B2Q Associates
100 Burtt Rd Suite 212
Andover, MA 01810
(978) 208 – 0609
www.b2qassociates.com

February 13, 2020

Ms. Margaret Nartowicz
Town Administrator
Town of Berlin
23 Linden St
Berlin, MA 01503

RE: Energy Efficiency Opportunities at the Municipal Complex and Highway Barn

Dear Margaret,

At your request, B2Q completed a walkthrough of two town facilities to investigate the potential for energy efficiency projects that could be eligible for a Green Communities Act grant application through the Massachusetts Depart of Energy Resources (DOER). We began at the town's Municipal Building and Public Safety Complex, comprised of the town offices, police station, and primary fire station, located at 23 Linden St. We then proceeded to the Highway Vehicle Maintenance Facility, also known as the Highway Barn, located at 112 West St. The following summarizes our opinion of the energy efficiency opportunities at each building, as well as a discussion of each. We have also included some non-energy efficiency measures that we noticed on our walkthrough that you may consider implementing outside of the Green Communities Act program for operations, maintenance, or comfort reasons.

Please review the following information and advise how you would prefer to proceed. We are happy to schedule a time to discuss further by phone if you have additional questions or concerns.

Thank you again for the opportunity to meet you all and to review these buildings.

Joseph Bliss

Joe Bliss, PE
Project Manager
B2Q Associates

CC: Dave Smith, Richard Andelman

MUNICIPAL BUILDING AND PUBLIC SAFETY COMPLEX

SUMMARY

The Municipal Building and Public Safety Complex could be a candidate for energy conservation projects through the Green Communities Act program or through other means. Our review of past energy efficiency studies of this building indicate that it already uses very little energy compared to other similar buildings, so energy savings potential and returns on investment may be limited; however, we believe a recommissioning project as outlined in ECM-2 below could provide reasonably strong savings with a good return on investment. Replacement of RTU-1 (ECM-1) is recommended for energy and maintenance reasons, though it may not qualify for the grant program, as outlined below. Additional energy conservation measures have been identified that could be pursued as well if desired by the town. Finally, we identified several other recommendations that should be considered, though there may be no energy savings benefit and/or further investigation may be required prior to committing to implement the changes.

ENERGY EFFICIENCY OPPORTUNITIES

1. **RTU-1 Replacement** – town staff indicated that there was a capital plan in place to replace the roof itself and that replacement of RTU-1 prior to or as part of the roof replacement may be required. We understand that RTU-1 is over 20 years old and has been suffering from some maintenance issues (see below). While replacement of this unit makes sense from a capital and operations perspective, we believe there would also be energy savings potential for an upgrade. Newer units can be purchased with higher efficiency cooling systems in the range of 12 – 14 EER, whereas the existing RTU-1 has an estimated efficiency of 10 EER. Additionally, improving the controls with the new unit relative to the existing, as outlined in ECM-2 below, could yield energy savings. On the other hand, the total installed cost for a 35 ton RTU replacement with the necessary rigging and roof curb work could exceed $100,000, which is the per project limit for the Green Communities grant program.

   High Level Economics: $2,000 - $5,000 savings, 20 – 40 year payback

   Next Steps: While this project is advisable for numerous reasons discussed above, it does not appear it would be a good fit for a Green Communities grant application. We would be glad to assist with implementation of this measure outside the context of Green Communities if desired.

2. **Recommissioning/Controls Optimization** – B2Q identified several smaller measures that could all be grouped together in a larger recommissioning and controls optimization category. Each is discussed further below.

   a. *Relocate Hot Water DP Sensor* – the existing differential pressure sensor is located at the pumps and the pump VFDs are controlled to maintain a fixed 12 psi differential pressure setpoint. Best practices suggest locating the DP sensor further into the building away from the pumps. This allows the system to control to a lower pressure setpoint, which saves energy during part load periods.

b. *Trim Schedules* - BAS graphics indicate that the existing schedules are as follows: RTU-1 and associated zones (Town Offices) – 3:00 am to 10:00 pm Monday through Friday and 6:00 am to 12:00 pm on weekends; RTU-2 and associated zones (Main Lobby) – 6:00 am to 12:00 am 7 days per week; AHU-1 and associated zones (Police and Fire Station) – 24/7. Some zones in the Public Safety part of the building may need to be 24/7, but many of the other zones could potentially be controlled to a shorter occupancy schedule. Alternatively, if schedules are inconsistent, occupancy sensors may be a preferable solution. See ECM-7 below.

c. *Improve Unoccupied Temperature Setbacks* – RTU-1's zones are programmed with unoccupied space temperature setpoints of 70 °F in heating and 80 °F in cooling. RTU-2's zone unoccupied setpoints are the same as the occupied setpoints (65 °F heating, 74 °F cooling), and AHU-1's zones control to either 65 °F heating, 77 °F cooling or 68 °F heating, 77 °F cooling. Typically, unoccupied setpoints of 62 °F heating, 80 °F cooling are achievable for more zones. If the Town is not aware of any operations or maintenance issues that would prevent the systems from bringing spaces back to occupied setpoints from these increased setbacks, then there may be energy savings associated with these changes.

d. *Fix AHU-1 Leaking HW Valve* – a sample screenshot from the BAS showed that the air temperature rose from 68 °F to 86 °F as it passed over the heating coil despite the coil valve being commanded closed. This could be an indicate of a valve or actuator failure causing the system to waste heating energy.

e. *Lower HW System Enable Threshold* – the BAS indicates that the hot water system is automatically enabled whenever the outside air temperature is below 75 °F. Best practices typically call for this threshold to be 50 °F – 60 °F. Decreasing the threshold would reduce runtime for the boilers and could save energy.

f. *Repair RTU-1 Leaking Damper* – a sample screenshot from the BAS showed that the mixed air temperature for the unit was 68 °F with a return air temperature of 82 °F and the outside air damper commanded fully closed. This could indicate that some cold outside air is unintentionally being allowed into the unit, adding unnecessary load to the heating system. The sample of temperatures we observed corresponds to a damper stuck and allowing at least 21% outside air into the supply airsteam. Because the RTU has a CO_2 sensor for demand control ventilation (DCV), the stuck damper could be preventing the system from achieving savings by reducing the outside air ventilation rate during low occupancy periods.

g. *Implement RTU-1 Static Pressure Reset* – according to the BAS graphics, RTU-1's supply fan VFD is controlled to maintain a fixed 1 in. wc static pressure setpoint. More sophisticated logic could be added to monitor the behavior of the downstream zone dampers to reduce the static pressure setpoint when the zones do not require full airflow, which could save fan energy.

h. *Improve RTU Discharge Temperature Control* – during our walkthrough, we observed that RTU-1's controls called for the unit to supply 85 °F air; however, the average zone temperature was more than 2.5 °F above setpoint, indicating that the unit potentially should have transitioned to cooling mode, and the actual supply temperature was 117 °F. A more detailed investigation would be required to diagnose the exact cause and recommended action, though, it does appear likely that the unit may be overheating the building and potentially wasting some heating energy.

High Level Economics: $3,000 - $6,000 savings, 5 – 10 year payback

Next Steps: Consider whether the above recommendations are feasible based on your experience with the facility, specifically the reduce schedule runtimes and changes in space temperature setbacks. If our recommendations above appear reasonable and the estimated economics meet your target levels, we can proceed with developing a turnkey proposal as the basis for a Green Communities Act grant application.

3. **Install a VFD for the Fire Station Garage Exhaust Fan** – Fire truck exhaust is provided by a 10 hp 2,500 cfm fan suspended within the garage. Each truck is supplied with a hose connection for the exhaust pipe to direct engine exhaust directly out of the area. Each hose is equipped with a shut off valve to stop exhaust when the engine is not running. It may be feasible to install a VFD on the exhaust fan to reduce the speed of the fan whenever less than full airflow is required, which would save energy.

   High Level Economics: $500 - $2,000 savings, 5 – 10 year payback

   Next Steps: For the purposes of this analysis, we have assumed the fan runs on average 8 hours per day, 365 days per year. Please inquire with relevant staff whether this estimate is reasonable. If our estimate above appears reasonable and the estimated economics meet your target levels, we can proceed with developing a turnkey proposal as the basis for a Green Communities Act grant application.

4. **Install VFD for AHU-1 Supply Fan** – AHU-1 serves a variable volume multizone system of zone dampers; however, AHU-1's supply fan runs constant speed and the air volume delivered to the zones is controlled by a bypass damper between the supply and return ducts. The same volume control could be achieved using a VFD on the fan and keeping the bypass damper closed and this approach would use less energy than the bypass damper approach.

   High Level Economics: $800 - $2,000 savings, 8 – 12 year payback

   Next Steps: Please inquire with relevant staff whether this measure appears feasible based on your experience with the equipment. If our analysis above appears reasonable and the estimated economics meet your target levels, we can proceed with developing a turnkey proposal as the basis for a Green Communities Act grant application.

5. **Retrofit Boiler Circulator Pumps with Variable Speed Pumps** – each of the three new Buderus boilers is equipped with a constant speed Grundfos circulator pump. We

observed during our walkthrough that all three pumps were set for full speed. It may be feasible to retrofit these pumps with variable speed pumps that could modulate the flow through each boiler to maintain a differential temperature setpoint. This approach would save pump energy and may also reduce boiler cycling losses by maintaining a larger boiler temperature differential at low load.

High Level Economics: $100 - $200 savings, 20+ year payback

Next Steps: The energy savings and return on investment of this measure make it not a strong candidate for a Green Communities grant application. We can assist with implementation outside of the program if desired.

6. **Install Occupancy Sensors** – during our walkthrough we observed that there were several spaces that were unoccupied or that would be expected to have variable occupancy over the course of the day. For example, these could include conference rooms, the hearing room, locker rooms, the booking room, and the holding cell. Installing occupancy sensors in these rooms and potentially others would reduce energy use when the space is not in use by allowing the temperature to float an additional 2 – 4 °F and then returning the temperature to normal when someone returns to the room.

   High Level Economics: $800 - $1,500 savings, 12 – 18 year payback

   Next Steps: Please inquire with relevant staff whether this measure appears feasible based on your experience with the building. If our analysis above appears reasonable and the estimated economics meet your target levels, we can proceed with developing a turnkey proposal as the basis for a Green Communities Act grant application.

7. **Retrofit Terminal Units and Exhaust Fans with EC Motors** – many of the small fan motors throughout the complex are permanent split core (PSC) technology. Newer electronically-commutated (EC) motors are more efficient and can typically be retrofitted as direct replacement. This would apply to approximately (3) unit heaters, (6) exhaust fans, and potentially (1) ceiling fan.

   High Level Economics: $1,200 - $2,000 savings, 15 – 20+ year payback

   Next Steps: Please inquire with relevant staff whether this measure appears feasible based on your experience with the equipment. If our analysis above appears reasonable and the estimated economics meet your target levels, we can proceed with developing a turnkey proposal as the basis for a Green Communities Act grant application. Note that there is a chance that this measure may exceed the 20 year payback limit typically used by DOER in reviewing grant applications, so as part of developing our proposal, we would need to obtain more precise cost estimating information to confirm whether the project would qualify.

Non-Energy Facility Improvement Opportunities

1. **Investigate HW Plant System Readings** – as part of our review of the BAS screenshots, we observed that the hot water pump was running at 79% speed, was maintaining a 12

psi differential pressure across the pump, and the loop showed a 50 °F temperature difference (supply temp – return temp). A 50 °F temperature difference is much higher than the typical 20 or 30 °F difference most systems are designed for. A higher than usual temperature difference often indicates insufficient flow from the pumps. On the other hand, when we reviewed the performance curves for this pump, we found that if it were operating at 12 psi and 79% speed, then it would be producing much more than the flow it is designed to produce. Therefore, we believe that one or more of the pressure sensor, supply temperature sensor, and the return temperature sensor is not reading correctly. We suspect the pressure sensor as the primary culprit based on the analog gauge readings in the plant, but further investigation would be required to confirm. This investigation could be done through a recommissioning effort, such as we outlined in ECM-2 above, though there may be no energy savings benefit. Alternatively, the town could contract a controls or balancing contractor to test the sensors.

2. **Investigate Boiler Room Temperature Control and Ventilation** – during our walkthrough we observed that the boiler room was colder than most comparable rooms in our experience. According to the BAS graphics, the room is controlled to attempt to maintain 60 °F, which is reasonable, but was only able to achieve 55 °F. Colder boiler rooms can cause issues such as condensation in the boiler exhaust, which is corrosive, but can also lead to freezing pipes if left unchecked. While in the boiler room, we observed at the exhaust vent for the room was open temporarily and the combustion air damper appeared to be open for the duration of our walkthrough despite the boilers only firing for part of that time. Typically, the exhaust vent damper would only open if the room was too warm and needed to release heat and the combustion air damper would be tied in with the boilers to only open when they are firing. Further investigation would be needed to confirm the current and ideal operation of these components. As with the item above, the investigation could be done through recommissioning, though there may be no energy savings. We recommend that the town consider investigating using your own service contractors or through a project with B2Q.

3. **Check RTU-1 Refrigerant Charge** – in a conversation while on the roof of the Town Offices, we learned that there had been on-going issues with icing on the cooling coil during cooling season. This issue is most commonly caused by insufficient airflow across the coil and/or insufficient refrigerant in the system. Given the age of the unit, our opinion is that low refrigerant charge is the more likely explanation. We recommend that the town reach out to a service contractor to check the charge and add more refrigerant if required.

4. **Check AHU-1 Static Pressure Control** – our review of sample BAS screenshots revealed that AHU-1 was unable to maintain its static pressure setpoint with the fan at full speed and the bypass damper commanded fully closed. The result is that the spaces served by AHU-1 may not be receiving sufficient airflow to properly heat or cool them. This issue may be caused by one or more potential underlying issues, such as a static pressure sensor that is out of calibration, a leaking bypass damper, an undersized fan, or an improper choice of static pressure setpoint. Further investigation is required to test and confirm the true cause(s) and recommended measures to address it. Such investigation

could be included in the recommissioning effort in ECM-2, though there may be no energy savings as a result.

5. **Standardize Zone Damper Sequence and Remove Overrides** – as part of our review of the BAS graphics, we found that there appeared to be some inconsistencies in how the zone dampers were responding to the temperatures in their corresponding zones. During the time of our observation, the temperature of the air leaving the air handling units was well above the actual zone temperature. Nevertheless, some zone dampers were commanded open when the zone was too hot, some were commanded open when the zone was too cold, some were commanded to minimum air when the system was too hot, and some were commanded to minimum air when the system was too cold. These kinds of discrepancies often arise from service issues with the equipment, such as failed components, incorrect sensor readings, or improperly designed zones and facilities/service personnel respond to these underlying issues by making individual adjustments and overrides through the controls system. If the building has been experiencing temperature control issues, we recommend a more detailed investigation be undertaken of these zones, the potentially improper controls changes that were made, and any underlying issues that may have necessitated the overrides are addressed. Such investigation could be included in the recommissioning effort in ECM-2, though there may be no energy savings as a result.

Highway Vehicle Maintenance Facility

Summary

The Highway Barn building is a relatively new construction building built in 2016. The HVAC system is comprised of (3) energy recovery ventilators (ERVs), an estimated (10) indoor variable refrigerant flow (VRF) fan coil units (FCUs), and (3) VRF outdoor condensing units. We understand that there is no natural gas or oil-fired equipment in the facility and no natural gas service is available in the area. This system design, especially for applications when no fossil fuels are available, is typically relatively efficient. The ERVs provide outside air for ventilation, required by code, but use energy from the exhaust air to pre-heat or pre-cool the supply air, which saves energy. The VRF FCUs provide either heating or cooling depending on the needs of the zones they serve and the system is capable of having some zones in heating and some in cooling at the same time.

We also understand that the building was originally intended to have solar photovoltaic (PV) arrays, but this system was value engineered out of the design prior to construction due to budget limitations. As a result, utility bills for the facility have been much higher than anticipated and have created a strain on the town.

Energy Efficiency Opportunities

None at this time. As explained above, there is limited visibility into the operation of the system without a building automation system with a user interface. In order to identify whether systems are not working as efficiently as they could, we would likely need to hire a service contractor to test the equipment and gather data about its operation over a sample period.

It may be possible to investigate energy conservation measures such as modulating the ventilation rates through the ERVs based on zone occupancy or to add occupancy controls for the fan coil units; however, these measures typically function best when the building has a central controls system and more investigation would be required to determine the capabilities of the existing equipment to incorporate these enhanced strategies.

Non-Energy Facility Improvement Opportunities

1. **Consider Adding Supplementary Heat for VRF System** – one of the potential drawbacks with a VRF system is that the heating capacity of the system decreases significantly as the outside air temperature drops on the coldest days, which thereby increases the heating demand. Many systems are designed with separate electric heaters and/or "low ambient kits" on the condensing units to provide backup and/or supplementary heat for the coldest days. Coincidentally, on the day of our visit, which was particularly cold, one of the condensing units had failed and the office section of the building had very limited heat as a result. Retrofitting the system this way would likely use more energy than the current system, but could provide redundancy and operational benefits for the occupants.
2. **Investigate Ductwork Layout** – during our walkthrough, we observed some unexpected features in the ductwork layout that may warrant further investigation. For example, in

the ceiling above the office section of the building, it appeared that the supply duct from one of the FCUs was feeding into the return duct of one of the other FCUs. We also observed that for at least one of the ERVs, it appeared that the exhaust duct was insulated, when typically the supply duct is the only one to be insulated. Finally, we were not able to identify the source of return air for the FCUs in one of the open bay spaces. Given the preliminary nature of our investigation and our lack of pre-existing knowledge about the facility, it is possible that our observations are mistaken or that the systems are in fact designed and installed properly. On the other hand, a more in-depth investigation would likely require a relatively small investment of time and could be warranted if the facility has experience temperature control issues in the past (other than the lack of heating capacity on the coldest days).