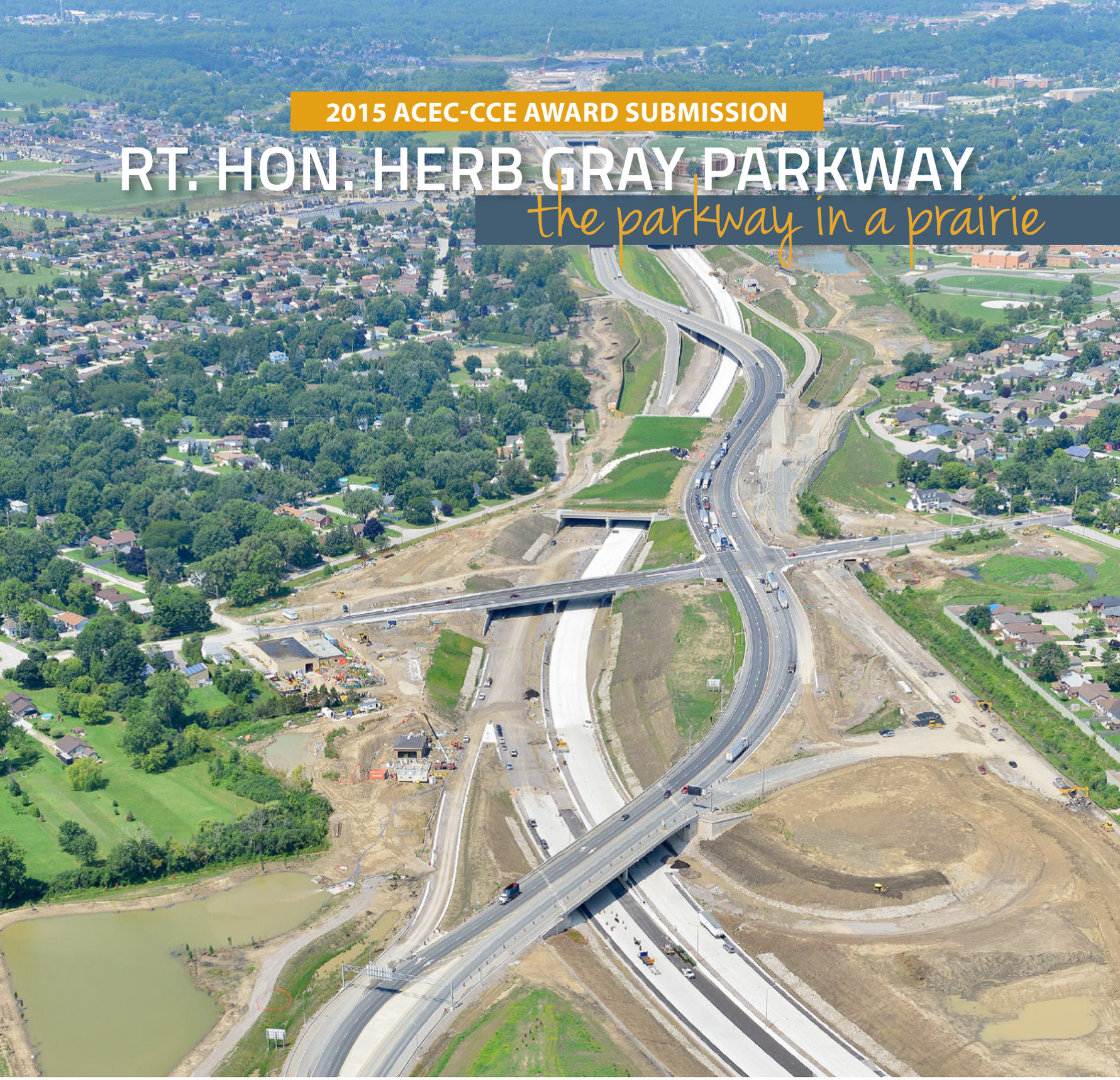

2015 ACEC-CCE AWARD SUBMISSION

RT. HON. HERB GRAY PARKWAY

the parkway in a prairie

CLIENT: PARKWAY INFRASTRUCTURE CONSTRUCTORS

TEAM: HATCH MOTT MACDONALD, DILLON CONSULTING, AMEC FOSTER WHEELER, & LEA GROUP

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA
ASSOCIATION DES FIRMES D'INGÉNIEURS-CONSEILS | CANADA

CANADIAN CONSULTING engineer

Project Overview

Rt. Hon. Herb Gray Parkway (RHHGP) is the roadway component of the new Detroit River International Crossing - a joint Canada/US initiative to provide safe, efficient and secure movement of people and goods. This once-in-a-generation undertaking that will improve traffic flow at Canada's premier trade gateway is unprecedented in its community enhancement and environmental features for a highway anywhere in Ontario. The project includes 11km/six-lane extension of Highway 401, 7.5km of urban freeway (4m-8m below grade), 7.5km of a four-lane service road, three interchanges, 14 overpasses, 12 signalized intersections, 12 cut-and-cover tunnels, 10 pedestrian crossings, and a multi-lane roundabout. Substantial municipal infrastructure supports this highway extension including dozens of culverts, stormwater management ponds and pump stations, new watermains with fire suppression systems, utility relocations and improvements to 16 municipal roads. Conventional illumination and Advanced Traffic Management System are also provided. Hatch Mott MacDonald (HMM) is leading the design team that includes Dillon, Amec Foster Wheeler and LEA Group.

Rt. Hon. Herb Gray Parkway

Upon completion, the Parkway will ensure the safe and efficient movement of people, goods and services to and from a proposed new Canadian inspection plaza and international bridge, separate local and international traffic, and eliminate stop-and-go traffic in residential areas.

Construction on the Parkway started in 2011 and completion is anticipated by summer 2015. It is estimated that the project is generating approximately 12,000 jobs by creating business opportunities, attracting new investment, and supporting existing industry. The majority of these jobs are in the Windsor-Essex region.

RSS Retaining Walls

Innovations

The team initiated major innovations that minimized material use and shortened construction times. One innovation related to soil improvement for the foundations. Using proprietary reinforced soil system (RSS) retaining walls instead of cast-in-place reinforced concrete, the interlinked concrete panels were secured by straps laid through compacted granular backfill or lightweight concrete, and founded on reinforced granular mat. This was the first use of this technique in Ontario. Since RSS walls are lighter and more flexible, they required less substantial foundations reducing construction time. Moreover, RSS walls were produced in a controlled environment with significantly improved

structural aesthetics.

For the 12 unique bridges buried under soil and landscaping, the team opted for precast Nebraska University (NU) Girders. These girders have a wide top flange providing better worker platform and shorter deck slab spans. The wide bottom flange increased strand capacity and flexibility, requiring fewer girders compared to the conventional "I" beams. Therefore, 485 fewer girders were needed, saving on bearings, precast panels and time. This was the first use of NU girders in Ontario.

NU Girder placement

The owner was particularly concerned about vehicle fire disabling these structures, and closing access to a busy border crossing. To protect this substantial asset and ensure life safety, the team incorporated stringent fire protection measures. The strict design requirements and the irregular NU girder shape made typical secondary fire protection of a large number of girders uneconomical and unreliable. The solution was two-fold: increase cover concrete thickness (up to 70mm in critical locations) to limit temperatures in the girder core and corresponding loss in structural capacity; and add sacrificial polypropylene fibres to the concrete mix to prevent explosive spalling in the event of such an incident. NFPA compliant fire alarm systems and monitoring systems were also provided in each tunnel to enhance safety and limit potential closures of these key corridor elements.

State-of-the-art programmable adaptive daytime lighting systems were designed for the highway sections passing through each of the 12 land bridges. To ensure optimum visibility while conserving energy, the daytime illumination levels are reduced passing through the tunnel from the entrance portal to exit to account for driver vision adaptation, in addition to overall illumination being proportional to the type of day (sunny, cloudy, overcast, dull) and direction of the sun relative to direction of travel. This immensely complex array of twelve tunnel lighting systems (some the length of over two football fields) combined to represent one of the most (if not the most) extensive tunnel lighting/electrical design and deployment undertaking of its kind in Canada's history.

The design of the RHHGP also includes an Advanced Traffic Management System (ATMS), with a series of CCTV cameras, light emitting diode dynamic message signs (DMS), a queue warning system, and a fibre optic communications system. The ATMS will be operated by the Ministry of Transportation of Ontario out of their West Region Traffic Operations Centre located in London, Ontario. With this system, traffic flow to and from the border can be monitored and traffic incidents identified and managed in a more expedient and safe manner. The DMS will be used to inform travellers of traffic conditions, incidents, tunnel and lane closures, and traffic queues. To date, this project represents the largest single design and deployment of Intelligent Transportation Systems (ITS) anywhere in Ontario.

Multi-lane roundabout

At the east end of the Parkway, a potentially complex interchange has been simplified with the inclusion of a modern roundabout on Highway 3, linking two provincial highways and a

municipal arterial roadway. The major benefits of the roundabout are reduced speed, improved safety, less congestion, and increased capacity due to fewer stops compared to a signalized intersection.

Other long-term benefits include eliminating maintenance and electricity costs associated with traffic signals, and reduced noise and air pollution from idling vehicles.

Overpass structure

Project Complexity

Surrounded by 121ha of parkland and ecological landscaping the project's principal objective was to create a 'road-in-a-park' that minimized the sense of an eight-lane highway, while maintaining community linkage and re-establishing habitat for species at risk. The team achieved this goal by providing 11 tunnels for road crossings, trail access, community areas and re-connecting ecological habitat.

Considerable traffic analysis and modelling was conducted to keep the existing four-lane highway and associated connections open. This resulted in comprehensive traffic management plans involving construction staging with numerous detours.

The design challenges associated with soil conditions due to the 10m high embankments on the west end were resolved by using silty clay fill from the east end excavations. Staged construction, and pre-loading with wick drains expedited settlement and improved the undrained sheer strength of weak and compressible clays.

Most structures required deep cuts (3m-5m) into lacustrine clay making the design of efficient and cost-effective foundations critical to the schedule. Using the innovative lightweight backfill materials, the team protected structural integrity and enhanced durability. Bridge and tunnel superstructures supported on steel H-piles were driven through the clay to bedrock, while the more cost-effective and environment-friendly solutions for RSS walls included false abutments (tunnels) and wingwalls (bridges). Reinforced granular mats beneath the walls and lightweight materials for backfill eliminated the need for piles despite weak underlying clay.

RHHGP features a network of structures that include 12 special cut-and-cover land bridges, 13 regular bridges, 10 trail crossings, culverts, and earth-retaining structures. The design of the unique land bridges (tunnels) presented distinctive challenges and offered opportunities for innovative structural design solutions. Covering over 2km of the highway below, these structures carry roads, but the

Bridge structure – view from below

majority (93%) of the tunnel tops are landscaped with 850mm of soil and vegetation. Their design incorporates a slab-on-girder system with precast concrete NU girders, precast deck panels and cast-in-place deck overlay.

Following are some of the design challenges and special features of the land bridges:

- The project required that the design of landscaped areas should include 850mm of soil fill, along with CAN/CSA S6-06 625kN compliance for truck load to allow maintenance vehicles to service the bridge tops, resulting in extraordinarily high structural loads. Comprehensive loading analysis was performed to evaluate the effects of the unconventional loading.
- The length and quantity of these structures facilitated optimal structural design and the pioneering use of NU girders in Ontario.
- Because the individual structures are extremely long, a state-of-the-art fire protection design had to be developed.
- Special bearing replacement procedures and design were developed to account for the unusually high super-imposed dead load and the unconventional width of the bridges.
- Due to the extraordinary width (up to 200m) of the land bridges, longitudinal expansion joints in the deck were required. Special expansion joint detail was developed to accommodate the relatively large movement and the stringent requirement of the structure's water-tightness.

The Rt. Hon. Herb Gray Parkway is a design-build project requiring multiple design and construction disciplines working in a synchronized manner to achieve timely substantial completion of deliverables throughout the project. There were over 1,000 staff working on the project at its peak. With the core team of 185 professionals scattered across the 26 offices in Canada, United States, and Europe working in different time zones, design coordination and collaboration was challenging. To resolve this issue, HMM selected ProjectWise as the central storage system. HMM hosted the integration server and strategically deployed file storage and caching server onsite, near the teams doing the work to allow local caching and improved speed. ProjectWise allowed the decentralized design teams to collaborate in real-time from any location, and to access more than 150,000 project documents totalling more than 300 GB of data.

ProjectWise was integrated with AutoCAD, modelling software, along with office applications, which enabled large inter-related files to be uploaded, shared and published reliably and securely. Leveraging the tools available in ProjectWise, HMM developed a detailed workflow to manage document interrelations and security settings on all 2D CAD files, 3D models, and other project documents stored in the system.

Customized workflow managed through the single platform improved:

- Overall team collaboration through accelerated work sharing, process of coordinating, and approval of design solutions across multiple companies and offices during design;
- Quality of deliverables generated by the engineering design teams through enforced standards during real-time collaborative production of deliverables; and
- Process of searching, navigating files and retrieving information from ProjectWise.

Social and Economic Benefits

The RHHGP is a key component of the border transportation system through Windsor-Detroit trade corridor serving 28% of the USA/Canada trade. It will promote significant economic activity not only due to the cross-border trade, but also from growth in other businesses and associated development required to support it. During implementation, the project created over 12,000 jobs primarily in the Windsor-Essex region, through business opportunities, attracting new investment, and supporting existing industry.

Benefits to the local community derive from improving numerous municipal roads, adding pedestrian crossings and 20km of recreational trails, set within a prairie landscaped park. Significant lengths of noise barriers mitigate the impact of the highway noise on the local community. Safety of the workers, residents, business owners and their patrons, and other users was paramount, both during execution and beyond. The design incorporated evidence-based road safety techniques and human-factor methods that used all feasible opportunities to improve safety.

Noise barriers

The aesthetic features of the structural elements infuse the tallgrass prairie theme into the design of the structures, patterns, surface texture and materials. There are seven pedestrian bridges linking the trail network, offering a great opportunity to introduce a First Nation's theme. To integrate the crossings into the history of the landscape, the team worked with a local First Nation artist to link these seven bridges to the indigenous people's "grandfather teachings" that embody the foundation of being a good person. These teachings relate to such things as humility, wisdom, respect and love. They have corresponding animal symbols such as bear and otter and specific colours associated with them. These motifs decorate the bridges with symbols on the abutments, and art installations on the trail approaches giving each a unique character. Although the road is new, the idea is to connect it to the area's past. The inspiration for this came from colours, teachings and clans of the local Anishinaabe First Nations as interpreted by members of Walpole Island First Nation.

The lasting legacy of the Parkway will be its important contribution as an international trade and transportation route, and the establishment of a contiguous and sustainable greenspace that enhances the quality of life of the local community while re-establishing ecologically rich Carolinian landscape.

Environmental Enhancements

Submerged culvert inlet

The RHHGP design minimizes impact on the rare Carolinian Prairie ecosystem to the south, a natural heritage area with several designated zones. Protection, enhancement and restoration of associated habitats were important design considerations. Steps taken to protect the region included relocating and providing unique habitats for species at risk, additional wetland and fish compensation areas, and landscaping appropriate for these ecosystems. For example, two types of snakes were carefully moved to safe new breeding sites with fencing to prevent them from straying too close to the new highway, and three rare

plants were trans-located. Through restoration efforts, much of the reinstated greenspace will evolve into a tallgrass prairie and oak savannah landscape allowing transition to a “parkway in a prairie”.

Tunnel tops and surrounding greenspace landscaping established both ecological and community connections. Multi-use pathways run on both sides of the corridor with frequent cross connections. These features provide easy access and enhance the quality of life in the community allowing uninterrupted recreational activities in an ecologically-based landscape setting.

The trails include extensive wayfinding and interpretative signage, laybys, urban rest areas and trailheads.

The ecosystem-based restoration and landscaping for the project will provide numerous benefits to people, plants and animal species. They include biodiversity, places of refuge for rare and endangered species, erosion control, wetlands and fisheries, pollination and recreation, and culture.

Embankments built from excavated materials provide screening and noise mitigation, and reduce exporting spoil from the Parkway.

The team made extensive use of LED lighting for night time, emergency systems within the tunnel and lighting on the primary trail network to reduce energy consumption, together with full cut-off to minimize light pollution.

RT. HON. HERB GRAY PARKWAY:

HIGHLIGHTS

10 pedestrian crossings

12 cut-and-cover tunnels

3 interchanges

12 signalized intersections

14 overpass structures

20 km of multi-use recreational trails

7.5 km of a four-lane service road

11 km of a six-lane extension of Highway 401 surrounded by 121 ha of parkland

14 km of supporting structures

- improvements to 16 municipal roads
- noise mitigation
- modern multi-lane roundabout
- ecological landscapes
- advanced traffic management system
- wildlife protection
- extensive municipal infrastructure

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