

Road over Rail Bridge Analysis



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Executive Summary

Alberta Regional Rail Inc. (ARR) is promoting a proposal to restore modern passenger and commuter rail service along the Calgary-Edmonton corridor, a 300-kilometer route that once carried up to 80,000 passengers annually before its closure in 1985. The revival of passenger rail service in this corridor depends fundamentally on improving safety and operational reliability; historical data show that collisions at grade crossings have resulted in numerous fatalities, service disruptions, and economic losses, which ultimately contributed to the suspension of the Dayliner service. Therefore, grade separation is identified as a necessary condition for any future rail system.

This report presents a strategic and technical Road over Rail Bridge Analysis solutions to eliminate at-grade crossings along the Calgary-Edmonton corridor. Three bridge types are evaluated: property access bridges, rural highway bridges, and urban bridges, based on conceptual geometric design parameters, constructability, environmental impact, and a high-level cost analysis (Class D or 4 – ROM). The methodology incorporates Canadian design standards (CSA S6-19, TAC, Alberta HGDG), best practices for constructability, and cost estimation frameworks (AACE 18R-97).

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1. Background and project context

The Calgary–Edmonton rail corridor gained significance when the Canadian Pacific transcontinental railway reached Fort Calgary in 1883 (Rise and Fall of Passenger Rail in Central Alberta – Forth Junction Project, 2022). Its history began in 1891 when its first line was completed; since then, it has served as a vital artery for the transport of people and goods across Alberta, helping the province become one of the fastest growing in Canada.

Scheduled passenger rail service began in 1930 and was operated by the Canadian Pacific Railway (CPR), starting with just three trains per day in each direction. At that time, the nearly 300-kilometer journey took approximately 6 to 7 hours. However, this line underwent a decisive transformation in 1955 when the first Budd Rail diesel railcar, known as the “Dayliner,” was introduced. This reduced travel time to 3.5 hours and brought annual ridership to an average of 80,000 in 1969, with three daily services (Alberta Regional Rail, 2022).

The Decline

The decline of this route between Calgary and Edmonton began when accidents started occurring at railroad crossings due to increased traffic on both road and rail networks, resulting in collisions, delays, and human and economic losses. Between 1982 and 1984 alone, at least eleven Dayliner accidents were recorded at level crossings, prompting Edmonton Mayor Laurence Decore to describe the more than 200 level crossings as a calamity causing too many deaths (Amtrak Unlimited Forum, 2021).

Although the Alberta government invested in the removal of about 12 level crossings, the intervention was insufficient, and the Dayliner made its final run on September 6, 1985, with its closure justified due to accidents and economic losses. Since then, Alberta has remained without an intercity passenger rail connection between its major cities

Current Events

Currently, numerous efforts are underway to restore passenger rail service, including private feasibility studies and policy initiatives that examine the possibility of restoring the line between Calgary and Edmonton. Among the most significant milestones is a

study that identified the potential for the railway to generate between \$3.7 billion and \$6.1 billion annually in benefits (Van Home, 2004).

Another milestone was the 2010 Rural Impact Study conducted by CPCS Transcom and the 2010 report by the Standing Committee on Alberta's Economic Future.

In 2022, Alberta Regional Rail Inc. formally proposed a modern commuter rail system combining intercity and regional services along the 2/QE2 corridor; this was presented to city councils (Resurrecting the Dayliner? A New Push for Calgary-Edmonton Rail Line, 2022).

The provincial government has launched the Alberta Provincial Passenger Rail Master Plan initiative, further validating the intention to revive the corridor. However, for any passenger rail operation to be viable, the systematic elimination of at-grade crossings is required as a prerequisite for safe and reliable service.

2. Safety justification for the separation of levels.

In this section, we will focus on the historical statistics that justify the project's development from a safety perspective, where it can be seen that the best solution to this problem is a grade separation between the tracks.

The Transportation Safety Board of Canada (TSB) has compiled historical data that highlights the key findings regarding this safety issue, such as:

- Between 1999 and 2022, collisions at railroad crossings in Canada resulted in 630 deaths and 774 serious injuries. Of those killed, 437 were vehicle occupants and 193 were pedestrians (Government of Canada, Transportation Safety Board of Canada, 2025).
- Between 2006 and 2010, collisions at grade crossings resulted in an average of 27 serious injuries and 25 fatalities per year, with one fatality for every 9 collisions and one derailment for every 40 collisions (Transport Canada Grade Crossings Handbook, 2023).
- Between 1999 and 2022, 69% of these collisions involved trains and motor vehicles (Government of Canada, Transportation Safety Board of Canada, 2025).
- In 2022, Canada had 19,458 public level crossings, including both active and passive ones, of which only 2 out of 3 are passively protected (Government of Canada, Transportation Safety Board of Canada, 2025).

This information demonstrates that the elimination of level crossings is not only a matter of operational efficiency to prevent service disruptions along the corridor, but also a fundamental issue of public safety.

2.1. Benefits of implementing an infrastructure for level separation.

The most well-known structures for solving the problem of level crossings are road-over-railways or rail-over-roadways, which are the prevailing international standard for eliminating most of the risks that can arise at level crossings. The key arguments for this type of solution are:

- Complete elimination of conflict points: An overpass eliminates all vehicle-rail interactions, reducing the risk of collision at the crossing to zero.

- Operational speed and reliability: Speed restrictions at these crossings are eliminated, allowing for higher operating speeds and better adherence to the schedule.
- Life-cycle cost: Although the initial cost may be higher compared to ground-level safety solutions, the investment pays for itself in the long term due to reduced operating costs for warning systems and liability costs associated with crossings.
- Regulatory inevitability: The Grade Crossing Regulations (GCR, SOR/2014-275), effective as of November 28, 2024, impose mandatory deadlines and compliance standards on road authorities and railway companies.

2.2. Regulatory framework for the implementation of level crossings.

Canada has an established regulatory framework for the implementation of grade crossings, which requires a commitment to developing solutions for these crossings, establishing regulatory coordination among regulatory bodies, and ensuring compliance with federal, provincial, and local regulations.

The primary regulatory driver to consider for level crossings is the Grade Crossing Regulations (GCR) SOR/2014-275, effective as of November 28, 2024. This is because its scope covers all public and private crossings of Canadian rail lines; This regulation had an initial compliance deadline of November 28, 2022, for high-priority crossings and November 28, 2024, for all other crossings. By 2021, 75% of crossings in Canada approximately 17,470 grade crossings were affected by delays in their resolution, generating increased government pressure to advance these solutions. (Transport Canada, 2021).

The implementation of this regulation can be funded through the Railway Safety Improvement Program (RSIP), which provides grants and contributions under the Railway Safety Act (RSA) for improvements and closures of crossings.

In conclusion, the lack of a planned solution for the restoration of the corridor between Calgary and Edmonton would jeopardize the project; for this reason, evaluating over-road solutions represents an appropriate long-term solution consistent with safety objectives and regulatory compliance.

Appendix A provides a summary of the regulatory instruments and relevant authorities for this project.

3. Alberta Regional Rail Inc. Our Scope Proposal.

In 2022, Alberta Regional Rail formally proposed reinstating modern passenger rail service along the Calgary–Edmonton Corridor, covering approximately 300 km along the CPR main line, with the aim of combining commuter and intercity operations between the following municipal jurisdictions:

- Urban endpoints: City of Calgary (south) and City of Edmonton (north).
- Intermediate urban centers: Airdrie, Crossfield, Didsbury, Innisfail, Red Deer, Lacombe, Ponoka, Wetaskiwin, Leduc.
- Rural county areas: Rocky View County, Mountain View County, Red Deer County, Ponoka County, Wetaskiwin County, Leduc County.

Taking as a critical starting point the QE2/Highway 2 corridor described by Alberta Regional Rail as the most urbanized area in Alberta, generating a significant concentration of activity that creates a variety of crossings requiring different types of bridges.

Bridge classification

Alberta Regional Rail Inc. identifies three types of railway bridges that provide a solution for at-grade crossings. See Appendix B for the classification and types of proposed bridges.

The analysis includes conceptual design parameters, a construction feasibility assessment, environmental impacts, and order-of-magnitude costs (Class D ROM estimates).

Explicit exclusions from this study include:

- Detailed structural design, construction drawings, and engineering calculations suitable for construction bids.
- Site-specific geotechnical investigations or environmental impact assessments
- Detailed cost estimates suitable for project financing or expenditure authorization (requires Class C/B/A estimates)
- Rail-over-road configurations (elevated rail over the road surface)
- Multi-span bridges exceeding 25 m in single-span configurations
- Grade-separated structures exclusively for pedestrians and cyclists.

4. Conceptual parameters defined for the three types of bridges (property, rural and urban).

This section presents the comprehensive geometric design parameters for the three highway-over-railway bridges identified above, in full compliance with the applicable transportation design standards of Canada and Alberta. This analysis addresses the geometric design parameters explicitly required by CSA S6:19 of the Canadian Highway Bridge Design Code (CHBDC), the Alberta Highway Geometric Design Guide (HGDG), Transport Canada's Railway Clearance Standards, and the Transportation Association of Canada's (TAC) Geometric Design Guide for Canadian Highways.

These guidelines and codes must be coordinated to ensure constructible and cost-effective designs, providing applicable standards organized into eight comprehensive categories.

See Appendix C: Conceptual parameters defined for the three types of bridges (property, rural, and urban).

4.1. Horizontal alignment parameters

Design speed

The design speed is defined as the maximum safe speed that can be maintained on a specific section of the roadway under favorable conditions; it is one of the fundamental parameters for geometric design and establishes the minimum values for visibility, horizontal curvature, superelevation, and vertical alignment (Alberta Transportation HGDG, Chapter B).

Minimum horizontal turning radius

This minimum curve radius is determined based on the design speed, maximum superelevation, and lateral friction factor. Chapter B of the Alberta Transportation Highway Geometric Design Guide provides two sets of recommended minimum radii for new construction. Chapter B of the Alberta Transportation Highway Geometric Design Guide.

Maximum superelevation rate

Superelevation is the rotation of the roadway's cross-section around its centerline to counteract centrifugal force on horizontal curves. Maximum limits are established based on climate, functional classification, and terrain. These limits are set by the Alberta Department of Transportation.

Spiral transition curve

Spiral transition curves provide a gradual change in curvature between tangent sections and circular curves, allowing for smooth cant transitions and preventing abrupt changes in direction. Chapter B of the Alberta Transportation HGDC specifies the minimum lengths of spirals based on design speed and cant rate.

The minimum spiral length is calculated to provide: an adequate cant run-out distance, a comfortable rate of change in lateral acceleration, sufficient distance for the driver to adjust direction, and coordination with the vertical alignment where horizontal and vertical curves overlap.

4.2 Vertical alignment parameters

Maximum grades

Longitudinal grades of the roadway affect vehicle handling, safety, sight distance, and construction costs; therefore, maximum grade criteria are established based on functional classification, speed, and terrain. In the case of a bridge over a railroad track, vertical clearance requirements must be taken into account.

Minimum Drainage Gradients

Bridges require a minimum longitudinal gradient to ensure proper drainage and prevent water accumulation on the roadway surface. The Alberta Transportation Department recommends a minimum gradient of 0.3% on all paved surfaces to ensure proper drainage.

K-values for vertical curves

The K-value defines the vertical curvature rate for both crest (top) and trough (bottom) vertical curves. It is mathematically defined as $K = L / A$, where L = length of the vertical curve (meters) and A = algebraic difference in gradients (percent). K values are established to provide an adequate braking sight distance (BSD) for the design speed; the minimum K values are derived from Chapter B of the Alberta Transportation HGDC (September 2020), Table B-4-4a (Crest) and Table B-4-5a.

4.3 Cross-section elements

Cross-sectional elements define the geometric configuration of the bridge by specifying its width and access lanes. Chapter D of the Alberta Transportation HGDC establishes standard cross-sectional elements based on functional classification, design speed, traffic volume, and operational requirements.

4.4 Sight Distance Requirements

Sight distance is the length of roadway ahead visible to the driver. Alberta Transportation HGDC Chapter B defines four types of sight distance: Stopping Sight Distance (SSD), Passing Sight Distance (PSD), Intersection Sight Distance (ISD), and Decision Sight Distance (DSD). All roadways must provide adequate SSD at all points.

4.5 Railway authorization requirements

The 7.1-meter vertical clearance requirement is derived from Transport Canada's Standards for Railway Clearances and the AREMA Handbook of Railway Engineering, Chapter 28. This clearance accommodates: standard rail freight cars (maximum height of 4.88 m), double-stack container cars (approximately 6.1 m), specialized equipment (up to 6.4 m), dynamic envelope for vehicle sway (0.3 m tolerance), and maintenance allowance for future ballast additions (0.3 m).

4.6 Structural design parameters

Structural design parameters are governed by the Canadian Highway Bridge Design Code (CSA S6-19, CHBDC), the primary mandatory standard for highway bridge design in Canada. The CHBDC establishes requirements for design loads (CL-625 truck load), load combinations, resistance factors, deflection limits, and structural analysis methods.

All bridge structures in Alberta must comply with CHBDC requirements, regardless of their jurisdiction or functional classification.

Design vehicles determine load requirements, service life specifies durability criteria, and the depth of the structure affects the overall elevation of the bridge profile and the quantities of approach earthworks.

4.7 Security and barrier systems

Safety elements are governed by Chapter F (Road Design) of the Alberta HGDG Transport and Chapter 7 of the TAC Geometric Design Guide.

4.8 Drainage and winter operations

The design of bridge drainage systems must prevent water accumulation on deck surfaces, protect structural elements from moisture damage, and minimize the risk of freezing. Alberta's winter climate (November–March) demands careful attention to drainage design and anti-icing strategies.

These parameters represent appropriate minimum values for conceptual planning; specific project designs may vary depending on site conditions, operational requirements, and regulatory approval. This deliverable serves as the technical basis for the Constructability Assessment, Environmental Impact Assessment, and Cost Analysis.

5. Constructability Assessment

The following is an assessment of the feasibility of constructing the three types of road-over-rail bridges identified in the Road-Over-Rail Bridge Analysis project.

This assessment addresses the construction sequence, the use of prefabricated components, crane requirements, the on-site construction footprint, and the identification of risks and limitations regarding construction feasibility (RSMMeans, 2024).

5.1 Typical construction sequence

In this section, we will outline the logical sequence of steps required for the construction of precast concrete highway-over-railway bridges in Alberta. This sequence can be applied to all three types of bridges.

Phase 1: Preliminary

This stage involves making all the necessary preparations to begin construction. Below, we will describe what must be considered:

- 1) Construction camps are set up, and adjustments are made to ensure site access. Additionally, traffic management measures are implemented, such as lane closures, detours, and signage. These traffic plans must be pre-approved by the authorities in each city or town where the work will take place.
- 2) Existing utility lines such as water, gas, electricity, or telecommunications must be relocated if necessary. This is an activity that often extends the construction phase.
- 3) Coordination must be carried out with Canadian Pacific Railway (CPR), to whom the construction work plan must be submitted for approval; the plan must demonstrate compliance with engineering standards and the requirements established by Canadian Pacific Railway.

Environmental protection planning is also carried out, including the installation of sediment barriers and erosion control measures in accordance with Alberta's environmental protection and improvement requirements. If there is a water source nearby, additional permits may be required.

Phase 2: Construction of the Substructure.

This phase involves the construction of the substructure below ground level, including initial excavation, installation of structural steel, and casting of the foundation. This includes the following steps.

- 1) Geotechnical analysis for foundation design: At this stage, boreholes are drilled in the area where the bridge will be built to determine the soil stratification. This helps establish the bearing capacity and the water table, thereby determining whether a deep or shallow foundation will be required.
- 2) Once the foundation plans have been approved, excavation and earthwork must be carried out. These excavations are typically between 2.5 and 3.5 meters deep if the foundation is shallow. This is because the national building code specifies that the minimum frost depth in Alberta is 2.4 meters.
- 3) Next, the footings must be constructed or the piles installed, depending on the specifications in the plans. These footings require formwork, the installation of reinforcing steel, and subsequent casting with concrete. All specifications for these materials will be established in the design drawings but must comply with ASTM C94.
- 4) The abutment walls and reinforced concrete retaining walls must be constructed; these walls may be made of cast-in-place concrete or precast concrete panels.

The technical specifications for the foundation must take into account the requirements of the applicable standard, CSA S6:19 of the Canadian Highway Bridge Design Code (CHBDC).

Phase 3: Assembly of the superstructure

This phase involves the construction of the substructure located above ground level.

- 1) Coordination with the supplier of the precast beams must take place simultaneously with the construction of the foundation substructure, since these beams are manufactured at plants operated by companies such as Eagle Builders. Typically, these beams have a total manufacturing lead time of 6 to 8 weeks from the approval of the shop drawings.

- 2) The precast beams must be transported to the job site on trailers that comply with all safety guidelines, as these beams can be up to 27 m long and 3.5 m wide, which requires applying for an oversized load permit from Alberta Transportation. It is recommended to transport these elements at night, and a route map is usually prepared, as passage in urban areas may be restricted due to their height and weight, which could cause damage to power lines or urban infrastructure.
- 3) Prior to the arrival of the beams, a hydraulic crane or a crawler crane must be installed on-site to unload the beam from the trailer and move it directly to the supports left in place from the superstructure. This assembly typically takes between 6 and 8 hours, and the most important aspect of this stage is to work during the track access periods approved by CPR. Keep in mind that for our project, the train track is not in operation; however, light vehicle traffic may still be present.
- 4) As the beams are being installed, a surveying team must continuously evaluate the elevation and horizontal alignment of the beams, ensuring proper alignment for the slab installation; if any discrepancies are found, shims can be placed under the support pads.

Phase 4: Deck and finished

This is the stage where the section that vehicles will travel on is constructed and finished.

- 1) At this stage, the bridge deck is poured; wooden formwork must be installed between the beams, the mesh and reinforcing bars are installed as specified in the drawings, and the drainage systems are pre-installed.
- 2) Once this is complete, the deck must be cast in place unless a prefabricated option is specified; Eagle Builders can also handle these options. These decks typically have a thickness of between 200 mm and 250 mm, depending on the bridge's design capacity.
- 3) Once the deck has been poured, passive safety elements are installed, such as guardrails that comply with Alberta transportation standards. If the bridge has pedestrian access, a separate guardrail must be installed.

- 4) After the deck has cured, the platform can be surface-waterproofed, and asphalt can be laid to provide greater protection during the winter season.

Phase 5: Access and Demobilization Roadwork

This phase is the final stage of the bridge construction, during which the bridge access areas are built and all temporary construction elements are dismantled. Below, we outline the process.

- 1) Construction of access embankments must first begin to achieve the required grade; the fill is placed in 300-mm layers and compacted to 95% of standard Proctor density.
- 2) The pavement connecting the bridge to the existing access road is installed.
- 3) Landscaping work is carried out, and protective elements such as construction fences and traffic control systems are removed.
- 4) The bridge undergoes load testing.
- 5) A final inspection is conducted, and approval is requested from the municipal authority to proceed with commissioning.

In conclusion, we see that the project consists of five main phases during the on-site construction phase, during which parallel activities can be carried out between the prefabricated component production plant and on-site activities in order to optimize time and costs.

Total duration of the construction project

The project consists of a preliminary design phase, which encompasses the entire process of design and permitting; a design phase, which covers the construction phase; and a post-construction phase. This implies not only a sequence of activities but also the time required for implementation.

The typical total duration of construction for a single-span precast concrete highway-over-railway bridge:

- Access bridge to the property: 14 to 18 weeks (3.5 to 4.5 months)
- Urban bridge: 18 to 24 weeks (4.5 to 6 months)
- Rural highway bridge: 16 to 20 weeks (4 to 5 months)

These time estimates are based on high-level analyses that recommend construction during non-winter months; if work is carried out during the winter, an additional 20% to 40% should be factored in due to reduced productivity and delays caused by concrete curing (*Standard Specifications for Bridge Construction. Edition 17 - Open Government, n.d.*).

5.2 Use of prefabricated elements for bridges

Using prefabricated components offers a time advantage, although the costs may be slightly higher; below we will look at the advantages.

Advantages of prefabricated construction.

- Quality control: Quality control is better because the components are manufactured in plants.
- Faster construction schedule: Beam fabrication takes place simultaneously with the construction of the substructure.
- Safety: Most concrete work is performed in a controlled plant environment.
- Weather independence: Precast manufacturing is not affected by Alberta's winter weather.
- Rail coordination: Precast construction minimizes work within the railway right-of-way, reducing CPR signaling costs and operational disruptions.

Types of precast girders for road-over-rail bridges

In Alberta, precast concrete beams can be used for bridge construction. These beams are shipped from the manufacturing plants to the construction sites and installed on-site within 1 or 2 days. Generally, the following three types of precast concrete beams are used.

Standard AASHTO beams (Type II, III, IV)

Prestressed concrete I-beams with standardized cross-sections established by the American Association of State Highway and Transportation Officials (AASHTO).

- Span range: Type II: 10–15 m; Type III: 12–20 m; Type IV: 18–27 m
- Application: Access bridges to properties and rural roads with spans of 25 m generally use AASHTO Type III or Type IV beams.
- Availability: All precast manufacturers in Alberta produce sections according to the AASHTO standard. The formwork is reusable, resulting in lower costs than custom sections.

CPCI (Canadian Precast and Prestressed Concrete Institute) Bulb-T Beams

Modified I-beams with a bulbous lower flange for greater structural efficiency. Also known as NU beams or bulb-T beams (DBT).

- Span: 20–40 m
- Application: Urban bridges and longer rural highway bridges. Bulb-T sections are more efficient (lower weight for equivalent capacity) than AASHTO I-beams, reducing the need for cranes and lowering transportation costs.
- Availability: Eagle Builders manufactures CPCI bulb-T sections and has completed several bridge projects in Alberta, including the Bow River Irrigation District Canal Bridge (24 girders, 12 to 14 m long, completed in 2021).

Spread Box Girders

Precast concrete sections (closed rectangular cross-section) with an integrated deck. Also known as “extended box girders.”

- Span: 15–30 m
- Application: Urban bridges where aesthetics are important. Box girders provide a clean appearance on the underside (no exposed girder webs) and a continuous deck surface.
- Limitations: Heavier than I-beams (60–100 tons), requiring larger cranes. Less common in Alberta; limited manufacturer capacity.

For the three types of bridges to be built for the Calgary–Edmonton corridor, we recommend using Nu Beams, which meet the span requirements for the intersections and can also be manufactured by Eagle Builders. However, while these can only be manufactured by Eagle Builders, installation must be performed by another contractor (Jacob V.Nieuwenhuyze of Eagle Builders, personal communication, February 2026).

5.3 Crane requirements

Cranes are essential equipment in bridge construction, primarily for moving heavy components such as beams or construction materials required on site. For this reason, the crane's capacity requirements are evaluated, as these are determined by the maximum load lifted, which consists of:

- Beam dead weight (25–80 tons, depending on the type of bridge).
- Lifting equipment weight (slings, spreader bars, shackles): 1–2 tons.
- Dynamic lifting factor: 15–25% of the static load.

Required crane capacity = (Beam weight + Rig weight) × 1.25 (dynamic factor). In practice, cranes with a capacity margin of 50 to 100% are selected to accommodate boom angle, radius, and operational flexibility.

To view crane requirements based on the type of bridge to be constructed, see Appendix D: Crane requirements according to bridge type (property, rural, and urban).

Considerations for Selecting the Type of Crane

In this section, we will evaluate the advantages and disadvantages of the types of cranes that can be used in bridge construction, such as mobile hydraulic cranes and crawler cranes. See Appendix D: Crane requirements according to bridge type (property, rural, and urban).

5.4 Approximate site area and access routes required during construction

When constructing each bridge, it is necessary to identify a site where not only the bridge will be erected but also where general construction work will take place throughout the process. Below, we provide an estimate of the total space required for the construction of each bridge.

- Excavation and abutment formwork area (both ends of the bridge): 15 m × 10 m per abutment = 300 m² total.
- Crane platform and swing radius: 20 m × 25 m = 500 m².
- Beam laying and assembly area: 30 m × 10 m = 300 m².
- Material storage area (excavated soil, aggregates, reinforcing steel): 20 m × 15 m = 300 m².
- Trailer and parking area: 15 m × 10 m = 150 m².
- Equipment and vehicle maneuvering area: 20% of the above = 270 m².

Approximate total area: 1,820 m² for the construction of an access bridge to the property. Urban and rural road bridges require larger areas due to the greater number of beams, the larger turning radius of cranes, and a more extensive traffic management infrastructure.

See Appendix E: Approximate areas affected by bridge construction.

Admission Requirements

During this construction phase, access requirements must be evaluated. These may include additional permits to transport beams along federal highways. Additionally, as mentioned, access roads must be wide enough to allow large-scale elements to pass safely; these roads should be at least 4 meters wide to accommodate cranes.

Additionally, traffic management plans must be considered in case temporary road closures are required; such plans must be approved by local authorities and typically require special signage and coordination with emergency services (such as ambulances, fire departments, and police). Finally, coordination with public utilities is necessary if any services—such as water, gas, electricity, or telecommunications—run through the area to be worked on. This may require coordination with the responsible companies.

5.5 Identification of Constructability Risks and Limitations

Developing infrastructure projects can give rise to various constraints and constructability risks. Below, we will assess the risks to which the project may be exposed and how they might be mitigated. See Appendix F: Risks and Limitations of Constructability.

Additional risk considerations

Alberta's construction industry often faces additional risks related to labor and equipment availability due to periods of high demand driven by the oil sector. During these periods, skilled labor and heavy machinery tend to become scarcer or more expensive, which could lead to delays or cost overruns. To avoid such circumstances, it is recommended that:

- Early contracting of contractors with strict performance clauses that ensure commitment and guarantee equipment and labor.
- Contracts based on fixed unit prices.
- Requirement for performance and surety bonds to support contracts with contractors and suppliers.

These considerations should also consider the production time for prefabricated components, as this process typically takes 3 months plus an additional 6 weeks for the shop drawings (Jacob V. Nieuwenhuyze of Eagle Builders, personal communication, February 2026).

Finally, it is important to consider the necessary environmental approvals, such as permits required if the project is located near water sources, which can take 6 to 12 months to process. For this reason, it is recommended to conduct an environmental assessment during the pre-design phase to identify where these types of special permits need to be obtained.

6. Environment Impact on Adjacent Land Uses

Due to the scale of bridge construction projects, they can have an environmental impact on the areas surrounding the Calgary-Edmonton corridor, which encompasses a wide range of land uses shaped by its role as Alberta's primary corridor for intercity transportation and economic development. The land use categories to consider when planning railway bridges are:

- **Agriculture:** Intensive crop production (wheat, canola, barley) and livestock farming predominate in the rural corridor, covering approximately 80% of the land area between the city limits of Calgary and Edmonton (Government of Alberta, 2024). County-level zoning typically designates these lands as "Agricultural District" or "Agricultural Land Preservation."
- **Urban residential and commercial areas:** Incorporated municipalities (Red Deer, Lacombe, Airdrie, Wetaskiwin, Leduc) have established residential neighborhoods, commercial districts, and light industrial zones adjacent to the Canadian Pacific Railway (CPR) corridor.
- **Industrial:** Concentrated in urban fringe areas, including grain terminals, rail-accessible warehouses, and manufacturing facilities that rely on direct rail access.
- **Natural Areas:** Riparian corridors along rivers and streams (Red Deer River, Blindman River, Battle River), provincially significant wetlands, and remnant patches of native grasslands protected under environmental reserve designations (Government of Alberta, 2024).

Since the project involves three types of bridges, we will assess the impact each would have based on its intended use.

Property bridge: Minimal Impact

These types of bridges, which must be built to provide access to properties, are typically located on land zoned for rural agricultural use, where they can cause the following impacts:

- Visual impact: This impact results from structures that can reach an average height of 8 to 10 meters from the ground to the deck, creating a visual disruption of the agricultural landscape.
- Division of the property: At some crossings, the bridge and the embankment may divide sections of the farm, which could hinder access for agricultural machinery moving between fields. However, these crossings currently already have a crossing controlled by the railroad.
- Noise: The noise generated temporarily by construction may affect the area surrounding the project.
- Pollution: The construction work may generate a significant amount of waste that must be disposed of at certified sites; however, during the construction period, dust may be generated by earthmoving activities. To mitigate this, water spraying can be used to reduce its spread.

In conclusion, this type of bridge is compatible with agricultural land use and has a minimal impact; the main concerns could be the temporary closure of the crossing during construction and the loss of land that could result from the widening of the right-of-way.

Urban Bridge: Moderate to High Impact

These types of urban bridges are located within or adjacent to municipalities or small towns along the corridor; these areas typically have diverse land uses and higher economic value, which makes the community more sensitive to this type of project development, leading to greater resistance and a greater impact on the surrounding environment:

- Visual impact: Urban bridges create a visual barrier 8 to 10 meters high, which affects the residential and commercial areas near the bridge, as the bridge

structure—including abutments and embankments—will be visible from homes, businesses, and parks.

- Privacy and visibility: The elevation of the roadway by the bridge allows people in vehicles and pedestrians crossing it to see into adjacent residential yards, which can create a sense of intrusion into privacy—a common concern in this type of project.
- Property values: Proximity to transportation structures can negatively affect the value of residential properties due to visual intrusion, noise, and a perception of insecurity. Studies conducted on urban highway overpasses in Alberta have documented reductions in property values ranging from 5% to 15% for homes located within 50 meters of elevated structures.
- Noise: Traffic noise from vehicles crossing the bridge is greater than at at-grade crossings due to the interaction between tires and the pavement on the bridge deck and the dispersion of exhaust gases. Urban bridges may require noise barriers or pavement surface improvements to mitigate the impact on adjacent homes.

In conclusion, urban bridges have a moderate to high impact on land use, which requires careful integration of the project through its design; this must involve the community in order to propose potential mitigation measures. Typically, municipalities implement land-use planning processes to address community concerns.

Rural bridge: low to moderate impact

These types of bridges will connect to existing rural roads that pass through agricultural areas and rural residential areas; their impact is typically low to moderate

- Visual impact: These bridges will have a moderate visual impact, as they will be visible from farms and rural residences; however, given their context and location, their impact will be relatively limited.
- Rural residential properties: Some rural road bridges cross areas with subdivisions (residential lots ranging from 1 to 4 hectares). These property owners are more sensitive to visual intrusion and privacy concerns than farmers, but less so than urban residents.

- Agricultural operations: Minimal impact on crop production. Possible minor impact on livestock operations if the bridge and embankments restrict livestock movement or access to pastures.
- Heritage and cultural landscapes: The Calgary-Edmonton corridor passes through several heritage-protected areas, including historic farms and protected landscapes. Rural bridges in these areas may require a heritage impact assessment and a review of design compatibility.

In conclusion, rural bridges have a low to moderate impact on land use, which depends largely on the presence of rural residential developments and heritage resources.

6.1 Additional Right-of-Way Requirements

Among the additional requirements that must be considered are existing right-of-way agreements for railways on highways. The main line of the Calgary–Edmonton corridor belongs to the Canadian Pacific Railway and operates within a right-of-way approximately 30 meters wide, established through historical land grants. This right-of-way is managed entirely by CPR and is not available without prior authorization from the company.

Land acquisition process

If private land is required, it must be acquired under the Alberta Expropriation Act (RSA 2000, c. E-13); the Alberta Transportation Department, municipalities, and other legal authorities have the power to expropriate land for transportation infrastructure projects. The process includes:

- Step 1: Notice of intent to expropriate served on registered landowners.
- Step 2: Offer of compensation based on a market value appraisal conducted by qualified land appraisers.
- Step 3: Negotiation period (typically 60 to 90 days) to reach a voluntary agreement.
- Step 4: If no agreement is reached, an expropriation order will be issued, and the Land Compensation Board will determine the compensation.
- Step 5: The landowner has the right to appeal to the Queen’s Bench Court if the compensation is disputed.

Compensation includes the market value of the land, damages caused by disturbances (crop loss, fence relocation, impacts on access), and business losses, if applicable. Typical compensation for agricultural land in central Alberta ranges from \$8,000 to \$15,000 per hectare (2023 values).

Access restrictions

Bridge construction can disrupt access to adjacent properties and affect road users, which would have an impact on local communities; these impacts may include the following:

Property Access

Loss of direct access: Properties that currently access the site via the at-grade crossing will lose that access during construction and permanently once the levels are separated. Alternative access must be provided via adjacent public roads or private access roads constructed as part of the project.

Access easements: If the alternative access requires crossing another landowner's property, formal access easements must be negotiated and recorded on the property title.

Movement of agricultural machinery: Large agricultural machinery (combine harvesters, seeders, grain trailers) may face restrictions when traveling over bridges with narrow lanes or low clearance. Alternative transport routes must be identified.

Access for pedestrians and cyclists

Urban bridges: Sidewalks and protected bike lanes must be provided to maintain connectivity for non-motorized users. Failure to provide these facilities creates accessibility barriers and may violate municipal design standards or accessibility laws.

Rural bridges: Space for pedestrians and cyclists is typically limited to paved shoulders. This is acceptable in rural settings with little pedestrian traffic, but may be insufficient near schools, parks, or rural residential areas.

Access for emergency vehicles

During construction: Road closures or alternating one-way traffic require coordination with emergency services (fire department, ambulances, police) to ensure access for emergency vehicles. Alternative routes must be identified and communicated.

Operational phase: The bridge's load limits (indicated on signage) may restrict access for heavy emergency vehicles or specialized equipment. The design load capacity must allow for the passage of fire trucks and ambulances.

6.2. Considerations regarding traffic interactions

The construction of bridges over railway lines can present significant challenges, such as traffic management, which may vary depending on whether the railway line or the crossing is in use. This information is referenced from the Traffic Management Guidelines for Road Construction, Government of Alberta.

Depending on the type of bridge, the following should be considered:

Property Access Bridges

- Traffic volume: Low (<200 AADT). Roads may be closed with proper public notice.
- Detour requirements: Agricultural traffic can generally be routed via roads adjacent to the section boundary line (with a 1.6 km spacing in Alberta's municipal grid system). The length of the detour is usually less than 5 km.
- Duration of closure: 14–18 weeks for complete construction. Construction can be carried out in phases to maintain single-lane access, but this would extend the duration by 30% to 50%.
- Severity of impact: Low. The affected users are primarily owners of adjacent properties, who can be notified and consulted individually.

Urban Bridges

- Traffic volume: High (between 1,000 and 20,000 vehicles per day, depending on the classification of the main road). A complete road closure causes severe disruptions.

- Requirements for detours: Urban detours are limited by the capacity of the road network. Alternative routes may experience traffic volume increases of between 50% and 100%, causing congestion on parallel streets. Detour signage, temporary traffic lights, and intersection modifications may be required.
- Duration of closure: Minimization is essential. Accelerated Bridge Construction (ABC) techniques can reduce closure duration from 6 months (conventional construction) to 2–4 weeks (installation of full-span precast elements).
- Impact on public transportation: Bus route detours increase travel time for public transportation users. Coordination with municipal transportation authorities is required.
- Impact on businesses: Road closures reduce customer access to adjacent businesses, resulting in economic losses. Compensation or support programs for businesses may be appropriate.
- Severity of impact: High. Requires a comprehensive traffic management plan, extensive public communication, and potentially significant investments in mitigation measures.

Rural Bridges

- Traffic volume: Moderate (200–1,000 vehicles per day, annual average). Detours are feasible but cause inconvenience.
- Detour requirements: The county's road network typically offers alternative routes within 3.2 km (2 miles). The length of the detour is typically 5 to 10 km, adding 5 to 10 minutes to travel time.
- Impact on school transportation: Rural roads often serve as school bus routes. Coordination with school districts is necessary to adjust bus routes and schedules.
- Seasonal restrictions: Spring traffic bans (weight restrictions during the thaw period, typically March through May) may limit the capacity of alternative routes for heavy trucks.
- Severity of impact: Moderate. Requires coordination with county highway authorities, school districts, and agricultural operators.

6.3 Surrounding environmental context (qualitative)

The Calgary-Edmonton corridor spans the Central Parks natural subregion and the Dry Mixed Grasslands natural subregion within Alberta's natural regions framework. This section helps us identify key environmental characteristics:

Vegetation and habitat

- Agricultural lands (80% of the corridor): Annual intensive agricultural production with little natural vegetation. Habitat value is low, except along field margins and forest edges, which provide nesting habitat for grassland birds (horned lark, prairie sparrow, evening sparrow) (Alberta Environment and Protected Areas, 2024).
- Native grasslands (remnant patches <5% of the corridor): Rare grassland ecosystems that remain preserved and possess high biodiversity value. Species present include rough fescue (*Festuca hallii*), northern quackgrass (*Elymus lanceolatus*), and native herbaceous species. Bridge construction that avoids these areas is preferred; if unavoidable, compensatory habitat may need to be created.
- Riparian corridors: Wooded areas along watercourses (Red Deer River, Blindman River, Battle River) provide critical habitat for migratory birds, white-tailed deer, and small mammals. These areas are highly ecologically sensitive..

Wildlife

- Large mammals: White-tailed deer and mule deer are common in rural areas. Railroad bridges do not significantly alter wildlife movement patterns compared to existing at-grade crossings, as both create barriers.
- Birds: Grassland bird species are declining throughout Alberta due to habitat loss. Bridge construction has minimal direct impact on birds, but cumulative habitat fragmentation is a concern (*Biodiversity in Alberta, 2026*).
- At-risk species: The Calgary-Edmonton corridor does not traverse critical habitats for federally listed endangered species. However, some species of regional importance (such as Sprague's pipit and the ferruginous hawk) may be present in grassland area.

Water resources

Impact near water resources along the Calgary-Edmonton corridor; these resources include rivers such as the Red Deer and Battle Rivers, which are primarily home to fish. Additionally, there are small streams and wetlands that serve as nesting habitats for birds and are protected under the provincial Water Act (Government of Alberta, 2000d) and the federal Migratory Birds Convention Act.

6.4 Meteorological context impacts

This section aims to assess the potential climate-related impacts of the project. Alberta has a climate characterized by cold winters, warm summers, and significant seasonal temperature variability; this section will help us identify the key meteorological parameters that must be taken into account when designing and operating the bridges.

- Temperature: Average annual temperature: 2–4 °C (between Calgary and Red Deer). Average winter temperature: –10 to –15 °C (December–February). Average summer temperature: 15–18 °C (June–August).
- Precipitation: Annual precipitation: 400–500 mm. Approximately 70% falls as rain (May–September) and 30% as snow (October–April).
- Freeze-thaw cycles: Their frequency is increasing due to climate change. In central Alberta, between 40 and 60 freeze-thaw cycles are currently recorded per year (days when the temperature drops below 0 °C), compared to 30–45 cycles during the 1950–1980 period. This is the most significant meteorological factor affecting bridge durability (Kienzle, 2018; University of Lethbridge, 2024).
- Extreme weather events: Severe thunderstorms, hail, and tornadoes occur mainly in the summer (June through August). Winter blizzards with strong winds and blowing snow create hazardous driving conditions and reduce visibility.

Effects of freeze-thaw cycles on bridge infrastructure

Alberta extreme weather conditions can affect the bridge's structural components.

Below, we will list the main causes that can lead to such impacts.

- Water infiltration: Rainwater or meltwater penetrates the concrete through cracks, pores, or construction joints.

- Freeze expansion: When the temperature drops below 0 °C, water freezes and expands by approximately 9% in volume, creating internal stresses in the concrete.
- Thawing contraction: When the temperature rises above 0 °C, the ice melts and the water contracts, leaving voids and microcracks.
- Cumulative damage: Repeated freeze-thaw cycles progressively widen cracks and cause spalling (detachment of the concrete surface), delamination, and structural deterioration.

Recommendations for these impacts

Mitigation strategies for durability against freeze-thaw cycles:

- High-performance concrete: Specify a low water-cement ratio ($w/c < 0.40$) and air-entrained concrete (5–8% air content) in accordance with CSA A23.1 standards. The incorporation of air creates microbubbles that provide space for the expansion of freezing water, thereby reducing internal stresses.
- Waterproofing membranes: Apply a waterproofing membrane to the bridge deck surface prior to the asphalt wearing course to prevent water infiltration.
- Joint sealants: Maintain expansion joint sealants in good condition to prevent water ingress into cracks and joints in the concrete.
- Corrosion-resistant reinforcement: Specify stainless steel reinforcement or epoxy-coated rebar in high-exposure areas (deck, parapets) to prevent chloride-induced corrosion from road salt.

Winter Operations and Ice Formation

- Ice formation on bridge decks: Bridge decks cool down faster than approach roads due to airflow beneath them. Ice forms on the bridge deck at ambient temperatures of +1 to +2 °C, while the approach roads remain ice-free. This creates dangerous “black ice” conditions that are difficult for drivers to detect.
- Mitigation measures: Warning signs reading “The bridge freezes before the road” (standard practice in Alberta), more frequent application of de-icing chemicals

(calcium chloride brine, magnesium chloride), installation of heating systems on the bridge deck (feasible but costly, used only on critical urban structures).

- Snow Accumulation: Wind-driven snow accumulates on bridge decks and on the leeward side of parapets, creating snowdrifts that reduce roadway width and visibility. The maintenance priority for snow removal on bridges is higher than on access roads.

Impacts of Extreme Heat

Bridges will not only be affected by extremely cold temperatures but will also be exposed to extreme heat; summer temperatures in central Alberta have risen by 0.5 to 1.5 °C since 1950 (Kienzle, 2018). The impacts of extreme heat on bridges include:

- Thermal expansion: Concrete and steel expand when heated. Bridge expansion joints allow for thermal expansion, but extreme heat can cause damage to the joints or deformation of the approach slabs.
- Asphalt deformation: Asphalt pavement surfaces on bridge decks can soften and deform under extreme heat (>30 °C) and heavy truck traffic. Mitigation: polymer-modified asphalt binders with higher softening temperatures.
- Construction restrictions: Concrete placement is restricted when ambient temperatures exceed 30 °C due to rapid moisture loss and the risk of cracking. Concrete placement procedures for hot weather are required (chilled mixing water, retarding admixtures).

6.5 Overview of Applicable Regulatory Environmental Framework

Overview of the regulatory framework governing the environmental and landscape impacts of bridge construction: In Alberta, this is subject to a framework involving federal, provincial, and municipal authorities. The appendix G, Environmental Regulatory Framework, includes a table summarizing the relevant agencies and factors that must be considered in bridge development.

7. High level Cost Analysis

In this section, we will provide a high-level cost analysis (ROM-Class D) for the three types of railways bridges we have identified for the Calgary–Edmonton corridor. This analysis establishes order-of-magnitude cost ranges for the bridge’s major components (direct costs), includes indirect costs and contingencies appropriate for a conceptual stage, and provides a clear statement of assumptions, accuracy range, and limitations of use.

The cost analysis is based on documented assumptions, historical cost data from Alberta Transportation projects, Canadian bridge construction cost indices, and industry-standard parametric estimation methods.

7.1. Estimate Class: ROM - Class D or 4

This cost analysis is classified as a Class D or 5 estimate, also known as a rough order of magnitude (ROM) estimate. We used Recommended Practice 18R-97 from the Association for the Advancement of Cost Engineering International (AACE International, 2020) and the standards of the Canadian Institute of Quantity Surveyors (Canadian Institute of Quantity Surveyors, 2021) for conceptual-level infrastructure estimates.

These calculations have the following limitations:

Class D estimates are appropriate for:

- Feasibility studies and strategic planning.
- Preliminary budgeting and funding applications.
- Comparing project alternatives at the conceptual design stage.
- High-level project prioritization and portfolio management.

Class D estimates are NOT appropriate for:

- Construction bidding or evaluation of contractor bids.
- Detailed project financing or guarantee.
- Final budget approval or expenditure authorization.
- Detailed evaluation of change orders or claims management.

The expected accuracy range for these estimates is -30% to +50% relative to the final project cost, which will be determined through detailed construction design. There is approximately a 50% confidence level that the actual cost will fall within this range, provided there are no significant changes to the scope.

As the project progresses from conceptual design to preliminary and detailed design, this estimate should be updated using more refined estimation methods (Class C, Class B, Class A) with improved accuracy, appropriate to the design's level of maturity.

Estimation methodology

A hybrid approach combining two estimation methodologies is proposed in order to ensure best practices when estimating costs and to provide additional cross-validation; AACE International RP 18R-97 explicitly recommends using multiple techniques for Class 4 estimates. These methods are as follows:

First, the unit cost method is used, in which the main components of the bridge (concrete volume, bridge deck area, linear meters of beams) are quantified based on conceptual design parameters and multiplied by the unit costs from standard industry cost databases (RSMeans, 2024).

Second, a percentage-based estimate is used, in which indirect costs (mobilization, traffic management, engineering) are estimated as percentages of direct construction costs, according to industry standards. Finally, for contingency analysis, design and construction contingencies are added based on the project's risk factors and the maturity of the estimate.

Assumptions for cost estimation

In this section, we will list the input parameters for each bridge. This will help us calculate estimates, allowing us at this stage to have a basis for each calculation and value. Even though we do not yet have a final design, we will use the parameters specified in the conceptual design. These parameters will be summarized in Appendix H: High-Level Cost Analysis.

General assumptions

This cost estimate is based on the following assumptions. If any of these assumptions prove to be invalid, the cost estimate must be revised:

- A single-span bridge configuration of 25 m in accordance with the geometric parameters.
- A superstructure consisting of precast concrete beams (not steel beams or cast-in-place concrete box girders).
- Shallow foundations on stable soil (access to properties and rural roads) or foundations on driven piles (30% probability for urban bridges).
- Construction during the normal construction season (May–October), not in winter.
- Balanced market conditions (neither boom nor recession).
- No major utility relocations required (only minor conflicts).
- RCP signaling services are available and scheduled within standard delivery times.
- Environmental permits obtainable without significant project delays or mitigation costs.
- Land acquisition at market prices without expropriation litigation or business relocation.

7.2 Cost ranges by order of magnitude: Direct and indirect costs

The total cost of the project consists of direct costs, which are construction costs directly attributable to the physical components of the bridge and on-site labor. We also take into account indirect costs, which are costs not directly associated with the physical components of the bridge but are necessary for its construction, such as design, administrative, and permitting costs. To view the direct and indirect costs managed in the project, see Appendix H: High-Level Cost Analysis.

7.3 Contingency

The contingency in this type of project is a reserve set aside for unforeseen events; it is a risk margin included in the budget to cover unknown situations that cannot be explicitly identified or quantified during the conceptual design phase. This type of reserve does not cover changes in scope or additional work requested by the client.

For this Class D or 4 estimate, the contingency covers:

- Geotechnical uncertainty: Actual soil conditions may differ from assumptions (e.g., poor bearing capacity requiring pile foundations, unexpected presence of groundwater requiring drainage).
- Quantity uncertainty: Conceptual design quantities may underestimate actual requirements (e.g., increased concrete volume in abutments due to design refinement, additional fill at approaches due to poor subgrade).
- Market conditions: Increases in material and labor costs between budget preparation and contract award.
- Regulatory requirements: Unforeseen permitting conditions or mitigation measures (e.g., additional environmental monitoring, enhanced erosion control, archaeological assessment).
- Construction complexity: Site-specific constraints not apparent at the conceptual stage (e.g., confined work area, restricted crane access, conflicts with utilities).

In accordance with Canadian public sector cost estimation standards for Class D or 4 infrastructure estimates, a 25–30% design and construction contingency is applied to the sum of direct and indirect costs.

This contingency range is consistent with AACE International Recommended Practice 18R-97 (a 20–30% contingency margin for Class 4–5 estimates).

Key cost drivers and sensitivities

In addition to contingencies for unforeseen events, there may also be additional factors that are not currently anticipated but must be considered as risks due to changes external to the project. These factors may include the following.

Building materials

Construction materials such as (cement, reinforcing steel, structural steel, asphalt) are subject to market price volatility. Recent trends (2020–2025) show:

- Cement: annual price increase of 3–8%.
- Reinforcing steel (rebar): annual volatility of 5–15% (linked to global steel markets).
- Structural steel: annual volatility of 4–10%.
- Asphalt cement (bitumen): annual volatility of 8–20% (linked to crude oil prices).

If construction is delayed by 12 to 18 months beyond the estimated date, rising material costs could increase the total project cost by 5% to 12%, consuming most or all of the contingency budget.

Foundation Conditions

- Geotechnical assumptions have a significant impact on costs:
- If the soil bearing capacity is adequate (150–200 kPa): Shallow foundations as planned. No impact on cost.
- If the soil bearing capacity is low (<100 kPa): Drilled pile foundations are required. Cost impact: +\$120,000 to +\$300,000 per bridge (+15–25% of the substructure cost).
- If groundwater is encountered: A drainage system is required. Cost impact: between +\$30,000 and +\$80,000 per bridge.

Acquisition of urban land

Land acquisition is the highest-risk component of urban bridge costs. Costs can range from zero (if the existing right-of-way is sufficient) to \$2 million or \$3 million (if full land acquisition and business relocation are required). This single variable can cause urban bridge costs to skyrocket from the lower end of the range to the upper end—or even beyond.

Winter construction premium

If the project schedule requires construction during the winter (November–March), additional costs must be considered:

- Cold-weather concrete mixes and heated formwork: +10–15% on concrete work.
- Reduced productivity (snow removal, frost protection, fewer daylight hours): +8–12% on labor costs.
- General winter construction surcharge: +15–25% of the total project cost.

8. Conclusions and Recommendations

This analysis, conducted for Alberta Regional Rail Inc., concludes that the proposed road over rail bridge solutions are technically and economically viable and that they also comply with national road safety standards. The three types of bridges analyzed are property access bridges, urban bridges, and rural bridges, all of which are suitable for the more than 200 at-grade crossings along the Calgary – Edmonton corridor, addressing the demonstrated need to resolve level crossings to prevent disruptions or accidents on the tracks, thereby providing a permanent solution to this challenge.

Technical feasibility has been confirmed through an analysis of the basic design parameters for the three bridge types, which comply with applicable federal, provincial, and national standards. These design parameters have been divided into eight main categories, including horizontal and vertical alignment parameters, cross-sectional elements, sight distance requirements, clearance requirements for railways, structural design parameters, and safety systems and barriers, thereby defining the minimum requirements for the technical approval of this type of project.

Second, a constructability analysis of the bridges is conducted, evaluating the typical construction sequence in five phases, the use of NU beams for bridges with a span of 25 meters, the crane requirements for hoisting the superstructure, and the identification of construction risks and limitations. Third, to verify its technical feasibility, an environmental impact analysis is conducted on the land where the bridges will be built, taking into account regulatory requirements, the difficulties that may arise regarding access to construction sites, considerations regarding traffic impacts, and how Alberta's environmental context may affect the project's development .

On the other hand, the economic feasibility study is conducted through a high-level analysis of Class D costs, based on RSMeans 2024 unit costs with Alberta location factors, Estimating an investment of between \$813,000 and \$2,623,000 per bridge, which includes a cost framework for all major construction components such as direct costs, indirect costs, and contingencies, providing Alberta Regional Rail with an appropriate preliminary budget guide for discussions on future financing .

This approach ensures a comprehensive coverage of all the elements necessary for a complete assessment of the construction of the three bridges.

Below, we will present the key findings that we must take into account for the next stages:

- According to the Grade Crossing Regulations (GCR, SOR/2014-275), effective as of November 28, 2024, it is mandatory to eliminate all grade crossings on Canada's railways.
- Grade-separated crossings completely eliminate the risk of collision and significantly improve operational reliability.
- Prefabricated bridge solutions (NU beams) offer the most efficient balance between cost, ease of construction, and construction time.
- Construction feasibility limitations are manageable for all bridge types, with greater complexity observed in urban environments due to the interaction between traffic and land use.
- Environmental and social impacts vary significantly depending on the type of bridge, with urban bridges eliciting the highest level of community sensitivity.
- Cost variability is primarily due to geotechnical conditions, land acquisition requirements, and the construction schedule (seasonality).

Recommendations

The following are recommendations to help Alberta Regional Rail Inc. move forward with the project to reopen the corridor between Calgary and Edmonton, focusing on the development of solutions to eliminate at-grade crossings.

Initially, once approval has been granted for the corridor's opening and funding secured for the construction of the bridges, early coordination should begin with stakeholders and regulatory agencies, such as municipal governments, Canadian Pacific Railway, and Alberta's transportation and environmental authorities. This will significantly reduce the time required to obtain permits and secure approval for the project..

Second, it is recommended that a decision-making framework be established to prioritize intersections, taking into account safety needs, traffic volume, community impact, construction feasibility, and cost-benefit analysis for Alberta Regional Rail operations. This will ensure an investment model designed to maximize impact and strategic value.

Third, based on the technical, constructability, environmental, and cost analyses conducted, we propose moving forward by hiring engineering consultants who can develop preliminary standardized designs with approximately 30% completion for the three types of bridges, ensuring that they address diverse urban and rural conditions with varying traffic volume requirements, thereby refining the structural configurations and constructability assumptions to produce Class C cost estimates with an improved accuracy range of -20% to +30%. This will allow them to increase confidence when seeking investment to finance the construction projects.

Fourth, it is also recommended to develop a phased implementation strategy focused on prioritizing the development of solutions to achieve results quickly. For example, Phase 1 could address rural intersections and property access points, which are relatively simple and can be implemented more quickly and at a lower cost, while still demonstrating early results and improvements in safety. Phase 2 could address corridors with higher traffic volumes, which are more complex and require more detailed planning and coordination among municipalities. The aim of this recommendation is to begin complying with the regulatory requirement that all at-grade crossings must be resolved by constructing overpasses.

Finally, it is recommended to carry out a pilot project initially involving three bridges, each of which represents one of the bridges analyzed, to validate cost estimates, test the construction sequence, and refine coordination procedures. These projects can provide learning opportunities that reduce risk and improve efficiency for subsequent phases, where groups of several bridges may be formed, facilitating execution and coordination due to their geographic location. These projects will establish performance metrics to evaluate cost management, monitor the schedule, and measure performance in safety and compliance with deliverables.

For this reason, This report provides a comprehensive technical and regulatory foundation to advance the application to open the corridor between Calgary and Edmonton, as it will provide the client with specific deliverables including complete conceptual parameters for three types of bridges in full compliance with Canadian and Alberta standards, validation of the construction methodology in accordance with Alberta industry practices and contractor capabilities, an environmental impact assessment aligned with regulatory requirements, Class D cost estimates suitable for preliminary budgeting and financing discussions, and clear recommendations for next-phase activities and priority actions directly aligned with the objectives stated by Alberta Regional Rail Inc.

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Appendices

Appendix A : Regulatory Framework Summary

Table A1

Regulatory Framework Summary

Instrument	Authority	Relevance to This Project
Railway Safety Act (RSA), R.S.C. 1985, c. 32 (4th Supp.)	Transport Canada / Federal	Primary federal statute. Governs construction, alteration, and safety standards for all works involving federally regulated railways. Requires P.Eng. approval for all engineering work (s. 11).
Grade Crossings Regulations (GCR), SOR/2014-275 – Full effect Nov. 28, 2024	Transport Canada	Establishes minimum safety standards for all 23,000 public and private grade crossings in Canada. Compliance with GCR is the direct regulatory driver for grade separation solutions.
Grade Crossings Standards (GCS), January 2019	Transport Canada	Technical companion to the GCR. Sets engineering best practices for geometry, sightlines, warning systems, and road approaches at grade crossings.
Rail Safety Improvement Program (RSIP)	Transport Canada	Federal funding mechanism for crossing safety improvements and closures, directly applicable to ARR infrastructure investment.
Alberta Transportation Act & Alberta Transportation Road Design Standards	Province of Alberta	Provincial design standards governing road geometry, bridge clearances, and design speeds applicable to road-over-rail structures in Alberta.

Appendix B : Classification and types of proposed bridges.

Table B1

Classification and types of proposed bridges.

Bridge Type	Primary Use	Typical Location	Key Characteristic
Property Access Bridge	Agricultural / industrial private access	Rural farm properties along corridor	Minimum footprint, low <200 AADT
Urban Bridge	Municipal roads, arterials, collectors	Towns: Airdrie, Lacombe, Red Deer, Leduc	Multi-lane, pedestrian/cyclist facilities , > 1000 AADT
Rural Road Bridge	County roads and secondary highways	Inter-municipal rural stretches	Single or 2-lane, standard shoulders, between 200 to 1000 AADT.

Note = Average Annual Daily Traffic (AADT)

Appendix C: Conceptual parameters defined for the three types of bridges (property, rural and urban).

Table C1

Horizontal Alignment parameters.

Horizontal Alignment Parameters			
Parameter	Property Access Bridge	Urban Bridge	Rural Road Bridge
Design Speed	60–80 km/h	50–70 km/h	80–100 km/h
Min. Horizontal Radius (absolute minimum)	95 m - 60 km/h 150 m - 80 km/h	60 m - 50 km/h 125 m - 70 km/h	230 m - 80 km/h 360 m - 100 km/h
Min. Horizontal Radius (desirable for new construction)	120 m - 60 km/h 190 m - 80 km/h	85 m - 50 km/h 165 m - 70 km/h	280 m - 80 km/h 440 m - 100 km/h
Maximum Superelevation Rate	8% (0.08 m/m)	6% (0.06 m/m)	6% (0.06 m/m)
Spiral Transition Length (minimum)	30–50 m	25–40 m	50–75 m
Superelevation Runoff Length	40–65 m	35–55 m	65–95 m

Source: Alberta Transportation HGDG Chapter B, Tables B-3-5-3a and B-3-5-3b (September 2020)

Table C1.1

Horizontal Alignment Parameters (Client-Based).

Parameter	Property Access	Urban Bridge	Rural Road
Design Speed (CLIENT-SPECIFIED)	30 km/h	50-60 km/h	80-90 km/h
Min. Horizontal Radius (absolute minimum)	28 m - 30 km/h	60 m - 50 km/h 95 m - 60 km/h	230 m - 80 km/h 280 m - 90 km/h
Min. Horizontal Radius (desirable)	40 m - 30 km/h	85 m - 50 km/h 120 m - 60 km/h	280 m - 80 km/h 360 m - 90 km/h
Maximum Superelevation	8% (0.08 m/m)	6% (0.06 m/m)	6% (0.06 m/m)
Spiral Transition Length	15-20 m	25-35 m	50-70 m
Superelevation Runoff	20-30 m	35-45 m	65-85 m

Source: TAC Geometric Design Guide (2017/2025), Chapter 1 - Very Low Volume Roads; Chapter 2 - Horizontal Alignment

Table C2

Vertical Alignment parameters.

Vertical Alignment Parameters			
Parameter	Property Access	Urban Bridge	Rural Road
Maximum Grade	8%	6%	6%
Minimum Grade (drainage)	0.30%	0.30%	0.30%
K-value (Crest)	26 - 60 km/h	17 - 50 km/h	43 - 80 km/h
Stopping Sight Distance	43 - 80 km/h	29 - 70 km/h	65 - 100 km/h
K-value (Sag)	26 - 60 km/h	17 - 50 km/h	37 - 80 km/h
Headlight Sight Distance	37 - 80 km/h	26 - 70 km/h	52 - 100 km/h
Critical Length of Grade (truck speed reduction)	Not typically applicable	300 m - 6% grade	200 m - 6% grade

Source: Alberta Transportation HGDG Chapter B, Section B.4 Vertical Alignment (September 2020)

Table C2.1
Vertical Alignment Parameters (Client-Based).

Parameter	Property Access	Urban Bridge	Rural Road
Maximum Grade (CLIENT-SPECIFIED)	6-7%	4-5%	3-4%
Minimum Grade (drainage)	0.30%	0.30%	0.30%
K-value (Crest)	7 - 30 km/h	17 - 50 km/h	43 - 80 km/h
Stopping Sight Distance (SSD = 35 m)		26 - 60 km/h	52 - 90 km/h
K-value (Sag)	9 - 30 km/h	17 - 50 km/h	37 - 80 km/h
Headlight Sight Distance		26 - 60 km/h	44 - 90 km/h
Critical Length of Grade	Not applicable (very low volume)	300 m - 5% grade	200 m - 4% grade

Source: TAC GDG Section 2.4 Vertical Alignment; Section 2.5 Sight Distance

Note: K-values calculated based on client-specified design speeds. Property Access uses very low K-values appropriate for 30 km/h private access roads.

Table C3
Cross Section Elements.

Cross-Section Elements			
Parameter	Property Access	Urban Bridge	Rural Road
Travel Lane Width	Single: 3.7 m	2-lane: 2 × 3.7 m	2 × 3.7 m
	Narrow 2-lane: 2 × 3.5 m	4-lane: 4 × 3.7 m	
Shoulder Width (paved)	0.5–1.0 m	1.5 m (min)	1.5 m (min)
		2.5 m (desirable)	2.5–3.0 m (desirable)
Normal Cross Slope (Crown/Camber)	2.0% (gravel)	1.5–2.0%	1.5–2.0%
	1.5% (paved)		
Median Width (divided sections)	Not applicable	2.5 m (raised median)	Not applicable
		4.0 m (desirable)	
Shy-Line Distance to Barrier	0.5 m	0.6 m (standard)	0.6 m (standard)
		1.0 m (desirable)	1.0 m (desirable)
Total Bridge Deck Width	4.7 m (single)	10.9 m (2-lane)	9.7–13.7 m
	9.0 m (2-lane)	20.3 m (4-lane)	
Sidewalk Width (if applicable)	Not required	1.8 m (min)	Not required
		2.1–2.5 m (desirable)	

Source: Alberta Transportation HGDG Chapter D, Cross Section Elements (2023)

Table C4
Sight Distance Requirements

Sight Distance Requirements			
Sight Distance Type	Property Access	Urban Bridge	Rural Road
Stopping Sight Distance (SSD)	85 m - 60 km/h	65 m - 50 km/h	130 m - 80 km/h
	130 m - 80 km/h	105 m - 70 km/h	185 m - 100 km/h
Passing Sight Distance (PSD) 2-lane roads only	Not required	Not applicable	490 m - 80 km/h
			580 m - 100 km/h
Intersection Sight Distance (ISD) all approaches	110 m @ 60 km/h	Required for all approaches	165 m - 80 km/h
		Varies by type	
Decision Sight Distance (DSD) complex locations	Not required	180 m - 50 km/h	275 m - 80 km/h
Object Height Assumptions	0.60 m (SSD)	0.60 m (SSD)	0.60 m (SSD)
	1.30 m (PSD, ISD)	1.30 m (ISD)	1.30 m (PSD, ISD)

Source: Alberta Transportation HGDC Chapter B, Section B.2 (September 2020); TAC GDG Section 2.5

Table C4.1
Sight Distance Requirements (Client-Based Speeds)

Sight Distance Type	Property Access	Urban Bridge	Rural Road
Stopping Sight Distance (SSD)	35 m - 30 km/h	65 m - 50 km/h	130 m - 80 km/h
		85 m - 60 km/h	160 m - 90 km/h
Passing Sight Distance (PSD) 2-lane roads only	Not required (single lane/very low volume)	Not applicable (urban context)	490 m - 80 km/h
			560 m - 90 km/h
Intersection Sight Distance (ISD) all approaches	45 m - 30 km/h (if applicable)	85 m - 50 km/h	165 m - 80 km/h
		110 m - 60 km/h	190 m - 90 km/h
Decision Sight Distance (DSD) complex locations	Not required	140 m - 50 km/h	275 m - 80 km/h
		180 m - 60 km/h	315 m - 90 km/h
Object Height Assumptions	0.60 m (SSD)	0.60 m (SSD)	0.60 m (SSD)
		1.30 m (ISD)	1.30 m (PSD, ISD)

Source: TAC GDG Section 2.5 Sight Distance

Note: Sight distances are directly calculated from client-specified design speeds. Property Access SSD of 35m , 30 km/h is significantly shorter than standard rural roads, reflecting very low speed private access conditions.

Table C5
Railway Clearance Requirements.

Railway Clearance Requirements			
Clearance Parameter	Property Access	Urban Bridge	Rural Road
Minimum Horizontal Span	25 m	25 m	25 m
Vertical Clearance (top of rail to soffit)	7.1 m (23.3 ft)	7.1 m (23.3 ft)	7.1 m (23.3 ft)
Lateral Clearance from Track Centerline to Pier/Abutment	≥ 7.5 m	≥ 7.5 m	≥ 7.5 m
Additional Clearance for Horizontal Curves	+25.4 mm per degree	+25.4 mm per degree	+25.4 mm per degree
Construction Clearance (during erection)	≥ 10 m from centerline	≥ 10 m from centerline	≥ 10 m from centerline
Impact Protection (if pier within 7.5–9.0 m)	TL-5 barrier wall	TL-5 barrier wall	TL-5 barrier wall

Source: Transport Canada Standards Respecting Railway Clearances (May 14, 1992); AREMA Manual Ch. 28 (2023)

Table C6
Structural Design Parameters.

Structural Design Parameters (CHBDC CSA S6:19)			
Parameter	Property Access	Urban Bridge	Rural Road
Design Vehicle	WB-20	WB-20	WB-23 (NHS routes)
Design Live Load	CL-625 (CHBDC)	CL-625 (CHBDC)	CL-625 (CHBDC)
Structure Depth (25 m span)	1.2–1.4 m (precast concrete)	1.3–1.6 m (steel plate girders)	1.2–1.5 m
Typical Girder Spacing	2.5–3.0 m	2.5–3.0 m	2.5–3.0 m
Design Life	75 years	75 years	75 years

Source: CSA S6-19 Canadian Highway Bridge Design Code; TAC GDG Section 1.5 Design Vehicles

Table C7
Safety and Barrier Requirements

Safety and Barrier Requirements			
Safety Element	Property Access	Urban Bridge	Rural Road
Clear Zone Width	3.0 m - 60 km/h	1.5–3.0 m	6.0 m - 80 km/h
	4.0 m - 80 km/h		8.0 m - 100 km/h
Bridge Railing Type	Open steel or concrete	Concrete parapet (TL-4)	Concrete parapet (TL-4)
Bridge Railing Height (min)	810 mm (32 in)	1,070 mm (42 in)	810 mm (32 in)
MASH Crash Test Level	TL-4	TL-4	TL-4 (TL-5 if high volume)
Approach Guardrail Transition	If slope > 4:1	Required at all approaches	Required at all approaches

Source: Alberta Transportation HGDG Chapter F, Roadside Design (February 2021); TAC GDG Chapter 7

Table C8
Drainage and Winter Operations

Drainage and Winter Operations			
Parameter	Property Access	Urban Bridge	Rural Road
Minimum Transverse Slope (cross slope on deck)	2.00%	1.5–2.0%	1.5–2.0%
Drainage System Type	Scuppers @ 12 m spacing	Continuous edge drain	Scuppers @ 10 m spacing
Bridge Deck Waterproofing	Required	Required	Required
Anti-Icing Considerations	Not required	Consider for grade > 4%	Consider for grade > 3%
Winter Maintenance Vehicle	Single-lane plow (2.5 m)	Two-lane plow (4.0 m)	Two-lane plow (4.0 m)

Source: Alberta Transportation Bridge Conceptual Design Guidelines; TAC GDG Section 8.5 Drainage Design

Appendix D: Crane requirements according to bridge type (property, rural and urban).

Table D1
Crane requirements according to bridge type

Bridge Type	Typical Girder Weight	Crane Capacity	Crane Type
Property Access Bridge	25–40 tonnes	65–100 tonnes	Mobile hydraulic crane (3-axle)
Urban Bridge	50–80 tonnes	150–250 tonnes	Mobile hydraulic crane (5-axle) or crawler crane
Rural Road Bridge	40–70 tonnes	100–200 tonnes	Mobile hydraulic crane (4-5 axle) or crawler crane

Table D2
Considerations for selecting the type of crane

type of crane	Advantage	Limitations
Mobile Hydraulic Cranes	Fast mobilization (drive to site on public roads), compact footprint, lower rental cost than crawler cranes (\$2,000–5,000/day depending on capacity).	Require firm, level ground for outrigger setup. Maximum reach is limited (30–40 m for 100–200 tonne cranes). Not suitable for soft ground or sites with limited crane pad area.
Crawler Cranes	Superior stability on soft ground (low ground bearing pressure 10–15 tonnes/m ²). Greater reach than hydraulic cranes (50–70 m boom length standard). Can operate on slopes up to 3%.	Require transport on low-bed trailers (cannot self-propel on highways). Longer mobilization time (1–2 days for assembly). Higher rental cost (\$5,000–10,000/day).

Appendix E: Approximate impact surfaces from bridge construction.

Table E1

Approximate impact surfaces from bridge construction.

Bridge Type	Working Area	Key Access Requirements
Property Access	1,500–2,500 m ² (0.15–0.25 ha)	Farm access roads (minimum 4 m wide), seasonal access constraints
Urban Bridge	3,000–5,000 m ² (0.3–0.5 ha)	Municipal road access, traffic management plan, utility relocation coordination
Rural Road	2,000–3,500 m ² (0.2–0.35 ha)	County road access, seasonal road restrictions, oversize load permits

Appendix F: Risks and limitations of constructability.

Table F1

Risks and limitations of constructability.

Risk Category	Description	Mitigation Strategy
Railway Operations Coordination	CPR operations continue during construction. Flagging required for work within 8 m of track centerline.	Obtain CPR flagging services. Schedule crane lifts during low-traffic periods (nights/weekends). Maintain 7.5 m minimum horizontal clearance.
Winter Construction	Alberta winter (Nov–Mar) limits concrete curing, crane operations, and site access. Frost heave affects foundation work.	Schedule superstructure erection May–Oct. Use heated enclosures for winter concrete work. Specify cold-weather concrete mixes (ASTM C94).
Precast Delivery Logistics	Girders up to 27 m long require oversize load permits and pilot vehicles. Urban routes constrained by overhead clearances and turning radii.	Coordinate with Alberta Transportation for oversize permits. Conduct route surveys for overhead/horizontal clearances. Schedule night deliveries in urban areas.
Geotechnical Uncertainty	Site-specific soil conditions unknown at conceptual stage. Poor bearing capacity requires deep foundations (piles).	Include geotechnical investigation allowance in cost estimates. Design spread footings with contingency for driven piles if required.
Traffic Management	Urban and rural road closures disrupt traffic. Detour capacity may be limited.	Phased construction to maintain one lane open. Accelerated Bridge Construction (ABC) to minimize closure duration. Public communication plan.

Appendix G: Environmental Regulatory Framework.

Table G1
Environmental Regulatory Framework

Regulatory Instrument	Authority	Bridge Project Application
Environmental Protection and Enhancement Act (EPEA)	Alberta Environment and Protected Areas (AEPA)	EPEA approval likely NOT required (bridges exempt per Activities Designation Regulation unless in sensitive areas). However, ECO Plan required per construction contract.
Water Act	AEPA	Water Act approval required if bridge construction disturbs watercourses, drainage patterns, or wetlands. Likely required for bridges crossing or near watercourses.
Fisheries Act (federal)	Fisheries and Oceans Canada (DFO)	Authorization required if work results in harmful alteration, disruption or destruction (HADD) of fish habitat. May apply to bridges near fish-bearing watercourses.
Municipal permits (development, building, land use)	Municipal authorities (e.g., City of Red Deer, Lacombe County)	Development permits and building permits required for urban bridges. May require land use rezoning or variance approvals.
Highways Development and Protection Act	Alberta Transportation	Regulates setbacks and access to provincial highways. May apply to bridges connecting to Highway 2, 2A, or other provincial routes.

Appendix H: High-Level Cost Analysis.

Table H1
Assumptions for cost estimation

Parameter	Property	Urban 2L	Urban 4L	Rural	Unit
Span Length	25	30	35		28 m
Total Deck Width	8.0	14.5	24.0		12.2 m
Deck Thickness	0.25	0.25	0.30		0.25 m
Girder Spacing	2.0	2.2	2.5		2.2 m
Sidewalk Width (each side)	1.8	1.8	1.8		1.8 m

Table H2
Quantities calculated by bridge type

Parameter	Property	Urban 2L	Urban 4L	Rural	Unit
Deck Area	200.0	435.0	840.0		341.6 m ²
Deck Concrete Volume	50.0	108.8	252.0		85.4 m ³
Number of Girders	5	8	11		7 units
Total Girder Length	125	240	385		196 LM
Barrier Length (both sides)	50	60	70		56 LM
Sidewalk Area (both sides)	90.0	108.0	126.0		100.8 m ²
Bearing Pads (qty)	10.0	16.0	22.0		14.0 pads
Approach Slab Area (m ²)	64.0	145.0	288.0		122.0 m ²
Approach Pavement (m ²)	264.0	580.0	1128.0		463.6 m ²
Joint Seal Length (LM)	8.0	14.5	24.0		12.2 LM
Waterproofing Area (m ²)	200.0	435.0	840.0		341.6 m ²
Drainage Scuppers (units)	4	6	8		6 units
Approach Fill Volume (estimated)	1500	2475	3900		2130 m ³

Table H3
Unit costs- RS Means 2024

Component	Low CAD	High CAD	Unit
Precast Girders	950	1,250	\$/LM
Deck Concrete	480	620	\$/m ²
Abutments	35,000	52,000	\$/unit
Barriers	210	260	\$/LM
Sidewalks	140	180	\$/m ²
Earthwork	30	42	\$/m ³
Miscellaneous	25,000	45,000	\$/project
Bearing Pads	\$500	\$1,000	\$/pad
Approach Slabs	\$200	\$300	\$/m ²
Approach Pavement	\$65	\$95	\$/m ²
Joint Seals	\$250	\$400	\$/LM
Waterproofing	\$18	\$28	\$/m ²
Drainage Scuppers	\$600	\$1,200	\$/unit

Table H4
Indirect Cost Factors - RS Means 2024

Component	Property	Urban 2L	Urban 4L	Rural
Mobilization %	6.5%	6.5%	6.5%	6.5%
Traffic Management %	4.0%	12.5%	12.5%	6.5%
CPR Coordination (Low)	125,000	125,000	125,000	125,000
CPR Coordination (High)	160,000	160,000	160,000	160,000
Engineering & Design %	13.5%	13.5%	13.5%	13.5%
Construction Mgmt %	9.0%	9.0%	9.0%	9.0%

Table H5
Direct Cost – Method Parametric RS Means 2024

Component	Property Access		Urban 2-Lane		Urban 4-Lane		Rural Road	
	Low (\$)	High (\$)	Low (\$)	High (\$)	Low (\$)	High (\$)	Low (\$)	High (\$)
Precast Girders	118,750	156,250	228,000	300,000	365,750	481,250	186,200	245,000
Deck Concrete	24,000	31,000	52,200	67,425	120,960	156,240	40,992	52,948
Abutments (2 units)	70,000	104,000	70,000	104,000	70,000	104,000	70,000	104,000
Barriers	10,500	13,000	12,600	15,600	14,700	18,200	11,760	14,560
Sidewalks	12,600	16,200	15,120	19,440	17,640	22,680	14,112	18,144
Bearing Pads (qty)	5,000	10,000	8,000	16,000	11,000	22,000	7,000	14,000
Approach Slab Area (m ²)	12,800	19,200	29,000	43,500	57,600	86,400	24,400	36,600
Approach Pavement (m ²)	17,160	25,080	37,700	55,100	73,320	107,160	30,134	44,042
Joint Seal Length (LM)	2,000	3,200	3,625	5,800	6,000	9,600	3,050	4,880
Waterproofing Area (m ²)	3,600	5,600	7,830	12,180	15,120	23,520	6,149	9,565
Drainage Scuppers (units)	2,400	4,800	3,600	7,200	4,800	9,600	3,600	7,200
Earthwork	45,000	63,000	74,250	103,950	117,000	163,800	63,900	89,460
Miscellaneous	25,000	45,000	25,000	45,000	25,000	45,000	25,000	45,000
TOTAL DIRECT COSTS	\$348,810	\$496,330	\$566,925	\$795,195	\$898,890	\$1,249,450	\$486,297	\$685,399

Table H6
Indirect Cost – Method Percentage RS Means 2024

Component	Property Access		Urban 2-Lane		Urban 4-Lane		Rural Road	
	Low (\$)	High (\$)	Low (\$)	High (\$)	Low (\$)	High (\$)	Low (\$)	High (\$)
Mobilization (6.5%)	22,673	32,261	36,850	51,688	58,428	81,214	31,609	44,551
CPR Rail Coordination (Fixed)	125,000	160,000	125,000	160,000	125,000	160,000	125,000	160,000
Traffic Management (Var %)	13,952	19,853	70,866	99,399	112,361	156,181	31,609	44,551
Engineering (13.5%)	68,909	95,640	107,952	149,348	161,282	222,324	91,060	126,158
Construction Mgmt (9%)	45,939	63,760	71,968	99,565	107,521	148,216	60,706	84,105
TOTAL INDIRECT COSTS	\$276,473	\$371,515	\$412,635	\$560,001	\$564,592	\$767,936	\$339,985	\$459,364

Table H7
Total Project Cost with Contingency

Cost Category	Property Access		Urban 2-Lane		Urban 4-Lane		Rural Road	
Category	Low (\$)	High (\$)	Low (\$)	High (\$)	Low (\$)	High (\$)	Low (\$)	High (\$)
Direct Costs	348,810	496,330	566,925	795,195	898,890	1,249,450	486,297	685,399
Indirect Costs	276,473	371,515	412,635	560,001	564,592	767,936	339,985	459,364
BASE COST (Direct + Indirect)	\$625,283	\$867,845	\$979,560	\$1,355,196	\$1,463,482	\$2,017,386	\$826,281	\$1,144,763
Design Contingency (17.5%)	109,425	151,873	171,423	237,159	256,109	353,043	144,599	200,334
Construction Contingency (12.5%)	78,160	108,481	122,445	169,399	182,935	252,173	103,285	143,095
TOTAL CONTINGENCY (30%)	\$187,585	\$260,353	\$293,868	\$406,559	\$439,045	\$605,216	\$247,884	\$343,429
TOTAL PROJECT COST	\$812,868	\$1,128,198	\$1,273,428	\$1,761,754	\$1,902,526	\$2,622,601	\$1,074,166	\$1,488,192