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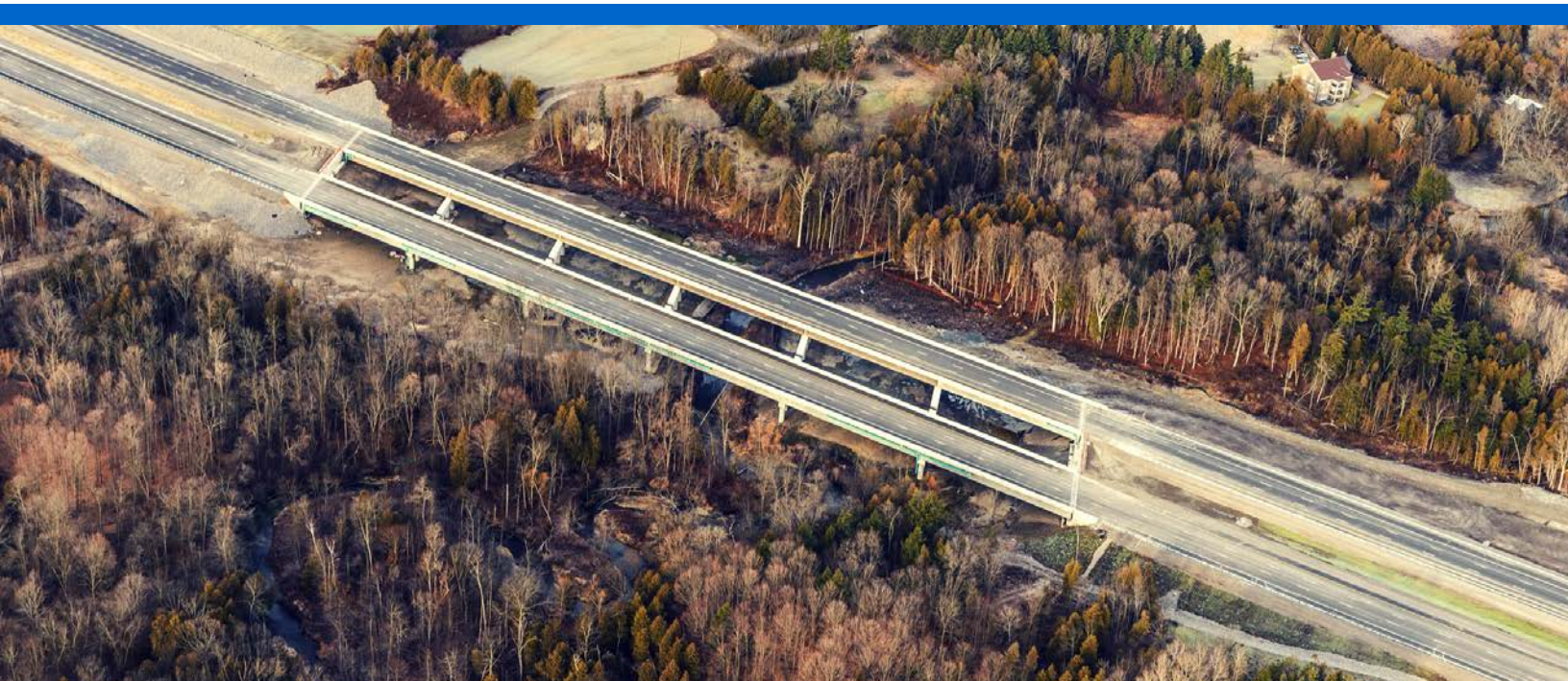
111 Gordon Baker Road, Suite 400 | Toronto, Ontario | M2H 3R1

AIA ENGINEERS CONSULTANTS

5770 Timberlea Blvd. Suite 205, Mississauga, Ontario L4W 4W7 | Tel: 647.797.9411 | Fax: 647.797.9415 | www.aiainc.com



Executive Summary

Project Objectives, Solutions and Achievements

The objective of the Highway 407 East Extension Phase 2A Project was to relieve gridlocks and provide a safe passage for both goods and community through the eastern Greater Toronto Area and beyond. Several studies carried out by the Ministry of Transportation in consultation with the Region of Durham and its constituents and surrounding municipalities resulted in a need to provide sustainable transportation choices that were safe, reliable, and efficient for the Region of Durham.

The Highway 407 East Extension Phase 2A Project was a logical solution to meet all of the transportation requirements in and beyond the Region. This Project provides a safe, reliable, and efficient transportation option for the community. This Project also supports and promotes sustainable growth across the region and also serves as a transportation strategy that serves the required travel demand and protects, conserves, enhances, and manages the natural resources efficiently. In addition, this Project supports and enhances sustainable land use patterns.

During the construction phase, the Project created thousands of design and construction jobs, and after completion, provides lasting economic benefits to Region of Durham and its surrounding areas. The Project will also generate new prospects for local businesses, and it will help the growth of population and employment in the Region of Durham. The Project is already providing positive impacts on the community with extra emergency detour routes and elimination of traffic congestion for the local users and is crucial for a fast growing community.

Multiple engineering feats were achieved during the design and the construction phases of the Project. Various design options were analyzed during the detail design. This included reverse stacking (Underpass to Overpass and vice versa), at several interchanges and crossing roads to provide the most efficient earth fill quantities which resulted in lesser impact to the environment.

Major crossing roads structures were designed to accommodate construction on a shifted alignment to allow free traffic movement throughout the construction phase; therefore, no closures were warranted at any crossing roads.

Transversal and optimization studies for all the bridge structures were carried out to determine the most efficient slab on girder cross section. The study concluded that NU-girders were the most effective slab on girder bridge option when compared to the traditional CPCI girders that are used extensively in the Province of Ontario. NU-girders allow the better use of girder cross section when compared to CPCI girders and result in having longer spans on the bridges. As an example, a CPCI 2300 standard girder can span a maximum length of 42 meters; comparatively, a NU 2400 girder can span a maximum length of 48.5 meters (restricted due to maximum length possible during transportation)

Several roadway profile options were analyzed to determine an efficient balance of cut and fill quantities resulting in less earth to be transported off site. This optimization study included the evaluation of different highway and crossing roads' horizontal and vertical profiles.

Project management has required the management of multiple teams and resources and coordinating diverse specialties to ensure quality work and timely delivery to meet project requirements, to provide cost-effective designs, to ensure engineering quality management, to accommodate site and construction requirements, and to manage costs and budget, all at an accelerated project schedule.

Level of Complexity and Project Challenges

Several challenges were encountered during the design and the construction phases of the Project. Below are few of the complex challenges that were overcome.

Numerous water crossing structure foundations encountered artisan waters which resulted in foundation construction difficulties. AIA along with the geotechnical team assessed this condition and developed a strategy which included placement of drainage pads underneath the foundation and channelling of the artisan water pressure through drain pipes and into the water crossings and roadside ditches in case of crossing road structures.

Several crossing road structures at the approaches had significant embankment settlement issues which required us to strategize a preloading procedure which extended to nearly two years for few structures. Settlement plates were installed on sand mats and on natural soil prior to the construction of the embankment. Settlement monitoring was carried out every two days in the first two weeks, every week in the following three months, and every two weeks afterwards until 95% of consolidation was obtained. The measurement accuracy of settlement was fixed to ± 1 millimeter. As a result, the schedule of construction of these structures was strategized to account for the preloading procedure to fit in within the project schedule.

Several water crossing structures had creeks inhabited with Redside Dace fish which are designated as Species at Risk (SAR) by the *Endangered Species Act*. This required undertaking all high impact construction activities, including all in-water and near-water work, within the Redside Dace construction timing window of July 1 to September 15 of any given year. Scheduling construction of these watercrossing structures was the biggest challenge considering stream realignments, fish habitat restoration, and construction of the bridge structure. This issue created a significant hurdle for one of the structures which was 197 meters long with 5 spans; however, it was completed within the stipulated time.

Numerous stormwater management ponds were designed to discharge to sensitive water courses that supported the Redside Dace habitat. These ponds were also required to be designed with thermal mitigation strategies. These strategies included different types of vegetation species similar to the surrounding landscape with higher density/quantity of trees to meet the objective of maximizing shading/cooling of the permanent pool and of minimizing temperature fluctuation during events when warm water from the first flush of the highway drainage system enters the pond. This strategy along with bottom draw outlet was implemented to protect cold water streams that support aquatic species (Redside Dace and Brook Trout) which are sensitive to temperature fluctuation.

Technical Excellence and Innovation

The Project scope allowed for the review of the Project design by an independent Road Safety Audit team which included human factor specialists who studied the human behaviour of highway users. This team provided, from a highway user's perspective, design recommendations for a higher level of safety for the highway users. These recommendations were incorporated into the design and significantly improved the safety of the highway.

Tolling design was one of the unique features involved in the design of this Project. The design included automatic toll collection which included design of the toll gantries at every interchange's entrances and exits. AIA's scope included the design of the toll gantries and associated electrical and communication design with very strict tolerances in order to accurately and automatically capture and record the toll collection. The toll gantries consist of radio antennas and a series of multiple cameras. To calculate the toll rates, radio antennas detect the vehicles with transponders at the entrances and exits of the interchanges. To calculate the toll rates for vehicles without transponders, an automatic number plate detection system embedded within the camera records the entrance and exit of the vehicles at the interchanges.

As a multi-disciplinary consulting firm with over 33 years of experience and expertise in the field of highway design, AIA Engineers utilized on this project their extensive experience and knowledge of cutting edge technologies. As the Highway 407 East Extension Phase 2A Project is a unique, high-profile Design-Build project, AIA used their previous Design-Build project experiences and expertise which has been developed and refined through the successful completion and commissioning of during the Detail design and Construction of Highway 407 East Phase 1 project and numerous projects in Texas and elsewhere in the United States.

Multiple discipline experts on AIA's staff, helped assess and provided expert opinions throughout the design and construction phases of the Project. Throughout the design process, AIA strengthened their local presence by hiring talented discipline staff within Ontario to lead and carry out the design and construction support successfully within schedule and budget.

Contribution to Economic, Social and/or Environmental Quality of Life

During the planning phase of this Project, major deficiencies existed within the transportation system in the Region of Durham and the Municipalities of Oshawa and Clarington. These deficiencies had a negative impact on the movement of community and goods and had an adverse effect on the natural and social environments. These short falls included insufficient capacity to accommodate existing and future travel demands, lack of connectivity to the surrounding communities and jurisdictions, and limited emergency management and detour routes. Economically, network congestion had an adverse effect on moving the goods at the international, federal, provincial, and local levels. It was projected that if the population and the employment figures grew, these figures will be exponentially impacted if no additional east-west and north-south transportation system was not provided. It was also recommended that improvements to local, Regional, and inter-regional transit be improved and developed.

The Project provided solutions to the all of the above concerns that were recognized during multiple transportation planning studies in the Region and within the Province. To address the improvements to the transit demands, the Project scope also included accommodating a 60 meter transit way corridor on the south side of the Highway 407 East Extension mainline for the entire length.

The Project provided solutions for a sustainable transportation choice which is safe, reliable, and efficient. Economic sustainability is increased as a result of this Project, providing safe, efficient, and reliable transport for both people and goods. The highway provides for local growth of population resulting in sustainable land use patterns and connections within the Region of Durham and Greater Golden Horseshoe including Greater Toronto Area communities to the west and Cities of Kawartha Lakes and Peterborough and the Counties of Northumberland to the east.

Highway 407 East Extension Phase 2A serves as a prime example of an engineer's contribution to the society. Technical excellences were achieved in all disciplines of this Project which resulted in the least possible impact to the environment during the construction phase and for the entire service life of the highway. From environmental and design perspectives, several alternatives were studied to have minimal to zero impacts to the wildlife and vegetation, communities, and local economy.

The Project design was optimized to efficiently meet the criteria and indicators in the following five areas:

- Natural Environment
- Social Environment
- Economic/Land Use Environment
- Cultural Environment
- Engineering and Technical Areas