BALES ENERGY ASSOCIATES

Date: April 22, 2014

DRAFT REVISION INCLUDING HEAT PUMP ANALYSIS

ENERGY STUDY
FOR
GILL TOWN HALL

325 Main Road
Gill, MA 01354

Completed By:

Bales Energy Associates
www.balesenergy.com
50 Miles Street
Greenfield, MA 01301
413-863-5020

Consulting Energy Engineer:
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Introduction

Bales Energy Associates, an energy efficiency engineering firm, was contracted to provide an ASHRAE Level 2 energy audit for Gill Town Hall located at 325 Main Road in Gill , Massachusetts.

Bart Bales, PE, MSME, senior engineer at Bales Energy Associates, visited the site, reviewed energy usage & billing information, examined relevant equipment and systems, and developed energy analyses and recommendations with regard to building's energy related systems.

Subsequent to the completion of this report and at the request of the Gill Energy Committee, Bales Energy Associates agreed to work in conjunction with Richard Baker, an IGSHPA certified heat pump specialist, to provide a preliminary evaluation of ground and air-source heat pump to this building. Cost estimates were provided by Mr. Baker and at the time of the provision of this draft study have not been independently evaluated by Bales Energy Associates.

Executive Summary

Energy Conservation Opportunities Evaluated

Bales Energy Associates has approached the Gill Town Hall in terms of the whole system. Improvements in various systems have interactive impacts with other systems. Key conclusions are the following:

1. **Heating Systems Recommendations**
   Three heating system replacement options were evaluated
   Option 1: Installation of a propane-fired, premium efficiency condensing boiler with a propane storage tank.
   Option 2: Installation of an oil-fired boiler with an integrated condensing economizer.
   Option 3: Installation of a wood pellet-fired boiler with a pellet storage silo.
   Option 4: Replace Existing System to Water-to-Water Ground-Source Heat Pump System with New Fan Coils and Hydronic Distribution
   Option 5: Installation of Distributed Split System Air-to-Air Heat Pumps for Basement & First Floor

   The added Heat Pump options are included in the appendices.

   a. **All options assume installation of an improved microprocessor-based scheduling time-clock** to provide scheduling of occupied and unoccupied periods.

      Install an outdoor air temperature sensor and a space temperature sensor. Use space temperature and outside air sensor inputs sensors to determine when boiler and circulator shall run for daytime temperature maintenance, and unoccupied temperature setback.

2. **Domestic Hot Water System Observations and Recommendations**
   Observations:
   a. Domestic hot water use is very limited in the building; there are two hand-washing sinks and one small kitchenette sink.

b. The existing tank-less coil water heater leads to undesirable boiler stand-by heating losses during the non-heating season.

Recommendations

a. All heating system replacement options assume the **installation of an 8-gallon electric mini-tank to provide hot water for lavatory hand-washing and kitchenette sinks**. Modify piping so that this unit can also serve the kitchenette sink.

3. **Enclosure Improvements** can reduce the building's heat loss characteristics but represent significant capital investments. Options include:

a. **Increasing the attic floor assembly R-value by R40 was evaluated.** Because the attic is un-floored, a superstructure would have to be added to allow for insulating the attic. This greatly increases the cost to insulate the attic area.

Insulating the attic requires installation of sub-flooring across the top floor ceiling joists to provide a structure to support cellulose insulation. This subflooring would also serve to limit air transport though the ceiling. Cellulose insulation sufficient to achieve the desired attic floor assembly R-value could then be added. In this approach the existing fiberglass insulation would be retained in place as is. Any bypasses and penetrations in the attic would be air-sealed and floored pathway to the cupola ladder provided. The measure is presented without and with costs to correct attic ventilation deficiencies to allow air flow through the attic properly to maintain proper conditions for humidity control in the attic.

The attic currently does not have low gable or soffit air intake openings required for proper attic ventilation. The cost to provide proper low ventilation openings is included in ECM 2B. ECM 2B also includes an allowance for the installation of a properly sized, insulated and structurally sound attic access hatch.

Bales Energy Associates recommends inclusion of elements in ECM 2B. ECM 2A is included in case needed by for grant evaluation purposes by the Division of Energy Resources.

b. The level and quality of the insulation of the walls at the Town Hall is uncertain. Members of the Energy Committee have expressed interest in using thermal imaging of the building to ascertain areas of greater heat loss. Areas in which the inside of walls such as above and around the former electric heater grills were examined and found to be insulated with dense cellulose insulation.

Thermal imaging was not included in the scope of the current study. Thermal imaging can be used to identify areas which are poorly insulated or in which insulated has settled to create voids. Areas of high infiltration (air leakage) can also sometimes be identified with thermal imaging. If significant insulation improvement opportunities are identified during such imaging, a wall insulation measure can be evaluated based upon the new information to provide the necessary documentation for inclusion in future Green Communities funding requests.

c. For long-term capital improvement, consider replacing the building's windows and framing to reduce air leakage and conduction heat losses**.**

The costs, savings, and economic payback for these energy conservation measures are presented in the following Executive Summary Chart. The values shown in the Executive Summary Table represent the savings with measures taken in the order of economic feasibility shown.

The calculations supporting each measure are included in the appendices.

Executive Summary Chart

							Oil	Electricity	Propane	Wood Pellets						
							$2.98	$0.162	$2.15	$242.50						
							$/Gallon	$/KWH	$/Gallon	$/Ton						
ECM #	Energy Conservation Measures	Cost	Incremental Cost ($)	Available Utility Rebates ($)	Total Cost after Rebate ($)	Incremental Cost after Rebate ($)	Oil Savings (Gallons/yr)	Electricity Savings (KWH/yr)	Propane Savings (Gallons/yr)	Wood Pellet Savings (Tons/yr)	Annual Savings ($/yr)	Total Payback (yrs)	Incremental Payback (yrs)	Total Payback Payback after Rebates (yrs)	Incremental Payback after Rebates (yrs)	Life Years
ECM1A	Install Propane-Fired Condensing Boiler & Mini-Domestic Hot Water Tank	$15,818	$8,818	0	$15,818	$8,818	1,000	-470	-1,042		$660	24.0	13.4	24.0	13.4	20+
ECM1B	Install Oil-Fired Boiler w/ Condensing Economizer, & Mini-Domestic Hot Water Tank	$13,718	$6,718	0	$13,718	$6,718	202	-470	0		$526	26.1	12.8	26.1	12.8	20+
ECM1C	Install Wood Pellet-Fired Boiler & Mini-Domestic Hot Water Tank	$26,668	$19,668	6,667	$20,001	$13,001	1,000	-470	0	-7.98	$966	27.6	20.4	20.7	13.5	20+
ECM2A	Insulate & Air-Seal the Attic	$6,525	$6,525	0	$6,525	$6,525		0	144	0.00	$311	21.0	21.0	21.0	21.0	30+
ECM2B	Insulate & Air-Seal the Attic, Add Attic Hatch & Provide Proper Attic Intake Air Venting	$8,714	$8,714	0	$8,714	$8,714		0	144	0.00	$311	28.0	28.0	28.0	28.0	30+
	Totals for ECM1A & ECM2B	$24,532	$17,532	$0	$24,532	$17,532	1,000	-470	-898	0	$971	25.3	18.1	25.3	18.1	
	Totals for ECM1B & ECM2B	$22,432	$15,432	$0	$22,432	$15,432	202	-470	144	0	$837	26.8	18.4	26.8	18.4	
	Totals for ECM1C & ECM2B	$35,382	$28,382	$6,667	$28,715	$21,715	1,000	-470	144	-8	$1,277	27.7	22.2	22.5	17.0	

Existing Conditions

Facility Description

The Gill Town Hall is a moderate sized wood-framed, sloped-roofed building located at 325 Main Road Gill, Massachusetts. The building comprises a basement and first floor of town offices and a second floor meeting hall.

Utility Energy Use

Utility data was collected and is tabulated below. Western Massachusetts Electric Company provides electricity. For heating, the Town Hall uses #2 fuel oil. (Note: WMECO (and its parent company Northeast Utilities, recently merged with NSTAR. As a result, changes in procedures and personnel in charge of related utility programs are in transition.)

Jul 2012-June 2013		Billed Energy Use Table for Electricity & Fuel					
Building Name		**Gill Town Hall**					
Owner		**Town Of Gill, MA**					
Account #							
		Electricity	Electricity	Electricity	Oil	Oil	**Energy $**
Month		KWH	KW	Total $	Gallons	$	**Totals**
Jul	7/16/2012	1440	5.0	$226			**$226**
Aug	8/14/2012	1500	4.5	$209			**$209**
Sept	9/13/2012	600	4.0	$94.33	66.3	$197	**$292**
Oct	10/12/2012	660	4.0	$121			**$121**
Nov	11/9/2012	780	4.5	$140	126.3	$376	**$516**
Dec	12/12/2012	900	5.5	$144	227.4	$677	**$822**
Jan	1/14/2013	1140	5.5	$191	215.0	$640	**$831**
Feb	2/12/2013	1080	4.5	$176	96.7	$288	**$464**
Mar	3/13/2013	1080	4.0	$171	114.9	$342	**$513**
Apr	4/12/2013	1080	4.5	$179	153.0	$456	**$634**
May	5/14/2013	840	5.5	$146			**$146**
Jun	6/14/2013	1320	5.5	$213			**$213**
Annual (Units)		12,420		$2,011	999.6	$2,977	**$4,988**
Heating Season (Units)		6,720		$1,122	933.3	$2,780	**$3,902**
						Energy Use Totals (Mbtu)	
Annual (Mbtu)		42,377			138,644.5	181,022	**Energy $ Totals**
Heating Season (Mbtu)		22,929			129,448.7	152,377	
$/Energy Unit		$0.16				$2.98	
$/Energy Unit						**Totals (Mbtu/sf)**	**($/sf)**
Annual (Mbtu/sf)		8.3			27.2	**35.5**	**$0.98**
Heating Season (Mbtu/sf)		4.5			25.4	**29.9**	**$0.77**
Building Name		**Gill Town Hall**			**Heated Square Footage**		**5,100**

Prescriptive and custom utility incentives are available for some of the measures described. When the report's contents are accepted by the client, the report may be presented to the utilities for review and determination of levels of custom incentives the utilities will offer, if any.

Western Massachusetts Electric Company contacts are: Lynn Ditullio (ditullb@nu.com) and Robert Dvorchik (dvorcrs@nu.com).

Heating, Ventilating & Air Conditioning Systems

Boiler

The building is served by a five-section, oil-fired non-condensing boiler (HB Smith, 8 Series, S/W-5) installed in 1999. This boiler can fire at two levels, high and low, with a maximum output rating of 175,000 Btu/hr. The boiler has a combustion efficiency of approximately 83%.

The design heat load for the building is approximately 76,000 Btu/hr.

Evaluated Boiler Improvement Measures

At the request of the energy committee, three boiler replacement options are evaluated in this study. Energy and dollar savings are evaluated for each option. The three replacement options are:

1. **Installation of a propane-fired, premium efficiency condensing boiler with a propane storage tank.**
2. **Installation of an oil-fired boiler with an integrated condensing economizer.**
3. **Installation of a wood pellet-fired boiler with a pellet storage silo.**

In an update to this report, the Energy Committee contracted for added evaluation of air and ground-source measures in this report. They are included in the Appendix.

These measures are evaluated in detail in the report's appendices.

Each of the heating system replacement options will significantly reduce heating costs. The greatest

Boiler Water Temperature Controls

The boiler system provides hot water at a constant temperature (180 F) and has no outside temperature sensor. The operating temperature of the water circulated through the boiler is not reset based upon the outside air temperature.

Heating Distribution Systems

The building is a (hot-water based) hydronic heating system comprising three circulation. One loop serves the second floor meeting hall; the other two serves the town offices on the first floor and in the basement. Terminal heating is provided by baseboard convectors.

Building Temperature & Scheduling Controls

Temperatures in the three zones are controlled by manual thermostats located in each zone.

As part of the boiler replacement measure, Bales Energy Associates **recommends Installation of an electronic programmable timeclock and an outdoor air sensor and an indoor space sensor.**

Cooling Systems

Window air conditioning units are used to cool the spaces in the building.

Domestic Hot Water Heating Systems

Hot water is provided by a tank-less coil in the boiler. This requires the boiler to remain operational throughout the non-heating months; during this time stand-by losses occur for the boiler to maintain itself in a ready state. Water usage is low in the building; water uses are limited to a small kitchenette sink and two lavatory sinks.

Domestic Hot Water Heating System Recommendation

To minimize stand-by heat losses from the domestic hot water system, **Bales Energy Associates recommends the installation of small well-insulated 8-gallon,mini-tank electric water heaters located near the sinks that they serve. The mini-tank could be located in the boiler room beneath the lavatories and piped to serve the two lavatories and the nearby kitchenette sink.**

Costs and savings for this measure are included in the Appendices.

Heating System Improvement Options

The three options have different costs, benefits, and trade-offs. Factors in addition to energy efficiency and savings may impact the option the Town chooses to implement. Bales Energy Associates discusses key parameters for consideration below. Domestic hot water use (comprising three low-flow sinks) is very limited at the town hall. For all options, Bales Energy Associates recommends the installation of a point-of-use mini-tank electric hot water heater for provision of hot water. This will allow the boiler to be turned off during the non-heating season, thus avoiding large boiler stand-by losses during those months.

Prior to the energy committee's interest in an evaluation of multiple heating system options, Bales Energy Associates tendency was to recommend the propane-fired system. This was due to uncertainty in how to weight the non-technical factors indicated below.

Bales Energy Associates will be happy to participate in a discussion aid the town in evaluating which option to implement.

- **Propane-Fired Condensing Boiler System**

  The propane-fired option will reduce source energy the most and result in the most efficient system. This option requires the installation on a town-owned propane tank. In this measure an underground tank is assumed. (The propane-fired option reduces fuel costs more than the oil-fired option.)

  Condensing boilers are designed and constructed to safely capture the latent energy in boiler exhaust by condensing the water vapor. This condensate contains sulfuric acid. For this reason condensing boilers must be constructed of materials designed to withstand such corrosive condensate. Quality condensing boilers are constructed with a stainless steel heat exchanger and with condensate neutralization to allow for environmentally acceptable disposal of condensate to drain.

  The boiler system should also be installed with sealed combustion. This means that the combustion air is brought from outdoors via a plastic intake pipe to directly provide air to the burner. The low-temperature exhaust may be side-vented from the building typically via plastic pipe as well.

- **Oil-Fired Boiler System with Condensing Economizer**

  The oil-fired option saves less energy than the propane-fired option. The oil-fired option allows the town to use an oil-biodiesel blend (up to 20%), if desired. The oil-fired option has the lowest first cost and the shortest economic payback. As far as the consultant knows, the Buderus oil-fired boiler with condensing economizer assumed in this measure is the only oil-condensing product line available in Massachusetts.

These boilers are designed and constructed to safely capture the latent energy in boiler exhaust by condensing the water vapor in an added economizer section attached to the exhaust of the boiler.

This condensate contains sulfuric acid. For this reason the economizer section must be constructed of materials designed to withstand such corrosive condensate. These boilers are equipped with condensate neutralization to allow for environmentally acceptable disposal of condensate to drain.

The boiler system should also be installed with sealed combustion. This means that the combustion air is brought from outdoors via a plastic intake pipe to directly provide air to the burner. The low-temperature exhaust may be side-vented from the building typically via plastic pipe as well.

According to Orange Oil, the local distributor/contractor providing the propane and oil-fired quotations, Orange Oil is the top provider of this product in the United States. Though sold widely in Europe and there is currently significant quantities of this product currently available, new stock of the Buderus boiler considered is not currently being imported into the United States. Orange Oil has indicated that Buderus has indicated a long-term commitment to providing support and parts for the product in the United States.

- **Wood Pellet-Fired System**

The wood pellet-fired option uses a non-fossil, partially renewable fuel source. It improves system energy efficiency less than the other two options but saves the most on fuel costs. Wood pellets cost substantially less than fossil fuels on a per unit basis for delivered energy.

The boiler system should also be installed with sealed combustion. This means that the combustion air is brought from outdoors via a plastic intake pipe to directly provide air to the burner.

Pellets are delivered to a large bulk silo. The system evaluated includes an auto-feed mechanism which delivers pellets without the need for operator oversight. (This system operates equivalently to the oil pump for an oil-fired boiler.) The system includes an ash compression system to increase ash storage capacity and increase the time period between ash removals.

The pellet boiler requires more maintenance attention than the other options. Periodic removal and disposal of ash is required. (The Okofen pellet boiler assumed in this measure is one of the only pellet boilers which meet the Massachusetts Code requirements for pressure vessels.)

A new upcoming state program is slated to provide a rebate of 25% of the installed cost of a pellet boiler system.

Sandri Energy, a local energy provider and contractor for heating, ventilating and air conditioning services, indicates that it has made a significant and long-term financial commitment to providing wood pellet delivery services for commercial and residential clients. Sandri provides and installs Okofen pellet boilers, as well as pellet delivery services.

Option 4: Ground-Source Heat Pump: Replace Existing Hydronic Boiler System with Water-to-Water Ground-Source Heat Pump System with New Fan Coils and Hydronic Distribution

This approach utilizes a water–to-water ground source heat pump system to provide conditioned water to new hydronic fan-coil units. Fan coil units will be installed to temper the various spaces. A new hydronic distribution loop will deliver water to each fancoil. Re-use of the extsiting radiators is not appropriate due to the lower water temperatures provided by the heat pump system.

Note that an added advantage of the heat pump system is that air conditioning capability is added for the building.

Option 5: Air-Source Heat Pump: Install Distributed Air-to-Air Split System Heat Pumps to Serve the Basement & First Floors

This approach utilizes new air –to- air- source heat pumps to provide conditioned airr to directly condition the various spaces. The existing boiler system is retained to serve the large top floor meeting hall.

Note that an added advantage of the heat pump system is that air conditioning capability is added for the building

Costs and savings for all five options are included in the Appendices.

Lighting Systems

Most spaces in the building are lighted with four foot fluorescent fixtures equipped with T-8 lamps and compatible electronic ballasts.

Building Enclosure

The finished basement, first, second floors of the Gill Town Hall comprise approximately 5,100 square feet of heated floor area.

Roof and Attic

The Town Hall has a cape-style -roof with a ventilation cupola on top. The attic has no soffit vents around the perimeter of the roof overhang nor does it have gable vents. The attic roof is not insulated.

There is a small floored section of the attic above the stage which is beneath the cupola. The spaces beneath the attic joists and above the drop ceiling is insulated with foil-faced fiberglass batts facing the drop ceiling. The ceiling is unevenly insulated. There are large air bypasses between the attic and the spaces below.

Recommendation for the Attic

Bales Energy Associates recommends that the attic floor joists be treated as the location thermal and air boundary layer. This involves the following steps:

1. Install subflooring (or other sufficient structure) to support the installation of cellulose insulation on top of the attic floor. Seal subflooring to reduce air leaks. Install a permanent hatch for access to the attic. Close off and air-seal all other penetrations.
2. Retain the cupola for ventilation out of the attic.
3. Insulate the attic floor assembly to add an R-40 level of loose-fill cellulose insulation to the attic.

Costs and savings for this measure are included in the Appendices.

APPENDICES

HEATING SYSTEM IMPROVEMENT MEASURES

Option#1: Propane-Fired Condensing Boiler

Space Heating Savings with Propane-Fired Condensing Hydronic Boiler						
		Gill Town Hall			Propane	
Oil Rate ($/gallon)		Gill, MA			$/gallon	
$2.98	Existing Condition:			New Condition:	$2.15	
Equipment Type	Space Heating Boiler	Space Heating Boiler		Space Heating Boiler	Space Heating Boiler	
Boiler #	1			1		
Make	HB Smith			Viessman		
Model	8 Series S/W-5			Vitodens 200 WB2-8-32		
Type	Atmospheric			Condensing		
Heating Medium	Hydronic			Hydronic		
Control Mode	High-Low			Modulating 4:1		
Maximum Output Mbtu/Hr	175			103		
Steady State Eff	83%			92%		
Input Mbtu/Hr	201			112		
Seasonal Eff	72%			92%		
Percentage of Load	100%			100%		
Installed System Costs				Condensing Boiler		
Boiler	$7,000	Propane-Fired Condensing Boiler		$12,550		
		Propane tank		$2,600		
		Mini-Tank Water Heater		$668		
Totals	$7,000			$15,818		
Annual Building Operating Load (MMbtu/year)	Summary of Existing Building-Related Heat Loads	Existing Oil Heating Usage Gallons	New Propane Heating Usage Gallons	Fuel Cost $	Peak Space Heating Load (Mbtu/hr)	Provide (#) 1 Boilers @ 100% of design Load
99,544	Existing Oil Use	1,000		$2,977	76	76
99,544	New Propane Use		1,042	$2,241		
		KWH				
Electric HW Use	New electricity use	470		$76		
Fuel Energy Before	138,645					
Fuel Energy After	108,200					
Added Electrical Energy	1,603					
Fuel Energy saved	28,841		Savings $	$660	76	
Assuming Existing Boiler Payback Calculation:						
		Cost	Savings	Payback		
Full Equipment Cost Basis:		$15,818	$660	24.0		
Incremental Equipment Cost Basis:		$8,818	$660	13.4		

Estimate Provider: Orange Oil, New Salem, MA

Proposal

Date: 09-10-13

Name	Gill Town Hall	Phone	413-863-9347
Address	325 Main Road	Job Name	Viessmann 200 Boiler
City, State, Zip	Gill, MA 01354	Job Location	SAME
Submitted by	Robert E. Harris III	Account #	

We hereby submit specifications and estimates for:

Viessmann Vitodens 200 WB2B 35 Boiler; Veissman Low Loss Header; Horizontal Venting Kit; Viessmann Neutralization Kit; Low Loss Sensor Kit; Extrol Package; (3) Grundfos Circulators; (1) Spirovent Air Eliminator; Watts S1156F, 9D; Argo ARM-4 Zone Relay; And all miscellaneous material for job completion.	6,900.00
Permit	150.00
Labor	4,800.00
TOTAL	**$ 11,850.00**

Proposal Does Not Include Wiring By Electrician

We Propose hereby to furnish material and labor – complete in accordance with above specifications, for the sum of:
Eleven Thousand Eight Hundred Fifty and 00/100 Dollars ($11,850.00)

Payment to be made as follows:
50% Down Upon Bid Acceptance ($5,925.00)
With Balance Due Upon Job Completion ($5,925.00)

All material is guaranteed to be as specified. All work to be completed in a substantial workmanlike manner according to specifications submitted, per standard practices. Any alteration or deviation from above specifications involving extra costs will be executed only upon written orders, and will become an extra charge over and above the estimate. All agreements contingent upon strikes, accidents or delays beyond our control. Owner to carry fire, tornado and other necessary insurance. Our workers are fully covered by Workmen's Compensation Insurance.

Authorized Signature
_____

Note: This proposal may be withdrawn by us if not accepted within **60** days.

Acceptance of Proposal - The above prices, specifications and conditions are satisfactory and are hereby accepted. You are authorized to do the work as specified. Payment will be made as outlined above.

Date of Acceptance: _____

Signature _____

Signature _____

Boiler estimate provided by Orange Oil, 45 Elm Street, New Salem, MA 01355 mail: PO Box 150, Orange, MA 01364 phone: (978)544-3222 or (413)773-0222

Note: Propane tank cost in measure was provided by George Propane of Goshen, MA. Bales Energy Associates has also included an added $500 allowance for wiring boiler by an electrician. These services were not included in Orange Oil's quotation.

Option#2: Oil-Fired Boiler with Condensing Economizer

Space Heating Savings with Oil-Fired Hydronic Boiler with Condensing Economizer Gill Town Hall Gill, MA						
Oil Rate ($/gallon)					Oil $/gallon	
$2.98	Existing Condition:			New Condition:	$2.98	
Equipment Type	Space Heating Boiler	Space Heating Boiler		Space Heating Boiler	Space Heating Boiler	
Boiler #	1			1		
Make	HB Smith			Buderus		
Model	8 Series S/W-5			GB-125 BE		
Type	Atmospheric			Condensing		
Heating Medium	Hydronic			Hydronic		
Control Mode	High-Low			Modulating 4:1		
Maximum Output Mbtu/Hr	175			97		
Steady State Eff	83%			90%		
Input Mbtu/Hr	201			108		
Seasonal Eff	72%			90%		
Percentage of Load	100%			100%		
Installed System Costs		Condensing Boiler				
Boiler	$7,000	Oil-Fired Boiler w/ Condensing Economizer		$13,050		
		Mini-Tank Water Heater		$668		
Totals	$7,000			$13,718		
Annual Building Operating Load (MMbtu/year)	Summary of Existing Building-Related Heat Loads	Existing Oil Heating Usage Gallons	New Oil Heating Usage Gallons	Fuel Cost $	Peak Space Heating Load (Mbtu/hr)	Provide (#) 1 Boilers @ 100% of design Load
99,544	Existing Oil Use	1,000		$2,977	76	76
99,544	New Oil Use		797	$2,375		
		KWH				
Electric HW Use	New electricity use	470		$76		
138,645	Fuel Energy Before					
110,604	Fuel Energy After					
1,603		Gallons Saved				
26,437	Fuel Energy saved	202	Savings $	$526	76	
Assuming Existing Boiler Payback Calculation:						
		Cost	Savings	Payback		
Full Equipment Cost Basis:		$13,718	$526	26.1		
Incremental Equipment Cost Basis:		$6,718	$526	12.8		

Boiler estimate provided by Orange Oil, 45 Elm Street, New Salem, MA 01355 mail: PO Box 150, Orange, MA 01364 phone: (978)544-3222 or (413)773-0222

Estimate Provider: Orange Oil, New Salem, MA

Proposal

Date: 09-10-13

Name	Gill Town Hall	Phone	413-863-9347
Address	325 Main Road	Job Name	Buderus GB125BE/2107
City, State, Zip	Gill, MA 01354	Job Location	SAME
Submitted by	Robert E. Harris III	Account #	

We hereby submit specifications and estimates for:

Buderus GB 125-35 BE Condensing Boiler with Blue Flame Burner; Buderus GB-125 Horizontal Venting Kit; Argo ARM-4 Zone Relay; Buderus HS-2107 Logamatic Control; Buderus BFU RoomSensor; Extrol Package; (3) Grundfos Circulators; (1) Spirovent Air Eliminator; Watts S1156F, 9D: Ball Valves; And all miscellaneous material for job completion.	8,000.00
Permit	150.00
Labor	4,400.00
TOTAL	**$ 12,550.00**

Proposal Does Not Include Wiring By Electrician

We Propose hereby to furnish material and labor – complete in accordance with above specifications, for the sum of:
Twelve Thousand Five Hundred Fifty and 00/100 Dollars ($12,550.00)

Payment to be made as follows:
50% Down Upon Bid Acceptance ($6,275.00)
With Balance Due Upon Job Completion ($6,275.00)

All material is guaranteed to be as specified. All work to be completed in a substantial workmanlike manner according to specifications submitted, per standard practices. Any alteration or deviation from above specifications involving extra costs will be executed only upon written orders, and will become an extra charge over and above the estimate. All agreements contingent upon strikes, accidents or delays beyond our control. Owner to carry fire, tornado and other necessary insurance. Our workers are fully covered by Workmen's Compensation Insurance.

Authorized Signature
_____

Note: This proposal may be withdrawn by us if not accepted within **60** days.

Acceptance of Proposal - The above prices, specifications and conditions are satisfactory and are hereby accepted. You are authorized to do the work as specified. Payment will be made as outlined above.

Date of Acceptance: _____

Signature _____

Signature _____

Note: Bales Energy Associates has included an added $500 allowance for wiring boiler by an electrician. These services were not included in Orange Oil's quotation.

Option#3: Wood Pellet-Fired Boiler

Space Heating Savings with Wood-Pellet-Fired Boiler						
			Gill Town Hall			Pellets
Oil Rate ($/gallon)			Gill, MA	New Condition:		$/ton
$2.98	Existing Condition:			Pellet-Fired		$242.50
Equipment Type	Space Heating Boiler	Space Heating Boiler	Pellets Btu/ton	Space Heating Boiler	Delivered Price	
Boiler #	1		15500	1		
Make	HB Smith			Okofen		
Model	8 Series S/W-5			PE(S)25		
Type	Atmospheric					
Heating Medium	Hydronic			Hydronic		
Control Mode	High-Low			Modulating 3.2:1		
Maximum Output Mbtu/Hr	175			85		
Steady State Eff	83%			87%		
Input Mbtu/Hr	201			98		
Seasonal Eff	72%			77%		
Percentage of Load	100%			100%		
Installed System Costs				Condensing Boiler		
Boiler	$7,000		Pellet-Fired Condensing Boiler	$21,500		
			Outside storage silo with air-based auto feed	$4,500		
			Mini-Tank Water Heater	$668		
Totals	$7,000			$26,668		

Annual Building Operating Load (MMbtu/year)	Summary of Existing Building-Related Heat Loads	Existing Oil Heating Usage Gallons	New Pellet Heating Usage Tons	Fuel Cost $	Peak Space Heating Load (Mbtu/hr)	Provide (#) 1 Boilers @ 100% of design Load
99,544	Existing Oil Use	1,000		$2,977	76	76
99,544	New Wood Pellet Use		7.98	$1,935		
		KWH				
Electric HW Use	New electricity use	470		$76		
138,645	Fuel Energy Before					
129,278	Fuel Energy After					
1,603	Added Electrical Energy					
7,764	Fuel Energy saved		Savings $	$966	76	

Assuming Existing Boiler Payback Calculation:		Cost	Savings	Payback
Full Equipment Cost Basis:		$26,668	$966	27.6
	New Program Rebate	$6,667		
	Net Cost after rebate	$20,001	$966	20.7
Incremental Equipment Cost Basis:		$19,668	$966	20.4
	New Program Rebate	$6,667		
	Net Cost after rebate	$13,001	$966	13.5

Estimated cost of wood pellet boiler and storage silo provided by Sandri Energy of Greenfield, MA.

(413) 772-2121, www.sandri.com

MINI-TANK ELECTRIC HOT WATER HEATER (Included with all options)

Bosch GL8Ti Ariston Pro Ti Electric Mini-Tank Water Heater

Ariston ProTi point-of-use electric mini tanks are designed with titanium for longer life. The "Titanium Plus Inside" glass lining protects the tank against leakage. These units can be installed independently or in-line with a larger hot water source eliminating long waits for hot water.

Bosch GL8Ti Ariston Pro Ti Electric Mini-Tank Water Heater offers three different models you can choose from that can be mounted on the wall or floor. Built with titanium for longer life and durable poly-composite housing resists corrosion. Also comes with an 8 year residential and commercial warranty from Bosch.

Bosch GL8Ti Ariston Pro Ti Electric Mini-Tank Water Heater Features:
• 3 Models to choose from (2.5, 4, and 8)
• Adjustable thermostat with thermal cut-out
• Dielectric isolation on inlet/outlet connections
• Units can be wall hung (bracket included) or floor mounted
• Durable poly-composite housing will not dent and resists corrosion
• Temperature/pressure relief valve included (plumb correctly for discharge)
• Simple 120V plug-in connection
• Built with titanium for longer life
• Meets ASHR 90.1 standard
• Mounts on wall or floor
• Three sizes to choose from

Bosch GL8Ti Ariston Pro Ti Electric Mini-Tank Water Heater Specifications:
• Tank Volume - 7.0 gallons
• Dimensions - 17½"x17½"x14½"
• Voltage - 120v
• Amperage - 12.5 amps
• Wire Size - 120v plug
• Heating Capacity - 1500 watts
• Recovery at 90°F Rise - 6.8 gph
• Temperature Range - 65º-145ºF
• Water Connections - ¾" NPT
• Operating Pressure - 150 psi
• Product Number: 348486
• Relief Valve - Included

Option#4: Replace Existing Hydronic Boiler System to Water-to-Water Ground-Source Heat Pump System with New Fan Coils and Hydronic Distribution

Space Heating Savings with Water-toWater Ground-Source Heat Pump System						
		Gill Town Hall Gill, MA			Electricity $/KWH	
Oil Rate ($/gallon)						
$2.98	Existing Condition:			New Condition:	$0.144	
Equipment Type	Space Heating Boiler			Ground-Source Heat Pump		
Boiler #	1			3		
Make	HB Smith			Hydron		
Model	8 Series S/W-5		Heat Pumps (2)	HWT026		
Type	Atmospheric		Fan Coil Units (10)	MHWW-09-H-3		
Heating Medium	Hydronic			Water-to-Water		
Control Mode	High-Low		Rating (tons)	6.6		
Maximum Output Mbtu/Hr	175			78.6		
Steady State Eff	83%			412%		
Input Mbtu/Hr	201			19		
Seasonal Eff	72%			412%		
Percentage of Load	100%			100%		
Installed System Costs		High-Performance Heating System				
Boiler	$7,000	Three (3) Water-to-Water Heat Pumps				
		Serving Ten (10) Fan-Coil Units				
		Ground-Coupling: Borefield with				
		Foot Boreholes		$87,000		
		Integrating Controls		$3,580		
		Subtotal		$90,580		
		Contingency		$9,058		
		Subtotal		$99,638		
		System Configuration Contractor Oversight		$9,964		
Totals	$7,000	Total		$109,602		
Annual Building Operating Load (MMbtu/year)	Summary of Existing Building-Related Heat Loads	Existing Oil Heating Usage Gallons	New Electricity Heating Usage KWH	Fuel Cost $	Peak Space Heating Load (Mbtu/hr)	Provide (#) 1 Boilers @ 100% of design Load
93,203	Existing Oil Use	933		$2,781	79	79
93,203	New Electricity Use		6,628	$954		
		KWH				
Fuel Energy Before	93,203					
Fuel Energy After	22,622					
Fuel Energy saved	70,581		Savings $	$1,827		
Payback Calculation:						
		Cost	Savings	Payback	Incentive per Ton	
Full Equipment Cost Basis:		$109,602	$1,827	60.0		
Renewable Thermal Incentive (CEC/DOER)		-$13,100			$2,000	
Utility Incentive (Mass-Save)		-$524			$80	
Full Equipment Cost Basis after Incentive:		$95,978	$1,827	52.5		
Incremental Equipment Cost Basis:		$102,602	$1,827	56.2		
Renewable Thermal Incentive (CEC/DOER)		-$13,100				
Utility Incentive (Mass-Save)		-$524				
Incremental Equipment Cost Basis:		$88,978	$1,827	48.7		

Ground-Source Heat Pump Data for Gill Town Hall
From Baker GSHP Preliminary Report

Project: Gill Town Hall HVAC upgrades
Prepared: March 13, 2014
Prepared By: Richard Baker, IGSHPA 24526-0209

RE: GSHP Preliminary Report Gill Town Hall

System Loads

System loads or peak loads are calculated based on a variety of details for an individual facility, assumed occupancy levels, the number of appliances operating, the number of doors & windows, and the tightness of the construction all contribute to the amount of energy required to maintain the thermostat set points given the historical extreme weather conditions in your area.

1 kBtu/hr = 1,000 Btu/hr

Zone	Total Heating Load	Total Cooling Load	SHF
Zone 1	76.0 kBtu/hr		0.900
Total	76.0 kBtu/hr		

1. Peak Loads used here as provided by: Bart Bales, PE
2. This report is primarily concerned with heating load and associated operational costs therefore cooling load is not being considered at this point.

Equipment Schedule

Based on the provided loads and space configuration considerations, the preliminary GSHP equipment schedule for this system is as follows:

Zone	Equipment	QTY	Heat Capacity KBtu/hr (Low Stage)	Heat Capacity kBtu/hr (High Stage)	Water Flow (GPM)	Air Flow (CFM)
Central Source	Hydron Module – HWT026 (ELT-110/50)	3	61.30	78.60	18.0	
Distributed	MHWW-09-H-1	10		80.70	18.0	270

1. All capacities shown are total
2. For water to water equipment, source and load water flows are assumed equal.
3. Capacities are adjusted for 32F EWT and Glycol protection to 15F with EAT 70F and ELT 110F
4. When equipment allows continuous fan operation is recommended
5. Avoid using dramatic night time set back
6. Air Flow rates are reported on a per unit basis. For total air flow in a zone, multiply the reported air flow by quantity.
7. Installed GSHP COP 3.32 High Capacity and 4.72 Low Capacity

GSHP Selection

Manufacturer: **Hydron Module**
Model: **HWT026**

Heat Pump Type: **Water to Water** Capacity: **Dual**

Installation Cost		$ 87,000

Ground Heat Exchange Summary

Grout is used inside of all bores in order to protect the deep earth environment from surface contaminants and to provide a more effective contact surface with GHEX piping that optimizes heat transfer between the fluid pumped through your GSHP and the earth. Deep Earth (below 20ft) temperature is a function of the average annual air temperature in your region and remains relatively constant regardless of season.

Deep Earth Temp (Tg) 52.0 F

Formation T.C.	1.20 Btu/hr ft F
Grout T.C.	1.00 Btu/hr ft F
EWTmin	30.0F
EWTmax	90.0F
Bore Diameter	6.00 in
Pipe Diameter	1.25 in
Bores in Series	1
Layout Rows	1
Bores per Row	3
Number of Bores	3
Bore Spacing	25.0 ft on center
Bore Depth	302 ft
Adj. Bore Depth*	341 ft
System Run Fraction	0.553

Adj. Bore Depth is the adjusted bore depth. This is the depth of bore that should be used to accommodate unbalanced ground loads over time. A pre-construction test bore is recommended.

Grouting the bore annulus: Each vertical bore is to be grouted from the bottom to the top. Grout field mix T.C. testing is recommended. Grout Recommendation: TGLite by GeoPro Inc.

GHEX Piping:

Vertical Bore: 1.25” HDPE SDR-11 with factory u-bend

Horizontal Piping:

From Bore to Building all pipe should be a minimum of 4’ below grade.
Supply lines should be below Return lines.
2” foam board insulation should separate supply and return lines when feasible.
2” foam board insulation should be above return lines when feasible.
Horizontal piping should be in backfill free from material that may be a hazard to the pipe.

GHEX Manifold:

Vertical bore loopfield will be (3) individual closed loop circuits bringing in a total of (3) 1.25” supply and (3) 1.25” return lines. Interior piping: install full port valves on each supply and each return to a common supply and common return header. Install fill and drain ports followed by full port valves on header. Connect supply and return to pumping station.

Note: Mechanical or ‘Stab’ fittings are not recommended for any portion of exterior below grade piping. All exterior below grade pipe connections are to be by fusion of HDPE pipe and HDPE fittings.

Wall penetrations to be sealed with 'link seal' style fittings inside pvc sleeve. Sleeve sealed with either silicone, hydrolic cement or similar.

Recommended freeze protection – 22% to 15 F with Propylene Glycol

System Sequencing

1. Individual Fan Coil thermostat calls for conditioning
2. Hydronic circulation begins to and from conditioned Water Storage Tank
3. Water Storage Tank aqua-stat calls for conditioning
4. GHEX circulator pump responds causing flow in GHEX
5. GSHP provides desired conditioning to Water Storage Tank

It is recommended that where GSHP equipment allows that the fan be set to on at all times. This maintains desired air circulation blending conditioned air more evenly throughout the conditioned space. Doing this will reduce the circumstance of hot spot/cold spot improving occupant comfort and reducing overall energy consumption.

GSHP (COP avg) 4.12

Option 5: Install Distributed Air-to-Air Split System Heat Pumps to Serve the Basement & First Floors

Space Heating Savings with Split Air-Source Heat Pump System						
		Gill Town Hall				
Oil Rate ($/gallon)		Gill, MA			Electricity $/KWH	
$2.98	Existing Condition:			New Condition:	$0.144	
Equipment Type	Space Heating Boiler			Air-Source Heat Pump		
Boiler #	1			7		
Make	HB Smith			Mitsubishi		
Model	8 Series S/W-5			MUZFE9NA (2)		
Type	Atmospheric			SEER: 26; HSPF:10		
Heating Medium	Hydronic			Air-to Air		
Control Mode	High-Low		Rating (tons)	6.4		
Maximum Output Mbtu/Hr	175			76.3		
Steady State Eff	83%		Mean	280%		
Input Mbtu/Hr	201			27		
Seasonal Eff	72%			280%		
Percentage of Load	100%			100%		
Installed System Costs		High-Performance Heating System				
Boiler	$7,000	Seven (7) Split-System Air-Source VRF Heat Pumps		$30,000		
		Four Networkable Programmable "Smart" Thermostats		$2,040		
		Subtotal		$32,040		
		Contingency		$3,204		
		Subtotal		$35,244		
		System Configuration Contractor Oversight		$3,524		
Totals	$7,000	Total		$38,768		
Annual Building Operating Load (MMbtu/year)	Summary of Existing Building-Related Heat Loads	Existing Oil Heating Usage Gallons	New Electricity Heating Usage KWH	Fuel Cost $	Peak Space Heating Load (Mbtu/hr)	Provide (#) 1 Boilers @ 100% of design Load
55,922	Existing Oil Use	933		$2,781	76	76
55,922	New Electricity Use		5,852	$843		
		KWH				
Fuel Energy Before	55,922					
Fuel Energy After	19,972					
Fuel Energy saved	35,950		Savings $	$1,939		
Payback Calculation:						
		Cost	Savings	Payback	Incentive per Ton	
Full Equipment Cost Basis:		$38,768	$1,939	20.0		
Renewable Thermal Incentive (CEC/DOER)						
Utility Incentive (Mass-Save)		-$509			$80	
Full Equipment Cost Basis after Incentive:		$38,260	$1,939	19.7		

Project: Gill Town Hall HVAC upgrades
Prepared: April 1, 2014
Prepared By: Richard Baker, IGSHPA 24526-0209

RE: ASHP Preliminary Report Gill Town Hall

System Loads

System loads or peak loads are calculated based on a variety of details for an individual facility, assumed occupancy levels, the number of appliances operating, the number of doors & windows, and the tightness of the construction all contribute to the amount of energy required to maintain the thermostat set points given the historical extreme weather conditions in your area.

1 kBtu/hr = 1,000 Btu/hr

Zone	Total Heating Load	Total Cooling Load	SHF
Zone 1	76.0 kBtu/hr		0.900
Total	76.0 kBtu/hr		

1. Peak Loads used here as provided by: Bart Bales, PE
2. This report is primarily concerned with heating load and associated operational costs therefore cooling load is not being considered at this point.

Equipment Schedule

Based on the provided loads and space configuration considerations, the preliminary GSHP equipment schedule for this system is as follows:

Zone	Equipment	QTY	Heat Capacity KBtu/hr (Low Stage)	Heat Capacity kBtu/hr (High Stage)	Water Flow (GPM)	Air Flow (CFM)
First Floor	Mitsubishi MUZFE09NA	7		62,566		
& Basement						

The Mitsubishi MUZFE09 outdoor unit with matching MSZFE09 indoor unit has a heating capacity of 10,900 btu/hr @ 5F and will have 82% of that at -4F and 62% of the 10,900 down to -13F. HSPF of 10 at 47F or 10btu/h/W

Anticipated Cost to install: $ 30,000

ATTIC INSULATION MEASURE INFORMATION

ECM#2	Summary of Energy Savings					
		Baseline Heat Load Mbtu/hr	After ECM #2 Mbtu/hr	Savings 10E6 Btu/yr	% Reduction	
Fuel Energy Usage (MMBtu/yr)		142.31	122.58	19.73	13.9%	
New Boiler System efficiency		92%	92%			
Fuel Energy Usage (MMBtu/yr)		155	133			
Energy Savings		% Reduction	Propane Use after ECM1a	Gallons Saved	$/Unit	$ Saved
		13.9%	1,042	144	$2.150	$311
					Total Savings ($)	$311

		Measure	Cost $	Savings $	Payback Years
Attic Insulation& Air Sealing Only	$6,525	ECM2A	$6,525	$311	21.0
Including Attic Ventilation Improvements & Hatch	$8,714	ECM 2B	$8,714	$311	28.0

Note:
Cost estimates were developed by BEA based upon quotes by EnergiaUSA

Town Hall

	Location	Measure	Depth	R-Value	# / SF	Cost
1	Attic Floor	Plywood over Joists			1,836	$2,387
2	Attic Floor	Cellulose Open Blow	11	41	1,836	$2,938
3	Attic	Air Sealing	0	N/A	16	$1,200
6	Attic Rim & Band	Vent Soffit	0	N/A	52	$1,456
7	Attic Rim & Band	Propavents	0	N/A	52	$208
8	Attic Hatch	Frame & Insulate Access	0	N/A	1	$525
	Total					$8,714

* Assumes that air sealing hours will be spent mostly on the perimeter where the plywood meets the external wall areas.

Insulation costs were provided by EnergiaUS located in Holyoke, MA.

Energía, LLC
242 Suffolk Street
Holyoke, MA 01040
(413) 322-3111

ANNUAL BUILDING HEAT BALANCE

EXISTING CONDITIONS

HEAT BALANCE		
GAINS AND LOSSES	BTU/HEATING SEASON*1E6	
CONDUCTION LOSSES	-92.6	
INFILTRATION LOSSES	-49.7	**LOSS TOTAL**
VENTILATION LOSSES	0.0	**-142.3**
SOLAR GAIN	24.9	
OCCUPANT GAIN	2.6	
ELECTRICAL GAIN	21.8	
NET HEATING DEMAND	-92.9	

Net Heating Demand (MMbtu)	/Energy Required (MMbtu)	Seasonal Efficiency %
92.9	129	72%

CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement	328	8	144	35	13	
		328	16	144	25	19	
		328	24	68	20	11	42.9
2	First Floor	160	8	144	35	6	
		160	16	144	25	9	
		160	24	68	20	5	20.9
3	Second Floor	221	8	144	35	9	
		221	16	144	25	13	
		221	24	68	20	7	28.8
	Total UA	709		Conduction Total			92.6

INFILTRATION LOSSES

0.5

#	Zone	VOLUME	ACH	HRS/ DAY	DAYS/ YR	0.018	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement	11,628	0.50	16	144	0.018	25	6.0	
		11,628	0.50	24	68	0.018	20	3.4	
	Occ.	11,628	0.50	8	144	0.018	35	4.2	13.7
2	First Floor	13,005	0.50	16	144	0.018	25	6.7	
		13,005	0.50	24	68	0.018	20	3.8	
	Occ.	13,005	0.50	8	144	0.018	35	4.7	15.3
3	Second Floor	16,065	0.55	16	144	0.018	25	9.2	
		16,065	0.55	24	68	0.018	20	5.2	
	Occ.	16,065	0.55	8	144	0.018	35	6.4	20.8
		40,698				Infiltration Total			49.7

		HEAT LOSS COEFFICIENTS				
Zone #	**Building Zone**		**U-Value (BTU/hr-sf-F)**	**Area (sf)**		**UA-Value (BTU/hr-F)**
1	**Basement**	Roof	0.054	0		0
		Walls-above grade	0.056	184		10
		Below Grade	0.220	1,092		241
		Doors	0.625	0		0
		Windows	0.550	17		10
		Slab/Floor	0.040	1,700		68
				Wing UA Total	**328.4**	
2	**First Floor**	Roof	0.054			0
		Walls	0.056	1,215		68
			0.220	0		0
		Doors	0.400	76		30
		Windows	0.400	154		62
		Slab/Floor	0.040			0
				Wing UA Total	**160.0**	
3	**Second Floor**	Roof	0.054	1,700		91
		Walls	0.056	1,215		68
			0.220	0		0
		Doors	0.400	18		7
		Windows	0.400	137		55
		Slab/Floor	0.040			0
				Wing UA Total	**220.9**	
				Building Total UA:	**709.3**	

ANNUAL BUILDING HEAT LOADS

AFTER ATTIC INSULATION &

AIR SEALING

HEAT LOAD AFTER ATTIC INSULATION AND AIR SEALING		
GAINS AND LOSSES	BTU/HEATING SEASON*1E6	
CONDUCTION LOSSES	-84.3	
INFILTRATION LOSSES	-38.3	
TOTAL	**-122.582**	

CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	**Basement**	328	8	144	35	13	
		328	16	144	25	19	
		328	24	68	20	11	42.9
2	**First Floor**	160	8	144	35	6	
		160	16	144	25	9	
		160	24	68	20	5	20.9
3	**Second Floor**	157	8	144	35	6	
		157	16	144	25	9	
		157	24	68	20	5	20.6
	Total UA	**646**		**Conduction Total**			**84.3**

				INFILTRATION LOSSES					
			0.4						
#	**Zone**	**VOLUME**	**ACH**	**HRS/ DAY**	**DAYS/ YR**	**0.018**	**TEMP DIFF**	**LOSSES (* 1E6)**	**Sub Totals**
1	**Basement**	11,628	0.40	16	144	0.018	25	4.8	
		11,628	0.40	24	68	0.018	20	2.7	
	Occ.	11,628	0.40	8	144	0.018	35	3.4	10.9
2	**First Floor**	13,005	0.40	16	144	0.018	25	5.4	
		13,005	0.40	24	68	0.018	20	3.1	
	Occ.	13,005	0.40	8	144	0.018	35	3.8	12.2
3	**Second Floor**	16,065	0.40	16	144	0.018	25	6.7	
		16,065	0.40	24	68	0.018	20	3.8	
	Occ.	16,065	0.40	8	144	0.018	35	4.7	15.1
	Total	40,698				**Infiltration Total**			**38.257**