ALTERNATIVE RESOURCE MANAGEMENT, INC.

Energy Analysis Of:

Burlington Trout Hatchery

16 Belden Road
Burlington, CT

Under the

State Energy Conservation Program

Project # BI - 2B - 176(20B)

for the

State of Connecticut Department of Public Works

Prepared by:

Alternative Resource Management, Inc.
27 Walnut Drive
Hebron, CT 06248
Telephone: 860 - 646 - 8760
Fax: 860 - 649 - 8960

January 28, 2005

TABLE OF CONTENTS

I.	Executive Summary	3
II.	Facility Description	
	a. General Information	5
	b. General Description	5
	c. Energy Sources and Utilities	5
	d. Building Envelope	7
	e. Heating Systems	7
	f. Temperature Control System	8
	g. Ventilation System	8
	g. Domestic Hot Water System	8
	h. Lighting Systems	8
	i. Well Water System	9
III.	Recommended Measures	
	Measure #1 Convert Steam & Elec. Htg. to HW Htg.	10
	Measure #2 Replace Fluorescent Lighting	11
	Measure #3 Install Motion Sensors	12
IV.	Measures Considered But Not Recommended	
	Measure #A Wall Insulation	13
	Measure #B Replacement of Windows and Door	14
APPENDIX A	Electrical Consumption History	16
APPENDIX B	Fuel Oil Consumption History	17
APPENDIX C	Measure Calculations	18

ACKNOWLEDGEMENT

Alternative Resource Management, Inc. would like to thank the following for their help in supplying information needed for this report:

David Zadrozny — Manager Burlington Trout Hatchery, Burlington, CT

I. EXECUTIVE SUMMARY

The hatchery building at the Burlington Trout Hatchery in Burlington, CT was studied for potential energy conservation measures. The building appears to be a good candidate for energy efficiency improvements when you compare the building's annual per-square foot energy consumption to that of other buildings. The annual per-square foot fuel oil consumption (0.55 gal/sq.ft.) of the Burlington Hatchery is twice the amount of the Quinebaug Valley Trout Hatchery (0.27 gal/sq.ft.) and twice the amount of figures published by the U. S. Department of Energy's Energy Information Administration. Some of this high fuel usage can be attributed to the artesian well system that can see water temperature as low as 40 degrees F continuously flowing through the tanks and some can be attributed to the age of the heating equipment and the building itself.

Analysis of plausible measures for conserving energy revealed that lighting revisions and conversion of the steam and electric heating systems to hot water heating are the only ones that can be recommended. We believe that the lack of measures that payback is due to the building being maintained at a relatively low temperature of 58 degrees F.

Although most of the measures do not meet the requirement of a ten year payback, there are other considerations that should be weighed. For example, the payback period for replacing the window is more than halved if you consider the cost of the repairing the existing windows. Having operable windows with screens can also fulfill the ventilation needs of the building and reduce the humidity.

Another example would be to insulate the building walls while doing the residing of the exterior walls. This could reduce the cost of the insulation process enough for the payback period to decrease by 25%.

The following page contains a table summary of the recommended measure and a table summary of the energy efficient measures not recommended.

Table #1 – Recommended Energy Efficient Measures

Burlington Trout Hatchery

Measure Number	Description	Annual Savings			Implementation Cost	Measure Life Years	Payback Period Years
		Electricity kWh	Fuel oil Gallons	Savings $			
1	Convert Steam & Electric Heating To HW Heating	15,380	670	$2016	$18,220	20	9.0
2	Replace Fluorescent Lighting	5,201	-45.7	$409	$3,740	15	9.1
3	Install Motion Sensors	1,442	-12.6	$442	$250	15	0.6

Table #2 – Project Summary Table

Burlington Trout Hatchery

Project	Measures Included	Total Implementation cost	Annual Savings				Weighted Average Project Life	Simple Payback Years
			Electrical kWh	Fuel Oil gallons	Total MMBtu	$		
I	1 and 2	$21,960	20,581	624.1	156.8	$2,425	19	9.1
II	1, 2 and 3	$22,210	21,676	617	159.6	$2,514	19	8.8

Table #3 – Energy Efficiency Measures Not Recommended

Burlington Trout Hatchery

Measure Number	Description	Annual Savings			Implementation Cost	Measure Life Years	Payback Period Years
		Electricity kWh	Fuel oil gallons	Savings $			
A	Wall Insulation	-	425	$425	$7,180	20	16.9
	Wall Insulation during residing	-	425	$425	$5,380	20	12.7
B	Replacement of Windows And Door	1415	463	$587	$28,150	25	48.0
	Replacement of Windows & Door Minus Needed Maintenance	-	-	-	$11,730	25	20.3

II. FACILITY DESCRIPTION

a. General Information

Burlington Trout Hatchery is located off Route 4 at 16 Belden Road in Burlington, CT. The hatchery began operation in 1925. The hatchery now provides approximately 98,000 lbs or about 172,000 trout each year.

The facility consists of a hatchery building, a four bay distribution garage, lab trailer, 63 earthen ponds or round tanks, an artesian well system and a vacant manager's residence. Only the hatchery building is considered in this study.

b. General Description

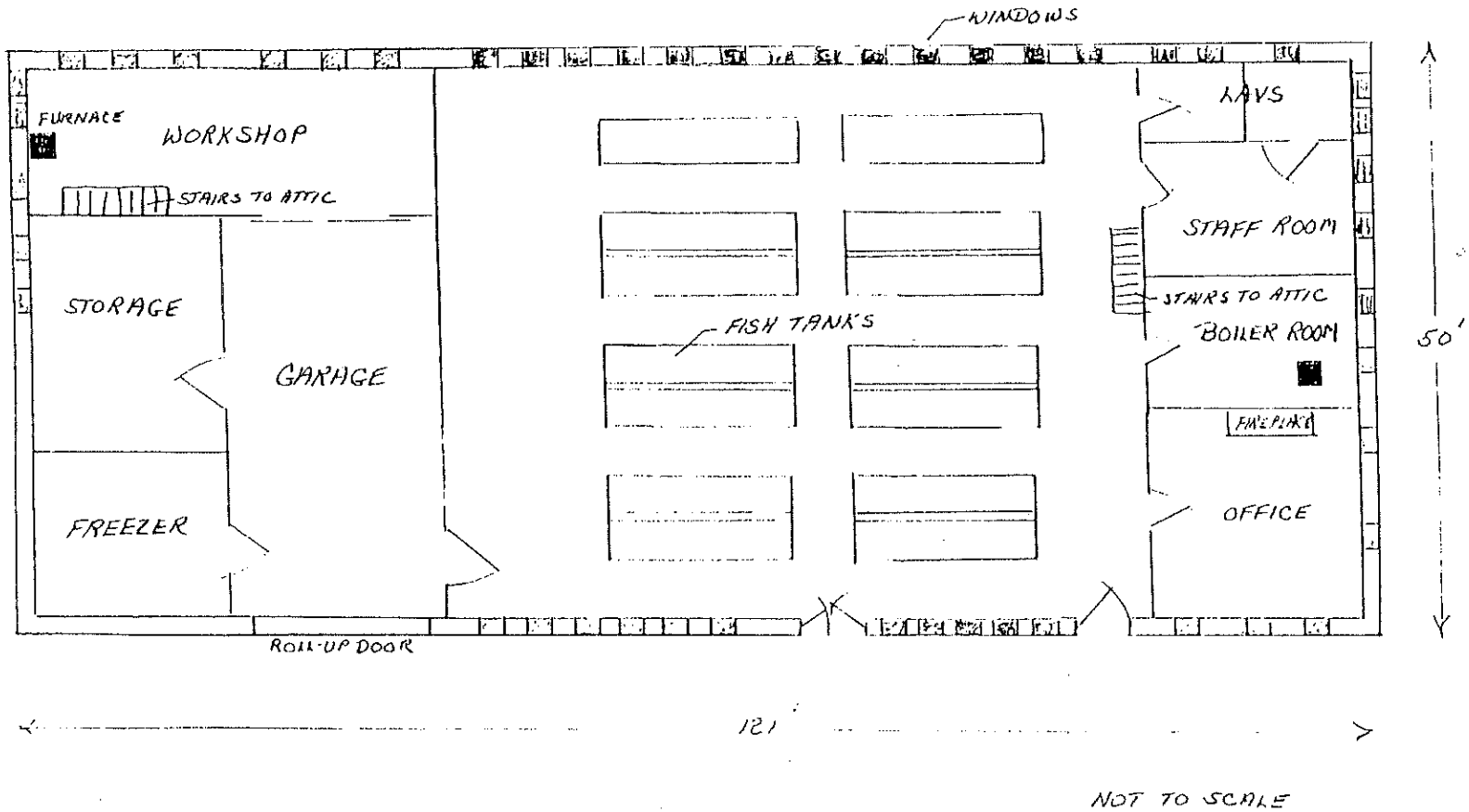
The hatchery building is a two story, wood building on a concrete slab with a hipped asphalt shingled roof. The building of approximately 6,050 sq. ft., houses the hatchery area with eighteen rectangular tanks, office, staff room, work shop, garage and storage areas. The first floor plan can be found on the next page. The second floor of the building consists of a three room attic area used for storage. The first floor of the hatchery building is maintained at around 58 degrees and is occupied 15 hours per day. The second floor is heated and generally unoccupied.

c. Energy Sources and Utilities

The facility relies on electricity and #2 fuel oil as energy sources.

Electricity is used for some space heating, domestic hot water, lighting and power. Electricity is provided by Connecticut Light and Power at a *Small General Service* rate for customers with annual peak demand less than 350 kW. Electricity for the hatchery building is metered by one meter. Peak demand is around 14 kW. The annual electrical consumption is approximately 65,000 kWh at a cost of approximately $5,690. The cost per kWh is about $0.0875. The summary sheets of electrical usage provided by D.E.P. Wildlife Division can be found in Appendix B, Energy Consumption History.

The facility uses #2 fuel oil for space heating. Fuel oil is stored in two underground tanks; one 1000 gallon and one 275 gallon installed in the 1950's. Fuel oil is delivered by Dime Oil Company. Annual consumption for the building is estimated to be 3,350 gallons per year at a cost of $2,875. The present cost per gallon used in this analysis is $1.00. The summary of fuel oil consumption provided by Dime Oil Company can be found in Appendix C, Energy Consumption History.


N
WINDOWS
FURNACE
WORKSHOP
STAIRS TO ATTIC
STORAGE
GARAGE
FREEZER
FISH TANKS
LAVS
STAFF ROOM
STAIRS TO ATTIC
BOILER ROOM
FIREPLACE
OFFICE
ROLL-UP DOOR
50'
121'
NOT TO SCALE

d. Building Envelope

The hatchery building exterior walls are wood shingles on sheathing, 2 x 4 framing with interior plaster board. There is no insulation in the walls. The U value of the walls is 0.22. The exterior appears to need residing.

The roof is a hipped roof with asphalt shingles on a wood suspension framing. The roof contains two vented cupolas. The roof was redone in 1983. There is no insulation on the roof. The attic floor is wood framed with 4 inches of blown cellulose insulation between the attic and the occupied areas below. The roof is reported to be in good condition with some leaks experienced.

The forty nine windows comprise more than 28% of the wall area. There are windows on all four sides of the building. The windows are wooden framed, single glazed, double hung windows with full size, removable, wooden storm windows. The windows are original to the building and are in fair to poor condition. The operation of the windows is questionable and the full storm windows are in place year round. There are no screens for the windows. The windows are in need of repair, glazing compound and painting.

The exterior door to the garage area is a newer aluminum roll up door. The central entrance to the hatchery area has a newer metal double door installed to make the facility handicap accessible. The single door entrance near the office area is an older wooden framed, single glazed windowed door. A large gap was noted between this door and the stone threshold.

e. Heating Systems

The heating system for the staff room and hatchery area is a two pipe steam heating system. Steam is supplied by a 6 section, Weil McLain model BL-676-WS boiler with a rated steam output of 306,100 Btuh. The burner is a Carlin burner model 201CRD with an input firing rate of 3.6 gph of #2 fuel oil. The boiler was installed in 1992 and operates at a steam pressure of 2 psig. Steam returns to a condensate receiver and is pumped back to the boiler.

Two ceiling mounted, steam, propeller fan, downblow unit heaters provide heat to the hatchery area. A wall mounted, steam, horizontal unit heater provides heat to the staff room.

The boiler room is vented through a transfer grille to the hatchery area. The forced ventilation system from the boiler room to the office area is no longer used.

The office and the lavatories have portable electric baseboard heaters. The heaters are estimated to have a heating capacity of 250 watts/ft.

The workshop area of the hatchery building has a separate bonnet furnace with an output rating of 105,000 Btuh and an input firing rate of 0.75 gph of #2 fuel oil. The furnace was installed in the 1950's. The furnace is considered to be unreliable by the employees and used only when they are in the workshop.

The heating unit in the storage room has been abandoned. Excess heat from the freezer's air cooled compressor provides some heat to the normally unoccupied area.

f. Temperature Control System

The hatchery area and the staff room have a thermostat for each unit heater. The thermostats are manually controlled and reported to be set for 58 degrees at all times.

The workshop furnace is thermostatically controlled. Heat to the workshop is turned on and off manually and run only when someone is working in the workshop area.

g. Ventilation System

The building is not mechanically ventilated except for the lavatory areas. Ceiling mounted exhaust fans serve the lavatories and are vented through the attic to the roof.

The attic space is vented through two roof mounted cupolas with trap doors to shut off the outside air during the winter months.

h. Domestic Hot Water System

The hatchery building's domestic hot water system is provided by an electric, tank style water heater. The water heater is a State Water Heater with a tank capacity of 19.9 gallons. The input rating is 1650 watts.

i. Lighting Systems

The fluorescent lighting fixtures throughout the hatchery building are eight foot fixtures with two tubes each. The lighting is T-12 technology controlled partly by a time clock and part manually.

The four exterior light fixtures are high pressure sodium controlled by a time clock.

j. Well Water System

The operation of the facility depends on the continuous flow of well water. The artesian wells enable the facility to operate with no mechanical pumping. The water temperature ranges from 52 degrees to 40 degrees.

III. RECOMMENDED MEASURE

Measure #1 Convert Steam and Electric Heating to HW Heating

Opportunity

Converting the existing steam heating system to a hot water system can save energy as well as reduce maintenance. The energy required to make 2 psig steam at 219 degrees F is much more than the energy required to heat water to typically 140 to 180 degrees. Hot water boilers are 2% more efficient than steam boilers. Additional savings are realized with reduced standby losses and losses associated with the vented condensate receiver. The need to repair or replace steam traps every three to five years and the losses associated with unnoticed failed traps is eliminated. The hot water heating system should be extended to the areas now heated by electric heaters and the bonnet furnace.

Proposal

The existing boiler was installed in 1992 and does not need to be replaced for the conversion. The boiler appears to be in good condition and should be able to withstand the maximum water pressure of the proposed system. Although the boiler is an obsolete Weil McLain model, water trim parts are still available.

An analysis of the buildings heating load showed that the boiler should be able to handle the additional load of the office and the lavatories now heated by electric baseboard and the workshop now heated by the antiquated bonnet furnace.

The conversion would include replacement of the steam unit heaters in the hatchery area and the staff room.

Analysis

The conversion of the steam heating system to a hot water heating system has an estimated fuel oil savings of 670 gallons per year or an annual cost savings of $670. The net electrical savings for replacement of the electric baseboard heaters with hot water heaters and the addition of heating supply pumps is 15,380 kWh per year at a cost savings of $1346. The cost to implement the measure is estimated to be $18,220. The payback period for this measure is 9.0 years.

Measure #2 Replace Fluorescent Lighting

Opportunity

The building is lighted by twenty five, two tube fluorescent fixtures of 8 foot length. The fixtures are of the older T-12 technology. The building is occupied 15 hours per day, 365 days per year.

Proposal

Retrofit the existing fluorescent lighting with electronic ballast and T-8 fluorescent lamps. Upgrading the lighting from T-12 to T-8 technology will reduce electrical consumption while providing the same or higher lighting levels.

Analysis

Retrofitting the fluorescent fixtures will save about 5,201 kWh of electricity per year. The reduction in lighting load will require additional heating equal to 45.7 gallons per year at a cost of $46. The net dollar savings are $409. With an implementation cost of approximately $3,740, the measured payback period is 9.1 years.

Measure #3 Install Motion Sensors

Opportunity

The office area and the staff room are two locations that could benefit from having motion sensors installed to control turning off the lights when the area are unoccupied. It is estimated that the lights could be turned off in each area, on average, five hours per day.

Proposal

Install one motion sensors in each room.

Analysis

The installation of motion sensors will save about 1,442 kWh of electricity per year. The reduction in lighting results in a slight increase in heating of 12.6 gallons of fuel oil per year at a cost of $13. The net dollar savings for this measure is $442. With an implementation cost of approximately $250 the measured payback period is 0.6 years.

IV. MEASURES CONSIDERED BUT NOT RECOMMENDED

Measure #A Wall Insulation

Opportunity

The exterior walls are not insulated. Insulation can be blown into the 2 x 4 inch framing to reduce heating cost.

Proposal

Add blown insulation to the exterior walls to increase the resistance of heat flow and reduce infiltration. The measure would reduce the U factor of the walls from 0.22 to 0.08 using insulation with a R-12 rating.

Analysis

The analysis shows a savings of 425 gallons of fuel oil per year at a cost savings of $425. The estimated cost of adding insulation to the wall cavities is $7180. The payback period is over 16.9 years.

If the decision is made to reside the building, the cost to insulate the walls would be reduced by about 25%. The cost to insulate would then be $5380 with a payback period of 12.7 years.

Measure #B Replacement of Windows and Door

Opportunity

The building's windows and entrance door reflect the age of the building. Replacing the windows and door to stop unwanted infiltration and adding better insulation qualities to both windows and doors will reduce heating costs and improve the building envelope.

Proposal

Replace the existing windows with insulated glass double hung windows with screens of the largest standard size suitable for the existing opening. It is expected that additional carpentry work would be needed to enclose a part of the area of the existing windows. Replace the entrance door with an insulated metal door and a new threshold.

Analysis

The energy savings for the windows and door were determined by estimating the reduction in transmission and infiltration losses using ASHRAE's crack method.

The window and door replacement calculations estimate the fuel oil savings at 463 gallons per year and electrical savings at 1415 kWh per year. The total cost savings is estimated to be $587. The estimated cost of replacing the windows and the door is about $28,150 which yields a simple payback of 48.0 years.

The existing windows and door are in need of repair, glazing compound and painting. The existing windows do not have screens. It is estimated that the cost of these repairs and screens is around $16,420. When the cost of the needed repairs are subtracted from the replacement cost, the additional outlay of $11,730 for new windows has a payback period of 20.3 years

APPENDIX

APPENDIX A

ELECTRICAL CONSUMPTION HISTORY

State of Connecticut
D.E.P. Wildlife Division
Connecticut Light and Power

DATE PAID	AMOUNT PAID	KWH USED
01/09/2002	$585.78	6,694
02/05/2002	$342.60	3,915
03/05/2002	$702.82	8,032
04/02/2002	$293.78	3,357
04/30/2002	$660.91	7,553
07/09/2002	$408.85	4,672
07/30/2002	$431.78	4,934
09/03/2002	$438.61	5,012
10/08/2002	$379.48	4,336
11/05/2002	$431.63	4,932
12/03/2002	$363.75	4,157
	$5,497.26	62,819
	$.0875/kWh	
01/07/2003	$516.56	5,903
02/04/2003	$517.37	5,912
03/04/2003	$474.73	5,425
04/02/2003	$429.39	4,907
05/06/2003	$355.25	4,060
06/19/2003	$374.52	4,280
07/24/2003	$397.57	4,543
07/31/2003	$474.87	5,427
09/02/2003	$435.42	4,976
10/01/2003	$722.02	8,251
11/06/2003	$557.29	6,369
12/02/2003	$546.42	6,244
	$5,801.41	66,297
	$.0875/kWh	

APPENDIX B

FUEL OIL CONSUMPTION HISTORY

State of Connecticut
D.E.P. Wildlife Division

SEASON	GALLONS	$/GALLON	AMOUNT PAID
2003 - 2004	3222.30	$0.92	$2964.52
2002 – 2003	3469.80	$0.86	$2986.07
2001 - 2002	1773.80*	$0.61	$1079.30

*The manager at the time did not operate the heating system during unoccupied hours. The practice was discontinued due to deterioration of building contents and interior surfaces.

The average consumption rate for the building is 3350 gallons per year.

The cost of fuel oil used for this analysis is $1.00 per gallon.

APPENDIX C

CALCULATIONS

Measure #1 Convert Steam and Electric Heating to HW Heating

Annual Fuel Oil Savings:

Estimates for overall savings for steam to HW conversions range from 16 to 39 percent.
Use 20% = 670 gallons or $670

Annual Electrical Savings:

Existing baseboard radiation estimated to be 4.5 kW. Electrical savings estimate using bin method = 16,770 kWh per year.

Hot Water System pumps electrical usage estimated at 1,390 kWh

Net savings = 16,770 – 1,390 kWh
= 15,380 kWh or $1346 per year

Implementation Cost:

Removals:	$2560
Boiler Trim:	$1500
Controls:	$2000
Pumps:	$1000
Piping:	$3325
Insulation:	$1840
Terminal Heaters:	$3620
	$15,845
15% Contingency:	$ 2,375
	$18,220

Payback Period

$18,220 ÷ ($670 + $1346)/yr = 9.0

APPENDIX C

CALCULATIONS

Measure #2 Replace Fluorescent Lighting

25 existing lighting fixtures @ 158 watts per fixture

25 new lamps and ballast @ 120 watts per fixture

Electrical Energy Savings
= 25 fixtures (158 watts – 120 watts) (15 hr/day) (365 days/yr) ÷ 1000 watts/kW
= 5201 kWh/yr or 17.8 MMBtu

Replace 3 months of electrical heat input with fuel oil heat
=3/12 (17.8 MMBtu) ÷ 138,6990 Btu/gal ÷ .70 = 45.7 gals/yr
= - 6.3 MMBtu

Savings $

Electrical	= 5201 kWh/yr x $0.0875/kWh
	= $455 yr.
Fuel Oil	= - 45.7 gals/yr x $1.00/gal
	= - $46
Net Savings	= $455 - $46
	= $409

Implementation Cost

Retrofit fixtures:	$3,250
15% Contingency:	$ 490
	$3,740

Payback Period
$3,740 ÷ $409/yr = 9.1 years

APPENDIX C

CALCULATIONS

Measure #3 Install Motion Sensors

Assume lighting in the office and staff rooms can be turned off a total of 5 hours per day.

5 existing lighting fixtures @ 158 watts per fixture

Electrical Energy Savings
= 5 fixtures (158 watts) (5 hr/day) (365 days/yr) ÷ 1000 watts/kW
= 1442 kWh/yr or 4.9 MMBtu

Added Heat Required
= 3/12 (4.9 MMBtu) ÷ 138,690 Btu/gal ÷ .70
= 12.6 gal/yr

Savings $
Electrical = 1442 kWh/yr x $0.0875/kWh
= $455 yr.
Fuel Oil = -12.6 gals/yr x $1/gal
= -$13
Net Savings = $455-$13
= $442

Implementation Cost

Retrofit fixtures:	$ 218
15% Contingency:	$ 32
	$ 250

Payback Period
$250 ÷ $442/yr = 0.6 years

APPENDIX C

CALCULATIONS

Measure #A Wall Insulation

Wall area: 3,270 sq. ft.
Existing wall: U = 0.22, infiltration = 0.23 cfm/sq. ft. of windward sides
Insulated wall U = 0.08, infiltration = 0.12 cfm/sq. ft. of windward sides

Annual Savings

Btuh = (3270 sq. ft.) (0.22 - 0.08) (52 degrees)
+ (1635 sq. ft.) (0.23 – 0.12 cfm/sq. ft.) (1.08) (52 degrees)
= 33,906 Btuh

Using Modified Degree Day Method at a base of 55 degrees

$$\text{Fuel Oil} = \frac{(33{,}906\ \text{Btuh})(24\text{hr/day})(3554\text{degree days})(.6)}{(49\ \text{degrees})(.6)(138{,}690\text{Btu/gal})}$$
= 425 gallons

Savings $ = 425 gallons x $1.00/gallons
= $425

Implementation Cost

Blown cellulose insulation cost:	$6,245
15% Contingency:	$ 935
	$7,180

Payback Period
$7180 ÷ $425/yr = 16.9

Cost of blown insulation while residing:	$4,680
15% Contingency:	$ 700
	$5,380

Payback Period
$5,380 ÷ $425/yr = 12.7

APPENDIX C

CALCULATIONS

Meqasure #B Replacement of Windows & Door

Existing Windows with fuel oil heat: 93% of total area
Existing windows with electric heat: 7% of total area

Infiltration rate determined by ASHRAE's crack method
Existing windows & door: 1147 cfm
New windows & door: 441 cfm

Annual Savings
Btuh = 1.08 (1147 - 441cfm) (58 – 6 degrees) = 39,650 Btuh

Using Modified Degree Day Method at a base of 55 degrees

$$\text{Fuel Oil} = \frac{(.93)(39{,}650\ \text{Btuh})(24\text{hr/day})(3554\text{degree days})(.6)}{(49\text{degrees})(.6)(138{,}690\text{Btu/gal})} = 463 \text{ gallons}$$

$$\text{Electricity} = \frac{(.07)(39{,}650\ \text{Btuh})(24\text{hr/day})(3554\text{degree days})(.6)}{(49\text{degrees})(.6)(3413\ \text{Btu/kWh})} = 1415 \text{ kWh}$$

Savings $ = 463 gallons x $1.00/gallons + 1415 kWh x $0.0875/kWh
= $463 +$124
= $587

Implementation Cost

Replacement of windows:	$20,090
Replacement of door:	$ 1,500
Removals	$ 930
Carpentry	$ 1,960
15% Contingency:	$ 3,670
	$28,150

Payback Period
$28,150 ÷ $587/yr = 48.0