Public Works Garage

Service Delivery - Energy Audit – Final Report
Project Location: Township of Chapleau
Wood Project Number: BE20102014

Prepared for:

Township of Chapleau
20 Pine Street W. P.O. Box 129

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Prepared by:

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited
900 Maple Grove Rd, Unit 10, Cambridge ON, N3H 4R7

7 October 2020

Executive Summary

Public Works Garage Energy Audit

Wood PLC (Wood) was retained by the Township of Chapleau to conduct an energy audit on the Public Works Garage located at 30951 Panet St, Panet Township Ontario. An energy assesment consistent with ASHRAE Level 2 guidelines was conducted for the Faciity. The site visit associated with this project was conducted on July 29th, 2020 by Nathan Sokolowski.

The aim of this study was to analyze the current energy performance of the Facility, conduct an onsite energy assessment, and produce a list of Energy Conservation Measures (ECMs) complete with relevant Opinion of Probable Costs.

The summary table below presents a list of opportunties during the energy assessment of the site Facility along with estimated costs, savings, and simple payback.

Table E-1 Summary of ECMs

ECMs	Measure	Opinion of Probable Cost	Estimated Savings				Estimated Total Savings	Simple Payback
			Propane	Electricity	Demand	Maintenance		
		($)	(L)	(kWh)	(kW)	($)	($)	(Years)
ECM-1	Infiltration Reduction	7,200	3,309 20.5%	2,000 4.6%	1 5.8%	-	2,239	3.2
ECM-2	Temperature Control Set Points	5,100	1,146 7.1%	1,941 4.5%	5 26.2%	-	943	5.4
ECM-3	Vehicle Exhaust Hose	2,700	354 2.2%	6 0.0%	-	-	212	12.8
ECM-4	Lighting LED Retrofit & Control	6,600	(688) (4.3)%	9,918 22.9%	3 17.4%	100	1,024	6.4
Scenario 1		22,000	3,986 24.7%	13,480 31.1%	6 36.6%	100	4,286	5.1

Notes:

(1) It should be noted that the estimated savings associated with each scenario may not match the aggregated sum of the included measures evaluated separately. This is due to interactive effects between measures.

Wood has combined the measures recommended in this assessment report to present a strategic implementation scenario which consists of the following opportunities listed below:

Scenario 1, which contains:

- ECM-1: Infiltration Reduction;
- ECM-2: Temperature Control Set Points;
- ECM-3: Vehicle Exhaust System; and
- ECM-4: Lighting LED Retrofit and Control.
-

By implementing the recommended measures, the following potential savings may be anticipated relative to the simulated baseline year:

- 13,480 kWh (31.1%) of electricity savings; and
- 3,986L (24.7%) of propane savings.

Wood recommends that the Township proceeds with the following building management and behavioral opportunities:

- Re-commissioning;
- Baseboard Heater Maintenance:
- Staff Training and Occupant Awareness; and
- Procurement Policy.

Further analysis is required to determine the potential savings and costs of these measures more accurately. It is recommended that the Township move forward to review the potential to incorporate these measures into the existing site energy and environmental management strategy.

Table of contents

List of figures

List of tables

Acronyms and Abbreviations

ACH	Air changes per hour
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
BTU	British Thermal Unit
C	Celsius
CDD	Cooling Degree Day
CO_2e	Carbon Dioxide Equivalent
DHW	Domestic Hot Water
ECM	Energy Conservation Measure
EUI	Energy Utilization Index
ft	Feet
ft^2	Square feet
g	Gram
GJ	Gigajoule
HDD	Heating Degree Day
HP	Horse Power
HPS	High Pressure Sodium
HST	Harmonized sales tax
IRR	Internal Rate of Return
kW	Kilowatt
kWh	Kilowatt hour
L	Litre
LED	Light emitting diode
m	Meter
m^2	Square meter
MBH	Thousand BTU's per hour
NPV	Net Present Value
V	Voltage
W	Watt
Wood	Wood Environment & Infrastructure Solutions, Inc
U-Value	Thermal transmittance measured in BTU/(hr·ft^2·°F)

1.0 Introduction

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood) was retained by the Township of Chapleau (client) to conduct energy audits for six (6) township buildings. This report is specific for the Public Works Garage located at 30951 Panet St, Panet Township Ontario.

The assessment involved a review of approximately 606 m^2 (6,522 ft^2) of office space, equipment storage and a maintenace garage. This revealed the potential for the implementation of energy management measures which may improve the overall efficiency of the facility.

Our assessment methodology can be found in **Appendix A**.

1.1 PURPOSE

The Purpose of this project is to conduct an energy assessment on the Town's owned facilities to assess and determine energy usage for equipment/facility consumption and operational performance. The goal of the energy assessment is to provide recommendations based on behavioral, operational, facility, equipment performance and how the facilities can be improved to reduce energy consumption and overall operating costs. The assessment will identify both operating and capital improvements and provide a detailed analysis on simple payback and energy consumption reductions.

1.2 SCOPE OF ASSESSMENT

The detailed energy assessment consists of an on-site facility assessment, a utility analysis, and a detailed review and analysis of Energy Conservation Measures (ECMs). The energy assessment report is organized as follows:

- Facility description;
- Utility analysis and benchmarking;
- ECMs; and
- Conclusions and recommendations.

The Township of Chapleau provided the following documents to Wood for review:

- Utility records.

The following appendices referenced below provide further background that form part of this report:

- Appendix A – Assessment Methodology;
- Appendix B – Assest Details;
- Appendix C – Lighting Inventory;
- Appendix D – Modeling methodology
- Appendix E – Utility data summary

1.3 BACKGROUND

1.3.1 Client Information

The following table summarizes key client information related to this assignment.

Table 1-1 Key Client Information Summary

Customer Name	**Township of Chapleau**
Site Address	30951 Panet St, Panet Township Ontario
Contact Person	Ms. Charley Goheen
Contact information	cgoheen@chapleau.ca
Utility Provider	HydroOne
Account Number	200103730959

1.3.2 Acknowledgements

Wood would like to acknowledge the contribution of the Township of Chapleau and Facility staff who help was invaluable in completing this assignment.

2.0 FACILITY DESCRIPTION AND CONDITION

The following sections summarize the observations made during the site investigation.

2.1 OVERVIEW

The Facility was constructed in 1979 with roughly 425m^2 of vehicle garage and 180 m^2 of storage, shop, and office space. The department performs numerous services including refuse collection, waste management, road and sidewalk snow removal, street sweeping and cemetery internments. The department is also responsible for maintenance of roadways, sidewalks, bridge and culverts, as well as the storm water, water distribution and sanitary sewer systems.

The operation of the Facility is typically between the hours of 8am and 5pm. There are seasonal variations to the operating schedule which include midnight to 8am in the winter for snow removal and 4am to 5pm in the summer for infrastructure maintenance. The departments is staffed by a superintendent and approximately 7 employees.

Table 2-1 summarizes an overview of the building information

Table 2-1 General Building Information

Building Type	**Public Works Garage**
General Occupants	2-7
Gross Floor Area	606 m^2
Floors	1
Year Built	1979
Occupancy schedule	8am to 5pm

2.2 BUILDING ENVELOPE

The Facility is a single story slab on grade constructed with structural steel framing and sheet metal wall assemblies. The garage ceiling is 16ft high with an attic space above and pitched roof with asphalt shingles. The storage and shop spaces have an interior gypsum board finish with 8ft ceilings; The office is similar but with plaster and drop ceilings. The windows at the facility are single pane slider except for the office portion which has insulated crank casement windows. A window in the shop room has a cracked pane.

Select photos representative of the general building envelope construction and interior are presented below and captured under **Figure 2-1** in the table of contents.

Figure 2-1 Public Works Garage Site Photos

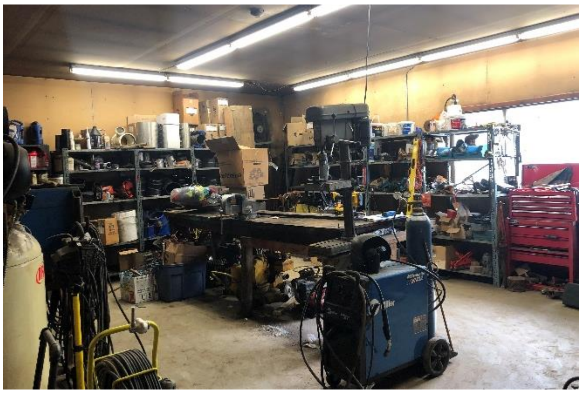
South-West façade

South-East Façade

Roof Shingles

Example of single pane window

Garage Interior



Shop

Office

2.3 MECHANICAL SYSTEMS

2.3.1 Heating, Ventilation and Air Conditioning

The garage is heated with four (4) propane fired Brandt Radiant Tube heaters that are 30 ft in length and rated at 75 MBH each. Each tube heater is controlled with a manual dial thermostat set between 12°C and 15°C (54 - 59°F). The garage is equipped with a 1/3 HP fan to exhaust vehicle fumes when needed.

The office, electrical room, and washrooms are heated with perimeter baseboard units controlled with manual thermostats to approximately 20°C (68°F). The shop contains a wall mounted electric heater that is operated manually when needed; Typically, the door is left open in the area so heat from the garage permeates into the space.

2.4 ELECTRICAL SYSTEMS

2.4.1 Domestic Hot Water

Domestic hot water (DHW) is available via a 175L capacity Cascade 3.0 kW electric hot water heater. The main hot water use is for faucets and showers.

2.4.2 Lighting Systems

The majority of interior lighting systems are T8 twin tube 4ft linear fluorescent fixtures. There is a small amount of incandescent or compact fluorescent (CFL) lamps in closet and washroom areas. All interior lighting is operated with manual on/off switches. Exterior lighting is commonly provided by LED bulbs at the exterior doorways but they appear to require new photocells as many were observed “on” during the audit. There is a one exterior high pressure sodium (HPS) fixture mounted at the front of the facility above the garage doors.

2.4.3 Plug Loads

Plug loads are common items essential to facility operation. These include desktops, laptops, printers and common office equipment or kitchen equipment such as microwaves, refrigerators and coffee makers. It also includes shop equipment audited on site including the welders, drill press, air compressor and pressure washer.

3.0 UTILITY ANALYSIS AND BENCHMARKING

The following sections detail the energy analysis that was performed for the Facility, and includes a utility analysis, a comparison to a benchmark, and a breakdown of energy consumed by fuel type and major end-use. Table 3-1 summarizes the electricity and propane oil consumption data for the years provided.

Table 3-1 Summary of Utility Data

Year	Electricity		Propane	
	Consumption (kWh)	Cost ($)	Consumption (L)	Cost ($)
Jan-2018 to Dec-2018	41,440	5,574	16,567	9,864
Jan-2019 to Dec-2019	48,200	6,483	15,658	7,209

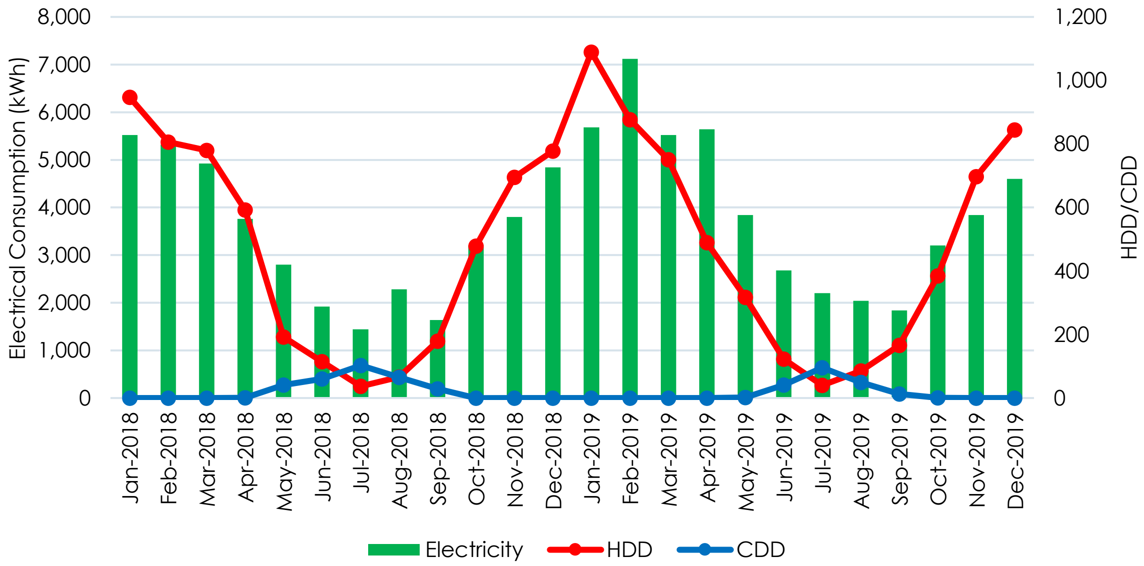
3.1 ELECTRICITY

There is one (1) electricity meter on site which measures the purchased energy for the building. Collected utility data can be found in **Appendix E**.

Utility data was provided for a period of two (2) years from January 2018 to December 2019. A blended rate, which accounts for transmission, use, regulatory fees, global adjustment and HST, was estimated at $0.134/kWh for the site.

The figure below illustrates the electrical consumption for the facility.

Figure 3-1 Monthly Electricity Consumption



The figure shows that electricity consumption peaks in the winter months which is to be expected as there is multiple sources of electric heat and the facility is located in a heating dominated climate. There is a baseload of roughly 2,000 kWh/moth which can be attributed to DHW heating, lighting, plug loads, and exhaust fans.

To establish a baseline year, a linear regression analysis (R-squared analysis) was completed on the electricity data The R-squared value is a measure of the degree of correlated agreement between the electricity consumed and the dependent variable chosen, in this case CDD and HDD. An R-squared value of 1 represents a perfect correlation, while a lower value indicates a lesser degree of influence between the variables. In general, an R-squared value indicates a strong correlation between 0.8 and 1; a moderate correlation between 0.7 and 0.8; and a weak correlation below 0.7. By using an R-squared analysis to correlate energy usage to outdoor temperature, it may be possible to normalize data to a typical year, thereby removing the effects of temporary peaks or lulls due to varying weather patterns and determine how closely energy consumption is related to the weather.

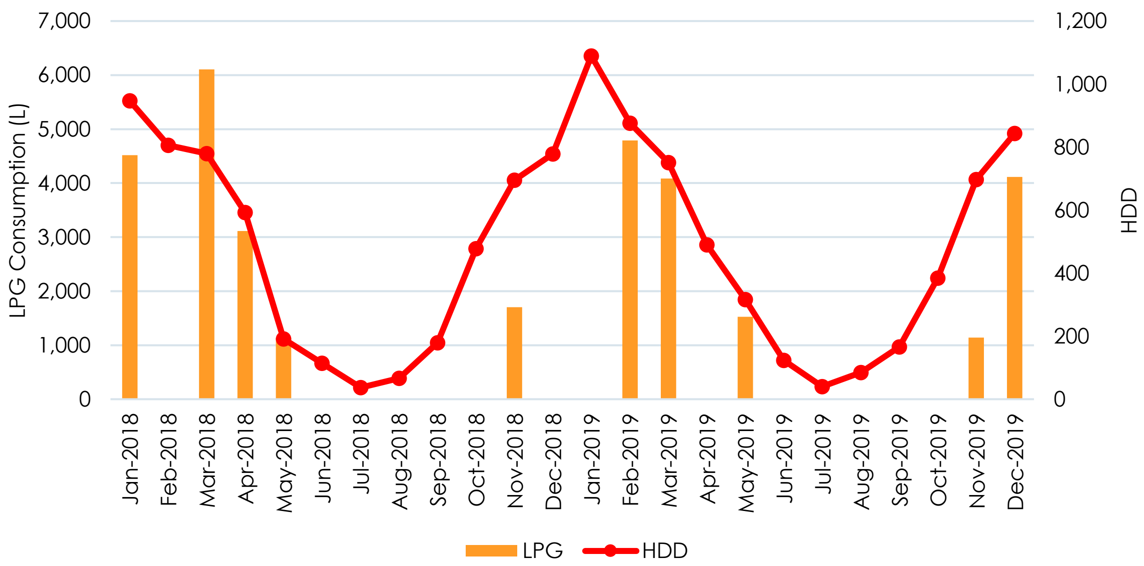
The calculated R-squared of **0.79** for HDD and **0.50** for CDD shows the facilities electricity consumption is influenced by a dropping outdoor air temperature. The correlation between CDD is poor as there is no air conditioning for the Facility.

3.2 PROPANE

Propane is purchased in bulk quantities. A total of 16,566 L and 15,658 L was purchased for 2018 and 2019 respectively. A rate of $0.5954/L was used for propane including purchase cost and GHG carbon tax. Quantities of propane purchased per month can be found in A**ppendix E**.

The figure below illustrates the monthly quantities of propane purchased for the facility.

Figure 3-2 Monthly Quantity of Propane Fuel Purchased



As can be seen in the figure above, propane is commonly purchased and used in the winter months; This is to be expected as this is when heating is needed for the garage. The actual monthly consumption is unknown but larger quantities of propane are typically acquired for months with high HDDs. A linear regression analysis has also been conducted in an effort to establish consumption for a typical year. The calculated R-squared value of **0.33** indicates a weak correlation between fuel consumption and HDD but this is likely due to the fact this data is based on bulk purchase and not actual monthly consumption. As such, the utility data was averaged for each month that was provided and was used as the baseline year.

3.3 SIMULATED BASELINE YEAR

Using a combination of Carrier's Hourly Analysis Program (HAP 5.11) software and Microsoft Excel based calculations, a baseline energy simulation was created and calibrated against the modeled energy consumption described previously to within the target of 20% of the annual consumption value. The accuracy of the calibration changes between utility record datasets due to the variability of weather; the modeled consumption has been normalized against weather for **electricity**, removing peaks and lulls due to varying weather patterns and allowing for a more accurate calibration. This model has been used as the basis for the end-use breakdowns in the subsequent sections. The modeling methodology can be found in **Appendix D**. Table 3-2 summarizes the simulated baseline year for the facility.

Table 3-2 Summary of Simulated Baseline Year Energy Consumption

Year	Electricity		Propane	
	Consumption (kWh)	Cost ($)	Consumption (L)	Cost ($)
Baseline	43,399	5,838	16,112	9,593

3.4 ANNUAL ENERGY CONSUMPTION BREAKDOWN BY TYPE

Electrical and fuel oil energy consumption figures have been converted to common units (GJ) of energy to be able to compare the total amount of energy from each source at the Facility. The following figures show the fuel type breakdown by both consumption and cost.

Figure 3-3 Annual Energy (GJ) Consumption Breakdown by Fuel Type

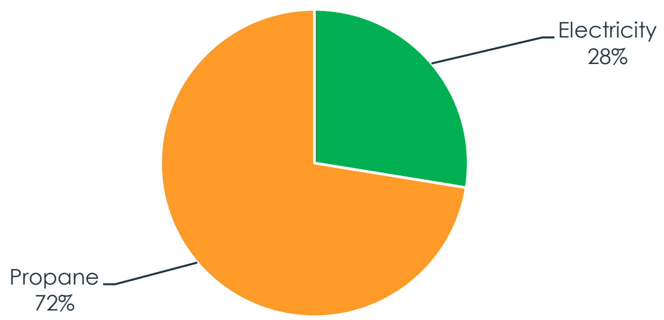
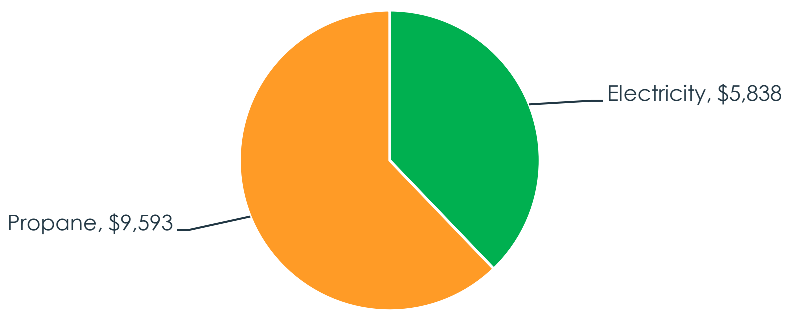


Figure 3-4 Annual Energy Cost by Fuel Type



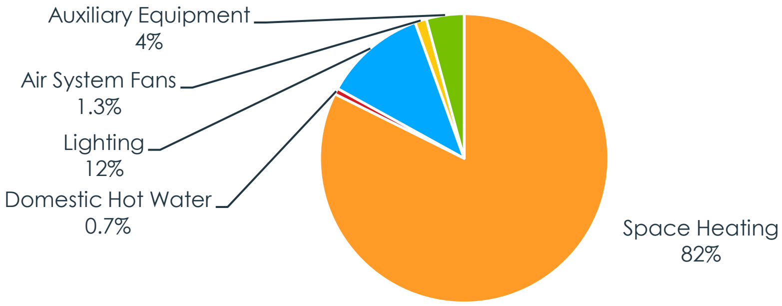
Electricity has been estimated to account for approximately 28% of all energy consumed at a cost of $5,838 while propane accounts for the other 72% at a cost of $9,593. The cost per energy metric for propane and electricity are $23.37/GJ and $37.36/GJ respectively.

3.5 ANNUAL ENERGY CONSUMPTION BREAKDOWN BY MAJOR END-USE

The total annual energy consumption of the Facility was analyzed and broken down into major end-use categories. These categories included in this analysis consist of:

- **Space Heating** – This includes all space heating provided by perimeter electric heat to maintain the space temperature and by the radiant tube heaters in the garage;
- **Domestic Hot Water** – All domestic hot water used in the terminal building;
- **Lighting** – All interior and exterior lighting.
- **Air System Fans** – All exhaust fans serving the facility;
- **Auxiliary Equipment** – This includes all energy consumed by all plugged in equipment such as computers and telephones as well as any shop equipment such as welders and air compressors.

Figure 3-5 Annual Energy (GJ) Consumption Breakdown by Major End-Use

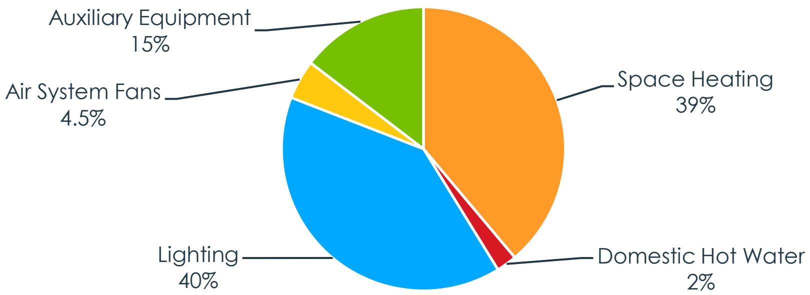


From the figure above, space heating is the end use that consumes the most energy at the facility with 81%. This is to be expected as there is fuel and electric sourced heating equipment on site and represent the largest opportunities for energy savings. Lighting is the next largest end user with 12%. Auxiliary equipment, air system fans and DHW make up the remainder with a combined portion of 6%.

Electrical Energy Consumption by Major End-Use

An estimation of the electricity consumption by major end-use has been made based on the listing of identified equipment on site, the estimated run hours, and any diversity in use that can be foreseen. The breakdown is shown in the figure below.

Figure 3-6 Annual Electricity (kWh) Consumption Breakdown by Major End-Use



3.6 BUILDING ENERGY UTILIZATION INDEX

The Facility Energy Utilization Index (EUI) was calculated by dividing the total annual energy used (all energy utilities in common units) by the gross floor area. Benchmarking of the EUI against other facilities of similar size and use was not possible for this facility due to the makeup of the complex and lack of similar facilities in the same climate that have been audited. This metric will assist as a starting point for tracking site energy performance of a yearly basis going forward.

Table 3-3 Energy Utilization Index

GJ/m^2	$ekWh/ft^2$
0.94	24.32

4.0 ASSESSMENT FINDINGS

This section provides an overview of the ECMs analyzed in this report. For each measure, estimates of the annual savings in each of the following were determined:

- Electricity demand and consumption;
- Fuel consumption;
- Total energy cost;
- Maintenance cost; and,
- GHG emissions.

The first two (2) items were determined using the simulated baseline model wherever possible. For some measures, hand calculations were used when the model was not able to simulate the measure. The maintenance cost premiums were estimated using commercial cost estimating software or based on Wood's experience with similar projects.

GHG emission reductions were calculated based on the results from the detailed analysis. The following table lists the GHG emission factors used.

Table 4-1 Energy Source Emission Factors

Energy Source	Emission Factor
Electricity	0.0000393 tonnes/kWh
Propane	1.55 tonnes/m^3

The following ECMs were reviewed:

- ECM-1: Infiltration Reduction;
- ECM-2: Temperature Control Set Points;
- ECM-3: Vehicle Exhaust System; and
- ECM-4: Lighting LED Retrofit and Control.

4.1 BUILDING ENVELOPE

4.1.1 ECM-1: INFILTRATION REDUCTION

All structural components within the building envelope are bound to experience varying levels of air or heat exchange at transection. Infiltration into the building can also create a significant heating load source in the buildings. Due to the age, construction and usage, the Facility may experience large heating loads due to air leakage and excessive infiltration through door openings, window openings, cracks, and exhaust/plumbing penetrations which can increase heating energy. Infiltration will occur during all hours of the day due to the absence of a ventilation system to provide positive pressurization to the building.

Because of the constant variation in wind speed and pressure, along with actual air infiltration greatly varying throughout the year, the average infiltration rate for the Facility was assumed to 1.2 air changes per hour (ACH).

Proposed Condition

The installation or replacement of worn or broken weather stripping, window caulking, and foam sealants can contribute towards reducing air infiltration around doors, windows, piping, cracks, and exhaust/plumbing penetrations. The broken window pane in the shop requires replacement.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The infiltration ACH for spaces with doors, walls and windows were reduced on average by 30% because of weather-stripping and caulking for all spaces except the office where weather stripping at the exterior door and windows is in good condition.

A detailed building envelope or thermography testing could be conducted to identify anomalies related to thermal bridges, air infiltration/exfiltration, and heat transfer due to design or construction of the building.

The following assumptions were made during the analysis of this measure:

- For calculation purposes, weather-stripping and caulking of walls, windows and doors can reduce infiltration by a minimum of 30%; and
- Replacing worn and/or broken weather-stripping and caulking would not require additional modifications to the buildings structure.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-2 ECM-1: Infiltration Reduction Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
3,309	20.5	2,000	4.6	1.0	5.8	-	2,239	5.3

The following table summarizes the financial analysis associated with this measure.

Table 4-3 ECM-1: Infiltration Reduction Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
7,200	2,239	3.2	7,314	21.9	3.4

This measure offers attractive financials and provides a simple payback of 3.2 years.

The following table summarizes the costs associated with this measure.

Table 4-4 ECM-1: Infiltration Reduction Opinion of Probable Cost Breakdown

Item	Cost ($)
Door Seal (x4)	230
Loading Dock (x3)	4,900
Window Caulking	360
Installation	200
Engineering (11%)	550
Commissioning and Training (7%)	430
Contingency (10%)	520
TOTAL (to nearest hundredth)	**7,200**

4.2 HVAC

4.2.1 ECM-2: TEMEPERATURE CONTROL SET POINTS

Existing Condition

The existing propane heaters which serve the garage area and perimeter electric heat which serve remaining spaces are manually set to operate based on the set point of these spaces with local thermostats. These thermostats are not locked-out and anyone in the building can adjust the temperature set point to whatever they see fit. It is also common these thermostats lose their accuracy and require calibration. It is assumed the tube heater set points are set between 12 and 15°C (54 - 59°F) and the office, electrical room, and washrooms are set to 20°C (68°F).

Proposed Condition

The existing manual thermostats can be upgraded to programmable thermostats to allow adjusting of temperature that best suit the space and its scheduling needs, as well as maintain a constant temperature in the given space. These thermostats also provide the opportunity to program night time setbacks which will save energy by reducing the amount of heating required within the spaces during unoccupied hours.

In terms of implementation, there are no additional space requirements for the programmable thermostats, as they should be able to directly replace the existing manual thermostats in the same space. The programmable thermostats are typically reliable with proper maintenance, and there are several vendors that carry them as part of their product line.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The heating set points in the garage were simulated to heat to 12.8°C (55°F) during occupied hours and 10°C (50°F) during unoccupied hours. The heating setpoints for the electric heating systems were simulated to heat to 20°C (68°F) during occupied hours and 15.5°C (60°F) during unoccupied hours.

The following assumptions were made during the analysis of this measure:

- The base case thermostats' set points are maintained at the suggested temperature throughout the year with no variance;
- The proposed case thermostats' set points are maintained at the suggested occupied and un-occupied temperature setpoint throughout the year with no variance;
- The existing radiant tube heaters and electric heat can support programmable thermostats and will operate accordingly; and
- 10 sensors would be required for proper coverage within the spaces listed.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-5 ECM-2: Temperature Control Set Points Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
1,146	7.1	1,941	4.5	4.5	26.2	-	943	2.0

The following table summarizes the costs associated with this measure.

Table 4-6 ECM-2: Temperature Control Set Points Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
5,100	943	5.4	3,392	10.9	5.8

This measure has a simple payback of 5.4 years and will result in reduced run times of the propane radiant tube heaters and the electric baseboard heaters.

The following table summarizes the costs associated with this measure.

Table 4-7 ECM-2: Temperature Control Set Points Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	3,950
Engineering (11%)	450
Commissioning and Training (7%)	280
Contingency (10%)	470
TOTAL (to nearest hundredth)	**5,100**

4.2.2 ECM-3: VEHICLE EXHAUST SYSTEM

Existing Condition

A 1/3 HP exhaust fan on the North-East wall operates to exhaust vehicle fumes from the garage when necessary. This results in infiltration of air into the building from various sources like unsealed doors and windows. In cold weather this air needs to be heated resulting in increased heating energy.

Proposed Condition

Vehicle exhaust kits can be purchased and utilized on operating vehicles inside the garage to directly exhaust vehicle fumes. These systems can be tailored to a variety of different vehicle exhaust types and will limit the volume of tempered air being exhausted.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The infiltration ACH for the garage was reduced by 3% or the equivalent of 45 CFM.

The following assumptions were made during the analysis of this measure:

- The wall exhaust fan ventilates 1,080 cfm and runs for 1 hour per day;
- The power consumption from the vehicle exhaust system and existing wall exhaust are equivalent; and
- Electrical savings are from reduction in radiant tube heater fan power.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-8 ECM-3: Vehicle Exhaust System Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
354	2.2	-	-	-	-	-	212	0.5

The following table summarizes the financial analysis associated with this measure.

Table 4-9 ECM-3: Vehicle Exhaust System Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
2,700	212	12.8	27	0.1	14.8

This measure can eliminate a safety hazard for staff and conserves conditioned air from being ventilated outdoors when the exhaust fan runs.

The following table summarizes the costs associated with this measure.

Table 4-10 ECM-3: Vehicle Exhaust System Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	2,100
Engineering (11%)	240
Commissioning and Training (7%)	130
Contingency (10%)	230
TOTAL (to the nearest hundredth)	**2,100**

4.3 LIGHTING

4.3.1 ECM-4: LIGHTING LED RETROFIT AND CONTROL

Existing Condition

The current lighting system is manually operated with the vast majority of interior spaces using T8 fixtures with lamps rated at 32W each.

There is one exterior HPS lamp at the facility rated at 70W. The remaining exterior fixtures are LED and have failed photocells or are manually controlled and often left running 24/7.

Proposed Condition

The T8 lamps could be replaced with 16 W LED lamps. The HPS lamps could be retrofitted with 22 W LED lamps. Note that since LED lamps have a longer service life than fluorescent lamps, maintenance savings will be achieved through fewer lamp replacements.

There are no additional space requirements for the new lamps, as they should be able to directly replace the existing lamps in the same space as the current fixtures. Depending on the style of the fixture, the entire fixture may need to be replaced rather than the lamp only; it is also possible that Town staff may wish to replace the fixture for cosmetic reasons.

LED lamps and fixtures are widely available from several vendors. Energy Star or Design Lighting Consortium (DLC) lamps and fixtures should be selected to ensure compliance with incentive programs. As there is little difference in the operation and maintenance of the new LED lamps no training will be required.

The Facility can utilize occupancy sensors with override capability to enable lighting setbacks in areas when they are not being used, or when Facility personnel inadvertently keeps the lights on. This configuration would reduce energy consumption by only having the lights on when the space is occupied. However, it is important that manual switches be readily accessible in case of emergency situations to control the lighting in the space or due to failure of the occupancy sensors.

In terms of implementation, a relatively small space needs to be allocated to the occupancy sensor, as it needs to be mounted either on the wall or ceiling. The sensors would be tied into the controller to control each zone individually. Consideration will need to be given to the details of wiring the sensor to the controller. Several vendors carry occupancy sensors in their product line and they require little maintenance to maintain proper operation. As the system will be largely automated little training will be required.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The lighting wattages of the affected areas were reduced to simulate the effect of the lower wattage LED lamps. The lighting schedule occupied hours were reduced for the spaces listed to simulate the effect of utilizing occupancy sensors to turn off lighting in these areas when unoccupied.

The following assumptions were made during the analysis of this measure:

- Existing lamp lifetime is 5 years and are replaced at the rate of 20% per year;
- Proposed LED lamp lifetime is 10 years;
- Proposed LED lamps replacing T8 will utilize 16 W LED lamps;
- Proposed LED lamps replacing HPS will utilize 22 W LED lamps;
- Minimum effort required to upgrade fixture with low ceiling heights;
- Lifting and hoisting equipment rental is required for high ceiling hung T8 lamp replacement;
- Occupancy sensors will reduce the lighting operating hours by approximately 50%;
- 15 occupancy sensors would be required for proper coverage within the facility;
- Photocell sensors will reduce the operating hours of the exterior lights by approximately 50%; and
- 3 photocell sensors would be required for the exterior LED fixtures.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-11 ECM-4: Lighting LED Retrofit and Controls Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-688	-4.3	9,918	22.9	3.0	17.4	100	924	-0.1

The following table summarizes the financial analysis associated with this measure.

Table 4-12 ECM-4: Lighting LED Retrofit and Controls Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
6,600	1,024	6.4	2,620	6.8	7.0

The following table summarizes the costs associated with this measure.

Table 4-13 ECM-4: Exterior Lighting Retrofit Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	5,100
Engineering (11%)	600
Commissioning and Training (7%)	350
Contingency (10%)	550
TOTAL (to nearest thousand)	**6,600**

5.0 IMPLEMENTATION GUIDELINES

It is recommended that the measures that are the simplest and have the least interruption to the occupants be implemented first. It is important to consider phasing as a means of implementation in order avoid occupant disruption, levels of expenditure, and time to implement. The following table summarizes the implementation guidelines for each measure, which are high level timeline estimates and can vary considerably.

Table 5-1 ECM Implementation Plan Outline by Measure

ECM/Scenario	Design Period	Construction Period	Seasonal Requirements	Occupant Disruption
Infiltration Reduction	1-2 Weeks	1-2 Weeks	None	None
Temperature Control Set Points	1-2 Weeks	None	None	None
Vehicle Exhaust System	2-4 Weeks	2-4 Weeks	Ideally Summer	Low
Lighting LED Retrofit	4-8 Weeks	3-4 Weeks	None	Moderate
Scenario 1	2-3 Months	1-2 Months	Ideally Summer	Moderate

6.0 BUILDING MANAGEMENT AND BEHAVIOURAL OPPORTUNITIES

Re-commissioning

Re-commissioning is the process of returning the building systems to their design specifications after the Facility has been in operation for a period of time, typically about five years, as well as updating operations to match the current needs of the Facility.

It is recommended the building undergo re-commissioning again in the near future.

Perimeter Baseboard Heater Maintenance

Baseboard heaters should be cleaned once a year to keep them working safely and efficiently. Debris such as dirt, dust, garbage and hair can accumulate on the fins. The heater cover should be removed and any visible debris inside the unit should be cleaned using a vacuum, soft brush or even a steam pressure cleaner. If any of the fins are bent or damaged they should be straighten using a pair of needle-nose pliers, metal scrapper, putty knife, or a fin comb. Occupants should also ensure units remain free from obstructions such as window treatments, carpet, and other items.

Staff Training and Occupant Awareness

Equipment operation practices and policies can also have a significant impact upon energy consumption. There is generally ample opportunity for energy savings from general equipment left on when not in use. An energy efficiency awareness program should be put in place to encourage staff to frequently check temperature set points if heating is not required, similarly if lights are manually left on when not in use at the end of the day, and for the weekends.

Procurement Policy

Purchasing efficient products reduces energy costs without compromising quality. It is strongly recommended that a procurement policy be implemented as a key element for the overall energy management strategy at the Township. An effective policy would direct procurement decisions to select EnergyStar® qualified equipment in contracts or purchase orders. For products not covered under EnergyStar®, the EnerGuide labeling should be reviewed to select products with upper level performance in their category. Improved energy performance will involve the investment in energy efficient equipment coupled with a user education and awareness program.

7.0 OTHER OPPORTUNITIES CONSIDERED

Garage Ceiling Fan Upgrade

Ceiling fans assist with air destratification by reducing the stack, or chimney effect of heat loss and also serve to distribute heated air more evenly throughout a space. It is recommended the Township of Chapleau replace the ceiling fans in the garage with a high volume low speed (HVLS) destratification fan when existing fans fail.

8.0 IMPLEMENTATION SCENARIO

Wood has combined the measures recommended in this assessment report to present a strategic implementation scenario.

It should be noted that the estimated savings associated with the scenario may not match the aggregated sum of the included measures evaluated separately. This is due to interactive effects between measures.

The following table summarizes the estimated energy savings associated with this scenario.

Table 8-1 ECM-Scenario 1: Annual Energy Savings

Estimated Propane Use		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
3,986	24.7	13,480	31.1	6.3	36.6	100	4,186	7.5

The following table summarizes the financial analysis associated with this implementation scenario.

Table 8-2 ECM-Scenario 1: Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
22,000	4,286	5.1	16,582	12.2	5.5

The scenario combines the four (4) energy conservation and efficiency measures and results in a simple payback just over five (5) years.

The following table summarizes the costs associated with this implementation scenario.

Table 8-3 ECM-Scenario 1: Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	17,300
Engineering (11%)	1,900
Commissioning and Training (7%)	1,000
Contingency (10%)	1,800
TOTAL (to nearest hundredth)	22,000

9.0 CONCLUSIONS AND RECOMMENDATIONS

Four ECMs were identified during the detailed energy assessment. The following table summarizes all the ECMs that were reviewed along with estimated costs, savings, and simple payback.

Table E-1 Summary of ECMs

ECM	Measure	Opinion of Probable Cost	Estimated Savings				Estimated Total Savings	Simple Payback
			Propane	Electricity	Demand	Maintenance		
		($)	(L)	(kWh)	(kW)	($)	($)	(Years)
ECM-1	Infiltration Reduction	7,200	3,309 20.5%	2,000 4.6%	1 5.8%	-	2,239	3.2
ECM-2	Temperature Control Set Points	5,100	1,146 7.1%	1,941 4.5%	5 26.2%	-	943	5.4
ECM-3	Vehicle Exhaust Hose	2,700	354 2.2%	6 0.0%	-	-	212	12.8
ECM-4	Lighting LED Retrofit & Control	6,600	(688) (4.3)%	9,918 22.9%	3 17.4%	100	1,024	6.4
Scenario 1		22,000	3,986 24.7%	13,480 31.1%	6 36.6%	100	4,286	5.1

Notes:

(1) It should be noted that the estimated savings associated with each scenario may not match the aggregated sum of the included measures evaluated separately. This is due to interactive effects between measures.

Wood recommends that the Township proceeds with the suggested ECMs stated in implementation scenario 1. This includes the four (4) identified ECMs as follows:

Scenario 1, which contains:

- ECM-1: Infiltration Reduction;
- ECM-2: Temperature Set Points;
- ECM-3: Vehicle Exhaust System; and
- ECM-4: Lighting Retrofit and Control.

By implementing the recommended measures listed above, the Facility has a potential savings of 13,480 kWh (31.1%) and 3,986L (24.7%) of propane that may be anticipated relative to the simulated baseline year.

10.0 STUDY LIMITATIONS

It must be noted that an energy audits prime goal is to identify the energy savings opportunities that likely meet the Township of Chapleau's minimum payback criteria. Energy savings and installation costs are estimates only. Detailed designs are always recommended before proceeding, along with final complete payback analysis.

This report documents work that was performed using methods and procedures that are generally consistent with the ASHRAE level 2 guidelines, subject to the level of investigative effort outlined in this report and generally accepted and prevailing industry standards at the time and location in which the services were provided. No other representations, warranties, or guarantees are made, including no assurance that this work has uncovered all potential issues associated with the identified property that may impact energy consumption or implementation of proposed measures.

This report provides an evaluation of potential for energy conservation opportunities at the Public Works Garage located at 30951 Panet St, Panet Township Ontario, that was assessed at the time the work was conducted and is based on information obtained by and/or provided to Wood at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by Wood to be correct. Wood assumes no responsibility for any deficiency or inaccuracy in information received from others.

Activities at the property or additional information subsequent to Wood's assessment may have significantly altered the potential and feasibility of the opportunities or conclusions identified within the report.

Conclusions made within this report consist of Wood's professional opinion as of the time of the writing of this report and are based solely on the scope of work described in the report, the limited data available, and the results of the work. The savings calculations are our estimate of saving potentials and are not a guarantee. The impact of building changes in space functionality, operations, usage, equipment retrofit, and weather need to be considered when evaluating the savings.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. Wood assumes no responsibility for losses, damages, liabilities or claims, howsoever arising, from third party use of this report.

This report is limited by the following:

- Our interpretation of the objective and scope of works during the study period;
- The information provided by the Municipality; and

- Measures identified in this report are subject to the professional engineering design process before being implemented.

The recommendations and our opinion of probable costs associated with these recommendations, as presented in this report, are based on walk-through non-invasive observations of the parts of the building which were readily accessible during our visual review. Conditions may exist that are not as per the general condition of the system being observed and reported in this report. Opinions of probable costs presented in this report are also based on information received during interviews with operations and maintenance staff.

The opinions of probable costs are intended for global budgeting purposes only. The scope of work and the actual costs of the work recommended can only be determined after a detailed examination of the site element in question, understanding of the site restrictions, understanding of the effects on the ongoing operations of the site/building, definition of the construction schedule, and preparation of tender documents. We expressly waive any responsibilities for the effects of any action taken as a result of these endeavors unless we are specifically advised of prior to, and participate in the action, at which time, our responsibility will be negotiated.

11.0 CLOSURE

Wood conducted an Energy Audit at the Public Works Garage located at 30951 Panet St, Panet Township Ontario. Electricity conservation and efficiency measures were investigated, provided, and assessed in terms of energy savings and utility cost savings along with capital project costs and financial analysis. Through our analysis we have identified four (4) ECMs. Wood has presented a strategic implementation scenario for the measures recommended in this assessment report. The scenario is estimated to reduce site electricity use by 31.1% and site propane use by 24.7% for an overall cost savings relative to the baseline year of $4,286.

Additional recommendations include the following building management and behavioral opportunities:

- Recommissioning;
- Baseboard heater maintenance;
- Staff Training and Occupant Awareness; and
- Procurement Policy.

Wood Environment & Infrastructure Solutions

a Division of Wood Canada Limited,

Prepared by:	Reviewed by:
Name: Nathan Sokolowski, CEM, P.Eng.	**Name: Ayman Nicola, M.Sc., C.E.T., P.Eng.**
Signature: Nathan Sokolowski	**Signature:** Ayman Nicola

Appendix A

Appendix A Assessment Methodology

Site Visits

The visit included a detailed interview with technical staff regarding the buildings' function as well as discussing any issues that were persistent and opportunities for operational optimization. A comprehensive tour of the site was also conducted to evaluate the HVAC, lighting, and controls systems.

Utility Analysis

An analysis of the Public Works Garage consumption provides a good starting point from which to:

- Identify potential energy conservation measures (ECMs); and,
- Develop a baseline against which ECM performance can be quantified.

The consumption (and demand) registered on historical data for the utility meter can also be examined to identify issues that are affecting the energy performance of the site.

Utility data for electricity was provided by the Township of Chapleau dating back to 2018 for the Chapleau Hydro utility meter.

Utility Rates

In terms of savings related to the identified measures, a blended rate is used which effectively assumes that reduction in consumption will only reduce the cost by the rate that applies to the last unit of energy used. The blended rates naturally include all fees, taxes, and bulk charges which may be included in each utility provider's billings. These rates are listed the table below.

Table A-1 Utility Rates (January 2019 – December 2019)

Item	Value	Units
Electricity Rate	0.134	$/kWh

Envelope System Assessment

The envelope and architectural assessment involves a non-intrusive visual inspection of the facility and a review of any available drawings to determine the condition and type of construction. Special attention will be paid to doors and windows during this review.

Mechanical System Assessment

The mechanical portion of the assessment involves taking a comprehensive inventory of mechanical components and an accurate appraisal of operational times and efficiencies for each mechanism. This is inclusive of all HVAC, Domestic Hot Water, and process related equipment. The Building Automation System (BAS) and/or manual equipment controls will be inventoried and assessed for integration. Sequence of operations will be examined for improvement opportunities.

Electrical System Assessment

A comprehensive assessment of the site's lighting includes a detailed review the existing fixtures and controls throughout the site. Consideration is also given to operational hours and the diligence of occupants at switching OFF manually operated lighting. A comprehensive assessment of the site's other electrical equipment including motors, transformers and process equipment.

Energy Conservation Measure Identification and Analysis

Each measure proposed for implementation on this project has been selected based on its viability, as measured against the following criteria:

- costs and savings within overall criteria for evaluation guidelines;
- appropriateness for tasks performed in the space;
- condition of existing systems;
- consistency of application (all areas of similar function are consistent);
- equipment approval by facilities personnel; and,
- impact on occupant behaviour and general acceptance of changes.

The energy savings calculations are based on a best estimate of the anticipated reductions taking into consideration direct savings from electrical consumption and electrical demand where appropriate. Savings associated with heating and cooling measures are calculated relating to heating and cooling degree-days for the site which are taken from the most appropriate local weather data source, which assumes an average balance point[1] temperature of 18°C (64.4 °F).

Costs associated with implementing the respective measures are estimated based on the approximate 'capital cost' for the materials and labor (including demolition and installation). Costs are determined from previous project experience and/or through published cost estimate data (RS Means…). All costs represent Wood's opinion on probable cost and are provided as approximate estimates to give economies of scale. Further investigation and detailed costing should be carried out prior to implementation.

For any systems or equipment that are on site and not functioning (not consuming energy) no energy conservation measures have been considered. The scope of this exercise is to find opportunities to reduce energy consumption and where there is no possibility to do so, no measures have been discussed in the report.

Recommendations

From the options considered, recommendations are put forward based on financial and practical feasibility using indicators such as simple payback, capital cost and net present value (NPV).

[1] The balance point temperature is the external temperature at which the building's heating equipment is initiated.

Appendix B

Appendix B **Asset Details**

The table below present the equipment inventory for the facility at the time of the site visit.

Description	Location	Manufacturer	Model	Qty	Phase	Voltage	Amps	HP	Demand (kW)	Total Demand (kW)
Base Board Heater	Corner Office	Global Commander	PEG1750BL	1	1	208	7.29		1.75	1.75
Base Board Heater	Office	Global Commander	PEG1750BL	1	1	208			1.75	1.75
Base Board Heater	Electrical Room	N/A	N/A	1	1	208			1.25	1.25
Base Board Heater	Washrooms	N/A	N/A	2	1	208			0.5	1.00
Wall heater	Shop	N/A	N/A	1	1	208			2	2.00
Ceiling Fans	Garage	N/A	N/A	5	1	120	0.6		0.072	0.36
Exhaust	Garage	Leader Fan Industries	AX24-1V	1	1	120	5	0.33	0.25	0.25
Exhaust	Shop	Emmerson	K55HXHTM-8879	1	1			0.33	0.25	0.25
Hot Water Heater	Office Closet	GSW	6E2175SC	1	1	240			3	3.00
Well Pump		N/A	N/A	1	1	230	6.4	0.75	0.55	0.55
Welder	Shop	Miller	Dialarc 250	1	1	230	68		15.64	15.64
Welder	Shop	Miller	Millermatic 212	1	1	230	27		6.21	6.21
Air Compressor	Shop	Ingersoll Rand	2475	1	1	230	22.8		5.244	5.244
Pressure Washer	Garage	Xstream	X-HW13008GEN	1	1	230	36		8.28	8.28
Garage Door Opener	Garage	N/A	N/A	3	1	230		0.5	0.37	1.12
									BTU/hr	Total BTU/hr
Radiant Tube Heater	Garage	Bradt Radiant Heaters Ltd	Re-Verber-Ray	4	1	120	4.8		75,000	300000

Appendix C

Appendix C Lighting Inventory

The table below presents the existing fluorescent lighting at the facility at the time of the audit.

Space	Qty	Fixture Housing	Fluorescent Lamp Type	Lamps	Lamp Length (ft)	Lamp Watts	Ballast	Fixture Watts	Total Watts
Garage	22	Surf, 1x4	T8, Instant start	2	4	32	Electronic	65	1430
Garage	20	High/low bay	T8, Instant start	2	4	32	Electronic	65	1300
Electrical	1	Surf, 1x4	T8, Instant start	2	4	32	Electronic	65	65
Hallway to Office	1	Surf, 1x4	T8, Instant start	2	4	32	Electronic	65	65
Wash room	1	Surf, linear	T12, Standard wattage	1	2	20	Mag-ES	26	26
Office	2	Rec, 2x4 troffer	T8, Instant start	2	4	32	Electronic	65	130
Lunch Room	14	Surf, 1x4	T8, Instant start	2	4	32	Electronic	65	910
Shop	10	Surf, 1x4	T8, Instant start	2	4	32	Electronic	65	650

The table below present the existing non-fluorescent lighting at the facility at the time of the audit.

Space	Qty	Fixture Housing	Fixture Type	Lamps #	Lamp Watts	Total Watts
Garage	1	Surf, circular	LED	1	18.5	18.5
Office Closet	2	Surf, circular	LED	1	18.5	37
Office Washroom	1	Surf, circular	LED	1	18.5	18.5
Exterior	1	Surf, sconce	Metal Halide	1	70	95
Exterior - Entrance	1	Surf, circular	LED	1	12	12
Exterior - Doorways	2	Surf, circular	LED	1	9.5	19

Appendix D

Appendix D Modelling Methodology

The building simulation program Carrier HAP version 5.11 was used to simulate how each recommendation would perform under the existing buildings characteristics. The program uses typical weather data along with input from the user of the building's HVAC equipment, building occupancy schedule, envelope materials, plug loads, and process loads to simulate design alternatives.

The Facility's internal gains were entered in the baseline model using occupancy counts and estimating electrical appliances such as computers, copiers, and printers amongst others; the ASHRAE Fundamentals 2013 Handbook was used as a guide for estimating the loads from this equipment.

To determine the Facility's lighting load consumption, lighting counts were taken on site and verified against the electrical reflected ceiling drawings, the lighting inventory was then used to determine the interior, exterior, and perimeter lighting loads. Where lighting information could not be obtained ASHRAE Fundamentals 2013 Handbook was used as a guide.

The Facility's HVAC components were generated in the model using a combination of manufacturer specifications, mechanical drawings, schedules, and equipment asset details for the HVAC systems. A combination of manufacturer specifications and nameplates were used for units within the Facility. In addition, the building operator's description of the Facility's HVAC sequences of operations and BAS information and setpoints were also accounted for in the model.

To ensure that the baseline model was operating similarly to the existing building, the Facility's baseline consumption based on the utility billing data was compared to the building simulation's energy consumption outputs. This comparison was done both analytically by comparison to total consumption and visually by comparing monthly trends to expected consumption.

Appendix E

Appendix E Utility Data Summary

The table below presents the collected utility data for the site.

Month-Year	Electricity Consumption (kWh)	Propane Consumption (L)
Jan-2018	5,520	4,515.20
Feb-2018	5,320	0
Mar-2018	4,920	6,106.50
Apr-2018	3,760	3,111.3
May-2018	2,800	1,132.8
Jun-2018	1,920	0
Jul-2018	1,440	0
Aug-2018	2,280	0
Sep-2018	1,640	0
Oct-2018	3,200	0
Nov-2018	3,800	1,700.7
Dec-2018	4,840	0
Jan-2019	5,680	0
Feb-2019	7,120	4,792.8
Mar-2019	5,520	4,087.1
Apr-2019	5,640	0
May-2019	3,840	1,526.8
Jun-2019	2,680	0
Jul-2019	2,200	0
Aug-2019	2,040	0
Sep-2019	1,840	0
Oct-2019	3,200	0
Nov-2019	3,840	1,138.6
Dec-2019	4,600	4,112.6