British Columbia’s Ministry of Transportation and Infrastructure is tackling a traffic nightmare. Congestion is part of any urban area, but the Vancouver area’s complex river system, including the Fraser River and its arms, the Pitt River and Burrard Inlet, poses unique challenges, since multiple bridge crossings must connect the area’s rapidly growing communities.

Carrying about 127,000 vehicles per day over the Fraser River, the five-lane Port Mann Bridge has one of the highest traffic volumes per lane and is the most congested of the bunch. More than 13 hours of daily congestion plague the bridge, making it the area’s busiest commuter corridor. It also is a critical economic link and major goods-moving corridor as part of the Trans Canada Highway.

In 1964, the bridge was built at four lanes to accommodate a population of 850,000 in the Lower Mainland. But now the population has reached 2.2 million, and it is growing fast.

The government projects an additional 1 million people by 2030 and not just from growth in Vancouver. The communities of Surrey and Coquitlam, on the south and north sides of the bridge, have seen drastic employment growth. The region needed a plan.

“We’re finding traffic patterns are from everywhere to everywhere,” said Pam Ryan, communications counsel for the Port Mann/Highway 1 Project. “We really need extended capacity in both directions on the bridge.

**A congestion-reducing solution**

Enter the Port Mann Bridge/Highway 1 Project, a $1.93 billion (U.S.) plan that will build a new cable-stayed bridge and upgrade interchanges and safety for 37 km of Highway 1 from the McGill Street Interchange in Vancouver to 216th Street in Langley. The improvements are expected to reduce travel times by as much as 30%, Ryan said.

The project will be divided into four portions: West (McGill to Brunette); Cape Horn Interchange; Port Mann Bridge; and East (new bridge to 216th Street in Langley). Most of the activity is focused on the Port Mann Bridge and Cape Horn Interchange, which is located...
just north of the bridge in Coquitlam and is one of the busiest interchanges along Highway 1.

The project will be financed by the government, but will eventually be paid for by user tolls.

“The project will address congestion, but will also provide for transportation alternatives: transit, cycling, HOV extension,” Ryan said. “There has been significant growth on the east side of the bridge, so we really needed expanded capacity.”

When the project is complete, the HOV lanes will run in both directions from Grandview Highway in Vancouver to 202nd Street in Langley. Currently, the westbound HOV lane starts on the west side of the bridge and runs to Grandview, and the eastbound runs from Grandview to 152nd Street in Surrey. Effectively, the project provides an additional 30 km of HOV lanes. This will allow for RapidBus service on Highway 1.

The Port Mann/Highway 1 project is part of the larger Gateway Program, a $3 billion program established by the province of British Columbia to address the region’s growing congestion and to improve mobility throughout metro Vancouver.

A design-build agreement

Port Mann/Highway 1 construction began in March 2009 and completion is expected in 2013, with the new Port Mann Bridge operational by December 2012. Currently, construction is nearing one-third complete, with all pile driving complete and most piers on the south side of the bridge formed.

The newly established Transportation Investment Corp., a crown corporation, will maintain government oversight of the project. TI Corp. was created in 2008 under the Transportation Investment Act to provide a public-private partnership framework for the project.

“We went through the procurement process from 2007 to 2008, and during final negotiations with the preferred proponent, the economy collapsed,” Ryan said. “We couldn’t get a deal that was in the best interests of B.C. taxpayers.”

When the public-private partnership deal fell through with the Macquarie Group, the government turned to a design-build contract with joint-venture partners Peter Kiewit Sons Co. and Flatiron Constructors Canada Ltd., which had been the design-builder for the Macquarie team. TI Corp. and the contractors reached a deal in March 2009.

“This is the largest and most exciting transportation project ever undertaken in North America, and with this tremendous signature bridge over the Fraser River, it is truly a once-in-a-lifetime opportunity,” said Jeffrey Ellis, deputy project director for the Kiewit/Flatiron General Partnership.

Choosing cable-stayed

In total, the new bridge calls for 12,900 tonnes of structural steel, 157,000 cu meters of concrete and 108 caissons.

Originally, the province had considered a twin structure: the existing structure plus five new lanes. However, the old bridge would require significant seismic upgrades, so long-term rehabilitation costs would be high. A new bridge also carried other benefits, including the use of fewer piers in the water and a design that includes through-lanes separated from local collector lanes, which significantly improves traffic flow, Ryan said.

T.Y. Lin International, based in San Francisco, in collaboration with International Bridge Technologies, is designing the 10-lane, 65-meter-wide cable-stayed bridge, which will be the widest in Canada. This includes 50 meters of roadways (five lanes in each direction), a 5-meter-wide sidewalk and a 10-meter-wide gap, where the central pylons are located. Its two 158-meter pylons will rise approximately 110 meters above the bridge deck and provide a minimum of 40
The pylons have a 10- by 12-meter concrete pier that supports outriggers for fixing the stays that stiffen the slender upper portion of the pylon.

To construct the pylons, Kiewit-Flatiron is using a slipform design that improves the quality of the concrete by allowing for a continuous pour. “It eliminates construction joints, and it’s much quicker,” Ryan said. “It allows for the contractor to maintain the project schedule.”

The new bridge will be constructed to the west of the existing steel tied-arch structure, with a 50-meter gap between the two bridges at the midpoint. It will have three through-lanes in each direction and two local-connection lanes in each direction for local access to and from Surrey and Coquitlam. Once the new bridge is finished, the old five-lane crossing will be removed.

The three-span, 850-meter-long bridge comprises two separate deck structures. Each separate roadway is supported by two planes of stay cables and consists of a classical composite structure with steel edge girders and floor beams combined with precast concrete deck panels made composite with cast-in-place strip pours.

The lower cable anchorage locations will be incorporated into the structural steel edge girders. Steel tie boxes cast into the upper pylons will incorporate anchorage locations for the upper stay anchors.

Steel piles driven into glacial till make up the bridge foundation. The north pylon is founded on 63 steel piles—each 1.8 meters in diameter and 70 meters long. The south pylon uses 50 steel piles at the same diameter but at a length of 80 meters.

Approximately 288 Freyssinet cables, with antivandalism tubes connected at the base, provide support for the decks. The stay cables are composed of high-tensile-strength, seven-wire steel strand, with 23 to 73 strands per cable. Each strand is 15.75 mm in diameter and encased in co-extruded HDPE with double helical fillets.

The design will incorporate a structural health monitoring system for real-time monitoring of structural responses resulting from seismic activity.
Building the approaches

However, the new Port Mann Bridge accounts for just half of the overall project cost. A 350-meter south approach and 820-meter north approach will comprise segmental precast sections erected span by span or as balanced cantilevers. The segments will be erected using a gantry, placed from one pier to the next as a single unit. The south approach has nine piers on land while the north approach uses 15 piers, with four in the Fraser River.

All 1,158 bridge approach segments, precast in a fabrication yard less than 1 km away in Coquitlam, will be trucked to the site using local roads. Precast deck sections are steam-cured and timing depends on segment size. Ryan said the construction team is able to produce about 14 per week with five molds.

Concrete strengths range from 40 to 60 MPa, and there is longitudinal post-tensioning in 20% of the deck.

The north approach on land includes 78 drilled shafts—2.5 meters in diameter and 53 meters long—and the river section includes 129 steel piles, each 1.8 meters in diameter and 67 meters long. The south approach foundations are mainly steel piles, with 122 piles at 1.8 meters in diameter and 44 meters long and 30 drilled shafts, each 2.5 meters in diameter and 31 meters long.

“In the water, we drove the full length of the pile as a single event, so they actually welded them together and used a large derrick barge to drive the pile in a single event,” Ryan said. “It significantly reduces the amount of impact hammering that needs to be done, especially since it is a concern for marine mammals.”

Working with the community

Traffic management also is an important part of the project, and the Internet is used extensively for frequent construction updates to the traveling public. These bulletins detail changes such as traffic-pattern shifts, temporary lane closures and details of upcoming construction.

Minimizing disruption to local residents on one of the busiest routes in all of metropolitan Vancouver also is a prime concern. Although the bridge itself connects Surrey and Coquitlam, the project crosses through four others: Vancouver, Burnaby, Langley and Port Coquitlam.

To address this, the project team has undertaken a comprehensive community consultation program, meeting with a “broad cross section” of each of those communities, Ryan said.

“The consultation with local communities was some of the most extensive we’ve ever seen in metro Vancouver,” she said.

To minimize disruption, the project team has performed construction at night, created noise-mitigation measures and has been cognizant of environmental considerations. R&B