKING FROM NORTH BANK SOUTHWARD

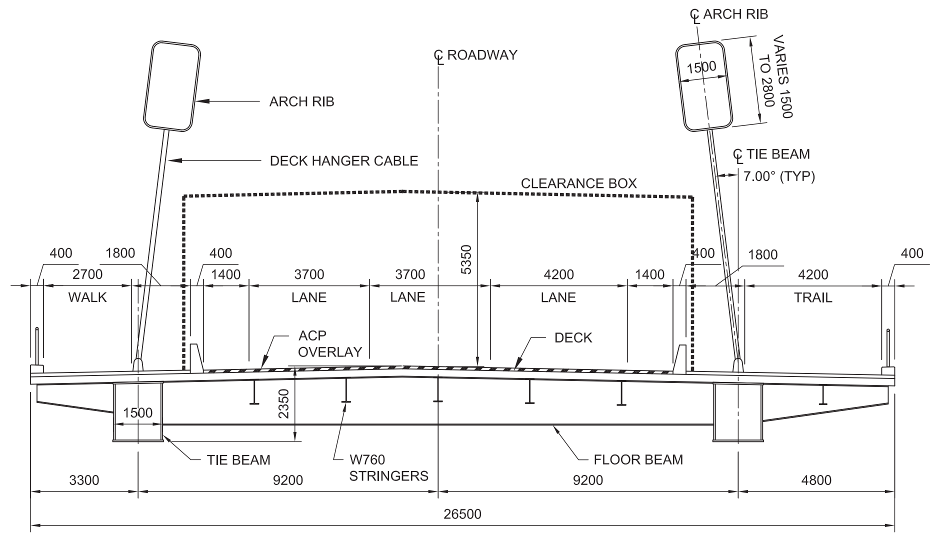


ELEVATION

LOOKING WEST 1:1000

BRIDGE PLAN

1:2000



SECTION

LOOKING NORTH 1:150

NO.	REVISIONS	BY	DATE	APP'D
7				
6				
5				
4				
3				
2				
1	ISSUED FOR APPROVAL	SB	2011-04	

PROGRAM NO. --

CONTRACT NO. --

NO.	ISSUE	BY	DATE
3	TO G.M.U.L.		
2	AS BUILT		
1	TENDER AWARD		

CONSTRUCTION RETURN

CONTRACTOR

SURVEYOR

DATE

FILE NUMBER

CONSTRUCTION ENGINEER DATE

GENERAL SUPERVISOR DATE

DIALOG

PRELIMINARY
NOT FOR CONSTRUCTION

APPROVED FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE

MANAGER, TRANSPORTATION PLANNING BRANCH DATE

DIRECTOR, FACILITY AND CAPITAL PLANNING DATE

SURVEY

JOB NO.

SCALE

HOR.

VER.

DRAWN JW DATE APRIL 2011

DESIGNED SLB DATE APRIL 2011

CHECKED CJM DATE APRIL 2011

THE CITY OF Edmonton

CAPITAL CONSTRUCTION DEPARTMENT

ROADS DESIGN AND CONSTRUCTION BRANCH

PROJECT

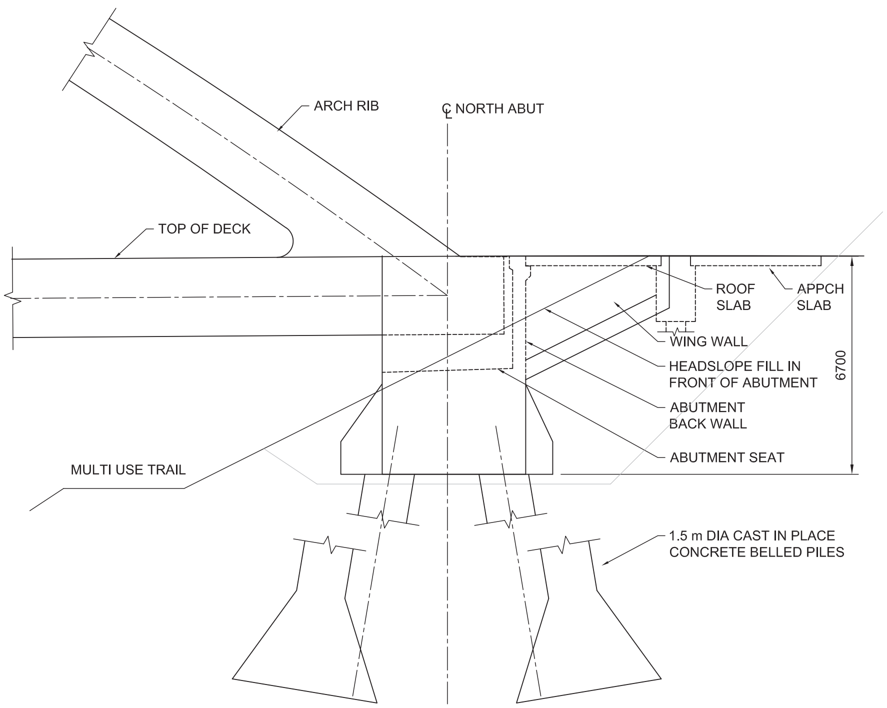
WALTERDALE BRIDGE REPLACEMENT

OVER THE NORTH SASKATCHEWAN RIVER

CONCEPTUAL DESIGN - RECOMMENDED ARCH ALTERNATIVE

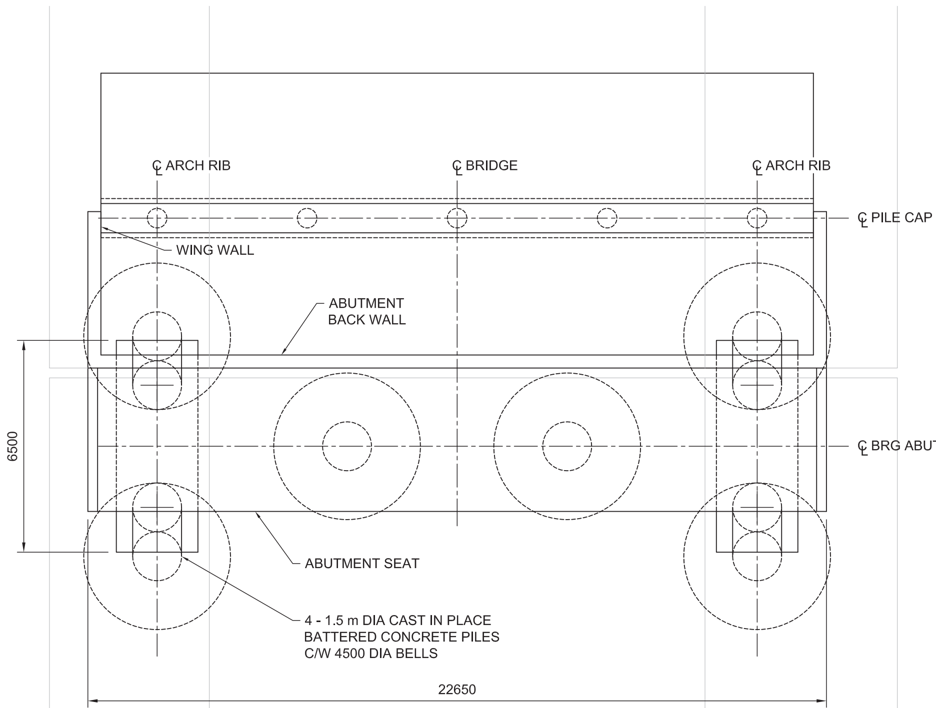
DRAWING

BWAL-111-S01



ABUTMENT ELEVATION

1:150



ABUTMENT PLAN

1:150

NO.	REVISIONS	BY	DATE	APP'D
7				
6				
5				
4				
3				
2				
1	ISSUED FOR APPROVAL	SB	2011-04	

PROGRAM NO. --

CONTRACT NO. --

NO.	ISSUE	BY	DATE
3	TO OJBJS.		
2	AS BUILT		
1	TENDER AWARD		

CONSTRUCTION RETURN

CONTRACTOR

SURVEYOR

DATE

FILE NUMBER

CONSTRUCTION ENGINEER — DATE

GENERAL SUPERVISOR — DATE

DIALOG™

PRELIMINARY

NOT FOR CONSTRUCTION

APPROVED FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE

MANAGER, TRANSPORTATION PLANNING BRANCH — DATE

DIRECTOR, FACILITY AND CAPITAL PLANNING — DATE

SURVEY

JOB NO.

SCALE

HOR.

VER.

		DATE
DRAWN	JW	APRIL 2011
DESIGNED	SLB	APRIL 2011
CHECKED	CJM	APRIL 2011

THE CITY OF Edmonton

CAPITAL CONSTRUCTION DEPARTMENT

ROADS DESIGN AND CONSTRUCTION BRANCH

PROJECT

WALTERDALE BRIDGE REPLACEMENT

OVER THE NORTH SASKATCHEWAN RIVER

CONCEPTUAL DESIGN - ABUTMENT CONCEPTUAL LAYOUT

DRAWING

BWAL-111-S02