



Fast Track Delivery of Calgary's West LRT



**Hatch Mott
MacDonald**



THE CITY OF
CALGARY



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Canadian Consulting Engineering Awards 2013

ENTERED BY:

Hatch Mott MacDonald
840 7th Avenue SW, Suite 1250
Calgary, Alberta T2P 3G2

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FAST TRACK DELIVERY OF CALGARY'S WEST LRT

Introduction

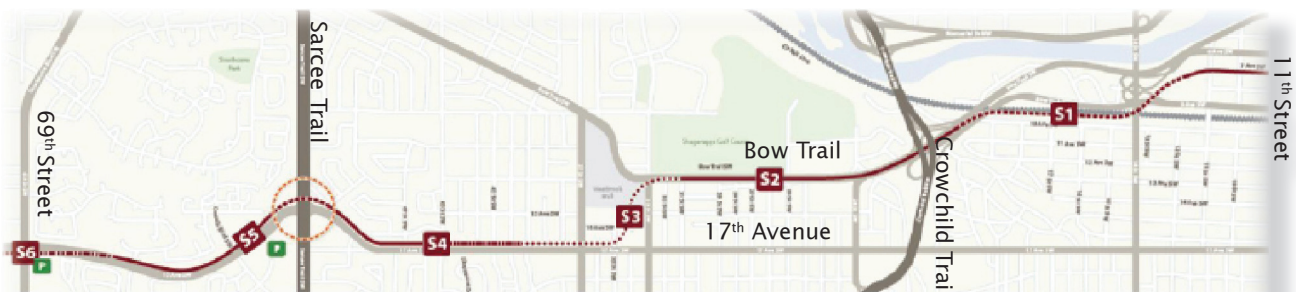
Calgary's West Light Rail Transit (LRT) project opened for public service exactly on schedule at 5am on December 10, 2012. This was almost exactly three years from when the then mayor of Calgary announced publically that the new LRT line would open on December 10, 2012. By every metric, delivery of the West LRT project was a success. The project consistently enjoyed public support for its duration. The project was implemented with the value of contract changes within budget and well below industry norm. The project was awarded the Consulting Engineers of Alberta's highest award of excellence in both the Project Management and Transportation Infrastructure categories. It was also awarded the Association of Professional Engineers and Geoscientists Alberta (APEGA) 2012-2013 project of the year award. The project also represented a number of "firsts" for the City of Calgary:

- Largest capital infrastructure project in the history of the City;
- First DB project carried out by The City using an integrated project team consisting of a dedicated City of Calgary group and the Hatch Mott MacDonald (HMM) team as the Owner's Engineer;
- First leg of The City's LRT system to be implemented by a design-build (DB) project approach;
- First LRT project to feature an elevated station;
- First LRT tunnels designed to include fire-life-safety measures to protect the public in the event of an underground fire;
- First underground LRT station;
- First leg of The City's LRT system designed to accommodate four-car trains running at increased frequency headways;
- First application of The City's standardized pedestrian/LRT crossing safety measures;
- First leg of The City's LRT system to be separately tested, commissioned and integrated into the existing Operation and Control Centre.



West LRT Opening Ceremony. L to R: Minister of Transportation & MLA Ric McIver, Premier Allison Redford, Alderman Richard Pootman, Mayor Naheed Nenshi

There has been a 28% increase in ridership since opening day with 15% of riders never having used transit before the West LRT had been completed.



Sunalta Station	S1	45 Street Station	S4	Park'n Ride	P
Shaganappi Point Station	S2	Sirocco Station	S5	Sarcee Trail / 17 Ave Interchange	O
Westbrook Station	S3	69 Street Station	S6		

Ground Level	—————
Elevated	—————
Trench	—————
Underground (Tunnelled)	—————

West LRT Alignment

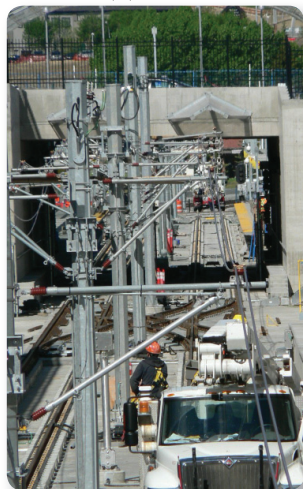
Test Train at 45th St Station



Sunalta Station



Overhead Catenary System



Project Facts

1	Grade Separated Interchange High School Relocated (Ernest Manning High School)
1.8	kilometers of Elevated Guideway
2	Park n' Ride Terminals Bus Terminals Utility Buildings
2.9	kilometers of Tunnel/Trench Rail
3	New Road Bridges (69 th Street, 45 th Street & 42 nd Street) Pedestrian Bridges (Sunalta Station, 24 th Street SW & 69 th Street Station)
3.3	kilometers of At-Grade Rail
4	Storey Commercial Building
6	LRT Stations
8	kilometers of Double Track Rail
50	Properties Acquired
62	months = project duration
115	Public Meetings
3,250	tonnes of CO ₂ Emissions to be Reduced Annually
7,300	Less Vehicles on Calgary's Roads each day
44,000	Forecasted Daily Passengers
3.1	Million Construction Manhours
\$1.4	Estimated Billion Project Cost

Project History and Background

Calgary's West LRT (WLRT) project is the most recent extension of Calgary's LRT system that originally commenced operation in 1981 with service from downtown to south Calgary. Since that time, extensions were added to the south line, and new lines were added to the northwest and northeast areas. Based on ridership, it is widely regarded as one of the most successful LRT systems in the world. The system currently carries over 290,000 passengers per weekday with annual ridership over 102 million, more than any other light rail system in North America.

In November 2007, City Council approved the alignment and funding for Calgary's WLRT project to serve communities in west Calgary. The Council decision also addressed a project completion date of December 2012, coinciding with a timeline that kept the overall program budget within a schedule for available Provincial funding.

The alignment of the WLRT line (presented below) connects to the existing LRT system near the downtown core on 7th Avenue at 11th Street SW, and continues west converging onto Bow Trail, to 33rd Street where it traverses adjacent to Westbrook Mall, south to 17th Avenue and then west along 17th Avenue to the terminus at 69th Street SW. This alignment features a combination of elevated, tunneled, trenched and at-grade guideways and stations.

Hatch Mott MacDonald served as the Owner's Engineer for the City of Calgary for this project, responsible for the preliminary design of all project elements, schedule development, cost estimating, development of contract and request for proposal documents, proposal reviews, constructability reviews, risk management, construction monitoring, and quality auditing. The HMM team included the following specialist sub-consultants:

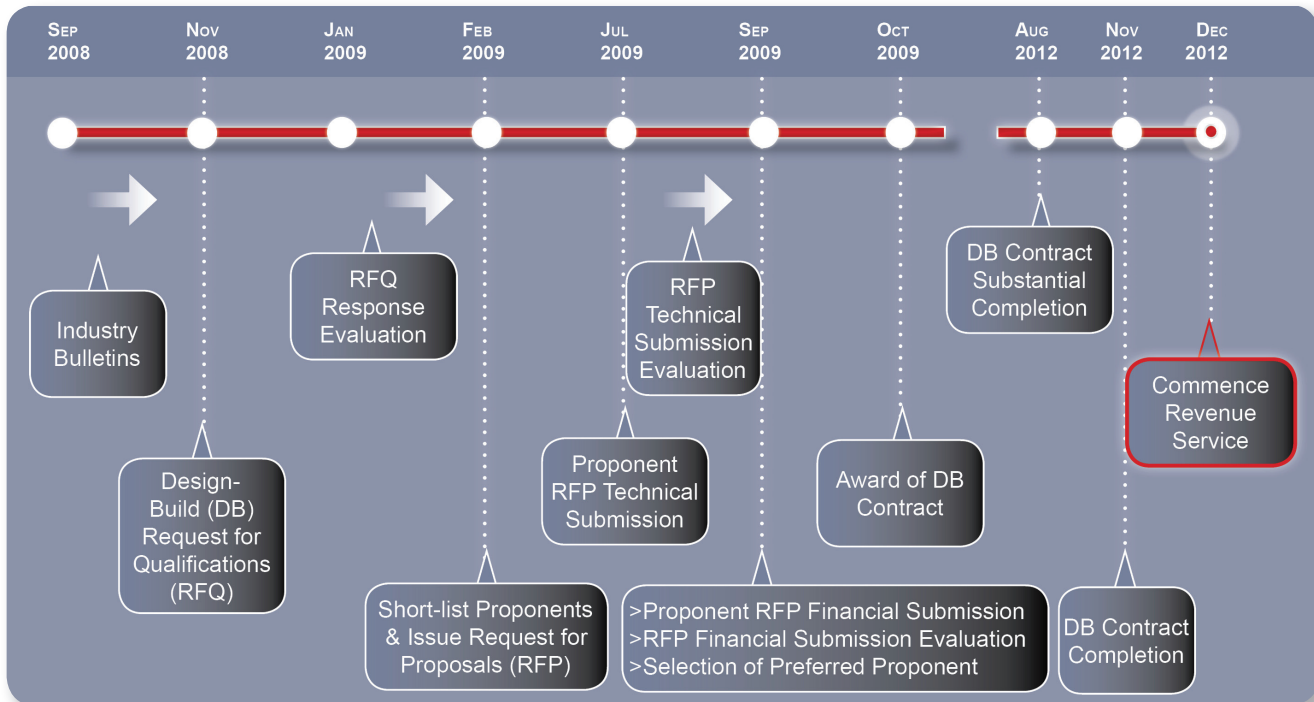
- GEC Architecture: architectural design
- Focus: roadways and utilities
- Associated Engineering: traffic management
- AECOM: environmental and mechanical/electrical monitoring (stations)
- Patching Associates: noise assessment
- Thurber: geotechnical
- Ground³: landscape architecture

"The use of fast track delivery of a project of this complexity is impressive"
Consulting Engineers of
Alberta Showcase Awards
2013

Schedule – The Key Priority

The December 2012 target completion date required delivery, within a five-year period, of the largest capital infrastructure project in the City's history. This represented an unprecedented project delivery schedule. It was therefore necessary to develop a project implementation schedule with a series of clearly defined and measurable milestones that became the primary project driver (see schedule below). Project success was consequently distilled down to a focused process of achieving each of these successive milestones regardless of the effort required. This project management strategy, together with innovative organization and planning, was key to the successful delivery of the WLRT project.

Milestone Schedule for Successful Project Delivery



Milestone Schedule for Successful Project Delivery

The project schedule presented a significant challenge and required implementation of a number of innovative planning, organizational and procurement initiatives including the following:

Fast-track Delivery: To achieve the December 2012 completion date, a fast-track project delivery strategy for the new LRT line was implemented whereby detailed design would be carried out concurrent with construction. Successful implementation of DB project delivery depends on a number of factors of which clear scope definition to allow for accurate costing and detail design by the DB contractor is key to achieving a high degree of cost and schedule certainty. On the WLRT project, this was achieved by preparing a request for proposal (RFP) package that defined the work via a series of concept drawings and a combination of both prescriptive specifications for Owner “must have” requirements, and performance specifications that would enable the project to benefit from contractor innovation where appropriate. To further accelerate the overall project schedule, this scope definition and preliminary design process was carried out in parallel with a number of iterative engagement processes addressing both public and internal stakeholders. It is believed that the fast-track delivery of this project by the DB approach advanced the schedule by at least one year as compared to the traditional design-bid-build approach.

Integrated Project Team: The City created a separate City group, the WLRT Project Office to direct the project. This group was supported by and integrated with HMM and their team of subconsultant specialists who served as the Owner’s Engineer. The Owner’s Engineer focused on design production and RFP development while the City team was enablers within the City, developing buy-in from other City departments and groups, and facilitating the way for timely reference design development. This integrated project team approach had never previously been done by The City and saved significant overall project time.

Accelerated Preliminary Design: This intensive multi-disciplinary engineering and architectural design effort required the completion of preliminary design for a highly complex work scope within a compressed nine-month period. The HMM team completed all of the key deliverables on time including: Request for Qualifications documents; preliminary design drawings; prescriptive and performance specifications; preliminary schedule and construction cost estimates; LRT design guidelines; RFP documents; proponent submission evaluations and public engagement exhibits.

Land Acquisition: In early 2008 the WLRT Office began an intensive 18-month process of negotiation, acquisition and possession of approximately 50 properties including residential, commercial and railway right-

of-way required to be concluded in time for commencement of construction of the project. The early identification and acquisition of properties under a “get it right the first time” approach was key to advancing the project schedule. Following this 18-month period, no further land acquisition was required.

Enabling Works Projects: A number of enabling works projects were implemented prior to commencement of the main LRT construction works. These included removal and relocation of acquired residential and commercial buildings, modifications to the TELUS World of Science building and parking lot, reconfiguration of Shaganappi Point Golf Course, relocation of high school playing fields, removal or relocation of commercial signage, raising of major overhead transmission lines, and clearing of the areas required for LRT construction.

Segregation of the WLRT from the Existing Operations and Control Centre (OCC): The WLRT office recognized that as with any new LRT line, a significant risk existed with integration of the new system into the existing OCC. The decision was made to carry out comprehensive testing and commissioning of the new system as a stand-alone activity separate from integration into the OCC. The project team designed a separate OCC integration plan to be implemented progressively in parallel with testing and commissioning of the project, thereby eliminating the twin risks of integration delay and change.



Direct Fixation Trackwork

Public Engagement: The public engagement process was based on The City's *Engage!* policy and framework commencing with development of a Public Engagement Plan. Community Advisory Committees were established to have input into key project elements such as station design, urban design, traffic, parking and noise attenuation. More than 115 meetings were held with community members resulting in changes to the vertical alignment at two locations, modification of the original design of all six LRT stations, influence on the urban design at each of the stations and identification of a number of residential areas that warranted noise attenuation.

Internal Stakeholder Engagement: A comprehensive process was implemented whereby stakeholder City departments were engaged to identify and address concerns about how their respective operations would perform during both construction and operation of the new line. This included City business units such as Calgary Transit, Roads, Water Resources, Transportation Planning, Community & Neighbourhood Services, Land Use Planning & Policy and others.

Design-Build Contractor Procurement: At the time of procurement, the project team was challenged with creating a competitive bidding process and attracting qualified proponents in a busy industry. To address this challenge, several initiatives were actioned. Industry bulletins were issued to keep the wider industry informed and updated on the WLRT project. A Fairness Advisor was hired for the proposal process to ensure the procurement process was open and fair to all proponents. A new DB agreement for The City was created. These and other related actions resulted in a clearly successful procurement process with competitive market related pricing, award of a contract to a well-qualified contractor and no legal challenges to the outcome by unsuccessful proponents.

“An excellent example of fast tracking and the success it can bring when done right.”
Consulting Engineers of Alberta Showcase
Awards 2013

Project Management

In addition to the many measures described above to address the schedule requirements of this project, successful delivery was founded on the establishment and effective implementation of a strong and clear project management approach. Key elements of this approach included the following:

Project Implementation: The City awarded a design-build agreement (DBA) to the successful proponent, SNC-Lavalin Constructors Pacific (SLCP), in November 2009. The DBA required work to be substantially performed by end of August 2012 and final completion by end of November 2012 in time for The City's planned revenue service date in mid-December 2012. SLCP as the Design-Build Contractor (DBC) and their local specialist partners were organized into four 50/50 joint ventures each responsible for separate components of the work.

The DBC was responsible for all detailed design and construction as well as for project management, construction management, coordination of third-parties (i.e. franchise utilities), quality management, environmental management, health and safety management, traffic management during construction, and system integration, project testing and commissioning.

Effective Project Scheduling: Immediately upon contract award in late 2009, the DBC mobilized their designers and commenced work on detailed design. Mobilization of construction forces commenced in early 2010 and construction, testing and commissioning was completed over the following three-year construction period. Correct staging of the work was critical to maintaining schedule. For example, work fronts were opened up concurrently along the entire alignment; utilities that conflicted with trenched or tunneled guideways were relocated before any significant excavation could commence. In other cases, roads were detoured and existing traffic lanes closed to allow for guideway and structures to be constructed. In very general terms, the construction focus in 2010 was on civil works (utilities, earthworks, concrete structures, guideway and

24th Street Pedestrian Bridge



Trenched Guideway Construction

roadworks). In 2011 the focus continued on civil works but also addressed construction of fixed facilities (stations, sub-stations, utility rooms) and trackwork. In 2012, the focus continued on trackwork but also addressed traction power and the overhead catenary systems, signals and communications and finally testing and commissioning of the LRT system.

Through effective schedule implementation and control, the project overcame a number of construction challenges in their drive to maintain schedule. This required an average of 100,000 manhours per month with a monthly peak of 162,800 manhours in 2011.

"With the support of our engineering and architectural team, we worked with many internal and external stakeholders to complete the preliminary design for the West LRT. This work forms the basis for the procurement of The City's largest design-build contract, awarded in 2009...The achievements we have made to date are a reflection of the team we have assembled for this project. Their dedication, creativity, passion and experience is the source for our continued success."

Jon Halford, P.Eng. City of Calgary, West LRT Project Director: 2008-2010

Risk Allocation: Through a risk management process that included a series of risk workshops, the project team identified a number of significant risks that needed to be addressed. This required profiling of the risks and allocation to the party best equipped to manage the risk. In this way a number of risks were either retained by The City to manage or allocated to the contractor. For example, a number of environmentally impacted areas were identified during the environmental assessment. Under the risk allocation process The City retained the cost for transportation, disposal and treatment of the actual encountered contaminated soil volume as required at a licensed landfill. Another example was that of the risk of dealing with private franchise utility companies. Under the risk allocation profile, The City retained the risk of any critical path schedule delays to relocation of these utilities beyond a four-month period providing the contractor with a level of confidence for costing of the work. Risks associated with other issues such as obtaining building permits, weather, identification of conflicting utilities and site investigations were assigned to the contractor.

Quality Management: A key innovation in the DB delivery of the project was the development of a new DB Agreement and procurement process that is expected to serve as The City's model for future DB projects. In addition to meeting the schedule and budget requirements, the Agreement addressed quality issues that were of concern to The City based on their experience on previous DB transportation projects. The new DB Agreement as well as the project management process that included a structured quality audit process carried out by the Owner's Engineer team resulted in the quality end product that The City desired.

Preliminary Cost Estimating and Scheduling: Implicit to effective project management is the need to manage scope, cost, schedule and quality. The project team developed detailed preliminary schedule and cost estimates that were used to control development of both scope and quality to procure a project within the approved budget and schedule. Due to a combination of the effectiveness of this schedule and cost control process and a favourable bidding environment, the contract was awarded for a lump sum fixed price value in line with the cost estimates developed by the project team.



Elevated Guideway Construction

Project Controls: A pre-requisite for effective project management is the ability to monitor and control various elements such as document management, cost control and change management. On the WLRT project, document control was achieved by use of a project extranet site where all official documentation between contracted parties was formally transmitted, logged and tracked. In total over 5,000 document packages were transmitted and processed via this system in addition to the many avenues of informal transmitting of information. A rigorous cost and change control process

was implemented whereby Owner contemplated changes, contractor notice of changes and change orders were rigorously managed. This process resulted in contract changes being maintained to well within comparable industry limits.

Communication: Projects of multi-year duration require a thorough and comprehensive communications plan to keep both internal and external stakeholders apprised of project progress and issues. Neglect of this aspect can result in significant stakeholder challenges to the project that have potential for serious disruption. For the WLRT project the City was particularly sensitive to keeping the public (their major stakeholder) informed. This was achieved primarily by the use of a high quality, informative project website that was updated on a weekly basis with current project notifications, photos, videos and traffic alerts. This was supplemented by regular distribution of project update flyers delivered to residential and commercial property owners along the alignment. A philosophy of providing high quality, accurate and credible information and updates together with a commitment of responsiveness to public complaints resulted in a very successful project-public alignment process. Evidence of this was the positive coverage of the project by local Calgary media.

At-Grade Guidway Construction



Partnering to Success: A major contributor to the success of the project, apart from the innovative planning, organizing and procurement strategies carried out by all project participants, lies with the willingness of all parties to partner for the success of the project. Contracted parties recognized that partnering, communication and alignment were crucial to the delivery of such a complex project within an aggressive schedule. This created a culture of respect and cooperation between parties that helped maintain focus and overcame many challenges both technically and contractually. The partnering process included development of a partnering charter, facilitated partnering sessions, and informal alignment meetings.

Project Highlights & Judging Criteria

Innovation - By their very nature new LRT lines are extremely complex multi-disciplinary undertakings requiring application of unique planning, engineering, project management and commissioning processes. The December 2012 target completion date required delivery, within a five-year period, of the largest capital infrastructure project in the City's history and represented an unprecedented project delivery schedule. Both these factors, namely the complexity and the unprecedented schedule, necessitated the requirement for robust, effective and innovative project management on behalf of the project delivery team. This was achieved by the application of a number of innovative strategies and processes:

- Adoption of a fast-track strategy of DB project delivery;
- Creation of an Integrated Owner's Project Team with HMM as Owner's Engineer;
- Accelerated nine month period for preliminary design and request-for-proposal package;
- Acquisition and possession of 50 properties under a "get it right the first time" approach;
- Completion of enabling works sub-projects prior to the primary LRT construction project;
- Segregation of WLRT from the Existing Operations and Control Centre (OCC) and management of integration under a separate and concurrent project;
- Extensive public engagement process with 115 public meetings;
- Extensive internal stakeholder engagement;
- Effective project scheduling and cost estimating;
- Comprehensive risk management process;
- Effective project controls;
- Implementation of a comprehensive and reliable communications plan;
- Strong commitment to a "One Team" culture of partnering.

Innovation of the project may also best be described in terms of the project elements that represent “firsts” for The City of Calgary. These include:

- Largest capital infrastructure project in Calgary’s history;
- First DB project carried out by The City using an integrated project team consisting of a dedicated City of Calgary group and the HMM team as the Owner’s Engineer;
- First leg of The City’s LRT system to be implemented by a DB project approach;
- First LRT project to feature an elevated station;
- First LRT tunnels designed to include fire-life-safety measures to protect the public in the event of an underground fire;
- First underground LRT station;
- First leg of The City’s LRT system designed to accommodate four-car trains running at increased frequency headways;
- First application of The City’s standardized pedestrian/LRT crossing safety measures;
- First leg of The City’s LRT system to be separately tested, commissioned and integrated into the existing Operation and Control Centre.

“This project confronted numerous significant challenges and redefined them to allow an on-time commitment of service to the public”

Consulting Engineers of Alberta
Showcase Awards 2013

Complexity: The WLRT project was a classic “brownfield” project requiring a comprehensive project management effort that addressed the design and construction of new multi-disciplinary infrastructure within a new right-of-way within an existing fully developed urban environment. This compounded the inherently highly technical complexity of the project by introducing many levels of project critical stakeholder interests that required active monitoring and management. The complex nature of the project is best described by the following summary list of work scope items:

- approximately 8 km of LRT right-of-way, with approximately 3.3 km at or near grade, 1.8 km elevated, and 2.9 km trenched, tunnel and portal;
- LRT systems including traction power, signals and communications;
- integration, testing and commissioning of the LRT system with the existing Operations Control Centre (OCC);
- six LRT stations including one elevated, one underground, two trenched, and two at-grade;
- nine traction power substations and two utility buildings;
- two LRT Park ‘n’ Ride facilities and two transit bus terminal facilities;
- a four-storey transit orientated development (TOD) building;



45th Street Station

- three pedestrian bridges, a new major freeway interchange and three new road bridges;
- modifications to existing roads, sidewalks, structures, and temporary detour roads to maintain access and accommodate construction;
- re-routing of existing and installation of new municipal utilities;
- coordination with third-party private utility companies for relocation of infrastructure;
- roadway and guideway lighting and traffic signals; and
- environmental remediation of contaminated sites.

Social and Economic Benefits: The major benefits to society resulting from the WLRT project include:

- Provision of a rapid, convenient, economical and safe mode of public transportation for approximately 44,000 people per day from the western quadrant to the downtown core of the City, with an estimated travel time of 13 minutes;
- Environmental benefits as described below;
- Reduction in an estimated 7,300 vehicles per day to the downtown core;
- Reduction in travel time for all travelers between the downtown core and west Calgary;
- 28% increase in ridership since opening day;
- 15% of new riders who were not LRT users before the WLRT was completed;
- Refurbishment of a significant portion of the infrastructure (roadways, utilities, landscaping, etc.) within the general area of the LRT alignment;
- Refurbishment of the Westbrook mall area resulting from the transit-oriented development provided by this project. Development in the area will provide added local services to the public;
- Redevelopment of a new high school in the west Calgary area;
- WLRT resulted in over 3.7 million manhours over the life of the project, mainly in the consulting and construction industries;
- Four-storey transit-oriented development building at Westbrook Station complies with LEED Gold environmental standards.



Elevated Sunalta Station

Successful on-time and on-budget implementation of the WLRT project demonstrates the economic viability of delivering linear public infrastructure by means of alternative project delivery models in the province of Alberta. This is best described by the following comment by a judge of the Consulting Engineers of Alberta (CEA) Showcase Award 2013 with regards to WLRT Project's winning submission *"The degree of complexity and co-ordination required on this project is awesome! It is approaching heavy industrial mega-project size and scope....Lessons learned here should be applied across all sectors to make Alberta construction projects cost effective and on time."*

Environmental Impact: The WLRT project is estimated to divert up to 7,300 automobile trips per day from Calgary roads. This equates to annual emissions reduction of 3,250 tonnes of carbon dioxide, 189 tonnes of carbon monoxide, 12 tonnes of nitrogen oxides and 25 tonnes of volatile organic compounds. In addition, the design and construction of the four-storey transit orientated development building at Westbrook Station complies with LEED Gold environmental standards.

Meeting Client's Needs: Calgary's WLRT project opened for public service on schedule at 5am on December 10, 2012 almost exactly five years from Council approval of the project. By every metric, delivery of the WLRT project, within an unprecedented five year period, has been a success. The project consistently enjoyed public support and met the expectations of stakeholders, both internal and external. The project was implemented with the value of contract changes within budget and well below industry norm. The project was awarded the Consulting Engineers of Alberta's highest award of excellence in both the Project Management and Transportation Infrastructure categories. It was also awarded the Association of Professional Engineers and Geoscientists Alberta (APEGA) project of the year award.



Train at 45th Street Station

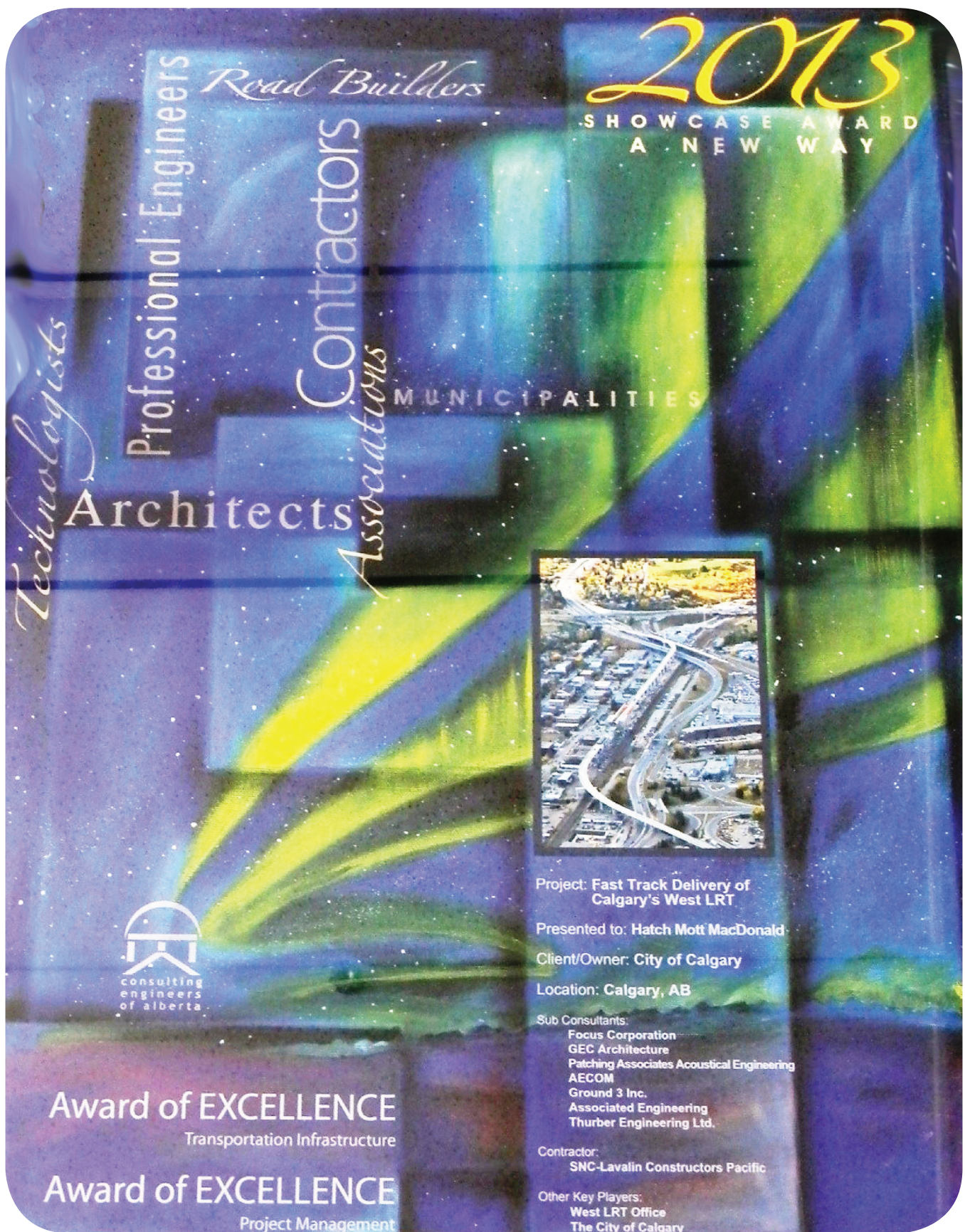
From conceptual design through DBC procurement and project implementation HMM played a key role in the successful delivery of Calgary's WLRT by the provision of Owner's Engineer services within an integrated Owner's project management team. In this role HMM and its team of sub-consultants provided multi-disciplinary consulting services that addressed all engineering, architectural and project management services for the following:

- Preliminary design and documentation required for the DB request for proposal package;
- Technical evaluation of DB submissions;
- Compliance and quality monitoring of all detailed design submissions and construction;
- Provision of all cost, document and change control services;
- Project reporting;
- Progress payment certification;
- Key technical and project management support for systems testing, commissioning and integration; and
- Support in all claims and dispute resolution.

APPENDIX A



CALGARY WEST LRT RECOGNITION



Consulting Engineers of Alberta (CEA) Showcase Awards 2013 for both Project Management and Transportation Infrastructure Categories



The Association of Professional
Engineers and Geoscientists of Alberta

January 17, 2013

Mr. Russel Delmar, P.Eng.
Hatch Mott MacDonald
1250-840 7 Ave SW
Calgary AB T2P 3G2

Dear Mr. Delmar:

RE: 2013 APEGA SUMMIT AWARDS®

On behalf of Council and all members of APEGA, congratulations to the Hatch Mott MacDonald's Calgary West LRT Project on being selected as this year's recipient of The Project Achievement Award. The award is given to a project demonstrating engineering or geoscience skills and representing a substantial contribution to technical progress and the betterment of society.

This year's Summit Awards® Gala takes place Thursday, April 18, 2013 at the Calgary TELUS Convention Centre. APEGA is pleased to provide four complimentary tickets to the Gala, where the award will be presented. You will be contacted in the near future regarding important details concerning your biography, photograph, rehearsal session and registration for the Gala and other Conference activities.

Once again, congratulations and I look forward to seeing you at the Summit Awards® Gala in Calgary this April.

Sincerely,

A handwritten signature in blue ink, appearing to read "Leah Lawrence", with a long horizontal flourish extending to the right.

Leah Lawrence, P.Eng.
President

LL/bls

Notice of APEGA Project Achievement Award 2013

APPENDIX B

PROJECT PHOTOGRAPHS





Elevated Guideway Construction



Construction of Shaganappi Point Station



East Tunnel Portal Under Construction



Construction of the Shaganappi Point Crossover



Cut and Cover Tunnel Construction



At-Grade 45th Street Station



Underground Westbrook Station



Elevated Sunalta Station