ENERGY AUDIT FINAL REPORT

Mountain View Elementary School

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Abbreviations

AHFC	Alaska Housing & Finance Corporation
ARRA	American Recovery & Reinvestment Act
ASD	Anchorage School District
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
BTU	British Thermal Unit
CCF	One Hundred Cubic Feet
CFM	Cubic Feet per Minute
DDC	Direct Digital Control
ECI	Energy Cost Index
ECM	Energy Conservation Measure
EUI	Energy Utilization Index
F	Fahrenheit
HP	horsepower
HPS	High Pressure Sodium
HVAC	Heating, Ventilating, and Air-Conditioning
in	inch(es)
IPLC	Integrated Power & Load Circuit
kWh	kilowatt-hour
LED	Light-Emitting Diode
O&M	Operations & Maintenance
sf	square feet
SIR	Savings-to-Investment Ratio
V	Volts
W	Watts

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REPORT DISCLAIMER

Privacy

The information contained within this report, including any attachment(s), was produced under contract to Alaska Housing Finance Corporation (AHFC). IGAs are the property of the State of Alaska, and may be incorporated into *AkWarm-C*, the Alaska Retrofit Information System (ARIS), or other state and/or public information systems. *AkWarm-C* is a building energy modeling software developed under contract by AHFC.

Limitations of Study

This energy audit is intended to identify and recommend potential areas of energy savings, estimate the value of the savings, and provide an opinion of the costs to implement the recommendations. This audit meets the criteria of a Level 2 Investment Grade Audit (IGA) per the American Society of Heating, Refrigeration, Air-conditioning Engineers (ASHRAE) and the Association of Energy Engineers (AEE), and is valid for one year. The life of the IGA may be extended on a case-by-case basis, at the discretion of AHFC. In preparing this report, the preparers acted with the standard of care prevalent in this region for this type of work. All results are dependent on the quality of input data provided. Not all data could be verified and no destructive testing or investigations were undertaken. Some data may have been incomplete.

This report is not intended to be a final design document. Any modifications or changes made to a building to realize the savings must be designed and implemented by licensed, experienced professionals in their fields. Lighting upgrades should undergo a thorough lighting analysis to assure that the upgrades will comply with State of Alaska Statutes as well as Illuminating Engineering Society (IES) recommendations. All liabilities for upgrades, including but not limited to safety, design, and performance are incumbent upon the professional(s) who prepare the design. Coffman Engineers, Inc (CEI) and Central Alaska Engineering Company (CAEC) bear no responsibility for work performed as a result of this report.

Financial ratios may vary from those forecasted due to the uncertainty of the final installed design, configuration, equipment selected, installation costs, related additional work, or the operating schedules and maintenance provided by the owner. Furthermore, many ECMs are interactive, so implementation of one ECM may impact the performance of another ECM. CEI and CAEC accept no liability for financial loss due to ECMs that fail to meet the forecasted financial ratios.

The economic analyses for the ECMs relating to lighting improvements are based solely on energy savings. Additional benefits may be realized in reduced maintenance cost, deferred maintenance, and improved lighting quality. The new generation lighting systems have significantly longer life leading to long term labor savings, especially in high areas like Gyms and exterior parking lots. Lighting upgrades displace re-lamping costs for any fixtures whose lamps would otherwise be nearing the end of their lifecycle. This reduces maintenance costs for 3-7 years after the upgrade. An overall improvement in lighting quality, quantified by numerous studies, improves the performance of students and workers in the built environment. New lighting systems can be designed to address all of the above benefits.

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I. Executive Summary

This report presents the findings of an energy audit conducted at Mountain View Elementary School as part of a contract for:

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Fig. 1 – Energy Audit Clients

This audit was performed using American Recovery and Reinvestment Act (ARRA) funds to promote the use of innovation and technology to solve energy and environmental problems in a way that improves the State of Alaska's economy. This can be achieved through the wiser and more efficient use of energy.

The average January 2009-December 2010 documented annual utility costs at this facility are as follows:

Electricity	$66,433
Natural Gas	$46,199
Total	$112,642

January 2009-December 2010 Energy Utilization Index (EUI) = 113.7 kBtu/sf
January 2009-December 2010 Energy Cost Index = 1.91 $/sf

Fig. 2 – Energy Benchmark Data

Energy Conservation Measures (ECMs) calculated to be cost effective are shown below in the Executive Summary Table with the energy analyst's best opinion of probable cost, savings, and investment returns. Be aware that the measures are not additive because of the interrelation of several of the measures. The cost of each measure for this level of auditing is ± 30% until detailed engineering, specifications, and hard proposals are obtained. See section VIII for detailed descriptions of all cost effective ECMs.

Table 1. Recommended Energy Conservation Measures, Mountain View Elementary

Executive Summary – Recommended ECMs						
Mountain View Elementary School (MES)						
Rank	**Feature**	**Recommendation**	**Annual Energy Savings**	**Installed Cost**	**SIR**	**Payback (Years)**
MES-0[a]	Refrigerators	Replace light commercial refrigerators/freezers older than 5 years old	-	-	-	<10
MES-1[b]	Boiler Shutdown	Shutdown boilers during summer months	$1,379	$720	30.95	0.5
MES-2	Setback Thermostat: Classrooms/ Offices, and Gym/MPR	Implement a Heating Temperatures Unoccupied Setback to 60.0 deg F for the classrooms, offices, gym, and multipurpose room	$4,279	$556	12.91	0.13
MES-3	Lighting: Library	Add new Occupancy Sensors	$555	$900	9.02	1.6
MES-4	Lighting: Classrooms	Add new Occupancy Sensors, and Replace T12 Light Fixtures with T8 Light Fixtures	$2,562	$4,351	2.52	1.7
MES-5	Lighting: Student Restrooms	Replace with 16 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$481	$3,300	2.13	6.9
MES-6	Lighting: Corridors	Replace T12 Light Fixtures with T8 Light Fixtures, Replace 3-Lamp T8 Light Fixtures with 2-Lamp Light Fixtures, Reduce Light Fixture Quantities	$2,348	$15,650	2.19	6.67

Executive Summary – Recommended ECMs						
Mountain View Elementary School (MES)						
Rank	**Feature**	**Recommendation**	**Annual Energy Savings**	**Installed Cost**	**SIR**	**Payback (Years)**
MES-7	Lighting: Offices	Add new Occupancy Sensors, and Replace T12 Light Fixtures with T8 Light Fixtures. Replace Incandescent Lamps with Compact Fluorescent Lamps	$1,841	$16,680	1.61	9.1
MES-8	Lighting: Exterior	Replace High Pressure Sodium Light Fixtures with LED Light Fixtures. Replace Inoperable Photocells.	$2,759	$26,700	1.51	9.7
MES-9	Lighting: Trophy Cases	Replace with 12 FLUOR T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensors	$277	$2,850	1.41	10.3
MES-10	Lighting: Multi-Purpose Room	Replace Incandescent Lamps with Compact Fluorescent Lamps, Replace Metal Halide Light Fixtures with Fluorescent T5HO Light Fixtures, Add new Occupancy Sensors	$765	$9,960	1.09	13.0
MES-11	Air Tightening	Perform air sealing to reduce air leakage by 20%	$1,785	$15,000	1.06	8.4
MES-12 [b]	HVAC and DHW	Install VFDs on 5HP pumps and EC motors on pumps less than 1HP	$2,180	$35,000	0.94	16.0

Notes:

[a] Due to advances in refrigerators in the previous 5 years, new Energy Star refrigerators are much more efficient and result in viable energy savings.

[b] ECM item was modeled with separate AkWarm model and as a result, the item is not an additive measure and is not included in the final totals.

Table 2. Recommended Energy Conservation Measures, Portable Building

Executive Summary – Recommended ECMs						
Mountain View Portable Building (PB)						
Rank	**Feature**	**Recommendation**	**Annual Energy Savings**	**Installed Cost**	**SIR**	**Payback (Years)**
PB-1	Setback Thermostat: Portable Building	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Portable Building space.	$780	$1,000	9.57	1.3
PB-2	Portable Building Skirting	Install R-15 rigid foam board to interior or exterior side of wall. Does not include cost of coverings	$782	$1,624	9.97	2.1
PB-3	Lighting: Portable lighting	Replace with FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor and Improve Manual Switching	$421	$2,250	2.88	5.3
PB-4	Exterior Door: Portable Building - Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$90	$781	2.38	8.7
PB-5	Air Tightening	Perform air sealing to reduce air leakage by 30%.	$112	$980	1.00	8.8

II. Introduction

This energy audit was conducted at Mountain View Elementary School (MES) for AHFC and Anchorage School District (ASD). The school is a 59,118 square foot (sf) campus that includes a 58,158 sf school and a 960 sf portable building. The school consists of classrooms, locker rooms, restrooms, administrative offices, a library, a gymnasium, a kitchen, and a multipurpose room. The location of the school is shown in the following regional and overhead images. The energy audit was conducted in order to evaluate areas and equipment where energy savings can be realized. The savings are then compared to a baseline and evaluated for reasonable project financial ratios and payback.

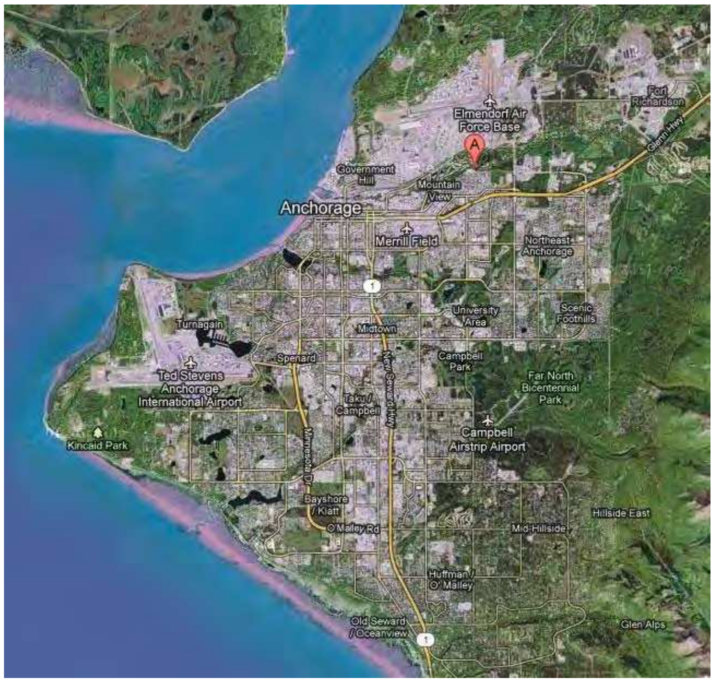

Fig. 3 – Anchorage, Alaska – Google Maps

Fig. 4 – Mountain View Elementary School – Google Maps

III. Energy Audit Process

Prior to visiting the school, the first task was to collect and review two years of utility data for electricity and natural gas usage. This information was used to analyze operational characteristics, calculate energy benchmarks for comparison to industry averages, estimate savings potential and establish a baseline to monitor the effectiveness of implemented energy conservation measures. A spreadsheet was used to enter, sum, and calculate benchmarks and to graph energy use information (see Appendix A). The primary benchmark calculation used for comparison and baseline data is the Energy Utilization Index, or EUI (see Section VI).

After gathering the utility data and calculating the EUI, the next step in the audit process was to review the architectural and engineering drawings to develop a building profile which documented building age, type, usage, and major energy consuming equipment or systems such as lighting, Heating, Ventilating, and Air Conditioning (HVAC), water heating, refrigeration, snow-melt, and etc. The building profile is utilized to generate, and answer, all possible questions regarding the facility's energy usage. These questions were then compared to the energy usage profiles developed during the utility data gathering step. After this information was gathered, the next step in the process was to conduct a site survey.

A site survey was completed on December 8, 2011. Time was spent inspecting the building systems that impact energy consumption and answering questions from the preliminary review of the school. The on-site contact during the investigation was Mr. Chris Lynch of the ASD Facilities Department[1]. The following information was also collected while on site: occupancy schedules, O&M practices, building energy management program, and other information that has an impact on energy consumption.

The following energy audit includes an evaluation of the information gathered, the researching of possible conservation opportunities, organizing the audit into a comprehensive report, and making ECM recommendations for mechanical, electrical, and building envelope improvements.

[1] Mr. Chris Lynch, (907) 348-5250 (office), (907) 748-2643 (mobile)

IV. Method of Analysis

Having completed the preliminary energy audit tasks, Coffman Engineers, Inc., (CEI) conducted a site survey. The site survey provides critical input in deciphering where energy savings opportunities exist within a facility. The audit team from CEI walked the entire site to inventory and investigate the building envelope and major equipment, including: HVAC, water heating, lighting, and equipment located throughout. An understanding of how the equipment is used is determined during the site survey.

The collected data was entered into *AkWarm Commercial*™ software, an energy calculating program for buildings. The data was processed by *AkWarm* to model a baseline from which ECMs could be considered. The model was compared to actual utility costs to ensure the quality of the baseline and proposed energy modeling performed by *AkWarm*. The recommended ECMs focus on the building envelope, HVAC, lighting, water heating, and other electrical measures that will reduce annual energy consumption.

ECMs are evaluated based on building use and processes, local climate conditions, building construction type, function, operational schedule, existing conditions, and foreseen future plans. When new equipment is proposed, energy consumption is calculated based on the manufacturer's cataloged information. Energy savings are calculated by *AkWarm*.

Implementation of more than one ECM often affects the savings of other ECMs. The savings may in some cases be relatively higher for an ECM implemented individually than when that ECM is just one of multiple recommended ECMs. For example, implementing reduced operating schedules of inefficient lighting systems may result in a given savings. Also implementing a more efficient lighting system will add to the savings, but less than the efficient lighting would alone because there is less energy to be saved when the lights are on a reduced operating schedule. Thus, if multiple ECM's are recommended, the combined savings are calculated and identified appropriately in groups.

In Appendix D, Energy Conservation Measures, the simple lifetime calculation is shown for each ECM, which is based on the typical life of the equipment being replaced or altered. The energy savings are extrapolated throughout the simple lifetime of the ECM. The total energy savings is calculated as the total lifetime multiplied by the yearly energy savings.

The cost savings and installation costs are used to calculate simple payback[2] and the Savings to Investment Ratio[3] (SIR). These are listed in Appendix D and summarized in the Executive Summary Table of this report. The SIR is calculated as a ratio by dividing the break even cost by the initial installed cost. Cost savings is calculated based on the historical energy costs for the building. Installation costs include labor and equipment to evaluate the initial investment required to implement an ECM. These are applied to each recommendation with simple paybacks calculated. The energy analyst's opinions of probable cost are garnered from RS Means Cost Data, other industry publications, and local contractors and suppliers. In addition, where applicable, maintenance cost savings are estimated and applied to the net savings.

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[2] The simple payback is based on the years that it takes for the net savings to payback the net installation cost (Cost divided by Savings).

[3] Savings to Investment Ratio (SIR): Break Even Cost divided by initial installed cost, where Break-Even Cost is how much can be spent and still have the measure be cost effective; it equals the Present Value (PV) of Savings over the life of the measure minus PV of maintenance costs.

V. Building Description

Mountain View Elementary School is a single story building consisting of classrooms, administrative offices, a gymnasium, a multipurpose room, a library, and several utility spaces. The school is arranged into three wings of classroom spaces with the gymnasium, multipurpose room, and administrative offices located in the center as can be seen in Figure 5 below.

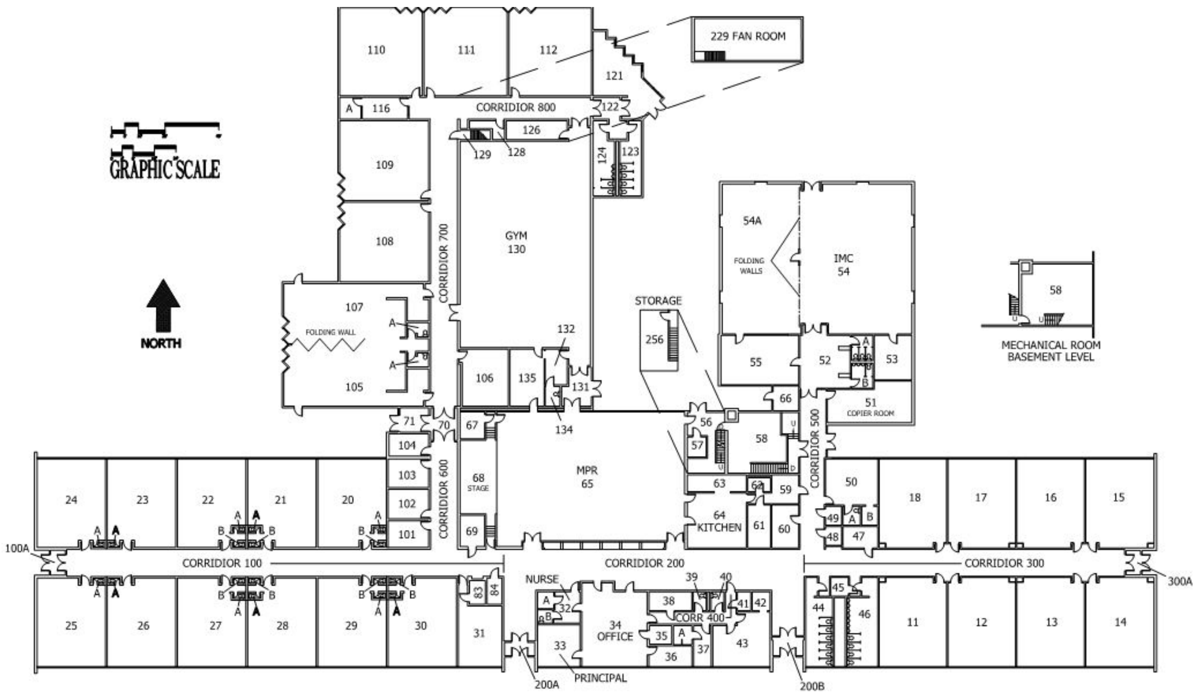


Fig. 5 – Mountain View Elementary Floor Plan

A portable building, using electric resistance heat, is located on the school campus and is occupied one day per week. The school was originally constructed in 1956 and has undergone several major additions and renovations throughout its history. A brief list of these major projects and years completed are shown below.

Table 3. Building History

Airport Heights Elementary – Building History*	
Date	**Addition or Renovation**
1956	Original Construction.
1970	Classroom and Office Addition
1983	Classroom and Gymnasium Addition
1983	Heating System Renovation
1988	Office Area Renovation
1991	Roof Renovation
1997	Boiler Replacement
2001/2003	Lighting Upgrades
2004	Roof Replacement
2005	HVAC Upgrades
*History is based on available drawings from ASD.	

Mountain View Elementary School is occupied by approximately 380 people from 7am-11pm weekdays from August through May. Most of the building, except the main office and maintenance areas is unoccupied and shut down from June to July.

V.I Architectural Description

Most of the school's original construction exterior walls are 10' high and composed of 6" thick poured concrete lined with furring strips on 16" centers, 2" blanket insulation and plywood sheathing. The exterior walls along the East and West face of the school building are composed of 6" concrete blocks, 2" rigid insulation, and a 4" brick veneer. These walls have an estimated R-value of R-3.5. The exterior wall of the multipurpose room is approximately 18' high and is constructed with 8" poured concrete overlaid with 2" rigid insulation and metal siding (R-14.1). Exterior walls of the 1970 addition are 11'-4" high and are composed of 8" concrete blocks with 2" furring strips, 2" blanket insulation, and plywood sheathing (R-3.5). The exterior walls of the 1983 addition are composed of 8" concrete blocks with 4" rigid insulation and a finishing system (R-19.9). Analysis of the architectural and construction drawings for the building shows a total of 20,147 sf of wall area.

The school's flooring construction details are from an analysis of the architectural and construction drawings. The floors in the building's original construction area consist of 4" thick concrete slab on grade with a 1" rigid perimeter insulation extending to the footing. The perimeter insulation in this area appears to be located on the interior face of the foundation wall. Flooring in the newer construction areas is also 4" thick concrete slab on grade but has 4" rigid perimeter insulation that extends to the footing and lies external to the foundation wall. There is approximately 54,628 sf of slab on grade floor area for the school. An additional 3,530 sf of floor area comes from a fan room and a storage area on the second floor, and an additional mechanical room on the first floor. The total square footage of the building is 58,158 sf.

The school's original construction area has a built-up flat roof containing a metal deck, 2" rigid insulation and sheet metal flashing. The roof of the school's 1970 addition is also a built-up flat roof but has 1.5" metal decking, a vapor barrier, and 3" rigid insulation. The roof of the 1983 addition was replaced in 2005 with a 2-ply vapor barrier, 1/2" gypsum sheathing, R-30 rigid insulation, a fiberglass base overlaid with 3-ply roofing and an SBS mineral cap sheet. The approximate overall R-value for the roof construction is R-32.6. Analysis of the architectural and construction drawings shows a total roof area of 54,628 sf.

The school has approximately 150 double pane, 1/2" air space, aluminum frame windows with an effective R-value of R-1.2. From the architectural drawings, the window headers appear to be insulated. The total South facing window area for the school is approximately 2,903 sf. All other window areas for the school total approximately 365 sf.

There are eight windowless exterior man doors located around the school that are hollow metal with insulated cores with an effective R-value of R-2.5. There are 14 hollow, metal entryway doors with insulated cores and half lite windows that provide an effective R-value of R-2.2. Several of the doors were installed during the original construction of the school and are approximately 55 years old. All of the building's exterior doors have weather stripping in fair condition.

V.II Mechanical Description

The school is heated using four gas-fired, cast-iron, sectional boilers. Boilers B-1 and B-2 are Burnham PF-505 series boilers that were installed in 1983 and are equipped with Power Flame CR1-G-12 burners that have a 996 MBH input rating. These boilers operate year round providing building heat to the 1983 classroom addition and have direct digital controls (DDC). The rest of the school is served by two Weil-McLain model 1388 boilers, B-3 and B-4. These boilers were installed in 1998 and are equipped with Gordon Piatt R10.1-G-30 burners that have a 2,840 MBH input rating each. Boilers B-3 and B-4 also operate year round and have DDC controls. A boiler circulation pump is provided for each boiler. The circulation pumps for the two Burnham boilers are 3/4 HP Bell & Gossett inline pumps while the circulation pumps for the two Weil-McLain boilers are 2 HP Armstrong inline pumps. It was reported that all of the boilers have been operating at temperatures higher than recommended, which may be due to a combination of the location of the return water temperature sensor in the hot water header and current DDC setpoints.

An A. O. Smith BT-100-926 gas-fired, 100 gallon domestic hot water heater and a Grundfos UP 25-64SF 180 watt inline circulation pump are located in the mechanical room. An A. O. Smith BT-140-540 gas-fired, 140 gallon domestic hot water heater and a Grundfos UPS-15-42ST 85 Watt inline circulation pump are located in the boiler room. These domestic hot water heaters and circulation pumps are used to provide hot water for the school and kitchen areas.

There are eight air handling units (AHUs) located throughout the building which provide supply air tempered using hot water coils. Due to multiple HVAC renovation projects, the AHUs are not labeled in sequential order and some labels are used more than once. Refer to Appendix C, Major Equipment List, for a detailed listing of each AHU by location. AHU-1 (1983), a Trane No. 17B Climate Changer, serves the 1983 addition classrooms with 8,620 CFM of conditioned air using a 7.5 HP fan. AHU-2 (1983), a Trane No. 8A Climate Changer, supplies the gym with 4,500 CFM using a 3 HP fan. AHU-5 (1956), an American Blower Company 215, supplies 5,500 CFM of condition air to the multipurpose room using a 2 HP fan. AHU-1 (2005), a Haakon WH0602A, provides 4,000 CFM to the Northwest classrooms of the original construction area using a 3 HP fan. AHU-2 (2005), a Haakon WH0901A, provides 7,200 CFM to the Southwest classrooms of the original construction area using a 5 HP fan. AHU-7 (2005), a Haakon WQ0801A, provides 4,800 CFM of air to the Southeast classrooms of the original construction area using a 3 HP fan. AHU-8 (2005), a Haakon WQ0602A, provides 3,600 CFM to the Northeast classrooms of the original construction area using a 3 HP fan. AHU-9 supplies the school's 1970 addition and is located in a fan room above the library entrance. Access was restricted to this area preventing inspection on the day of the CEI site survey. An older roof-top AHU (1956), a Pace A18FO, is no longer used and is not in service. No mechanical cooling is provided for any equipment in the building.

Mechanical ventilation for the building is also provided by relief fans, supply fans, and exhaust fans located on the roof and throughout the building. RF-1 is a roof-mounted centrifugal relief fan with a 3 HP motor equipped with a variable frequency drive (VFD). RF-2 is also a roof-mounted centrifugal relief fan with a 2 HP motor equipped with a VFD. RF-1A is a return fan with a 2 HP motor located in the fan room. Supply fan F-1 is a centrifugal fan with a 3/4 HP motor that supplies combustion air to the boiler room. VF-1 is a centrifugal supply fan with a 240 W motor. Exhaust fans EF-1, EF-2, EF-3, and EF-6 are roof-mounted units and are each equipped with fractional horsepower motors. These fans ventilate the school's restrooms. Exhaust fans EF-4 and EF-5 are roof-mounted units equipped with 1 HP motors and ventilate the mechanical room. EF-4A, an exhaust fan with a 1 HP motor, provides recirculation to the multipurpose room. See Appendix C, Major Equipment List, for a detailed list of the ventilation units.

The school's building energy management and control system was originally pneumatically controlled. In 2005, all pneumatic controls were replaced with a direct digital control system.

V.III Electrical Description

The school is served by a 1200 amp (A), 120/208 volt (V), three phase, 4-wire, underground electrical service connected to a pad mounted utility transformer. Electricity is distributed throughout the school via three main distribution panels that feed numerous small distribution panels scattered throughout the school.

Lighting in the corridors was originally provided by fluorescent T12 light fixtures but many portions of the school have been upgraded to T8 lighting, to conserve energy. The lighting levels are adequate throughout most of the corridors, however they are in excess of the IESNA suggested lighting levels in one portion of the school with the upgraded T8 lighting. Numerous nightlights with battery backed emergency ballasts are present in the corridors; all other fixtures are controlled by a contactor interfaced with the security system that shuts the corridor lights off while the security system is armed. A few trophy cases are present in the corridors. One set is illuminated by two fluorescent single lamp T12 strip lights that are controlled by a local light switch. The other set of trophy cases is illuminated by about (12) two-lamp, 3' T12 light fixtures that appear to be controlled by the same contactor as the corridor lights.

The library lighting is provided by 3-lamp T8 Fluorescent light fixtures and recessed down lights with two 26 watt (W) compact fluorescent lamps (CFL). The library lighting is split into multiple zones, all controlled by wall switches.

The lighting in nearly all of the classrooms has been upgraded to three and four lamp fluorescent T8 lighting with the exception to one small resource room with four three-lamp T12 light fixtures. Approximately 75% of the T8 light fixtures are provided with bi-level switching where two lamps are controlled by one wall switch and the remaining lamps are controlled by a second switch. The balance of the lights are controlled by a single light switch. Many of the classrooms are also equipped with a small restroom for student use. These spaces are illuminated by a mixture of T8, T12, and circline T9 fluorescent lighting along with some 60W incandescent lights. All of the classroom restroom lights are controlled by local wall switches

The office spaces in the school are primarily illuminated by fluorescent two and three-lamp T12 light fixtures and approximately 15% of the spaces have been upgraded to three-lamp T8 lighting. All of the fluorescent light fixtures are controlled by wall switches. Additionally there is a single incandescent lamp used for task lighting in room 53.

The multi-purpose room (MPR) is illuminated by 400W metal halide (MH) high bay light fixtures that are controlled by wall switches. These types of light fixtures are difficult to switch frequently due to a long start up time and therefore usually remain on the entire time that the building is occupied. There is also a stage area integrated into the MPR with two small semi-enclosed stairways leading to it from the MPR. Each stairway is illuminated by a two-lamp 60W incandescent light fixture that is controlled by a wall switch. A discussion with the staff revealed that these light fixtures are commonly left on while the space is unoccupied.

Lighting in the student restrooms is provided by two-lamp T12 fluorescent lighting that appears to be controlled by the same lighting contactor that controls the corridor lighting.

The gymnasium lighting consists of (21) four-lamp fluorescent T5HO fixtures that are controlled by wall switches. A few small storage areas used for housing gym equipment are illuminated by a mixture of T8 and T12 light fixtures and are controlled by wall switches.

The Kitchen is illuminated by approximately (17) two-lamp T12 light fixtures with magnetic ballasts. These light fixtures are controlled by a wall switch.

Exterior of the school building is illuminated by several 150W high pressure sodium (HPS) wallpack and canopy lights. The walkways and parking areas are illuminated by 150W pole mounted LED light fixtures. The playground and skating rink are illuminated by 400W HPS pole mounted light fixtures. The building mounted wallpack and canopy lights are controlled by several photocells that, when functioning correctly, switch the lights off during the day. Several of these photocells were observed to be inoperable, leaving a few of the light fixtures on continuously. The pole mounted light fixtures are all controlled by a central photocell controlled contactor that shuts the lights off during the day. The contactor is also interfaced with the security system to shut the lights off when the building security system is alarmed.

Other electricity-using equipment not previously described in the mechanical or electrical sections include a commercial reach-in freezer, a commercial reach-in refrigerator, a microwave and other kitchen equipment, and various user equipment such as projectors, computers, and printers.

V.IV Portable Building Description

There is a single, 960 sf portable building located on the Mountain View Elementary school campus. It is minimally occupied approximately one day per week. The portable was constructed in 1983 and consists of 2”x4” wood studs on 16” centers with R-11 fiberglass batt insulation for a combined R-value of R-11.4. The exterior face of the wall is T1-11 siding with drywall on the interior. The exterior wall height is nine feet under the roof eaves, and the end walls vary in height up to 11’ at the roof peak. The portable building has 1,280 sf of exterior wall area.

The portable has an above grade floor resting on sleepers. Plywood skirting protects the sleepers and floor construction from the weather. The floor construction is plywood flooring resting on 2x8 wood joists with R-13 fiberglass batt insulation. The portable has 960 sf of floor area.

The portable is covered by a cold roof with shingles on top of a plywood decking. It is estimated that the roof is insulated with R-13 fiberglass batt insulation. The portable has approximately 1,012 sf of roof area.

There are two double pane, wood framed windows in the portable with an estimated R-value of R-2.0. There are two insulated metal doors with an R-value of R-1.7 for each door.

The portable is heated by electric resistance perimeter baseboards where the temperature set point is controlled by a dial thermostat on each individual baseboard. This makes it easy for the electric baseboards to be left on at higher temperatures than is required. Building occupants confirmed that the portable building is often overheated. Due to the need to keep these buildings moveable and due to combustion safety issues, the Anchorage School District states its desire to keep all portable buildings on electric heat and not utilize natural gas heating at this time.

A 120/208V single phase overhead feeder is supplied to the portable building from the school building. The service terminates in a small distribution panel that distributes power to the portable's lighting, heating, and receptacles. The lighting in the portable is provided by (12) four-lamp, 4’ long, T12 light fixtures with magnetic ballasts. The 4’ fluorescent fixtures are controlled by wall switches. Additionally there is a single 2’x2’ recessed troffer with two 40W U-tube T12 lamps with a magnetic ballast that is not switched and is on continuously.

A separate AkWarm model was created to model this portable building. See Appendix E, Energy Conservation Measures – Mountain View Portable Buildings, for details of the recommended ECMs for the portable building.

VI. Historic Energy Consumption and Cost

Tables provided in Appendix A, Energy Benchmark Data Report, represent the electric and natural gas energy usage for the surveyed facility from January 2009 to December 2010. Anchorage Municipal Lighting &Power provides the electricity and Enstar Natural Gas provides the natural gas to the building. Both utility companies bill the facility using a commercial rate schedule. The actual utility bills were not provided to be able to verify the data received to assure 100 percent accuracy of the data.

The AkWarm model of the facility was built to match the facility's average annual electric and natural gas consumption, so that a realistic model could be created. The monthly energy consumption of the AkWarm model matches the actual average monthly consumption of the facility within 25%, which is adequate for this level of modeling. Overall, the energy consumption trends of the AkWarm model and the actual facility match appropriately. Graphical representations of the monthly energy consumption are included in Appendix A.

VI.I Electrical Consumption Data

The electric utility costs consist of several components: a fixed monthly customer charge, an energy usage charge, fuel surcharge, taxes, and a demand charge. The energy usage and fuel surcharge are based on the customer's usage as measured in kilowatt-hours (kWh). The usage (kWh) is determined by load wattage divided by 1,000, times hours running. For example, a 1,000 watt load operating for one hour will use 1 kWh of electricity as would ten, 100 watt lamps operating for one hour or one, 100W lamp operating for 10 hours. One kWh is equivalent to 3,413 BTU. Utility data used in this report reflects the historical data provided for the building in a summarized format.

VI.II Natural Gas Consumption Data

The natural gas supplier bills for consumption in CCF of natural gas; where one CCF equals 100 cubic feet of natural gas. The average heating value of natural gas is 1,000 BTUs per cubic foot, making 1 CCF equal to 100,000 BTUs (also called one "Therm").

VI.III Overall Energy Consumption Data

The overall cost for energy use is calculated by dividing the total cost by the total usage. Based on the electric and fuel oil utility data provided, the average cost for the energy and consumption calculations at the surveyed facility are summarized in the table below.

Table 4. Energy Cost and Consumption Data

Energy Cost and Consumption Data			
	2009	**2010**	**Average**
Electric	0.12 $/kWh	0.13 $/kWh	0.13 $/kWh
Natural Gas	1.00 $/CCF	0.87 $/CCF	0.94 $/CCF
Total Cost	$116,090	$109,193	$112,642
ECI	1.96 $/sf	1.85 $/sf	1.91 $/sf
Electric EUI	30.1 kBtu/sf	30.7 kBtu/sf	30.4 kBtu/sf
Natural Gas EUI	86.8 kBtu/sf	79.7 kBtu/sf	83.2 kBtu/sf
Building EUI	116.9 kBtu/sf	110.4 kBtu/sf	113.6 kBtu/sf

The Energy Cost Index (ECI) is derived by dividing the annual cost by the building square footage. The building square footage was calculated to be approximately 59,118 sf. This area includes the 58,158 sf school and the 960 sf portable building.

The annual EUI is expressed in Thousands of British Thermal Units per Square Foot (kBtu/sf) and can be used to compare energy consumption of similar building types or to track consumption from year to year in the same building. The EUI is calculated by converting annual consumption of all fuels used to Btu's and then dividing by the area (gross conditioned square footage) of the building. EUI is a good indicator of the relative potential for energy savings. A comparatively low EUI indicates less potential for large energy savings. Building architectural, mechanical, and electrical drawings were obtained and utilized to calculate and verify the gross area of the facility. The gross area was confirmed on the physical site investigation.

VII. Equipment Inventory and Photo Survey

Following the completion of the field survey a detailed equipment list was created and is attached as Appendix C. The major equipment listed are considered to be the major energy consuming equipment in the building whose replacement could yield substantial energy savings.

An approximate age was assigned to the equipment if a manufactured date was not shown on the equipment's nameplate. As listed in the 2011 ASHRAE Handbook for HVAC Applications, Chapter 37, Table 4, the service life for the equipment along with the remaining useful life in accordance to the ASHRAE standard are also noted in the equipment list.

Where there are zero (0) years remaining in the estimated useful life of a piece of equipment, this is an indication that maintenance costs are likely on the rise and more efficient replacement equipment is available which will lower the operating costs of the unit. Maintenance costs should also fall with the replacement.

Additionally, photos of various equipment and the building construction were taken during the site visit. Several photos are included in Appendix F.

CEI made miscellaneous thermographic images of the building using a FLIR T300 Infrared Camera. This is not a thermographic study, but rather just a few snapshots to illustrate easy-to-identify heat losses. These thermographic photos are included in Appendix G.

VIII. Energy Conservation Measures

VIII.I School Energy Conservation Measures

ECM# MES-0 – Replace light commercial refrigerators/freezers older than 5 years old

Annual Energy Savings	Installed Cost	SIR	Payback (years)
-	-	-	<10 years

Due to advances in refrigerators in the previous five years, new Energy Star refrigerators and freezers are significantly more efficient than previous models. Replacing existing refrigerators and freezers, which are older than five years old, with new energy star models will typically have paybacks of less than 10 years.

ECM # MES-1– Shutdown Boilers During Summer Months

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$1,379	$720	30.95	0.5

The four gas fired boilers in the building operate year round, even during the summer when limited heating needs are required. By turning off the boilers from June to the end of August, energy savings can be achieved. ASD has had trouble with older generation grooved joint couplings when subjected to cyclic heating and cooling from seasonal shutdowns. However, due to the fact that the hydronic piping in Mountain View Elementary does not contain grooved joint couplings, leaks should not be an issue when boilers are shut down seasonally. The maintenance cost of a trained technician restarting the boilers was included in the installed cost, but no capital cost is required. This ECM was modeled with a separate AkWarm model and as a result, the item is not an additive measure in AkWarm. It is therefore, not included in the final cost savings total in the final AkWarm model in Appendix D.

ECM # MES-2 – Setback Thermostat: Classrooms, Offices, Gym, and Multipurpose Room

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$4,279	$556	12.91	7.7

Currently there is a night setback schedule that lowers building temperatures to 65 deg F during unoccupied times. However, even greater energy savings exist by reducing the room temperature of the classrooms, offices, gymnasium, and multipurpose spaces further to 60 deg F during unoccupied times. Lowering the heat load of the building will reduce natural gas consumption. Since the school's thermostats are already connected to the DDC system, the costs of this ECM only includes the time required to program a night setback which can be performed by maintenance personnel. The 60 deg F night setback is feasible but may require that other DDC setpoints be changed, such as the low temperature alarm. This ECM is a compilation of items 1, and 2 as modeled in AkWarm which are intended to be implemented concurrently. Details of the individual items are shown in Appendix D.

ECM # MES-3 – Upgrade Library Lighting Controls

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$555	$900	9.02	1.6

The Library lighting is provided by approximately (63) 3-lamp T8 Fluorescent light fixtures and (18) recessed can lights with two 26 watt (W) compact fluorescent lamps (CFL). These lights are controlled in multiple zones by wall switches. It is recommended that approximately six ceiling mounted occupancy sensors are installed to control these light fixtures.

This description is for a compilation of several ECMs that are intended to be implemented at the same time, however due to constraints with the AkWarm modeling software the different lighting configurations were modeled separately. See items 3 and 18 in Appendix D for details of individual measures.

ECM # MES-4–Provide Classroom Occupancy Sensors

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$2,562	$4,351	2.52	1.7

The 29 classrooms in the school are primarily illuminated by two, three, and four-lamp fluorescent T8 light fixtures with electronic ballasts. It is recommended that one occupancy sensor is installed in each of the 29 classrooms to control all of the light fixtures in that room.

This description is for a compilation of several ECMs that are intended to be implemented at the same time, however due to constraints with the AkWarm modeling software the different lighting configurations were modeled separately. See items 4, 6, 7, 8, and 10 in Appendix D for details of individual measures.

ECM # MES-5 – Upgrade Student Restroom Lighting and Provide Occupancy Sensors

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$481	$3,300	2.13	6.9

Lighting in the six student restrooms is provided by (16) two lamp T12 fluorescent lighting that appears to be controlled by the same lighting contactor that controls the corridor lighting. It is recommended that the light fixtures in these areas be replaced, one-for-one, with 2-lamp T8 light fixtures, and six new ceiling mounted occupancy sensors are added for control. See item 20 in Appendix D for more information.

ECM # MES-6 – Upgrade Corridor Lighting

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$2,348	$15,650	2.19	6.67

Lighting in the corridors was originally provided by fluorescent T12 light fixtures but many portions of the school have been upgraded to T8 lighting to conserve energy. The lighting levels are adequate throughout most of the corridors, however they are in excess of the IESNA suggested lighting levels in corridors 100, 200, and 300 which were upgraded with T8 lighting. Numerous nightlights with battery backed emergency ballasts are present in the corridors. All other fixtures are controlled by a contactor interfaced with the security system that shuts the corridor lights off while the security system is armed. It is suggested that the (15) single-lamp T12 and (37) two-lamp T12 light fixtures be replaced, one-for-one, with single and two-lamp T8 light fixtures respectively. It is also recommended that the lighting levels in corridors 100, 200, and 300 be reduced to IESNA recommended levels. This can be achieved by replacing ballasts in the three-lamp light fixtures with two lamp ballasts and removing the middle set of tombstones so that the fixture will only accept the outer two lamps. Additionally the number of normally switched light fixtures should be reduced by 50%, and reducing the number of light fixtures to 53. It is not recommended that the number of emergency battery backed light fixtures be reduced.

This description is for a compilation of several ECMs that are intended to be implemented at the same time, however due to constraints with the AkWarm modeling software the different lighting configurations were modeled separately. See items 13, 22, and 27 in Appendix D for details of individual measures.

ECM # MES-7 – Upgrade Office Lighting and Controls

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$1,841	$16,680	1.61	9.1

The office spaces in the school are primarily illuminated by fluorescent two and three-lamp T12 light fixtures and relatively few spaces have been upgraded to three-lamp T8 lighting. All of the fluorescent light fixtures are controlled by wall switches. Additionally there is a single incandescent lamp used for task lighting in room 53. It is recommended that the (36) two-lamp, and the (52) three-lamp T12 light fixtures are replaced one-for-one by T8 light fixtures, and the single 52W incandescent desk lamp should be replaced by a CFL. One new ceiling mounted occupancy sensor should be installed in each of the 23 office spaces to control the (88) previously described fluorescent light fixtures in addition to the (12) existing three-lamp T8 light fixtures.

This description is for a compilation of several ECMs that are intended to be implemented at the same time, however due to constraints with the AkWarm modeling software the different lighting configurations were modeled separately. See items 14, 21, 26, and 29 in Appendix D for details of individual measures.

ECM # MES-8 – Upgrade Exterior Lighting

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$2,759	$26,700	1.51	9.7

Approximately three photocells were observed to be inoperable during the site visit to the school leaving seven 150W HPS light fixtures on continuously. It is recommended that these photocells be replaced in addition to replacing the (24) 150W HPS building-mounted, wallpack, and canopy light fixtures with 70W LED source light fixtures. The pole mounted nine 400W HPS light fixtures should be replaced with

150W LED light fixtures. Though replacing the inoperable photocells will reduce operations and maintenance costs due to extending the life of the system, these savings were not modeled in AkWarm.

This description is for a compilation of several ECMs that are intended to be implemented at the same time, however due to constraints with the AkWarm modeling software the different lighting configurations were modeled separately. See items 5, 9, 15, 16, 17, 19, 46, and 47 in Appendix D for details of individual measures.

Note – AkWarm measures with SIRs less than one were included in this compiled annual energy savings, installed cost, SIR, and payback of this since they should be upgraded congruently.

ECM # MES-9 – Upgrade Trophy Case Lighting and Controls

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$277	$2,850	1.41	10.3

A few trophy cases are present in the corridors and are one set is illuminated by two fluorescent single lamp 4' T12 strip lights that are controlled by a local light switch. These light fixtures should be replaced one-for-one with 4' single lamp T8 strip lights, and the wall switch should be replaced with an occupancy sensor.

A second set of trophy cases is illuminated by about (12) fluorescent two-lamp, 3’ T12 light fixtures that appear to be controlled by the same contactor as the corridor lights. This bank of trophy cases is partitioned into 6' sections and each section has two 3' fixtures. Each set of two 3' fixtures should be replaced by one 4' and one 2' two lamp fluorescent T8 light fixtures. Two new occupancy sensors should also be added to control these light fixtures to switch them off while no one is present in the adjacent areas.

This description is for a compilation of several ECMs that are intended to be implemented at the same time, however due to constraints with the AkWarm modeling software the different lighting configurations were modeled separately. See items 12, 24, and 58 in Appendix D for details of individual measures.

ECM # MES-10–Upgrade Multi-Purpose Room Lighting

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$765	$9,960	1.09	13.0

The MPR is illuminated by (12) high bay 400W MH light fixtures that are controlled by wall switches. Due to the long strike time associated with MH light fixtures they usually remain on the entire time that the building is occupied, and they cannot be easily controlled by occupancy sensors. The stage area integrated into the MPR has two semi-enclosed stairways leading to it from the MPR. Each stairway is illuminated by a two lamp 60W incandescent light fixture that is controlled by a wall switch. It is recommended that the MH light fixtures in the MPR be replaced one-for-one by high bay fluorescent six-lamp T5HO light fixtures controlled by new wall mounted light switches. Additionally the wall switches in the two stairways should be replaced by occupancy sensors that will automatically shut the lights off when the space is unoccupied, and that the incandescent lamps are replaced with CFL's.

This description is for a compilation of several ECMs that are intended to be implemented at the same time, however due to constraints with the AkWarm modeling software the different lighting configurations were modeled separately. See items 11, 28, and 42 in Appendix D for details of individual measures.

ECM # MES-11–Air Tightening

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$1,744	$15,000	1.03	8.6

By tightening the building envelope with air sealing improvements, infiltration into the building will be reduced. This in turn will reduce the heating load required by the building and reduce the amount of natural gas being burned by the boilers. While a blower door test was not completed, it is anticipated that air leakage is occurring through old weather stripping around doors, window frames, and wall and roof penetrations. Methods to decrease the infiltration into the building include: sealing around the windows and doors with caulking and insulation, adding new weather stripping to doors, providing gaskets to all exterior cover plates and sealing all roof and wall penetrations. To achieve a viable economic benefit, up to $15,000 can be invested and still achieve an SIR ≥ 1 by reducing air leakage by 20%. See item 31 in Appendix D for more information.

ECM # MES-12–Install VFDs on 5HP pumps and EC Motors on pumps less than 1HP

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$2,212	$35,000	0.96	15.8

It is recommended that Variable Frequency Drives (VFDs) be installed on 5 HP pumps (P-3A, 3B, 4A, and 4B) so that the pumps can modulate in order to satisfy the heating load of the hydronic system for the building. This will reduce the electricity required for pumping.

The eight existing circulation pumps (P-5, 6, 7, and 8 and PMP-1,2, 3, and 4) are constant speed pumps. New, high efficiency pumps with electronically commutated (EC) motors require no DDC interface and have integral speed controls which read system demand, allowing the pump to slow down with significant electrical savings. It is recommended to replace the existing pumps with new pumps with EC motors.

Though this ECM does not have an SIR above one according to the AkWarm model, it should still be considered as a viable energy conservation measure. This ECM was modeled with a separate AkWarm model and as a result the item is not an additive measure in AkWarm. It is therefore not included in the final cost savings total in the final AkWarm model in Appendix D.

VIII.II Portable Building Energy Conservation Measures

ECM #PB-1 – Setback Thermostat

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$780	$1,000	9.57	1.3

Significant energy savings exist by reducing the room temperature of the portable building during unoccupied times. However, due to the fact that the portable building has perimeter electric baseboard heaters, each with individual dial thermostats, it is difficult to obtain a desired set point in the portable building. As a result, the temperature in the portable is typically much higher than required. Also, the temperature cannot be set back during unoccupied times. It is recommended that a central programmable thermostat be installed in the portable building that can turn the perimeter electric baseboards on or off to control occupied and unoccupied temperature set points. Reducing the portable temperature from 65F to 60F during unoccupied times will save $780 annually in electricity bills. See item 1 in Appendix E for more information.

ECM #PB-2 – Add Insulation to Portable Skirting

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$264	$960	5.70	3.6

The Portable has uninsulated plywood skirting which protects the above grade floor from the weather. The skirting is estimated to have an R-value of R-3.0. Installing R-15 rigid insulation to the interior side of the portable skirting will reduce heat loss and reduce electricity consumption. See item 2 in Appendix E for more information.

ECM #PB-3 – Upgrade Portable Lighting

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$421	$2,250	2.88	5.3

The portable is currently illuminated by (12) fluorescent four-lamp T12 light fixtures with magnetic ballasts. These fixtures should be replaced one-for-one with four-lamp T8 fluorescent light fixtures with programmable start ballasts and controlled by a ceiling mounted occupancy sensor. Additionally there is a 2'x2' two lamp 40W u-tube T12 troffer that should be replaced by a 4' two-lamp T8 light fixture and controlled by a wall mounted occupancy sensor.

This description is for a compilation of several ECMs that are intended to be implemented at the same time, however due to constraints with the AkWarm modeling software the different lighting configurations were modeled separately. See items 3 and 4 in Appendix E for details of individual measures.

ECM #PB-4 – Replace Exterior Doors

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$91	$781	2.42	8.6

The portable building has two poorly insulated (R-1.7) metal doors. It is recommended that both doors be removed and replaced with new R-6.25 minimum (U-0.16) insulated doors. The new doors should have proper weather stripping on them to reduce air infiltration. See item 5 in Appendix E for more information.

ECM #PB-5 – Seal Building Envelope and Reduce Infiltration by 30%

Annual Energy Savings	Installed Cost	SIR	Payback (years)
$115	$980	1.02	8.5

By tightening the portable building envelope with air sealing improvements, infiltration into the portable will be reduced. This in turn will reduce the heating load and reduce the amount of electricity being used by the electric heaters. While a blower door test was not completed, it is anticipated that air leakage is occurring around old weather stripping around doors, window frames, and wall and roof penetrations. Methods to decrease the infiltration into the portable include: sealing around the windows and doors with caulking and insulation, adding new weather stripping to doors, providing gaskets to all exterior cover plates and sealing all roof and wall penetrations. To achieve a viable economic benefit, up to $980 can be invested and still achieve an SIR ≥ 1 by reducing air leakage by 30%. See item 6 in Appendix E for more information.

VIII.III Administrative Controls for Energy Conservation and Optimization

While the intent of many energy conservation measures is to increase the efficiency of fuel-burning and electrical equipment, an important factor of energy consumption lies in the operational profiles which control the equipment usage. Such profiles can be managed by administrative controls and departmental leadership. They determine how and when fuel-burning and electrical equipment are used, and therefore have a greater impact on energy savings potential than simply equipment upgrades alone. Significant energy cost savings can be realized when ECMs are combined with efficient-minded operational profiles.

Operational profiles may be outlined by organization policy or developed naturally or historically. These profiles include, but are not limited to: operating schedules, equipment setpoints and control strategies, maintenance schedules, and site and equipment selection.

Optimization of operational profiles can be accomplished by numerous methods so long as the intent is reduction in energy-using equipment runtime. Due to the numerous methods of optimization, energy cost savings solely as a result of operational optimization are difficult to predict. Quantification, however, is easy to accomplish by metering energy usage during and/or after implementation of energy-saving operational profiles and ECMs. Shown below are some examples which have proven successful for other organizations.

Optimization of site selection includes scheduling and location of events. If several buildings in a given neighborhood are all lightly used after regularly occupied hours, energy savings can be found when after-hours events are consolidated and held within the most energy efficient buildings available for use. As a result, unoccupied buildings could be shut down to the greatest extent possible to reduce energy consumption.

Two operational behaviors which can be combined with equipment upgrades are operating schedules and equipment control strategies including setpoints. Occupancy and daylight sensors can be programmed to automatically shut off or dim lighting when rooms are unoccupied or sufficiently lit from the sun. Operating schedules can be optimized to run equipment only during regular or high-occupancy periods. Also, through a central control system, or with digital programmable thermostats, temperature setpoints can be reduced during low-occupancy hours to maximize savings. In addition, sporadically used equipment can be shut down during unoccupied hours to further save energy. In general, having equipment operating in areas where no occupants are present is inefficient, and presents an opportunity for energy savings.

Operational profiles can also be implemented to take advantage of no- or low-cost ECMs. Examples include heating plant optimizations (boiler section cleaning, boiler flush-through cleaning) and tighter controls of equipment setbacks and shutdowns (unoccupied zones equipment shutdown, easier access to and finer control of equipment for after-hours control). In a large facility management program, implementation of these measures across many or all sites will realize dramatic savings due to the quantity of equipment involved.

Changes to building operational profiles can only be realized while simultaneously addressing health, safety, user comfort, and user requirements first. It is impractical to expect users to occupy a building or implement operational behaviors which do not meet such considerations. That said, it is quite practical for management groups to implement administrative controls which reduce losses brought about by excess and sub-optimum usage.

Appendix A
Energy Benchmark Data

REAL Preliminary Benchmark Data Form

PART I – FACILITY INFORMATION

Facility Owner	Facility Owned By	Date
MOA	Municipal Government/Subdivision	07/22/11
Building Name/ Identifier	**Building Usage**	**Building Square Footage**
Mountain View Elementary	Education - K - 12	59,118
Building Type	**Community Population**	**Year Built**
Mixed	261,500	1958
Facility Address	**Facility City**	**Facility Zip**
4005 Mcphee Ave	Anchorage	99517

Contact Person

First Name	Last Name	Middle Name	Email	Phone
Calvin	Mundt		mundt_calvin@asdk12.org	742-5213

Mailing Address	City	State	Zip
	Anchorage	AK	

Primary Operating Hours	**Monday-Friday**	**Saturday**	**Sunday**	**Holidays**	
	8-4:30				
Average # of Occupants During					

Renovations

Date	Details
	1958 - 35830 SF Original **1970 - 5685 SF Classrooms** **1983 - 16643 Classroms, MPR** **Total = 58158 SF**

PART II – ENERGY SOURCES

1. Please check every energy source you use in the table below. If known, please enter the base rate you pay for the energy source.

2. Provide utilities bills for the *most recent two-year period* for *each energy source* you use.

Heating Oil	Electricity	Natural Gas	Propane	Wood	Coal
$ /gallon	$ / kWh	$ / CCF	$ / gal	$ / cord	$ / ton
Other energy sources?					

Mountain View Elementary

Buiding Size Input (sf) = ***59,118***

2009 Natural Gas Consumption (Therms)	**51,285.00**
2009 Natural Gas Cost ($)	**51,420**
2009 Electric Consumption (kWh)	**522,208**
2009 Electric Cost ($)	**64,670**
2009 Total Energy Use (kBtu)	**6,910,796**
2009 Total Energy Cost ($)	**116,090**
Annual Energy Use Intensity (EUI)	
2009 Natural Gas (kBtu/sf)	86.8
2009 Electricity (kBtu/sf)	30.1
2009 Energy Utilization Index (kBtu/sf)	**116.9**
Annual Energy Cost Index (ECI)	
2009 Natural Gas Cost Index ($/sf)	0.87
2009 Electric Cost Index ($/sf)	1.09
2009 Energy Cost Index ($/sf)	**1.96**
2010 Natural Gas Consumption (Therms)	**47,139.00**
2010 Natural Gas Cost ($)	**40,977**
2010 Electric Consumption (kWh)	**531,090**
2010 Electric Cost ($)	**68,216**
2010 Total Energy Use (kBtu)	**6,526,510**
2010 Total Energy Cost ($)	**109,193**
Annual Energy Use Intensity (EUI)	
2010 Natural Gas (kBtu/sf)	79.7
2010 Electricity (kBtu/sf)	30.7
2010 Energy Utilization Index (kBtu/sf)	**110.4**
Annual Energy Cost Index (ECI)	
2010 Natural Gas Cost Index ($/sf)	0.69
2010 Electric Cost Index ($/sf)	1.15
20010 Energy Cost Index ($/sf)	**1.85**

Note:

1 kWh = 3,413 Btu's

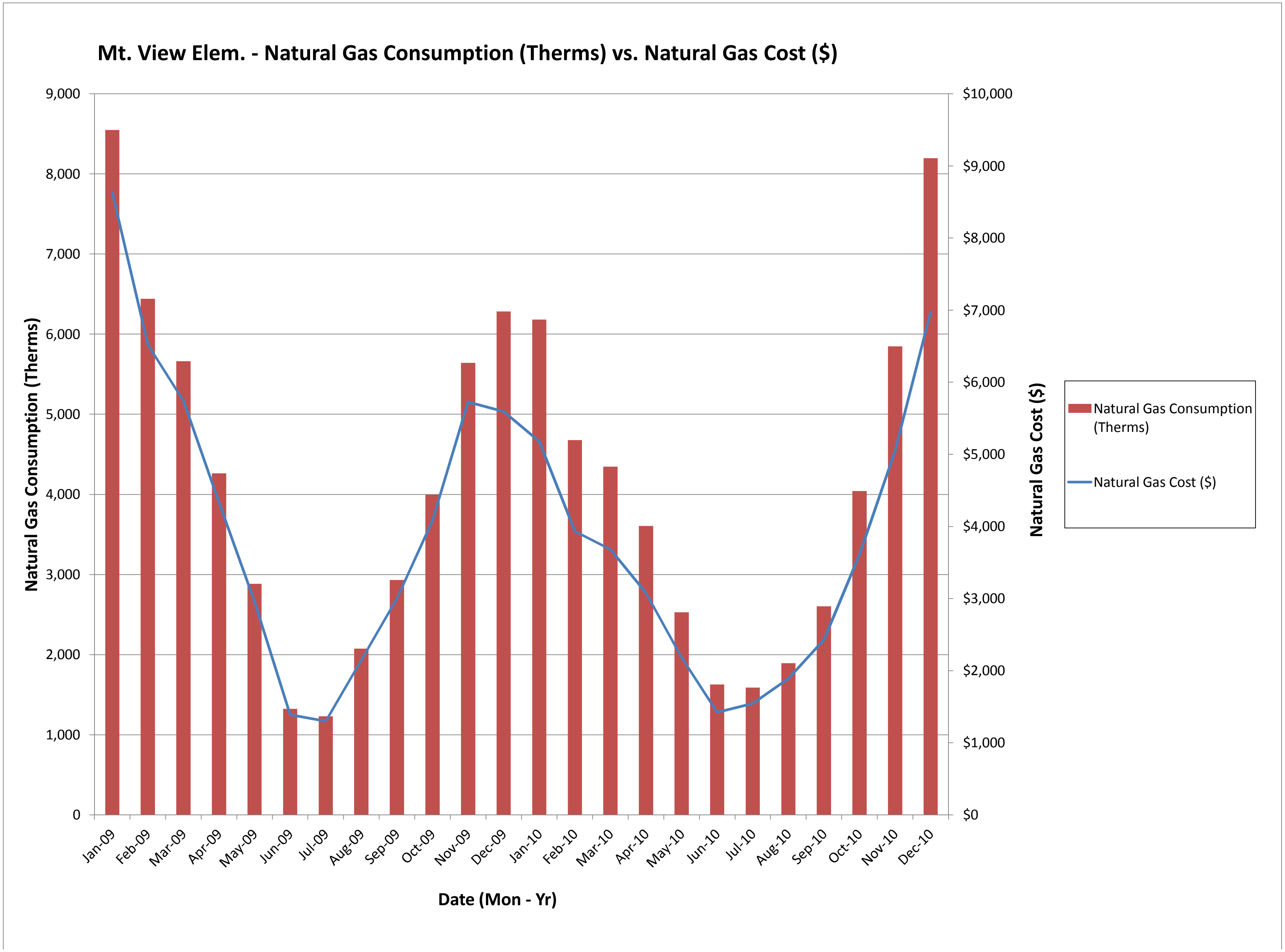
1 Therm = 100,000 Btu's

1 CF ≈ 1,000 Btu's

Mountain View Elementary

Natural Gas **Btus/CCF =** 100,000

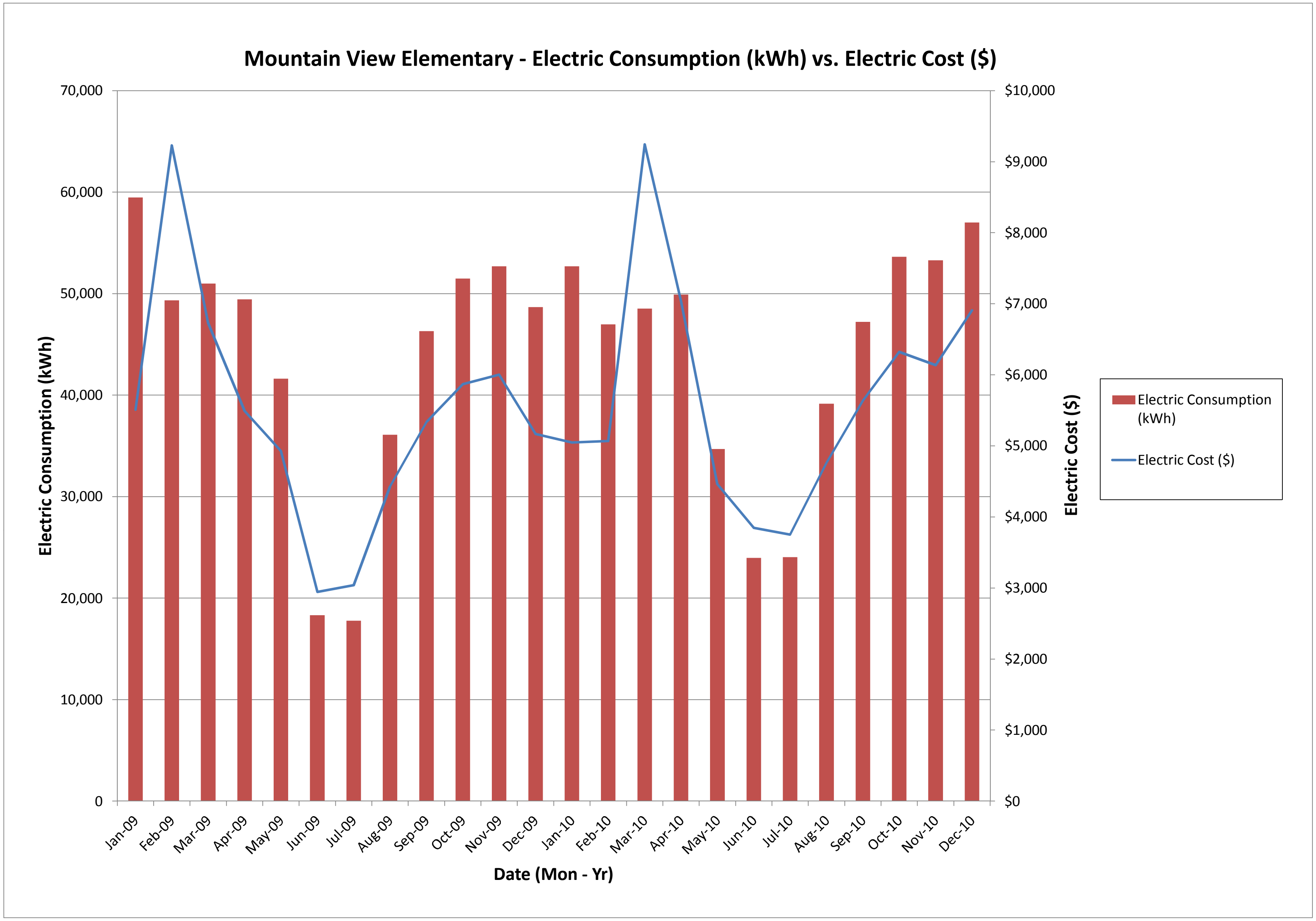
Provider	Meter #	Month	Start Date	End Date	Billing Days	Consumption (CCF)	Consumption (Therms)	Demand Use	Natural Gas Cost ($)	Unit Cost ($/Therm)	Demand Cost ($)
Enstar NGC	139756	Jan-09	01/12/09	02/11/09	30	8,548	8,548		$8,632	$1.01	
Enstar NGC	139756	Feb-09	02/11/09	03/11/09	28	6,443	6,443		$6,520	$1.01	
Enstar NGC	139756	Mar-09	03/11/09	04/13/09	33	5,662	5,662		$5,739	$1.01	
Enstar NGC	139756	Apr-09	04/13/09	05/11/09	28	4,264	4,264		$4,337	$1.02	
Enstar NGC	139756	May-09	05/11/09	06/11/09	31	2,885	2,885		$2,958	$1.03	
Enstar NGC	139756	Jun-09	06/11/09	07/13/09	32	1,323	1,323		$1,387	$1.05	
Enstar NGC	139756	Jul-09	07/13/09	08/12/09	30	1,231	1,231		$1,299	$1.06	
Enstar NGC	139756	Aug-09	08/12/09	09/11/09	30	2,075	2,075		$2,148	$1.04	
Enstar NGC	139756	Sep-09	09/11/09	10/12/09	31	2,931	2,931		$3,003	$1.02	
Enstar NGC	139756	Oct-09	10/12/09	11/10/09	29	3,996	3,996		$4,075	$1.02	
Enstar NGC	139756	Nov-09	11/10/09	12/09/09	29	5,643	5,643		$5,727	$1.01	
Enstar NGC	139756	Dec-09	12/09/09	01/12/10	34	6,284	6,284		$5,595	$0.89	
Enstar NGC	139756	Jan-10	01/12/10	02/10/10	29	6,181	6,181		$5,178	$0.84	
Enstar NGC	139756	Feb-10	02/10/10	03/11/10	29	4,678	4,678		$3,932	$0.84	
Enstar NGC	139756	Mar-10	03/11/10	04/13/10	33	4,345	4,345		$3,681	$0.85	
Enstar NGC	139756	Apr-10	04/13/10	05/11/10	28	3,607	3,607		$3,079	$0.85	
Enstar NGC	139756	May-10	05/11/10	06/09/10	29	2,529	2,529		$2,185	$0.86	
Enstar NGC	139756	Jun-10	06/09/10	07/12/10	33	1,627	1,627		$1,422	$0.87	
Enstar NGC	139756	Jul-10	07/12/10	08/11/10	30	1,589	1,589		$1,545	$0.97	
Enstar NGC	139756	Aug-10	08/11/10	09/10/10	30	1,893	1,893		$1,888	$1.00	
Enstar NGC	139756	Sep-10	09/10/10	10/12/10	32	2,603	2,603		$2,428	$0.93	
Enstar NGC	139756	Oct-10	10/12/10	11/09/10	28	4,043	4,043		$3,615	$0.89	
Enstar NGC	139756	Nov-10	11/09/10	12/09/10	30	5,848	5,848		$5,047	$0.86	
Enstar NGC	139756	Dec-10	12/09/10	01/12/11	34	8,196	8,196		$6,977	$0.85	
				Jan - 09 to Dec - 09 total:		51,285	51,285	0.00	$51,420		$0
				Jan - 10 to Dec - 10 total:		47,139	47,139	0.00	$40,977		$0
								Jan - 09 to Dec - 09 avg:		$1.01	
								Jan - 10 to Dec - 10 avg:		$0.89	


Mt. View Elem. - Natural Gas Consumption (Therms) vs. Natural Gas Cost ($)
Natural Gas Consumption (Therms)
Natural Gas Cost ($)
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
$10,000
$9,000
$8,000
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Date (Mon - Yr)
Natural Gas Consumption (Therms)
Natural Gas Cost ($)

Mountain View Elementary

Electricity **Btus/kWh =** 3,413

Provider	Customer #	Month	Start Date	End Date	Billing Days	Consumption (kWh)	Consumption (Therms)	Demand Use	Electric Cost ($)	Unit Cost ($/kWh)	Demand Cost ($)
ML&P	21032986	Jan-09	1/6/2009	2/6/2009	31	59,471	2,030	170	$5,508	$0.09	0
ML&P	21032986	Feb-09	2/6/2009	3/6/2009	28	49,340	1,684	170	$9,228	$0.19	0
ML&P	21032986	Mar-09	3/6/2009	4/7/2009	32	50,984	1,740	159	$6,731	$0.13	0
ML&P	21032986	Apr-09	4/7/2009	5/7/2009	30	49,437	1,687	159	$5,492	$0.11	0
ML&P	21032986	May-09	5/7/2009	6/5/2009	29	41,631	1,421	153	$4,927	$0.12	0
ML&P	21032986	Jun-09	6/5/2009	7/8/2009	33	18,323	625	141	$2,943	$0.16	0
ML&P	21032986	Jul-09	7/8/2009	8/7/2009	30	17,782	607	71	$3,039	$0.17	0
ML&P	21032986	Aug-09	8/7/2009	9/8/2009	32	36,097	1,232	143	$4,429	$0.12	0
ML&P	21032986	Sep-09	9/8/2009	10/7/2009	29	46,306	1,580	149	$5,337	$0.12	0
ML&P	21032986	Oct-09	10/7/2009	11/6/2009	30	51,482	1,757	155	$5,867	$0.11	0
ML&P	21032986	Nov-09	11/6/2009	12/4/2009	28	52,683	1,798	155	$6,003	$0.11	0
ML&P	21032986	Dec-09	12/4/2009	1/6/2010	33	48,672	1,661	157	$5,166	$0.11	0
ML&P	21032986	Jan-10	1/6/2010	2/16/2010	41	52,700	1,799	158	$5,048	$0.10	0
ML&P	21032986	Feb-10	2/16/2010	3/8/2010	20	46,969	1,603	159	$5,068	$0.11	0
ML&P	21032986	Mar-10	3/8/2010	4/7/2010	30	48,525	1,656	159	$9,245	$0.19	0
ML&P	21032986	Apr-10	4/7/2010	5/6/2010	29	49,903	1,703	147	$7,037	$0.14	0
ML&P	21032986	May-10	5/6/2010	6/18/2010	43	34,691	1,184	147	$4,464	$0.13	0
ML&P	21032986	Jun-10	6/18/2010	7/7/2010	19	23,964	818	147	$3,848	$0.16	0
ML&P	21032986	Jul-10	7/7/2010	8/6/2010	30	24,036	820	78	$3,750	$0.16	0
ML&P	21032986	Aug-10	8/6/2010	9/7/2010	32	39,151	1,336	145	$4,757	$0.12	0
ML&P	21032986	Sep-10	9/7/2010	10/6/2010	29	47,226	1,612	151	$5,635	$0.12	0
ML&P	21032986	Oct-10	10/6/2010	11/4/2010	29	53,625	1,830	154	$6,323	$0.12	0
ML&P	21032986	Nov-10	11/4/2010	12/6/2010	32	53,287	1,819	161	$6,135	$0.12	0
ML&P	21032986	Dec-10	12/6/2010	1/5/2011	30	57,013	1,946	161	$6,906	$0.12	0
				Jan - 09 to Dec - 09 total:		522,208	17,823	1782	$64,670		0
				Jan - 10 to Dec - 10 total:		531,090	18,126	1766	$68,216		0
								Jan - 09 to Dec - 09 avg:		$0.13	
								Jan - 10 to Dec - 10 avg:		$0.13	


Mountain View Elementary - Electric Consumption (kWh) vs. Electric Cost ($)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Electric Consumption (kWh)
$10,000
$9,000
$8,000
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
Electric Cost ($)
Electric Consumption (kWh)
Electric Cost ($)
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Date (Mon - Yr)

Appendix B
AkWarm Commercial Reports

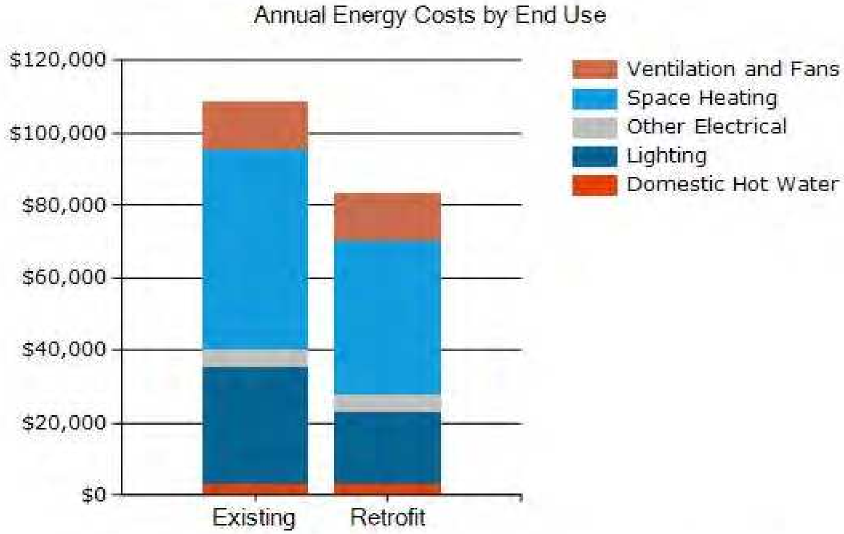
Elementary School

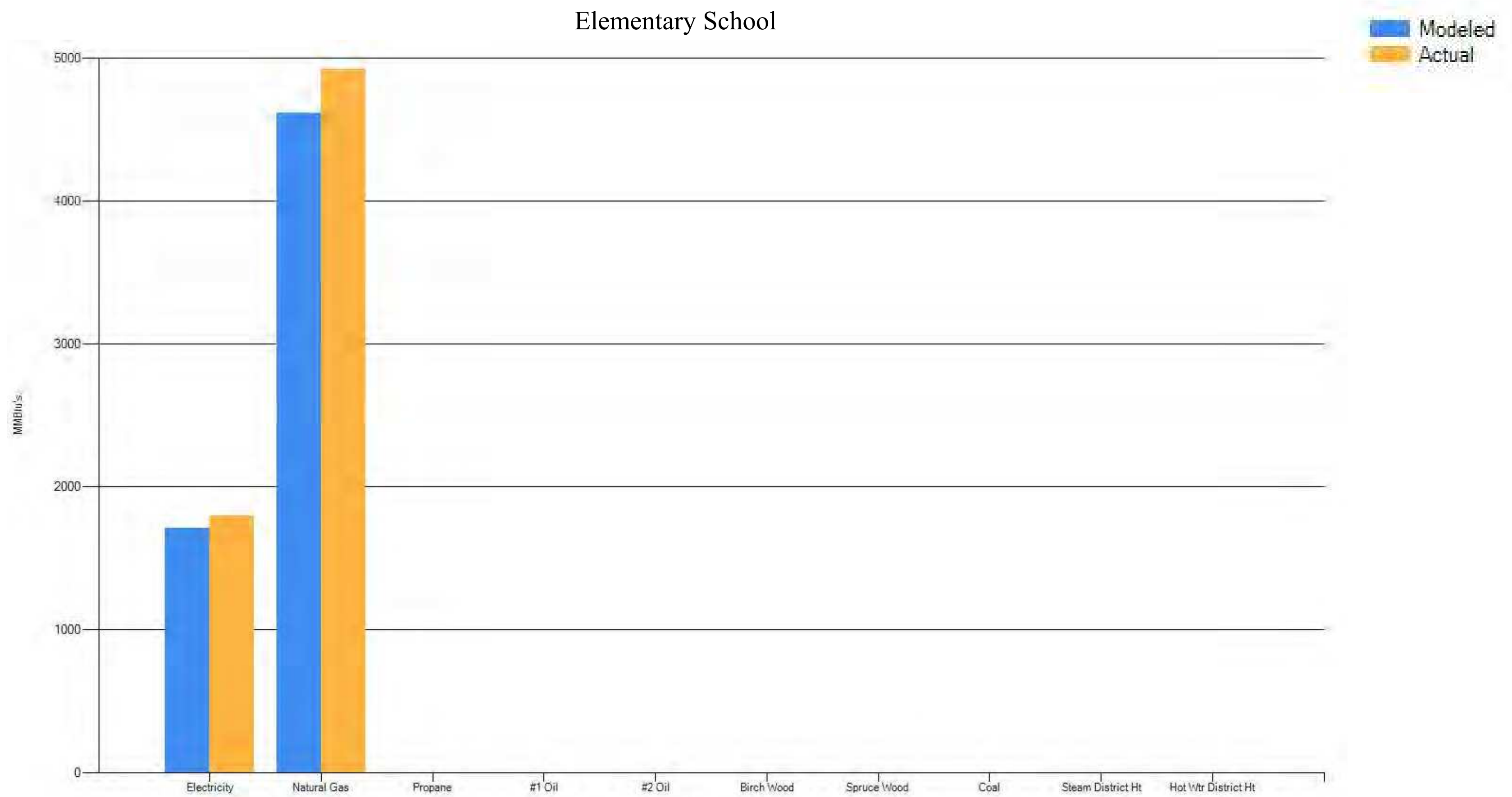
ENERGY AUDIT REPORT – PROJECT SUMMARY – Created 2/16/2012 10:19 AM	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Mountain View ES	**Auditor Company:** Coffman Engineers, Inc.
Address: 4005 Mcphee Ave	**Auditor Name:** Walter Heins PE, CCP, CxA, CEA
City: Anchorage	**Auditor Address:** 800 F Street Anchorage, AK 99501
Client Name: Calvin Mundt	
Client Address:	**Auditor Phone:** (907) 276-6664
	Auditor FAX:
Client Phone: (907) 742-5213	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 58,158 square feet	**Design Heating Load:** Design Loss at Space: 1,413,555 Btu/hour with Distribution Losses: 1,461,914 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 2,228,527 Btu/hour Note: Additional Capacity should be added for DHW load, if served.
Typical Occupancy: 380 people	**Design Indoor Temperature:** 68 deg F (building average)
Actual City: Anchorage	**Design Outdoor Temperature:** -18 deg F
Weather/Fuel City: Anchorage	**Heating Degree Days:** 10,816 deg F-days
Utility Information	
Electric Utility: Anchorage ML&P - Commercial - Sm	**Natural Gas Provider:** Enstar Natural Gas - Commercial - Sm
Average Annual Cost/kWh: $0.130/kWh	**Average Annual Cost/ccf:** $0.940/ccf

Elementary School

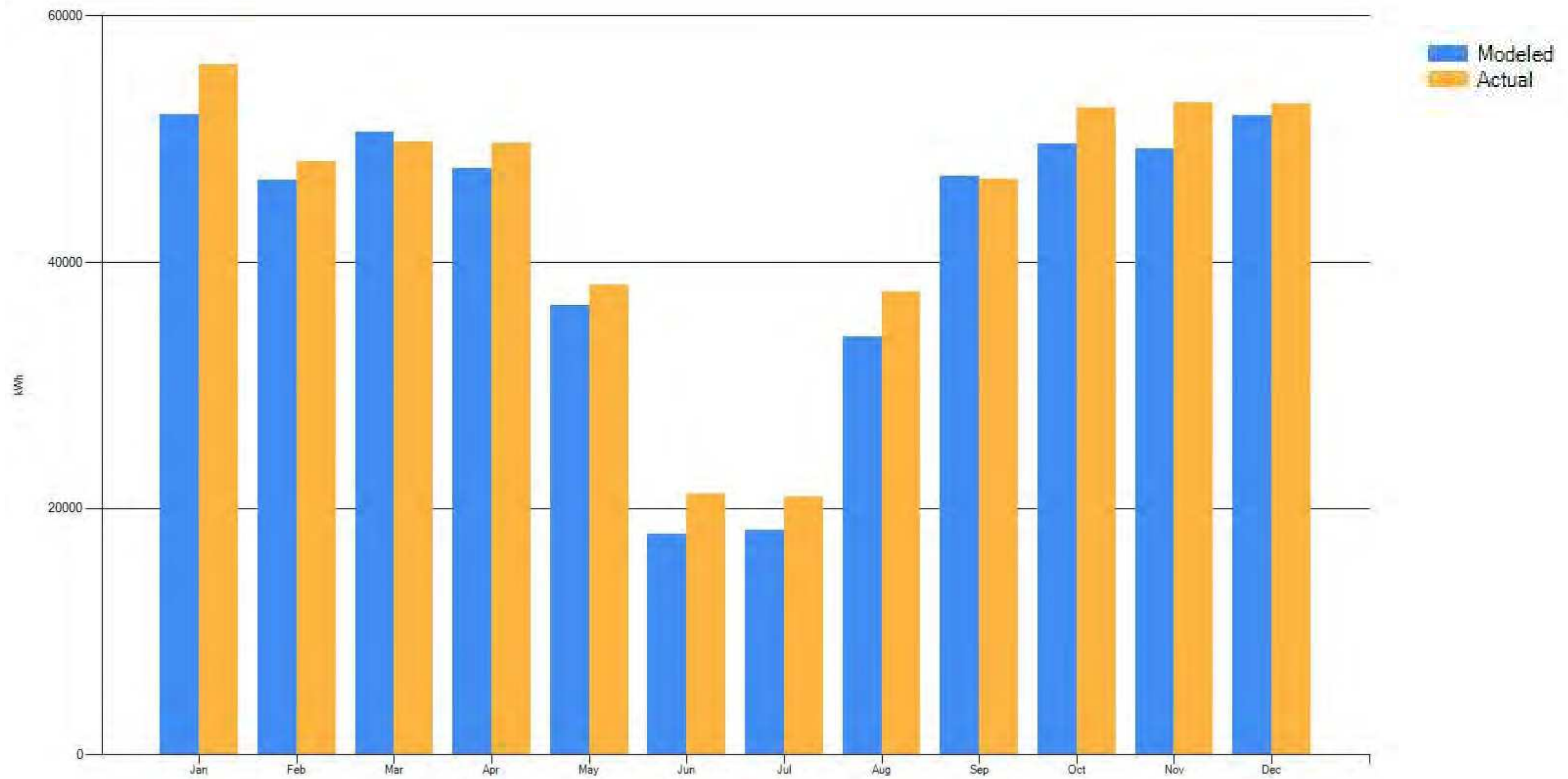
Annual Energy Cost Estimate										
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Lighting**	**Other Electrical**	**Cooking**	**Clothes Drying**	**Vent Fans**	**Service Fees**	**Total Cost**
Existing Building	$55,304	$0	$3,226	$32,056	$4,770	$0	$0	$13,204	$0	**$108,560**
With Proposed Retrofits	$42,104	$0	$3,226	$19,955	$4,770	$0	$0	$13,204	$0	**$83,259**
SAVINGS	$13,200	$0	$0	$12,101	$0	$0	$0	$0	$0	**$25,301**

Elementary School

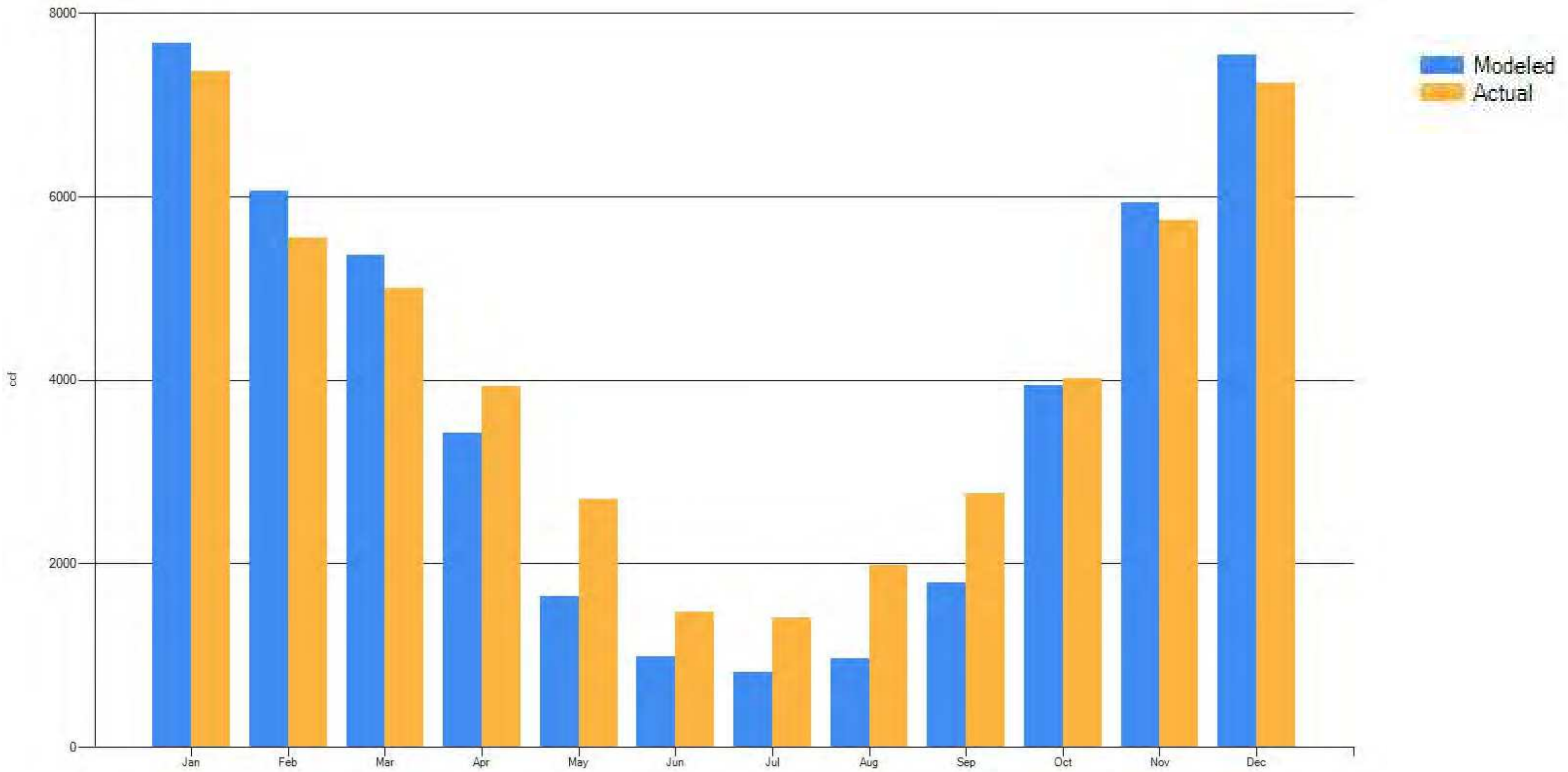




Annual Modeled Consumption (Blue) compared to Actual Electric (Left) and Natural Gas (Right) Consumption (Orange).



Monthly Modeled Consumption (Blue) compared to Actual Electric Consumption (Orange).



Monthly Modeled Consumption (Blue compared to Actual Natural Gas Consumption (Orange).

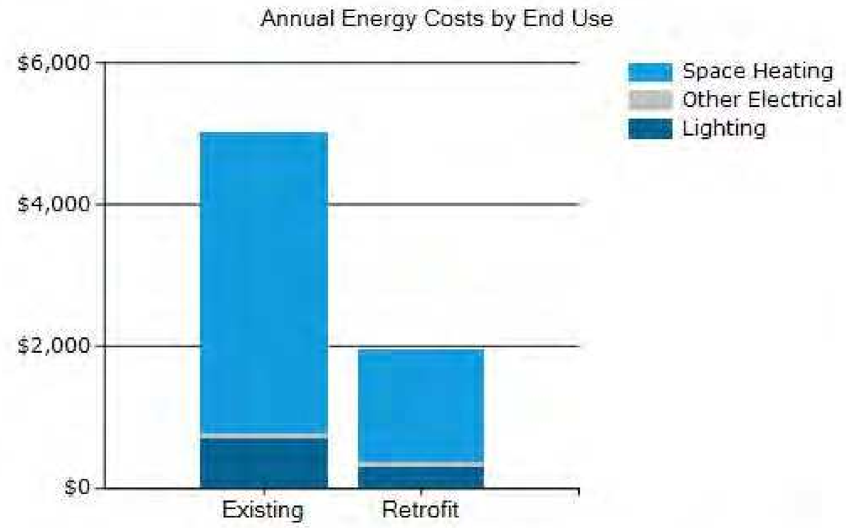
Portable Buildings

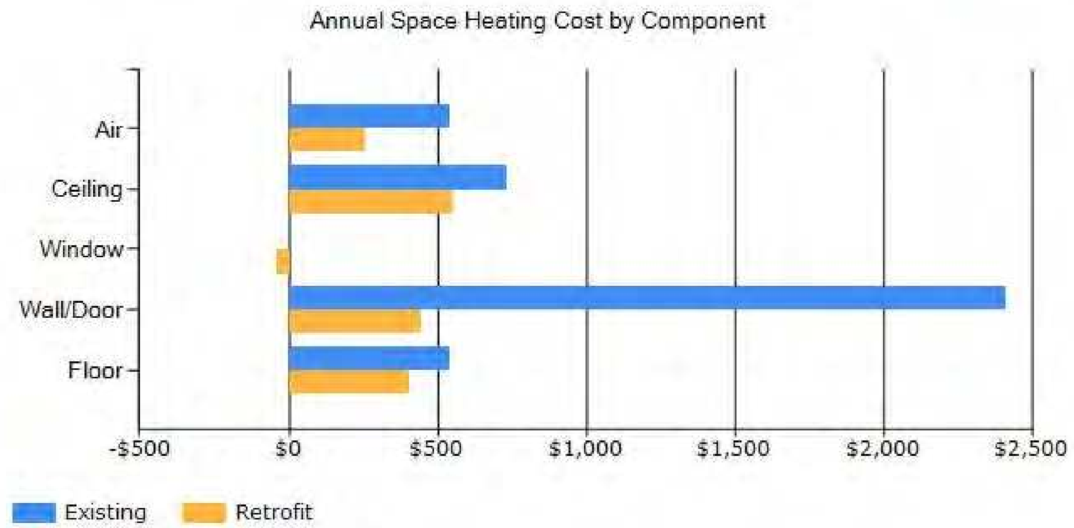
ENERGY AUDIT REPORT – PROJECT SUMMARY – Created 2/16/2012 10:32 AM	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Mountain View ES - Portable Building	**Auditor Company:** Coffman Engineers, Inc.
Address: 4005 Mcphee Ave	**Auditor Name:** Walter Heins, PE, CCP, CxA, CEA
City: Anchorage **Client Name:** Calvin Mundt	**Auditor Address:** 800 F Street Anchorage, AK 99501 Anchorage, AK 99501
Client Address:	**Auditor Phone:** (907) 276-6664 **Auditor FAX:** (907) 276-5042
Client Phone: (907) 742-5213 **Client FAX:**	**Auditor Comment:**
Design Data	
Building Area: 960 square feet	**Design Heating Load:** Design Loss at Space: 27,972 Btu/hour with Distribution Losses: 27,972 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 42,641 Btu/hour Note: Additional Capacity should be added for DHW load, if served.
Typical Occupancy: 10 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Anchorage	**Design Outdoor Temperature:** -18 deg F
Weather/Fuel City: Anchorage	**Heating Degree Days:** 10,816 deg F-days
Utility Information	
Electric Utility: Anchorage ML&P - Commercial - Sm	**Natural Gas Provider:** Enstar Natural Gas - Commercial - Sm
Average Annual Cost/kWh: $0.130/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Portable Buildings

Annual Energy Cost Estimate											
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Lighting**	**Refrigeration**	**Other Electrical**	**Cooking**	**Clothes Drying**	**Ventilation Fans**	**Service Fees**	**Total Cost**
Existing Building	$4,240	$0	$0	$726	$0	$65	$0	$0	$0	$0	**$5,031**
With Proposed Retrofits	$1,621	$0	$0	$305	$0	$65	$0	$0	$0	$0	**$1,990**
SAVINGS	$2,619	$0	$0	$421	$0	$0	$0	$0	$0	$0	**$3,041**

Portable Buildings





Appendix C
Major Equipment List

MAJOR EQUIPMENT INVENTORY										
TAG	LOCATION	FUNCTION	MAKE	MODEL	TYPE	CAPACITY	EFFICIENCY	MOTOR SIZE	ASHRAE SERVICE LIFE (YEARS)	ESTIMATED REMAINING USEFUL LIFE (YEARS)
B-1	BOILER RM	BUILDING HEATING	WEIL-MCLAIN	1388	CAST IRON GAS FIRED	2840 MBH	≈ 80%		30	≈ 17
B-2	BOILER RM	BUILDING HEATING	WEIL-MCLAIN	1388	CAST IRON GAS FIRED	2840 MBH	≈ 80%		30	≈ 17
B-3	MECH RM	BUILDING HEATING	BURNHAM	PF-505	CAST IRON GAS FIRED	966 MBH	≈ 81%		30	≈ 2
B-4	MECH RM	BUILDING HEATING	BURNHAM	PF-505	CAST IRON GAS FIRED	966 MBH	≈ 81%		30	≈ 2
WH-1	BOILER RM	DOMESTIC HOT WATER	AO SMITH	BTP-140-540	GAS	140 GAL	≈ 75%		15	≈ 2
WH-2	MECH RM	DOMESTIC HOT WATER	AO SMITH	BT-100	GAS	100 GAL	≈ 80%		15	0
P-1	BOILER RM	HEATING WATER CIRC	ARMSTRONG	4380	INLINE	190GPM 23'	≈ 84%	2HP	10	0
P-2	BOILER RM	HEATING WATER CIRC	ARMSTRONG	4380	INLINE	190GPM 23'	≈ 84%	2HP	10	0
P-3A	BOILER RM	HEATING WATER CIRC	ARMSTRONG	4030	BASE MOUNTED	223GPM 54'	≈ 86%	5HP	20	7
P-3B	BOILER RM	HEATING WATER CIRC	ARMSTRONG	4030	BASE MOUNTED	223GPM 54'	≈ 86%	5HP	20	7
P-4A	BOILER RM	HEATING GLYCOL CIRC	ARMSTRONG	4030	BASE MOUNTED	175GPM 58'	≈ 86%	5HP	20	7
P-4B	BOILER RM	HEATING GLYCOL CIRC	ARMSTRONG	4030	BASE MOUNTED	175GPM 58'	≈ 86%	5HP	20	7
P-5	BOILER RM	BOILER RECIRC	ARMSTRONG		INLINE	10GPM 10’	≈ 86%	1/6HP	10	0
P-6	BOILER RM	BOILER RECIRC	ARMSTRONG		INLINE	10GPM 10’	≈ 86%	1/6HP	10	0

MAJOR EQUIPMENT INVENTORY										
TAG	LOCATION	FUNCTION	MAKE	MODEL	TYPE	CAPACITY	EFFICIENCY	MOTOR SIZE	ASHRAE SERVICE LIFE (YEARS)	ESTIMATED REMAINING USEFUL LIFE (YEARS)
P-7	BOILER RM	HEATING WATER CIRC	ARMSTRONG	4380	INLINE	100GPM 12’	≈ 86%	1/2HP	10	0
P-8	BOILER RM	HEATING WATER CIRC	ARMSTRONG		INLINE	100GPM 12’	≈ 86%	3/4HP	10	0
PMP-1	MECH RM	HEATING GLYCOL CIRC	BELL & GOSSETT		INLINE	50GPM 26’	≈ 85%	3/4HP	10	0
PMP-2	MECH RM	HEATING GLYCOL CIRC	BELL & GOSSETT		INLINE	50GPM 26’	≈ 85%	3/4HP	10	0
PMP-3	MECH RM	HEATING COIL AHU-1	BELL & GOSSETT		INLINE	14.2GPM 9’	≈ 85%	1/6HP	10	0
PMP-4	MECH RM	HEATING COIL AHU-2	BELL & GOSSETT		INLINE	15GPM 8.5’	≈ 85%	1/6HP	10	0
PMP-5	MECH RM	DOMESTIC HOT WATER RECIRC	GRUNDFOS	UPS-15-425T	INLINE	5GPM 7.9’	≈ 85%	1/12HP	10	0
P-10	BOILER RM	DOMESTIC HOT WATER RECIRC	GRUNDFOS	UP-25-64SF	INLINE	5GPM	≈ 85%	85W	10	0
F-1	BOILER RM	COMBUSTION AIR	GREENHECK	BCF-208-7	CENTRIFUGAL	1880CFM 0.75"		3/4HP	25	12
RF-1	ROOF	RELIEF AIR	ACME	PV365M	CENTRIFUGAL	11200CFM 0.5"		3HP w/VFD	25	19
RF-2	ROOF	RELIEF AIR	ACME	PV365L	CENTRIFUGAL	8000CFM 0.5"		2HP w/VFD	25	19

MAJOR EQUIPMENT INVENTORY										
TAG	LOCATION	FUNCTION	MAKE	MODEL	TYPE	CAPACITY	EFFICIENCY	MOTOR SIZE	ASHRAE SERVICE LIFE (YEARS)	ESTIMATED REMAINING USEFUL LIFE (YEARS)
RF-1A	MECH RM	RETURN AIR	TWIN CITY FAN & BLOWER CO		PROPELLER	4500CFM 0.6"		2HP	15	0
VF-1	FAN RM	SUPPLY AIR	COOL	GN-862	CENTRIFUGAL	800CFM 0.6"		240W	25	19
EF-1	RESTROOM	GIRLS RESTROOM EXHAUST	CARNES	VEDB-06-825	PROPELLER	450CFM 0.25"		1/12HP	15	0
EF-2	RESTROOM	BOYS RESTROOM EXHAUST	CARNES	VEDB-06-825	PROPELLER	450CFM 0.25"		1/12HP	15	0
EF-3	RESTROOM	TOILET EXHAUST	CARNES	VEDB-06-825	PROPELLER	130CFM 0.25"		1/20HP	15	0
EF-4	ROOF	MECH RM EXHAUST	CARNES	VEBA-20	PROPELLER	3600CFM 0.5"		1HP	15	0
EF-4A	MPR FAN RM	MPR EXHAUST	ABCO	222	PROPELLER	4200CFM		1HP	15	0
EF-5	ROOF	MECH RM EXHAUST	CARNES	VEBA-20	PROPELLER	3600CFM 0.5"		1HP	15	0
EF-6	RESTROOM	TOILET EXHAUST	CARNES	VEDB-6-825	PROPELLER	130CFM 0.25"		1/20HP	15	0
AHU-1 (2005)	FAN RM	NW CLASSROOMS	HAAKON	5W0602A	AIR HANDLER	4000CFM 1.5"		3HP	25	19
AHU-2 (2005)	FAN RM	SW CLASSROOMS	HAAKON	5WH0901A	AIR HANDLER	7200CFM 1.5"		5HP	25	19
AHU-7 (2005)	FAN RM	SE CLASSROOMS	HAAKON	5WQ0801A	AIR HANDLER	4800CFM 1.5"		3HP	25	19

MAJOR EQUIPMENT INVENTORY										
TAG	LOCATION	FUNCTION	MAKE	MODEL	TYPE	CAPACITY	EFFICIENCY	MOTOR SIZE	ASHRAE SERVICE LIFE (YEARS)	ESTIMATED REMAINING USEFUL LIFE (YEARS)
AHU-8 (2005)	FAN RM	NE CLASSROOMS	HAAKON	5WQ0602A	AIR HANDLER	3600CFM 1.5”		3HP	25	19
AHU-1 (1983)	MECH RM	CLASSROOMS	TRANE	CLIMATE CHANGER 17B	AIR HANDLER	8260CFM 2.5”		7.5HP	25	0
AHU-2 (1983)	MECH RM	GYM	TRANE	CLIMATE CHANGER 8A	AIR HANDLER	4500CFM 1.75”		3HP	25	0
AHU-5 (1956)	FAN RM	MPR	ABCO	215	AIR HANDLER	5500CFM 0.87”		2HP	25	0
AHU	FAN RM	LIBRARY	-	-	AIR HANDLER			≈5HP	25	0

Appendix D
Energy Conservation Measures
Mountain View Elementary School

PRIORITY LIST – RECOMMENDED ENERGY EFFICIENCY MEASURES

Rank	Feature	Recommendation	Annual Energy Savings	Installed Cost	SIR	Payback (Years)
1	Setback Thermostat: Classroom / Office	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Classroom / Office space.	$4,042	$462	112.97	0.1
2	Setback Thermostat: Gymnasium / Multipurpose	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Gymnasium / Multipurpose space.	$237	$94	32.50	0.4
3	Lighting: Library	Add new Occupancy Sensor	$475	$450	15.44	0.9
4	Lighting: Classroom	Add new Occupancy Sensor	$43	$46	13.58	1.1
5	Lighting: Exterior	Improve Manual Switching	$411	$600	10.02	1.5
6	Lighting: Classroom	Add new Occupancy Sensor	$1,770	$2,904	8.90	1.6
7	Lighting: Classroom	Add new Occupancy Sensor	$587	$1,056	8.13	1.8
8	Lighting: Classroom	Add new Occupancy Sensor	$157	$333	6.91	2.1
9	Lighting: Exterior	Replace with 3 LED 72W Module StdElectronic	$329	$900	5.35	2.7
10	Lighting: Classroom	Add new Occupancy Sensor	$4	$12	5.13	2.9
11	Lighting: Multi Purpose Room	Replace with 2 FLUOR (2) CFL, Spiral 23 W	$41	$60	4.27	1.4
12	Lighting: Trophy Cases	Add new Occupancy Sensor	$80	$300	3.91	3.7

PRIORITY LIST – RECOMMENDED ENERGY EFFICIENCY MEASURES

Rank	Feature	Recommendation	Annual Energy Savings	Installed Cost	SIR	Payback (Years)
13	Lighting: Corridors	Replace with 53 FLUOR (2) T8 4' F32T8 32W Standard (2) Program StdElectronic	$1,496	$7,850	2.78	5.2
14	Lighting: Offices	Add new Occupancy Sensor	$77	$414	2.70	5.4
15	Lighting: Exterior	Replace with 12 LED 72W Module StdElectronic	$659	$3,600	2.67	5.5
16	Lighting: Exterior	Replace with 5 LED 72W Module StdElectronic	$274	$1,500	2.67	5.5
17	Lighting: Exterior	Replace with 4 LED 72W Module StdElectronic	$220	$1,200	2.67	5.5
18	Lighting: Library	Add new Occupancy Sensor	$80	$450	2.60	5.6
19	Lighting: Exterior	Improve Manual Switching	$144	$900	2.34	6.3
20	Lighting: Student Restrooms	Replace with 16 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$481	$3,300	2.13	6.9
21	Lighting: Offices	Replace with 52 FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic and Add new Occupancy Sensor	$1,227	$9,594	1.87	7.8
22	Lighting: Corridors	Replace with 37 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic	$679	$5,550	1.79	8.2
23	Lighting: Classroom Toilet	Add new Occupancy Sensor	$33	$269	1.79	8.2

PRIORITY LIST – RECOMMENDED ENERGY EFFICIENCY MEASURES						
Rank	Feature	Recommendation	Annual Energy Savings	Installed Cost	SIR	Payback (Years)
24	Lighting: Trophy Cases	Replace with 12 LED 12W Module StdElectronic	$173	$1,800	1.40	10.4
25	Lighting: Classroom Toilet	Add new Occupancy Sensor	$13	$135	1.35	10.8
26	Lighting: Offices	Replace with 36 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$532	$6,642	1.17	12.5
27	Lighting: Corridors	Replace with 15 FLUOR T8 4' F32T8 32W Standard Program StdElectronic	$173	$2,250	1.12	13
28	Lighting: Multi Purpose Room	Replace with 12 FLUOR (6) T5 45.2" F54W/T5 HO Standard (2) StdElectronic and Add new Occupancy Sensor	$711	$9,600	1.08	13.5
29	Lighting: Offices	Replace with FLUOR CFL, Spiral 23 W	$5	$30	1.05	5.9
30	Lighting: Mechanical, Storage, and Custodial	Replace with FLUOR (2) CFL, Spiral 23 W and Add new Occupancy Sensor	$8	$100	1.04	12
31	Air Tightening	Perform air sealing to reduce air leakage by 20%.	$1,744	$15,000	1.03	8.6
32	Lighting: Faculty Toilets	Replace with FLUOR CFL, Spiral 23 W	$4	$30	0.89	7
33	Above-Grade Wall: Orig. Const. Walls	Add R-10 rigid foam to interior or exterior of existing wall; cost does not include siding or wall coverings.	$2,866	$76,786	0.87	26.8

PRIORITY LIST – RECOMMENDED ENERGY EFFICIENCY MEASURES

Rank	Feature	Recommendation	Annual Energy Savings	Installed Cost	SIR	Payback (Years)
34	Above-Grade Wall: New Const. 4 Rm Addition	Add R-10 rigid foam to interior or exterior of existing wall; cost does not include siding or wall coverings.	$1,124	$30,242	0.86	26.9
35	Lighting: Classroom Toilet	Replace with 11 FLUOR CFL, Spiral 23 W and Add new Occupancy Sensor	$73	$1,070	0.84	14.6
36	Lighting: Mechanical, Storage, and Custodial	Add new Occupancy Sensor	$4	$70	0.82	17.8
37	Window/Skylight: Orig. Const. - East Windows	Install Lexan magnetic storm window on interior	$24	$536	0.75	22.2
38	Window/Skylight: Orig. Const. - North Windows	Install Lexan magnetic storm window on interior	$35	$774	0.75	22.2
39	Window/Skylight: Orig. Const. - West Windows	Install Lexan magnetic storm window on interior	$18	$410	0.75	22.2
40	Lighting: Classroom Toilet	Replace with 2 FLUOR (2) T8 4' F32T8 32W Standard (2) Program StdElectronic and Add new Occupancy Sensor	$22	$435	0.73	20.1
41	Window/Skylight: Orig. Const. - South Windows	Install Lexan magnetic storm window on interior	$1,006	$25,398	0.66	25.2
42	Lighting: Multi Purpose Room	Add new Occupancy Sensor	$13	$300	0.63	23.3
43	Exterior Door: Orig. Const. - East Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$44	$1,640	0.62	37.4

PRIORITY LIST – RECOMMENDED ENERGY EFFICIENCY MEASURES

Rank	Feature	Recommendation	Annual Energy Savings	Installed Cost	SIR	Payback (Years)
44	Exterior Door: Orig. Const. - South Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$44	$1,640	0.62	37.4
45	Exterior Door: Orig. Const. - West Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$44	$1,640	0.62	37.4
46	Lighting: Exterior	Replace with 2 LED (2) 150W Module (2) StdElectronic	$321	$8,000	0.59	24.9
47	Lighting: Exterior	Replace with 5 LED 150W Module StdElectronic	$401	$10,000	0.59	24.9
48	Exterior Door: New Const. - North Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$9	$410	0.53	44.1
49	Exterior Door: New Const. - East Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$37	$1,640	0.52	44.3
50	Exterior Door: Orig. Const. - North Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$19	$820	0.52	44.3
51	Exterior Door: New Const. - South Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$9	$410	0.53	44.2
52	Exterior Door: New Const. - West Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$9	$410	0.52	44.4

PRIORITY LIST – RECOMMENDED ENERGY EFFICIENCY MEASURES

Rank	Feature	Recommendation	Annual Energy Savings	Installed Cost	SIR	Payback (Years)
53	Lighting: Mechanical, Storage, and Custodial	Replace with 11 FLUOR CFL, Spiral 23 W and Add new Occupancy Sensor	$46	$1,095	0.52	23.8
54	Window/Skylight: New Const. - East Windows	Install Lexan magnetic storm window on interior	$14	$451	0.51	32.5
55	Window/Skylight: New Const. - West Windows	Install Lexan magnetic storm window on interior	$14	$451	0.51	32.5
56	Window/Skylight: New Const. - North Windows	Install Lexan magnetic storm window on interior	$18	$577	0.51	32.5
57	Lighting: Kitchen	Replace with 17 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic	$88	$2,550	0.50	29
58	Lighting: Trophy Cases	Replace with 2 LED 12W Module StdElectronic and Add new Occupancy Sensor	$24	$750	0.47	30.9
59	Lighting: Mechanical, Storage, and Custodial	Replace with 28 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$164	$6,146	0.39	37.6
60	Lighting: Faculty Toilets	Replace with 4 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$31	$1,200	0.38	38.2
61	HVAC And DHW	Replace Boilers B-4 with a high efficiency condensing boiler.	$1,171	$54,130	0.36	46.2

PRIORITY LIST – RECOMMENDED ENERGY EFFICIENCY MEASURES

Rank	Feature	Recommendation	Annual Energy Savings	Installed Cost	SIR	Payback (Years)
62	Lighting: Classroom Toilet	Add new Occupancy Sensor	$15	$672	0.32	45.3
63	Lighting: Mechanical, Storage, and Custodial	Replace with FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic	$3	$150	0.32	46
64	Lighting: Gym Storage	Add new Occupancy Sensor	$4	$225	0.24	60.5
65	Cathedral Ceiling: Flat Roof	Install R-5 rigid board insulation. No cost included for covering insulation.	$622	$82,488	0.18	132.6
66	Above-Grade Wall: Orig. MPR Wall	Add R-10 rigid foam to interior or exterior of existing wall; cost does not include siding or wall coverings.	$49	$8,397	0.14	170.3
67	Lighting: Faculty Toilets	Add new Occupancy Sensor	$1	$150	0.13	112.3
68	Lighting: Gym Storage	Replace with 5 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$7	$975	0.10	141.5
69	Lighting: Mechanical, Storage, and Custodial	Replace with 2 FLUOR (4) T5 45.2" F54W/T5 HO Standard (2) StdElectronic	-$3	$400	-0.12	-119.6
	TOTAL		**$25,301**	**$400,867**	**0.99**	**15.8**

ENERGY AUDIT REPORT – ENERGY EFFICIENT RECOMMENDATIONS

1. Building Envelope

Insulation

Rank	Location	Existing Type/R-Value	Recommendation Type/R-Value	Installed Cost	Annual Energy Savings
33	Above-Grade Wall: Orig. Const. Walls	Wall Type: Single Stud Siding Configuration: Just Siding Insul. Sheathing: None Structural Wall: 2 x 6, 16 inches on center None Window and door headers: Insulated Modeled R-Value: 3.5	Add R-10 rigid foam to interior or exterior of existing wall; cost does not include siding or wall coverings.	$76,786	$2,866
34	Above-Grade Wall: New Const. 4 Rm Addition	Wall Type: Single Stud Siding Configuration: Just Siding Insul. Sheathing: None Structural Wall: 2 x 6, 16 inches on center None Window and door headers: Insulated Modeled R-Value: 3.5	Add R-10 rigid foam to interior or exterior of existing wall; cost does not include siding or wall coverings.	$30,242	$1,124
65	Cathedral Ceiling: Flat Roof	Framing Type: I-Beam (TJI) Framing Spacing: 24 inches Insulated Sheathing: None Bottom Insulation Layer: R-30 Batt:FG or RW, 9.5 inches Top Insulation Layer: None Modeled R-Value: 32.6	Install R-5 rigid board insulation. No cost included for covering insulation.	$82,488	$622
66	Above-Grade Wall: Orig. MPR Wall	Wall Type: Other Wall Construction: 2x6" Metal Stud Wall, R-19, 16" o.c.+ 1"rigid Modeled R-Value: 14.1	Add R-10 rigid foam to interior or exterior of existing wall; cost does not include siding or wall coverings.	$8,397	$49

Exterior Doors – Replacement					
Rank	**Location**	**Size/Type/Condition**	**Recommendation**	**Installed Cost**	**Annual Energy Savings**
43	Exterior Door: Orig. Const. - East Doors	Door Type: Entrance, Metal, fiberglass core, half lite Modeled R-Value: 2.2	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$1,640	$44
44	Exterior Door: Orig. Const. - South Doors	Door Type: Entrance, Metal, fiberglass core, half lite Modeled R-Value: 2.2	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$1,640	$44
45	Exterior Door: Orig. Const. - West Doors	Door Type: Entrance, Metal, fiberglass core, half lite Modeled R-Value: 2.2	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$1,640	$44
48	Exterior Door: New Const. - North Doors	Door Type: Entrance, Metal, polyurethane core, metal edge Modeled R-Value: 2.5	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$410	$9
49	Exterior Door: New Const. - East Doors	Door Type: Entrance, Metal, polyurethane core, metal edge Modeled R-Value: 2.5	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$1,640	$37
50	Exterior Door: Orig. Const. - North Doors	Door Type: Entrance, Metal, polyurethane core, metal edge Modeled R-Value: 2.5	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$820	$19
51	Exterior Door: New Const. - South Doors	Door Type: Entrance, Metal, polyurethane core, metal edge Modeled R-Value: 2.5	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$410	$9
52	Exterior Door: New Const. - West Doors	Door Type: Entrance, Metal, polyurethane core, metal edge Modeled R-Value: 2.5	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$410	$9

Windows and Glass Doors – Replacement					
Rank	**Location**	**Size/Type/Condition**	**Recommendation**	**Installed Cost**	**Annual Energy Savings**
37	Window/Skylight: Orig. Const. - East Windows	Glass: Double, glass Frame: Aluminum, No Thermal Break Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.81 Solar Heat Gain Coefficient including Window Coverings: 0.46	Install Lexan magnetic storm window on interior	$536	$24
38	Window/Skylight: Orig. Const. - North Windows	Glass: Double, glass Frame: Aluminum, No Thermal Break Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.81 Solar Heat Gain Coefficient including Window Coverings: 0.46	Install Lexan magnetic storm window on interior	$774	$35
39	Window/Skylight: Orig. Const. - West Windows	Glass: Double, glass Frame: Aluminum, No Thermal Break Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.81 Solar Heat Gain Coefficient including Window Coverings: 0.46	Install Lexan magnetic storm window on interior	$410	$18

Windows and Glass Doors – Replacement					
Rank	**Location**	**Size/Type/Condition**	**Recommendation**	**Installed Cost**	**Annual Energy Savings**
41	Window/Skylight: Orig. Const. - South Windows	Glass: Double, glass Frame: Aluminum, No Thermal Break Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.81 Solar Heat Gain Coefficient including Window Coverings: 0.46	Install Lexan magnetic storm window on interior	$25,398	$1,006
54	Window/Skylight: New Const. - East Windows	Glass: Double, glass Frame: Aluminum w/ Thermal Break Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.62 Solar Heat Gain Coefficient including Window Coverings: 0.46	Install Lexan magnetic storm window on interior	$451	$14
55	Window/Skylight: New Const. - West Windows	Glass: Double, glass Frame: Aluminum w/ Thermal Break Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.62 Solar Heat Gain Coefficient including Window Coverings: 0.46	Install Lexan magnetic storm window on interior	$451	$14

Windows and Glass Doors – Replacement					
Rank	**Location**	**Size/Type/Condition**	**Recommendation**	**Installed Cost**	**Annual Energy Savings**
56	Window/Skylight: New Const. - North Windows	Glass: Double, glass Frame: Aluminum w/ Thermal Break Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.62 Solar Heat Gain Coefficient including Window Coverings: 0.46	Install Lexan magnetic storm window on interior	$577	$18

Air Leakage					
Rank	**Location**	**Estimated Air Leakage**	**Recommended Air Leakage Target**	**Installed Cost**	**Annual Energy Savings**
31		Air Tightness estimated as: 1.00 cfm/ft2 of above-grade shell area at 75 Pascals	Perform air sealing to reduce air leakage by 20%.	$15,000	$1,744

2. Mechanical Equipment

Mechanical			
Rank	**Recommendation**	**Installed Cost**	**Annual Energy Savings**
61	Replace Boilers B-4 with a high efficiency condensing boiler.	$54,130	$1,171

Setback Thermostat					
Rank	**Location**	**Size/Type/Condition**	**Recommendation**	**Installed Cost**	**Annual Energy Savings**
1	Classroom / Office	Existing Unoccupied Heating Setpoint: 65.0 deg F	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Classroom / Office space.	$462	$4,042
2	Gymnasium / Multipurpose	Existing Unoccupied Heating Setpoint: 65.0 deg F	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Gymnasium / Multipurpose space.	$94	$237

3. Appliances and Lighting					
Lighting Fixtures and Controls					
Rank	**Location**	**Existing**	**Recommended**	**Installed Cost**	**Annual Energy Savings**
3	Library	63 FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching	Add new Occupancy Sensor	$450	$475
4	Classroom	4 FLUOR (3) T12 4' F40T12 40W Standard (2) Magnetic with Manual Switching	Add new Occupancy Sensor	$46	$43
5	Exterior	4 HPS 150 Watt Magnetic with Manual Switching	Improve Manual Switching	$600	$411
6	Classroom	253 FLUOR (4) T8 4' F32T8 32W Standard Program StdElectronic with Manual Switching, Multi-Level Switch	Add new Occupancy Sensor	$2,904	$1,770
7	Classroom	92 FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching	Add new Occupancy Sensor	$1,056	$587

3. Appliances and Lighting					
Lighting Fixtures and Controls					
Rank	**Location**	**Existing**	**Recommended**	**Installed Cost**	**Annual Energy Savings**
8	Classroom	29 FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching, Multi-Level Switch	Add new Occupancy Sensor	$333	$157
9	Exterior	3 HPS 150 Watt Magnetic with Manual Switching	Replace with 3 LED 72W Module StdElectronic	$900	$329
10	Classroom	FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic with Manual Switching	Add new Occupancy Sensor	$12	$4
11	Multi Purpose Room	2 INCAN (2) A Lamp, Std 60W with Manual Switching	Replace with 2 FLUOR (2) CFL, Spiral 23 W	$60	$41
12	Trophy Cases	12 FLUOR T12 4' F40T12 40W Standard Magnetic with Manual Switching	Add new Occupancy Sensor	$300	$80
13	Corridors	53 FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching	Replace with 53 FLUOR (2) T8 4' F32T8 32W Standard (2) Program StdElectronic	$7,850	$1,496
14	Offices	12 FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching	Add new Occupancy Sensor	$414	$77
15	Exterior	12 HPS 150 Watt Magnetic with Manual Switching	Replace with 12 LED 72W Module StdElectronic	$3,600	$659
16	Exterior	5 HPS 150 Watt Magnetic with Manual Switching	Replace with 5 LED 72W Module StdElectronic	$1,500	$274
17	Exterior	4 HPS 150 Watt Magnetic with Manual Switching	Replace with 4 LED 72W Module StdElectronic	$1,200	$220

3. Appliances and Lighting					
Lighting Fixtures and Controls					
Rank	**Location**	**Existing**	**Recommended**	**Installed Cost**	**Annual Energy Savings**
18	Library	18 FLUOR (2) CFL, Plug-in 26W Quad Tube StdElectronic with Manual Switching	Add new Occupancy Sensor	$450	$80
19	Exterior	3 HPS 150 Watt Magnetic with Manual Switching	Improve Manual Switching	$900	$144
20	Student Restrooms	16 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 16 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$3,300	$481
21	Offices	52 FLUOR (3) T12 4' F40T12 40W Standard (2) Magnetic with Manual Switching	Replace with 52 FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic and Add new Occupancy Sensor	$9,594	$1,227
22	Corridors	37 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 37 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic	$5,550	$679
23	Classroom Toilet	4 FLUOR (4) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching	Add new Occupancy Sensor	$269	$33
24	Trophy Cases	12 FLUOR T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 12 LED 12W Module StdElectronic	$1,800	$173
25	Classroom Toilet	2 FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching	Add new Occupancy Sensor	$135	$13

3. Appliances and Lighting					
Lighting Fixtures and Controls					
Rank	**Location**	**Existing**	**Recommended**	**Installed Cost**	**Annual Energy Savings**
26	Offices	36 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 36 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$6,642	$532
27	Corridors	15 FLUOR T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 15 FLUOR T8 4' F32T8 32W Standard Program StdElectronic	$2,250	$173
28	Multi Purpose Room	12 MH 400 Watt Magnetic with Manual Switching	Replace with 12 FLUOR (6) T5 45.2" F54W/T5 HO Standard (2) StdElectronic and Add new Occupancy Sensor	$9,600	$711
29	Offices	INCAN A Lamp, Std 60W with Manual Switching	Replace with FLUOR CFL, Spiral 23 W	$30	$5
30	Mechanical, Storage, and Custodial	INCAN (2) A Lamp, Std 60W with Manual Switching	Replace with FLUOR (2) CFL, Spiral 23 W and Add new Occupancy Sensor	$100	$8
32	Faculty Toilets	INCAN A Lamp, Std 60W with Manual Switching	Replace with FLUOR CFL, Spiral 23 W	$30	$4
35	Classroom Toilet	11 INCAN A Lamp, Std 60W with Manual Switching	Replace with 11 FLUOR CFL, Spiral 23 W and Add new Occupancy Sensor	$1,070	$73
36	Mechanical, Storage, and Custodial	FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching	Add new Occupancy Sensor	$70	$4
40	Classroom Toilet	2 FLUOR (2) T12 4' F40T12 40W Standard (2) Magnetic with Manual Switching	Replace with 2 FLUOR (2) T8 4' F32T8 32W Standard (2) Program StdElectronic and Add new Occupancy Sensor	$435	$22

3. Appliances and Lighting					
Lighting Fixtures and Controls					
Rank	**Location**	**Existing**	**Recommended**	**Installed Cost**	**Annual Energy Savings**
42	Multi Purpose Room	2 INCAN (2) A Lamp, Std 60W with Manual Switching	Add new Occupancy Sensor	$300	$13
46	Exterior	2 HPS (2) 400 Watt (2) Magnetic with Manual Switching	Replace with 2 LED (2) 150W Module (2) StdElectronic	$8,000	$321
47	Exterior	5 HPS 400 Watt Magnetic with Manual Switching	Replace with 5 LED 150W Module StdElectronic	$10,000	$401
53	Mechanical, Storage, and Custodial	11 INCAN A Lamp, Std 60W with Manual Switching	Replace with 11 FLUOR CFL, Spiral 23 W and Add new Occupancy Sensor	$1,095	$46
57	Kitchen	17 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 17 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic	$2,550	$88
58	Trophy Cases	2 FLUOR T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 2 LED 12W Module StdElectronic and Add new Occupancy Sensor	$750	$24
59	Mechanical, Storage, and Custodial	28 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 28 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$6,146	$164
60	Faculty Toilets	4 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 4 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$1,200	$31
62	Classroom Toilet	10 FLUOR Circline 8.25" FC8T9 22W StdElectronic with Manual Switching	Add new Occupancy Sensor	$672	$15

3. Appliances and Lighting					
Lighting Fixtures and Controls					
Rank	**Location**	**Existing**	**Recommended**	**Installed Cost**	**Annual Energy Savings**
63	Mechanical, Storage, and Custodial	FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic	$150	$3
64	Gym Storage	4 FLUOR (3) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching	Add new Occupancy Sensor	$225	$4
67	Faculty Toilets	INCAN A Lamp, Std 60W with Manual Switching	Add new Occupancy Sensor	$150	$1
68	Gym Storage	5 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching	Replace with 5 FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor	$975	$7
69	Mechanical, Storage, and Custodial	2 FLUOR (2) T12 8' F96T12/HO 110W Standard Magnetic with Manual Switching	Replace with 2 FLUOR (4) T5 45.2" F54W/T5 HO Standard (2) StdElectronic	$400	-$3

Appendix E
Energy Conservation Measures
Mountain View Portable Building

PRIORITY LIST – RECOMMENDED ENERGY EFFICIENCY MEASURES						
Rank	Feature	Recommendation	Annual Energy Savings	Installed Cost	SIR	Payback (Years)
1	Setback Thermostat: Portable Building	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Portable Building space.	$1,138	$1,000	13.97	0.9
2	Below- (part or all) Grade Wall: Portable Building Skirting	Install R-15 rigid foam board to interior or exterior side of wall. Does not include cost of coverings.	$782	$1,624	9.97	2.1
3	Lighting: Portable lighting	Replace with FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor and Improve Manual Switching	$74	$300	3.80	4.1
4	Lighting: Portable Lighting	Replace with 12 FLUOR (4) T8 4' F32T8 32W Standard (2) Program StdElectronic and Add new Occupancy Sensor	$347	$1,950	2.74	5.6
5	Exterior Door: Portable Building - Doors	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$90	$781	2.38	8.7
6	Air Tightening	Perform air sealing to reduce air leakage by 30%.	$112	$980	1.00	8.7
7	Above-Grade Wall: Portable Building - 2x4 Stud Wall	Install R-20 rigid foam board to exterior and cover with T1-11 siding or equivalent.	$475	$11,597	0.85	24.4
8	Window/Skylight: Portable Building - Double Pane Windows	Replace existing window with U-0.35 wood window	$21	$1,635	0.20	76.1
	TOTAL		**$3,041**	**$19,867**	**2.5**	**6.5**

ENERGY AUDIT REPORT – ENERGY EFFICIENT RECOMMENDATIONS

2. Building Envelope

Insulation

Rank	Location	Existing Type/R-Value	Recommendation Type/R-Value	Installed Cost	Annual Energy Savings
2	Below- (part or all) Grade Wall: Portable Building Skirting	Wall Type: All Weather Wood Insul. Sheathing: None Framed Wall: 2 x 4, 16" on center None Modeled R-Value: 3	Install R-15 rigid foam board to interior or exterior side of wall. Does not include cost of coverings.	$1,624	$782
7	Above-Grade Wall: Portable Building - 2x4 Stud Wall	Wall Type: Single Stud Siding Configuration: Just Siding Insul. Sheathing: None Structural Wall: 2 x 4, 16 inches on center R-13 Batt:FG or RW, 3.5 inches Window and door headers: Not Insulated Modeled R-Value: 11.4	Install R-20 rigid foam board to exterior and cover with T1-11 siding or equivalent.	$11,597	$475

Exterior Doors – Replacement

Rank	Location	Size/Type/Condition	Recommendation	Installed Cost	Annual Energy Savings
5	Exterior Door: Portable Building - Doors	Door Type: Metal - fiberglass or mineral wool Modeled R-Value: 1.7	Remove existing door and install standard pre-hung U-0.16 insulated door, including hardware.	$781	$90

Windows and Glass Doors – Replacement					
Rank	**Location**	**Size/Type/Condition**	**Recommendation**	**Installed Cost**	**Annual Energy Savings**
8	Window/Skylight: Portable Building - Double Pane Windows	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with U-0.35 wood window	$1,635	$21

Air Leakage					
Rank	**Location**	**Estimated Air Leakage**	**Recommended Air Leakage Target**	**Installed Cost**	**Annual Energy Savings**
6		Air Tightness estimated as: 818 cfm at 50 Pascals	Perform air sealing to reduce air leakage by 30%.	$980	$112

2. Mechanical Equipment

Setback Thermostat					
Rank	**Location**	**Size/Type/Condition**	**Recommendation**	**Installed Cost**	**Annual Energy Savings**
1	Portable Building	Existing Unoccupied Heating Setpoint: 70.0 deg F	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Portable Building space.	$1,000	$1,138

3. Appliances and Lighting					
Lighting Fixtures and Controls					
Rank	**Location**	**Existing**	**Recommended**	**Installed Cost**	**Annual Energy Savings**
3	Portable lighting	FLUOR (2) T12 F40T12 40W U-Tube Standard StdElectronic with Manual Switching	Replace with FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic and Add new Occupancy Sensor and Improve Manual Switching	$300	$74
4	Portable Lighting	12 FLUOR (4) T12 4' F40T12 40W Standard (2) Magnetic with Manual Switching	Replace with 12 FLUOR (4) T8 4' F32T8 32W Standard (2) Program StdElectronic and Add new Occupancy Sensor	$1,950	$347

Appendix F
Site Survey Photos

	
1. School Main Entrance	2. Boiler Room Access
	
3. Boiler B-4 in Mechanical Room	4. AHU-1 in Mechanical Room

	
5. Boiler B-2 in Boiler Room	6. Abandoned-in-place Rooftop AHU
	
7. Heating Water Circulation Pumps P-3A and P-3B in Boiler Room	8. Domestic Hot Water Heater, WH-1, in Boiler Room

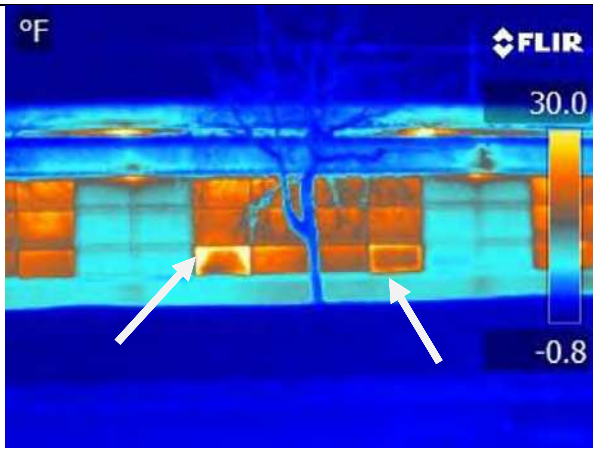
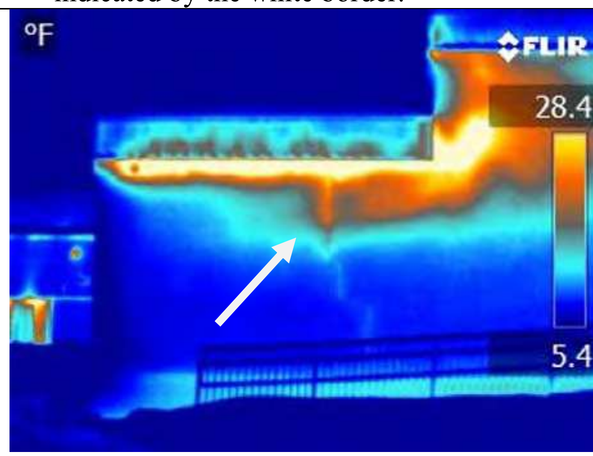
	
9. Lighting in the Multipurpose Room	10. Roof Mounted Exhaust Fan, typical
	
11. Portable building – South Face	12. Weather stripping on exterior door

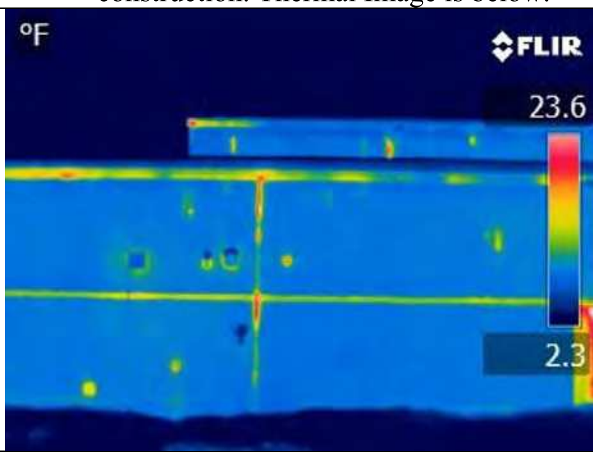
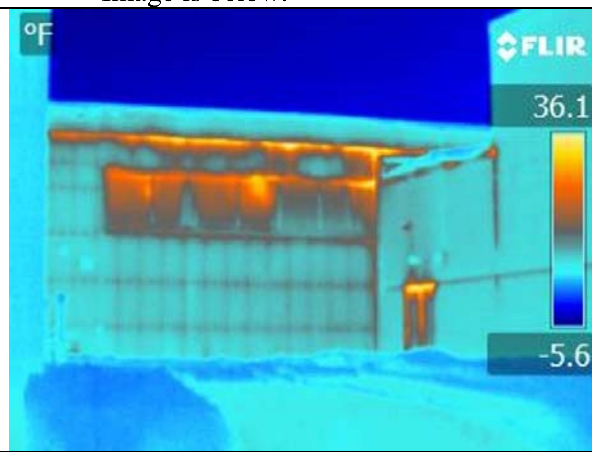
Appendix G
Thermographic Photos

Coffman Engineers made miscellaneous thermographic images of Mountain View Elementary School using a FLIR T300 Infrared Camera. This is not a thermographic study, rather photographs to illustrate easy-to-identify heat losses.

1. Optical Image, Main School Entrance. Thermal Image is below.

2. Thermographic Image, Main Entrance. No unusual heat loss observed. Temperatures indicated by color scale on right. Yellow indicates heat leakage. The outside temperature was about -14°F.

<table>
<tr><td></td><td></td></tr>
<tr><td>3. Optical Image, South Face. Thermal Image below is indicated by the white border.</td><td>4. Optical Image, West face –original construction. Thermal Image below is indicated by the white border.</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>5. Thermographic image, South Face. Heat loss around operable windows can indicate air leakage.</td><td>6. Thermal Image, West face. Heat loss is observed from the roof seam and propagates through a crack in the wall.</td></tr>
</table>

	
7. Optical Image, West Face –new construction. Thermal Image is below.	8. Optical Image, MPR wall. Thermal Image is below.
	
9. Thermal Image, West face – new construction. Heat loss is observed through building seams and damage to exterior insulation and finish system.	10. Thermal Image, MPR wall. Heat loss is observed around the door seals, roof seam, and from the former glass brick windows of the MPR.
End of Report	