

TO:	CHAIR AND MEMBERS CIVIC WORKS COMMITTEE MEETING ON SEPTEMBER 25, 2018
FROM:	KELLY SCHERR, P.ENG., MBA, FEC MANAGING DIRECTOR ENVIRONMENTAL & ENGINEERING SERVICES AND CITY ENGINEER
SUBJECT:	BUSINESS CASE – SWITCHING TO COMPRESSED NATURAL GAS (CNG) WASTE COLLECTION VEHICLES

RECOMMENDATION

That, on the recommendation of the Managing Director, Environmental & Engineering Services and City Engineer, the following actions **BE TAKEN**:

- a) Civic Administration **BE AUTHORIZED** to proceed with the Compressed Natural Gas (CNG) vehicle switching project by purchasing CNG waste collection vehicles as per the vehicle replacement schedule;
- b) Civic Administration **BE AUTHORIZED** to negotiate a CNG purchase agreement with Union Gas at the Highbury Road South and Highway 401 (Flying J) fuelling station;
- c) Civic Administration **BE AUTHORIZED** to spend up to \$1,382,625 on facility modifications for the Exeter Road Operations Centre (EROC) Fleet Maintenance Facility to be CNG compliant and any City-specific capital upgrades to the fast fill CNG waste collection vehicles at the Highbury Road South and Highway 401 (Flying J) fuelling station as part of the agreement noted in b) above;
- d) Civic Administration **BE AUTHORIZED** to undertake all administrative acts in regard to project development and implementation;
- e) the Civic Administration **BE AUTHORIZED** to revise the sources of financing for the previously approved capital project ME1208 – CNG Fuel Switching Project as set out in the Source of Financing Report attached, hereto, as Appendix A; and
- f) Civic Administration **BE DIRECTED** to report back on progress on this project to the Civic Works Committee in late 2019.

PREVIOUS REPORTS PERTINENT TO THIS MATTER
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Relevant reports that can be found at www.london.ca under City Hall (Meetings) include:

- Ontario Municipal Greenhouse Gas (GHG) Challenge Fund Transfer Payment Agreement for Phase 1 – Fuel Switching Project – Diesel to Compressed Natural Gas (CNG) Transition, March 19, 2018 meeting of Civic Works Committee (CWC).
- Municipal Greenhouse Gas (GHG) Challenge Fund Applications, October 24, 2017 meeting of CWC, Agenda Item #15.
- Community Energy Action Plan – Update and Status, August 29, 2017 Civic Works Committee, Agenda Item #11.

STRATEGIC PLAN 2015-2019

Municipal Council has recognized the importance of solid waste management, climate change and other related environmental issues in its 2015-2019 - Strategic Plan for the City of London ([2015 – 2019 Strategic Plan](#)). With respect to this CWC Report, three of the four Areas of Focus address fleet greening activities:

Building a Sustainable City

- Strong and healthy environment
- Robust infrastructure

Growing our Economy

- Local, regional, and global innovation
- Strategic, collaborative partnerships

Leading in Public Service

- Proactive financial management
- Innovative & supportive organizational practices
- Collaborative, engaged leadership
- Excellent service delivery

SUMMARY

The business case supports moving to compressed natural gas (CNG) for the City's waste collection vehicles based on the following benefits:

1. The business case has identified that under the expected case, the average annual savings to the City will be \$79,000. This includes paying back the capital loan (plus interest) of \$1,382,625 to the Efficiency, Effectiveness & Economy (EEE) Reserve over an 8 year period. Savings per year increase after the loan is repaid.
2. Cheaper fuel costs, less than half the cost of B5 biodiesel that is currently used for the Waste Collection Fleet. As each vehicle is replaced with a CNG powered unit, it will save \$8,750 annually in fuel costs with total expected fuel saving of \$322,500 annually once the entire fleet of waste collection vehicles is replaced by 2025. This is included in the savings identified in 1. Above.
3. Funding for Green Fleet initiatives that support alternative fuel solutions has been set aside in the capital program.
4. CNG vehicles are significantly cleaner, reducing greenhouse gas (GHG) emissions from the 37 diesel waste collection vehicles by about 200 tonnes annually (a reduction of 12%), and significantly reducing tailpipe emissions of fine particulate matter (about 50% reduction) and nitrogen oxides (about 90% reduction).
5. CNG vehicles operate much quieter than diesel vehicles.
6. Project is in line with future plans to produce and utilize renewable natural gas (RNG) from the W12A Landfill to further reduce GHG emissions by blending this RNG into the CNG used as fuel.
7. Current opportunity to partner with Union Gas and the private sector in the development and use of an off-site, privately owned and operated CNG fuelling station that provides enhancements to our waste collection service and environmental, economic, and social benefits to London. For example, the development and use of the off-site, privately owned and managed fast fill CNG station strategy provides a sound model for moving to an alternative source of transportation fuel without significant upfront capital and ongoing operating expenditures associated with building, operating and managing our own CNG refueling system.
8. Project provides opportunities for economic growth and development in the London area as the CNG fuelling station will be open to the public and other commercial fleets making CNG more commercially available close to Highway 401. It will also be available to transport trailers using the 400 series highway corridors between Quebec and destinations in the United States.

As with any change in process, it comes at a cost and with risks and challenges as follows:

1. Fuel switching to compressed natural gas requires upfront capital to modify the existing waste collection repair garage at the Exeter Road Operations Centre (EROC) to provide adequate safety and environmental controls. Feasibility and engineering work has been done and \$681,125 has been budgeted for this work.
2. Capital investment is also required for off-site, fast fill refuelling infrastructure and to support a defuelling system at EROC. The investment in the start-up provides the City of London a service level agreement, priority fuelling lanes during peak periods and a reduced pricing for the CNG fuel. The refuelling capital investment budget has been set at \$701,500. Further analysis will occur on this work in relation to defuelling, preferred locations for capital investments and fuelling optimization.
3. CNG waste collection vehicles are more expensive and will cost an estimated \$50,000 more per vehicle due to the chassis design, tanks and specialized Cummins Westport CNG Engines. Over the seven year transition period the additional capital required for the entire waste collection fleet (37 units) above the amount allocated in the Vehicle and Equipment Reserve is \$1,850,000.
4. There are modest operational impacts expected as crews and technicians will require additional training and time to adjust to the CNG trucks and become accustomed to new work procedures and fueling protocols.
5. As a long term potential impact there could be a slight reduction in the salvage value for CNG waste collection trucks locally at end of life.

Moving to CNG for the City's waste collection fleet is a viable and sustainable choice for London. There are upfront capital cost required for startup and ongoing for the vehicles however the investment is recoverable over time as CNG fuel has significantly lower fuel costs.

The transition supports our own strategic priorities of innovation, healthy environment, and climate change reduction strategies. CNG vehicles will reduce hundreds of tonnes of GHG emissions annually from entering the atmosphere and removes harmful pollutants and carcinogens.

Making this investment in CNG now will allow the City to be ready and aligned to move to RNG in the future. RNG opportunities from landfill gas and further waste diversion strategies creates an optimal situation as waste is turned into fuel and used to power the waste collection fleet.

The proposed CNG fuel switching plan also supports local partnerships and economic opportunities. Working with Union Gas and Clean Energy in the development of a local commercial CNG refuelling centre at the Flying "J" (Highbury Road South and Highway 401) opens up great opportunities for London in their efforts to promote low carbon choices and be "open for business" by exhibiting a culture of change, innovation and economic growth in the transportation sector.

BACKGROUND

PURPOSE

The purpose of this report is to provide Civic Works Committee and Council with the business case that supports switching the current waste collection vehicles fuelled by diesel to waste collection vehicles fuelled by compressed natural gas (CNG) as new collection vehicles are needed.

CONTEXT

Examining and/or implementing CNG as a fuel, potential costs savings, environmental and health benefits, etc. are captured in two documents (Community Energy Action Plan and Council's Strategic Plan) and through Council direction as follows:

Community Energy Action Plan (2014 – 2018)

Promoting the use of CNG as a vehicle fuel is referenced in a number of locations within the Community Energy Action Plan (CEAP):

Policy Support for Community Energy Action Planning – under Stakeholder Actions:

6. *Union Gas, as described in Your Partner in Integrated Energy Planning, will promote:*
 d. *Transportation – natural gas transport and fleet vehicles*

Vehicles and the Transportation System – under Key Strategies for the City of London to 2018:

4. *Work with Union Gas to promote the use of compressed natural gas (CNG) and renewable natural gas (purified biogas) as a substitute for diesel fuel for heavy-duty vehicles in London.*

Vehicles and the Transportation System – under Stakeholder Actions:

5. *Union Gas will:*
 b. *Work with major local fleet operators (e.g., City of London, London Transit, private sector) to encourage the use of CNG in “return-to-base” fleet vehicles*

Council Strategic Plan (2015 – 2019)

Examining fuel choices, environmental and health benefits, and cost savings is specifically identified in several areas of Council's Strategic Plan:

Building a Sustainable City of London

1. Robust Infrastructure
 E. Fund innovative ways to adapt to Climate Change

Building a Sustainable City

3. Strong and healthy environment
 B. Reduce fuel use through innovation and research

Growing our Economy

3. Local, regional and global innovation
 B. Lead the Development of new ways to resource recovery, energy recovery and utility and resource optimization with our local and regional partners to keep our operating costs low and assist business with commercialization to help grow London's economy

Leading in Public Service

5. Excellent service delivery
 A. Continue to effectively and efficiently deliver nearly 100 services that Londoners rely on each day

Recent Council Direction

The role of CNG and renewable natural gas (RNG) has been a topic of discussion and direction with Council on a number of occasions. These are the most recent directions:

RNG – City Council, October 11, 2016

12. *Landfill Gas Utilization Update and Next Steps (Relates to Bill No. 371)*
 d) *the Civic Administration BE DIRECTED to examine renewable natural gas production as the preferred option for utilization of the remaining volume of landfill gas at the W12A Landfill; and*
 e) *the Civic Administration BE DIRECTED to report back to the Civic Works Committee on the options for the production of renewable natural gas from landfill gas;*

CNG – City Council, January 17, 2017

13. Updates: Garbage and Recycling Collection and Next Steps

b) the Civic Administration BE DIRECTED to report back to Civic Works Committee by December 2017 with:

- i) a Business Case, including a detailed feasibility study of options and potential next steps, to change the City's fleet of garbage packers from diesel to compressed natural gas (CNG); [and]*

CNG – City Council, March 27, 2018

18. Ontario Municipal Greenhouse Gas (GHG) Challenge Fund Transfer Payment Agreement for Phase 1 - Fuel Switching Project - Diesel to Compressed Natural Gas (CNG) Transition

a) the proposed by-law, as appended to the above-noted staff report BE INTRODUCED at the Municipal Council meeting to be held March 27, 2018 to:

- i) authorize and approve the Transfer Payment Agreement, as appended to the above-noted by-law, to be entered into between Her Majesty the Queen in Right of Ontario, as represented by the Minister of the Environment and Climate Change for the Province of Ontario and The Corporation of the City of London, for the provision of funding of a fuel switching project to transition from diesel to compressed natural gas for London under the Ontario Municipal GHG Challenge Fund;*

To address Council direction this CWC report is divided into two sections, key questions and a business case. The following key questions are answered in Attachment A:

1. What are the general advantages of switching from diesel-powered waste collection vehicles to CNG-powered vehicles?
2. What are the general disadvantages?
3. Why CNG is being considered for the City of London?
4. What fuel options were considered for the waste collection vehicles?
5. What about past concerns of using CNG as a fuel?
6. What are the fueling options for CNG vehicles?
7. How will the London vehicles be refuelled?
8. How will the vehicles be maintained?
9. How will CNG waste collection vehicles be procured by the City?
10. What additional capital costs will be incurred for CNG vehicles?
11. What are the operating cost comparisons?

In the discussion section below, a business case is presented.

DISCUSSION – BUSINESS CASE

The business case is presented below under the following headings:

1. Environmental Considerations
2. Social Considerations
3. Financial Considerations
4. Sensitivity Analysis
5. Risk Analysis and Mitigation

The key capital and operating parameters of the business case include:

- CNG vehicles (capital) - are approximately \$50,000 more per vehicle than their equivalent diesel counterpart. Converting 37 units at \$50,000 extra per truck results in a premium of \$1,850,000 for using CNG compared to diesel vehicles.
- Garage and fuelling station modifications (capital) – upfront capital to modify the existing waste collection repair garage to provide adequate safety and environmental controls (estimated at \$681,125). Investment is required for refuelling infrastructure and to secure adequate capacity and equipment to service the waste collection service needs (estimated at \$701,500). A combined budget of \$1,382,625

has been allocated to this work. Final details of the location of the work components will take place in the next phase of the project (e.g., final engineering designs, equipment layout, discussions with Union Gas, etc.)

- Fuel savings by switching from B5 biodiesel to CNG (operating) – pricing for CNG will be in the range of \$0.50 per diesel litre equivalent (DLE) versus B5 biodiesel at \$1.15 per litre.
- Other operating costs – for the purpose of this analysis, minor costs savings on vehicle maintenance are offset by potentially some additional costs on refuelling at an off-site station on some waste collection days.

1. Environmental Considerations

Once all 37 CNG waste collection trucks are in place, it is estimated that the switch from B5 biodiesel to CNG will reduce annual fleet GHG emissions by around 200 tonnes per year. This represents a 12% reduction in waste collection GHG emissions and a 3% reduction in overall fleet GHG emissions.

Using CNG as a fuel will also have significant air pollutant emission reductions, with an estimated 50% reduction in tailpipe fine particulate emissions, 90% reduction in nitrogen oxides, and the elimination of emissions of sulphur dioxide, diesel soot, and polycyclic aromatic hydrocarbons.

Even more attractive is that the movement to CNG is a precursor to using RNG produced from methane collected at landfills and from organic waste streams for use as fuel for the City's waste collection vehicles. RNG almost completely eliminates GHG emissions. It is estimated that the waste collection trucks would only use a small portion (up to 7%) of the estimated RNG produced that could be produced from the W12A Landfill.

Future plans to divert organic waste from the landfill could also include the use of anaerobic digesters to produce additional biogas to increase RNG production.

2. Social Considerations

CNG waste collection vehicles will enhance quality of life in our communities by producing less noise than diesel trucks when operating through residential neighbourhoods during collection cycles. This is an important feature for waste collection service delivery especially during early morning waste pickup.

Municipal adoption of alternative fuels, fuel switching and low carbon initiatives demonstrate leadership and confidence around change. Being a front runner in the community and among municipalities gives us an opportunity to have conversations about low carbon choices, improved air quality and reducing the impacts of climate change.

Businesses will watch closely as adoption and infrastructure become more readily available, enabling them to move into low carbon alternative fuel space in the transportation sector over time.

Adopting alternative fuel strategies is good for future generations and promotes social responsibility and culture change toward conservation and accountability.

3. Financial Considerations

In March 2018, via Council approval, a budget of \$1,382,625 was established for the CNG Fuel Switching project in conjunction with the Municipal Greenhouse Gas (GHG) Challenge Fund (GHG Challenge Fund). At that time, 50% (\$691,313) of the project estimate was funded by the City of London via the Efficiency, Effectiveness & Economy (EEE) Reserve, while the other 50% (\$691,312) of the project was funded by the province. Cancellation of the provincial Cap & Trade program, which supported the GHG Challenge Fund, has resulted in the loss of the provincial funding.

In the recommended option, funding in the amount of \$691,312, is available via an additional drawdown from the EEE Reserve which continues to be the recommended source of financing given the nature and benefits of the proposed project. All (100%) of the amount borrowed from this reserve will be paid back with interest at the City's internal borrowing rate which is the bank prime lending rate less 1.38%. Currently the bank prime lending rate is 3.7% which would result in an internal borrowing rate of 2.32%. The amount borrowed will be paid back through annual savings realized in fuel and maintenance costs. This approach is consistent with the LED Street Light Upgrade project which is funded via the EEE Reserve and generates a return for the City. The estimated payback period for the current CNG project is 8 years assuming annual savings materialize as forecasted.

The business case to proceed with this project weighed the following options:

- a. Option 1 - Business-as-Usual – Continue operating with diesel vehicles.
- b. Option 2 - 100% City Funded – Switch to CNG fuel vehicles over 9 years and fund the entire project with internal sources of financing.
- c. Option 3 - 50% FCM Grant + Loan – Switch to CNG fuel vehicles over 9 years via external financing that is available from the Federation of Canadian Municipalities (FCM) Green Municipal Fund (GMF) Grant and Loan Program. The City would still fund its original 50% of the project as established in March 2018.

Through the options analysis, Civic Administration investigated the potential of acquiring a grant from the FCM GMF low-interest loan and grant program. Under the terms of this program the City would also have to accept a substantial loan for which there is no identified need and subsequently pay interest over a 10 year period. The projected total of these interest costs exceeds the value of the grant that would be received to replace the lost GHG Challenge Fund financing. Due to these facts and the results illustrated in Table 1 below, this option was not recommended.

The options analysis concluded that Option #2 is the best course of action for the City at this time. While this option requires approval of additional capital funding from internal sources it also results in the best overall financial outcome. Table 1 illustrates the results for each option considered.

Table 1 - Operating Budget Impacts Over 10 Years

	Option 1	Option 2	Option 3
	Business-as-Usual	100% City Funded Switch to CNG	50% FCM Grant + Loan
Avg. Annual Tax Levy Impact ¹	0.28% ²	0.27% ³	0.34% ³
Avg. Annual Operating Savings (Expense)	\$0	\$ 79,000 ⁴	\$ (332,000) ⁴

Notes:

1. Based on the approved 2018 Annual Update - Tax Supported Revised Net Budget.
2. Included in the current operating budget. Current diesel fuel & maintenance expenses quantified for comparative purposes to establish the baseline.
3. Includes 100% payback of the EEE Reserve.
4. This is the average annual savings / (expense) versus Business-as-Usual (includes payback of the EEE Reserve).

The financing approved in March 2018, and being requested above, is to replace the lost GHG Challenge Fund financing for refuelling station infrastructure and CNG compliant maintenance/repair facility upgrades. Funding for the 37 CNG vehicles is available in the current 10 year capital plan. This includes funding for the \$50,000 per vehicle premium of a CNG model over diesel. These costs have been incorporated into

the analysis of each option. Table 2 summarizes the capital investments of the recommended options.

Table 2 – Capital Investments – 100% City Funded Switch to CNG

	Option 1	Option 2
	Business-as-Usual	100% City Funded Switch to CNG
Filling Station & Maintenance Facility	\$0	\$1,382,625
Diesel Vehicle Replacement	\$10,826,000	\$10,826,000
CNG Vehicle Premium	\$0	\$2,100,000 ²
TOTAL (Over 10 Years)	\$10,826,000	14,308,625

Notes:

1. All amounts currently included in the current ten year capital plan.
2. This includes \$250,000 to replace the first 5 CNG vehicles purchased in 2019. The funding included in the current capital plan in 2028 is based on replacement of diesel vehicles that would no longer exist. The total premium to replace the current 37 diesel vehicles remains \$1,850,000 as noted above.

4. Sensitivity Analysis

A sensitivity analysis was carried out using the following scenarios with the results of each presented in Table 3:

- Best-case: \$133,000 lower fuel station and maintenance facility cost, 10% lower CNG vehicle cost premium, 10% higher CNG fuel savings over diesel
- Worst-case: 20% higher CNG vehicle cost premium, 20% lower CNG fuel savings over diesel; no federal carbon tax

Table 3 - Operating Budget Impacts – Sensitivity Analysis Results

	Option 1	Option 2 Expected Case	Option 2 Best Case	Option 2 Worst Case
	Business-as-Usual	100% City Funded Switch to CNG	100% City Funded Switch to CNG	100% City Funded Switch to CNG
Avg. Annual Tax Levy Impact ¹	0.28% ²	0.27% ³	0.25% ³	0.30% ³
Avg. Annual Operating Savings (Expense)	\$0	\$ 79,000 ⁴	\$ 181,000 ⁴	\$ (103,000) ⁴

Notes:

1. Based on the approved 2018 Annual Update - Tax Supported Revised Net Budget.
2. Included in the current operating budget. Current diesel fuel & maintenance expenses quantified for comparative purposes to establish the baseline.
3. Includes 100% payback of the EEE Reserve.
4. This is the average annual savings / (expense) versus Business-as-Usual (includes payback of the EEE Reserve).

This analysis shows that both the expected and best case scenario's benefit the City financially. The worst case scenario could result in an additional \$103,000 annually over 10 years to operate the new CNG facility, fuelling station and vehicles. This potential cost would still be offset by the qualitative benefits of undertaking a project of this nature.

5. Risk Analysis and Mitigation

Several United States and Canadian municipalities and waste collection contractors have successfully moved to CNG for their waste collection vehicles. The design and costs of these projects are quite often unique but share some common risk factors and best practices for implementation. Several barriers to adoption were considered for the business case and are summarized below:

- Escalation of costs for implementation above budget
- Price certainty of CNG fuel
- Business continuity CNG refuelling site
- Poor reliability of CNG units
- Impact on operational efficiency and reliability
- Safety of CNG

The model being proposed for London has a number of unique features that reduce risk and insulate the City against the major adoption concerns above:

- Escalating cost of implementation – A significant amount of work has been done to ensure that the real cost have been fairly evaluated. The start-up costs of the refuelling site, the repair facility modification and the CNG truck designs have been researched and several assessments completed and analysed to predict the real costs.

The off-site refuelling infrastructure proposal reduces the initial capital investment required so will immediately provide cost control. In addition, the fuelling site will be owned, operated and managed independently, so it relieves pressure and provides protections from escalating costs for items of a CNG system like compressors, dryers, compounds, service, maintenance, and energy costs.

In terms of the controlling the expense of outfitting the repair facility standard practices will be used to spec and select vendors and products for the work. Union Gas and Clean Energy have been working closely with City engineering and technical staff to design a layout that meets safety and code requirements however is appropriately outfitted for the City's purpose. The use of a defuelling system is key to mitigating the expense of significant building modifications and is part of the scope of work that Union Gas is doing as part of the refuelling infrastructure investment.

- Price certainty of CNG fuel – fuel as a whole is a volatile market and price certainty can be difficult to predict actual costs. The fact that the refuelling strategy operator (Clean Energy) is closely connected the utility authority (Union Gas) provides security and assurances.

There are factors beyond the control of the supplier like provincial or federal taxation (fuel tax for road and infrastructure investment for example) that could be a threat to the pricing model set forward in the model. Future fuel agreements would need to be negotiated and locked in once the project is approved. The success of the program depends on the price for CNG so this will be closely monitored. Fleet analysts review fuel pricing and fuel usage data daily and fuel management is a critical piece of the rental rate and fleet budgetary processes.

- Business Continuity should the CNG refuelling site go down – The project team has considered the impact to service should the off-site fuelling centre go off line for any reason. During the early stages of the project with the phased in approach of the fleet vehicles (5 to 7 units at a time starting in 2019), the risk of serious service interruption is low. However as the fleet transition expands, the risk increases.

The partners understand the demand for service on the waste collection vehicles and will be required to provide contingencies and service level agreements as part of the refuelling service agreements. The continuity plan will include identifying contingencies like alternative service suppliers to fill the short term need and mobile CNG fuelling. In addition, the on-site defuelling system at the repair facility will be designed to be able to do some slow fill refuelling in emergency circumstances.

- Poor reliability of CNG units – During the late 1990's and early 2000's there were situations where early adopters of CNG were frustrated with the performance of natural gas engines. In some cases this resulted in discontinued use of natural gas and significant expense to decommission systems and return to diesel powered units.

City staff have reviewed and discussed these issues and for the most part the problems stemmed with the first generation natural gas engine technology. The CNG engines were basically retrofitted diesel engines with conversion systems. The current technology has undergone several iterations and now the industry standard are not conversion systems but purpose-built CNG engines that are warrantied and approved for use in all the major truck manufacturers that build CNG vehicles. This specialization provides greater certainty, reliability and expertise. Failure analysis and reliability will be key during the initial stages of the implementation to ensure that the service level, reliability and performance is maintained.

- Impact on operational efficiency and reliability – Moving to a model of off-site fuelling will have some operational impacts. There is expected to be additional travel required on certain collection days and the risk of running out of fuel or low fuel in the operational facility or on the road. To mitigate these risks protocols and refuelling procedures will be developed as well as a small defuelling/fuelling system at the operations facility as a back-up. The defuelling system is also a critical piece on the repair facility strategy to reduce costs for building outfitting and manage safety controls and energy costs.

In consultation with the service area and other CNG adopters, it is anticipated that there will not be any significant operational disruptions directly as a result of the transition to CNG. It should be expected that there will be some logistical concerns and items that will require refining but nothing that would be problematic to service delivery or the project. Moving to a model of off-site fuelling will have some operational impacts which could include additional travel time on certain collection days or the risk of running out of fuel in the operational facility or on the road. However, these concerns will be mitigated through training, route optimization and strict refuelling procedures and protocols.

The CNG fuel station will be upgraded and designed with the City's investment to minimize the fill time to that comparable to a standard diesel vehicle. This requires additional compression and horsepower as a full time operating engineer at the site at least 8 hours per day. There has been assurances that the design will ensure that the tanks will be filled to meet our requirements even in back to back fill situations at peak periods.

- Safety of CNG - CNG is a clean safe fuel and has been successful as a transportation and heating fuel across the country for decades. However, the properties of natural gas versus traditional diesel and gasoline powered vehicles are different and require special controls. Natural gas used as a transportation fuel has a number of features that actually enhance safety. First, natural gas has a lower specific gravity than air, therefore it is lighter than air, so if there was an unexpected release the gas is going to up and away from the source. Diesel on the other hand, being a liquid fuel, if it is spilled or released it pools around the vehicle. Second, the tanks that the CNG is stored in on the vehicle are very robust and are more resistant to failure or damage than a standard diesel tank. Lastly, CNG systems and tanks have pressure release valves that allow the gas to be released in a controlled way should there be excessive pressure conditions in the tank from things like a collision or a fire.

To mitigate the risk at the EROC repair facility, several modifications will occur. The building design and control program has been assessed through consultants and engineers to ensure the building will have the appropriate safeguards to operate as a CNG repair facility.

All the current Motor Vehicle (repair) Technicians have Alternative Fuel Certification. They will also receive additional training on the specific units once purchased through the manufacturer. The building control and safety systems will be outfitted to ensure that adequate controls are in place to ensure Technician safety while service the CNG units.

Waste Collection Operators are not expected to have any additional risk as part of moving to CNG vehicles. They will however receive very specific training and safe operating procedures for CNG operations and for refuelling the vehicles and emergency procedures.

ACKNOWLEDGEMENTS

This report was prepared with assistance from Jason Davies, Alan Dunbar, Laurie Green and Janice Verhaeghe, Financial Planning & Business Support.

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Appendix A Sources of Financing

Attachment A Questions and Answers of CNG Vehicles and Switching to CNG as a Fuel

c Anna Lisa Barbon, Managing Director, Corporate Services & City Treasurer, Chief Financial Officer

ATTACHMENT A

Questions and Answers of CNG Vehicles and Switching to CNG as a Fuel

1. What are the general advantages of switching from diesel-powered waste collection vehicles to CNG-powered vehicles?

- The average annual operating budget for waste collection vehicles is estimated to be \$79,000 lower with the use of CNG as a vehicle fuel, which would reduce the average annual tax levy by 0.01%.
- Help the City of London become a cleaner and environmentally friendly City.
- Natural gas is an accessible, plentiful and relatively low cost energy source in Canada.
- Investment in innovation and cleaner fuels could bring additional economic value and technology opportunities to London and region, enhancing growth and business development.
- CNG is a cleaner burning fuel than diesel. CNG-powered vehicles produce an estimated 10% lower greenhouse gas emissions (GHGs), 50% lower particulate matter (PM) emissions and 90% lower nitrogen oxide (NO_x) emissions than diesel-powered vehicles. It also eliminates emissions of hazardous air pollutants, namely diesel soot, which is a known carcinogen.
- The price of CNG, as a fuel, has typically been 35% to 45% lower than diesel. Longer term estimates from the U.S. Energy Information Administration suggests that the price of diesel is going to increase annually at about 6% versus 2% for CNG.
- Natural gas will provide cost and risk control to the new federal carbon tax systems being planned to start in 2019.
- The City may be able to create renewable natural gas (RNG) from landfill gas at the W12A Landfill that could be used to directly or indirectly fuel the garbage packers.
- CNG-powered collection vehicles produce between 10% and 15% less noise than diesel-powered vehicles.
- CNG-powered vehicles are equipped with onboard gas detectors and other safety devices such as tank safety valves.
- Natural gas is lighter than air. Therefore, it will not pool as a liquid or vapour on the ground as it will rise and disperse rapidly. This eliminates environmental concerns around contaminating solid and groundwater from diesel fuel spills and leaking diesel fuel storage tanks.
- Natural gas has a higher ignition temperature than diesel or gasoline; therefore, it is much harder to ignite.

2. What are the general disadvantages?

- Significant capital outlay for both fuelling infrastructure and vehicle equipment assets.
- Fleet maintenance facilities will require capital upgrades to meet the regulatory requirements of the Technical Standards & Safety Authority (TSSA).
- From purely an economic perspective, the CNG investment in infrastructure assets will not reach a return on investment for many years, likely not until the second generation of CNG waste collection trucks are introduced or increasing the number of City high-mileage fleet vehicles to convert to CNG.

- CNG-powered heavy duty vehicles currently have initial capital outlay of up to \$50,000 more per vehicle than equivalent diesel-powered vehicles to cover engine technology, chassis design and CNG fuel tanks.
- One CNG fuelling system is currently being developed in London. The limited availability of stations does pose challenges for fleet operators. Similar challenges have been experienced in the electric vehicle market which are currently being overcome through strategic partnerships and user networks.
- Currently the natural gas fuel market has not been exposed to some taxes that diesel fuels have like the federal and provincial fuel excise taxes. If these taxes eventually flow through to natural gas prices this will lessen the current pricing advantage over time.
- The purchase price, maintenance costs, fuel stability and salvage values of CNG-powered collection vehicles are not established, which increases the risk and potential impact to internal rental rates.
- Compared to diesel powered vehicles with a long track record in all Canadian seasons, there is much less experience with CNG-powered vehicles in cold weather climates.

3. Why CNG is being considered?

The City's Solid Waste Collection area provides the majority of curbside waste collection for London. This service also includes collection routes that include bulk lift collections at various high density residential dwellings and apartments and Western University.

Several years ago, City staff began assessing greenhouse gas (GHG) reducing options through the exploration of CNG as an alternative fuel for the City of London's waste collection fleet (37 trucks) that use roughly 600,000 litres of B5 blended diesel fuel (5% biodiesel, 95% diesel) annually. Although this blend produces fewer emissions, it does have its own challenges. For example, B5 blended diesel fuel comes at a premium of between 5 and 7 cents per litre. Also, biodiesel supply has had inconsistent availability in the coldest months, has incurred several delivery challenges for the distributor and at times we have received poor quality biodiesel (clouding) despite the relatively low bio blend. This limits the ability to increase the biodiesel content.

More than half of new waste collection trucks in North America run on CNG instead of diesel. Conversion of a fleet from diesel to CNG results in lower GHG emissions and less annual fuel costs; however, significant initial investment is required to modify garages, install fuelling stations and buy CNG trucks.

CNG is a common solution for waste collection fleets because the operation of waste collection usually involves longer daily distance travelled, and thus is critically reliant on fuel and the cost of that fuel for its service delivery performance. CNG can provide relief from the expensive and volatile diesel fuel market. Additionally, CNG waste collection vehicles provide significantly quieter operation and produce fewer GHG and smog-forming emissions. In addition, many waste collection suppliers that have returned to base operations have also opted for an onsite slow fill CNG alternative which provides greater savings and increase tank filling capacity.

Perhaps the most compelling reason for CNG in waste collection fleets is the direct link between waste disposal and the ability to transition seamlessly into renewable natural gas (RNG) over time. The complete cycle of curbside waste being turned into RNG and powering the waste collection vehicles is a very attractive scenario. Some collection operations have not only switched to CNG vehicles, but are also producing RNG from their waste streams and using it to fuel their vehicles. EBI in Quebec is one, the City of Surrey, BC is another. Toronto has begun moving to this solution as well. Using 100% RNG as a fuel would result in about 90% reduction in GHG emissions from waste collection vehicles.

4. What fuel options were considered for the waste collection vehicles?

Three fueling options were considered; CNG, RNG and electricity versus biodiesel and regular diesel. Each was assessed against basic operational requirements determined in consultation representatives of Fleet procurement, maintenance, asset management, solid waste collection, solid waste disposal and environmental programs (air quality).

Basic operational requirements to successfully perform the function of collection operations in London are:

- Sufficient power, range and operational speed to complete routes. London needs vehicles that can travel 150 km with one fill and have a capacity of roughly 10 tonnes)
- Reliable vehicles (maintain “up time”; no need for more back up units; reliable in cold weather conditions)
- Reasonable maintenance regime (parts, tech training, scheduling)
- Dependable accessible supply of fuel (on-hand supply in case of emergencies, and ability to fuel during power outages)
- Acceptable noise levels (no louder than status quo)
- Safe operation (meets applicable safety standards)
- Staff and public acceptance (comfort with safety and noise levels)

CNG/RNG

CNG meet these requirements. Renewable natural gas (RNG) would meet these same requirements; however there is limited supply available at this time. RNG blended with CNG is a scenario that can work technically however the pricing structure is unknown.

Electricity

Electric waste collection trucks are relatively new and use has been limited. Currently, there are no electric waste collection trucks that can meet City requirements of eight to ten hours continuous work time, operation in severe winter conditions, and accommodate travel distances required for a full day of collection services.

The two known examples of electric powered collection trucks reviewed were in Los Angeles and Chicago. These units however have only 4-ton capacity (about 3.5 tonnes versus a normal 10 tonne capacity required for our purposes) with a range of 100 miles (160 km). Further, the electric waste collection truck cost, due to the extremely limited number built, is \$1.2 million per truck, compared to \$280,000 for diesel trucks and \$330,000 for CNG trucks with a 10-ton capacity.

At this time the technology is not at the point it could meet London’s needs.

5. What about past concerns of using CNG as a fuel?

The 2014-2015 Canada Natural Gas Vehicle Market Report notes that conversion to CNG has been much greater in the US than in Canada, and part of that is access to appropriate natural gas supply. In Canada fleet managers could be suffering from ‘once bitten, twice shy’ syndrome as this is not the first time it has explored gas as a road transport fuel. Having invested once already in the late 1990s and early 2000s only to see oil prices collapse and investments wiped out, caution the second time around is understandable.

London Transit Commission’s Past CNG Experience

The LTC implemented CNG as an alternate fuel for its transit fleet in the early 2000s. It was discontinued based on reliability issues. The primary reason was engine issues that resulted in frequent breakdowns, service disruptions and road service calls. At the time these buses had first generation engine technology and since that time CNG engines have undergone significant refinement and technological advancements. The Cummins Westport CNG engine is now the industry standard and is available in most the major truck manufacturers as a factory build. The Cummins Westport CNG engine has provided much greater reliability, warranty and standardization.

6. What are the fueling options for CNG vehicles?

There are essentially three types of CNG fueling stations: slow (time) fill; fast fill and a combination of the two.

Onsite CNG “Return to Base” Slow (Time) Fill Systems

Slow (time) fill stations are used primarily by fleets and work best for vehicles with large tanks that refuel at a central location every night. The time it takes to fuel a vehicle depends on the number of vehicles, compressor size, and the amount of buffer storage. Vehicles generally take several hours to fill. The main industries taking up CNG are waste and transit fleets which consistently return to base (return to works yard) in the evenings. CNG fuelling is done parking stall style – the truck is parked, hooked up to the feeder hose, and left overnight (5 to 7 hours to refuel).

CNG Fast Fill Stations

CNG fast fill stations provide refuelling with service times similar to existing diesel refuelling. Generally, fast fill stations are best suited for retail situations or a combination of retail/dedicated contracts where vehicles of various sizes arrive as required and need to fill up quickly. These stations have a look and feel similar to traditional fuel stations. Fast-fill stations receive fuel from a local gas utility line at a low pressure and then use a compressor on site to compress the gas to a high pressure. Once compressed, the CNG moves to a series of storage tanks for dispensing. CNG can be delivered alongside gasoline or other fuel dispensers.

Combination Fill Stations

These CNG stations combine both slow fill and fast fill options to increase flexibility. These applications will be more common in areas that serve major highways (e.g., for use by transport fleets) and have additional space where vehicles can be parked for longer duration (e.g., to serve a fleet residing in an industrial park).

7. How will City of London waste collection vehicles be refuelled?

City staff examined two options; building a slow fill station at EROC and determining the availability of a fast fill stations in London.

Slow (Time) Fill System

Much of the cost of CNG filling station infrastructure is the compressors and storage tanks required. The home-base for London’s waste collection operations fleet is at the EROC Centre which does not currently have the required high pressure natural gas feed pipe that would be required to effectively install a fuelling station at this location.

A very preliminary cost estimate of a slow fill station at EROC indicated an investment of between \$1 and \$2 million just for the initial infrastructure and service capability. In addition to those initial cost the City would then have to incur the expense of CNG compression storage and dispensing equipment expected to be several more million as the capacity and demand increased.

This model was not recommended based on these costs, the increased risk and expense involved with operating and managing our own site, and this model did not offer the economic, social and public accessibility benefits of the fast fill off site model.

Commercially Available CNG Fast Fill Station

The London fast fill station was introduced by Union Gas over a year ago and is currently under construction. It includes three distinct partners: Clean Energy Solutions (a non-regulated company of Union Gas) as the CNG fuelling station operator, the Flying “J” Truck Stop (Highbury and Highway 401) which owns the property and Union Gas as the project coordinator and natural gas distributor and supplier.

In this scenario, the City of London would become an “anchor tenant” of the site as transition to CNG waste collection vehicles. The proposed Union Gas/Clean Energy/Flying J site presented an excellent opportunity for the City of London to have a local fuelling source within the city limits along a main transportation corridor. The refuelling supply and operation of the site allows the City to move into the CNG vehicle

transition on a planned and systematic way without the significant investment and ongoing maintenance of onsite compressors, dryer and dispensing equipment.

The partnership with Union Gas and their partners also provides lower pricing for the natural gas for the City of London (in the \$0.50 per diesel litre equivalent - DLE - range), dedicated fill lanes during peak refuelling times, extra compression and capacity to meet our needs along with support and technical advice for facility modifications, defuelling systems, and emergency back-up slow fill supply at the operations centre.

8. How will the vehicles be maintained?

CNG vehicles will be maintained and repaired at the Exeter Road Operations Centre (EROC). However, engineering and facility upgrades to the waste collection shop and welding bays are required to facilitate safe repairs and maintenance in those areas.

Natural gas is lighter than air, and therefore can pool in the ceilings of garages. Ceilings have lights, heaters, and electrical wiring that requires adjustment such that natural gas vehicles can be maintained indoors. Many organizations that have moved to CNG have had the benefit of a smaller garage that is dedicated to collections operations trucks exclusively and had simpler construction (City of Toronto), or are building brand new facilities and can design the garage with natural gas safety in mind from the outset (City of Calgary). However, London's collection fleet is maintained in a portion of the bays at the existing EROC which serves as a hub for the maintenance and repair for the waste collection fleet.

The fixed cost for engineering design work, defueling an slow fill systems, sensors, installation, heating and ventilating requirements vary depending on the type of work being done and what condition and configuration the existing building architecture, HVAC and electrical systems are in.

Previous technical consultant work for these modifications has estimated this work to be about \$690,000. Funding for some of the general upgrades to maintenance facilities was included in future periods of the capital plan. These savings will be redirected to pay back the amount being borrowed from the EEE reserve fund.

9. How will CNG waste collection vehicles be procured by the City?

Over the next 7 years, all City waste collection vehicles will reach end of life. One of the major advantages of using the Union Gas commercially available CNG fast fill station is that the City's plan can be phased in and aligned with the current vehicle replacement timeline and strategy. As older vehicles are replaced, there will be a shift from diesel to CNG. This will ensure that the life of the existing vehicles are optimized and full value is extracted. This also reducing the capital loss of retiring assets early, allows for smoother transition and less operation change and allows time to build knowledge, confidence and experience with the technology.

Purchases of CNG vehicles would occur as follows:

Number of Collection Vehicles	Expected Retirement Date
5	2019
6	2020
6	2021
6	2022
6	2024
8	2025

10. What additional capital costs will be incurred for CNG vehicles?

CNG vehicles are roughly \$50,000 more than their equivalent diesel counterpart. Converting 37 units at \$50,000 extra per truck results in a premium of \$1,850,000 for using CNG compared to diesel vehicles. Note that trucks are sourced from the United States, therefore changes in currency exchange rates can have a dramatic effect on price. The salvage remarketing value is not clear and needs to be considered as demand at this time is almost negligible. Therefore, the value of CNG trucks when it comes time for disposal may be lower than traditional waste collection vehicles.

11. What are the operating cost comparisons?

Fuel Costs

The fuel savings between diesel and natural gas varies with fluctuations in prices. One litre of diesel is equal to 1.032 cubic metres of natural gas; however natural gas engines are less efficient than diesel. For each litre of diesel used, 1.15 cubic metres of natural is used. Currently natural gas costs roughly 30 cents per cubic metre or approximately 50 cents per diesel litre equivalent, about half of the price of diesel when purchased in bulk.

Fuel System Operation:

Fleet Services operates an automated bulk diesel fuel site at EROC to serve all City services, EMS vehicles and assigned Fire and Police vehicles. The movement away from diesel fuel to CNG fuelling over the next 5 to 7 years will significantly reduce demand for diesel at the EROC site by about 600,000 to 700,000 litres per year.

The new CNG fuelling station will be externally operated and managed by Clean Energy. This is very valuable to the City of London as the responsibility and costs for the operation of the >150hp CNG compressor system falls to the fuel system operator.

Sites of this capacity require an on-site engineer at a cost of up to \$150,000 annually as per the current natural gas plant regulations. This provides cost avoidance for the City of London. For example, Toronto has three engineers to cover-off their two CNG fuelling stations.

The private CNG station model saves the City of London money, time and resources on energy and maintenance costs. The compressors for a CNG site like this could have electricity costs over \$50,000 annually and annual maintenance costs close to \$60,000.

The Flying J CNG station will have dedicated lanes for City waste collection vehicles during peak fueling times but will be open for the general public and other commercial fleets.

Switching from diesel to CNG will also mean fewer hours lost for staff and Fleet Technicians doing diesel engine “re-gens”. Diesel trucks have many starts and stops do not run hot enough at times to burn off particulate in their Diesel Particulate Filter (DPF) Therefore staff regularly need to ‘re-gens’ (vehicle is required to idle at 1500 rpm for 45 minutes to 90 minutes). This activity is required several times per week. CNG trucks do not have to go through this process. This additional capacity in operator time would be offset by the minor increase in time of driving to the Flying J CNG fuelling station.

Vehicle Maintenance

Vehicle maintenance, service and repair costs are reported to be similar or even slightly lower than their diesel counterparts by those municipalities and contractors who have transitioned from diesel to CNG.

Further, it is reasonable to project that in the future CNG engines will be less costly to maintain as the industry gains more experience, improves processes and becomes more efficient.