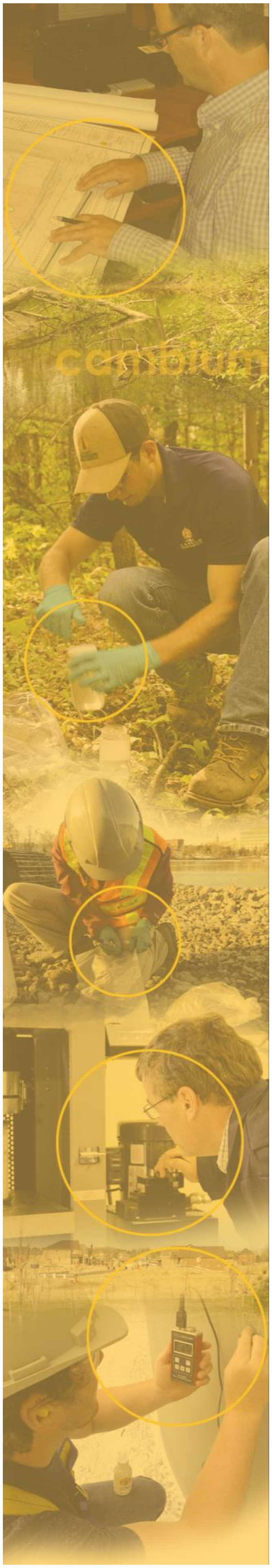

Energy Consumption Investigation

Cambium Reference No.: 2990-003

2014-10-28

Prepared for: The Township of Bonnechere Valley

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EXECUTIVE SUMMARY

The Township of Bonnechere Valley has expressed concern regarding the fluctuation of energy consumption of some of their facilities, and the increase in consumption of others, particularly those in which energy conservation efforts were made in recent years. The objective of our analysis was to determine whether or not the concern was justified for five (5) facilities: the museum, the community centre, the arena, the water treatment plant, and the sewage treatment plant.

In most cases we determined that the annual consumption figures being used and reported through the Energy Planning Tool (EPT) were not accurate and that the adjusted consumption figures showed less dramatic swings in the annually, as can be seen in the table below.

Facility	2011 Consumption (kWh)		2012 Consumption (kWh)		2013 Consumption (kWh)	
	EPT	**Analysis**	**EPT**	**Analysis**	**EPT**	**Analysis**
Arena / Ice Plant	244,344	250,141	271,359	278,067	263,890	266,607
Community Centre	145,419	159,720	77,426	165,471	244,022	172,399
Museum	14,329	14,278	15,125	14,924	10,598	13,270
Sewage Treatment Plant	251,850	280,335	324,246	292,593	272,147	227,903
Water Treatment Plant	203,460	284,942	246,868	287,234	317,965	339,435

Using the adjusted consumption figures, along with information gathered from visits to each site and discussions with the various facility operations managers we were able to justify the annual changes in energy consumption for the museum, the community centre, and the sewage treatment plant. In the case of the arena and the water treatment plant, some of the changes in consumption remained unexplainable despite further data gathering and additional discussions with the facility operations staff. While the analysis provided the benefit of greater understanding of each operation's use of energy, there remain opportunities to improve energy tracking and reduce energy consumption.

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1.0 INTRODUCTION

The Cambium team was retained by the Township of Bonnechere Valley (TBV) to investigate the energy consumption associated with the operation of the following five (5) facilities: the Bonnechere Museum, the Eganville arena, the Eganville community centre, the water filtration plant, and the sewage treatment plant.

TBV expressed concern regarding the fluctuation of energy consumption of some of the buildings, and the increase in consumption of others, particularly those in which energy conservation efforts were made in recent years.

The timeframe examined in our analysis centred on the years 2011, 2012, and 2013, as these are the years that have been subject to Ontario Regulation 397/11 reporting.

Our analysis of each facility included a review of all pertinent background information, a physical tour of each along with the respective facility operator, further background research and investigation, and follow-up discussions with facility operators. In analyzing each facility's energy use, we followed a similar process as outlined below:

- Overview - an overview of the facility including the location, the type and hours of use, and the systems requiring energy;
- Energy Conservation Initiatives – any initiatives completed on the facility or its equipment in recent years;
- Energy measurement – how the various types of energy use are measured;
- Energy consumption – total annual energy consumption for the years 2011, 2012, and 2013;
- Changes in Use or Equipment – any changes that took place over the past 3 years that may impact energy consumption;
- Impact of weather – how fluctuations in temperature may have impacted energy consumption;
- Conclusion – whether or not the energy consumption is reasonable; and,
- Additional opportunities for consideration – additional potential actions that could be taken to reduce energy consumption by the facility

With the areas above, the impact of weather requires some further explanation.

1.1 IMPACT OF WEATHER

Given the relatively wide fluctuation of temperatures during the year, the energy associated with the heating and cooling of facilities sometimes represents a large portion of their energy consumption.

In addition, the year to year changes in seasonal temperatures often have a corresponding direct impact in year over year energy consumption comparison. For example, if the average winter temperature is lower in year 2 than it was in year 1, then the energy consumption associated with heating a facility will generally be higher in year 2 than it was in year 1.

A commonly used method to measure the year over year variance in temperatures is through heating degree days and cooling degree days. The more heating degree days in year, the greater the need for heating the facility; the more cooling degree days, the greater the need for cooling the facility. A more detailed description can be found in the Glossary at the back of this report.

In looking across the years 2011, 2012, and 2013, the following weather related variances were observed based on heating and cooling degree days.

Summer Months

The summer of 2012 was approximately 46 percent warmer than that of 2011, while the summer of 2013 was approximately 42 percent cooler than 2012. The expected result would be an increase in energy consumption associated with cooling in 2012 versus 2011, and a decrease in energy associated with cooling in 2013 versus 2012.

Winter Months

The winter of 2012 was approximately two (2) percent warmer than that of 2011, while the winter of 2013 was approximately eight (8) percent colder than 2012. The expected result would be a slight decrease in energy consumption associated with heating in 2012 versus 2011, and a more significant increase in energy consumption associated with heating in 2013 versus 2012.

2.0 BONNECHERE MUSEUM

The Bonnechere Museum is a 220 square metre facility located at 85 Bonnechere St. in Eganville, Ontario. The facility was constructed in 1912 and currently is used to showcase culturally and historically significant displays and exhibits. The facility operates approximately 1,170 hours per year based upon 65 hours per week between Victoria Day and Labour Day (18 weeks). Additional special events occur at other times during the year including: the Rural Ramble, Christmas Tea, and occasional evening meetings.

Energy is used by the following systems:

- Heating – a hydronic radiator system fed by an oil fired boilers, one (1) hot water tank
- Cooling – one (1) air conditioning unit
- Lighting- 17 fluorescent fixtures (T8 lamps), specialty lighting for display purposes, exit sign lighting, and some incandescent lighting (2nd floor)

- Plugged-in Equipment – IT equipment (computers, display monitors)

The boiler is controlled by hydronic outdoor reset control, and the radiators are controlled by local thermostats. The cooling system is controlled by a thermostat located on the second floor. The lighting is controlled by manual switches.

2.1 ENERGY CONSERVATION INITIATIVES

Over the past 5 years, several energy conservation projects have been completed at the facility, and are summarized below.

- In 2007, the lower level windows were sealed and insulated from the inside;
- In 2008, the front doors were replaced, which improved the building envelope insulation; and
- In 2012, the T12 fluorescent light fixtures were replaced with T8 fixtures and tubes. This was a recommendation from the 2006 energy audit;

2.2 ENERGY MEASUREMENT

The Bonnechere Museum measures electricity through its own dedicated electricity meter. Fuel oil is measured using vendor invoices for the oil purchased, and therefore represents an approximation of fuel consumption during the year.

2.3 ENERGY CONSUMPTION

The facility utilizes both electricity and fuel oil as sources of energy. Electricity is used for lighting, cooling, and plugged-in equipment (i.e. computers). Oil is used for heating via the oil fired boiler.

Over the past three years, overall energy consumption for the building has fluctuated, with total energy use decreasing by 15.5% in 2012, then increasing by 19.4% in 2013. The electricity consumption increased in 2012 compared to 2011 but then fell in 2013. At the same time, the fuel oil consumption was lower in 2012, but increased in 2013. Table 1 provides a summary of the facility’s energy consumption.

Table 1 - Bonnechere Museum Energy Consumption

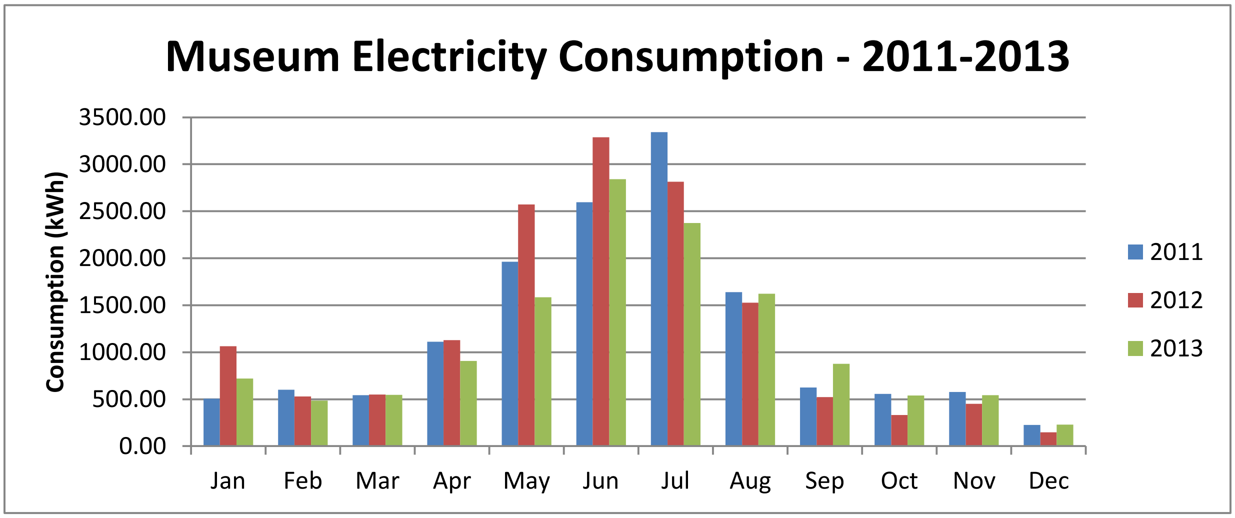
	2011	2012	% Change	2013	% Change
Electricity (kWh)	14,278	14,924	+4.5	13,270	-11.1
Fuel Oil (L)	7,344	5,937	-19.2	7,518	+26.5
Total Energy Use (ekWh)	93,153	78,687	-15.5	94,013	+19.4
Source: Electricity from LAS spreadsheet / Fuel Oil from TBV Green Energy Act spreadsheet					

2.3.1 ELECTRICITY CONSUMPTION

The graph below represents the electricity consumption for the museum over the past three years. The data was based in information from Local Authority Services, which includes estimates for some months. The heating oil consumption is unable to be graphed on a monthly basis as only annual amounts are available.

The graph is consistent with the seasonal operation of the museum, which is generally open May through August.

Figure 1 - Bonnechere Museum Electricity Consumption



2.4 CHANGES IN USE OF FACILITY OR EQUIPMENT

According to Museum staff, the operating hours have remained generally the same since 2011 and no new energy using equipment has been added since 2011.

2.5 IMPACT OF WEATHER

The Museum's electricity consumption increased in 2012 and then decreased in 2013, while fuel oil consumption decreased in 2012 and then increased in 2013. This would be a result consistent with the weather experienced over the past three (3) years, where 2012 was a warmer year than 2011 and therefore would have required more cooling (greater electricity use) and where 2013 was cooler than 2012 and therefore would have required more heating (greater heating oil use).

2.6 CONCLUSION

Based upon our investigation, it appears that the energy consumption experienced in the years 2011, 2012, and 2013 is in line with the expected experience.

2.7 ADDITIONAL OPPORTUNITIES FOR CONSIDERATION

Taking into account the museum collection may be affected by rapid daily temperature and humidity changes it is not recommended to install programmable thermostats. However, it is advisable to lower the interior building temperature during the winter months, when the museum is closed and unoccupied, to an acceptable level that will protect from freezing. Periodic auditing is recommended to ensure temperatures are adequate.

It is also suggested that TBV confirm with heating contractor that the boiler has an outdoor reset control, and if so to ensure that it is enabled and functioning properly. This control varies the temperature of the boiler heating loop with the outside temperature, such that when the temperature is warmer outside, the boiler loop temperature increases.

3.0 EGANVILLE ARENA & ICE PLANT

The Eganville Arena and Ice Plant is a 1,789 square metre facility located at 178B Jane Street in Eganville, Ontario. The facility was constructed in 1947 and had a major renovation in 1977. The 1977 renovation included an upgrade of the walls and the steel frame of the structure. The facility operates approximately 1040 hours , with more operating hours generally taking place during the winter months. The arena offers ice rentals from September to April, hosting hockey, figure skating, and public skating for Eganville and the neighbouring communities. The facility also hosts occasional events at other times including the annual gun show, and approximately three (3) weddings per year.

Energy is used by the following systems:

- Heating: eight (8) electric baseboard heaters (dressing rooms, lobby, cleaning room), three (3) propane heaters (back dressing rooms and Olympia Room), one (1) hot water tank and one (1) instantaneous water heater (used with ice making equipment);
- Lighting: T8 fluorescent tubes in dressing rooms and common areas, exterior lighting (Note: the ice pad lighting connected to the community centre electricity meter);
- Ice-making related equipment, including a 40 HP Cimco compressor (1989), a 30 HP Mycom compressor/condenser (2002), a brine pump, a chiller, a condenser, and two (2) dehumidifiers; and,
- Various plugged-in equipment

Heating, including the new dressing room baseboard heaters is controlled by a thermostat. The ice surface lighting is controlled by manual switches. The dressing room lighting is controlled by manual switches. The exterior lighting is controlled by light sensors.

The Arena and Ice Plant are housed within the same building as the Eganville Community Centre. There is no cooling in the Arena or Ice Plant.

3.1 ENERGY CONSERVATION INITIATIVES

Over the past 5 years, a number of energy conservation projects have been completed at the facility including the following:

- In 2006, the ice surface lights were replaced with 400-watt metal halide fixtures (however lighting is metered on the community centre meter);
- In 2009, a new tankless hot water system was installed in the ice resurfacing room;
- In 2009, the ice resurfacing machine was replaced with a new Olympia unit;
- In 2009, three (3) electric hot water tanks were replaced with propane tanks;
- In 2010, a new LED time clock was installed; and
- The bathroom exhaust fan was replaced with heat recovery ventilator with electric coil (since 2006)

In addition, the facility is currently undergoing a roof replacement which will include additional insulation.

As the timing of the energy conservation measures falls outside of the timing of our analysis, no impact on energy consumption is expected from the above measures during the three (3) years under review.

3.2 ENERGY MEASUREMENT

The Eganville Arena / Ice Plant measure electricity consumption through its own dedicated electricity meter. For the purpose of reporting on energy consumption as per Ontario Regulation 397/11, the total is split by allocating approximately 95% to the Arena and 5% to the Ice Plant. It is important to note that the electricity consumption associated with the ice surface lighting is not on this meter, but is instead connected to the Community Centre meter.

Propane consumption is measured using the vendor invoice of propane purchased, and therefore represents an approximation of the annual propane consumption.

3.3 ENERGY CONSUMPTION

The facility utilizes electricity and propane as its sources of energy. Electricity is used for heating, lighting, and ice-making related equipment. Propane is used for the heating the two (2) rear dressing room and the Ice Plant area, and for the hot water tanks used for the ice resurfacing machine. The Arena does not heat the seating area.

Over the past three years the total energy consumption has fluctuated showing an increase of approximately eight (8) percent in 2012, but a decrease of four (4) percent in 2013. During that time period electricity consumption fluctuated, while propane consumption has decreased in each year. Table 2 below provides a summary.

Table 2 - Eganville Arena/Ice Plant Energy Consumption

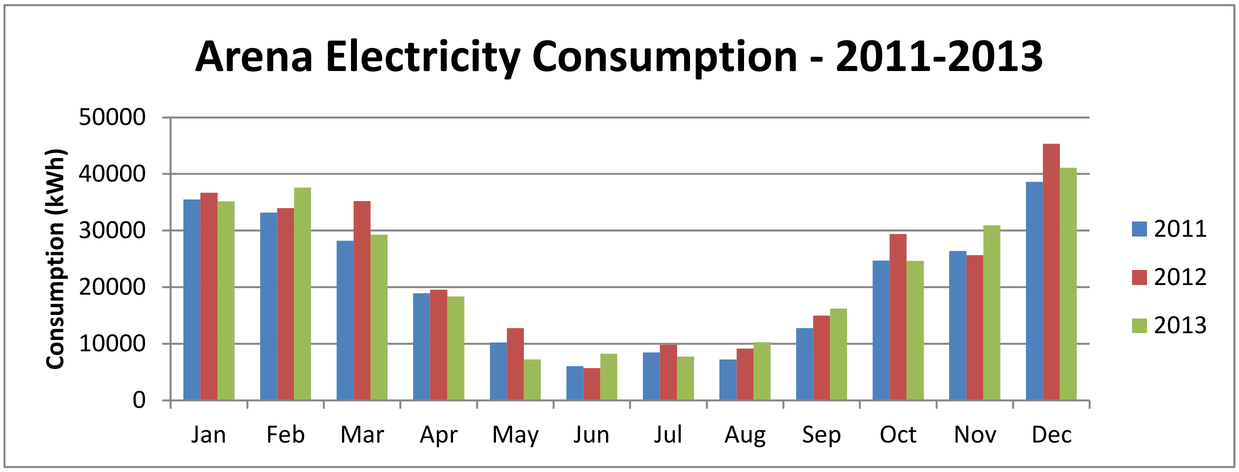
	2011	2012	Change	2013	Change
Electricity Consumption – Arena & Ice Plant (kWh)	250,141	278,067	+11.2%	266,607	-4.1%
Propane Consumption (L) – Ice Plant	3,668	2,981	-18.7%	2,913	-2.3%
Total Energy Consumption (ekWh)	**276,147**	**299,202**	**+8.3%**	**287,260**	**-4.0%**
Source: Electricity - LAS Energy Consumption spreadsheet / Propane from TBV staff Propane conversion factor: http://www.nrcan.gc.ca/energy/publications/efficiency/buildings/5985					

3.3.1 ELECTRICITY CONSUMPTION

Figure 2 below represents the electricity consumption for the arena and ice plant over the past three years. The data was based on summary information from Local Authority Services, which includes estimates for some months. Hydro One invoices were not available for review for 2011 and for January through April of 2012, and as such electricity consumption could not be verified for those months. Propane consumption is unable to be graphed on a monthly basis as only annual amounts are available.

The graph indicates that the 2012 increase in electricity consumption was the result of a spike in the months of March, October, and December of that year. Reasoning for the spikes was unable to be determined during our investigation. Electricity consumption in the arena is driven by heating systems and the ice-making equipment.

Figure 2 - Arena Electricity Consumption



3.4 CHANGES IN USE OF FACILITY OR EQUIPMENT

There were no significant changes in use of the facility in 2012 versus 2011. However, in 2013 a local youth group utilized the arena during the months of July and August, therefore requiring lighting and the use of washrooms for five (5) days per week during that time period. This additional use had not occurred in the previous two (2) years. Given the fact that the arena lighting is connected Community Centre electricity meter, this additional use would have had minimal only impact on the energy consumption for the Arena.

In 2013, exterior wall-pack lighting and a new electrical panel and feeder line were installed at the arena. These changes would have had only minor impact on the total energy consumption.

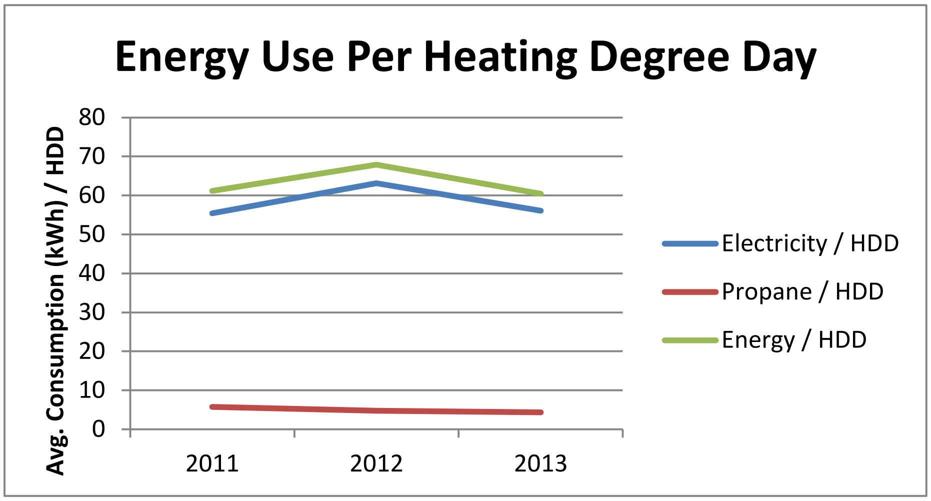
3.5 IMPACT OF WEATHER

Arenas sometimes have the difficult challenge of heating (seating area) and cooling (ice surface) the facility at the same time. However, the Eganville Arena does not heat its seating area. Heating is limited to the dressing rooms and the lobby area.

During the ice-making season, generally September through April, the outside temperature impacts energy consumption by requiring more energy to make and maintain the ice when temperatures are warmer, and less when temperatures are colder. Given the weather experience of a slightly warmer winter in 2012 versus 2011, the arena would have potentially experienced higher energy use in the winter of 2012 in order to maintain the ice surface. This is in line with the energy consumption data. And with the slightly colder winter in 2013 versus 2012, the arena would have potentially experienced lower energy use in the winter of 2013 in order to maintain the ice surface. Again, this is in line with the energy consumption data.

However, weather is not likely the sole reasoning behind the 2012 increase. As per Figure 3 below shows the average energy consumption per heating degree day rose in 2012 indicating that the building required relatively more energy to heat (was less efficient) than in the other two years.

Figure 3 - Energy Use Normalized for Weather



3.6 CONCLUSION

Our investigation resulted in improved accuracy of the electricity consumption information over the past three years and has provided valuable information regarding the operation of the facility and related energy consumption. However, even with the improved accuracy, the year over year fluctuation of the consumption remains largely unexplained, particularly the jump in electricity consumption in 2012, and the significant decline in propane consumption in the same year.

3.7 ADDITIONAL OPPORTUNITIES FOR CONSIDERATION

Given the challenge in explaining the jump in 2012 electricity consumption, an opportunity exists to monitor energy use on a more frequent basis and provide this information to facilities operations staff, in order to identify and potentially rectify increased energy consumption situations.

A terrific overview of arena energy use, including a number of potential energy conservation initiatives can be found at the following link: http://0101.nccdn.net/1_5/323/2b5/275/Arenas-Workshop.pdf

In addition, a few further considerations are outlined below[1].

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[1] Taken from http://www.spra.sk.ca/resources-and-advocacy/advocacy/utility-rates/bhpk.pdf

3.7.1 FLOOD WATER HEATING

Air in the water acts like insulation, making it harder for the brine in the slab to freeze the top layer of ice. The air is removed from the water by heating it above 130°F. Such water is warm enough to bond with the base ice, but not so hot that is imposes a huge load on the refrigeration system. Industry standard for flood water temperature is between 140°F-160°F. Heating the water beyond this range potentially adds unnecessary additional energy costs to the operation – more energy used to heat the water, and then more energy to freeze it.

During our investigation, it was indicated the current flooding water temperature is 180°F, so there may be an opportunity reduce the flooding water temperature to 140°C. Reducing the temperature would be achieved by lowering the temperature on the water heaters. A recommended approach would be to reduce the flood water temperature in 5°F increments and see if it affects the quality of the ice.

3.7.2 NIGHT SHUTDOWN

The arena ice can be hard or soft. As noted in the 2006 energy audit, hockey players prefer hard ice, 16°F (-9°C) brine returning at 18°F (-8°C), while figure skaters like soft ice, 22°F (-6°C) brine returning at 24°F (-4°C). Maintaining harder (colder) ice consumes more energy than maintaining softer (warmer) ice. Night shutdown involves letting the ice warm slightly during the overnight hours when the arena is not in use, then cooling the ice again prior to the start of the day. It is estimated that each degree Fahrenheit that you raise the ice temperature reduces the energy load on the ice plant by two percent.

Ice level temperature sensors and building automation technology could be used to raise the ice temperature during off hours. It is our understanding that the current Honeywell controller has night setback options. Night shutdown is achieved by shutting down the refrigeration plant at night including the brine pump. Ideally, all heat loads in the arena would be shut off at the same time. Once the slab sensor detects 25°F (-4°C), the brine pump and one compressor would be started to prevent the ice from warming any further.

In addition, the softer ice in the morning will be easier to cut and groom for the new day, which potentially reduces wear and tear on the ice maintenance equipment and saves on fuel.

While difficult to quantify accurately, estimated savings resulting from night shutdown at other facilities has been as high as $10,000 to $12,000 annually.

In addition, there may be an opportunity to exploit some untapped capabilities of the Honeywell controller system. TBV may considering discuss opportunities with TBV’s Honeywell representative for advanced staff training.

3.7.3 VARIABLE SPEED BRINE PUMP (CIMCO'S SEASONAL CONTROLLER PROPOSAL)

Often, when an arena's refrigeration system (particularly its motors and pumps) is designed, the equipment is selected to operate on the hottest days of the year, in order to ensure that the ice can be maintained. That means for a large part of the operating season, the plant is running less efficiently than it could be, as any day that isn't at the hottest temperature results in wasted energy.

The inefficient use of energy occurs in a couple of ways. The motors/pumps currently operate at a single speed. The action of this pumping introduces a large amount of heat to the brine, which means additional energy is required to cool the brine to maintain the ice temperature. Operating the current 20 hp pump is like running a 15 kW heater in the brine. The solution is to install a variable frequency drive (VFD) on the pump motor, which allows the pump to operate at a lower speed, when the full speed is not required. The result is that energy savings are achived through improved brine pump control – less energy used by the motor and well as not introducing the additional heat to the brine, which eliminates need for additional cooling.

Cimco has developed technology to eliminate this issue. They have proposed the installation of a seasonal controller which utilizes floating head pressure to match the refrigeration plant with the outdoor ambient conditions. By enabling the system to adapt to varying weather conditions, the refrigeration plant improves its operating efficiency, and creates the energy related savings.

Specifically, the Cimco proposal involves the installation of a seasonal controller, wells and sensors, and the replacement of existing motor with an invertor duty motor. The cost of to instal the new system is $20,500 plus taxes. With Save ON Energy grant and estimated energy savings, the payback has been calculated at 4.4 years. However, it may be prudent to assume a payback period of five (5) to six (6) years given the potential for additional installation costs, and lower energy savings.

4.0 TOWNSHIP SEWAGE TREATMENT PLANT

The Eganville Sewage Treatment Plant is a 220 square metre facility located at 131 John Street in Eganville, Ontario. Associated with the Plant is the dewatering process that takes place at a facility located across the street. In addition, the Plant's treatment process is supplemented by four (4) sewage pumping stations which assist movement of the sewage from various points in the community to the treatment plant. The sewage treatment plant was constructed in 1970 and provides wastewater treatment for the Town of Eganville. The facility operates 24 hours per day, 7 days per week which results in 8760 hours per year of operation.

Energy is used by the following systems:

- Heating: eight electric baseboard heaters, eight (8) barn/space heaters, and an air source heat pump.
- Cooling: air source heat pump
- Lighting: T8 fluorescent fixtures
- Pumping Stations; and,
- Waste Water Treatment Equipment including: clarifiers, aeration system, equalizer tanks, exhaust fans, and pumps, backup generator

The heat pump is controlled by a digital, programmable thermostat. The barn/space heaters are controlled by thermostats on each unit. Lighting is controlled by manual switches. The exhaust fan is controlled by a sensor.

4.1 ENERGY CONSERVATION INITIATIVES

Over the past five (5) years, several energy conservation projects have been completed at the facility, including the following:

- In 2006 the T12 fluorescent light fixtures were replaced with T8 light fixtures;
- In 2010 the heating and cooling system was upgraded with the installation of the heat pump system; and,
- In 2011, the chemical building had R40 insulation installed

Based upon the projects noted above, it was anticipated that energy consumption would decrease over time.

4.2 ENERGY & VOLUME OF SEWAGE MEASUREMENT

The wastewater treatment facility and dewatering facility share a single electricity meter. A new meter was installed on November 25, 2010. For Ontario Regulation 397/11, the electricity is split according to the following approximate percentages: sewage treatment facility 98%, dewatering facility 2%.

Over the three year period under review there was nine (9) month period where no meter readings took place and only estimates of consumption were provided - the electricity meter was read on July 22, 2011 but not again until May 2, 2012. While the total energy consumption for this period can be calculated, it is difficult to allocate the consumption accurately on a monthly basis. The method used was pro-ration of the total consumption for the period based upon the number of days in each month.

The total volume of sewage treated was provided by TBV staff. The volume is wastewater treated is metered on site at the point where the treated water is returned to the river, and the meter is certified annually as per provincial legislation requirements. The volume of bio-solids treated is measured by the geo-tube input system.

4.3 ENERGY CONSUMPTION

The facility utilizes electricity as its main source of energy. A minimal amount of fuel oil is used for the monthly testing of the backup generator. The vast majority of energy is consumed by the extensive sewage treatment equipment, particularly the air compressors. The sewage treatment equipment operates 24 hours per day, 7 days per week, throughout the entire year. The sewage treatment process is continued across the street at the de-watering facility. The treated sewage is pumped from one facility to the other.

Over the past three (3) years, the volume of wastewater treated has fluctuated, as has the total bio-solids treated, and the amount of electricity consumed. While the energy consumption has not moved in line with the volume of wastewater treated, it does appear to have a direct relationship with the volume of bio-solids treated. As shown in Table 3 below, the energy consumption and volume of bio-solids treated appear to rise and fall together.

The table also indicates that there is not a direct relationship between the volume of wastewater treated (as measured at the end of pipe before entering the river) and the volume of bio-solids treated. As such, it appears that volume of wastewater leaving the facility is not indicative of the “work” (energy used) to get the sewage to the point where it can be returned to the river.

Table 3 – Sewage Treatment Plant - Energy Consumption vs. Wastewater Treated

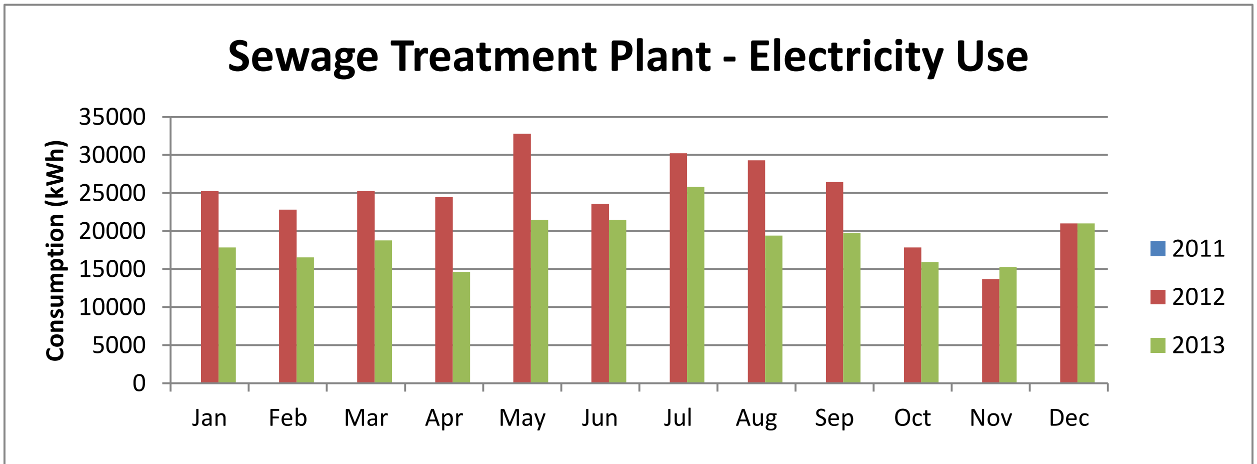
	2011	**2012**	**Change**	**2013**	**Change**
Total Energy Consumption – Sewage Treatment & Dewatering (kWh)	280,335	292,593	+4.4%	227,903	-22.1%
Wastewater Treated (Ml)	193	171	-11.4	183	+7.0
Bio-solids Processed (m3)	1,459	1,485	+1.2%	1,210	-18.5%

4.3.1 ELECTRICITY CONSUMPTION

The graph below displays the monthly electricity consumption for the sewage treatment plant for 2012 and 2013. During 2011 the electricity meter was read only every second month and therefore monthly data was not available to be included in the graph. The data is based upon the meter readings taken from available Hydro One invoices, which do include estimates for some months.

The graph reveals a significant drop in consumption during the January 2013 through September 2013 time period. A review of the supplementary information provided and a discussion with sewage treatment plant staff did not reveal an explanation for the consumption drop.

Figure 4 - Sewage Treatment Plant Energy Consumption



Note: January 2012 through April 2012 represent prorated consumption figures

4.4 IMPACT OF WEATHER

Compressors, blowers, and pumping processes generally consume the vast majority of energy associated with sewage treatment plants. As such, the energy consumption would be minimally impacted by annual variances in the temperature from year to year. Some impact could result from a significant variance amount of rainfall from year to year, and more rainfall would increase the flow of sewage and volume treated due to rain infiltration which occurs during the treatment and dewatering process.

4.5 CHANGES IN USE OF FACILITY OR EQUIPMENT

There have been no changes in the use of the facility during the period reviewed. However, in 2013 the facility had to run 2 blowers for a number of weeks during the summer due to mechanical issues. In the fourth quarter of 2013 the blower was rebuilt to rectify the situation, and the facility returned to using a single blower.

4.6 CONCLUSION

Our investigation resulted in improved accuracy of the electricity consumption information from the past three years and has provided valuable information regarding the operation of the facility and related energy consumption. In addition, while the energy consumption over the past three (3) years is not in line with the volume of wastewater treated, it does seem to be directly related to the volume of bio-solids treated. Given the fact that the volume of bio-solids treated is more representative of the energy required in the sewage treatment process, we would conclude that the energy consumption experience is in line with expectations.

4.7 ADDITIONAL OPPORTUNITIES FOR CONSIDERATION

Compressed air most likely accounts for a large amount of energy consumed at the plant. The Township may consider putting in place a system to measure compressed air usage so that any variances in consumption can be addressed in a more timely fashion.

5.0 TOWNSHIP WATER FILTRATION PLANT

The Eganville Water Filtration Plant is a 669 square metre facility located at 401 Water Street in Eganville, Ontario. The facility was constructed in 1991 and provides water treatment for the Town of Eganville. The facility operates 24 hours per day, 7 days per week, which equates to 8,760 hours in a year.

Energy is used by the following systems:

- Heating: seven (7) surface and ground source heat pumps, 3 electric baseboard heaters, 3 electric barn/space heaters, one (1) hot water heater (located in garage)
- Cooling: geothermal heat pumps
- Lighting: 75 T12 fluorescent fixtures and 50 T8 fluorescent fixtures.
- Water Filtration Equipment: Treatment Process: The raw water from the Bonnechere River is processed using a conventional type treatment plant with chemical coagulation, flocculation, clarification and filtration. Disinfection is achieved by the introduction of sodium hypochlorite which maintains free chlorine residual in the treated water. (Source: Township of Bonnechere Valley website)

The heating and cooling area controlled by thermostat. Lighting is controlled manually. The plant draws water from the Bonnechere River for use in its geothermal heat pump system.

5.1 ENERGY CONSERVATION INITIATIVES

Over the past five (5) years, several energy conservation projects have been completed at the facility, including the following:

- Since 2008, there have been on-going replacements of T-12 with T-8 Fluorescent Light Fixtures – approximately 40% of fixtures have been switched to date;
- In 2011, a new SCADA control system and electrical panel was installed;
- In 2012, a geothermal heat pump system was installed; and,
- In May of 2013, new High/Low lift pumps were installed

Based upon the projects noted above, it was anticipated that energy consumption would decrease in 2013.

In addition to the equipment changes made to the facility, the municipality installed residential water meters in order to encourage water conservation activities by residents. The meters were activated in 2011.

5.2 ENERGY & VOLUME OF WATER MEASUREMENT

The water filtration plant shares an electricity meter with the Queen St. sewage pumping station. For Ontario Regulation 397/11 reporting purposes, the proportion of electricity consumption allocated to the water treatment plant is 86%, while the remainder is allocated to the pumping station.

The volume of water treated is measured by incoming and outgoing flow meters, which determine the raw water and treated water volumes respectively. The volumes used in our review were taken from the annual flow reports supplied by TBV staff.

5.3 ENERGY CONSUMPTION & WATER TREATED VOLUME

The water treatment plant utilizes electricity as its only source of energy. The vast majority of energy used in the facility is consumed by the water filtration equipment.

Table 4 below provides a summary of the energy consumption and volume of water treated. Over the past three (3) years, the plant experienced a slight increase in energy consumption in 2012 followed by a significant increase of approximately 18% in 2013.

During the same period the volume of raw water entering the facility remained relatively stable, while the volume of treated water (water leaving the facility) dropped 2.6% in 2012 and dropped a further 2.1% in 2013.

Two items of note arise upon a review of the information shown in Table 4. Firstly, it would generally be expected that energy consumption at the facility would rise or fall in line with the volume of water treated. However, the numbers run counter to the expected direct relationship between the two: energy consumption has risen while the volume of water treated has fallen.

The second item of note is the change in efficiency of the water treated, which fell slightly in 2012 and again in 2013.

Table 4 - Energy Consumption vs. Water Filtered

	2011	2012	Change	2013	Change
Energy Consumption (kWh)	284,942	287,234	+0.8%	339,435	+18.2%
Raw Water (Megalitres)	209	209	0%	210	+0.5%
Water Treated (Megalitres)	193	188	-2.6%	184	-2.1%
Efficiency (Treated Water/Raw Water)	92%	90%	-2.2%	88%	-2.2%

5.3.1 WATER TREATED

Table 4 above indicates a drop in both 2012 and 2013 in the volume of water treated. Discussions with facility operations staff confirmed that the water treated is directly related to the demand for potable water by the community. It is our understanding that residential water meters were recently installed and activated in 2011. Given the drop in demand in 2012 and 2013, it appears that the water meters may be having their intended effect and are contributing to reduction in water consumption.

5.3.2 ELECTRICITY CONSUMPTION

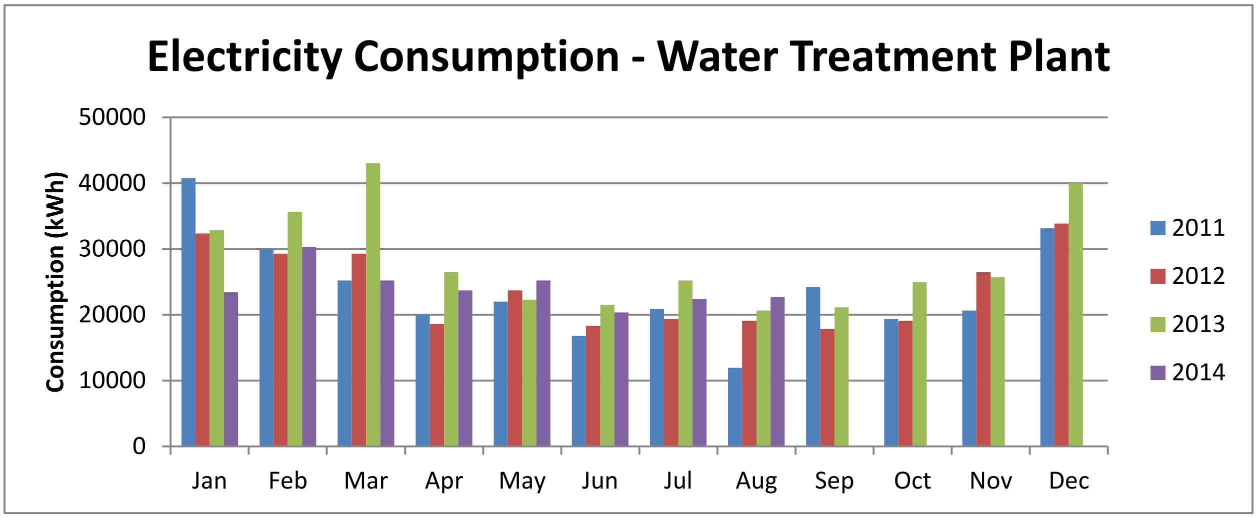
The graph below (Figure 5) displays the monthly electricity consumption for the water treatment plant over the past three and a half years. For this facility, we also examined the 2014 consumption to date to determine if the energy conservation initiatives were having the desired impact.

The consumption figures used were taken from a thorough review of all available Hydro One invoices and the associated meter readings in each, as opposed to utilizing the data found on the Hydro One Customer Activity Statement or the Local Authority Services summary sheets. In completing our review, it has been determined that there has been a significant discrepancy in reporting of energy use for Ontario Regulation 397/11 and the corrected consumption for this facility.

The graph reveals a ‘seasonality’ to the plant’s energy use, whereby more electricity is used in the winter months. This is generally a result of increased energy consumption for heating the facility during the winter.

However, the graph also indicates a significant jump in electricity use in February, March, April and December of 2013 versus the 2012 consumption. Discussion with facility operations staff revealed that the plant did not operate as efficiently in those months, which caused short filter run times, and more backwashes. The result of was more energy used and more water wasted (decreased efficiency).

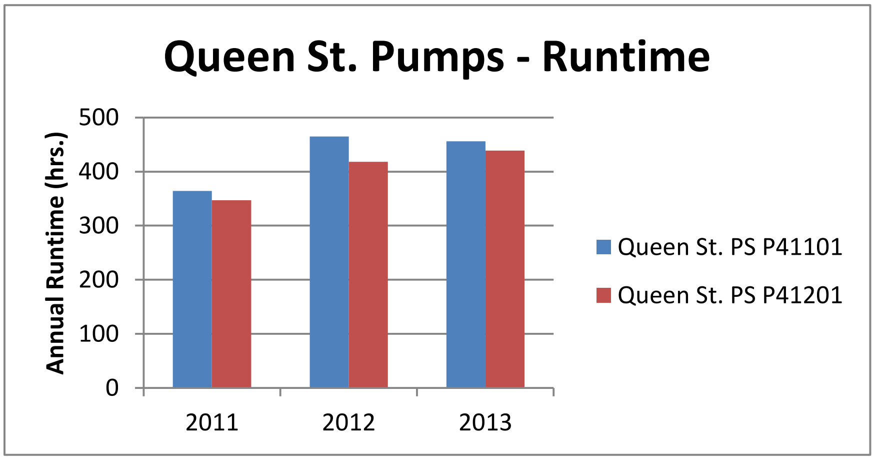
Figure 5 - Energy Consumption - Water Treatment Plant



5.3.3 QUEEN ST. SEWAGE PUMPING STATION – RUNTIME

As outlined in Figure 4 below, a review of the annual hours of operation, or runtime, of the pumps for the Queen St. pumping station indicates a marked increase in 2012 and 2013 over the year 2011. The pumping station utilizes two (2) ten horsepower pumps. As this pumping station is connected to the same meter as the water filtration plant, the increase would have the effect of increasing the overall electricity consumption for the plant for 2012 and 2013 but not to a significant extent.

Figure 6 - Queen St. Pumps - Annual Runtime



5.4 CHANGES IN FACILITY USE OR EQUIPMENT

There have been no changes in the use of the facility during the period reviewed. However, there have been several changes to the facility's equipment as noted in Section 5.1 above. In addition, ceiling fans were installed in the treatment room in 2013.

5.5 IMPACT OF WEATHER

Similar to the sewage treatment plant, compressors, blowers, and pumping processes generally consume the majority of energy associated with water filtration plants, while heating for the facility is usually second. As such, the energy consumption of the plant would be impacted by annual variances in the temperature from year to year, but not to a great extent, particularly following the installation of the geothermal heat pump system in 2012. Given the colder temperatures experienced in the winter of 2013 versus 2012, the expected impact would be an increase in energy consumption.

5.6 CONCLUSION

Following the equipment changes made at the facility in 2012 and 2013, it was anticipated that the energy consumption would decrease, however the 2013 consumption rose 18.2%.

Our analysis has determined several factors have combined to contribute to the increase, including:

- A colder winter in 2013 versus 2012 requiring more energy for heating;
- Several months of inefficient plant operation resulting in shorter filter runs, more backwash cycles and more wasted water; and,
- Increased operation of the Queen St. pumping station

While the above factors provide some explanation to the energy consumption experienced over the past three years, we were unable to confirm that they fully explain the magnitude of the 2013 increase, particularly given the recent installation of the geothermal heat pump system and new high/low pumps.

A review of the energy consumption to date for 2014 indicates that the facility is running 15% lower than 2013.

5.7 ADDITIONAL OPPORTUNITIES FOR CONSIDERATION

The new SCADA system installed in 2011 represents a tremendous opportunity to monitor the plant's efficiency and electricity consumption, as electrical monitoring was installed as part of the system.

During our investigation it was unclear as to whether or not this meter was working correctly or was commissioned. It is suggested that this be investigated further as this would allow for verification Hydro One readings and invoices as well as provide real time electricity consumption data.

6.0 TOWNSHIP COMMUNITY CENTRE

The Eganville Community Centre is a two-storey, 669 square metre facility attached to the Eganville Arena, and located at 178A Jane Street in Eganville, Ontario. The facility was constructed in 1947 and had a major renovation in 1977. The 1977 renovation included upgraded the walls, and steel frame of the structure. The facility operates approximately 20 hours a week, with around 1040 hours operating in a year. The Community Centre is home to the Eagle's Nest (a banquet hall and pub) located on the upper level, and the arena canteen on the lower level. The canteen is generally open September through March when the arena is operating. The Community Centre offers year round hall rentals, hosting various events including an annual dinner theatre group which utilizes the facility May through August.

Energy is used by the following systems:

- Heating: electric baseboard (lower level, washrooms), HVAC unit (upper level);
- Cooling: HVAC unit (upper level);
- Lighting: mainly T-8 fluorescent, stage lighting (dinner theatre) – the arena lighting 400W (total of 40) metal halide is connected to the community centre electricity meter;
- Canteen Equipment: fryer, 2 electric stoves, 2 fridges, exhaust system;
- Pub Equipment: fridge, exhaust system; and
- Plug-in Equipment: includes 2 vending machines

Heating and cooling for the upper level are controlled by programmable thermostats, and by baseboard switches on the lower level. Lighting is controlled by manual switches throughout.

6.1 ENERGY CONSERVATION INITIATIVES

Over the past 5 years, several energy conservation projects have been completed at the facility.

- In 2008, most of the fluorescent lighting was upgraded to T-8's
- In 2009 a new HVAC unit was installed to serve the Eagle's Nest hall
- In 2009, three (3) new propane hot water tanks were installed
- In 2014, the baseboard heaters were replaced

As the timing of the energy conservation measures falls outside of the timing of our analysis, no impact on energy consumption is expected from the above measures.

6.2 ENERGY MEASUREMENT

The community centre has its own dedicated electricity meter. However, the consumption data provided contains many estimates and gaps which cross over the years analyzed. These factors prohibit our development of year over year monthly consumption totals which would have assisted in our analysis. A new electricity meter was installed on April 20, 2012.

No measurement was available for the propane consumption.

6.3 ENERGY CONSUMPTION

The facility utilizes mainly electricity as its source of energy. Propane is used for the cooking equipment (fryer) in the canteen and for hot water heating for the change rooms.

Given the estimates and gaps in electricity consumption data noted above, it was difficult to determine accurately the annual amounts, however our best efforts resulted in the consumption summary as shown in Table 5 below.

Table 5 - Total Electricity Consumption - Community Centre

	2011	2012	% Change	2013	% Change
Electricity Consumption (kWh)	159,720	165,471	+3.6	172,389	+4.2

These values differ significantly from what has been recorded in accordance with Ontario Regulation 397/11. For that reporting it appears that a portion of the 2012 consumption was inadvertently reported as 2013 consumption. This created a shift of energy use which underrepresented the 2012 values and overstated the 2013 values. The energy bills have been sorted and adjusted to provide a more accurate representation of the actual annual energy use.

6.4 CHANGES IN FACILITY USE OR EQUIPMENT

According to facility operations staff, the hours of operation and number of hall rentals have essentially remained the same over the past three (3) years. However, in 2013 a youth group utilized the arena for 5 (five) days per week over the entire summer. Given the fact that the arena lighting is tied to the community centre electricity meter, this would have resulted in an increase in electricity consumption over the previous year.

6.5 IMPACT OF WEATHER

Given the fact that there have been minimal changes to the hours of operation or building use between 2011 and 2012, any significant changes in year over year temperatures would have had a pronounced impact on the energy consumption associated with heating and cooling the building. The summer of 2012 was significantly warmer than 2011 resulting in increased electricity consumption associated with cooling the upper level hall during summer activities. The winter of 2013 was colder than 2012 while the summer was significantly cooler resulting in more energy needed for heating in the winter offset by less energy needed for cooling in the summer: the overall effect likely be minimal.

6.6 CONCLUSIONS

Our investigation resulted in improved accuracy of the electricity consumption information from the past three years, but without the availability of invoices and meter readings, there exists the potential that the information could be improved further. The revised energy consumption data showed an increase in both 2012 and 2013.

Our analysis has determined several factors have combined to contribute to these increases, including:

- Increased heating required in the summer of 2012; and,
- Increased arena lighting use in the summer of 2013

Given the above, we conclude that the energy consumption is in line with expectations.

6.7 ADDITIONAL OPPORTUNITIES FOR CONSIDERATION

During our investigation it was noted that the exhaust fan in the lower level canteen runs constantly in the winter in order to prevent cold outside air infiltration back through the duct work and into the canteen when the fan is not running. The installation of a back draft damper on the exhaust should be considered.

Since the central heating/cooling system was installed on the upper level hall replaced to the baseboard heaters, the exhaust fans are no longer required after. The exhaust fan switches should be removed or locked off so that the system cannot be turned on accidentally by groups renting the space.

The upper level heating/cooling system is controlled by two locked thermostats. During our investigation one of the thermostats appeared not to be working. It is suggested that the thermostat be repaired and also that the Township confirm with their heating and ventilation contractor that the thermostats are programmable and that programmed schedules be implemented. In addition, facility operations staff should be trained to alter schedules if required.

GLOSSARY OF TERMS

Heating Degree-Days[2]	Heating degree-days for a given day are the number of degrees Celsius that the mean temperature is below 18°C. If the temperature is equal to or greater than 18°C, then the number will be zero. For example, a day with a mean temperature of 15.5°C has 2.5 heating degree-days; a day with a mean temperature of 20.5°C has zero heating degree-days. Heating degree-days are used primarily to estimate the heating requirements of buildings.
Cooling Degree-Days	Cooling degree-days for a given day are the number of degrees Celsius that the mean temperature is above 18°C. If the temperature is equal to or less than 18°C, then the number will be zero. For example, a day with a mean temperature of 20.5°C has 2.5 cooling degree-days; a day with a mean temperature of 15.5°C has zero cooling degree-days. Cooling degree-days are used primarily to estimate the cooling requirements of buildings.

Due to the Cold Canadian Climate, there are significantly more Heating Degree-Days than Cooling Degree-Days. HDD and CDD follow typical seasonal changes with more HDD in the winter, and more CDD in the summer.

In General, 2012 has a slightly warmer winter that 2.4% less HDD than 2011. 2013 was cooler than 2012, with 7.8% more HDD than 2012.

For Cooling Degree-Days, 2012 was warmer than 2011, and had 46.2% more CDD than in 2011. 2013 was cooler than 2011 and 2012 with 42.4% less CDD than in 2012.

The fluctuation in HDD and CDD from 2011 to 2013 would result in less heating required in 2012 but more cooling required. 2013 would require more heating energy but less cooling energy.

Weather data for this analysis was gathered from the Environment Canada weather station at Petawawa airport. Annual Heating and Cooling Degree-Days are shown in the graph below.

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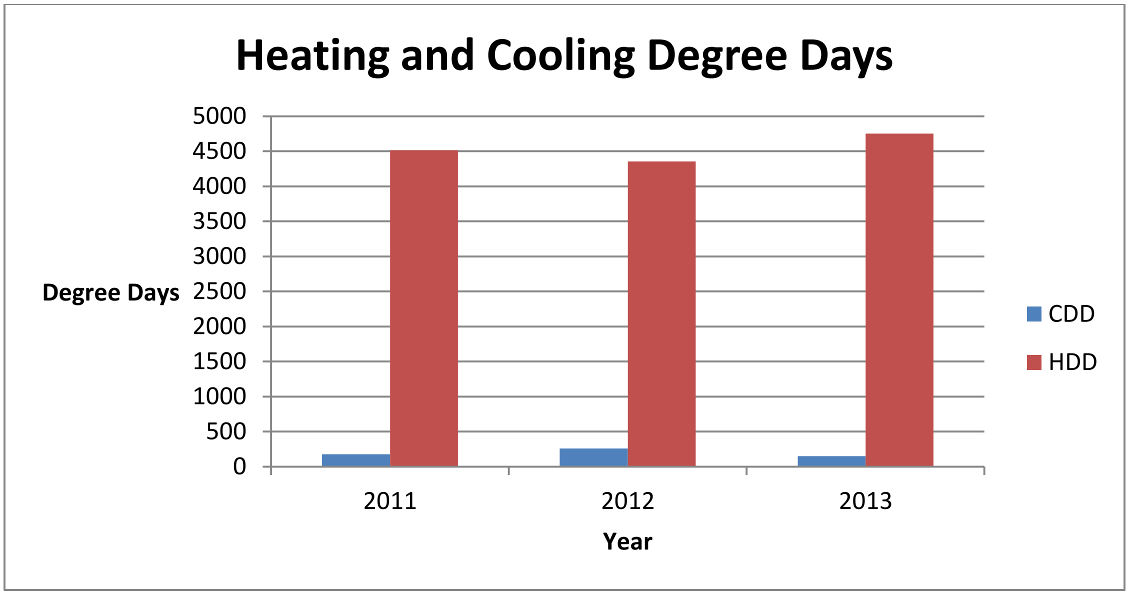
[2] Source: Government of Canada website on climate and weather


Heating and Cooling Degree Days
Degree Days
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2011
2012
2013
Year
CDD
HDD