THE APEX BRIDGE REPLACEMENT – CONNECTING COMMUNITIES

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Abstract

The community of Apex, Nunavut, historically relied on a single-lane Bailey bridge installed in 1955 to cross the Niaqunngusiariaq River. After nearly 70 years of service, the aging structure was deemed unsafe for modern traffic loads and was recommended for replacement in 2021. The primary objective of the project was to design a modern crossing capable of supporting two-way traffic and heavy emergency vehicles while providing a dedicated, safe pedestrian sidewalk. This upgrade was essential to provide the community with reliable access to vital municipal services from the nearby City of Iqaluit.

The bridge replacement faced significant arctic engineering hurdles, including complex shipping logistics without local fabricators, highly restricted sealift schedules, unexpected traffic volumes, and unpredictable bedrock depths. To overcome these challenges, engineers designed a new two-lane modular panel bridge with a 75-year lifespan, completing the project in 2024 alongside crucial roadway and sightline improvements. Ultimately, the modular design effectively addressed logistical and environmental constraints, improved public safety, maintained the visual aesthetic of the original structure.

Introduction

The geography of Frobisher Bay (Figure 1) is defined by rugged tundra, extreme tidal variances, and the rocky distinctiveness of Baffin Island. Five kilometers southeast of the bustling hub of Iqaluit lies the smaller, more traditional community of Apex, known in Inuktitut as Niaqunngut. Separating these two settlements is the Niaqunguk River (Apex Creek), a fast-flowing waterway that drains into the Koojesse Inlet.

Figure 1. Apex Overlooking Frobisher Bay



Source: M.Penner

For decades, community members of Apex have relied on a physical connection between Iqaluit (formerly Frobisher Bay) and Apex over the Niaqunguk River. The community began as a remote outpost

navigated by traditional knowledge and military improvisation, transitioned into a settlement dependent on cable and plank pedestrian bridge followed by a repurposed wartime surplus bridge, and finally emerged as a modern Canadian capital requiring code-compliant, safe, and permanent infrastructure.

In the early times (pre-1956), citizens crossed the river on ice in winter and over a makeshift cable and plank system in summer. These simple suspension footbridges, constructed from steel cables anchored into rocky banks and wooden planks, were unstable, swayed in Arctic winds, and were entirely unsuitable for vehicles. In 1956, a military surplus Bailey bridge was installed to provide the citizens of Apex with a year-round vehicular crossing opportunity, relieving seasonal constraints. As modernization progressed and the community grew, the Bailey bridge experienced significant fatigue, surpassing its intended structural use.

Project Objectives and Historical Context

The evolution of the Niaqunguk River crossing can be categorized into three distinct phases: the pre-infrastructure era of expedient crossings, the military surplus era, and the modern municipal era.

The Pre-Infrastructure Era: Ice, Water, Cable and Plank

The first bridge structure to cross the Niaqunguk River between Apex and the City of Iqaluit was a cable and plank system. The cables were anchored into rock and a series of planks were draped across the cables to provide access across the river for pedestrians. This system would have been utilized mainly in summer months and during heavy flows when crossing the river on foot would be treacherous.

Figure 2. Cable and Plank Pedestrian Bridge



Source: Nunatsiaq News (Photo by Daron Letts)

The Military Era: The Bailey Bridge (1956-2024)

The defining moment for the Apex crossing arrived in the mid-1950s when the U.S. Army Corps of Engineers carved a road through the rocky tundra to Apex, now known as Niaqunngusiariaq Road. The solution to crossing the river was a surplus Bailey bridge, a portable, pre-fabricated truss structure designed during World War II for rapid military assembly. The structure featured a single-lane width, accommodating only one vehicle at a time, and a wooden plank driving surface that became notorious for its clattering sound.

For 69 years, this temporary military structure served as the permanent lifeline for Apex. However, by the 2010s, the "temporary" truss bridge was showing its age, having outlasted its proposed lifespan by decades. The City of Iqaluit (COI) faced several pressing issues that necessitated a replacement:

- Safety Concerns: The mixture of pedestrian and two-way vehicular traffic on a single lane was inherently dangerous, requiring pedestrians to share the narrow deck with vehicles.
- Structural Fatigue: The superstructure experienced severe corrosion, and by July 2022, some bracing connections were no longer stable. The wooden deck required constant maintenance.
- Community Growth: With the growth of Apex and a substantial increase in city traffic, the single-lane bridge was no longer suitable to handle the high volume of vehicles and emergency responders.

Figure 3. Apex Bailey Bridge



Source: M. Penner

Objectives of the Replacement Project

The primary objective of the Apex Bridge Replacement project was to provide a safe, permanent, and code-compliant structure. It was determined that a new modular panel bridge placed on concrete abutments was the most suitable option to replace the deteriorated Bailey bridge. The selected structure was required to maintain a similar architectural feel to the historical crossing while providing modern essential services, a 75-year lifespan, and simultaneous two-way traffic.

Nearby Iqaluit is accessible by air year-round and by a sealift in unfrozen conditions. A modular panel bridge would be the most feasible option with respect to logistics of the remote northern community and would be the most constructable from a schedule and cost perspective.

Figure 4. Typical Modular Bridge Packaged for Transit



Source: M. Penner

Pre-Engineering and Design Methodology

In preparation for the project, Dillon Consulting Limited was retained to undertake a traffic study, detailed design, hydrotechnical assessment, fish habitat assessment, and topographic survey.

Traffic Analysis

During the initial site visit on July 5, 2022, observers noted minimal traffic and reviewed the need for a two-lane structure. A traffic study for the crossing was initiated to determine the extents and frequency of the crossing users. The traffic study was completed using two motion-activated cameras running 24 hours per day for one week to gather an average daily traffic volume. One of the cameras was placed at the west approach of the existing bridge and the other placed on the nearby detour road of Helen Magsakak Road (Angel Street). The cameras were placed by City staff on power poles adjacent to the roadway approximately three (3) meters above the existing ground. The camera heights were set to reduce the amount of tampering during the study and the cameras were placed in tamper proof lock boxes. The cameras were adjusted to approximately 15 degrees below level to have the trigger function capture vehicles in both lanes and the shoulders of the existing roadway for pedestrians. The program was in place in August of 2022 and the City's staff collected the equipment at the end of the week. The data was sent back to the design team for analysis and processing.

The study generated an average vehicle volume of 1,367 vehicles per day utilizing the crossing, alongside an average of 50 pedestrians per day. This high volume highlighted the significant risk and safety concerns of the existing single-lane configuration and warranted a replacement to be a two-lane structure.

The motion activated cameras, took photos of everything that tripped the motion detector, including birds, dogs, bicycles, ATV's, pedestrians, and vehicles. The data was sorted in numerous ways including frequency during peak hours, types of vehicles, cars, trucks, service vehicles, and pedestrians crossing the camera sites. The number of users crossing the structure greatly exceeded the anticipated amount from the site visit. This is suspect to July being off season and no school was in session. This method of traffic analysis was proven as each activation of the camera was associated with an image. The images could then be sorted into a data analysis count to assist with the report of traffic observed.

Figure 5. Apex Bridge Traffic Study (Pedestrians and Motorists)



Source: M. Penner

Hydrotechnical and Environmental Considerations

A hydrotechnical review determined that the existing Apex Bridge crossing exceeded all design criteria with respect to design flow, clearance, and freeboard. This is due to a steep hydraulic fall as the river drops off adjacent to the structure.

No in-water work was required therefore the environmental impact was minimized. The project obtained necessary regulatory approvals, including a Request for Review (RFR) approval from the Department of Fisheries and Oceans. Confirmation was obtained from the Nunavut Water Board that no water licence was required. This crossing was not identified as a navigable crossing by Transport Canada and did not require additional permitting.

Substructure Design

During the initial stages of the design, discussions and input from stakeholders regarding width requirements for emergency and maintenance vehicles was considered. Through this review, an 11.52 meter wide modular panel bridge featuring 7.36 meters of roadway width and a 1.50 meter external cantilevered sidewalk was the preferred choice for the bridge replacement.

The existing river crossing was aligned at the narrowest available point, where the bedrock protruded inwards toward the water. Because this hourglass-shaped rock configuration could not adequately support the wider structure, the proposed bridge was lengthened to establish a secure foundation. This increased length also created appropriate landings and side slopes for pedestrians accessing the sidewalk.

The proposed traffic staging plan was to divert existing traffic to a temporarily signalized single-lane bypass route via Helen Magsagak Drive (Angel Street). This allowed the full closure of the site and no additional traffic staging would be required throughout the project.

A geotechnical investigation report, originally included in an options analysis completed by others, was provided by the City of Iqaluit. The report reviewed the options of spread footings directly on bedrock or installation of rock socketed caissons. Ultimately, design of spread footings directly on bedrock was deemed feasible as borehole data included in the report indicated depth to sound bedrock ranged from 1.0 to 2.8 meters and required less specialized drilling equipment.

The initial design of the substructure consisted of:

- A concrete working slab to account for approximately 0.5 meters of undulating bedrock to provide a level base for formwork;
- Reinforced concrete footings complete with drilled dowels 800 mm into the existing bedrock with 25M rebar;
- Reinforced concrete bearing seat with positive drainage away from bearings; and
- Reinforced concrete wingwalls to contain the embankment fill.

Superstructure Design

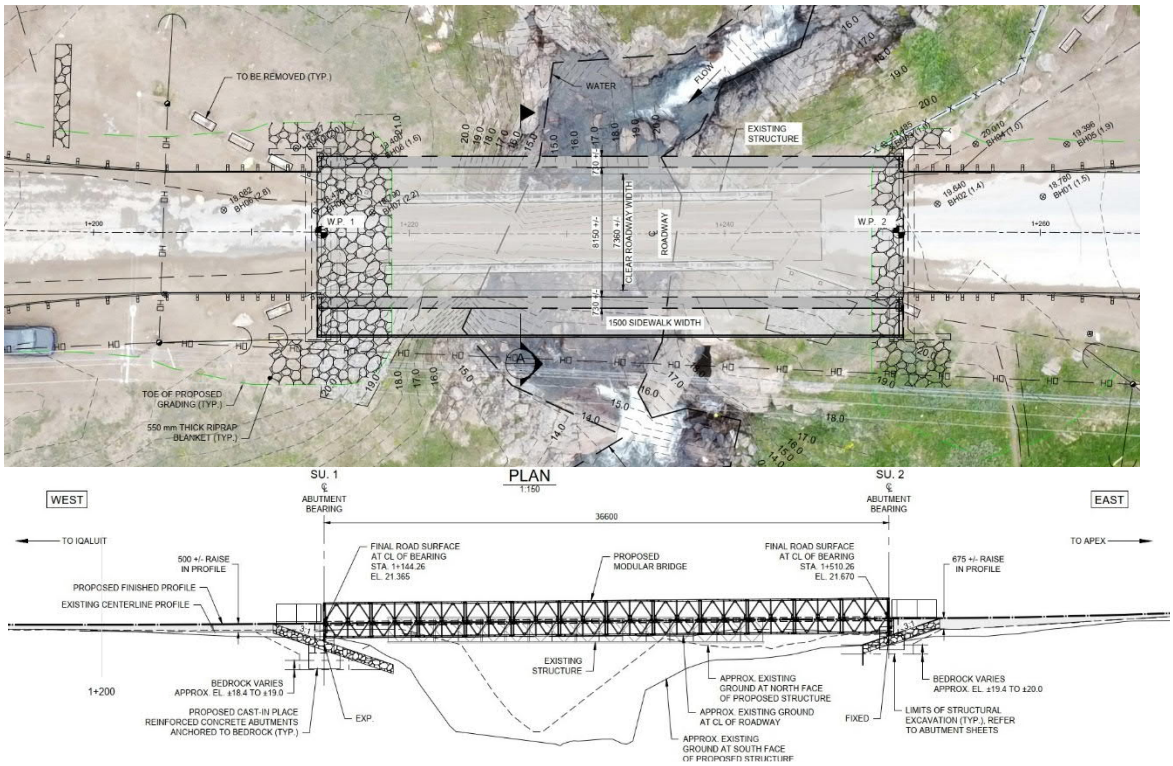
The selected superstructure was a 36.6-meter-long prefabricated modular panel bridge. Its structural design was handled by Algonquin Bridge and followed the Canadian Highway Bridge Design Code (CHBDC) 2019 under CL-625 live loading criteria. Additionally, the exterior cantilevered sidewalk design was safely positioned outside the vehicular roadway to resolve historical safety conflicts between pedestrians and vehicles.

Highway and Roadside Safety

The proposed roadway profile was also reviewed, and an increased vertical curve K value was applied which improved site lines to provide a safer roadway for the public throughout the crossing and approaches. Proposed paved approaches were designed to reduce the amount of unwanted aggregate on the epoxy coated steel deck panels. The pavement was removed and was to be part of a separate stand-alone contract.

Installation of a French drain was proposed for the northwest embankment at the bottom of the sag curve to promote subgrade drainage and detailed design of the new approach roadway widths were designed in accordance with the Transportation Association of Canada (TAC) Geometric Design Guide 2019. To accompany the proposed bridge and roadway, roadside safety end treatments were included, specifically W-beam guardrail that transitioned to thrie-beam guardrail along the bridge.

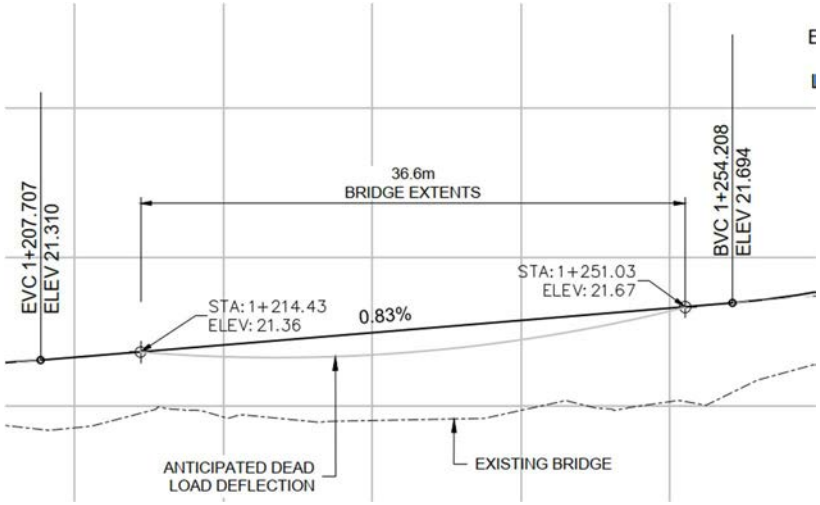
Figure 6. Proposed Bridge Plan and Elevation



Source: M. Penner

To prevent surface runoff from the bridge draining directly into the river below, an elevation differential of approximately 300 mm was applied to the east end bridge elevation. Figure 7 refers to the adjustment positioned anticipated dead load deflection (low point) of the modular panel bridge over the west headslope, effectively minimizing the amount of sediment and granular material falling directly into the watercourse.

Figure 7. Profile of Anticipated Dead Load Deflection



Source: M. Penner

During the constructability review, an existing power pole and cable anchor were identified to cause conflict on the western approach and staging area. The pole and cable were to be removed and temporarily relocated prior to any construction works on the site. This utility pole served as a transverse support to the existing power poles and could effectively be braced with a timber strut on the adjacent side of the powerline.

Construction Methodology and Phasing

Construction (on-site works) commenced on July 21, 2024 by Tower Arctic Ltd. (Tower), the general contractor for the project.

Phase 1: Detour Implementation

During the kickoff meeting with the stakeholders, the City indicated that traffic signal lights would be recommended for the single lane detour vs the original yield due to the volume of vehicles and the length of the detour. The contractor was able to obtain two traffic signals, and to the authors knowledge, were the only two active traffic signals in Nunavut at the time.

Figure 8. Traffic Light Installation on Angel Street



Source: M. Penner

Phase 2: Existing Bridge Decommissioning

Structural excavation on the east abutment began on July 30, 2024. To prepare for delaunching, the contractor removed the existing timber deck and curbing to reduce the overall weight of the structure. On August 10, 2024, the historic truss bridge was removed using a crane-assisted delaunch procedure. A crane supported the east end of the bridge while the west end was placed on a series of rollers and gently rolled to the west embankment. The bridge was subsequently dismantled using torches, field cuts, and hauled to the City's yard for disposal.

Figure 9. Crane Assisted Delaunch



Source: M. Penner

Phase 3: Substructure Construction and Bedrock Mitigation

During structural excavation, actual bedrock elevations varied from the anticipated depths at both abutments:

- West Abutment: Bedrock elevations deviated significantly from the design model. The bedrock was found to be approximately 3.0 meters lower on the south side and 1.0 meter higher on the north side.
- East Abutment: Localized areas of bedrock were higher than expected. To reach the proper foundation elevation, the contractor expended additional effort, utilizing an excavator equipped with a rock-breaking attachment to remove the isolated protrusions.

Figure 10. East Abutment Working Slab



Source: M. Penner

Following discussions with geotechnical engineers for the west abutment foundation, several options were evaluated:

- Granular Fill: Deemed unsuitable due to the steep drop-off of the underlying bedrock.
- Socketed Steel Pipe Piles: Ruled out due to constructability challenges, limited contractor availability, and schedule constraints associated with redesigning the abutment.
- Reinforced Concrete Infill (Preferred Solution): The chosen approach involved a design adjustment using reinforced concrete infill dowelled directly into the bedrock. This option aligned best with the project schedule, material availability, and workforce capacity.

Design Adjustment Details:

- Structural Changes: The stem of the west abutment was removed on the north side, where the bedrock elevation is higher. Extra doweled reinforcing was then added to the south side of the abutment.
- Material Impact: This modification required approximately 30 cubic meters of additional concrete. However, the reinforcing steel from the removed abutment stem was successfully repurposed for the new pour.

Figure 11. West Abutment Forming



Source: M. Penner

Phase 4: Bridge Erection and Commissioning

The modular panel bridge components were fabricated in Thorndale, Ontario, and shipped via sealift through the port of Montreal. The panels were assembled on the west side of the crossing with an excavator and loader. Site representatives from the bridge supplier were present during the erection and launching of the structure.

On September 16, 2024, the fully assembled bridge was launched across the Niaqunguk River. Following the launch, the nose of the bridge was disassembled, and the bridge was jacked down the on to the abutment bearings. Once the bridge was sitting in its final position, the forming and pouring of the concrete backwalls and wingwall commenced.

Figure 12. Modular Panel Bridge Launch



Source: M. Penner

Phase 5: Approach Roadworks

After the bridge launch was completed, the contractor placed the approach roadway materials and installed the remaining components of the structure including epoxy coated deck panels, guardrails, signage, and drains. The bridge was substantially completed in late October of 2024 and opened to public traffic on November 13, 2024.

Figure 13. Approach Roadworks



Source: M. Penner

Phase 6: Warranty

The warranty period for the Apex bridge replacement was active for a one-year period. The final warranty inspection was completed in unfrozen conditions in August of 2025. During the warranty inspection, representatives from the contractor and City met with the consultant for a final walk through. Minor items were noted and rectified by the contractor closing out the project.

Figure 14. Celebration of Completed Apex Bridge



Source: Nunatsiaq News (Photo by Daron Letts)

Conclusions

Each replacement of the historic Apex Bailey bridge signifies a critical infrastructure milestone for the community of Apex and the City of Iqaluit. Table 1 represents the comparative analysis for the crossing structures.

Table 1. Comparative Analysis of Infrastructure Eras

Feature	Cable & Plank (Pre-1956)	Bailey Bridge (1957-2024)	Modern Modular (2024-Present)
Primary Use	Foot traffic	Vehicular / Single Lane	Municipal Highway/Multi Lane with Pedestrian Sidewalk
Material	Steel Cable, Wood Slats	Concrete Abutments, Surplus steel truss, timber deck	Modernized concrete abutments, High-grade steel Algonquin Bridge, Epoxy Coated Aggregate Deck.
Traffic Flow	Single file (pedestrian)	Single lane (alternating yield)	Double lane (simultaneous)
Safety	Low (Unstable, no guardrail, limited stability)	Moderate (mixed traffic conflict with pedestrians, not suitable for emergency vehicles, high traffic volumes for single lane)	High (pedestrian traffic separated from roadway, suitable for emergency vehicles, two way traffic)
Lifespan	Temporary (seasonal)	69 years (extended temporary)	75 years (permanent design)

For nearly seven decades, the temporary military surplus structure served as an essential lifeline, but escalating structural fatigue and surging traffic volumes, averaging over 1,300 vehicles daily, rendered the single-lane crossing undersized and posed a risk to pedestrian safety.

Delivering a modern, code-compliant crossing in the Canadian Arctic required overcoming severe logistical and geotechnical constraints. The project successfully navigated highly restricted sealift schedules, remote fabrication dependencies, and unforeseen bedrock elevation variances encountered during structural excavation. By implementing an adaptable 36.6-meter modular panel superstructure and utilizing rock-dowelled, reinforced concrete infill to stabilize the substructure, the engineering and construction teams effectively mitigated these site-specific challenges without compromising the project timeline.

Ultimately, the new two-lane bridge provides a permanent, 75-year design life solution that directly addresses the community's safety and capacity needs. The inclusion of a dedicated, cantilevered pedestrian sidewalk reduces vehicle-pedestrian conflicts, while the truss design maintains the visual heritage of the original crossing. The successful 2024 commissioning of the Apex bridge not only secures reliable access to vital municipal and emergency services for Apex residents, but also establishes a highly

constructible, resilient infrastructure model for other remote northern communities facing similar environmental hurdles.

Figure 15. Completed Apex Bridge 2024



Source: M. Penner

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