

AECOM Zero Emission Bus Experience

ON THE COVER

Stoney Transit Compressed
Natural Gas (CNG) Bus Storage
and Transit Facility, Calgary, AB

Delivering a better world

About Us

We are the world’s trusted infrastructure consulting firm, delivering professional services throughout the project lifecycle — from planning, design and engineering to program and construction management. Our teams are driven by a common purpose to deliver a better world through our unrivalled technical expertise and innovation; a culture of equity, diversity and inclusion; and a commitment to environmental, social and governance priorities.

Through our legacy firms across Canada, we have been creating, enhancing, and sustaining Canadian infrastructure for well over 100 years. In Canada alone, we have more than 25 office locations and employ over 3,200 skilled professionals. Our local experts collaborate across our broad global network of professionals to ensure sustainable project outcomes — those that integrate harmoniously with natural and social environments, meet regulatory requirements and promote social responsibility.

We remain atop Engineering News Record’s list of the Top 500 design firms where we are ranked #1 in General Building and Transportation, delivering integrated and sustainable solutions to solve our clients’ most complex challenges and shape a better future. Our global network of 50,000 employees delivers projects in over 128 countries and is unified by common goals and values — delivering unrivaled expertise, protecting people and the environment, and making the world a better place.

Through our Think and Act Globally strategy we are focused on extending our industry-leading, global expertise to each of our projects around the world, transforming the way we deliver work through technology and digital platforms, and enhancing our position as a leading Environment, Social & Governance (ESG) company. We’re committed to managing our business with the upmost responsibility and to always strive for better — be that reducing emissions, creating social value or diversifying our senior leadership and workforce.

The fusion of architecture, industrial design, planning, engineering, environment and economics helps AECOM to balance operational needs and facilitates functional layout and relationships. Our services promote sustainability and deliver valuable, long-term benefits for a wide range of community interests.

Who is AECOM?

AECOM is a premier, fully integrated infrastructure firm.

We design, build, finance, and operate the world’s most complex projects.

128+
COUNTRIES

Client-Driven

Clients benefit from a large, diverse portfolio of services in various places around the world.

Most Admired

Considered one of the most admired companies by *Fortune*.

Strong Bonding Capacity

Positioned to win the at-risk megaprojects of today.

Industry Leader

Engineering News Record
#1 General Building
#1 Transportation
#2 Top Design Firm

A Fortune 500 Company

13.3B
FY22 REVENUE

50K+
TOTAL EMPLOYEES

ARCHITECTURE

- Master Planning
- Programming
- Sustainable + LEED* Design
- Needs Assessment
- Facilities Planning + Design
- Interior Design
- Space Planning
- Landscape Architecture

DESIGN + PLANNING

- Landscape Design
- Master Planning
- Environmental + Ecological Planning
- Strategic Planning + Economic Development

BUILDING ENGINEERING

- MEP Engineering
- Structural + Seismic Engineering
- Civil Engineering
- Industrial Engineering
- Security + Communications Systems
- Environmental Engineering
- Sustainable Advisory
- Advanced Design + Modeling

PROGRAM + CONSTRUCTION MANAGEMENT

- Project Management
- Facility Assessment
- Constructability Review
- Value Engineering
- Contract Administration
- Construction Management + Review
- Scheduling
- Commissioning

ECONOMICS

- Market Studies
- Financial Feasibility Analysis
- Professional Quantity Surveying
- Funding Strategies, Public Private Partnerships
- Infrastructure Feasibility Planning

Why Partner with AECOM?

Our adaptable and flexible approach to projects allows us to deliver with consistency, longevity, high quality and with efficiencies in cost and time. **AECOM adds value to your projects - let us show you how.**

Aligned Corporate Priorities

Environmental, Social, and Governance (ESG) is at the heart of value creation across all our client groups and is increasingly a key growth driver across nearly every market we serve. AECOM is the largest and most diverse global consulting firm as ranked by ENR, a leader in several public markets, is a leader in green buildings and green design, and is advancing next generation transportation and renewable energy infrastructure, positioning all of our businesses ideally to deliver for our clients' sustainability initiatives.



Strong Client Relationships

We maintain ongoing client relationships with transit agencies across Canada. We understand the operating requirements associated with the numerous and varied transit systems across the country.

Our Market Sector Leader, Amin Sadeghi, has led the design of many transit maintenance facilities. He is supported by an exceptional Canadian core team, including a team of architects and engineers with a working understanding of the requirements and challenges that transit agencies face. This core team is supported by subject matter experts from across North America.

LEAN Methods Used and Their Success



FOSTER COLLABORATIVE EXCELLENCE

The project team created and embraced a collaborative environment similar to an integrated project delivery model; with project goal setting of maximizing value and eliminating waste at the forefront of all processes and workflows.



IMPLEMENT PROJECT EFFICIENCY

Using LEAN Principles such as Task, Flow and Value Management the project team was able to understand and implement the required principles of the building. Ensuring that the "wants and needs" were separate issues, the team utilized LEAN waste space reduction principles to create a more productive environment, while maintaining the project budget. AECOM also used spatial adjacencies that ultimately increased productivity, met all client needs and simultaneously reduced unwanted costs.



MINIMIZE SURPRISES

A collaborative use of Building Information Modeling (BIM) was used on the project. The use of this programming allowed for extensive problem-solving using clash detection before ever making it to site, reducing rework and eliminating site installation surprises.



STREAMLINE DESIGN AND CONSTRUCTION

The LEAN methodology was employed when applying tools such as BIM. In the preparation of the design, coordination between the disciplines, the BIM model guided the review of construction progress and material take-off calculations.



INCREASE SAVINGS, PRODUCTIVITY, AND QUALITY

Applying BIM benefitted the project by reducing project costs and delivery time, increasing productivity and quality, construction cost control and predictability, and the potential for building lifecycle management. During the design we also used BIM for coordination of disciplines.



MITIGATE CONSTRUCTION RISKS AND ENHANCE BUDGET CONTROL

We also used BIM to mitigate construction risk with more complete site documentation. Using BIM as a tool to determine material take off assisted in construction budget control. Additionally, we used BIM in the review of the construction schedule.

Why Partner with AECOM?

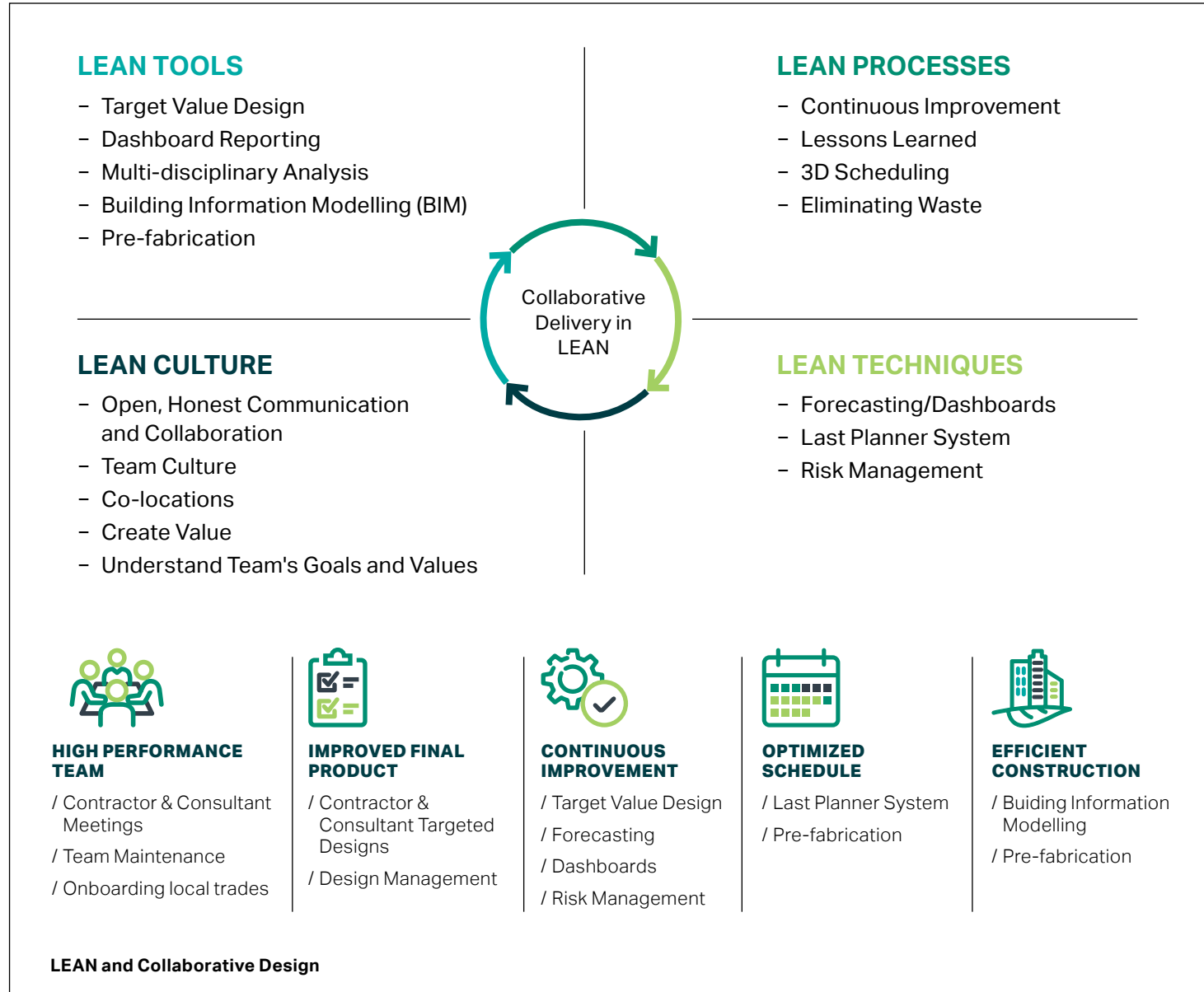
LEAN and Collaborative Design

With the involvement of the Construction Manager, the Value Engineering exercise can occur within each phase of design and then the estimate is a check instead of a scope cutting exercise. Contractors use the LEAN best practices to supplement traditional construction methods creating schedule and cost efficiencies throughout the design and construction process. AECOM can apply lessons learned from previous projects to support future work.

Leading the Industry In Zero Emission Design

As a global leader in engineering consulting, we have more than 6,500 employees working in the transportation sector in North America alone, including a dedicated Transportation Electrification practice. You have access to our global network of dedicated specialists and we will leverage the talents of our global experts in addition to our local specialists.

As a global leader in emerging **zero emission** transportation technologies and innovations, we have a well proven track record of collaborating on various zero emission projects for transit agencies, municipalities and private organizations. Our teams have provided Zero Emission Vehicle services for provincial, state and local municipalities across North America **for over 15 years**. We understand the challenges of evolving innovative technologies and the wide-ranging expectations of residents and businesses when it comes to public transit.



Supporting **over 20 transit agencies** in their fleet electrification efforts



Led engineering, procurement and design management to deploy **over 300 DC fast chargers** throughout the Netherlands and Germany



Electric Vehicle Charging Infrastructure System at JFK International Airport Terminal 5 project received **ACEC NY 2021 Diamond Award**



Leading program management that will deliver infrastructure to **18 locations** across Doha, Qatar that will be used by electric buses, trucks, and light duty vehicles



Partnered with The American Public Transportation Association to modify the **industry standard** bus specification to include battery electric bus technology



We have led **over 80 projects** supporting cities, utilities and fleet owners in transportation electrification efforts

Why Partner with AECOM?

Our solutions for planning and our experience with national and municipal transportation partners supports how we understand changing commuter and traffic trends, prepare for future electrification demand and charging infrastructure, and produce holistic analyses and simulations involving all stakeholders in the move to an efficient, more sustainable future.

We combine best practices, operational insight, knowledge and skills across the complete life cycle of services to deliver cost-effective and innovative solutions to exceed expectations.

As leaders in transportation and energy consulting, engineering and infrastructure, our team is accelerating the adoption of zero emissions technologies.

Our dedicated Transportation Decarbonization team leads the transition to zero emission transportation technologies. These team members can bring their global knowledge and experience to your project.

Whether planning, designing, implementing, or operating zero emission technologies, we bring a full range of understanding of the benefits, challenges, and successes that these solutions offer. We have performed electrification feasibility studies, decarbonization studies, grid infrastructure assessments, designed and engineered EV charging and supply installations, facilities retrofit designs and constructed electrification projects for various clients.

Our experience and expertise spans the entire lifecycle of the electrification process, and we can bring this knowledge to support the transition of transit fleets to zero emission technology.

It's not just about bus conversion – cities, utilities, and owners of fleets and infrastructure will also need

services to develop new infrastructure to support the transition. Fleet owners are the catalyst for transportation electrification.

We are ready to respond with:

- Fleet feasibility studies, planning design and deployment
- Facility siting and retrofit design
- Energy and charging infrastructure planning, design and deployment
- Transportation electrification planning and strategies
- Modeling and forecasting electrification impacts, incentives and programs
- Program management of electric vehicle program and fleet conversions
- Charging infrastructure planning and modeling
- Utility coordination and services
- Charging infrastructure master planning and program management

Innovation

We are developing tools and business models to apply innovative solutions to how we plan, design, finance and deploy critical transportation and energy infrastructure to drive our zero emissions future.

ev.readi™ Our proprietary tool models impacts of transportation electrification so cities, utilities and infrastructure owners can make data-driven decisions for policies and charging infrastructure deployments.



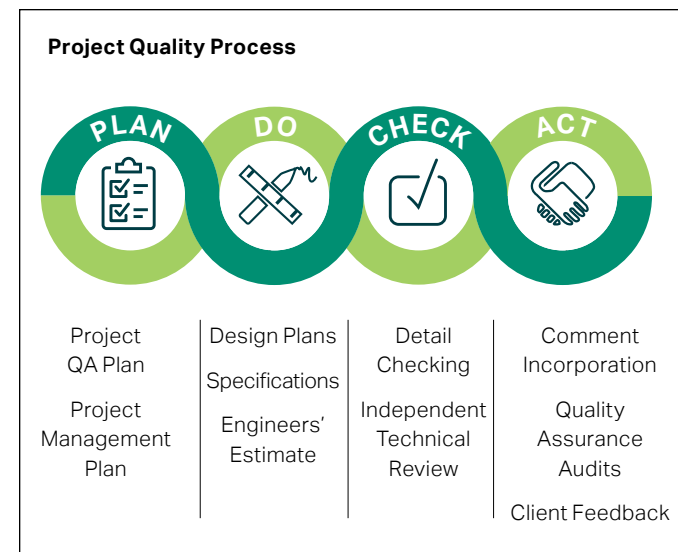
Charging as a Service: A unique delivery model that accelerates charging infrastructure deployment to realize benefits early, reduce risks, and optimize operational costs.

Implementing Related Experience

We have longstanding experience working with various transit agencies and municipalities. We provide our most relevant experience performing similar scope of work successfully in our representative projects.

Quality Documentation Yields High Quality Results

From the Ragged Lake Transit Facility expansion project, AECOM's experience in producing accurate information in specifications and drawings concluded in tender results significantly below estimate. Three contractors provided bids and the variation between them was within 3%.



In addition to our detailed benefits, we provide:

- Understanding of how to minimize risks on complex projects requiring phasing.
- Innovative designs that reduce schedule and cost - our culture promotes innovations through total cost of ownership, risk and opportunity management, schedule management, and claims avoidance techniques.
- Successful delivery track records: schedule, budget and innovations.
- Safety for Life Management System incorporates safety into everything we do.
- A structured project management approach where AECOM's project management culture is one of active financial management and a high degree of consistent communication. We possess a highly developed system of procedures and controls to validate that we deliver the correct work product and deliverables, within schedule, budget, and with a high degree of coordination and quality. AECOM Canada Ltd. is ISO 9001 accredited.



Safety for Life is our comprehensive SH&E program. Guided by our Life-Preserving Principles, it provides the policies, procedures and processes needed to avoid incidents—whether work-related injuries or illnesses, property damage or environmental loss—and to make our operations sustainable.

Transit Maintenance & Storage Facility Expertise

Today's maintenance and storage facilities are characterized by their unusual complexity, demanding schedules and increasingly constrained budgets. Our clients are often looking for buildings that express a unique identity while also achieving design standardization and sustainability. The fusion of architecture, industrial design, planning, engineering, environment, and economics allows us to balance the relationship between esthetics, operational needs and functional layouts.

Our team brings together a versatile and collaborative team of planning, design and engineering professionals who work to create livable, sustainable and equitable cities. We are proud to have delivered maintenance and storage facility services to municipalities and public agencies across the country including the Toronto Transit Commission, Metrolinx, GO Transit and the cities of Winnipeg, Calgary and Edmonton, to name a few.

On every assignment, we assemble the right blend of in-house architectural, engineering, planning, environmental and industrial design professionals to provide a fully integrated suite of services that is tailored to your specific requirements. Our experience spans facility projects of all scales and types in locations across North America and around the world. We are recognized for listening to your concerns, understanding your goals and creating innovative designs that address both highly specialized functions and routine operations, while respecting fiscal, regulatory and environmental conditions.

We collaborate with all stakeholders and draw on our vast network of building and transportation expertise from multiple disciplines to enhance designs and make them technically sound. Whatever the project delivery approach, traditional design-bid-build or alternative project finance and delivery methods, we develop comprehensive solutions that meet your vision for efficient and sustainable operation and maintenance facilities.

Our staff, through the completion of numerous transit service and facility projects for various municipalities, Metrolinx/GO Transit, Toronto Transit Commission (TTC), York Region Transit and other transit agencies, have developed experience in solving the complex planning, environmental and design challenges that may be encountered in bus storage and maintenance facilities.

AECOM has completed projects from inception through environmental assessment, design and construction administration. We continue to demonstrate our creativity in sustainable, context-sensitive design, our commitment to client schedules, our cooperation as a trusted partner with stakeholders, our ability to work proactively with regulatory authorities and community groups and elected officials, and our commitment to design excellence and quality.

Our experience in designing LEED-certified and Net Zero bus maintenance and storage facilities will benefit your project, as our staff will use their lessons learned from past assignments and apply them to your project.

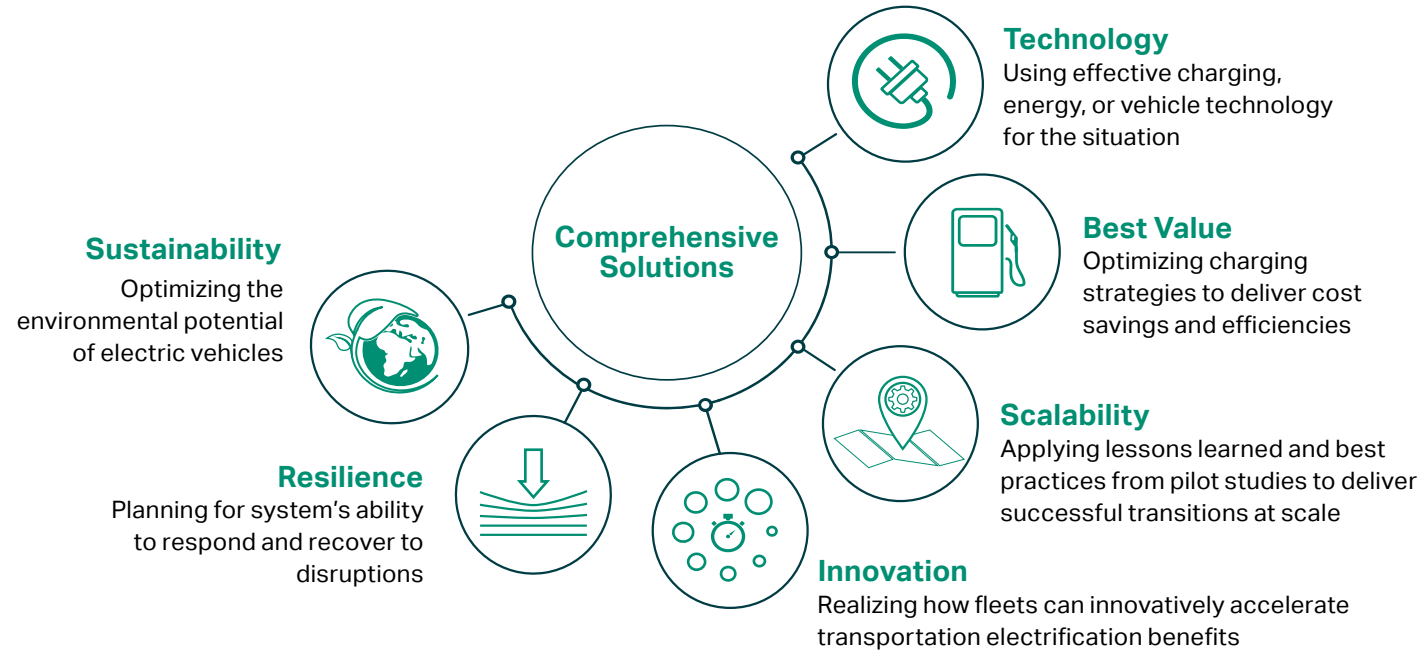
We will apply our lessons learned from our groundbreaking achievement in the design of the first and only Canadian Net Zero maintenance garage in Canada, the Ellesmere Fleet Maintenance Facility for the City of Toronto, which is now under construction.

Whether we're developing a new facility or transforming an existing one, we deliver leading technologies, functional layouts and cost-effective designs that meet all conceptual and operational objectives.

We have completed large, complex transit maintenance facilities as well as new and upgraded bus maintenance facilities across Canada including:

| Client | Project (\$) | No. Buses Built | Year |
|---|---|--|------------------|
| Halifax Regional Municipality (HRM) | Ragged Lake Transit Centre Expansion & Conversion (\$20M) | 60 new buses total = 40 BEBs expansion + 20 BEBs conversion | Target: May 2024 |
| City of Toronto | Ellesmere Fleet Maintenance Garage (\$33M) | 262 subway cars, 6-car subway train | 2019 |
| GrandLinq Contractors/Region of Waterloo | Waterloo Light Rail Transit Operations, Maintenance and Storage Facility (\$500M) | 40 Low Floor Light Rail Vehicles | Dec 2018 |
| City of Mississauga | MiWay Central Parkway Transit Garage Renovation (\$50M) | 410 buses | 2011 |
| Metrolinx 22 | Whitby Rail Maintenance and Storage Facility (\$860M) | 12-car trains | Feb 2023 |
| | Willowbrook Rail Maintenance Facility (\$45M) | 12 car consists | Dec 2009 |
| | Sheppard East Maintenance and Storage Facility (\$80M) | 100 new LFLRV vehicles | 2012-2013 |
| City of Calgary/PCL Construction | Stoney Transit CNG Transit Bus Facility (\$120M) | 424 | Jan 2019 |
| PCL Canada Constructors, Inc. | Winnipeg Transit Facility Bus Maintenance and Repair Garage Expansion (\$43.9M) | space for 40 and 60-foot buses | June 2019 |
| City of Edmonton | Thomas Ferrier Transit Bus Garage (\$143M) | 288 dedicated bus parking spaces, 120 electric buses charging stations | 2018 |
| York Region Rapid Transit Corporation | VivaNext Bus Garage Operations and Storage Maintenance Facility (\$100M) | 196 buses, 18 bus repair bays | 2015 |
| Toronto Transit Commission | Leslie Barns Maintenance and Storage Facility (\$370M) | 204 Low Floor Light Rail Vehicles | 2016 |
| | Wilson Bus and Subway Complex Expansion (North Expansion) (\$51M) | 250+ | 2019 |
| | Wilson Bus and Subway Complex Expansion (South & East Expansion) (\$66M) | 250+ | 2019 |
| | Birchmount Bus Garage Modernization (South & East Expansion) (\$12M) | 326 | 2014 |

A Zero Emissions Future



With a massive change underway across our cities, fleets and utilities that will bring social, environmental and economic change through the deployment of new transportation technologies, our global team is delivering comprehensive solutions to electrify the future of transportation.

Transit agencies are embracing electrification and shifting their fleets from internal combustion engines to EVs and buses. With these changes come numerous challenges around procurement, routing, and charging. Buses and charging infrastructure will need to be selected and deployed to meet the needs of existing and future route conditions. Municipal and transit fleet facilities will need to be upgraded to support EV and bus charging. Maintenance operations, route schedules, and operations budgets will also need to be aligned with the needs of an electrified fleet.

At the same time, the shift towards electrification presents an opportunity for transit agencies to meet sustainability and carbon emissions reductions goals.

An electrified fleet can help agencies realize reduced operating expenses and reduce space needed for fueling stations. The AECOM team can help agencies understand and quantify these cobenefits and ensure EV technologies selected will support existing mandates and goals.

We have deep expertise in developing electrification implementation plans for transit agencies. We have supported clients with the transportation planning, financial analysis, and engineering solutions needed to create robust EV strategies. We can also provide analysis and planning for future maintenance, training, financial, and infrastructure needs. The following table demonstrates some of our relevant projects.

Zero Emission Transit Buses

Relevant Project Matrix

| | Technology Feasibility Assessment | Electrification Business Case | Design of Charging Infrastructure | EV Modelling | Grid Management | Contract Administration | Technical Advisor | Public Engagement | Facilities Upgrade | Hydrogen Fuel Studies |
|---|-----------------------------------|-------------------------------|-----------------------------------|--------------|-----------------|-------------------------|-------------------|-------------------|--------------------|-----------------------|
| Halifax Regional Municipality (HRM) – Ragged Lake Transit Centre Battery Electric Bus Facility Expansion | • | | • | • | | • | • | | • | |
| City of Edmonton – Thomas Ferrier Electric Bus Garage Conversion | | | • | | • | | | | • | |
| Minnesota Valley Transit Authority – Zero Emission Fleet Transition Plan and Technical Assistance for Electric Bus Program | | • | | • | • | | • | | | |
| Canadian Food Inspection Agency – Fleet Transition Strategy | • | • | | • | | | • | | | |
| Canadian Blood Service – EV Charging Station Whitepaper and Integration Policy | • | • | | • | | | | | • | |
| Town of Aurora – EV Policy and Infrastructure Paper | | | | | | | • | • | • | |
| City of Saskatoon – Zero Emissions Vehicle Adoption Roadmap | • | | | • | • | • | • | | • | |
| City of Toronto – Public Electric Vehicle Charging Plan | • | | • | • | • | | • | | | |
| Shell Program – DC Rapid Charger design and installation | | | • | | • | • | • | | • | |
| Transport for London – Source London Phase II Network Expansion | | • | • | | • | • | • | • | • | |
| Fresno Council of Governments – Electric Vehicle Charging Infrastructure Network Plan | • | • | | • | | | • | • | | |
| CN Rail – Railyard DC Supercharger installations | | • | • | | • | • | • | | • | |
| Fresno County Rural Transit Agency – Electrical Grid Analysis Study | | | | • | • | | | | • | |
| City of Roseville – Assessment of Growing Plug-in Electric Vehicle Demand and Charging Services | • | • | | • | | | • | | | |
| Kings County Association of Governments – Electric Vehicle Readiness Plan | • | • | | • | | | | • | | |
| Los Angeles Department of Transportation – Bus Electrification Project Management | • | | • | • | • | • | • | • | • | |
| Washington Metropolitan Area Transit Authority – Washington Metropolitan's Electric Bus Program | • | • | • | • | • | • | • | • | • | |
| Dallas Area Rapid Transit - DART Zero Emission Transition Plan | | | | | | | | | | • |
| Rhode Island Public Transit Authority - RIPTA Action Plan for Electrification and Service Growth | | | | | | | | | | • |

Our robust team of experts, in both the Canadian transit market and the emerging market of transit electrification, have experience with over 20 agencies in North America alone, studying, deploying, and integrating zero emission buses into their fleets.

Our Canadian market knowledge as well as global transportation electrification subject matter expertise will be needed to truly understand the opportunities related to transit bus fleet electrification. Our local team has been involved in major transportation and transit projects throughout Canada, including the design services for the City of Edmonton's bus garage to support and charge up to 120 electric buses for their future fleet conversion and the masterplan for the Guelph Fleet maintenance and storage garage. Supporting our local team, AECOM brings global expertise, who have worked with transportation agencies, transit agencies, local municipalities, and utilities of all sizes to study and model the impacts of electrification, deploy electric buses and vehicles, and manage their facility upgrades to support electric vehicles.

 Recently, AECOM has been awarded the new Ottawa Electrical Bus Garage and the new Winnipeg Zero emission Electric Bus Facility recognizing AECOM as the most trusted consultant in the emerging zero emission bus market. With staff located across the globe, we're ready to support your transit project.

Additionally, we are supporting planning efforts for the Los Angeles Department of Transportation (LADOT) for the bus facility retrofit needs to support their entire fleet electrification conversion, which is anticipated to be 520 buses and five facilities by 2030. AECOM is leading these efforts with LADOT and is also conducting analysis on strategies to optimize their facility capital and operational spend with components such as on-site energy storage and generation, smart charging technology, and agency-owned electrical infrastructure, as opposed to utility-owned.



AECOM's local team of Canadian transit experts led consulting services for the City of Edmonton's fleet electrification for 120 buses



Our global experts in transit fleet electrification are leading planning efforts for LADOT 2030 fleet conversion of 520 buses, which includes a heavy focus on strategies to overcome barriers of fleet electrification early, as one of the earliest full fleet adopters in North America.

Our team's approach will combine knowledge of the markets with a robust set of best practices, studies, and analyses on zero emission bus technology, and outlook, financial impacts of bus conversion, anticipated total cost of ownership, and operational savings that our team has developed for clients throughout North America.



Pictured top-bottom:
City of Edmonton
 Thomas Ferrier Garage: Existing garage conversion feasibility study
Halifax Regional Municipality
 Ragged Lake Transit Centre: Existing garage conversion
Minnesota Valley Transit Authority
 Bus Facility: Fleet transition plan



Hydrogen- Fueling the Future of ZEB

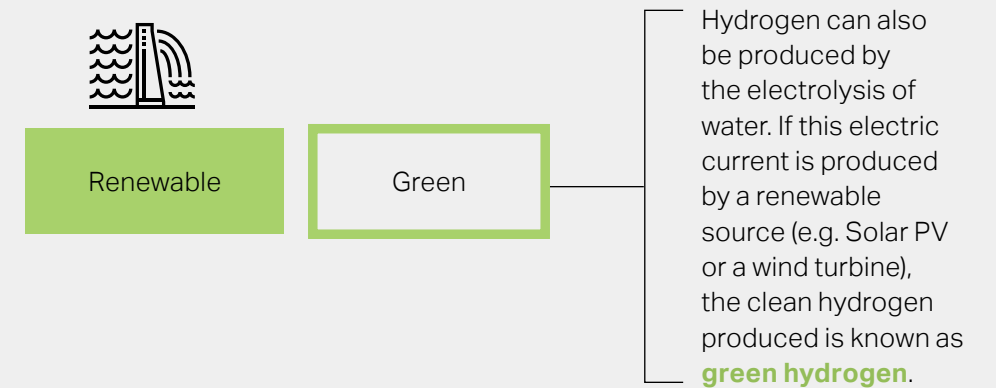
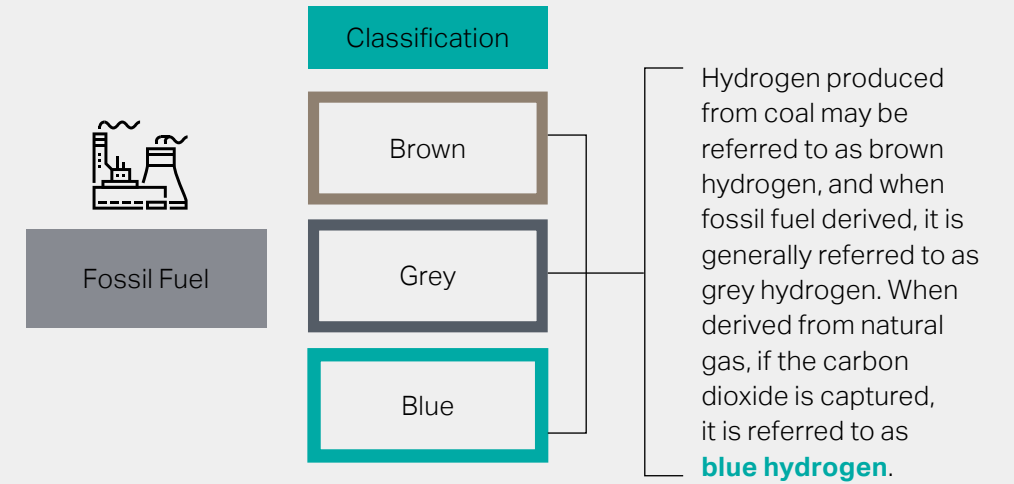
Hydrogen is one source of energy for zero emission buses. Electrochemical hydrogen production involves the use of an electrical current to split water molecules into hydrogen and oxygen. In cases where the electrolytic process is powered through renewable energy, it becomes possible to produce clean (green) hydrogen as zero emissions are released during this production process. Clean hydrogen, produced at scale, has the potential to enable deep decarbonisation across the energy and industrial sectors. Current barriers to market penetration include the relative cost of production (specifically when compared to the overall cost of supply for natural gas) and the current lack of infrastructure to support the clean hydrogen value chain.

Hydrogen is an emerging energy vector, many components of which are mature technologies. Current hydrogen technology is already able to provide

advantages over other energy vectors and many of its challenges are being actively addressed by research and development.

Although hydrogen is not currently viewed as a significant energy vector (transfer, storage or secondary energy source), even though substantial quantities are produced and consumed in various industrial processes, AECOM's team has deep expertise in developing hydrogen action plans for US based clients who have started to think about hydrogen fuel implementation. This includes bus garage evaluation studies, hydrogen fuel storage, hydrogen availability studies, hydrogen deployment environmental studies and fiscal operating impact studies. This has led in the preparation of robust strategies addressing the use of hydrogen fuel. The following table demonstrates some of our relevant projects.

| Hydrogen Fuel Projects Relevant Project Matrix | Vehicle Energy Capabilities Modeling | Bus Garage Evaluation | Hydrogen Fueling & Storage Concept Design | Hydrogen Availability Survey | Hydrogen Deployment Environmental Survey | Fiscal Operating Impact Study |
|---|--|-----------------------|---|------------------------------|--|-------------------------------|
| | Rhode Island Public Transit Authority (RIPTA) Action Plan for Electrification and Service Growth | • | • | • | • | |
| Dallas Area Rapid Transit (DART) Phase 2 Zero Emission Transition Plan | • | • | | | • | • |
| Capital Metropolitan Transit Authority Energy, Infrastructure and Resilience Strategy | • | • | | | | |
| North Central Region Transit District Zero Emission Bus Transition Plan | • | • | | | | |
| Minnesota Valley Regional Transit (MVRT) Phase 2 Zero Emission Transition Plan | • | • | | | | |



Representative Projects



Ragged Lake Transit Centre Battery Electric Bus Facility Expansion

Halifax, Nova Scotia | Halifax Regional Municipality (HRM)

Background and Context

The Ragged Lake Transit Centre (RLTC) was constructed in 2009 with an expansion to the bus storage garage facility completed in 2013. The building is one of two locations from which Halifax Transit (HT) provides bus maintenance and storage.

The property is bordered by Ragged Lake Boulevard to the south, Grassy Lake Drive to the east and undeveloped land to the west and north. There are two separate buildings located on the property: one that accommodates fleet storage/administration/bus operator facilities and one for fleet maintenance. The bus storage/administration/bus operator facility is approximately 120,000 sq. ft. with a current capacity to store 180 Standard Bus Equivalents (SBE) indoors. The maintenance facility is approximately 55,920 sq. ft. and provides maintenance operations for service, body/paint, wash/fuel bays, tool and tire storage, parts depot, revenue room and an administrative support area. The existing building consists of a steel structure with tilt-up concrete insulated sandwich panels on concrete foundation. Bus access to the facility is provided from two entrance gates, one each from Grassy Lake Drive and Ragged Lake Blvd. The staff/visitor parking lot is accessed from Grassy Lake Drive.

The RLTC Expansion & Fleet Electrification project aims at reducing greenhouse gas emissions of the Halifax Transit fleet and storage facility. The project includes the expansion of the RLTC bus storage garage to accommodate up to 62, SBE Battery Electric Buses (BEBs) and charging infrastructure and chargers including design/engineering and construction.

Project Description

To accommodate the existing site constraints and requirement for 60 SBE Battery Electric Buses, the bus storage garage requires an addition to each of the south and west building elevations (total of approx. 50,000 sq. ft). To align with the HalifACT target of net-zero municipal operations by 2030, the new addition will be built to a net-zero standard or net-zero ready.

The facility is currently one of HRM's largest energy consumers. The buildings underwent an energy study in 2019 which identified significant opportunities to enhance energy performance. Energy efficiency enhancements currently underway include adding demand-controlled ventilation, electrification with heat pumps, large solar PV array (est. 500kW), battery storage (est. 1,000kWh), recommissioning, air curtains and destratification fans. It is not anticipated these projects will impact the expansion project to the bus garage.



Core Services

Program Management, Transit Ops Planning, Architecture, Structural, Mechanical, Industrial, Electrical, Civil, Landscaping, Net-Zero Sustainability, Cost Estimating

Subconsultants

- EastPoint (Civil, Bldg Cx &CA)
- Morrison Hershfield (local building code analysis)

Key Contact Details

Michael MacDonald, Project Manager, Facility Design & Construction, Halifax Regional Municipality
T: 902-476-2744
E: macdoner@halifax.ca

Start / Completion Date

March 2022; Target Finish: May 2024

Project Value

Construction: \$20 million
Consulting fee: \$1.1 million

This project is part of a long-term expansion strategy for both Ragged Lake Transit Centre (RLTC) and Burnside Transit Centre (BTC). At present, both facilities have approached the limits of their operational constraints primarily with regards to fleet storage, maintenance inventory storage, and the ability to accommodate alternative fuel (i.e. electric) vehicles. From a long-term strategic standpoint, the optimal configuration and expansion of the Ragged Lake Transit Centre is necessary for HRM asset maintenance, minimizing transit operating costs, and the ability to adopt new fuel and vehicle technologies without compromising service delivery.

Challenges Encountered and Results Achieved

In-facility storage and charging within are understood to deliver the most efficient use of space given a site's physical restraints. The Ragged Lake facility has limited space available to place the additional 60 BEBs on the given site with an existing wetland and current operating patterns.

Furthermore, the construction of the facility must be completed with the minimal of disruption to the schedule of deployment of the existing fleet. This constraint must be addressed with a strong construction phasing plan.

Key Elements

- In-facility storage and charging within are understood to deliver the most efficient use of space given a site's physical restraints.
- The Ragged Lake facility has limited space available to place the additional 60 BEBs on the given site with an existing wetland and current operating patterns.
- The construction of the facility must be completed with the minimal of disruption to the schedule of deployment of the existing fleet. This constraint must be addressed with a strong construction phasing plan.



Thomas Ferrier Electric Bus Garage Conversion

Edmonton, Alberta | City of Edmonton

Background and Context

The City of Edmonton is Canada’s fifth largest municipality with an area population of just over one million people. The City’s public transit service called Edmonton Transit Service (ETS) operates 191 bus routes with 7,456 stops and 26 hubs. ETS also operates 2 LRT lines with 18 stations. ETS has a fleet of 932 buses including diesel, hybrid and electric. The daily ridership of ETS is 397,400 per weekday.

To reduce greenhouse gas emissions and introduce green initiatives, the City of Edmonton introduced a hybrid bus pilot program in 2008 and evaluated bus reliability, performance, maintenance costs, fuel efficiency, noise, and environmental impact. The hybrid buses were not very effective and later in 2014 a four-month pilot program of a full electric bus platform was introduced. The fully electric buses were a success under the pilot program and an investment and procurement strategy was initiated to add electric buses to the fleet.

In 2017, AECOM was retained under an invite-only competitive procurement process to provide professional consulting services to renovate, upgrade and expand Thomas Ferrier Bus Garage including

the capability to accommodate, service and charge 120 electric buses. Ferrier Bus Garage is located at 8620 58 Avenue NW and serves the City’s south end. The existing gross floor area of the building is approximately 17,500 square metres. AECOM was tasked with a pre-design study to evaluate the existing conditions develop a full program for infrastructure requirements. This was followed by schematic design including conceptual plans, a detailed design narrative report, construction phasing strategy, schedule timeline, and cost estimate to support a future capital funding request. At present, the project has not yet proceeded into detailed design or construction.

Project Description

The scope of this project included design of the following infrastructure elements:

- Total increase in gross floor area from 17,500 square metres to 57,300.
- Increase existing garage capacity of diesel fleet from 241 buses to 288.
- Expand garage building into the north parking lot to accommodate 120 electric buses complete with charging infrastructure. Charging infrastructure via overhead mezzanine.



Core Services

Program Management, Planning, Architecture, Interior Design, Structural, Mechanical, Industrial, Electrical, Sustainability, Cost Estimating

Subconsultants

- Gh3 (collaborating Architect)
- RWDI (Sustainability)

Key Contact Details

Sean Buchanan, Project Manager
 City of Edmonton
 T: 780-496-4742
 E: Sean.Buchanan@edmonton.ca

Start / Completion Date

May 2017 to December 2018

Project Value

Construction: \$143 million
 Consulting fee: \$1.5 million

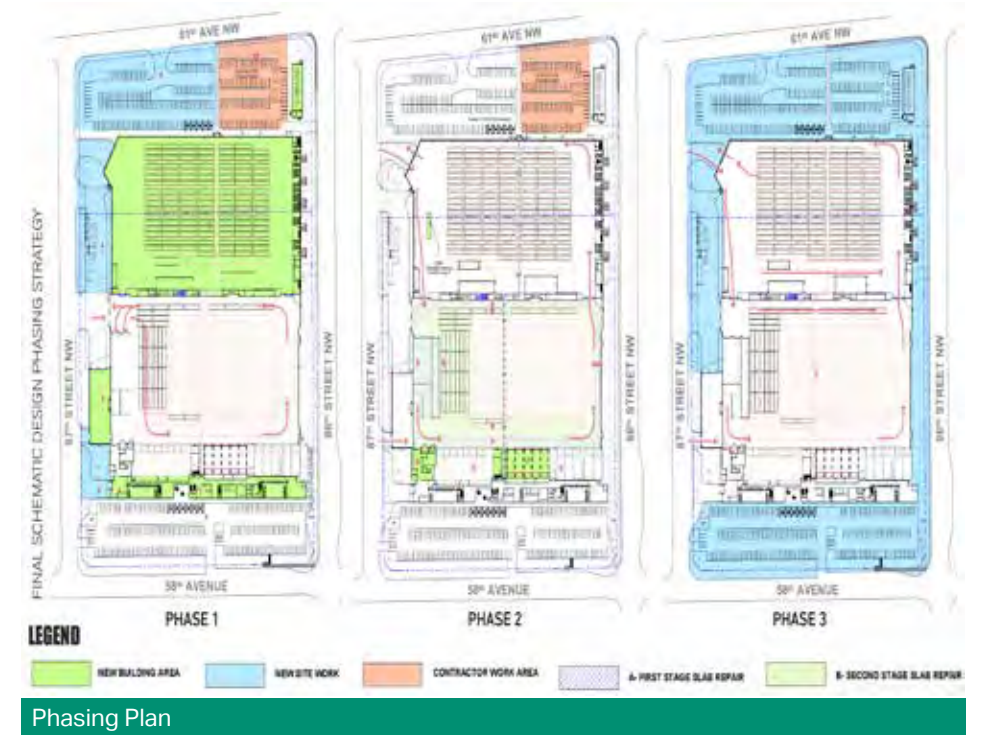
- New high voltage substation, five (5) new electric power transformers at the rear of the building, 10.5 MW capacity generator for back-up power, and roof-top solar cells for renewable energy.
- Relocation of the administrative area to new two-storey addition on south side of building in order to increase maintenance shop and hoist numbers.
- Addition of maintenance functional areas including steam bay, in-ground pits, dual service bay for articulating buses, interior bus wash bays, under-bus wash facility, additional parts storage, and improved staff facilities.
- Reconfigured maintenance office, booker shack, and coin rooms.
- Reconfigured and expanded parts and receiving areas.
- Increase of on-site car parking to accommodate staff growth as well as addition of fire route laneway and bus queuing areas.
- New fueling tankage and internal refueling area for articulated diesel buses.
- Site wide landscaping upgrades to meet City By-law requirements.
- Stormwater management improvements on new roof top areas and at ground level.
- Sustainability improvements to achieve LEED Silver Certification.

Challenges Encountered and Results Achieved

The main challenge of this project was the construction staging and sequencing of interim phases to reach the end state. The overarching concept behind the construction phasing was to minimize disruption or impacts to the existing facility operations. The phasing strategy considered three distinct yet consecutively planned construction phases. Each was devised to be constructed, commissioned, and ready for occupancy as a unit. Color coded plans were developed to provide a high-level visual representation of the approach along with a detailed narrative to describe the finer details and nuances of each stage. Phase 1 generally included constructing the addition to the north, new HV substation, segregated south building expansion, site works, and a constructor lay-down area. Phase 2 would utilize the infrastructure that was constructed in Phase 1 as a swing space to renovate the existing garage. Lastly, Phase 3 would be a clean-up phase and focus on landscaping, removing contractor lay-down areas, and final commissioning.

Key Elements

- Besides the experience of completing transit facilities in several municipalities, helping a municipality determine which steps to take for decisions has been a strength of AECOM.
- AECOM understands that the future facilities will have to have the necessary flexibility to accommodate different models which is how the Thomas Ferrier electric bus garage conversion study was completed for the City of Edmonton.



New front facade with balcony protection (reduces entrance maintenance)

Winnipeg Transit Facility Bus Maintenance

Winnipeg, Manitoba | PCL Constructors Canada Inc.

Background and Context

Winnipeg is the capital of Manitoba and is centered on the confluence of the Red and Assinboine rivers. It has a population of approximately 750,000 people. Winnipeg Transit operates a bus fleet of 640 buses on 90 different routes with 5,170 stops and has a daily ridership of 170,000. The entire bus fleet is diesel at present and is serviced from three depots: Fort Rouge, Brandon, and the North Garage. Winnipeg Transit is now using up to four New Flyer Xcelsior® battery-electric transit buses in daily service as part of an electric bus demonstration.

In 2017 under a Design-Build procurement, Winnipeg award the renovation of the Fort Rouge Bus Garage to the PCL Constructors team with AECOM as the lead designer. Fort Rouge Bus Garage is located at 120 Osborne Street and was originally constructed 50 years ago. The objective of this project was to expand the existing garage to offer greater capacity, upgrade and modernize the existing facility, incorporate green initiatives, and ensure the existing operations were minimally disrupted or impacted during construction. As a subconsultant to PCL, AECOM provided

schematic, detailed design, construction documents, and non-resident engineering services.

Project Description

The renovation to Fort Rouge included a 6,000 square-metre (67,000 square-foot). The project also included the extensive renovation of a 1,300 square-metre (14,000 square-foot) area in the existing bus garage facility, and exterior works.

Major components of the project include new bus maintenance space for 40-foot and 60-foot buses, complete with refurbishment and overhaul, bus body and mechanical repairs, and general bus maintenance functionality. Equipment includes in-ground lifts, refurbishment and wash bays, prep and paint booths, engine fluids distribution, and fall arrest systems. Ancillary spaces include a fabrication and welding shop with overhead crane, storage spaces with racking, and offices to support the maintenance and repair operation. Electrical work includes a new 25 kV electrical service main loop and transformation along with upgrade of the existing distribution system panels and four diesel generators to provide 100 percent backup for the overall transit campus.



Core Services

Design Management, Architecture, Interiors, Mechanical, Electrical, Industrial, Civil

Key Contact Details

Matt McInnis, P.Eng.
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Start / Completion Date

Design:
January 2017 to May 2017
Construction:
August 2017 to June 2019

Project Value

Construction: \$43.9 million
Consulting fee: \$3.1 million

The mechanical systems included large capacity heat recovery ventilators, and infrared heating. Exterior works included alteration of Brandon Avenue to create a new parking lot, landscaping, and site road and drainage improvements. The renovation includes interior fit-up of approximately 14,000 square feet of existing interior space including a high security treasury area with dual door large vault.

Challenges Encountered and Results Achieved

As the transit garage operates 24/7, phasing and sequencing of work was strategically developed in consultation with Winnipeg Transit end-users to minimize impact of construction to existing operations and maintain safety at all times.

Key Elements

- Strong understanding of Winnipeg Transit Operations and stakeholder requirements
- Design experience in Industrial Equipment & Maintenance Bays, way-finding systems, and wash bays



Stoney Transit Compressed Natural Gas (CNG) Bus Storage and Transit Facility

Calgary, Alberta | PCL Construction Management, City of Calgary

Background and Context

The City of Calgary has a population of approximately 1.3 million people ranking it as the third-largest municipality in Canada. Calgary Transit has a fleet of 965 buses and 160 light rail vehicles with an annual ridership of 105.3 million. Calgary Transit has a mixed bus fleet of diesel and compressed natural gas (CNG).

Under a Private Public Partnership (P3) contract, the City procured a new bus transit maintenance facility for a developing CNG fleet. The consortium Plenary Infrastructure Calgary signed a \$174 million fixed-price contract with the City for the project. Plenary Group (Canada) was the Developer/Facility Operator, while AECOM was the Designer. PCL Construction Management was the Constructor.

Project Description

The new 44,300-square-metre facility is located in north Calgary at 12620 - 15 Street N.E. It has 36 maintenance bays, two steam cleaning bays, on-site CNG gas compression and fuelling infrastructure, associated staff facilities and can store 424 buses in the garage area. Throughout the fleet's transition to CNG, the facility will continue to service diesel bus operations.

AECOM provided design services for all aspects of the building, designed to maximize interior sight lines and natural light within the building and incorporate sustainable measures such as plate systems for exhaust air heat recovery and displacement ventilation systems to address gas safety. The facility is LEED Gold certified and includes many sustainable initiatives.

The storage area is sized for 424 buses plus an additional 70 vehicles in overflow areas. The maintenance area is sized for 36 vehicle maintenance bays, with a mix of 40' and 60' transit buses. The bus service area is divided into three lanes with two fuelling and service points in each. Fuelling is provided for both CNG and diesel fuel at each fuelling point. Each service lane feeds to the storage area through a drive through bus wash.

The Bus Storage area is equipped with an on-demand ventilation system and sophisticated gas detection system. Lighting is by LED fixtures. The area is configured to allow for the storage of three 40' vehicle or two 60' articulated vehicles between designated access aisles for maximum flexibility in vehicle storage.

The CNG Fuelling system is sized to take natural gas at 100psi and compress it to the correct pressures for fuelling vehicles. The fuelling system is designed



6 service lanes designed to complete fuel and daily service

Core Services

Structural, Mechanical and Electrical Engineering Services

Service Areas

Investigation & Reports, Design Concept, Design Development, Energy Modeling, Lifecycle Impact Assessment, LEED v4 Assessments, Tender and Construction Support

Key Contact Details

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City of Calgary, Danny Panday
Senior Project Manager
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Start / Completion Date

November 2016 - March 2019

Project Value

Construction: \$120 million
Consulting fee: \$6.7 million
Maintenance: \$174 million

Awards

- Silver medal from the National Council for Public-Private Partnerships in 2019 National Awards for Innovation and Excellence In Public-Private Partnerships
- Consulting Engineers of Alberta, Award of Merit, Sustainable Design, 2020
- Consulting Engineers of Alberta, Award of Merit, Building Engineering - Institutional, 2020

to allow a single bus to be filled in 4 minutes with an average fill time of 6 minutes. The system has been designed to fill six buses simultaneously.

The maintenance area is arranged with a central access aisle and maintenance bays located off that aisle. Designated bays for 40' buses are back in, and designated bays for 60' vehicles are drive through. Each 40' bay is equipped with a two-point, scissor-style lifting hoist. Each 60' bay is equipped with a three-point scissor-style lifting hoist. Designated 60' bays will accommodate a 40' vehicle for specific maintenance tasks. The maintenance area includes training rooms, tool storage rooms, library, parts storage, tire storage, tire shop, degrease area, detailed cleaning, inspection, oil changes and wheel alignment spaces. There are loading docks and waste handling spaces included.

The administrative area contains appropriate offices for a satellite garage with designated training areas, meeting rooms, dispatch and operations spaces. The area also provides amenity spaces for both operators and maintenance staff. The amenities include dedicated lunchrooms, lounges, fitness centre, locker and shower rooms, as well as some outdoor patio and recreation spaces.

The site accommodates 600 parking spaces for staff and visitors, including designated stalls for handicapped parking, green vehicle parking (including electric vehicle charging) and carpooling.

On the site is a Natural Gas compressor compound with high pressure storage to take utility provided natural gas and compress it to 4500psi to allow for fuelling of the CNG powered buses. It is the intent of Calgary Transit to operate 400 CNG powered vehicles out of this facility within five years of occupancy.

Challenges Encountered and Results Achieved

This particular property presented challenges due to its configuration and location between two environmental reserve areas, including a wetland. This had a significant impact on the building configuration and caused it to depart from traditional transit facility models and operational flows. By organizing the facility around a central amenities and office space, it was possible to maintain efficient flows for both daily service and maintenance activities while separating transit vehicle movements in a safe manner. Keeping the daily fueling and washing space as part of the storage garage element with interior circulation provides the necessary climate and environmental protection for both the site and the operation.

Onsite energy efficiency and electrical generation is always a challenge. This facility used a combination of local Utility provided Cogeneration unit, Solar PV panels and diesel generators to provide power and heat to the facility. Back up power for life safety systems related to the CNG requirements was provided by both the Cogeneration unit and diesel generators.

Maintaining a combined diesel and CNG fleet in the same facility was an additional challenge. This necessitated an innovative approach to ventilation to address the characteristics of vehicle exhausts and possible natural gas leaks from the storage areas. The use of a jetted displacement ventilation design provided positive airflow around the buses and addressed both exhaust and natural gas concerns. The gas detection system added measures to control and communicate with both ventilation and fire alarm systems for a safe and effective ventilation strategy. Presentations were made to the Authorities Having Jurisdiction to address specific regulatory issues and

aspects not covered by current regulations to achieve permits and acceptances.

CNG Bus fuel tanks are located on the roof of the vehicle and roof access is now required for inspections, maintenance and replacement of the CNG tanks in that location. Two dedicated roof access bays were design and constructed. These bays have a 5 tonne and 1.5 tonne overhead bridge crane sized for the tanks and other equipment as loads. A travel restraint / fall arrest system is located above each bus position to allow for full and safe personnel movements while undertaking works on the top of the bus.

Key Elements

- Innovative mechanical system design saving over \$1M in material savings
- Renewable Energy: the facility integrates the combination of a Utility provided Cogeneration unit, Solar PV panels, and skylights to reduce significantly the power usage for the site. This contributed to the Achievement of 28 or 33 points LEED Gold v4 BD+C including:
 - 18/18 Optimize Energy Performance
 - 6/6 Enhanced Commissioning
 - 1/1 Advanced Energy Metering
 - 1/2 Demand Response
 - 1/3 Renewable Energy Production
 - 1/1 Enhanced Refrigerant Management

"AECOM Engineering was our Design Partner and this design team proved to be a valuable part of the success of the project. AECOM Engineering provided cost effective and energy efficient designs which contributed to the achievement of LEED v4 Gold for this design-build project."

Owen Nordmark C.E. TVP & District Manager – Calgary



Stoney Transit Facility Site



Green Roof Area



Storage garage - designed to accommodate alternative fueled vehicles



Maintenance Garage

Ellesmere Fleet Maintenance Garage

Toronto, Ontario | City of Toronto

Background and Context

With a recorded population of 2,794,356 in 2021, Toronto is the most populous city in Canada and the fourth most populous city in North America. AECOM has >20 years doing business with City of Toronto.

The existing Fleet maintenance facilities were condemned by the building department and the City required a complex that would bring together their operations and management team under the same roof.

The City also required a modern building that met Net zero requirements and was designed to Lean principles to reduce operational time and costs.

Project Description

AECOM is providing Architectural, Civil, Structural, Mechanical and Electrical services to The City of Toronto for the New Fleet Repair Garage and Office Modernization Program (OMP) along with a new Salt Barn and Brine Facility at Ellesmere Yard Complex "C". The Fleet Maintenance Facility consists of 14 maintenance bays, welding bay, wash bay, tool storage areas, spare parts, and back of house staff service rooms and office building. The design and engineering for the new facility will comply with the Toronto Green Building Standard.

Key sustainable design features and services include:

- 24 EV Level II car chargers in the employee parking lot and strategically located near the main entrance; this is part of Toronto Green Standards where 25% of the parking spaces are allotted for EV chargers which comes with built-in load management system
- Net-Zero energy and emissions by 2026 to align with the City's climate targets
- Tier-3 performance level for the office-side, OBC SB-10 for garage-side
- Perform energy modelling, by using IES Virtual Environment software,
- Solar Roof Panels – Coordinated with Environment & Energy Section of the City of Toronto

The mechanical design includes air source heat pumps with a dedicated energy recovery ventilator unit and hydronic heating in the office areas provided by electric boilers. Specific energy-efficient electrical design features include:

- LED light sources in accordance with applicable standards to achieve optimum LPD
- Power distribution designed to voltage drop limited to 2% and lower for feeder circuits and 3% and lower for branch circuits
- Digital customer metering to analyze energy demand and performance



Core Services

Project Management, Architecture, Engineering (Civil, Structural, Electrical, Mechanical), Cost Estimating, Building Code Review, Construction Administration

Service Areas

Planning, Preliminary Design, Detailed Design, Construction Documents, Tender and Construction Support

Key Contact Details

Lloyd Brierley, General Manager, Fleet Services Division
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Start / Completion Date

2019 - Ongoing

Project Value

Construction: \$33 million
Consulting fee: \$1.05 million

- Equipment motors designed to CSA C390, NEMA MG1, MG2 requirements
- Transformers for the building designed to conform to common energy efficient standards
- Solar readiness to accommodate connections to solar PV Technologies Connection in accordance with City designed PV systems.
- Submetering to select feeders from main switchboard with high anticipated demand and where exceeding 250kVA as required by NECB.

Beyond the electrical and mechanical design elements, electrical vehicle charging capability has been integrated in 25% of the building's parking facility. Bike racks will be installed and showers will be provided to encourage active transportation among building staff. The pocket park also connects with nearby trails and paths via the enhanced sidewalks to support active living within the community.

Automatic dark sky compliant fixtures will reduce light pollution from within the building and exterior glazing will mitigate bird collisions. The building's hardscape incorporates solar reflective materials and heat reducing pavement to minimize Toronto's urban heat island effect. With regards to landscaping, over 60% of the proposed plant materials are native species and drought-tolerant plants have been incorporated to 50% of the landscaped areas.

Challenges Encountered and Results Achieved

The City of Toronto required the project to follow LEAN design guidelines and the City reduced construction budget during the design. Dividing the maintenance shop floor into two sections and by providing the main service areas within walking distance in a central location was a means of achieving some of the LEAN criteria. Our value engineering process managed to cut some of the features that were primarily requested by the client. However, through design we allowed for future expansion of the spaces on a third floor and

provided space for future elevators.

Defined by the City of Toronto (the City) as an "Emerging Main Type" street, Ellesmere Road calls for urban designs with strong, pedestrian-friendly built edges and buildings that are setback at a minimum of 3 metres. With trucks driving in and out of the maintenance bays, the Ellesmere Fleet Maintenance Facility (Ellesmere FMF) building design had to accommodate a significant turning radius for large vehicles. This necessary functionality made it impossible to position the building within the defined street edge prerequisite.

An initial approach with parking located in front of the building and adjacent to the street edge was proposed and subsequently rejected because it contradicted the City's design guidelines. In collaboration with the City, the existing parking bylaws were slightly modified and the Ellesmere FMF Pocket Park—a public green space that will act as a buffer between the future building and the street—was born. Located in the heart of an industrial area, this pocket park will create a visual enhancement from the street and provide a welcome green space for those living and working in the community.

Key Elements

- 14 drive through maintenance bays- one with an inspection pit
- Weld shop
- Interior and exterior truck wash
- Centrally located parts and tools storage
- Dedicated offices and training rooms
- Truck lay-by area
- Staff parking
- Rail impact crash wall
- Full back up generators
- Solar panels
- Designed to achieve Net zero Certification



The design of the Ellesmere FMF building and its exterior environments incorporates several measures to improve sustainability and mitigate environmental impacts. To achieve net zero status, insulation, air tightness and triple glazing were used in the architectural design.



Massport Bus Maintenance Facility/Green Bus Depot

East Boston, Massachusetts | Massachusetts Port Authority

Project Description

AECOM provided architectural and engineering design services and permitting support for Massport's 75,000 SF bus maintenance facility for Logan International Airport. The facility is composed of covered and/or enclosed bus parking / storage for 50 buses, 7 bus maintenance bays, a bus wash, maintenance shops and support space, bus fueling and an administrative and office area for facility and bus fleet maintenance operations. This facility is the home for Massport's new fleet of clean and efficient CNG and Hybrid Diesel buses, providing bus fueling, washing, storage and maintenance.

The five-acre waterfront site is adjacent to residential neighbourhoods and the MBTA Blue Line subway. Design services provided include Environmental (ENF) permitting, noise and air quality impact studies, site planning, geotechnical, civil, architectural, structural, and MEP/FP engineering services, as well as sustainable design/LEED certification support.

AECOM's project involvement began in the early programming and planning phase, developing site concept studies to understand the parameters, constraints and challenges of the site, and finding a best fit for the program and budget. AECOM was also involved in the preparation of materials for use in public meetings to neighborhood stakeholder groups. The project was performed under the MA Chapter 149A, CM at Risk process, and pursued certification under LEED v.3.

Key Elements

- Adjacent to MBTA Blue Line
- Architectural/Engineering Services
- Public Outreach
- Planning/Environmental/Geotechnical
- Sustainable Design



Lee Tran Bus Administration, Operations & Maintenance Facility

Ft Myers, Florida | Lee County, Florida

Project Description

AECOM provided complete architectural and engineering design services for the new \$32 million bus maintenance facility for the Lee County, Florida bus fleet. The new Lee Tran Administration, Operations and Maintenance Facility serves the expanding needs of Lee Tran and houses administrative, service operation, and maintenance functions. It includes administrative offices of 12,800 sf, transportation operations offices of 20,000 sf, and a vehicle maintenance building of 44,500 sf.

The maintenance building has 18 bays with lifts for repair of the buses. The facility includes bus fueling and cleaning stations in ancillary buildings. The facility supports approximately 500 employees, 124 buses, 90 paratransit vehicles, 47 support staff vehicles, and 300 employee parking spaces.

The maintenance buildings provide for maintenance staff, warehouse functions, route maintenance, facility maintenance, vehicle maintenance and repair, inspection, wash, interior detailing and fueling. The administrative offices serve office and clerical staff, customer service, provides public meeting space, IT and training functions. The operations building houses

supervisory staff, dispatch, driver check-in and prep area, vehicle inspection and release for both Fixed Route and Paratransit Services.

All buildings have steel frame and tilt-up concrete wall construction, LED lighting, and energy efficient mechanical systems. The maintenance building incorporates a continuous clerestory window system bringing natural light to the center of the maintenance bays. A concrete strengthening agent was added to the concrete flooring in the maintenance bays to provide added durability.

The project is registered with the US Green Building Council for LEED certification. It is anticipated the project will receive LEED silver certification for the Administration/Operations Building and LEED certified for the Maintenance Building.

Key Elements

- Fueling and Cleaning Station
- Architectural/Engineering Design
- Sustainable Design



MiWay Central Parkway Transit Garage Renovation

Mississauga, Ontario | City of Mississauga

Background and Context

The City of Mississauga is the sixth most populated municipality in Canada, third most in Ontario, and second-most in the Greater Toronto Area. It encompasses an area of approximately 292 square kilometres and is home to a population of near 750,000 residents. The City’s public transit agency is called MiWay and has more than 950 transit operators, 500 fully accessible buses, 80 bus routes and 3,400 bus stops across the City. MiWay currently has two transit bus garages which are the main facility at 975 Central Parkway West and a satellite facility at 6780 Professional Court in eastern Malton area of Mississauga.

AECOM (as legacy firm URS) was asked by the City of Mississauga to undertake an analysis of the City’s main transit facility at 975 Central Parkway, with a view to accommodating an expanded transit fleet. The feasibility study included a review of existing facilities and operations, development of strategies, conceptual design of options for expansion, life cycle costing, and evaluation of options. The recommended option consisted of a new “transit campus” design, incorporating three new buildings totaling 18,000 m², plus the renovation of existing 23,000 m² (operations, bus storage, bus maintenance).

The AECOM team provided complete engineering, architectural design and general construction review, of this fast-paced Construction Management project.

Project Description

In the aerial perspective shown, the only previously existing building was the red brick Bus Storage and Repair Garage at the top right, which was undergoing significant mechanical and electrical upgrades. Some older City-owned buildings were demolished, and occupants relocated under another project, resulting in a 23.5-acre comprehensive transit site.

The infrastructure AECOM designed included:

- A New Body Shop with articulated-bus-size paint booth and prep area, plus 10 hoist-equipped bays (left side of rendering, above). Work included demolition of two buildings and construction of the Shop which is now in use.
- Doubling of the Bus Repair Garage, in the form of a 55,000 ft² expansion (rightmost building). The expansion includes 13 hoist-equipped maintenance bays, an electronics repair room, 2 specialized maintenance pits with pit jacks, controlled temperature room for testing bus AC and heating, stores, and staff amenities for mechanics.
- A New Bus Storage Garage with service lines and

interior cleaning drive-through bus maintenance building bus storage building for 120 buses (“L-shaped” building), including 2 service lines with wash bays, 2 interior cleaning bays, and staff amenities for operators and service personnel.

- A Bus Storage and Servicing Facility for 290 buses, including indoor fuelling and bus wash facilities. Renovations include replacement of lighting and portions of the ventilation systems.
- A Two-Storey Office Building renovations included revisions to building layout to support current needs, updated lighting and HVAC, modifications for barrier-free accessibility, and the addition of a fitness area.
- Existing Bus Repair Garage Renovation included lighting and ventilation upgrades, and major structural reinforcement of the one-story stores area to support additional snow loads resulting from an adjacent addition.

The project includes a number of “green” initiatives including light coloured roofing, partial vegetated roof, and extensive use of heat recovery for the large rooftop heating and makeup air units. The building meets the City of Mississauga’s standards for barrier-free accessibility, to the degree practical for a facility of this type. The design team worked with the City’s



Core Services

Program Management, Planning, Strategy, Architecture, Interior Design, Structural, Mechanical, Industrial, Electrical, Sustainability, Cost Estimating

Subconsultants

- McCormick Rankin Corporation

Key Contact Details

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Start / Completion Date

2005 to 2011

Project Value

Construction: \$50 million
Consulting fee: \$3.9 million

Awards

- HPNC Certificate of Recognition: The High-Performance New Construction (HPNC) Program recognized the Mississauga Transit Campus – Bus Storage Garage “E” and Mississauga Transit Campus – Bus Storage Garage “A” for their commitment to energy-efficiency in Ontario, June 2011

Accessibility subcommittee to ensure that this public building would take a leadership role in barrier free initiatives for industrial facilities.

AECOM worked closely with PCL as Construction Managers, in order to provide for effective coordination of the multiple buildings that were constructed on this site which is active 24 hours each day.

Challenges Encountered and Results Achieved

Site Design: Concepts addressed included: maintaining operations while developing the site in a phased manner; maintaining separate circulations for buses and employee vehicles; providing 615 on-site parking spaces; providing new and upgrades to existing services; and providing a network of underground ducts interconnecting all on-site buildings for power, telephone, data, CCTV, security communications, fire alarm and BAS systems.

Architectural Design: The Body Shop contains a down-draft Preparation Area, a state-of-the-art Paint Spray Booth and a Paint Storage Room. The maintenance bays were constructed with concrete floors, steel super structure, prefinished insulated metal exterior wall system and PVC white colour single membrane roofing, incorporating vegetated green roofing in selected areas. The bays are equipped with overhead cranes, high volume air exchange systems and life safety building systems; they have direct access to shops and associated storage spaces for ease of access to component supplies and parts. The service bays include automated drive-through wash bays and interior cleaning bays. The ancillary staff areas include lunchrooms, locker rooms, washrooms and showers. The administrative areas include reception areas, offices, meeting rooms, control rooms, change and locker rooms with associated washrooms, lunchrooms and first aid rooms.

Structural Engineering: The predominantly steel based structural design for the facility was designed for seismic, snow and wind loading as well as for a green vegetated roof in selected areas. Superstructure in the 7.5 m high bay area was designed for a 5-tonne overhead crane coverage while buses are in the jacked position.

Mechanical Engineering: AECOM developed the mechanical systems concepts sufficiently to establish their feasibility and comparative capital and operating costs, for input into the option analysis. The general ventilation rate is 8 air changes/hour, and the exhaust systems will be controlled and monitored by a CO/NO₂ gas detection system utilizing a make-up air system with heat recovery capability. Process mechanical equipment include; two below-ground diesel storage tanks; pits with hoists; specialized area for testing bus heating and cooling systems; three 4,500 L underground coolant storage, windshield fluid and engine oil storage tanks; 110 psi compressed air; and bus wash systems. The bays are equipped with controlled trench drains for the removal of oils and wastewater during cleaning operations. All building M&E systems are provided with a web-based BAC system.

Electrical Engineering: For each of the concept options, AECOM developed the electrical systems concepts sufficiently to establish their feasibility and comparative capital and operating costs. The site was provided with 300 and 1250kW backup diesel generators, for maintaining critical functions during a general power outage.

Site /Campus Security: Site lighting and landscaping were designed to provide visibility for security of personnel. The existing CCTV cameras, used to view key points throughout the property, were upgraded. Design of buildings and site features incorporated safety and security through the use of CPTED

principles. All Emergency Exits Only doors were outfitted with warning buzzers (Piezo) to alert staff when doors are opened.

Specialized Equipment: AECOM specified and provided all necessary infrastructure for specialized equipment including: two and three-post hoists able to accommodate 9m, 12m or 18m buses; high-volume diesel fuel dispensers; drive-through bus washers; vacuum units for interior bus cleaning; a forced air heating system for drying cleaned bus interiors; 5-tonne travelling bridge cranes; a controlled environment room for HVAC analysis and repairs; a "clean" room for electronics diagnostics and repair; a bay equipped with frame straightening equipment; a self-contained spray paint booth with capacity for 18m buses; a small spray paint booth for parts; tailpipe exhaust systems throughout busses; and a secure sally port to accommodate, fare box coin movements.



For more information, contact:

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