New York State
Pollution Prevention Institute

# New York State Pollution Prevention Institute

RIT Golisano Institute for Sustainability

*Final Report for:*

## *Town of Geneva*

*Town of Geneva, NY*

# Energy Efficiency Measures in Town Owned and Operated Buildings

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## A. Executive Summary

The New York State Pollution Prevention Institute (NYSP2I) at Rochester Institute of Technology (RIT) conducted a project entitled, “Energy Efficiency Measures in Town Owned and Operated Buildings” for the Town of Geneva (Geneva). The objective of the project was to review the energy use in a selection of town owned and operated buildings and identify energy conservation measures (ECMs). In pursuit of this objective, NYSP2I reviewed Geneva’s energy utility costs for three high opportunity buildings, performed high level energy opportunity assessments, and reported a list of opportunities from the three assessments to Geneva.

The results of this project include a list of suggested ECMs for Geneva’s Town Hall, Highway Department Office building and Highway Department Garage Bay building. Some of the ECMs should require little to no cost to implement and will provide immediate savings while other ECMs have some associated costs but with energy cost savings. Geneva should prioritize each list and implement as many ECMs as possible to maximize energy cost savings.

## B. Introduction

The Town of Geneva, first incorporated in 1806, is a community of 3,291 residents (2010 Census) located on the eastern edge of Ontario County. The Town of Geneva is part of the Climate Smart Communities (CSC) which is a New York State program which helps local governments take action to reduce greenhouse gas emissions and adapt to a changing climate. As part of their focus to become more sustainable, Geneva wants to identify potential energy savings and operate more efficiently. They requested assistance from NYSP2I in the assessment and identification of potential energy efficiency measures (EEM) in Geneva owned and operated buildings.

## C. Project Objective

The objectives of this project were to find energy waste or inefficiencies within Geneva’s highest opportunity buildings and recommend ECMs to correct or improve the problems.

## D. Work Performed and Results

To achieve the project objectives, NYSP2I performed the following tasks as specified by the project contract:

### Task 1 – Review Energy Use Data

Geneva provided NYSP2I access information to their Portfolio Manager account. NYSP2I compared both the energy use index (EUI) and annual energy consumption of each of Geneva's buildings. NYSP2I then reviewed utility bills from Geneva's buildings to understand the various charges like delivery, use, and demand.

### Task 2 – Select High Opportunity Buildings

NYSP2I and Geneva's project team considered EUI, energy consumption, and building age to select the Town Hall, and the Highway Department Buildings as having highest potential opportunities.

### Task 3 – Perform High Level Energy Assessments

NYSP2I conducted energy walk-throughs known as walkdowns in the Geneva Town Hall/Courthouse, and the Highway Department Buildings. For each building, NYSP2I walked through and around the building using tools to identify energy waste.

Some of the tools used were:

- Thermal Imaging Camera
- Handheld environmental multi-meter that includes:
    - Temperature
    - Relative Humidity
    - Anemometer
    - Light meter
- Extendible hot-wire anemometer
- Handheld thermocouple sensor

During the walk-throughs, NYSP2I observed or measured building conditions, environmental conditions, mechanical equipment, temperature set-points, and light switch status. Specifically, the following items were observed or measured:

- Building Envelope – insulation, walls, roof, windows, doors, utility entrances, etc.
- Lighting – interior and exterior control schedules, lamp types, lighting levels, etc.
- Office Equipment

- Indoor Environmental Conditions
- HVAC – temperature set-points and schedules, chiller and boiler equipment condition and maintenance, equipment sizing, outdoor air reset, plumbing, air distribution, makeup air control, economizers, etc.
- Hot Water set-points and use

The results of the walkdown were used to identify opportunities and recommend ECMs for each building below. More in-depth exploration of the Walkdown Reports for the Town Hall and Highway Department Buildings can be seen in Appendix A. The team also documented successful sustainability practices already in place.

Geneva Town Hall/Courthouse

The Town Hall/Courthouse walk through started at approximately 7:30 am on Friday March 6, 2020. The outdoor air temperature was near 50 degrees and the relative humidity was approximately 39% during NYSP2I's visit.

All thermostats were covered by locking guards, a good measure to prevent unauthorized users from altering schedules and set points. Temperature set points in most areas were 1-2°F higher than ASHRAE (American Society of Heating, Refrigeration and Air-conditioning Engineers) recommended heating set points (68-72°F) but one was several degrees higher set at 76°F. Additionally, only one of the thermostats was programmed with a (minimal) set-back of 2°F Monday-Saturday at 5pm and all day Sunday. Daily temperature set-backs are an easily executed, no cost energy conservation measure. NYSP2I also noted that there were many unoccupied rooms/offices that were heated to occupied temperatures, even though many of the rooms/offices consistently have minimal occupancy. One such example, the Court room, which is the largest room in the building is only scheduled to be occupied for a handful of hours per week yet has the second highest set point and is heated 24/7.

NYSP2I noted that all the thermostats are simple, single zone style which result in varied temperatures in offices/room because of the current zoning configuration. This results in problems such as one occupant needing to open their window to cool off while another needs supplemental heating. A building automation system with zone temperature sensors and timed override button in each office could prove to be a more effective solution for managing the

heating and cooling of the variously occupied spaces, albeit with a much higher cost than temperature set-backs.

Additionally, NYSP2I discovered that both air handlers as well as the make-up air unit in the attic space were missing air filters. Filters are important for maintaining indoor air quality and filters of the appropriate size and efficiency should be added as soon as possible.

Another area for consideration is the external building envelope. In several locations the soffit has come loose and is hanging lower than it should. This can cause excessive ventilation of the attic space increasing heating and cooling cost as well as allow rodents and insects an easy access point commonly leading to compromised insulation and other types of damage and health hazards. NYSP2I also noted that the breakroom exhaust fan vent damper was stuck open and appears to currently, or recently had a bird(s) living inside of it. This can cause: the vent to operate improperly, air leakage out of the conditioned building space increasing heating costs and poses potential health hazards.

Other findings for the Geneva Town Hall/Courthouse included:

- Missing/worn weather stripping on exterior doors
- Seals and insulation reused when condensers on roof were upgraded
- Missing insulation above court room
- No warm water in bathrooms despite hot water circulator running
- Considerable thermal bridging in bathrooms despite mild outdoor conditions

Geneva Highway Department Office & Garage Bay Buildings

The Geneva Highway Department Office & Garage Bays walk-through was performed on Friday March 6, 2020 at approximately 1:30 pm. The outdoor air conditions were approximately 45°F and 55% relative humidity when the walk through began. The Highway Department Office & Garage Bay Buildings are in good shape because of proactive measures taken by Geneva. The building envelope of both structures has been augmented by the addition of exterior foam insulation, insulated garage bay doors, and the upgrade to double pane windows in the Highway Department Office Building. Most of the areas of improvement involve operational modifications rather than building or equipment upgrades.

NYSP2I observed a window air conditioning unit installed in the office of the Garage Bay building even though the walk-through was still in Early Spring. Best practice is to remove the window unit when switching from cooling to heating season. Window units are notoriously difficult to seal and they increase heating costs when they are in place based on their limited insulation. Upgrading the remaining aluminum frame double pane windows to vinyl double pane windows in the Garage Bay building would further reduce the heat loss from the office.

Compressed gas is used throughout both buildings, with the compressor located in the Highway Department Office building and plumbed into the Garage Bay Building. Since the efficiency of compressed air as a power source is particularly low (5-10%) air leaks can waste significant amounts of energy. Several leaks were identified, one of which is the result of using a water valve in the compressed air plumbing. Geneva should also consider conducting periodic leak audits to measure the overall leak rate and to find and repair air leaks.

NYSP2I also observed that all thermostats in both buildings were basic single set point types. Upgrading the thermostats to programmable type and setting a schedule for occupied and unoccupied hours could lead to potentially significant energy savings while still allowing equipment to be started easily in cold weather.

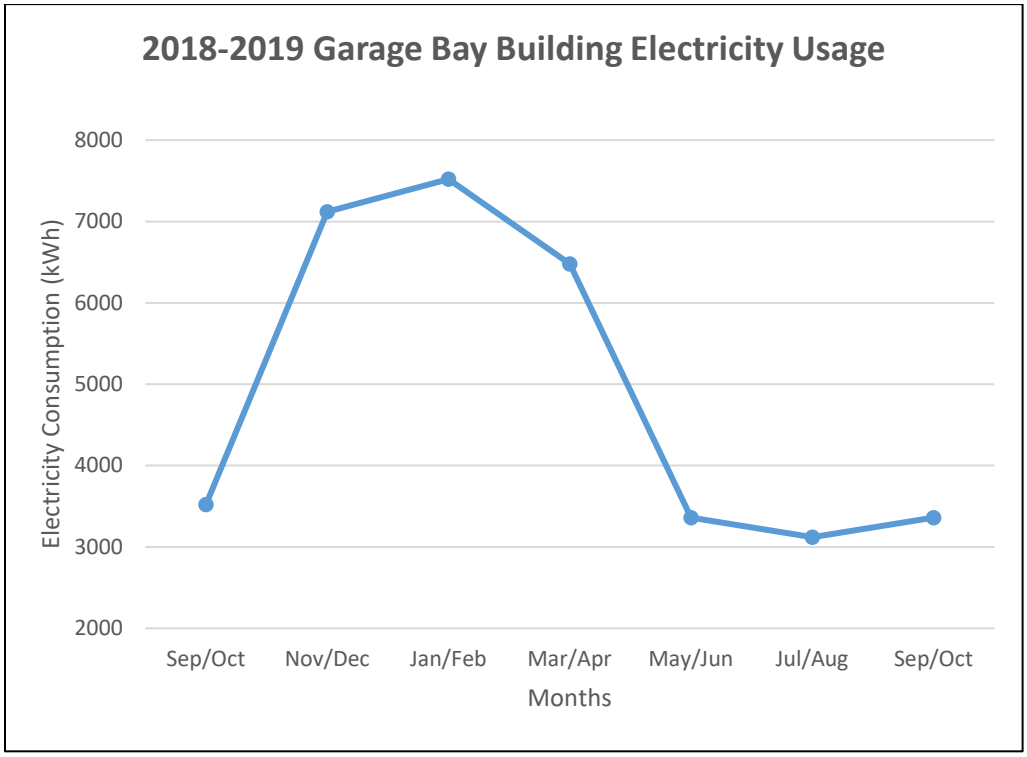



**Figure 1, Electricity Consumption in Garage Bay Building**

Figure 1 shows the electricity use of the Garage Bay Building from September 2018 to October 2019. The electrical energy use more than doubles during the cooler months and is likely from the electric baseboard heaters in the office since the garage bays are heated with natural gas radiant heaters. An electric heat pump should be considered as a replacement for the baseboard heaters since they are significantly more efficient and can easily cut heating energy costs by 50%. Because there was no electric billing information for Highway Office building, it is assumed that it is included in the Garage Bay Building meter.

Other findings from the Geneva Highway Department Office & Garage Bay Buildings included:

- Self-closing mechanisms on person doors will reduce heat loss
- Louvres on the south side of the Garage Bay building appear to be open
- Damaged overhead door panels have compromised insulation
- Gaps and cracks observed around overhead doors

## E. Conclusions and Next Steps

The Energy Efficiency Assessment by NYSP2I at Geneva, NYSP2I unveiled several ECM opportunities. Many of the ECMs have no/low implementation costs and provide immediate cost savings. Other ECMs may require a small cost or effort but will provide energy cost savings with a quick payback. There were also some ECMs that require a more significant investment that could save significant energy cost. The options that Geneva can take towards pursuing their sustainability goals are briefly described below:

<u>No/Low Implementation Cost/Immediate Savings</u>

- Programming Town Hall thermostats with occupancy dependent set-backs
- Investigate Town Hall warm water circulation system
- Repair leaks in compressed air lines in all vehicle bays
- Remove window air conditioner for heating season from Garage Bay Building Office
- Sealing gaps and crack on overhead vehicle bay doors
- Turning off unnecessary lights or keeping doors closed in winter

<u>Moderate Cost or Effort/Quick Payback</u>

- Repairing loose soffits on the Town Hall
- Repairing Town Hall breakroom ventilation
- Replacing worn or missing weatherstripping in exterior doors and windows in all buildings
- Self-closing mechanisms on exterior person doors in Highway Department Buildings
- Upgrading thermostats to programmable type in all Highway Department buildings and using occupancy dependent set-backs

Larger Investment/Significant Cost Saving Potential

- Upgrading Town Hall thermostats to a building automation system with zone temperature sensors and timed override buttons in each office
- Replacing electric baseboard heater in Garage Bay Building office with electric heat pump
- Replacing/upgrading Highway Department air compressor (dependent on use frequency, currently not known) or replacing with two smaller units, one for each building

## F. Appendix

# Building Re-Tuning Walk-down Observations for Geneva Town Hall

## Background

Commercial buildings account for almost 20% of the total U.S. energy consumption and up to 30% of the energy they use is stated due to improper and inefficient operations[1]. As a result, in recent years, much attention has been given to energy efficiency of large commercial buildings. The concept of re-commissioning these large buildings to reduce energy use after a period of operation has shown that improvements are possible even to well designed and maintained buildings. More recently, reduced scope versions of building re-commissioning have been developed for commercial buildings called Building Re-Tuning. The U.S. Department of Energy's Building Technologies Office and the Pacific Northwest National Laboratory (PNNL) have developed classroom and online training for commercial Building Re-Tuning.

In 2012, the National Institute of Standards and Technology sponsored the development of a Building Re-Tuning (BRT) Curriculum for Small to Medium sized Industrial buildings. Rochester Institute of Technology (RIT), in partnership with PNNL and the City University of New York (CUNY) developed a curriculum to train owners of small to medium sized industrial buildings how to perform building energy retuning assessments of their buildings.

Using walkdown and analysis techniques from the BRT curriculum, New York State Pollution Prevention Institute (NYSP2I) from RIT performed a BRT walkdown of Geneva's Town Hall building.

## Executive Summary

NYSP2I performed a walk down of the Town Hall on Friday March 6, 2020. The walkdown was started at approximately 7:30am. The purpose of the walkdown was to identify energy conservation measures (ECM) in the building.

The building re-tuning effort focuses on evaluating the buildings operation and energy performance and on low and no cost opportunities that may lead to reduced energy consumption and improved comfort.

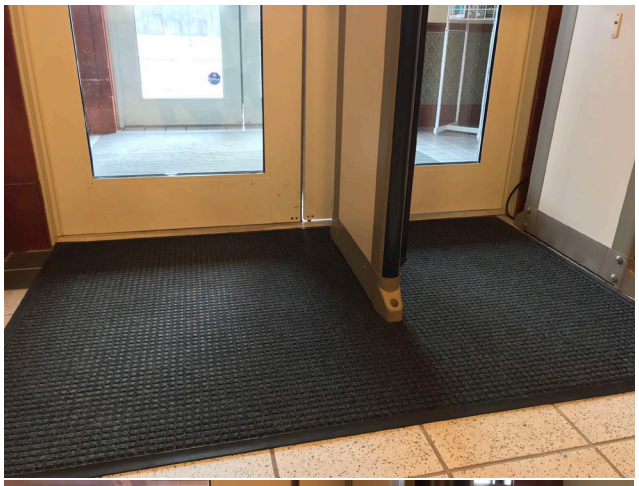
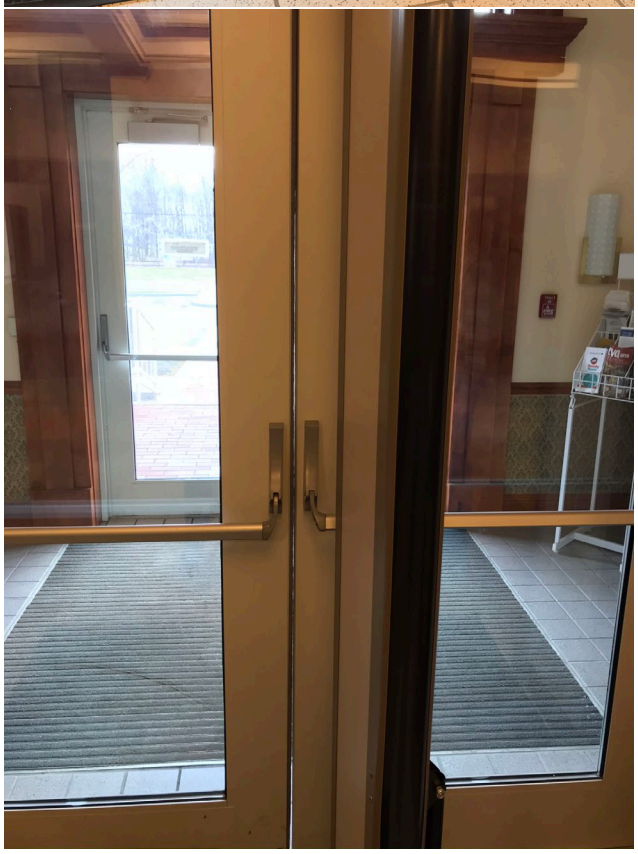
[1] US Energy Information Administration's 2018 Commercial Buildings Energy Consumption Survey (CBECS) - https://www.eia.gov/consumption/commercial/

The following list covers the opportunities identified by NYSP2I during the Town of Geneva, Town Hall walkdown and suggested energy conservation measures to mitigate inefficiencies. The list is categorized by energy users and includes occupant behavior since the occupants can impact building energy use. Many of the opportunities are low or no cost implementations but some will require capital expenditures. In the following list, some of the re-tuning opportunities and ECMs are qualified for effort and energy savings. The qualitative ratings of low, medium, and high are somewhat subjective but low effort generally means that the ECM takes a few hours to implement and low savings indicate less than 5% reduction. High effort generally indicates extensive capital cost and/or many hours of effort and high savings indicate 10-30% energy reduction(footnote). NYSP2I encourages Geneva to contact the local utility to inquire about energy conservation programs that might offset the cost of implementing costly measures but may still have a reasonable payback period (less than three years).

**Building Envelope**

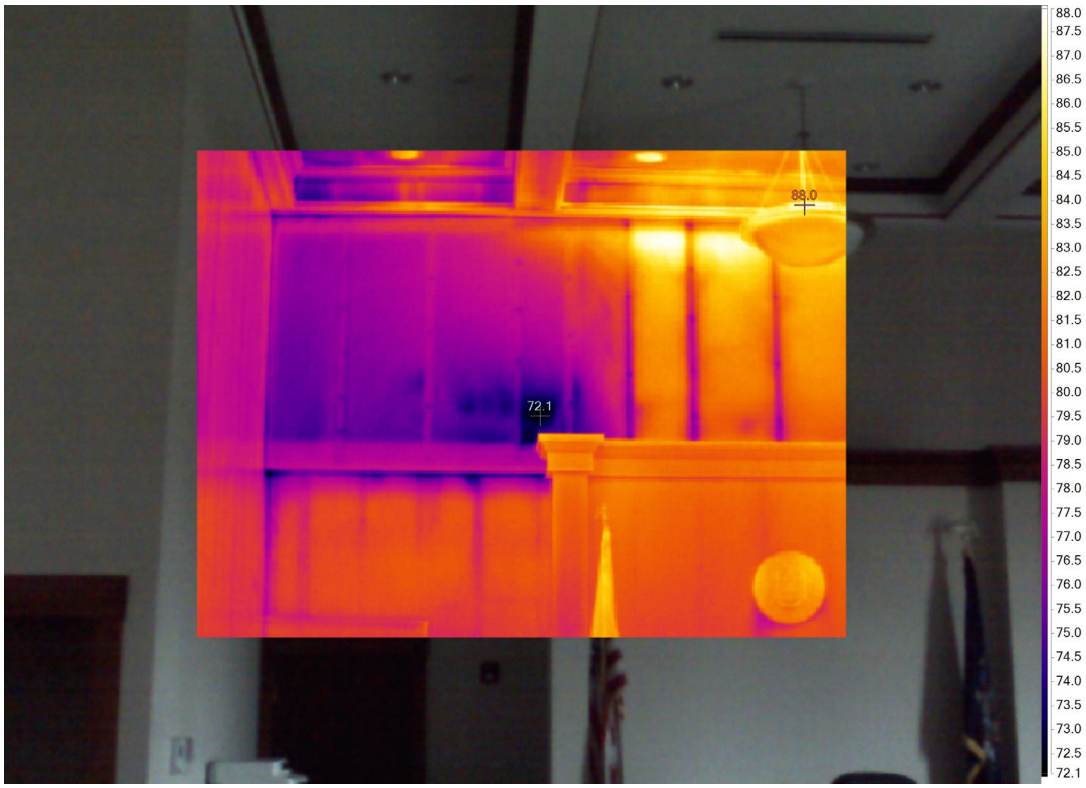
The outdoor air temperature was near 50 degrees (Fahrenheit) and the relative humidity was approximately 39%.

- The Town Hall/Court House was built around the year 2000
- Gross area is approximately 8,450 sqft
- New furnaces and an RTU were recently installed
- LED lighting upgrades were recently installed
- Building insulation was improved approximately 7-8 years ago.
- Reception and town clerk areas were originally separated by a wall that was removed in 2006
- Lobby
    - Gross floor area 521 sqft
    - Air temperature 70°F
    - Gaps, missing weatherstripping around entry door

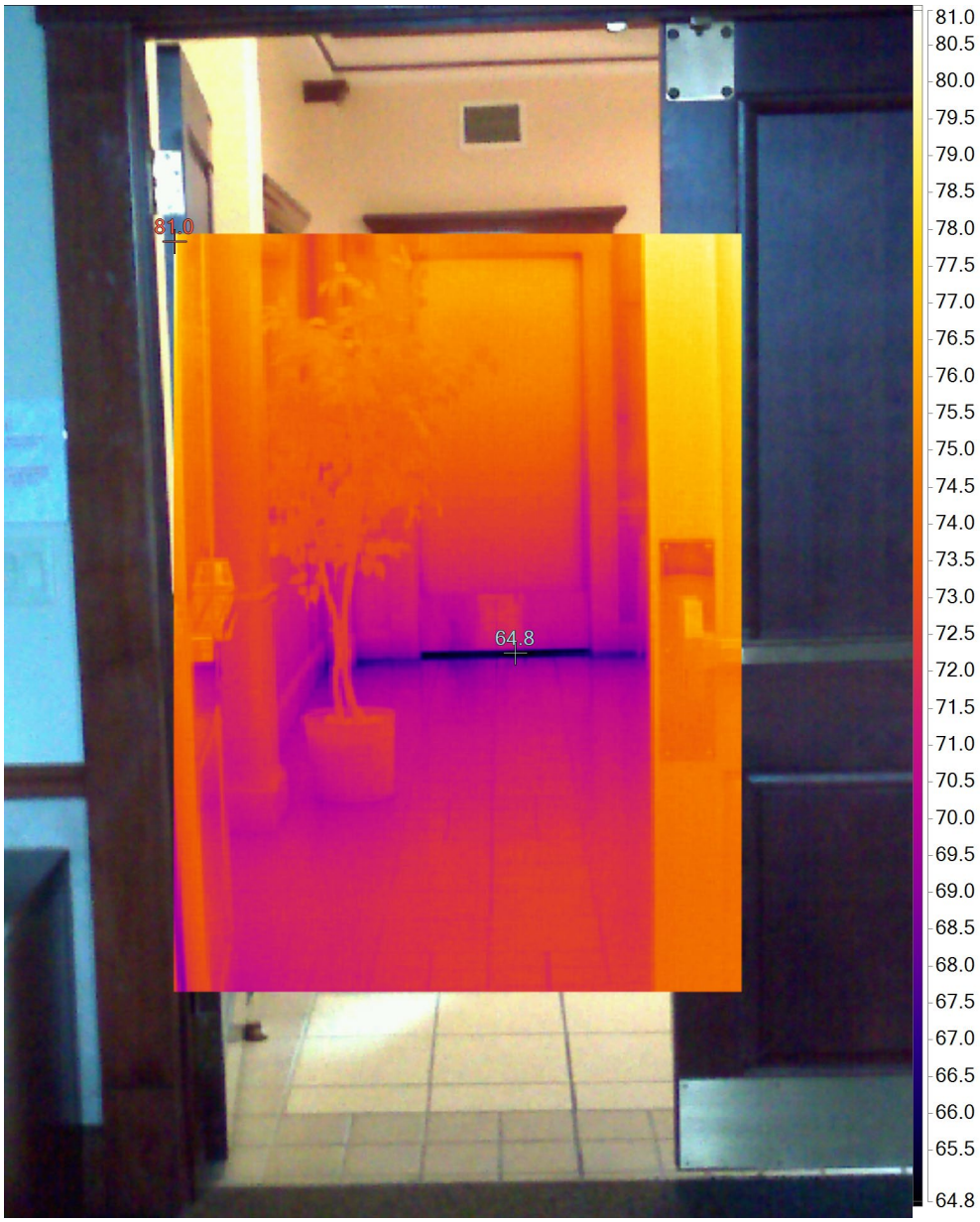
- 
- 
    - Fluorescent lighting can be switched to LED for energy savings
- Vestibule
    - Gross floor area 92 sqft
    - Air temperature 60°F
    - Electric wall heater
        - Knob control
        - Low set point according to dial, but accessible to all staff and visitors

- Gaps, missing/worn weather stripping around exterior doors

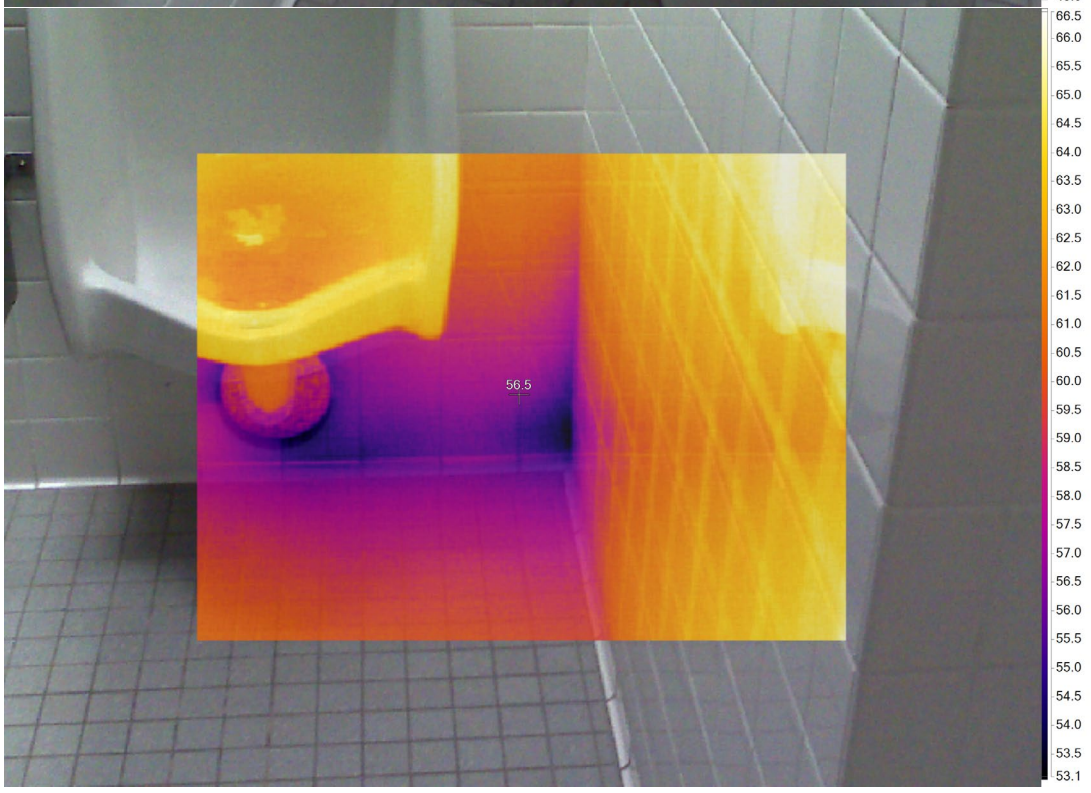
- Court Room
  - Gross floor area 1492 sqft
  - Air temperature 73°F
  - Equipment
    - Copier
  - Cool spot high on the south wall shows missing insulation and heat loss into attic/roof access corridor



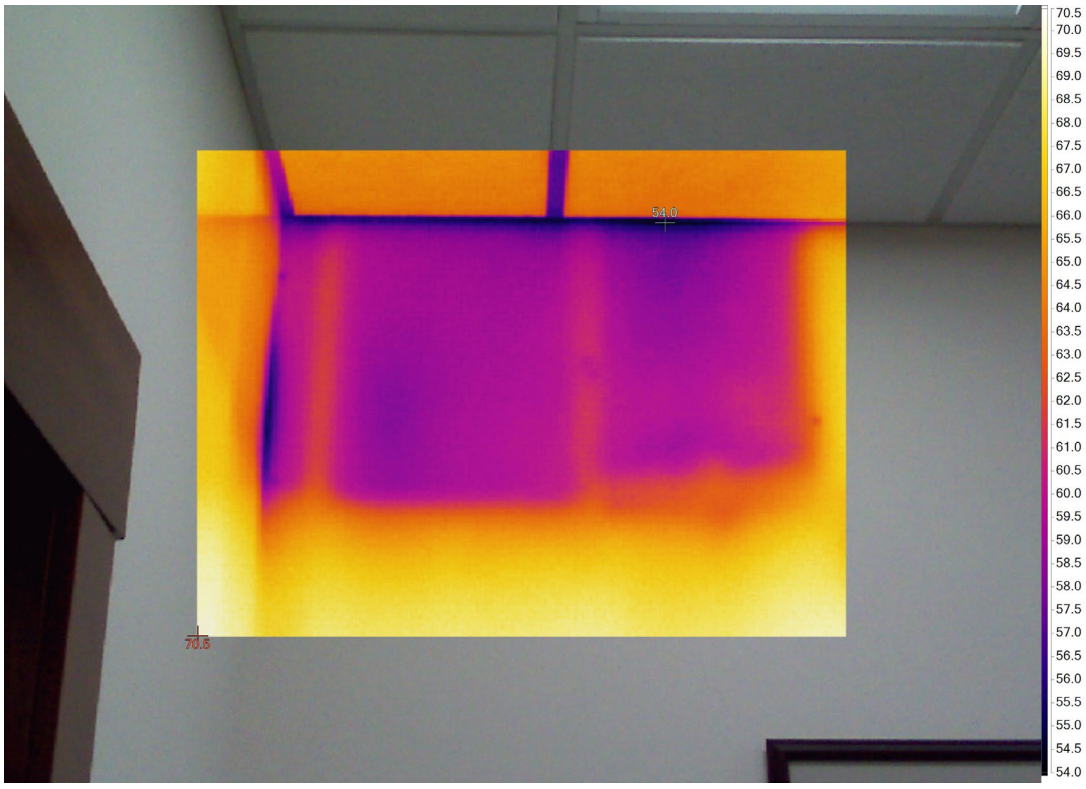

- Men's Restroom
  - Gross Floor Area 135 sqft
  - Air temperature 64°F
  - Can see the temperature difference between the restroom and lobby under the door in IR image



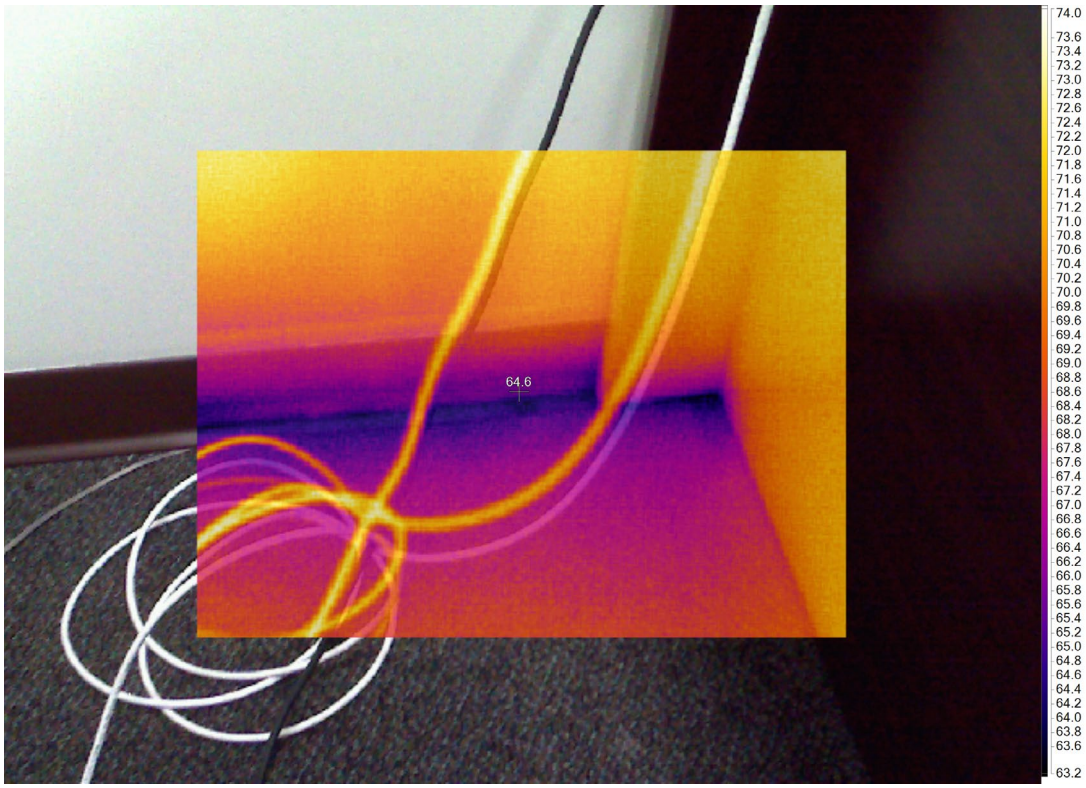

- Cold spots visible on the wall near the floor indicate significant thermal bridging despite relatively mild outside air temperatures (50°F)

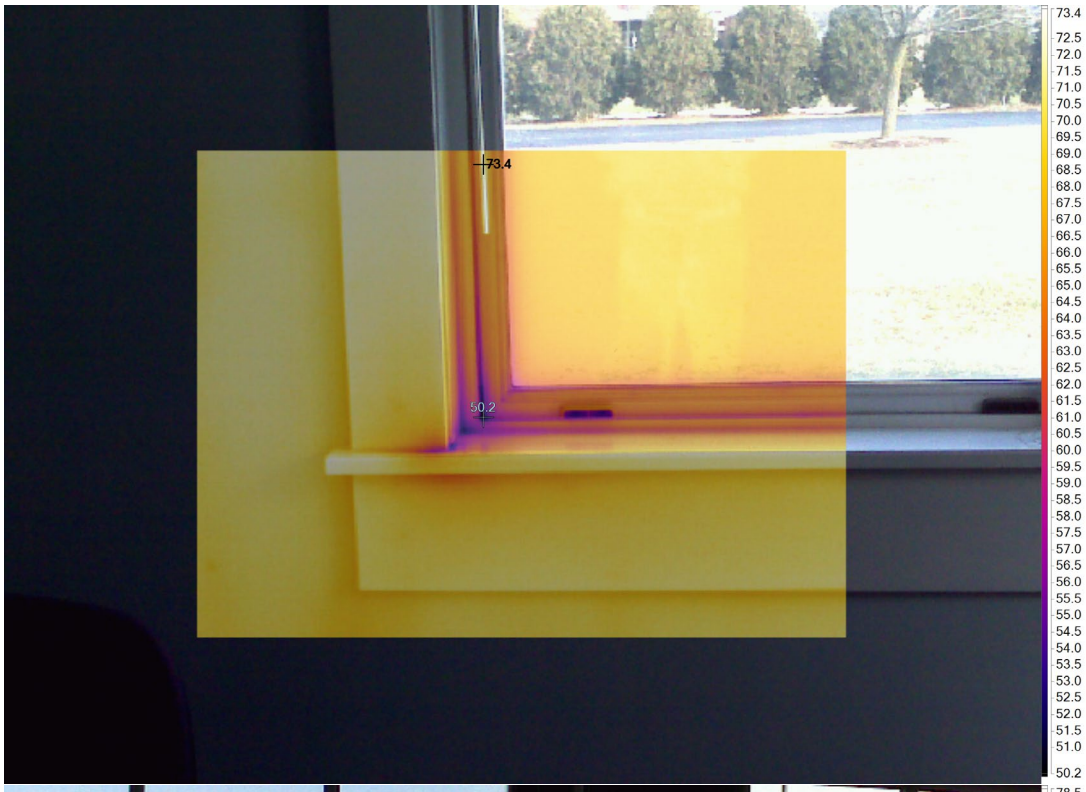

- Women's Restroom
  - Gross floor area 135 sqft
  - Air temperature 70°F

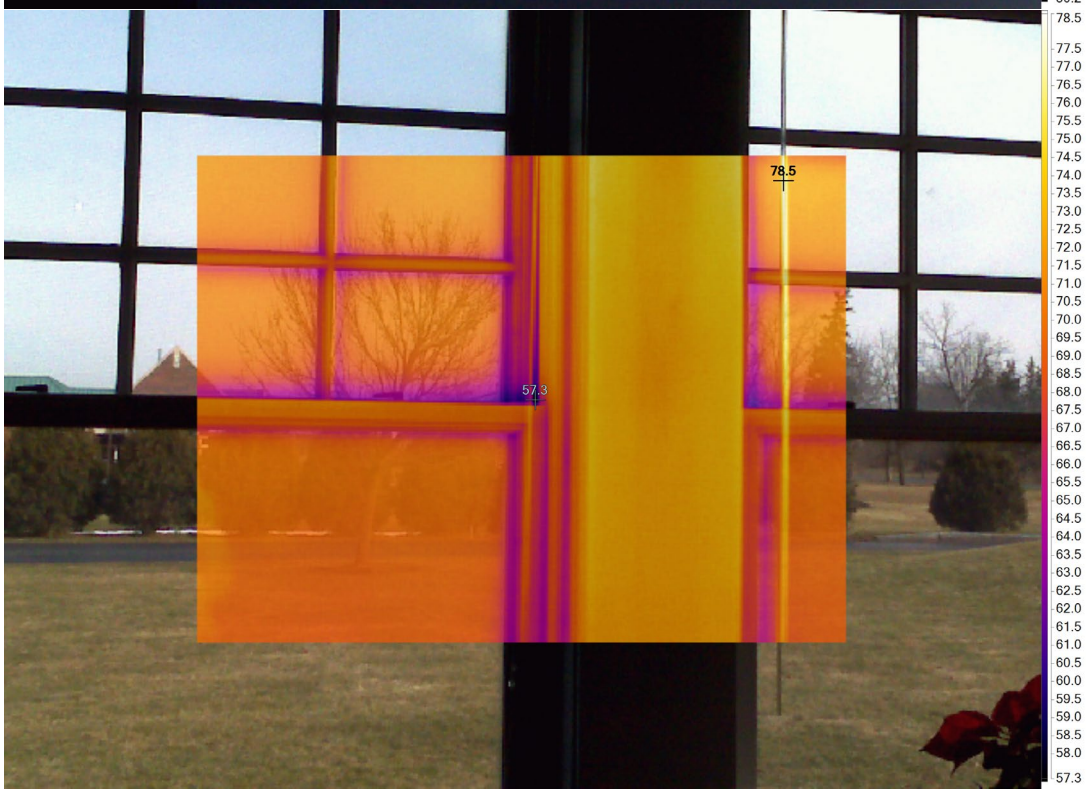
- Reception
  - Gross floor area 121 sqft
  - Air temperature 70°F
  - Weekly hours: Monday – Friday, 7am-4pm
  - Heater under desk because wall feels cold
  - Cold spots high on the wall indicate lack of insulation in portions of the attic space
    - 

  - Cold spots at floor level indicate thermal bridging, though less severe than in the Men's Restroom




- Town Clerk
  - Gross floor area 203 sqft
  - Air temperature 70°F
- Assessor Office – Interior
  - Gross floor area 131
  - Air temperature 73°F
  - Weekly hours: Monday – Thursday, 9:30am-3pm
  - Both doors open, hallway and breakroom
- Tax Collector
  - Gross floor area 131 sqft
  - Air temperature 75°F
  - Weekly hours: 15 hours/week
- Bookkeeper
  - Gross floor area 151 sqft
  - Air temperature 73°F
  - Gets so hot occupant must open windows daily
  - Desk against the wall blocking return air vent
- Town Supervisor
  - Gross floor area 216 sqft
  - Air temperature 73°F
  - Weekly hours: 1 hour/day, variable
  - Cold spot in corner of window could be indicative of:
    - Thermal bridging from aluminum windows

- 

- 

- Worn weather stripping letting air leak through

- Code Enforcement
  - Gross floor area 252 sqft

    - Air temperature 75°F
    - Weekly hours: Monday – Friday 8am-4pm
- Copier area/room
    - Gross floor area 338 sqft
    - Air temperature 76°F
- Bookkeeper 2
    - Gross floor area 142 sqft
    - Air temperature 77°F
    - Weekly hours: Monday – Friday, 8am-12pm
- Conference Room
    - Gross floor area 168 sqft
    - Air temperature 75°F
- Breakroom
    - Gross floor area 180
    - Air temperature 76°F
- Archives
    - Gross floor area 384
    - Air temperature 74°F
- Rear vestibule
    - Gross floor area 109 sqft
    - Air temperature 67°F
    - Gap on exterior door

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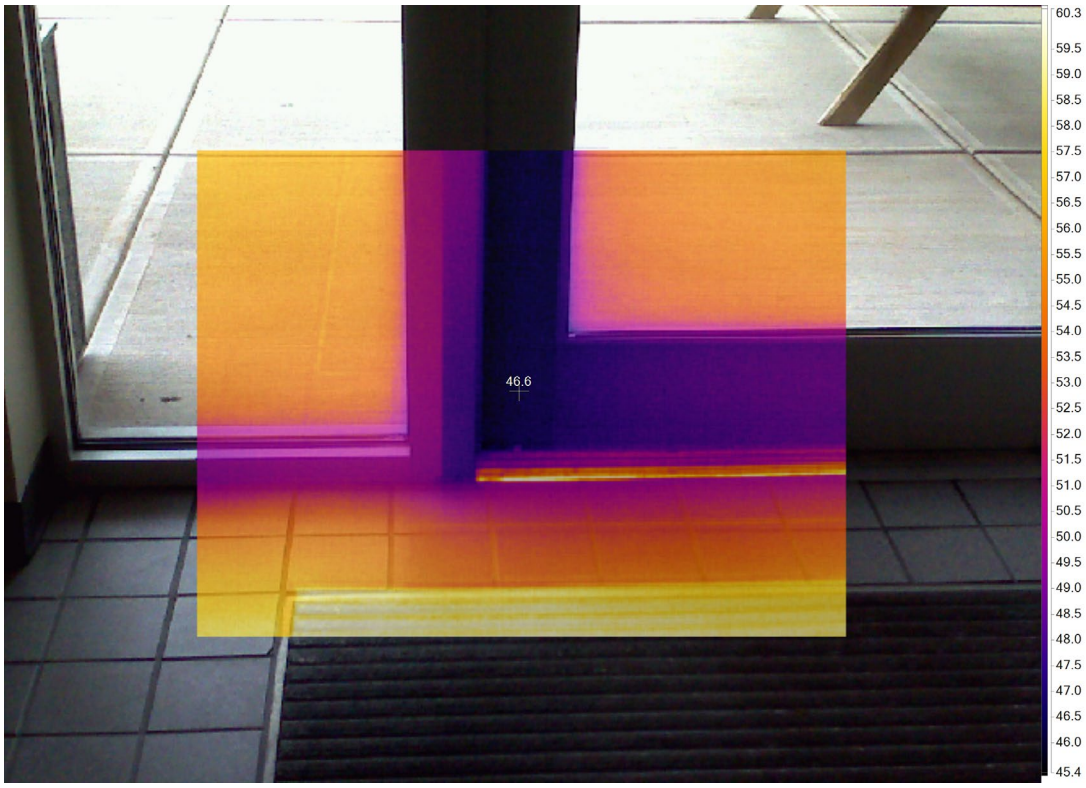
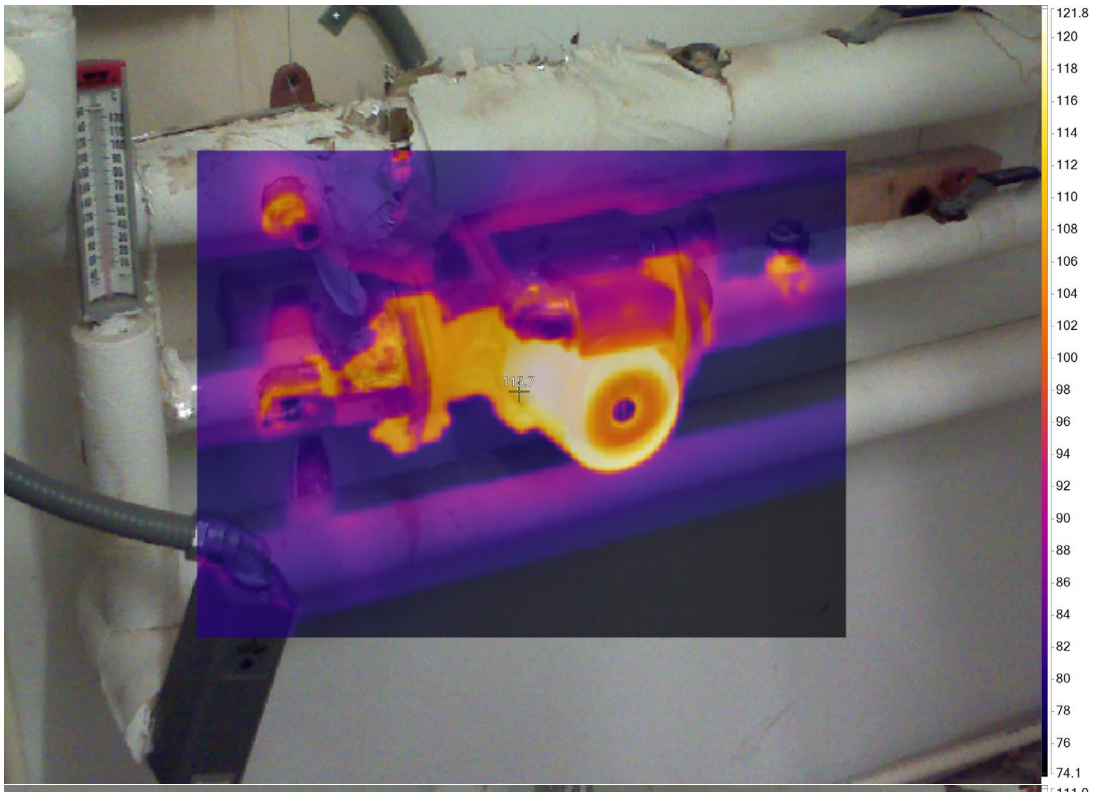
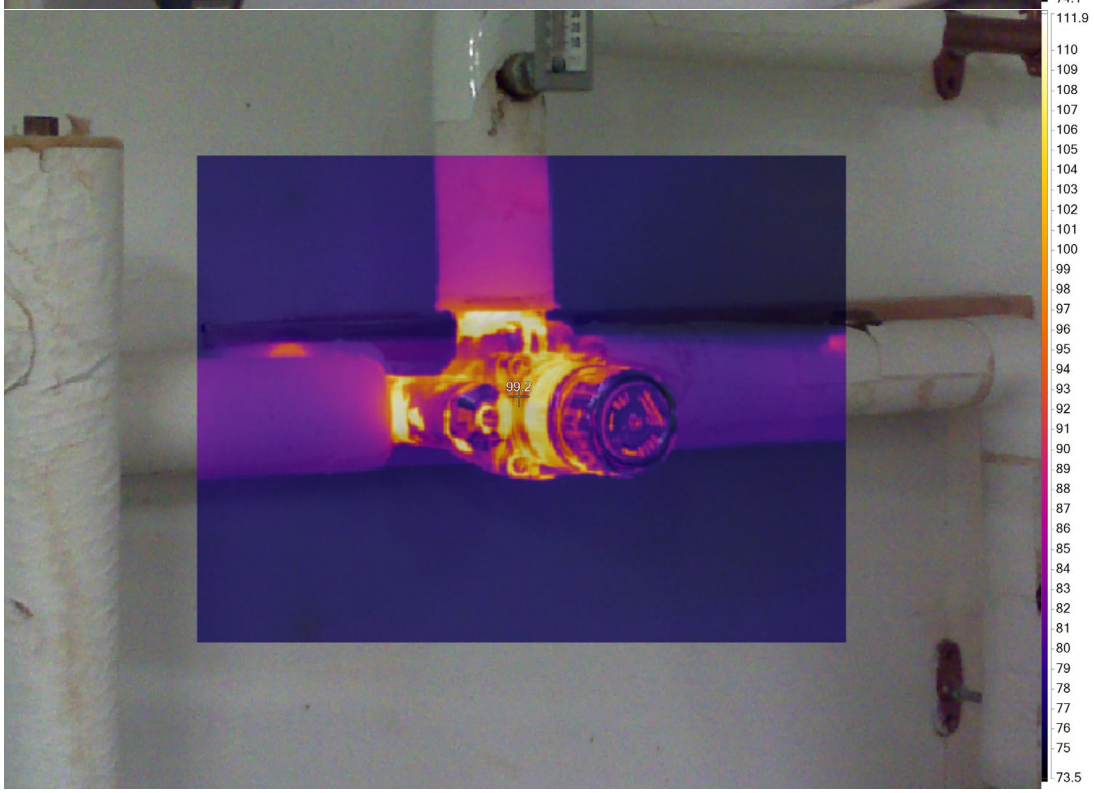
- Aluminum door frames are poorly insulated
- 

- Sheriff's Office
  - Gross floor area 177 sqft
  - Air temperature 67°F
- Holding Cell
  - Gross floor area 104 sqft
  - Air temperature 71°F
- Justice area
  - Gross floor area 250 sqft
  - Air temperature 72°F
  - Weekly Hours 4-6
- Court Clerk
  - Gross floor area 257 sqft
  - Air temperature 73°F
  - Return air vent partially covered
- Court Restroom
  - Gross floor area 55 sqft
  - Air temperature 69°F
- Court Conference room
  - Gross floor area 196 sqft
  - Air temperature 70°F
- Attic
  - Hot water circulator pump and mixing valve very warm but no warm water in either bathroom
    - Should be investigated further

- 

- 

  - Air handlers are missing the filters

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- Some air handlers missing the appropriate screws, or the screws are not fastened. Leads to leakage out of the unit and wasted energy


- Missing insulation section over court room
  - Further investigation seems to indicate that courtroom ceiling may be uninsulated

**Figure 2, section of missing insulation**

**Figure 3, Looking down at Courtroom Ceiling through hole pictured above**

- Roof
  - Debris left on roof from air conditioning upgrades
    - Should be removed, potential puncture hazard to roof membrane
  - Suction lines on condensers has reused insulation
    - Primary issue is the potential for water ingress through roof penetrations
    - Secondary issue is poor insulation reduces the efficiency of the system

- 

    - Unable to check for filter in Roof top unit, but based on the other three units in attic, would not be surprised if it were missing a filter as well.
- Exterior
    - Soffit hanging loose in multiple locations
        - Can allow pest in

- Can cause excessive or over ventilation of attic
- 

- 
  - Exhaust air vent from break room stuck open
    - Evidence of bird nesting activities

- Pieces of shingle coming off roof/shingle degradation

**Occupant Behavior**

- Some occupants state that they need supplemental heating and others need to open windows during winter to maintain a comfortable temperature. Having open windows can cause the HVAC system to operate more than necessary.
  - ISO-50001 style training for occupants to educate them on the operation, energy efficiency, and performance of the HVAC system.
- Temperature set-backs are not used for unoccupied times despite all zones have capable programmable thermostats.
  - Schedule different set-backs for weekdays and weekends
  - Consider typical occupancy for scheduling
- Some computers/monitors left on
  - Computers can be programmed to turn off the display when not used

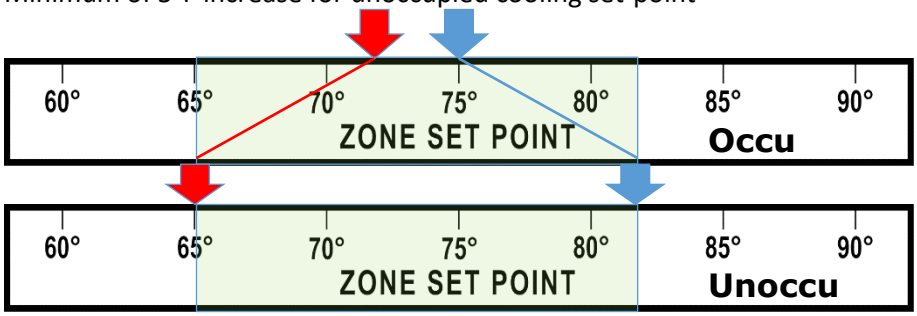
**Occupancy**

- Large areas of the building are unoccupied for most of the week, yet the thermostats are programmed as if they are occupied continuously.

**Lighting**

- Majority of lights converted to LED already, consider converting remaining fixtures

**HVAC**

- Not currently using set-backs on current programmable thermostats
  - Set-backs are known to reduce energy use when ASHRAE guidelines are followed.
  - 70-72°F occupied set-point is comfortable for most office staff
  - Minimum of 5°F heating set-back for unoccupied times
  - Minimum of 2°F difference between heating and cooling occupied set-points (3°F is better). 75-78°F is recommended cooling set-point for cooling season.
  - Minimum of 5°F increase for unoccupied cooling set-point
  - 

- Thermostats distributed across many rooms
  - It is unclear which thermostat controls a given room

**Table 1, Thermostat Data Geneva Town Hall**

| Thermostat location (room) | Thermostat set point | Room temperature | Thermostat schedule |
|---|---|---|---|
| **Court Room** | 74°F | 73°F | 74°F – 24/7 |
| **Reception** | 73°F | 70°F | Monday-Saturday:<br>• 6am – 73°F<br>• 5pm – 71°F<br>Sunday:<br>• All day – 71°F |
| **Code Enforcement** | 76°F | 75°F | 76°F – 24/7 |
| **Copier area/room** | 74°F | 76°F | 74°F – 24/7 |
| **Court Clerk** | 72°F | 73°F | 72°F – 24/7 |

**Table 2, Duct Register Air Temperature and Velocity**

| Vent location | Velocity of air leaving duct (feet per minute) | Temperature of air leaving duct (°F) |
|---|---|---|

| | | |
|---|---|---|
| **Assessor** | 500 | 90°F |
| **Tax Collector** | 400 | 104°F |
| **Supervisor 1 – near door** | 257 | 107°F |
| **Supervisor 2** | 320 | 112°F |
| **Code Enforcement 1 – near door** | 350 | 118°F |
| **Code Enforcement 2** | 240 | 117°F |
| **Copier area/room 1 – near roll up** | 220 | 97°F |
| **Copier area/room 2 – near copier** | 320 | 103°F |
| **Bookkeeper 2** | 80 | 96°F |
| **Conference Room** | 72 | 82°F |
| **Breakroom** | 200 | 107°F |
| **Sheriff** | 250 | 79°F |
| **Justice 1 – near door** | 420 | 96°F |
| **Justice 2** | 300 | 94°F |
| **Court Clerk** | 380 | 82°F |

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Follow-Up Re-Tuning Recommendations

Re-tuning should be continued on a continuous or periodic basis, after the initial re-tuning visit. Follow-up actions should include the following.

1) All operation and maintenance actions recommended in this report should be implemented to maximize energy savings, reduce energy costs, and improve the comfort of occupants. Actions with a status of "recommended" should be implemented in the days and weeks following initial re-tuning.

2) Continue to re-tune your building as changes occur (such as changes in tenants, schedules, remodels, etc.). A similar walkdown should be performed during spring, summer and fall seasons.

3) Operation and maintenance staff should continually look for the problems and opportunities covered in this report and in the building walkdown. Doing so can be as simple as looking for the sorts of conditions examined during re-tuning while walking routinely through the building or by conducting walk downs periodically.

4) Document your plans for continuous re-tuning. Establish schedules for your re-tuning activities and refer to them frequently as a reminder and to ensure that follow up continues. This is the best way to keep your building at peak operating condition and minimize energy use and costs. You will also find in the long run that the cost of operation and maintenance decreases.

# Building Re-Tuning Walk-down Observations for Geneva Highway Garage Office & Garage Bay Buildings

## Background

Commercial buildings account for almost 20% of the total U.S. energy consumption and up to 30% of the energy they use is stated due to improper and inefficient operations[2]. As a result, in recent years, much attention has been given to energy efficiency of large commercial buildings. The concept of re-commissioning these large buildings to reduce energy use after a period of operation has shown that improvements are possible even to well designed and maintained buildings. More recently, reduced scope versions of building re-commissioning have been developed for commercial buildings called Building Re-Tuning. The U.S. Department of Energy's Building Technologies Office and the Pacific Northwest National Laboratory (PNNL) have developed classroom and online training for commercial Building Re-Tuning.

In 2012, the National Institute of Standards and Technology sponsored the development of a Building Re-Tuning (BRT) Curriculum for Small to Medium sized Industrial buildings. Rochester Institute of Technology (RIT), in partnership with PNNL and the City University of New York (CUNY) developed a curriculum to train owners of small to medium sized industrial buildings how to perform building energy retuning assessments of their buildings.

Using walkdown and analysis techniques from the BRT curriculum, New York State Pollution Prevention Institute (NYSP2I) from RIT performed a BRT walkdown of Geneva's Highway Department Office & Garage Bay Buildings.

## Executive Summary

NYSP2I accompanied by Bernie Peck, Town of Geneva highway superintendent, performed a walk down of the Highway Department Office and Garage Bay buildings on Friday March 6, 2020. The walkdown was started at approximately 1:30pm. The purpose of the walkdown was to identify energy conservation measures (ECM) in the buildings.

[2] US Energy Information Administration's 2018 Commercial Buildings Energy Consumption Survey (CBECS) - https://www.eia.gov/consumption/commercial/

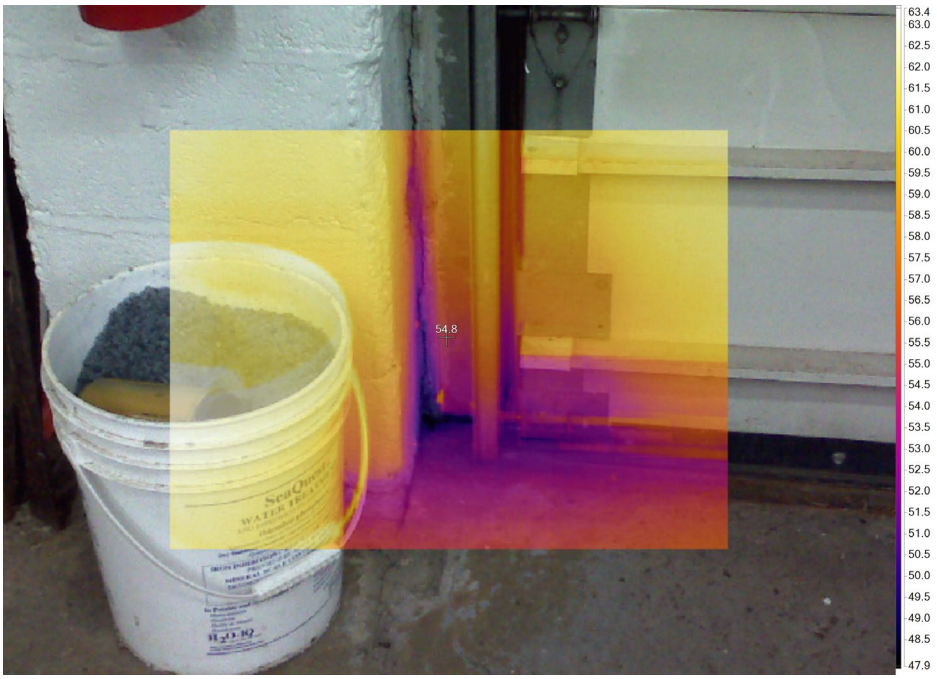
The building re-tuning effort focuses on evaluating the buildings operation and energy performance and on low and no cost opportunities that may lead to reduced energy consumption and improved comfort.

The following list covers the opportunities identified by NYSP2I during the Town of Geneva, Highway Department Office & Garage Bay walkdown and suggested energy conservation measures to mitigate inefficiencies. The list is categorized by energy users and includes occupant behavior since the occupants can impact building energy use. Many of the opportunities are low or no cost implementations but some will require capital expenditures. In the following list, some of the re-tuning opportunities and ECMs are qualified for effort and energy savings. The qualitative ratings of low, medium, and high are somewhat subjective but low effort generally means that the ECM takes a few hours to implement and low savings indicate less than 5% reduction. High effort generally indicates extensive capital cost and/or many hours of effort and high savings indicate 10-30% energy reduction(footnote). NYSP2I encourages Geneva to contact the local utility to inquire about energy conservation programs that might offset the cost of implementing costly measures but may still have a reasonable payback period (less than three years).

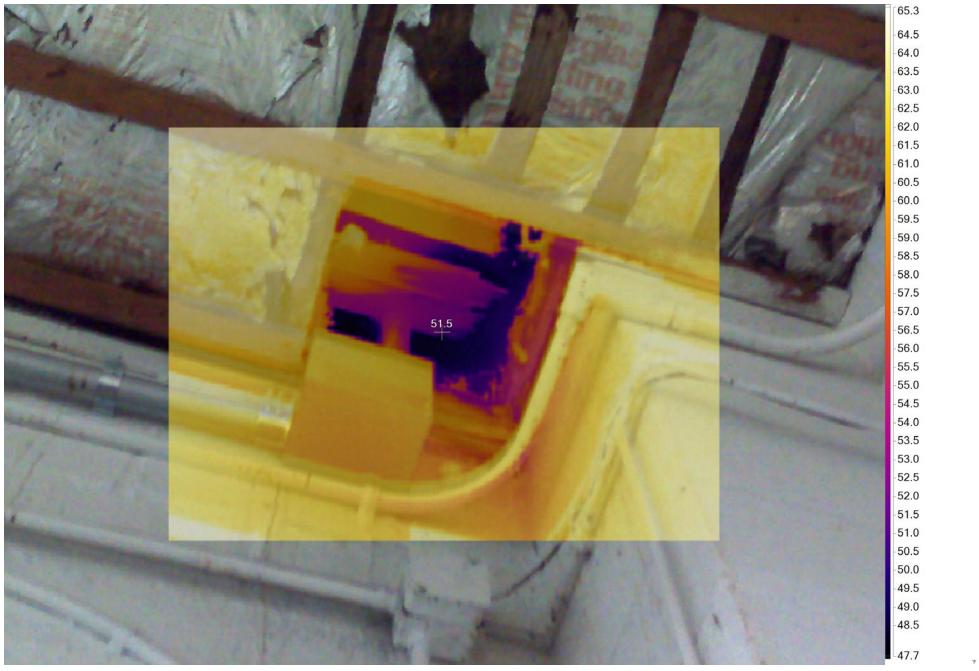
**Building Envelope**

The outdoor air temperature was in the mid-forties (Fahrenheit) and the relative humidity was approximately 55%.

- Highway Department Office Building
  - The entire building has been retrofitted with two inches of exterior foam insulation
  - Original windows were replaced with double pane windows
  - Garage Area
    - Air Temperature 64°F
    - Gross floor area 2750 square feet
    - Estimated weekly operating hours: 10-20
    - Overhead garage doors are insulated
      - Any gaps and cracks around doors should be addressed as they contribute to lost heat



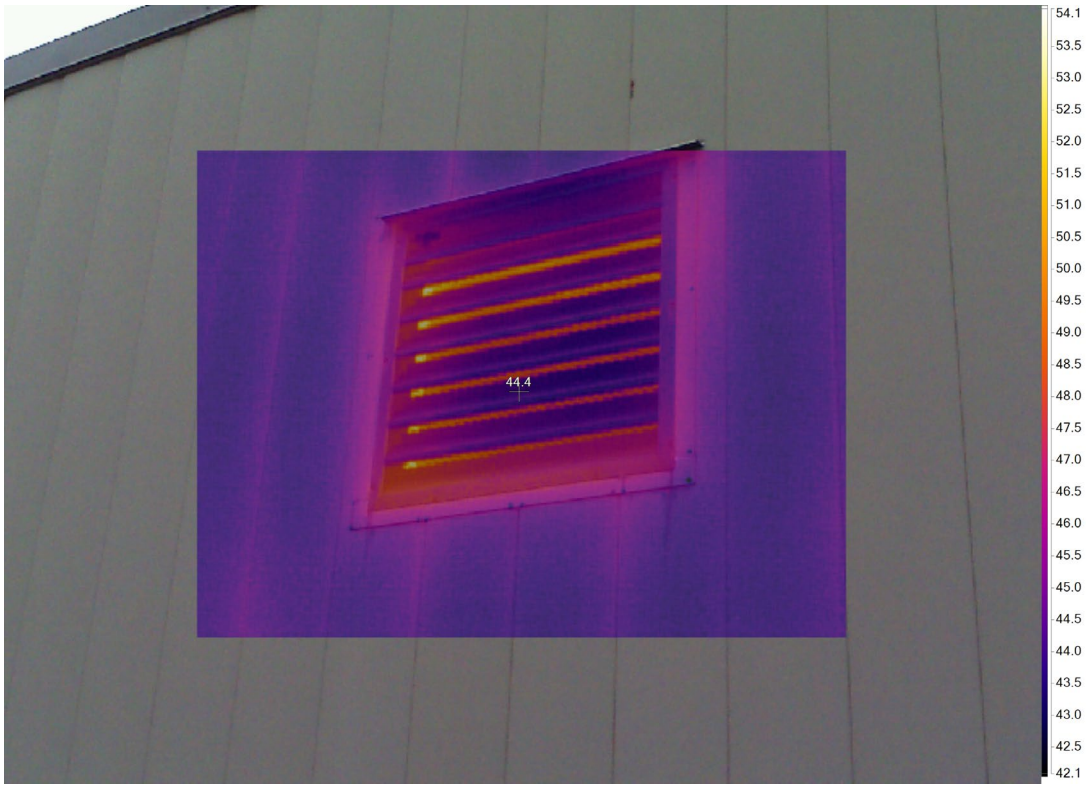

- Visible ceiling insulation was six inches R-19 fiberglass batts
  - Could consider increasing to reduce heat loss
- Seal off attic access to keep warm air in conditioned space




- Ceiling mounted natural gas radiant heaters
- Compressed air
  - Valve to Garage Bay building is a water valve and leaking
  - Connection above toolbox leaking
  - Fixing leaks will save compressor energy and run time

- Office
  - Gross floor area 457 sqft
  - Air temperature 67°F
  - Natural gas wall heater
    - Old and comparatively inefficient
    - Cycling behavior noted could be indicative of:
      - The unit being improperly sized for the space and heating load
      - That the thermostat is not properly located
      - That the thermostat is not operating correctly
    - Could consider a centralized system to serve the three rooms in place of separate heating units for each room
  - Computer, Printer, TV should be off when not being used
- Lobby
  - Air temperature 69°F
  - Gross floor area 113 sqft
  - Door is relatively new with good weather seals
  - Self-closing mechanisms on all exterior doors would help reduce heat loss
- Bathroom
  - Air temperature 75°F
  - Gross floor area 203 sqft
  - Electric oil heater left on continuously
    - Consider upgrading to a model with a programmable thermostat
    - significantly higher than the surrounding rooms indicate the set point could be too high

- <u>Garage Bay Building</u>
  - The entire building was recently retrofitted with two inches of exterior foam insulation
    - Self-closing mechanisms on exterior person doors could help reduce heat loss
  - Louvres on the south side of the building appear to be open




- Garage Area
  - Gross floor area 4707 sqft
  - Air temperature 63°F
  - Compressed air
    - Valve coming into building leaking
    - Quick disconnect on the door side of building leaking
    - Threaded connections at ceiling level, multiple leaks
    - Fixing leaks will save compressor energy and run time
- Office
  - Gross floor area 284 sqft
  - Air temperature 63°F
  - Computer, TV, printer, fridge, window ac unit
    - Unused equipment should be shut down when not in use
  - Aluminum frame windows could be upgraded to reduced heat loss
  - Removing the window air conditioner for the winter would help reduce heat loss
- Bathroom
  - Gross floor area 66 sqft
  - Air temperature 62°F

**Occupant Behavior**

- Ventilation fan for welding area not used in Highway Department Office Bay

    - Occupants stated that the ventilation fan cannot overcome the prevailing wind and fumes are not evacuated.
    - Consider getting ventilation fan system recommissioned.
- Building occupants set their own temperature
    - Consider limiting access to thermostat to building manager
- Garage doors left open for significant periods of time can increase the heating load on the building
    - Suggest opening doors for as briefly as is reasonable
    - If vehicles need to run inside the building for extended periods, consider an exhaust removal system
    - Consider a heat interlock with the doors so that the heat will turn off when overhead doors are open

**Occupancy**

- Occupants state that the buildings are generally occupied 10-20 hours per week
    - Significant potential for programmable thermostats and occupancy sensing lighting

**Lighting**

- Fluorescent lighting can be upgraded to LED for improved lighting efficiency
- Occupancy sensing lights can help prevent lights accidentally being left on for long periods of time when building is unoccupied

**HVAC**

- Radiant ceiling mounted heater in bays of Garage Bay Building set point of 63°F
- Radiant ceiling mounted heater in bays of Highway Department Office building set point of 64°F
    - Recently replaced
- Baseboard electric heat in large garage office 60°F set point
- Could consider switching non-garage spaces in both buildings to heat pumps for reduced emissions and higher efficiency, compared to electric baseboard and electric space heaters.
- Upgrading from single setpoint thermostats to programmable thermostat could save considerable energy
    - Occupancy scheduling
    - Appropriate temperature set-backs

Follow-Up Re-Tuning Recommendations

Re-tuning should be continued on a continuous or periodic basis, after the initial re-tuning visit. Follow-up actions should include the following.

1) All operation and maintenance actions recommended in this report should be implemented to maximize energy savings, reduce energy costs, and improve the comfort of occupants. Actions

with a status of “recommended” should be implemented in the days and weeks following initial re-tuning.

2) Continue to re-tune your building as changes occur (such as changes in tenants, schedules, remodels, etc.). A similar walkdown should be performed during spring, summer and fall seasons.

3) Re-tuning efforts should include compressed air leak checks and pressure adjustments. Compressed air systems without heat recapture are only about 7% efficient and compressors are less efficient at higher pressure. Set the compressor pressure to the lowest pressure needed for the pneumatic equipment to minimize compressor energy. Use electric tools instead of air tools wherever possible.

4) Operation and maintenance staff should continually look for the problems and opportunities covered in this report and in the building walkdown. Doing so can be as simple as looking for the sorts of conditions examined during re-tuning while walking routinely through the building or by conducting walk downs periodically.

5) Document your plans for continuous re-tuning. Establish schedules for your re-tuning activities and refer to them frequently as a reminder and to ensure that follow up continues. This is the best way to keep your building at peak operating condition and minimize energy use and costs. You will also find in the long run that the cost of operation and maintenance decreases.