



HIGHWAY 407 EAST PHASE 2

ONTARIO, CANADA



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PROJECT NAME	Highway 407 East Phase 2
LOCATION OF PROJECT	Durham Region, Ontario
YEAR COMPLETED	2019
CATEGORY OF ENTRY	B. Transportation
ROLE IN PROJECT	Prime Consultant
PROJECT OWNER / CLIENT	Infrastructure Ontario
DESIGN TEAM	Ainley Group Urban Systems Great Northern Engineering Consultants
GENERAL CONTRACTORS	Dufferin Construction Company Ferrovial Agroman Canada
PROJECT SUMMARY	<p>The Highway 407 East Phase 2 Project extends Highway 407 from Oshawa to Clarington. The project will ease traffic congestion, improve the flow of goods and services, and stimulate economic growth. Through innovative design solutions and collaboration with the Contractor, the Klohn Crippen Berger-led design-build team was able to deliver the project in an efficient and cost-effective manner. It is the first design, build, finance, and maintain project in Ontario to be completed on schedule.</p>



INNOVATION

In 2015, Blackbird Infrastructure Group (Blackbird) signed a \$1.2 billion contract with Infrastructure Ontario to design, build, finance, and maintain the Highway 407 East Phase 2 Project. The project extends Highway 407 about 22km from Harmony Road in Oshawa to Highway 35/115 in Clarington, and includes construction of the new Highway 418. The project involves a total of 32 km of highway, 70 bridges, 28 culverts, 4 wildlife passage structures, 8 major interchanges, 10 million m³ of earthworks and 10 km of drainage infrastructure.

Due to the aggressive design and construction schedule, the project was delivered in two phases using two design teams: Phase 2A, which opened to traffic in January 2018; and Phase 2B, which opened to traffic in December 2019. Blackbird retained the Kohn Crippen Berger (KCB)-led team consisting of Urban Systems Ltd. (Urban Systems), Great Northern Electrical Consultants (GNEC), and the Ainley Group (Ainley) to perform the design management, structural, highway, traffic staging, drainage, and electrical design, and construction services for approximately half of the project.

A major goal for the Design-Build team was to deliver a cost-effective design, on schedule, without compromising quality or safety.

KCB developed several options for each bridge, which entailed evaluating several span configurations, foundation

types, and girder types to determine which was best suited to each site. KCB also endeavored to standardize as many of the design details as possible, allowing for more efficient fabrication and installation which reduced construction time.

Given the large scale of the project, moving fill around the site proved costly and time consuming. Urban Systems worked with the Contractor to optimize the highway alignments and profiles to balance cut and fill volumes and reduce costly earthworks and shorten the construction schedule.

Ainley developed the highway drainage design for more than 450 hectares using a combination of enhanced swales, dry ponds and wet ponds. Some ponds were designed as wetland/stormwater facilities to preserve natural habitats, while simultaneously providing water quality treatment for the highway drainage. By optimizing the drainage design, Ainley eliminated several of the major ponds shown in the reference design.

Through innovative design solutions and working with the Contractor, the design-build team was able to deliver the project in an efficient and cost-effective manner. Both phases of the project opened to traffic on schedule, making the Highway 407 East Phase 2 project the first design, build, finance, and maintain project in Ontario to be completed on schedule.



The construction of the Highway 401/418 Interchange involved challenging traffic management to construct the bridges without closing Highway 401.



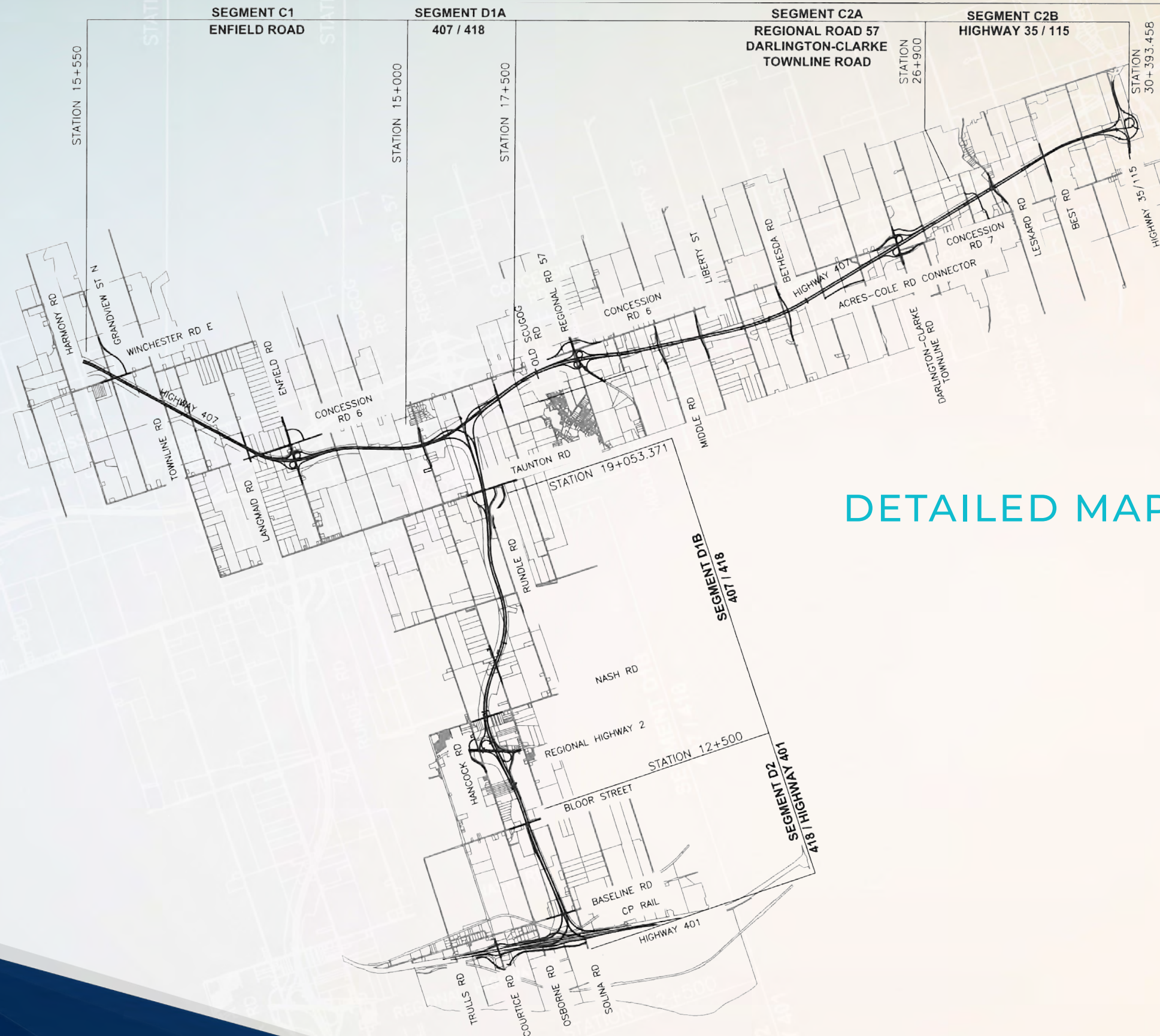
COMPLEXITY

The project presented numerous logistical and technical challenges which needed to be overcome. A key challenge was optimizing the bridge designs while meeting the needs of multiple stakeholders. For example, the highway crossed an environmentally sensitive wetland under the jurisdiction of three environmental authorities. Each authority had different requirements for the minimum span of the structure based on the perceived implications to the environmentally sensitive area. The team was able to identify a bridge configuration that addressed their concerns, but was still economical and reduced the length of the bridge by 70m compared to the reference design.

The project included stringent requirements, such as strict glare and light pollution limits, which made it difficult to provide adequate roadway lighting without impacting the surrounding wildlife habitat. GNEC studied several options

and proposed LED highmast lighting. The use of LED lighting provides additional benefits such as improved roadway safety, lower operating and maintenance costs, and reduced energy consumption.

Another challenge was coordinating a multi-disciplinary design team located across five cities and liaising with a contractor based in both Spain and Ontario, while meeting the project's tight schedule. The team prepared detailed design management plans and held regular coordination meetings to ensure that the design was progressing as planned. Regular and ongoing communication allowed the Contractor to benefit from the designer's knowledge and the designers to benefit from the Contractor's construction experience which helped with project efficiencies.



DETAILED MAP



SOCIAL AND/OR ECONOMIC BENEFITS

The project created thousands of direct and indirect jobs, including about 750 workers at peak construction. With the completed Highway 407 Extension now open to traffic, the project has improved safety, reduced delays, eased traffic congestion, generates revenue for the Province of Ontario, and will continue to provide other economic benefits for years to come.

Safety was one of the top priorities throughout the design and construction of the project. The design team worked with the Contractor and the Roadside Safety Auditor using a “safety through design” approach to effectively mitigate potential hazards to the public. This included maximizing sightlines for drivers, providing enhanced clear-zones and recovery slopes at the shoulders, and implementing a barrier-free design wherever possible. The resulting highway network has a reduced risk of collisions and provides improved safety and reliability for road users.

The new highway relieves congestion, which will help the flow of goods and services between Toronto and eastern Ontario and stimulate population and economic growth in the Durham and Clarington regions. Improved freight productivity and lower transportation costs will make existing and future industry more accessible and will benefit the local, provincial and national economy. Lower traffic congestion will also encourage local tourism and recreational travel.

Because the Province of Ontario owns the Highway 407 toll road, revenue generated from the tolls will help the government fund a variety of programs and services, including new infrastructure and transit projects across the province.

Protecting the environment was a top project priority. The Contractor's environmental team worked together with the design team to minimize impacts to the environment and provide habitat compensation to offset the impacts of construction. Some of the habitat compensation included creating engineered wetlands incorporated in the stormwater facilities, building nesting boxes for bats and native bird species, installing wildlife exclusion fencing, constructing bridges and culverts to allow wildlife passage, and replanting native species like butternut trees. In addition, noise pollution was mitigated using sound walls, and light pollution was controlled using focused LED lighting.

The design team provided innovative technical solutions for the bridge, roadway and drainage designs, which minimized disruption to the surrounding environment, community and road network. By reducing bridge lengths, adjusting highway alignments and profiles, and optimizing the drainage design, the team was able to reduce the amount of new construction materials, reduce earthworks, and eliminate several major drainage ponds to minimize the project's overall environmental footprint.

The completed project will help to alleviate traffic congestion and the associated adverse environmental impacts, such as higher levels of CO₂ emissions, noise and vibrations.

MEETING CLIENT'S NEEDS

The main project goal for the design-build team was to deliver a cost-effective design on schedule without compromising quality or safety.

The project contract included a strict penalty clause for late construction completion, so meeting the final construction deadline was a priority for the Contractor. The design team developed standardized construction details, minimized earthworks and eliminated major drainage infrastructure to help accelerate construction. The team also collaborated frequently and coordinated design and construction activities to improve efficiency. The highway was opened to traffic on schedule in December 2019.

Despite a compressed project schedule, the Contractor challenged the design team to evaluate multiple options to optimize the designs and reduce construction costs. KCB evaluated numerous bridge configurations and types to determine which was best suited for each site. The final bridge designs included curved steel box girder bridges, NU girder bridges, concrete box girder bridges, a two-stage post-tensioned concrete bridge, and a unique, highly skewed "trellis" structure. Offering multiple conceptual bridge options allowed the Contractor to select the most economical one.

The design team provided full-time field personnel during construction to help confirm compliance with the design. The continuous construction monitoring, design revisions in response to field observations, and close coordination between the Contractor and design team led to a safe and high-quality finished product.

Despite the size and complexity of the project, it was successfully delivered through careful management, innovative design, and teamwork.



Twin steel box girder bridge was constructed over Highway 401 with minimal impact to traffic.



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