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Energy Audit, Level 3

9 November, 2011

Prepared For: **Town of Rye**

Property Address:	**10 Central Street** **Rye, New Hampshire 03870**

Table of Contents

Executive Summary

This is an 1800's church that has been converted into a municipal building. A lighting audit had previously been accomplished with lighting improvements implemented. The Town's intent is to reduce heating and air conditioning fuel consumption by installing a geothermal system to replace the existing conditioning systems. The current systems have been inspected and a geothermal system designed to carry the current building loads. Due to the previous lighting audit and systems inspection, this report focuses primarily on the building's shell and air barrier to assess energy saving opportunities. A comparison of reported annual heating fuel consumption to data provided by the US Information Administration, for office buildings within the appropriate climatic zone, reveals that this building consumes **41.5%** more heating fuel per square foot of conditioned space than average. Not surprisingly the calculated heating season fuel consumption, if all recommended thermal boundary and air barrier improvements were implemented, reduces the expected fuel consumption by **53%.**

The building's air barrier was assessed using a dual fan calibrated blower door. Due to the metal ceiling in the main building section, the building was pressurized to +50 Pa with reference to the exterior for infiltration rate testing and then depressurized to -12 Pa for thermal imaging inspection. Air leakage tested at 10,980 CFM @ +50 Pa. This level of air leakage indicates that significant energy savings can be achieved through moderate air sealing efforts and cost. Infrared imaging and visual inspection was accomplished of the entire building shell. A significant percentage of the building's thermal boundary was found without insulation. Many building assemblies were found lacking a proper air barrier contributing significantly to the building's energy load due to excessive air exchange. It should be noted that if the recommended building shell improvements are implemented the size of the new geothermal system can be *significantly* and proportionately reduced to address the reduced heating and cooling loads with the improved thermal boundary and air barrier.

Energy modeling was conducted to simulate the building's expected fuel burn with the recommended improvements. The modeled improvements to the thermal boundary and air barrier include:

- 40% reduction in infiltration
- Insulating all wall and attic assemblies that are currently uninsulated
- Improving the insulated attics to achieve R50
- Adding R10 foundation / slab perimeter insulation to 2' below grade
- Insulating the Attic side walls with cavity insulation, plus R10 continuous insulation
- Improving the attic hatches to R40 weather-stripped hatches

The estimated cost of the thermal boundary and air barrier improvements noted in this report is $27,500.00 with an expected annual energy savings of **$4,365.00**. This provides a **15.8%** return on investment and a simple payback of **6.3** years. Additionally the reduced fuel burn would reduce carbon dioxide emissions by **14.3** tons annually. The slab and foundation wall improvements are the highest cost per square foot, significantly higher then the attic and wall improvements. Estimated costs included a reasonable sum to excavate the perimeter of the foundation to install slab and foundation insulation below grade.

Future expansion plans may result in the complete removal of the Eastern section of the building. This may discourage investment into improvements for that section. It is estimated that the recommended attic and wall improvements for that section would pay for itself in approximately one heating season. Unless the expansion plans are implemented within the next 18 months, the investment into the thermal boundary and air barrier improvements for the Eastern section would be a cash positive transaction.

OVERVIEW

For each section of the report thermal images from the inspected building were used unless annotated as "file images." The "comments" for each section specifically pertain to the inspected building and are used for additional clarification or explanations.

Assessed R values are for "whole wall R values" which is a total R value for the assembly as a whole. This takes into account the type, amount, and quality of the existing insulation, incorporates the thermal resistance of the existing framing and incorporates the percentage of total framing area compared to insulated cavity area. R values recommended for improvements are considered minimum R values that are currently cost effective with consideration to current fuel prices and the type of insulation contemplated. Greater R values will reduce energy losses further but at diminishing returns on investment. Installing greater R values than recommended is encouraged particularly if you believe energy prices will significantly rise in the future.

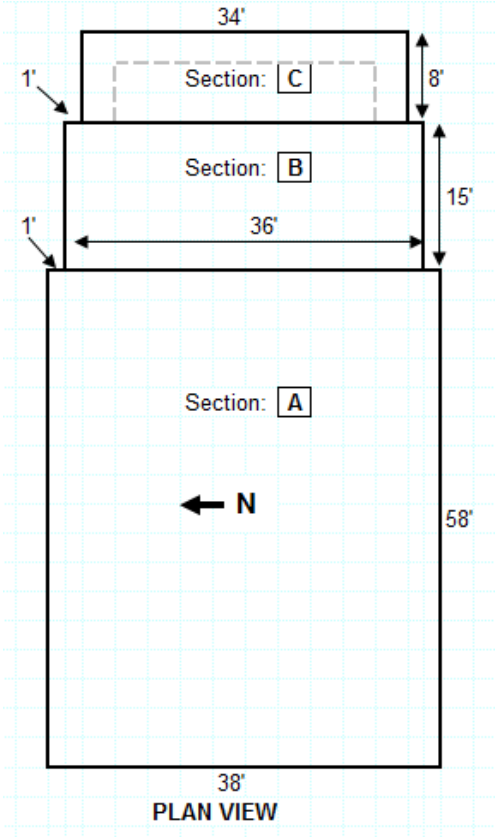
The data collected from testing, deficiencies found during inspection, and recommendations are organized, cataloged and presented in seven separate sections at the beginning of this report. These sections include:

- Observations and Test Data Section
- Estimated Energy Savings & Environmental Impact
- Air Infiltration Report – Total Air Leakage Calculated
- Thermal Boundary Report
- Air Barrier Report
- Other Improvements and Considerations Section
- Health Safety & Building Durability Section

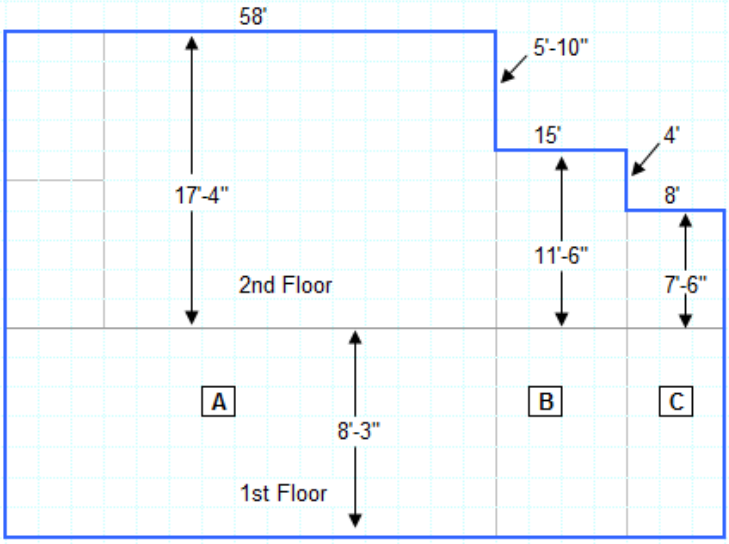
It is important to note that a quality contractor may have different methods or ideas to remediate the problems noted in this report and may make additional recommendations to achieve the same objective towards air sealing and improving the thermal boundary. Contractors that have achieved the Building Performance Institute's (BPI) certification in their field have demonstrated advanced proficiency and are highly qualified.

A gravity draft boiler and furnace is located in the building. You should be aware that air sealing could impact the pressures in this zone which could affect the draft of combustion appliances, such as your boiler, particularly when dryers, fans or other draft appliances are running. Please refer to the warning concerning this possibility at the bottom of the air infiltration report.

Building Diagrams



PLAN VIEW



PROFILE VIEW of Thermal Boundary / Air Barrier

Building Pictures


Northwest Corner


Northeast Corner


Southeast Corner


Southwest Corner

OBSERVATIONS & TEST DATA

Building Envelope Air Leakage Testing

Air leakage testing was accomplished utilizing a calibrated blower door to determine the structure's overall air leakage rate. This test requires a 50 Pascal (Pa) pressure differential with reference to outside and adjusted for the normal baseline pressure of the structure. Test data, and the data normalized to various denominations are provided below.

Section	Sq. Feet	Volume	CFM 50	CFM / ft2	ACH 50	ACHn	Leakage Area Sq. Inches	Leakage Area Sq. Ft
Entire Structure	6032	74196	10980	1.82	6.76	0.68	1465	10.17

CFM50: The amount of air flow in cubic feet per minute (CFM) required to maintain a structure at -50 Pascals pressure, with reference to outside and adjusted for structure's normal base line pressure.

ACH50: Number of air exchanges per hour at 50 Pascal pressure differential.

ACHn: Air Changes per Hour. The annual average rate of exchange of conditioned inside air with outside air on an hourly basis at normal pressure, considering structure elevation and exposure. Determined by calculations utilizing structure volume and calibrated blower door measurements.

Leakage Area: An equivalent sharp edge single hole area that would leak at the same flow rate when the hole is subject to the same target test pressures.

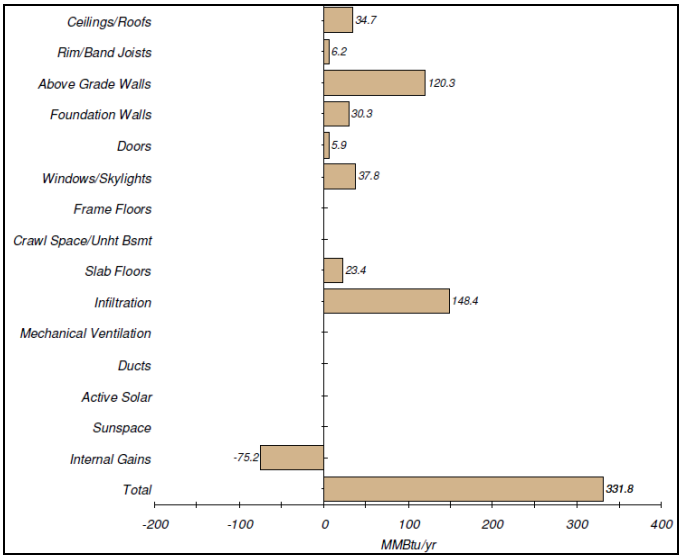
Heating Fuel Consumption Analysis

An analysis was conducted using the fuel consumption for the 2010 heating season with a reported consumption of 2152 gallons. Occupants reported the use of electric space heaters during winter months to supplement zonal heating. Gallons consumed were adjusted by 10 % to account for and convert the supplemental electric heating fuel.

BTUs Per Sq-Ft of Conditioned Space					
Gallons of Fuel Consumed	Converted to Millions of BTUs	Sq-FT of Heated Space	BTUs per Sq-ft	Average For Climate Zone	Difference From Average
2367	331.8 MBtus	6032	**55,006**	38,860*	**+ 41.5%**
Note: Data from U.S. Energy Information Administration for Non-Mall Commercial Buildings for Climate Zone with greater than 7000 Heating Degree Days					

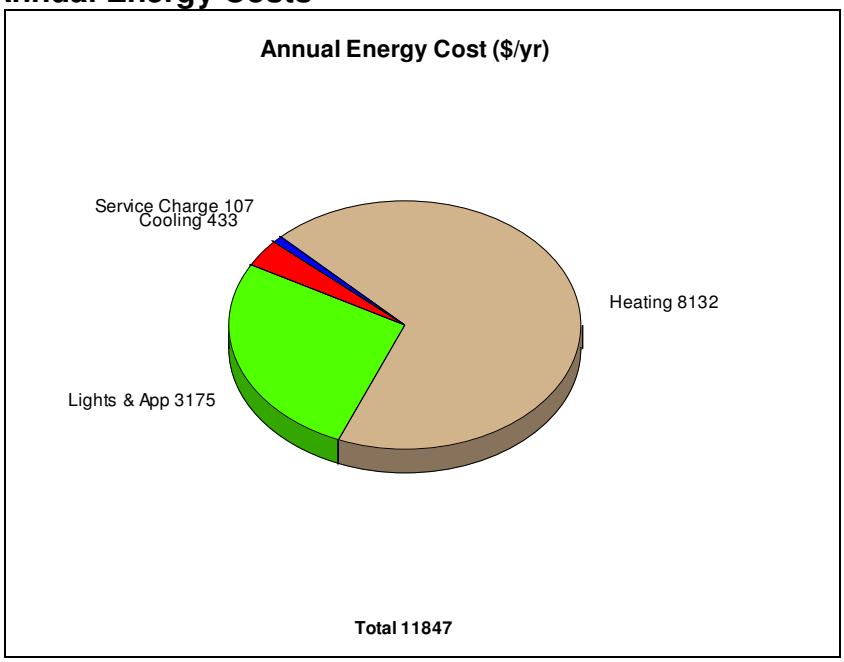
Estimated Heating Consumption by Building Component

HEATING SEASON (MMBtu/yr)	
Ceilings/Roofs	34.7
Rim/Band Joists	6.2
Above Grade Walls	120.3
Foundation Walls	30.3
Doors	5.9
Windows/Skylights	37.8
Frame Floors	0.0
Crawl Space/Unht Bsmt	0.0
Slab Floors	23.4
Infiltration	148.4
Mechanical Ventilation	0.0
Ducts	0.0
Active Solar	0.0
Sunspace	0.0
Internal Gains	-75.2
Total	331.8



In MBtu/yr

Annual Energy Costs



Building Shell Measurements and Ratios

Total Area (sq ft)	
Conditioned Space:	6032
Shell Area:	12002
Foundation Wall:	492.5
Slab Floor:	2670
Frame Floor:	0
Rim And Band Joist:	238.0
Above-Grade Wall:	5566.5
Window:	541.0
Door:	93.7
Ceiling:	3035
Skylight:	0.0
Duct:	0.0

Ratios	
Window-to-Wall:	0.089
Window-to-Floor:	0.090

Window Area By Orientation (sq ft)	
North:	173.2
Northeast:	0.0
East:	34.9
Southeast:	0.0
South:	233.4
Southwest:	0.0
West:	99.5
Northwest:	0.0

ESTIMATED SAVINGS & ENVIRONMENTAL IMPACT

Annual Building Energy Consumption All Fuel Sources Combined and Converted to BTUs			
	Total Annual MBtus Consumed	**Total Annual Energy Costs**	**CO2 (Tons)**
Baseline Building – "As Is"	**432.8**	**$11,847.00**	**39.2**

Improvement Packages with Associated Savings									
			CO2 Emissions			**Energy Savings**		**Financial Savings**	
	Estimated Annual MBtus	**Estimated Annual Energy Costs**	**CO2 (Tons)**	**Tons Saved**	**% From Baseline**	**MBtus Saved**	**% From Baseline**	**Dollars Saved**	**% From Baseline**
Envelope Improvements	265.7	$7,474.00	24.9	14.3	36%	167.1	39%	$4,373.00	36%
Envelope & Systems*	246.8	$7,142.00	23.8	15.4	39%	186	43%	$4,705.00	39%

Comments: The System modeled was an 87% AFUE replacement oil boiler. Air conditioning systems remain unchanged and geothermal was *not* modeled. This chart is for total fuel consumption to include air conditioning, lighting and plug loads. A lighting audit was not conducted. Default values for lighting were used based on lumens per square foot. Actual electric energy bills were not available at time of report. Electric load are default loads based upon building size and use.

Heating Fuel Consumption		
	Total Seasonal Gallons Consumed	**Total Seasonal Heating Fuel Costs**
Baseline Building - As Is	2391	**$8,113.00**

Improvement Packages with Associated Savings					
			Savings		
	Estimated Seasonal Gallons	**Estimated Seasonal Energy Costs**	**Gallons Saved**	**Dollars Saved**	**% From Baseline**
Envelope Improvements	1105	$3,748.00	1286	$4,365.00	53%
Envelope & Systems*	1003	$3,404.00	1388	$4,709.00	58%

Comments: The System modeled was an 86.5% AFUE replacement oil boiler. Geothermal was not modeled.

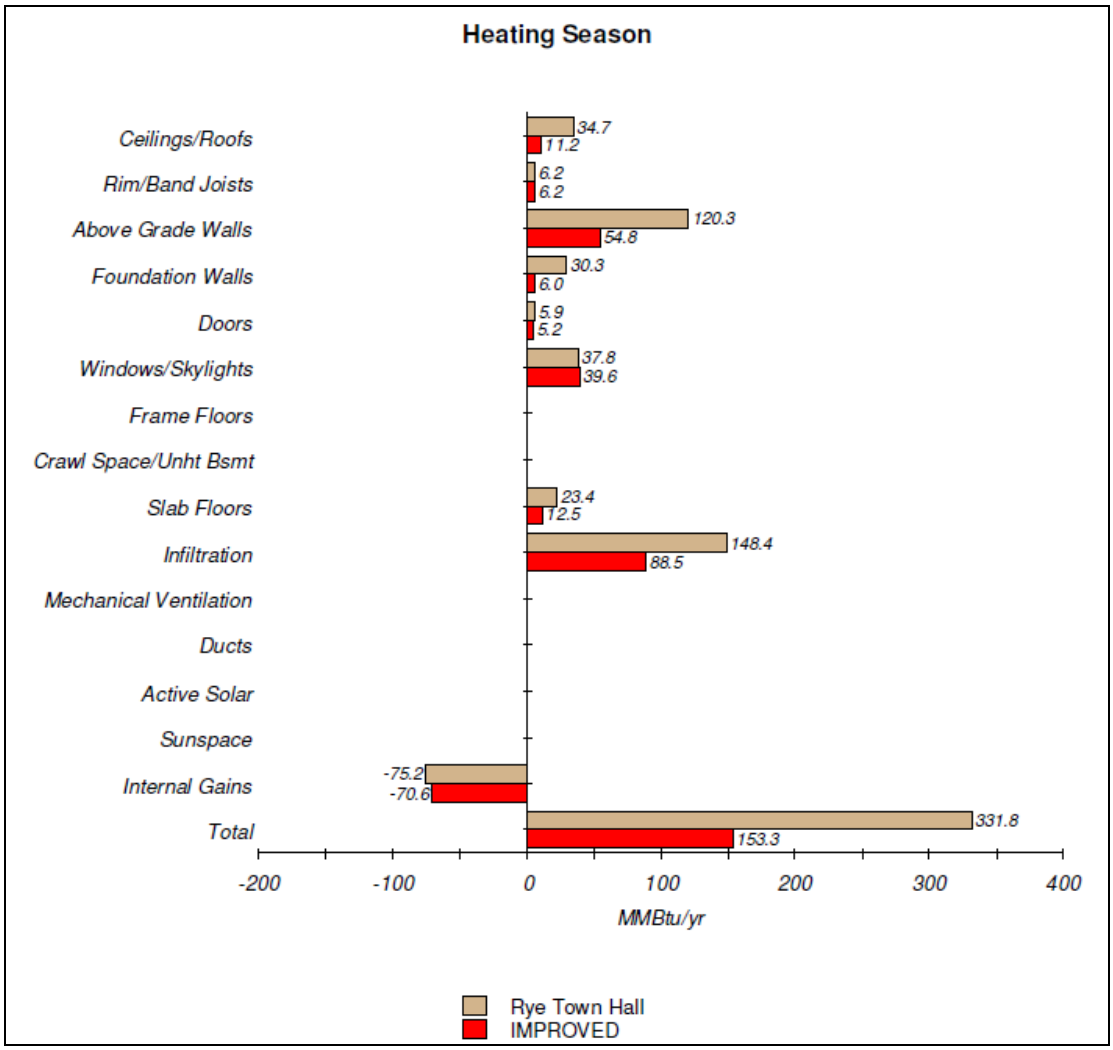
Improvements Modeled to Calculate Estimated Energy Savings

Envelope Improvements	
Air Infiltration	40% Reduction
Uninsulated Framed Walls	Insulate with Dense Packed Cellulose – 4" Cavity Depth
Uninsulated Foundation / Masonry Walls	Add R10 EIFS to 2' below grade
Uninsulated Slab	Add R10 Perimeter Insulation*
Uninsulated Attic	Improve Air Barrier - Insulate to R50
Insulated Attics	Improve Air Barrier – Add Insulation to Achieve R50
Uninsulated Slopes	Dense Pack with Cellulose – 7" Cavity Depth
Attic Side Walls	Insulate with Dense Packed Cellulose – Add R10 Rigid Insulation
Attic Hatches (2)	Weather-strip and insulate to R40
Note: Slab perimeter insulation was included in foundation wall improvements	
Envelope & System Improvements	
Includes All Building Shell Improvements plus new 86.5 % AFUE Oil Fired Boiler	

Comparison of Improved building to Current Building Condition

	Rye Town Hall	IMPROVED	DIFF	% DIFF
HEATING SEASON (MMBtu/yr)				
Ceilings/Roofs	34.7	11.2	23.5	67.7%
Rim/Band Joists	6.2	6.2	0.0	0.6%
Above Grade Walls	120.3	54.8	65.5	54.5%
Foundation Walls	30.3	6.0	24.2	80.1%
Doors	5.9	5.2	0.7	12.0%
Windows/Skylights	37.8	39.6	-1.8	-4.7%
Frame Floors	0.0	0.0		
Crawl Space/Unht Bsmt	0.0	0.0		
Slab Floors	23.4	12.5	10.9	46.6%
Infiltration	148.4	88.5	59.9	40.4%
Mechanical Ventilation	0.0	0.0		
Ducts	0.0	0.0		
Active Solar	0.0	0.0		
Sunspace	0.0	0.0		
Internal Gains	-75.2	-70.6	-4.6	-6.1%
Total	331.8	153.3	178.4	53.8%

In MBtu/yr



AIR INFILTRATION REPORT

☐	An air infiltration Report created from TECTITE Software is provided separately

Calibrated Blower Door Measurement: 1098 CFM @ -50 Pascals reference to outside adjusted for building baseline pressure

Zone:		2
Exposure:		Normal
Heating Degree Days:		Software determined for location
Mechanical Ventilation:	No	
Software Modeling Performed:	Yes	

Air Infiltration of Building Tested: 0.68**ACHn**
6.76 ACH @ 50 Pa

Estimated Cost of Excess Air Leakage: **$1,621.00 per heating season**

Savings @ $ 3.40 / Gallon
* Based on boiler efficiency of 78 %

Definitions:
ACHn – Air Changes per Hour. The average annual rate of exchange of conditioned inside air with outside air on an hourly basis at normal house pressure, considering house elevation and exposure. Determined by calculations utilizing house volume and calibrated blower door measurements.

Warning: Many Combustion Appliances such as furnaces, boilers, water heaters etc. obtain air for combustion and draft from inside the building envelope. Such appliances require a specific amount of air volume and/or flow to function properly and the required volume and/or flow is cumulative for multiple appliances. The MVG addressed in your report is for indoor air quality only and does not take into consideration the required air volume and/or flow of your combustion appliances which utilize indoor air for their operation. Diligence should be observed to ensure that air sealing the building envelope does not adversely impact the proper functioning and drafting of your combustion appliances. If there is any doubt whether your combustion equipment utilizes indoor air for combustion and drafting, or if future air sealing efforts may degrade their function, an appropriate HVAC contractor, and/or local building inspector familiar with your equipment can and should be consulted. Failure to provide the appropriate amount of combustion air volume and/or air flow can result in back drafting, carbon monoxide spillage into your building, and flame "roll out" of its combustion chamber.

THERMAL BOUNDARY REPORT

Main Attic Spaces

Assessment

Location: **Section "A"**

Thermal Boundary Location: ☒ Floor ☐ Slope & Gables ☐ None

Assembly	Framing	Dimensions	Sq-Ft	Insulation	Depth	Grade	R-Value
Floor	2x7-26	58 x 38	2204	Fiberglass	12"	2	38
Slope		x	0				
Gable Wall		x	0				
Side Wall		x	0				

Attic Flooring ☒ Open Joist ☐ Planked Floor ☐ Plywood Covered

Attic Access ☐ Pull Down Stairs ☒ Hatch ☐ Stairs ☐ None

Access Dimensions: **36 x 24** Inches

- ☐ Assembly is Not Insulated
- ☒ Assembly is Under Insulated
- ☐ Bath Fans Exhaust to this Space
- ☐ Bath Fan & Ductwork Present
- ☐ HVAC Ducts / Air Handlers are Present
- ☐ Drop Soffits are Present
- ☐ Recessed Lights Present – Qty:
- ☐ Chimneys are Present – Qty:
- ☐ Water Pipes are Present
- ☐ Unsafe Wiring was Noticed
- ☐ Sky Light Shafts are Present -
- ☐ Signs of Water Leaks Present
- ☐ Side Wall Insulation not in Full Contact w/ Air Barrier (Batts not Split Around Wiring)
- ☐ Side Wall / Gable Wall Insulation is Not Protected with an Air Barrier
- ☐ Floor Insulation is Exposed to Soffit Air Flow
- ☐ Floor Insulation is not in Full Contact with Air Barrier (Batts with Strapping)
- ☒ Excessive Air Leakage Through Primary Air Barrier
- ☐

Recommendations

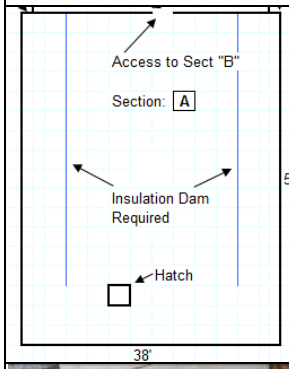
☐ Relocate Thermal Boundary to Slopes and Gable Walls ☒ Keep Thermal Boundary at Present Location

☐ No Improvements Recommended

Improve	Install Insulation - Type	Depth	Install Air Barrier / Rigid Insulation - Type
☒ Floor:	1" Closed Cell & 4" Cellulose	5"	
☐ Slope:			
☐ Gable Wall			
☐ Side Wall			

- ☐ Seal Gap Between Chimney & Framing (Comply with Code)
- ☐ Install Insulation Dam Around Chimney (Comply with Code)
- ☐ Install Recessed Light Domes (Comply with Code) Qty:
- ☐ Seal Plumbing Penetrations and / or Chase
- ☒ Seal Electrical Penetrations through Framing
- ☒ Seal Wall Top Plates Prior to Insulating floor
- ☐ Seal Gap Around HVAC Penetrations
- ☒ Install Insulation Dam Around Attic Hatch (Comply with Code)
- ☒ Insulate and Weather-strip Hatch (See Hatch Section)
- ☐ Add Propa Vents or Baffles at Exterior walls – Qt:
- ☐ Install Insulation Dam Around Gable Vents
- ☐ Protect Floor Insulation from Soffit Air Flow with Blocking
- ☐ Seal Drop Soffits with Air Barrier Sealed to Sheetrock
- ☐ Access Cut is Required to Gain Entry
- ☐

- ☒ Insulation Must be Moved to Conduct Improvements
- ☒ Existing Insulation can be Re-used
- ☐ Floor Planking requires Removal Prior to Insulating
- ☐ Install Cross Framing to Add Cavity Depth (Comply with Code)
- ☐ Replace Bath Fan Prior to Installing Insulation
- ☐ Replace Bath Vent Line: ☐ Insul Flex ☐ Insul Hard
- ☐ Install Vent Exhaust Hood: ☐ Soffit ☐ Wall
- ☐ Seal Air Ducts ☐ Add Duct Insulation
- ☐ Install Gable Vents – Qty:
- ☒ Install "Catwalk" Above Planned Insulation Level
- ☐ Insulate Water Pipes / Burry Under Insulation
- ☐ Correct Unsafe Wiring Prior to Insulating
- ☐ Fix Water Leaks Prior to Insulating
- ☐
- ☐



Comments: This attic section is insulated with approximately 12" of blown fiberglass insulation. The ceiling assembly for this section is comprised of a metal ceiling installed over a plaster and lathe ceiling. Currently the old plaster is the primary air barrier and is failing with many gaps and defects observed. It is recommended that the blown fiberglass be removed and a 1" flash spray installed directly over the lathe to create a new air barrier. Once this is accomplished the original blown fiberglass can be re-used and capped with an additional 4" of cellulose insulation to bring the total R value of the assembly to R50+. The perimeter of this attic section slopes down to the walls. An insulation dam would be required approximately 4' inside of the perimeter to allow the flat ceiling area to maintain a full 16" insulation depth. Additional insulation would be required for the sloped sections to ensure the entire sloped section maintains adequate insulation depth. It is also highly recommended that a "catwalk" be built approximately 17" above the level of the lathe and plaster to allow adequate access from the existing hatch to the opposite end of the attic without having to walk through the new insulation. The attic hatch is not insulated. It is recommended that this hatch be rebuilt to include a full height insulation dam, weather-stripped and insulated to R40.

Hatch

Lathe & Plaster Ceiling

Metal Ceiling Under

Insulation Dam Required

Main Attic Spaces

Assessment

Location: **Section "B"**

Thermal Boundary Location: ☒ Floor ☐ Slope & Gables ☐ None

Assembly	Framing	Dimensions	Sq-Ft	Insulation	Depth	Grade	R-Value
Floor	**2x7-26**	**36 x 15**	**540**	**Fiberglass**	**12"**	**2**	**38**
Slope		**x**	**0**				
Gable Wall		**x**	**0**				
Side Wall	**3x4-32**	**36 x 5.9**	**212**	**None**			**4.2**
Light Shaft		**x**	**0**				

Attic Flooring ☒ Open Joist ☐ Planked Floor ☐ Plywood Covered

Attic Access ☐ Pull Down Stairs ☒ Hatch ☐ Stairs ☐ None

Access Dimensions: x Inches

- ☐ Assembly is Not Insulated
- ☒ Assembly is Under Insulated
- ☐ Bath Fans Exhaust to this Space
- ☐ Bath Fan & Ductwork Present
- ☐ HVAC Ducts / Air Handlers are Present
- ☐ Drop Soffits are Present
- ☐ Recessed Lights Present – Qty:
- ☒ Chimneys are Present – Qty: :1
- ☐ Water Pipes are Present
- ☐ Unsafe Wiring was Noticed
- ☐ Sky Light Shafts are Present – Qty
- ☐ Signs of Water Leaks Present
- ☐ Side Wall Insulation not in Full Contact w/ Air Barrier (Batts not Split Around Wiring)
- ☐ Side Wall / Gable Wall Insulation is Not Protected with an Air Barrier
- ☐ Floor Insulation is Exposed to Soffit Air Flow
- ☐ Floor Insulation is not in Full Contact with Air Barrier (Batts with Strapping)
- ☐ Space Could Not be Inspected – Best Estimate
- ☒ Excessive Air Leakage Through Primary Air Barrier

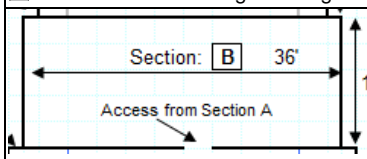
Recommendations

☐ Relocate Thermal Boundary to Slopes and Gable Walls ☒ Keep Thermal Boundary at Present Location

☐ No Improvements Recommended

Improve	Install Insulation - Type	Depth	Install Air Barrier / Rigid Insulation - Type
☒ Floor:	**1" Closed Cell & 4" Cellulose**	**5"**	
☐ Slope:			
☐ Gable Wall			
☒ Side Wall	**Blown Cellulose**	**4"**	2" Extruded Polystyrene
☐ Light Shaft			

- ☒ Seal Gap Between Chimney & Framing (Comply with Code)
- ☒ Insulation Must be Moved to Conduct Improvements
- ☒ Install Insulation Dam Around Chimney (Comply with Code)
- ☒ Existing Insulation can be Re-used
- ☐ Install Recessed Light Domes (Comply with Code) Qty:
- ☐ Floor Planking requires Removal Prior to Insulating
- ☐ Seal Plumbing Penetrations and / or Chase
- ☐ Install Cross Framing to Add Cavity Depth (Comply with Code)
- ☒ Seal Electrical Penetrations through Framing
- ☐ Replace Bath Fan Prior to Installing Insulation
- ☒ Seal Wall Top Plates Prior to Insulating floor
- ☐ Replace Bath Vent Line: ☐ Insul Flex ☐ Insul Hard
- ☐ Seal Gap Around HVAC Penetrations
- ☐ Install Vent Exhaust Hood: ☐ Soffit ☐ Wall
- ☐ Install Insulation Dam Around Attic Hatch (Comply with Code)
- ☐ Seal Air Ducts ☐ Add Duct Insulation
- ☐ Insulate and Weather-strip Hatch (See Hatch Section)
- ☐ Install Gable Vents – Qty:
- ☐ Add Propa Vents or Baffles at Exterior walls – Qt:
- ☒ Install "Catwalk" Above Planned Insulation Level
- ☐ Install Insulation Dam Around Gable Vents
- ☐ Insulate Water Pipes / Burry Under Insulation
- ☐ Protect Floor Insulation from Soffit Air Flow with Blocking
- ☐ Correct Unsafe Wiring Prior to Insulating
- ☐ Seal Drop Soffits with Air Barrier Sealed to Sheetrock
- ☐ Fix Water Leaks Prior to Insulating
- ☐ Access Cut is Required to Gain Entry
- ☐
- ☐



Comments: This attic section is insulated with 12" of blown fiberglass. However the primary air barrier is the tongue and grove wood ceiling. It was assessed via blower door testing that there is excessive air exfiltration through the tongue and grove ceiling assembly and through the fiberglass insulation. The same recommendations are made as was made for Section "A", remove the blown fiberglass to one side of the attic and overspray the attic side of the tongue and grove ceiling with a 1" flash spray of closed cell spray foam to create an adequate air barrier. Once this is accomplished the fiberglass insulation can be re-installed and capped with 4" of cellulose insulation to bring the entire assembly to R50. There is a chimney located in the Northwest corner. Any gap between the chimney and the framing should be sealed with code approved methods and an insulation dam built around the chimney to maintain code required free air space requirements around the chimney. The West wall of this attic is a wall to conditioned space. This wall is not insulated. It is recommended that cellulose insulation be dense packed into this wall assembly from that attic side. It may be possible to insulate this wall assembly from the associated open top plates. 2" XPS rigid insulation can then be installed over the assembly to add R10 continuous insulaiton. All seams of the rigid insulation should be taped and the perimeter sealed. An alternative to using 2" XPS rigid insulation would be to use 2" of closed cell insulation applied directly to the attic side wall after it is dense packed with cellulose.

Main Attic Spaces

Assessment

Location: **Section "C"**

Thermal Boundary Location: ☐ Floor ☐ Slope & Gables ☒ None

Assembly	Framing	Dimensions	Sq-Ft	Insulation	Depth	Grade	R-Value
Floor	**2x3-53**	**6.9 x 31.5**	**217**	**None**			
Slope	**2x6-21**	**1.5 x 49**	**73**	**None**			
Gable Wall		**x**	**0**				
Side Wall	**3x4-32**	**34 x 4**	**136**	**None**			

Attic Flooring ☒ Open Joist ☐ Planked Floor ☐ Plywood Covered

Attic Access ☐ Pull Down Stairs ☒ Hatch ☐ Stairs ☐ None

Access Dimensions: **16" x 16"** Inches

☒ Assembly is Not Insulated
☐ Assembly is Under Insulated
☐ Bath Fans Exhaust to this Space
☐ Bath Fan & Ductwork Present
☐ HVAC Ducts / Air Handlers are Present
☐ Drop Soffits are Present
☐ Recessed Lights Present – Qty:
☐ Chimneys are Present – Qty: :
☐ Water Pipes are Present
☐ Unsafe Wiring was Noticed
☐ Sky Light Shafts are Present – Qty
☒ Signs of Water Leaks Present
☐ Side Wall Insulation not in Full Contact w/ Air Barrier (Batts not Split Around Wiring)
☒ Side Wall / Gable Wall Insulation is Not Protected with an Air Barrier
☒ Excessive Air Leakage Through Primary Air Barrier
☐ Floor Insulation is not in Full Contact with Air Barrier (Batts with Strapping)

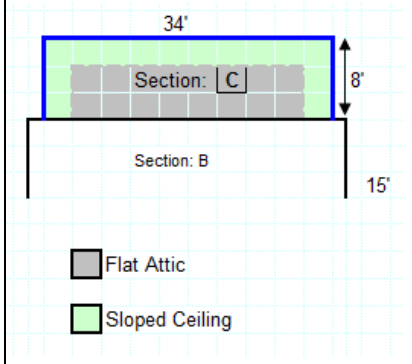
Recommendations

☐ Relocate Thermal Boundary to Slopes and Gable Walls ☒ Keep Thermal Boundary at Present Location

☐ No Improvements Recommended

Improve	Install Insulation - Type	Depth	Install Air Barrier / Rigid Insulation - Type
☒ Floor:	**1" Closed Cell & 4" Cellulose**	**16"**	
☒ Slope:	**Blown Cellulose**	**4"**	
☐ Gable Wall			
☒ Side Wall	**Blown Cellulose**	**4"**	2" Extruded Polystyrene

☐ Seal Gap Between Chimney & Framing (Comply with Code)
☐ Remove and Discard Old Insulation Prior to Insulating
☐ Install Insulation Dam Around Chimney (Comply with Code)
☐ Remove / Discard FG Batts within 4' of perimeter
☐ Install Recessed Light Domes (Comply with Code) Qty:
☐ Floor Planking requires Removal Prior to Insulating
☐ Seal Plumbing Penetrations and / or Chase
☒ Install Cross Framing to Add Cavity Depth (Comply with Code)
☐ Seal Electrical Penetrations through Framing
☐ Replace Bath Fan Prior to Installing Insulation
☐ Seal Wall Top Plates Prior to Insulating floor
☐ Replace Bath Vent Line: ☐ Insul Flex ☐ Insul Hard
☐ Seal Gap Around HVAC Penetrations
☐ Install Vent Exhaust Hood: ☐ Soffit ☐ Wall
☒ Install Insulation Dam Around Attic Hatch (Comply with Code)
☐ Seal Air Ducts ☐ Add Duct Insulation
☒ Insulate and Weather-strip Hatch (See Hatch Section)
☐ Install Gable Vents – Qty:
☐ Add Propa Vents or Baffles at Exterior walls – Qt:
☒ Install "Catwalk" Above Planned Insulation Level
☐ Install Insulation Dam Around Gable Vents
☐ Insulate Water Pipes / Burry Under Insulation
☐ Protect Floor Insulation from Soffit Air Flow with Blocking
☐ Correct Unsafe Wiring Prior to Insulating
☐ Seal Drop Soffits with Air Barrier Sealed to Sheetrock
☒ Fix Water Leaks Prior to Insulating



Comments: This attic space was found uninsulated. Occupants report water leaks from this attic section. Interview with workers that utilize this space stated that most of the water leaks seemed to occur during the winter months. It is possible that these leaks are actually the result of condensation from warm interior air condensing in the cold space; however the workers also reported leaks during the recent hurricane. Before any improvements are completed in this space the roof shingles and associated flashing should be inspected by a qualified roofer with appropriate repairs made as necessary. This ceiling assembly is uninsulated tongue and grove wood with short uninsulated slopes around the exterior perimeter. There is an attic side wall on the West side that separates this attic space from the conditioned space of Section "B". Inspection revealed this side attic wall to be mostly uninsulated. Rosin paper installed on this side attic wall was used as the original air barrier. This paper has failed and provides little air barrier value. Both this ceiling and the side attic wall contribute significantly to the overall air leakage of this building in that neither has an appropriate air barrier. The framing of the flat ceiling area is assessed as inadequate to support a worker. This can be corrected by the installation of 2x6 framing between the ceiling rafters and the side wall to create solid support for work to be accomplished. This framing should be installed 15" above the ceiling level so future access can be gained after the insulation is installed. As with the recommendations for the previous attic spaces, it is recommended that an adequate air barrier be established by installing 1" closed cell insulation on the attic side of the flat ceiling area. This would then be capped with 14" of blown cellulose to bring the ceiling to R50. The side attic wall would require a dense packed cellulose blow. Once the cavities are fully insulated than 2" XPS rigid insulation should be installed over the side wall to create an adequate air barrier and to provide a layer of continuous R10 insulation. All seams should be taped and the perimeter sealed. A 2" application of closed cell insulation could be substituted for the XPS rigid insulation. The small sloped assembly surrounding the exterior perimeter of this space would require a dense packed cellulose blow. Due to the limited cavity depth of these slopes the maximum R-value achievable by dense packing alone would be R20. Consideration should be given to installing 2" polyisocyanurate on the interior sides of the sloped assemblies to be covered by sheetrock. This combination of dense packing the slopes and the additional R13 provided by the continuous insulation would provide R33. The hatch assembly would require full R40 Insulation, weather-stripping and an insulation dam.

Section "C" Flat Attic

Short Slopes

Side Wall to Section "B"

Inadequate Air Barrier


Small Hatch to Space

Attic Hatches

Assembly	Assessment	Recommendations
Attic Hatch Space 1	Location: **Section "A"**	☒ Add Insulation to Achieve R40 – Amount: **8"** Insulation Type: 2" Extruded Polystyrene
	Hatch Material: ☐ Sheetrock ☐ Plywood ☒ Wood Plank	☒ Replace Hatch with Plywood Hatch ☒ Install Weather Stripping
	Type: ☒ Hatch ☐ Pull Down Stairs	☒ Install Insulation Dam ☒ Build / Install "Thermadome"
	Insulation Type: **Uninsulated** Insulation Depth:	☐ Larger Hatch is Required for Worker Access ☐
	Insulation Grade: Assessed R-Value:	☐ ☐
	Hatch Dimensions: **36"x24"**	☐ ☐

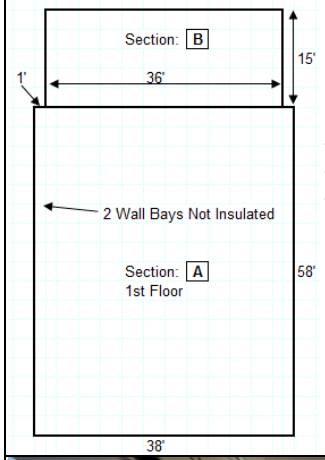
Comments: It is recommended that this hatch be reconstructed to provide a fully weather-stripped removable hatch insulated to a minimum of R40.

Assembly	Assessment	Recommendations
Attic Hatch Space 2	Location: **Section "C"**	☒ Add Insulation to Achieve R40 – Amount: **8"** Insulation Type: 2" Extruded Polystyrene
	Hatch Material: ☐ Sheetrock ☐ Plywood ☒ Wood Plank	☐ Replace Hatch with Plywood Hatch ☒ Install Weather Stripping
	Type: ☒ Hatch ☐ Pull Down Stairs	☒ Install Insulation Dam ☐ Build / Install "Thermadome"
	Insulation Type: **Uninsulated** Insulation Depth:	☒ Larger Hatch is Required for Worker Access ☐
	Insulation Grade: Assessed R-Value:	☐ ☐
	Hatch Dimensions: **16"x16"**	☐ ☐

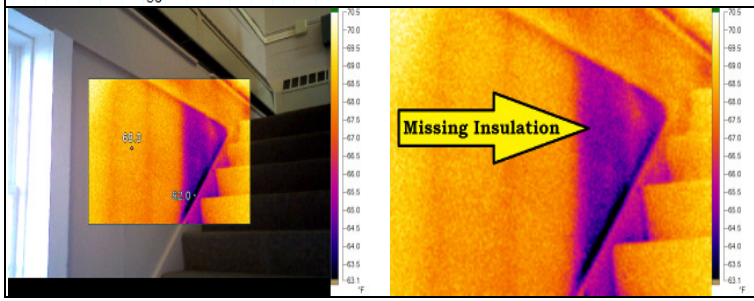
Comments: It is recommended that this hatch be reconstructed to provide a fully weather-stripped removable hatch insulated to a minimum of R40. This hatch may require enlargement to provide adequate worker access.

Exterior Walls

Assessment							Recommendations		
Location: **Framed Walls – Sections "A" & B" - 1st Floor Only**							☒ Recommend Improvements – For Areas Described in Comments ☐ No Improvements Recommended		
Framing	**Dimensions**	**Sq-Ft**	**Insulation**	**Depth**	**Grade**	**R-Value**	**Install Cavity Insulation - Type**	**Depth**	**Install Interior Air Barrier / Rigid Insulation - Type**
3x4-32	**170 X 8.25**	**1402**	**Blown Fiberglass**	**4"**	**2**	**12.7**			
Interior Surface: **Sheetrock**			Exterior Cladding: **Wood Clap**				☐ Exterior Paint Should be Checked for Lead		☐ Add Exterior Insulation when Exterior Siding is Replaced
☐ Assembly is Not Insulated			☐ Assembly is Under Insulated				☐ Air Seal Interior Penetrations		☐ Requires an Interior Insulation Blow
☐ Insulation is Not Protected from Air			☐ Chimneys are Present –				☐ Requires an Exterior Insulation Blow		☐ Comply with Lead Paint Abatement Procedures
☐ Excess Air Exchange w/ Exterior			☐ Signs of Water Leaks Present				☐ Batts can be Installed from Interior		☐ Fix Water Leaks Prior to Insulating
☐ Wall is "Balloon" Framed			☐ Unsafe Wiring is Present				☐ Air Seal Exterior Penetrations		☐ Correct Unsafe Wiring Prior to Insulating
☐									☐
Associated Rim Band Between Conditioned Floor Levels (Not Basement or Crawlspace Rim Bands)							**Associated Rim Band Between Conditioned Floor Levels**		
							☐ Recommend Improvements		☒ No Improvements Recommended
Framing	**Linear Ft**	**Insulation**		**Depth**	**Grade**	**R-Value**	**Install Insulation - Type**	**Depth**	**Install Interior Air Barrier / Rigid Insulation - Type**
6x6	**238**	**None**				**7**			
☐ Assembly is Not Insulated			☐ Assembly is Under Insulated				☐ Air Seal Penetrations		☐ Ensure Rim Insulation Ties into Foundation Insulation
☐ Excess Air Exchange w/ Exterior			☐ Signs of Water Leaks Present				☐ Air Seal Gaps		☐ Fix Water Leaks Prior to Insulating
☐ Wall is "Balloon" Framed			☐ Unsafe Wiring is Present				☐ Requires an Exterior Insulation Blow		☐ Correct Unsafe Wiring Prior to Insulating
☐ Not able to Assess			☐ Wood Rot is Present				☐ Ensure Rigid Insulation is Sealed in Place		☐ Correct Wood Rot Prior to Insulating
☐			☐				☐ Remove and Discard Existing Insulation		☐

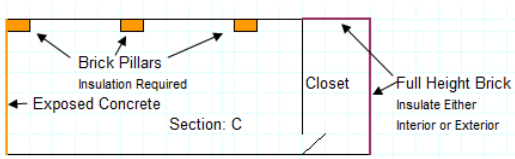


Comments: The walls for sections "A" and "B" are comprised of an elevated foundation wall with a framed wall above. The framed section of these walls has been retrofitted with blown fiberglass insulation. A defect was found with the wall bays associated with the stair well on the North side. The interior wall section below the stairwell did not have interior sheathing and the insulation fell out of these bays after installation. Access to the underside of the stairs is by an opening from the boiler room. It is recommended that OSB sheathing be installed on the interior wall side and the specific bays dense packed with cellulose insulation. No notable defects were found with the remaining framed walls for sections "A" and "B". However the lower half of these walls has an elevated foundation that is framed on the interior. Some sections of Section "B" have full height brick walls. It was assessed through infrared imaging that the interior framed portions of these masonry walls are not insulated. The "Foundation Wall" section of this report will describe the recommended remedial measures for those specific assemblies.



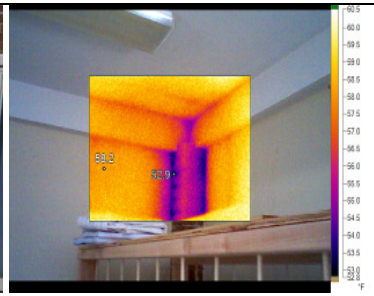
Exterior Walls

Assessment							Recommendations		
Location: **Section "C" – 1st Floor only**							☒ Recommend Improvements	☐ No Improvements Recommended	
Framing	**Dimensions**	**Sq-Ft**	**Insulation**	**Depth**	**Grade**	**R-Value**	**Install Cavity Insulation - Type**	**Depth**	**Install Interior Air Barrier / Rigid Insulation - Type**
2X4-16	**36 x 6.5**	**234**	**Fiberglass**	**4"**	**2**	**1.6 - 10.2**			
Interior Surface: **Sheetrock**			Exterior Cladding: **Wood Clap**				☐ Exterior Paint Should be Checked for Lead		☒ Add Interior Insulation to Uninsulated Masonry Surfaces
☒ Assembly is Not Insulated			☒ Assembly is Under Insulated				☐ Air Seal Interior Penetrations		☒ Comply with Building Code Thermal Barrier Requirements
☐ Insulation is Not Protected from Air			☐ Chimneys are Present –				☐ Requires an Exterior Insulation Blow		☐ Comply with Lead Paint Abatement Procedures
☐ Excess Air Exchange w/ Exterior			☐ Signs of Water Leaks Present				☐ Batts can be Installed from Interior		☐ Fix Water Leaks Prior to Insulating
☐ Wall is "Balloon" Framed			☐ Unsafe Wiring is Present				☐ Air Seal Exterior Penetrations		☐ Correct Unsafe Wiring Prior to Insulating
☐									☐

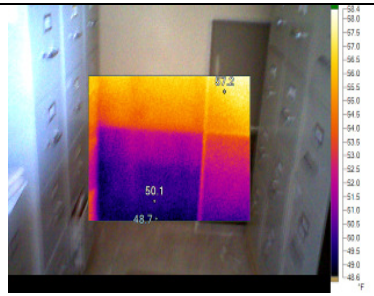


Comments: This section appears to have been an open porch that has been framed in. The framed portions of this section's walls were determined to be insulated via infrared imaging and visual inspection and are assessed at R10.2 for "whole wall" R-value. The Southern closet however has uninsulated masonry walls and a very low R-value and leaky door. The uninsulated brick is assessed an R-value of 1.6 and the door is approximately R1. The East wall of this section has uninsulated brick pillars, and the North wall has uninsulated exposed concrete on the lower half. The foundation wall section of this report provides improvement recommendations that include exterior insulation for the masonry foundations / walls. For this particular section of the building there is an option to put insulation on the interior of the masonry walls instead of the exterior, or both could be accomplished. 2.5" extruded polystyrene protected with a code approved thermal barrier, such as sheetrock, would be appropriate and provide an R13 insulation level. The brick pillars in the East wall and the exposed concrete on the North wall should also be covered with 2.5" rigid foam board with sheetrock. It appears that the exterior door in the South closet is not used and is sealed shut. If this door is not required then it is recommended that this door be fully sealed to create a weather tight barrier then insulated over with rigid insulation and a thermal barrier.

Uninsulated / Leaky Door



Uninsulated Brick Pillars



Uninsulated Concrete

Exterior Walls

Assessment

Location: **Section "A" - 2nd Floor**

Framing	Dimensions	Sq-Ft	Insulation	Depth	Grade	R-Value
3x4-32	17.33 x 156	2309	None			4.2

Interior Surface: **Sheetrock** Exterior Cladding: **Wood Clap**

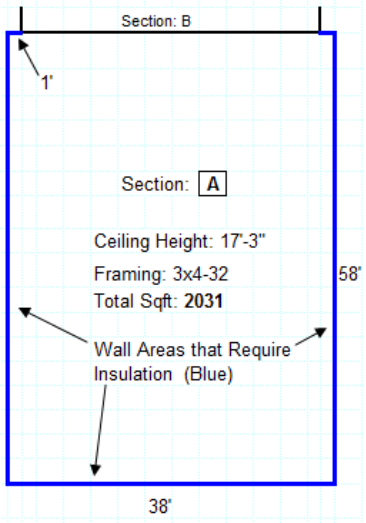
- ☒ Assembly is Not Insulated
- ☐ Insulation is Not Protected from Air
- ☐ Excess Air Exchange w/ Exterior
- ☒ Wall has open top plates
- ☐ Assembly is Under Insulated
- ☐ Chimneys are Present –
- ☐ Signs of Water Leaks Present
- ☐ Unsafe Wiring is Present

Recommendations

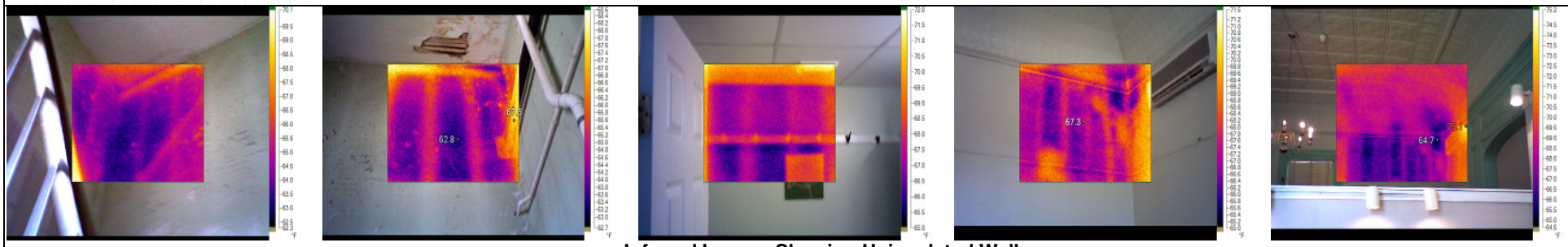
☒ Recommend Improvements ☐ No Improvements Recommended

Install Cavity Insulation - Type	Depth	Install Interior Air Barrier / Rigid Insulation - Type

- ☒ Exterior Paint Should be Checked for Lead
- ☒ Air Seal Interior Penetrations
- ☒ Requires an Exterior Insulation Blow
- ☐ Batts can be Installed from Interior
- ☒ Air Seal Exterior Penetrations
- ☐ Add Exterior Insulation when Exterior Siding is Replaced
- ☐ Requires an Interior Insulation Blow
- ☒ Comply with Lead Paint Abatement Procedures
- ☐ Fix Water Leaks Prior to Insulating
- ☐ Correct Unsafe Wiring Prior to Insulating



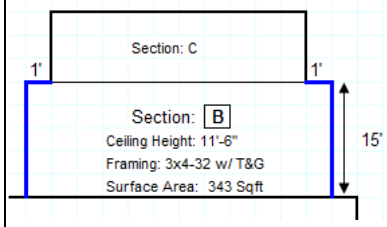
Comments: The Sq-Ft of the wall surface area listed above excludes the surface areas of the windows and is the actual surface area of the wall cavities that require insulation. Infrared imaging and visual inspection from the attic revealed these bays to be void of insulation. Due to the open wall top plates, minor amounts of blown fiberglass have fallen into these bays when the blown fiberglass was installed in the attic. Improvements to these walls will require an exterior cellulose blow. Due to the age of this structure, lead paint abatement procedures would be applicable unless approved RRP testing determines the absence of lead. The interior sheetrock has many unsealed gaps and seams. Interior air sealing should first be accomplished prior to dense packing cellulose to prevent excessive dust and debris from entering the office spaces and to reduce infiltration. Of important note is that there are air ducts in both the North and South Walls. It was not determined during the audit if there is actual ductwork installed in the wall cavity or if the wall cavity itself was panned off and used as the air duct. It is ***extremely*** important that the follow on insulation contractor first determine if actual air ducts are present in these wall bays prior to blowing insulation into these wall cavities. For either scenario it is highly inefficient to have ductwork inside an exterior wall cavity, and would be significantly worse if the cavity itself was used as the air duct. Even with perfectly tight ductwork (highly doubtful) these specific wall bays can not be properly insulted while the ductwork remains. It is highly recommended that this particular ductwork be re-routed to the interior of the primary air barrier (interior sheetrock).



Infrared Images Showing Uninsulated Walls

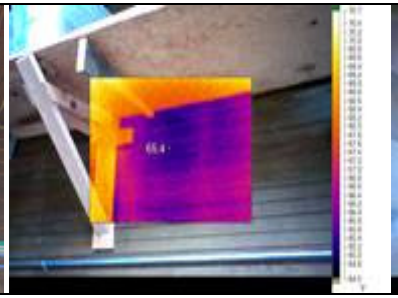
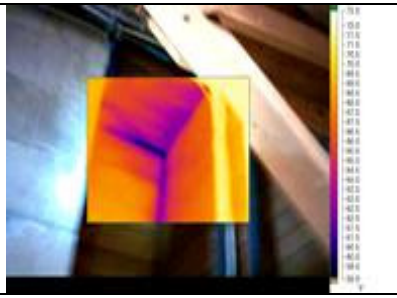
Exterior Walls

Assessment							Recommendations		
Location: **Section "B" – 2nd Floor**							☒ Recommend Improvements	☐ No Improvements Recommended	
Framing	**Dimensions**	**Sq-Ft**	**Insulation**	**Depth**	**Grade**	**R-Value**	**Install Cavity Insulation - Type**	**Depth**	**Install Interior Air Barrier / Rigid Insulation - Type**
3x4-32	**11.5 x 32**	**340**	**None**			**4.9**	**Dense Packed Cellulose**	**4"**	
Interior Surface: **3/4" Wood Panel**			Exterior Cladding: **Wood Clap**				☒ Exterior Paint Should be Checked for Lead	☐ Add Exterior Insulation when Exterior Siding is Replaced	
☒ Assembly is Not Insulated			☐ Assembly is Under Insulated				☒ Air Seal Interior Penetrations	☐ Requires an Interior Insulation Blow	
☒ Inadequate Air Barrier			☒ Chimneys are Present – 1				☒ Requires an Exterior Insulation Blow	☒ Comply with Lead Paint Abatement Procedures	
☐ Excess Air Exchange w/ Exterior			☐ Signs of Water Leaks Present				☐ Batts can be Installed from Interior	☐ Fix Water Leaks Prior to Insulating	
☒ Wall has open top plates			☐ Unsafe Wiring is Present				☐ Air Seal Exterior Penetrations	☐ Correct Unsafe Wiring Prior to Insulating	
☐								☐	



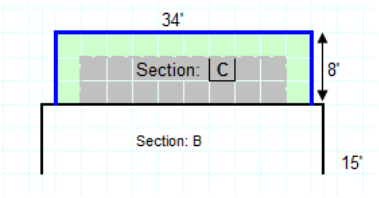
Comments: This section's walls were determined to be uninsulated via infrared inspection. The interior wall surfaces are tongue and grove wood which provides an inadequate air barrier. In addition these walls have many "cut outs" through which wiring had been run. These walls would require and exterior cellulose blow after the holes have been sealed. Lead paint abatement procedures would apply unless the exterior paint tested negative for lead using approved RRP lead testing procedures. The installation of *interior* 2" extruded polystyrene rigid insulation over the tongue and grove is an additional efficiency upgrade to be considered. This would significantly improve the air barrier reducing infiltration along with providing a layer of continuous R10 insulation. The wall currently is assessed at R5. Dense packing the cavities with cellulose would bring the wall assembly to R14. Dense packing the cavities and adding a layer of R10 interior insulation and sheetrock would bring the assembly to R25 and would provide a superior air barrier. This interior insulation would require a code approved thermal barrier, such as sheetrock. This interior insulation recommendation was not modeled into the energy saving calculations provided previously in this report due to the unlikelihood that this particular improvement would be conducted at this time, but should be considered if funding allows. The square feet provided in the table above are for the opaque wall area exclusive of windows.



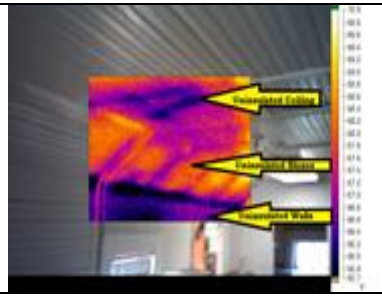




Exterior Walls

Assessment							Recommendations		
Location: **Section "C" – 2nd Floor**							☒ Recommend Improvements	☐ No Improvements Recommended	
Framing	**Dimensions**	**Sq-Ft**	**Insulation**	**Depth**	**Grade**	**R-Value**	**Install Cavity Insulation - Type**	**Depth**	**Install Interior Air Barrier / Rigid Insulation - Type**
2X4-16	**6.5 x 50**	**292**	**None**			**4.9**	**Dense Packed Cellulose**	**4"**	
Interior Surface: **3/4" Wood Panel**			Exterior Cladding: **Wood Clap**				☒Exterior Paint Should be Checked for Lead	☐Add Exterior Insulation when Exterior Siding is Replaced	
☒ Assembly is Not Insulated			☐ Assembly is Under Insulated				☒Air Seal Interior Penetrations	☐ Requires an Interior Insulation Blow	
☒ Inadequate Air Barrier			☐ Chimneys are Present –				☒Requires an Exterior Insulation Blow	☒ Comply with Lead Paint Abatement Procedures	
☐ Excess Air Exchange w/ Exterior			☐ Signs of Water Leaks Present				☐Batts can be Installed from Interior	☐ Fix Water Leaks Prior to Insulating	
☒ Wall has open top plates			☐ Unsafe Wiring is Present				☐Air Seal Exterior Penetrations	☐ Correct Unsafe Wiring Prior to Insulating	
☐								☐	



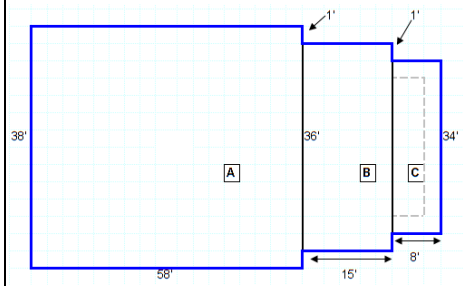
Comments: The same recommendations are made for this section as were made for building section "B". These walls were determined to be uninsulated and the tongue and grove provides a poor air barrier. As seen in the associated sections of this report this entire 2nd floor section of this building has uninsulated assemblies to include walls, the sloped ceiling sections and the flat attic section. The door to exterior is a very low R-value door and would be a candidate for replacement. The square feet provided in the table above are for the opaque wall area exclusive of windows and the door.



Foundation Walls

Assessment							Recommendations		
Location:	**Sections: All – Lower Sections with Masonry or Stone**						☒ Recommend Improvements	☐ No Improvements Recommended	
Framing	**Dimensions**	**Sq-Ft**	**Insulation**	**Depth**	**Grade**	**R-Value**	**Install Cavity Insulation - Type**	**Depth**	**Install Exterior Rigid Insulation**
Masonry	**x**	**674**	**None**			**1.5 – 3.0**			R 10 EIFS

Interior Surface: **Finished**	Exterior Cladding: **Exposed Masonry or Stone**		
☒ Assembly is Not Insulated	☐ Assembly is Under Insulated	☐ Improve Existing Insulation to Grade 1	☐ Ensure Ceiling Insulation is in Full Contact with Subfloor
☐ Insulation is Not Protected from Air	☐ Chimneys are Present –	☐ Remove and Discard Old Insulation	☐ Leave Bottom 6" Uninsulated Due to Dampness
☐ Excess Air Exchange w/ Exterior	☐ Signs of Water Leaks Present	☐ Cover Exposed Wall Insulation with Air	☐ Tape Seams of Rigid Insulation and Seal Perimeter
☐ Wall is "Balloon" Framed	☐ Unsafe Wiring is Present	☐ Air Seal Penetrations	☐ Moisture Problems Must be Corrected Prior to Insulating
☐		☐ Insulate Hatch / Door	☐ Correct Unsafe Wiring Prior to Insulating
		☐ Weather-Strip Hatch / Door	☐ Vent Dryer to Exterior



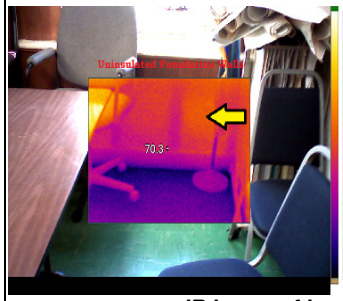
Comments: This building has an uninsulated slab on grade and the lower portions of the foundation walls are uninsulated. Infrared imaging of the foundation wall sections that have finished interiors has lead to the assessment that these foundation walls have no interior insulation. The uninsulated slab on grade along with the uninsulated foundation walls are a significant source of energy losses for this structure. It is recommended that these walls be improved with an Exterior Insulation Finishing System (EIFS) that provides a minimum of R10 with higher R-values preferred. To obtain maximum benefits, and to provide the slab perimeter insulation, it is recommended that the exterior insulation extend 2' below ground level if funding allows. This would require excavation around the perimeter. The below grade exterior rigid should extend down the below grade foundation wall and then horizontal for an additional 2'. If a full 2' depth is not practical due to limitations of funding, then the above grade portion, with as much below grade installation as feasible, is still recommended. One company that specialized in exterior foundation insulation is Associated Concrete Coatings, of Manchester NH. The exterior brick wall segment associated with the "vault" has a through wall vent that presently is covered by the exterior bulletin board on the South Side. Though this vent is covered by the bulletin board, excessive air leakage was noted through this vent. If it is determined that this vent is not required or needed then this vent should be sealed and insulated over.

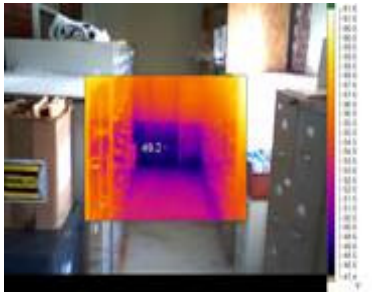
Section A – South

Sections B & C – South

Section C – South

Section A – North & West

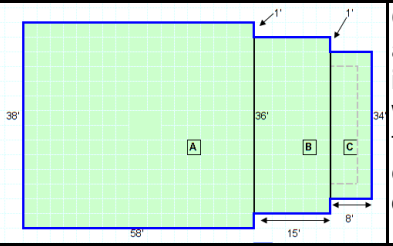




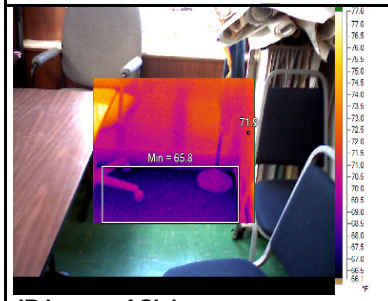
IR Image of Lower Foundation

Slab Floors

Assembly	Assessment				Recommendations
Slab Floor Space 1	Location: **Entire Structure**				☒ Add Perimeter Insulation – R-Value: **10** Recommended Type: EIFS Quantity:
	Covering: **Combination**	Floor Dimensions:			☐ Recommend Rigid Insulation Installed Between Sleepers when Carpet is Replaced or Space Finished
	LF On Grade: **238**	LF Below Grade:	**73**		☐ Cover Exterior Insulation with UV Protection ☐
	Insulation Under: **No**	Perimeter Insulation:	**No**		☐
	Insulation Depth:	Assessed R-Value:	**< 1**		
	☐ Assembly is Under Insulated				
	☒ Assembly Is Not Insulated				
	☐ Above Grade Exterior Insulation is not Protected				
	☐				



Comments: The recommendations for the slab perimeter improvements were made in the foundation wall section of this report. An additional improvement to the slabs would be to install R10 rigid insulation on the top side of the slab. Normally this type of installation would install the rigid insulation between pressure treated sleepers mechanically fastened to the slab. A new subfloor would be installed over. Other insulation systems rely upon sleepers installed over a continuous layer of rigid insulation. However this would require a specific compressive strength required of the rigid insulation. This improvement was not modeled into the energy savings calculation provided due to the assessment that it would not be accomplished at this time, and that the best section to conduct this improvement, section “C”, may be removed during future expansion.

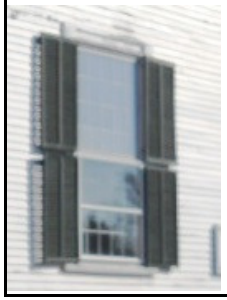


IR Image of Slab

Examples of Interior Slab Insulation Systems

Windows

Assembly	Assessment	Recommendations
Windows Type 1	Locations: **Throughout Building** Assessed U Value: **0.58** ☒ Single Pane ☐ Double Pane ☐ Triple Pane ☒ Wood ☐ Metal ☐ Vinyl ☐ < ½ Air Space ☐ ½ " Air Space ☐ > ½ " space Low E Coatings: Storm Window: Yes	☐ Add Exterior Storm Window ☐ Add Interior Storm ☐ Install Weather-Striping ☐ Consider Replacement Comments: Building has significant glazing area. The majority of the windows were single pane wood with storm windows and were assessed as fairly tight. Occupants report that the large 2nd floor windows are very difficult to operate and do not have a counterweight system. New recoil style counter weights systems area available. It is recommended that client consult a contractor that specializes in historic windows to install a counterbalance system to allow windows to be used for ventilation. With these windows operable natural ventilation could be used to a greater extend reducing air conditioning loads.



Exterior Doors

Door Type 1	Assessment	Recommendations
	Locations: **Solid Wood Panel Doors – South and West Entrances** Assessed R Value: **1.6** **Door Glazing Assessment** ☒ Single Pane ☐ Double Pane ☐ Triple Pane ☐ Wood ☐ Metal ☐ Vinyl ☐ < ½ Air Space ☐ ½ " Air Space ☐ > ½ " space	☐ Add Exterior Storm Door ☐ Consider Replacement ☐ Requires New Weather Stripping ☐ Door Latch Needs Adjusting ☐ Requires Door Sweep ☒ No Improvements Recommended Comments: Due to the historical nature of the building, replacing the low R-value wood doors for the South and West Entrance is not recommended. However door replacement for the 2nd Floor East Entrance should be considered.

Door Type 2	Assessment	Recommendations
	Locations: **1st Floor East Entrance** Assessed R Value: **4.4** **Door Glazing Assessment** ☐ Single Pane ☐ Double Pane ☐ Triple Pane ☐ Wood ☐ Metal ☐ Vinyl ☐ < ½ Air Space ☐ ½ " Air Space ☐ > ½ " space	☐ Add Exterior Storm Door ☐ Consider Replacement ☐ Requires New Weather Stripping ☐ Door Latch Needs Adjusting ☐ Requires Door Sweep ☒ No Improvements Recommended Comments: This is an insulated door that had minimal air leakage. No recommendation made for this door.

Door Type 3	Assessment	Recommendations
	Locations: **South Side – Section "C"** Assessed R Value: **1.2** **Door Glazing Assessment** ☐ Single Pane ☐ Double Pane ☐ Triple Pane ☐ Wood ☐ Metal ☐ Vinyl ☐ < ½ Air Space ☐ ½ " Air Space ☐ > ½ " space	☐ Add Exterior Storm Door ☒ Consider Replacement ☐ Requires New Weather Stripping ☐ Door Latch Needs Adjusting ☐ Requires Door Sweep ☐ No Improvements Recommended Comments: It appears that this door is no longer used. It is recommended that this door be sealed and insulated on the interior as recommended previously in this report.

AIR BARRIER / AIR LEAKAGE REPORT

Locations to Consider Air Barrier Improvements					
Assembly	**Assessment**				**Comments**
Attic	Major	Moderate	Minor	NA	
Wall Top Plates	☒	☐	☐	☐	All exterior and interior walls to attics
Electrical Penetrations	☐	☒	☐	☐	All Penetrating into attics
Plumbing Penetrations	☐	☐	☒	☐	
Electrical / Plumbing / HVAC Chases	☒	☐	☐	☐	Air Ducts in Wall Cavites, 2nd Floor North & South
Recessed Lights	☐	☐	☐	☒	
Ceiling Penetrations – Lights or Smoke Alarms	☐	☐	☒	☐	
Attic Hatch	☒	☐	☐	☐	Both attic hatches were very leaky
HVAC – Gap Between HVAC Boots and Sheetrock	☐	☐	☐	☒	
Chimney – Gap Between Masonry and Chimney	☐	☐	☒	☐	
Unsealed Air Ducts	☒	☐	☐	☐	Air Ducts in Wall Cavites, 2nd Floor North & South
Office Areas	Major	Moderate	Minor	NA	
Floor to Wall Junctions	☐	☐	☒	☐	
Wall to Ceiling Junctions	☐	☒	☐	☐	Sections B & C
Wall to Wall Junctions	☐	☒	☐	☐	Sections B & C
Gaps or Cracks in Sheetrock or Plaster	☒	☐	☐	☒	Section A - Holes in Plaster ceiling, gaps in sheetrock on walls
Electrical / Phone / Cable outlets – Walls	☐	☐	☒	☐	
Plumbing Penetrations Through Walls	☐	☐	☐	☒	
Through Tongue & Groove or Wood Planked Walls	☒	☐	☐	☒	Sections B & C
Windows – Through Window Seals	☐	☐	☒	☐	
Windows – Around Trim / Through Rough Opening	☐	☐	☒	☐	
Exterior Doors	☐	☐	☒	☐	
Stairs	☐	☐	☐	☒	
Beams	☐	☐	☐	☒	
Fireplace – Damper	☐	☐	☐	☒	
Fireplace – Gap Between Masonry and Sheetrock or Floor	☐	☐	☐	☒	
Fireplace Chimney – Gap Between Chimney and Framing	☐	☐	☐	☒	
Bath Fan – Back Draft Damper	☐	☐	☐	☒	Consider installing an inline back draft damper in fan vent line
Kitchen Fan – Back Draft Damper	☐	☐	☐	☒	
Fan – Vent penetrations	☐	☐	☒	☐	
Dryer Vent Penetration	☐	☐	☐	☒	
Basement or Crawlspace	Major	Moderate	Minor	NA	
Penetrations for Electrical or Plumbing through Floor	☐	☐	☐	☒	
Air Exchange via Cantilevered Floors	☐	☐	☐	☒	
Air Exchange through Framed Floor	☐	☐	☐	☒	
Dryer Vent Penetration	☐	☐	☐	☒	
Penetrations Through Rim Band	☐	☐	☐	☒	
Basement Hatch or Door to Exterior	☐	☐	☐	☒	
Additional Comments:					

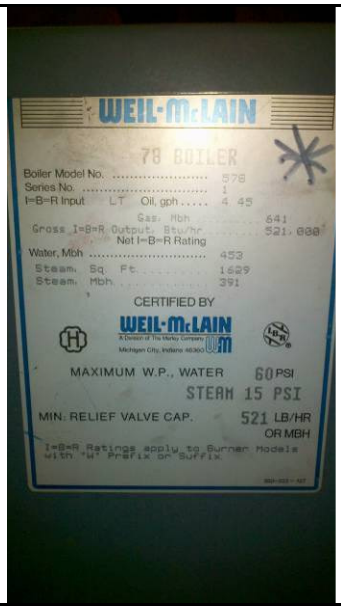
SYSTEMS REPORT

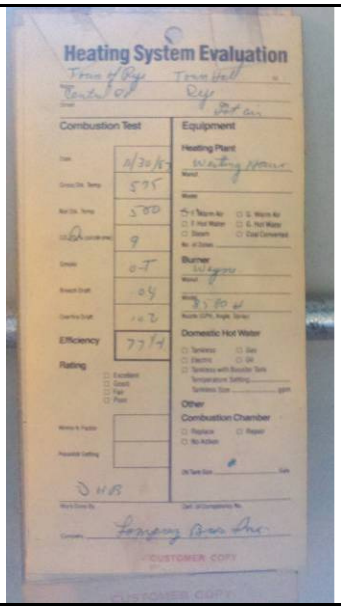
Heating System Assessment									
Type of System	☐ Forced Hot Air ☒ Forced Hot Water ☒ Hydro / Air ☐ Electric Baseboard ☐ Steam ☐ Geothermal ☐ Air Source Heat Pump ☐ Other								
Fuel Type	Oil	Propane	Kerosene	Electric	Nat. Gas	Cord wood	Wood Pellets	Wood Chips	Other
	☒	☐	☐	☐	☐	☐	☐	☐	
Estimated System Efficiency	78% AFUE			Manufacturer		Model Number			
Estimated Age	16-18 Years			Weil-McLain		578			
Programmable Thermostats	Yes								

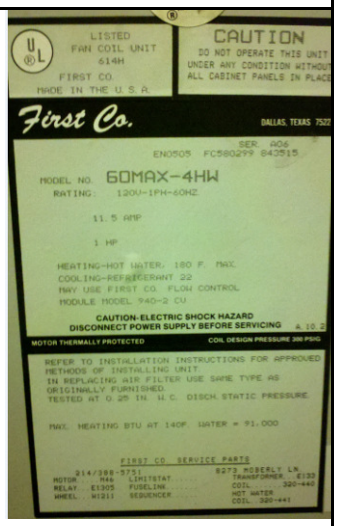
Note: Refer to "Health & Safety" Section for Results of Combustion Safety Testing
Refer to "Other Improvements Recommendations" For Hydronic Pipe Insulation Recommendations

☐ System should be serviced ☐ Additional Inspection is recommended by a HVAC technician
☒ Consider replacement with a high efficiency system
☐ Replace with high efficiency system at end of current system's useful life
☐

Comments: Detailed inspection of the existing heating systems was not accomplished due to previous contractor evaluating the building's systems and plan to enstall new geothermal system.







Air Conditioning Assessment

Type of System	☒ Central Air – Air Source ☐ Central Air – Ground Source ☐ Window Units ☐ Floor Units ☒ Mini Split ☐ Multiple Systems are Used ☐ Other:
Programmable Thermostats	Yes

	Age	Efficiency	Size	Manufacturer	Model Number
System 1	**16 yrs**	**10.2 SEER**	**1.5 Ton**	**Sanyo**	**C1822**
System 2	**16 yrs**	**10.0 SEER**	**2 Ton**	**Sanyo**	**C2422**
System 3	**16 yrs**	**10.0 SEER**	**2 Ton**	**Sanyo**	**C2422**
System 4	**16 yrs**	**10.0 SEER**	**2 Ton**	**Sanyo**	**C2422**
System 5	**16 yrs**	**10.0 SEER**	**2 Ton**	**Sanyo**	**C2422**
System 6	**16 yrs**	**10.0 SEER**	**5 Ton**	**American Standard**	**7A0060A100A**

☐ System should be serviced ☐ Additional Inspection is recommended by a HVAC technician
☐ System is oversized for building ☐ Consider replacement with a high efficiency system
☐ Replace with high efficiency system, that is appropriately sized for building, at end of current system's useful life
☒ No Improvements Recommended

Comments: Systems 1-5 are ductless mini-splits. All systems are low efficiency compared to current systems available. Due to plans to have systems replaced with geothermal system, no recommendations are made for the air conditioning systems.

Air Duct Assessment

☐ No Air Ducts Present ☒ Air Ducts Are Not Sealed ☐ Air Ducts Are Under Insulated
☐ Leakage Noted by Feel or IR ☐ Air Ducts Tested Leaky ☒ Air Ducts Located in Exterior Wall Cavities

Tested CFM 25 Leakage of Ducts: **Not Tested** ☐ Total Leakage Test ☐ Leakage to Outside

Recommendations for Air Ducts

☒ Seal air ducts with mastic ☐ Insulate with R9 minimum ☐ Burry under attic insulation
☐ Seal ducts with closed cell Recommended Inches of closed cell:
☒ Comply with building code and manufacturer's recommendation for application of insulation in proximity of heating system / plenum
☐

Comments: The air duct system used for the Hydro air and the 5 ton air conditioning system was not tested. As noted in previous sections of this report additional inspection is recommended to determine if the ducts registers on on the upper level of Section "A" North and South Walls have ductwork inside the walls or if the wall cavity was used without dedicated dutwork. It is highly recommended that these wall cavities not be used for duct work and that the ducts be re-routed to remain inside the primary air barrier / thermal boundary. Once this is done then these wall cavities can be completely dense packed with cellulose insulation.

Domestic Hot Water Assessment

System Type / Information	Tank	Tankless	From Boiler	Insulation Blanket	Heat Traps	Pipe Insulation
	☐	☐	☒			

	Electric	Propane	Nat. Gas	Oil	Wood	Solar	Combo
Fuel Type	☐	☐	☐	☒	☐	☐	☐
Estimated Efficiency:	**70%**						

Recommendations For Domestic Hot Water System

Note: Refer to "Other Improvements Recommendations" for Pipe Insulation

- ☐ Consider replacing system with high efficiency system of same type
- ☐ Consider replacing with tankless system
- ☐ Replace with high efficiency system at end of current systems useful life
- ☐ Add Insulation Blanket
- ☐

Comments: It is assessed that very little hot water is used in this building. Due to the plan to install geothermal, it is assumed that the geothermal system will provide the hot water. If this is not the case then it is recommended that a high efficiency tankless system be installed to provide hot water supply.

Mechanical Ventilation Assessment

System Type: ☐ Exhaust ☐ Balanced HRV
☐ Supply ☐ Balanced ERV
Distribution: ☐ Connects to FHA ☐ Dedicated Ducts

		Manufacturer	Model Number	CFM	Hours of Operation
System 1	Estimated System Efficiency				
	Estimated Age:				
System 2	Estimated System Efficiency:				
	Estimated Age:				

- ☐ System should be serviced
- ☐ Additional Inspection is recommended by a HVAC technician
- ☐ System over ventilates building
- ☐ Consider replacement
- ☐ System under ventilates building
- ☐ Refer to Air Leakage Report for calculated flow rate
- ☐ Monitor interior humidity trends and adjust run time accordingly
- ☐

Comments: No ventilaiton system installed

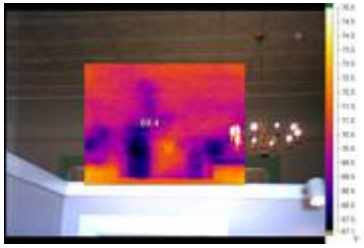
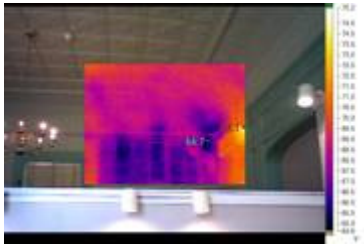
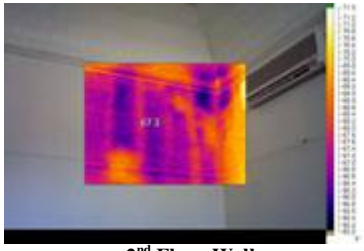
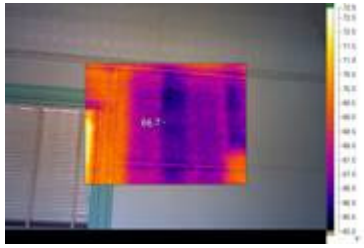
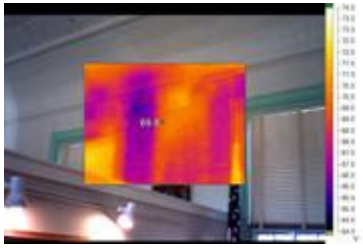
OTHER IMPROVEMENTS, RECOMMENDATIONS & CONSIDERATIONS

Item	Comments / Location	Recommendations
☒ Hydronic Heating Pipes		Insulate with high quality / high R-value insulation Estimated LF:
☒ Domestic Hot Water Pipes		Insulate with high quality / high R-value insulation Estimated LF:
☐ Domestic Hot Water Tank		Add tank wrap insulation – follow manufacture's guidance Tank Size:
☐ Low Flow Shower Heads		Install Quantity: Color:
☐ Low Flow Aerators		Install Quantity:
☐ Solar Hot Water System		Your site is conducive for solar hot water installation
☐ Drain Waste Heat Recovery		Your plumbing configuration is conducive to a waste heat recovery system
☐ Programmable Thermostats		Install and use setback when building is not occupied Quantity: Type:
☒ Air Ducts – Leakage		Have all accessible ducts sealed (See Systems Report)
☒ Air Ducts - Other	Ducts in Wall Cavities – Section A	**Verify is ductwork is present or if wall cavity is used. Recommend completely removing ductwork from wall cavity and re-install inside the primary air barrier / thermal boundary.**
☐ Air Ducts – Insulation		Insulate all air ducts in non conditioned spaces to R9 or better (See Systems Report)
☐ Lighting		Use compact florescent lighting to fullest extent possible
☐ Lighting Controls		Automatic occupant sensing and shutoff switches are recommended
☒ Phantom Electrical Loads		Use "smart" power strips for major items and turn off electrical devices at power strips at end of work day. Keep any items with AC/DC converter unplugged unless required for charging.
☐ Attic Ventilation		Additional attic ventilation is recommended - Type:
☐ Inefficient Freezer		Replace with an ENERGY STAR chest freezer appropriately sized
☐ Kitchen Appliances		Replace with ENERGY STAR appliances at end of current appliances useful life
☐ Laundry Appliances		Replace with ENERGY STAR appliances at end of current appliances useful life
☒ Computers		Use the power save feature on your computers
Additional Comments:		

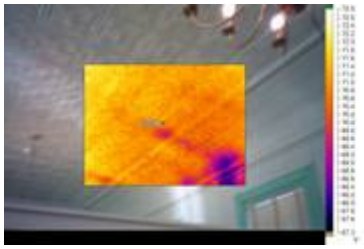
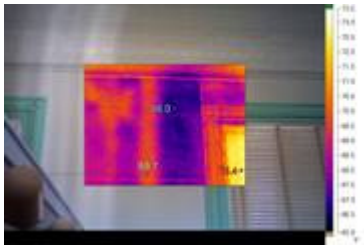
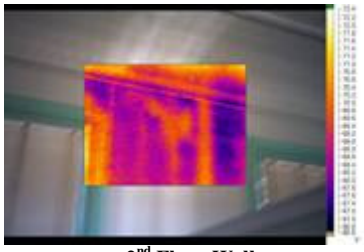
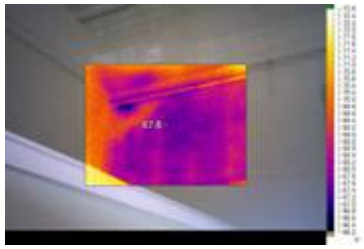
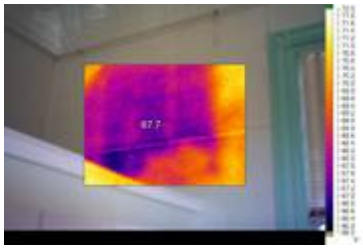
HEALTH, SAFETY & BUILDING DURABILITY

Item		Comments	Recommendations
☐ **Heating System – Emergency Service**			**Your Heating System Failed a Safety Check – Immediate Service is Required** ☐ CAZ Worst Case Depressurization ☐ CO Spillage ☐ Flue CO ☐ Flue Draft
☐ **Heating System – Service Past Due**			Heating system is past due for service – recommend servicing
☒ **Heating System – Annual Maintenance**			Have heating system serviced annually by a qualified technician
☒ **Combustion Appliance Zone (CAZ) Testing**		Air sealing could impact draft of combustion appliances	Have CAZ testing accomplished upon completion or air sealing. Ensure carbon monoxide detector is installed in combustion appliance zone.
☒ **Combustion / Make Up Air for Combustion Appliances**			Ensure adequate combustion air is provided for all combustion appliances.
☐ **Carbon Monoxide Detectors**		☐ No Detectors Installed ☐ Inadequate Quantity Installed ☐ No CO Detector in CAZ	**Install CO Detectors Per Code requirements** Quantity Required:
☐ **Smoke Detectors**		☐ No Detectors Installed ☐ Inadequate Quantity Installed ☐ No Detector in CAZ	**Install Smoke Detectors Per Code Requirements** Quantity Required:
Bath Fan & Venting ☐ **Note: All Bath Fans were verified exhausting to exterior**	Fan Location Floor:	☐ No Fan Installed ☐ Poor Quality Fan ☐ Fan has Low Air Flow	☐ Recommend bath fan installation or replacement ☐ Recommend time delay switch for fan control Type of fan recommended: CFM Recommended:
	Ductwork Location	☐ Ductwork should be replaced ☐ Ducts require insulation ☐ Fan vents to attic space ☐ Not able to inspect	**All Bath Fans *Must* Vent to the Exterior Via Insulated Ducts** Length of Duct Run: ☐ Exterior Vent is Required – Color: Type of Vent Required: ☐ Wall ☐ Roof ☐ Use Insulated Flex Duct ☐ Use Insulated Hard Pipe
☐ **Sump pump pit**			**Moisture Sources Should Always be Mitigated Prior to Insulating or Air Sealing** Cover sump pump pit with a cover that minimizes water vapor diffusion into basement area but would still allow water drainage from basement floor into pit in event of basement flooding. Alternative is to fit foil faced polyisocyanurate over pit to reduce vapor diffusion but constructed so polyisocyanurate will "float up" in event basement floods. Ensure discharge drains well away from structure.
☐ **Wet or Damp Basement or Crawlspace Space 1** Location:		☐ Standing water present ☐ Dampness observed ☐ No vapor barrier installed ☐ Exterior could not be observed ☐ Owner reports space remains dry ☐ Owner reports dampness	**Moisture Sources Should Always be Mitigated Prior to Insulating or Air Sealing** ☐ Install 6 Mil or better vapor barrier over dirt floors and sealed to walls ☐ Install gutters and drainage system that drains well away from structure ☐ Install sump pump and drainage system that drains well away from structure ☐ Install dehumidifier or exhaust ventilation controlled by humidistat ☐ Improve exterior grading and drainage
☒ **Humidity Levels**			Monitor indoor humidity levels after air sealing and / or improvements to the thermal boundary. Average humidity should be below 60% in summer / 40% in winter.

SELECTED INFRARED IMAGES

2nd Floor Walls

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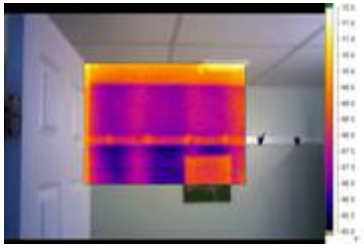
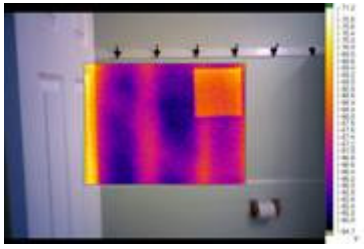
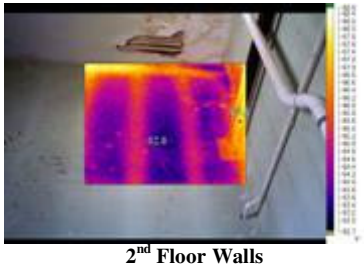
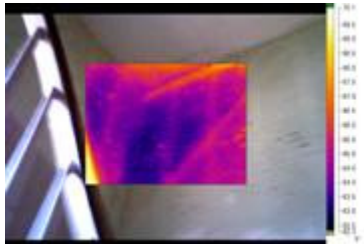
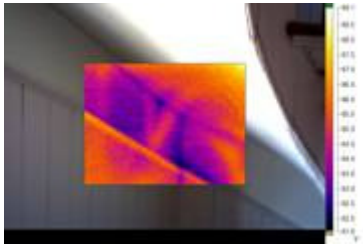

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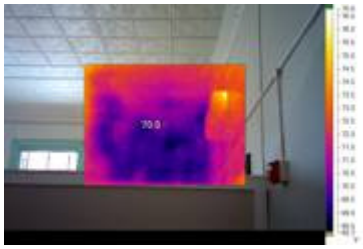
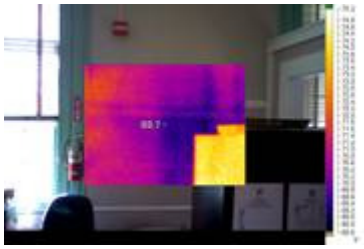
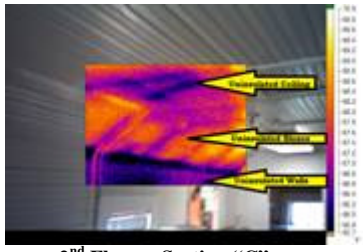
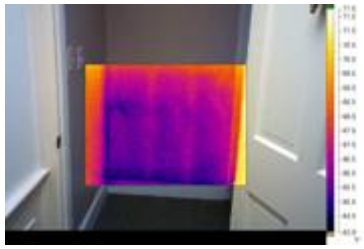
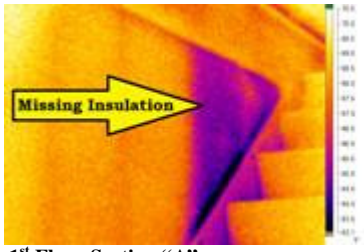







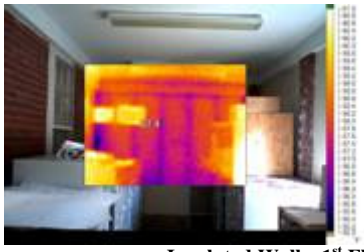
2nd Floor – Section "C"

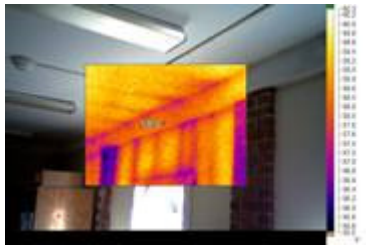
Uninsulated Foundation / Walls



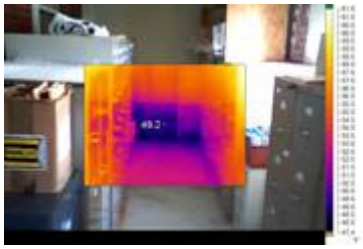
1st Floor Section "A"

Uninsulated Slab

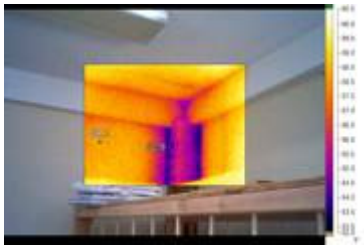




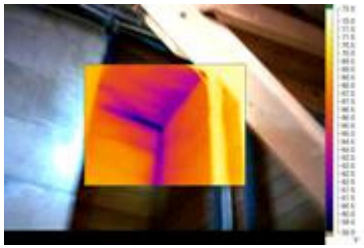
Insulated Walls- 1st Floor Section "C"

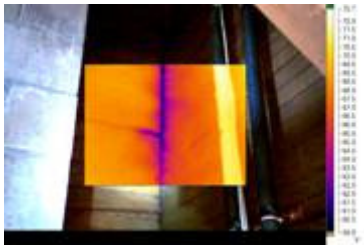


Uninsulated Foundation



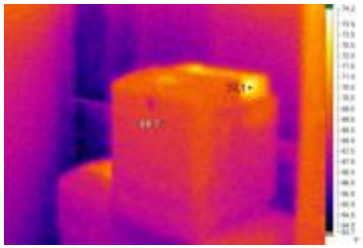
Uninsulated Masonry



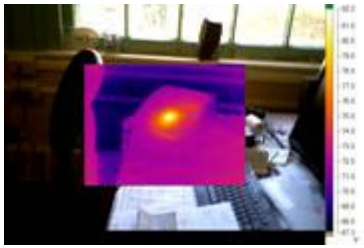


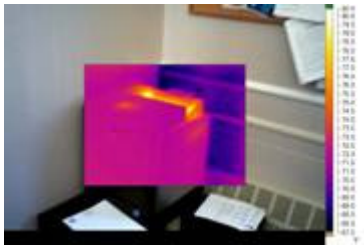
Air Leakage

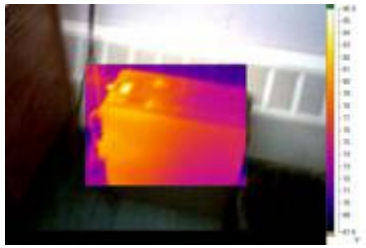
Uninsulated Foundation / Wall



"Phantom" Electrical Loads







"Phantom" Electrical Loads

SELECTED DIGITAL IMAGES

Section “A” Attic

Wall Between Conditioned Space and Attic

Defective Air Barrier

Section “C” Attic

Defective Air Barrier

Uninsulated Hatch – Section “C”

Inadequate Air Barrier / Holes in Air Barrier

Metal Ceiling

Inadequate Air Barrier

Uninsulated Foundation / Slab

Unused Low R-Value / Leaky Door