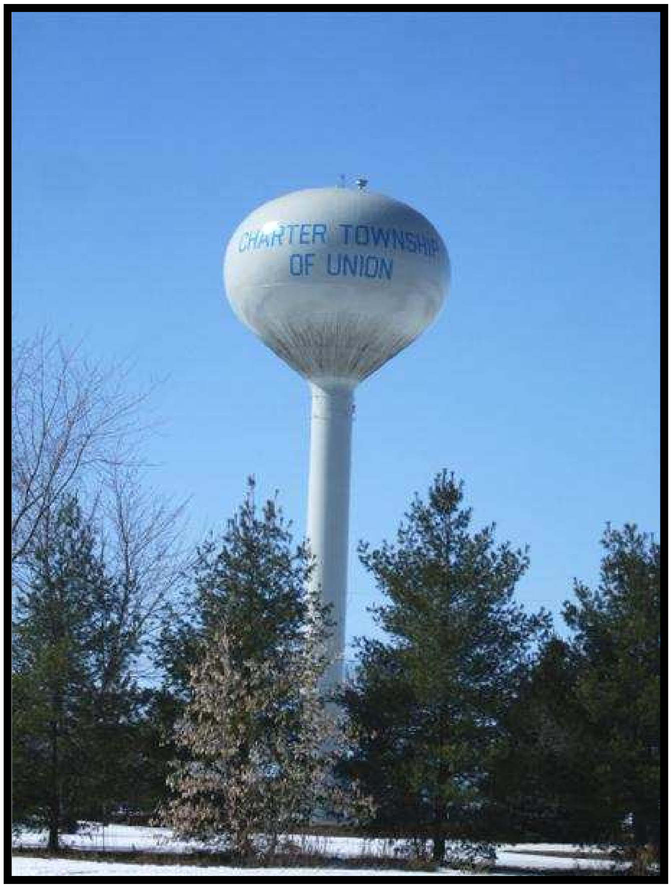
Facility Energy Audit

Union Township Facilities
Charter Township of Union, Michigan



August 31, 2010

GMBae
ARCHITECTURE + ENGINEERING

Facility Energy Audit

Union Township, MI

Client:	Charter Township of Union
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A/E Project Number:	#5-1724
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Table of Contents

Executive Summary 2
Building Locations 3
Overall Building Energy Performance 4
Energy Improvement Summary 5
Technical Analysis of Each Building / Site 11
  Township Hall 12
  Wastewater Treatment Plant 38
  McDonald Park 60
  Jameson Park 75
  Isabella Well (#1 & #2) 97
  Meridian Well (#3 & #4) 108
  Wells #5 & #6 & Shops 120
  Deerfield Lift Station #6 141
  Isabella Lift Station #2 152

For each Building / Site
- Energy Performance Score
- Building Overall Description & Observations
- Building Energy Cost Information
- Behavioral, Operations and Maintenance Improvements (BOMIs)
  - Narrative Descriptions
- Energy Conservation Measures (ECMs)
  - Narrative Descriptions
  - ECM Detailed Description Forms
- Light Fixture Inventory
- Photographs & Thermal Images

Executive Summary

GMB Architecture + Engineering has worked in conjunction with Union Township to perform an energy audit study for twenty buildings owned by the Township at nine different sites. That study has been completed, and this report summarizes the findings and presents recommendations for further action.

The study shows that there are many opportunities to address energy use within the Township facilities. These opportunities have been divided into two categories – low-cost energy improvements and capital energy improvements. This report is intended to serve as a guide for the Township to use in implementing the low-cost, short payback projects and to plan for implementation of the higher cost capital projects.

Union Township spent about $200,000 annually in 2008 and 2009 for end use energy (electricity, natural gas and propane) for all of the locations included in this energy audit combined, the majority of this for electricity. Usage per square foot, however, varies by location with some buildings using significantly more per square foot than others. This is due partly to the differences in building function and partly due to differences in building age and condition. Any reduction in energy use would benefit the Township budget immediately and into the future.

Low-cost improvements recommended in this report include items such as lamp replacement, occupancy sensors, insulation, sealing of air leaks, calibration, and repairs. These items are relatively inexpensive and have relatively short paybacks. It is recommended that all of the low-cost energy improvements be implemented in the near future.

Capital improvements include items such as light fixture replacement, more extensive building insulation improvements, and replacement of equipment with higher efficiency alternatives. These items are higher cost and generally have longer payback periods. It is recommended that these projects be evaluated further by the Township and that capital planning be initiated for implementation of those that are considered to be viable. A total of about $285,000 in potential capital projects have been identified, although not all of these will prove to be feasible.

The following two pages include a list of all the buildings included in the study and a quick summary of the overall energy performance of each of those buildings. The body of the report contains more detailed information for each specific building, including basic building information, observations and discussion on what was seen in each, and identification of potential energy projects. It is intended that the section for each building could be separated from this overall report and still stand alone as a resource for that individual building.

Following the two building/energy summary pages are summary tables showing all the low-cost and capital improvements discussed in this report. These summaries should not be used as the sole resource to budget for and implement these projects. More detailed budgets should be developed as the scope of each project becomes more defined. The body of this report also contains more detailed information on each item listed in the tables.

Union Township is a vibrant and growing community. GMB is proud to be part of this community and desires to assist the Township in continuing to provide quality services and a good environment for life and work. It is hoped that this energy audit will help to accomplish that goal.

Building Locations

This energy audit addressed 20 buildings/structures located at 9 different sites within Union Township. Those buildings/sites are listed below along with an address and mapped location.

A. Township Hall
2010 S Lincoln Road

B. Wastewater Treatment Plant
4511 E River Road
(3 buildings)

C. McDonald Park
1776 E Pickard Road
(4 buildings + picnic shelter)

D. Jameson Park
5142 & 5144 Bud Street
(2 buildings + picnic shelter)

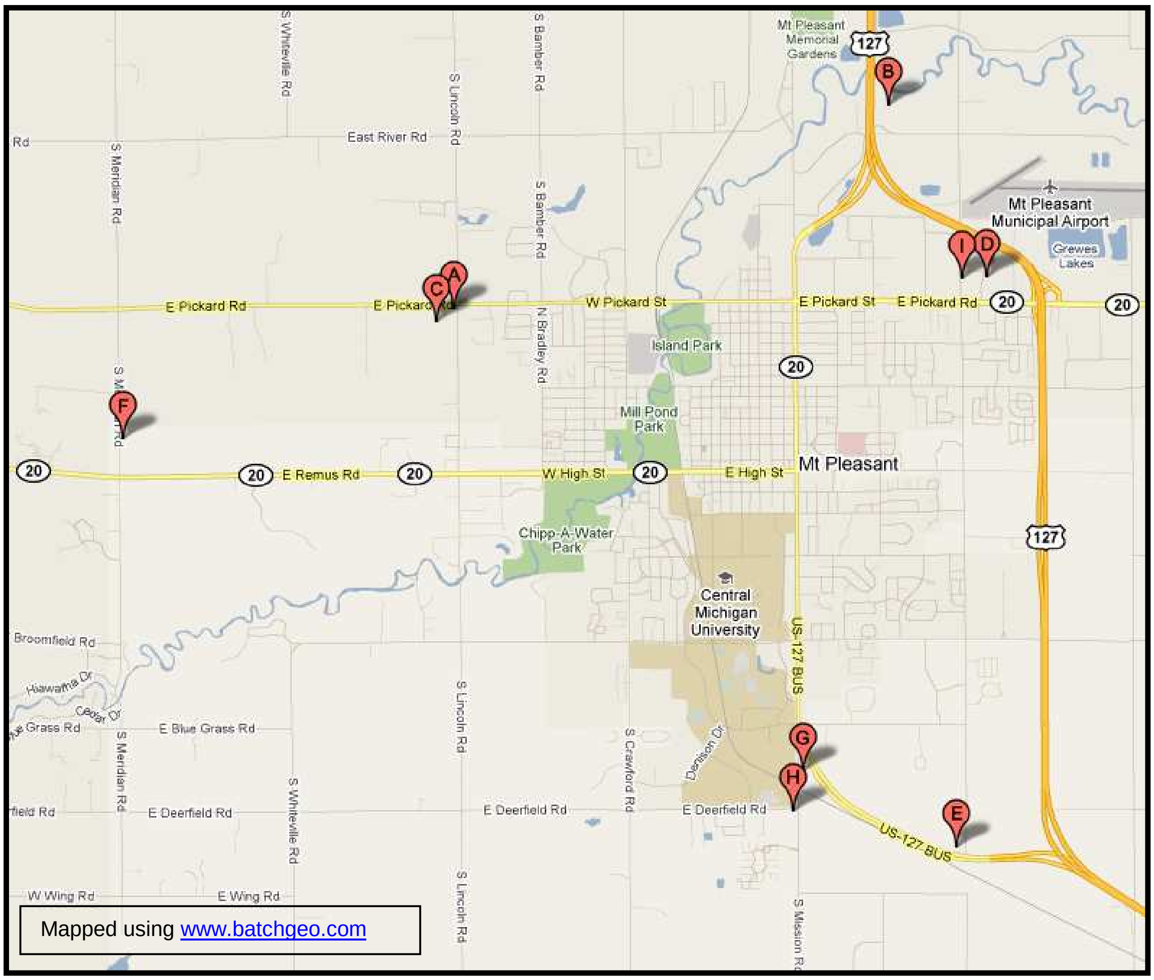
E. Isabella Well (#1 & #2)
5228 S Isabella Road

F. Meridian Well (#3 & #4)
2279 S Meridian Road

G. Wells #5 & #6 & Shops
4795 & 4797 S Mission Road
(4 buildings)

H. Deerfield Lift Station #6
3998 E Deerfield Road

I. Isabella Lift Station #2
1933 S Isabella Road



Overall Building Energy Performance

This report includes a great deal of detailed information about the condition of and the energy used by many different buildings owned by Union Township. The table below summarizes that information into a single, simple table. Each column in the table below presents a different metric to illustrate how each building compares to other Township buildings.

Note that a building that performs well in one metric does not necessarily perform well in the others. This is because each metric uses different performance criteria. The differences between columns reflect the extreme variety in the age, use, and condition of the various buildings.

Union Township – Facility Energy Audit				
Facility	**Energy Code Score**	**EUI** (MBTU/Sq Ft/Yr)	**Energy Costs** ($/Sq Ft/Yr)	**Square Footage**
Township Hall	FAIR	87.3	1.37	7,875
WWTP (3 buildings + process loads)	GOOD	630.2	14.79	6,880
McDonald Park (4 buildings + shelter)	FAIR	5.2	0.20	7,730
Jameson Park (2 buildings + shelter)	FAIR	23.1	0.45	5,319
Isabella Well (#1 & #2) (includes pump power)	FAIR	622.6	13.88	1,152
* Meridian Well (#3 & #4) (includes pump power)	FAIR	679.1	19.33	912
Wells #5 & # 6 & Shops (4 buildings + pump power)	FAIR	167.2	4.20	8,720
Deerfield Lift Station #6 (includes pump power)	FAIR	425.1	10.30	528
Isabella Lift Station #2 (includes pump power)	FAIR	405.1	9.54	792
* No natural gas usage data was recorded for Meridian Well				

Energy Code Score – Each building was assigned a score to gauge how well the building and its systems meet the requirements of the energy code. The score is based largely on the requirements of ASHRAE Standard 90.1-2004, but also uses subjective criteria from field observations in each building. More detailed information on the scoring criteria is found in the sections for each individual building.

In general terms, the Energy Code Score indicates the following:

- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

Energy Utilization Index – The Energy Utilization Index (EUI) is a measure of the total amount of energy consumed in a building in units of thousand Btu's per gross square foot per year. EUI values for each building can be compared from year to year to see whether the building's energy use is changing. Note that the WWTP, wells and lift stations all have fairly high EUIs relative to the other buildings. This is because the process electrical loads (pumps, etc.) are included in this figure.

Energy Costs – The average total cost per square foot is shown for natural gas, electricity and propane for the last 2 years. Note that the WWTP, wells and lift stations all have fairly high Energy Costs relative to the other buildings. This is because the process electrical loads (pumps, etc.) are included in this figure.

Square Footage – Building areas are shown to provide an idea of how much impact each building has on the Township's total energy use.

Energy Improvement Summary

The following pages provide a tabular summary of all the Behavioral, Operations and Maintenance Improvements (BOMIs) and Energy Conservation Measures (ECMs) that are presented in this report.

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

All BOMIs are summarized in the following tables. Some additional explanation for each BOMI is included in the detailed narrative for each building.

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

All ECMs are summarized in the following tables. Additional explanations for each ECM are included in the detailed narrative for each building, and more detail on the estimated costs and savings are presented in the Detailed Description Forms for each ECM. It is not expected that Union Township will implement all the ECMs shown. Some ECMs are shown with relatively long paybacks and are not economically feasible. The information is included in this report with the hope that it will stimulate thoughts on other related improvements that may be feasible. The long-payback ECMs are also presented, along with detailed cost and savings estimates, so that if the Township finds that operating conditions are different than shown or the Township is able to implement those ECMs at a lower cost than the estimates shown, the resultant savings and simple paybacks can be readily calculated from the information given.

BOMI Summary Form
Union Township
(Page 1)

Township Hall

BOMI Number	System	Proposed BOMI
1	Envelope	Check & Adjust/Repair Roof/Attic Insulation
2	Envelope	Repair Window Air Leakage
3	Mechanical	Repair/Replace Exterior Refrigerant Line Insulation
4	Controls	Ensure Electric Fintube Shutoff at Night
5	Lighting	Verify Flagpole Light Controls, Modify If Needed
6	Lighting	Replace Incandescent Lamps
7	Lighting	Replace or Retrofit Incandescent Exit Lights

Waste Water Treatment Plant

BOMI Number	System	Proposed BOMI
1	Envelope	Control Building – Repair Window Air Leakage
2	Controls	Control Building – Verify Thermostat Operation
3	Mechanical	Control Building – Rebalance Air Distribution
4	Controls	Control Building – Verify Furnace System Economizer Operation
5	Mechanical	Control Building – Install Combustion Air Damper (Water Heater)
6	Plumbing	Control Building – Repair Backflow Preventer
7	Controls	Control Building – Adjust Time Clock
8	Lighting Controls	Control Building – Install Occupancy Sensors
9	Controls	Headworks Building – Verify & Adjust Room Temperature Settings
10	Mechanical	Solids Building – Repair Discharge Damper
11	Controls	Solids Building – Verify & Adjust Room Temperature Settings
12	Controls	Solids Building – Reduce Domestic Water System Temperature

McDonald Park

BOMI Number	System	Proposed BOMI
1	Controls	Concessions & Restrooms – Install Timer on Water Heaters
2	Lighting	All Buildings – Replace Incandescent Lamps
3	Lighting	All Buildings – Replace or Retrofit T12 Fixtures
4	Lighting Controls	All Buildings – Install Occupancy Sensors
5	Lighting Controls	Picnic Shelter – Install Lighting Controls

Jameson Park

BOMI Number	System	Proposed BOMI
1	Controls	Community Center – Replace Thermostats
2	Controls	Community Center – Install Timer on Water Heater
3	Lighting	Community Center – Replace or Retrofit Incandescent Exit Lights
4	Controls	Restrooms – Install Timer on Water Heater
5	Lighting	Restrooms – Replace Incandescent Lamps
6	Lighting	Picnic Shelter – Replace Incandescent Lamps
7	Lighting Controls	Picnic Shelter – Install Lighting Controls

BOMI Summary Form
Union Township
(Page 2)

Isabella Well (#1 & #2)

BOMI Number	System	Proposed BOMI
1	Envelope	Add Sweeps to Back Door
2	Mechanical	Replace Unit Heater
3	Controls	Verify & Adjust Room Temperature Settings
4	Lighting	Replace or Retrofit T12 Fixtures
5	Lighting Controls	Install Occupancy Sensors

Meridian Well (#3 & #4)

BOMI Number	System	Proposed BOMI
1	Envelope	Repair Door Seals & Sweeps
2	Mechanical	Replace Unit Heater
3	Mechanical	Repair Damper on Intake Louver
4	Controls	Verify & Adjust Room Temperature Settings
5	Controls	Install Timer on Water Heater
6	Lighting	Replace or Retrofit T12 Fixtures
7	Lighting Controls	Install Occupancy Sensors

Wells #5 & #6 & Shops

BOMI Number	System	Proposed BOMI
1	Envelope	Office/Shop – Verify Roof Insulation, Add as Needed
2	Envelope	Office/Shop – Repair Wall Insulation
3	Envelope	Office/Shop – Repair Overhead Door Seals
4	Mechanical	Office/Shop – Replace Unit Heater
5	Controls	Office/Shop – Install Timer on Water Heater
6	Lighting	Office/Shop – Replace Incandescent Lamps
7	Controls	Office/Shop – Add Controls to Ventilation Fan
8	Envelope	Well Building – Verify Roof Insulation, Add as Needed
9	Mechanical	Well Building – Replace Unit Heater
10	Controls	Well Building – Verify & Adjust Room Temperature Settings
11	Mechanical	Well Building – Repair Fan Shutoff Damper
12	Controls	Well Building – Install Timer on Water Heater
13	Envelope	Garage – Seal Air Leakage, Man Door
14	Envelope	Garage – Repair Overhead Door Seals
15	Mechanical	Garage – Replace Unit Heater
16	Controls	Garage – Verify & Adjust Room Temperature Settings
17	Lighting Controls	Garage – Install Occupancy Sensors
18	Lighting	Pole Barn – Replace Incandescent Lamps

BOMI Summary Form
Union Township
(Page 3)

Deerfield Lift Station #6

BOMI Number	System	Proposed BOMI
1	Envelope	Install Door Seals & Sweeps (Man Door)
2	Envelope	Install Door Seals (Overhead Door)
3	Mechanical	Replace Unit Heater
4	Mechanical	Repair Damper on Intake Louver
5	Lighting	Replace Incandescent Lamps
6	Lighting Controls	Install Occupancy Sensors

Isabella Lift Station #2

BOMI Number	System	Proposed BOMI
1	Envelope	Seal Air Infiltration
2	Envelope	Install Door Seals & Sweeps (Man Door)
3	Envelope	Install Door Seals (Overhead Door)
4	Mechanical	Replace Unit Heater
5	Mechanical	Repair Damper on Intake Louver
6	Lighting	Replace Incandescent Lamps
7	Lighting	Replace or Retrofit T12 Fixtures
8	Lighting Controls	Install Occupancy Sensors

ECM Summary Form
Union Township
(Page 1)

Township Hall

ECM Number	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
1	Replace Main Entry Door & Lites	3,890	70	55.6
2	Add Vestibule at Main Entrance	8,000	94	85.1
3	Improve Wall Insulation	20,700	1,164	17.8
4	Replace Boiler	1,600	719	2.2
5	Replace Condensing Units	2,500	388	6.4
6	Install Geothermal Heating & Cooling System	76,920	1,945	39.6
7	Replace Domestic Water Heater	300	181	1.7
8	Replace or Retrofit T12 Fixtures	14,550	2,675	5.4
9	Install Occupancy Sensors	4,500	1,369	3.3
8 & 9	Combined – T12 Fixtures & Occupancy Sensors	19,050	3,133	6.1
	Total (using combined 8 & 9)	132,960	7,694	17.3

Waste Water Treatment Plant

ECM Number	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
1 Control Building	Replace Furnace	3,000	204	14.7
2 Control Building	Replace Condensing Unit	1,667	81	20.6
3 Control Building	Recover Energy From Wastewater	22,567	1,083	20.8
4 Headworks Building	Improve Wall Insulation	1,350	101	13.4
5 Headworks Building	Eliminate Water Heater	4,000	39	103
	Total	32,584	1,508	21.6

McDonald Park

ECM Number	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
1	Insulate Walls & Ceiling (Restroom Service Closet)	3,000	96	31.3

Jameson Park

ECM Number	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
1 Community Center	Improve Wall Insulation	23,300	312	74.7
2 Community Center	Add Roof Insulation	1,600	183	8.7
3 Community Center	Replace or Retrofit T12 Fixtures	3,450	57	60.5
4 Community Center	Install Occupancy Sensors	1,350	100	13.5
3 & 4	Combined – T12 Fixtures & Occupancy Sensors	4,800	117	41.0
5 Restrooms	Replace or Retrofit T12 Fixtures	600	24	24.5
6 Restrooms	Install Occupancy Sensors	600	22	27.8
5 & 6	Combined – T12 Fixtures & Occupancy Sensors	1,200	38	31.6
	Total (using combined 3 & 4 and 5 & 6)	30,900	650	47.5

ECM Summary Form
Union Township
(page 2)

Isabella Well (#1 & #2)

ECM Number	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
1	Improve Wall Insulation	22.050	2,358	9.4

Meridian Well (#3 & #4)

ECM Number	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
1	Improve Wall Insulation	19,500	581	33.6

Wells #5 & #6 & Shops

ECM Number	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
1 Office/Shop	Replace or Retrofit T12 Fixtures	2,700	430	6.3
2 Office/Shop	Install Occupancy Sensors	1,050	267	3.9
1 & 2	Combined – T12 Fixtures & Occupancy Sensors	3,750	522	6.8
3 Well Building	Improve Wall Insulation	19,125	572	33.4
4 Well Building	Replace or Retrofit T12 Fixtures	1,050	72	14.6
5 Garage	Replace Overhead Doors	5,280	190	27.8
	Total (using combined 2 & 3)	29,205	1,356	21.5

Deerfield Lift Station #6

ECM Number	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
1	Improve Wall Insulation	6,300	347	18.2

Isabella Lift Station #2

ECM Number	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
1	Improve Wall Insulation	7,600	420	18.1
	Total			

Total – All Buildings / Sites Combined

Number of ECMs	Proposed Energy Conservation Measure/ECM Name	Cost to Install ($)	Cost Savings ($)	Simple Payback (years)
30	All	284,099	15,010	18.9

Not all ECMs can be implemented, some are mutually exclusive (i.e. if you implement one you cannot implement another)
Savings for multiple ECMs are not additive, implementing some ECMs will affect the savings of other ECMs

Costs, savings and simple payback calculations depend on the assumptions made in the calculations for each ECM. Care should be taken to validate this data to the extent possible before proceeding with implementation of any individual item.

- Costs are opinions of probable construction cost based on estimating guides and practical knowledge of the construction industry.
- Savings are calculated based on the broad assumptions listed in the Detailed Description Form for each ECM.
- Simple Payback is the ratio of costs to savings.

Technical Analysis of Each Building / Site

The following sections of this report comprise a technical analysis of each of the Township buildings. The technical analysis for each building includes detailed information on the building itself, it's mechanical and electrical systems, energy use, current condition and potential for energy improvements. At the end of each section are specific recommendations for potential energy improvements within the building.

The section for each building includes the following parts:

- The Overall Energy Performance Score provides a visual overview of the energy performance of the building and it's systems
- The Utility Overview provides two years of electrical and natural gas or propane data, along with totals and statistical data to summarize the use of these utilities in the building
- The Building Description provides general information on the building structure, it's systems and current operation
- Observations and Discussion describes specific items identified during the audit that directly impact energy usage in the building. Many of these are related to the condition of the building and potential repairs or other corrective action. Some of them indicate an item that may require further investigation.
- A full list of Potential Energy Improvements is provided for each building, broken down into low-cost improvements and capital improvements

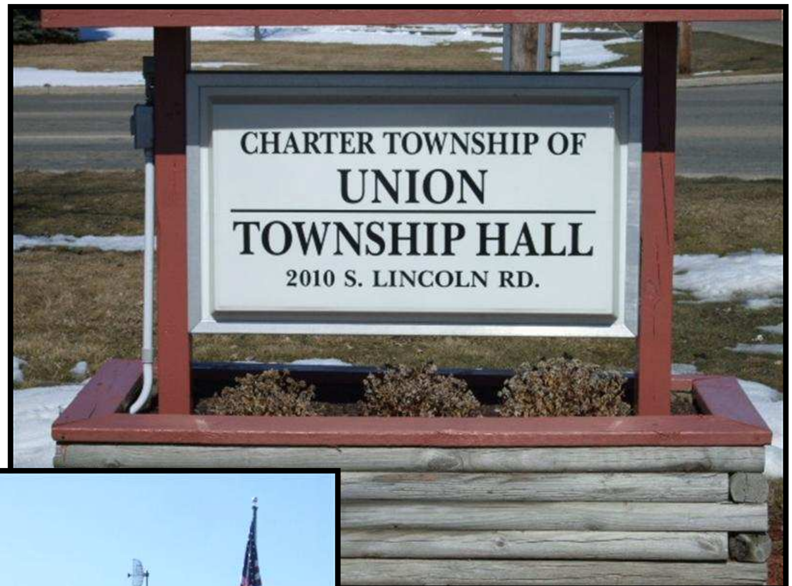
All of the information presented and discussed is organized into six fundamental categories: the building envelope, mechanical systems, plumbing systems, electrical systems, plug loads and occupancy/operations/ schedule. The envelope includes the roof, walls, windows and doors. The primary mechanical systems include heating, cooling, and controls. The primary plumbing systems include domestic hot water and plumbing fixtures. Electrical systems include lighting, lighting controls and power. Plug loads include loose equipment that is plugged into building receptacles. Occupancy/operations/schedule includes the functional aspects of how the building is operated, including scheduling and maintenance and repairs.

The Technical Analyses of these individual buildings represent the largest part of this report. Together, the information presented for these twenty buildings is an integral part of the Township-wide energy audit. These sections include the most in-depth information about each building, and they are the basis for the potential energy improvements and recommendations that follow.

The Technical Analysis for each individual building was also written, however, with the intent that the section for each building can be separated from the overall report as a working resource for that building. Management and staff can use the section written for their specific building to gain a better understanding of the current status of the building and the energy-saving opportunities specific to them. In this way, the building occupants can be closely involved in the improvements within their own building.

Township Hall

Union Township, MI



2010 S Lincoln Road

Date of Construction: Unknown, last addition 1996

Current Size: 7,875 Square Feet

Energy Performance Score

The table below is a simple metric to illustrate how well this building utilizes energy. The scores are based largely on the building performance requirements of the Michigan Energy Code, ASHRAE Standard 90.1, but also on subjective criteria from the field observations in each building.

The scoring is as follows:

- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

The following Building Overall Description and Observations section of this report provides additional insight into the factors that were used to determine these scores.

Energy Performance	
Township Hall	
Description	**Score**
Envelope	
Roof	Fair
Walls	Poor
Windows	Fair
Infiltration	Poor
Mechanical	
Heating System	Fair
Cooling System	Good
Domestic Hot Water	Poor
Insulation	Good
Controls	Fair
Electrical	
Lighting	Poor
Lighting Controls	Poor
OVERALL CONDITION	**FAIR**

The performance of this energy audit included a field assessment of the building. This section of the report discusses some of conditions that were observed. This is not intended to be a comprehensive discussion of all building deficiencies. However the items discussed represent the conditions found and the general condition of the building. Many of the potential energy improvements that are presented in this report are based on the discussions below.

This building is primarily used as office space for township staff and as a place for public meetings. The facility also provides space for communications equipment and storage. The main floor includes 12 individual offices and an additional work station space, a large meeting room, smaller conference room, a small kitchen and some toileting and storage rooms. The basement includes a large open room used for storage and multiple smaller rooms used for storage and mechanical equipment.

The original building was relatively small, but two subsequent additions have increased the size and functionality. The dates of construction for the original building and the first addition are unknown, but they were reportedly built in the 1940s or 1950s. The last addition, which comprises the majority of the building square footage, was constructed in 1996. In general the building appears to be maintained in good condition.

The photographs included in this report illustrate some aspects of the building construction.

General Information

- Size:
  - Total 7,875 square feet
  - 19xx Original – 2,240 square feet
  - 19xx Addition – 896 square feet
  - 1996 Addition – 4,739 square feet (3,056 sf on the main floor, 1,683 sf basement)
- Single story with a partial basement
- Schedule
  - The building is used weekdays year round with the exception of holidays
  - Hours of operation for the office areas are generally 8:30 am – 4:30 pm Monday through Friday
  - Evening meetings are held frequently, at least one night a week

The Building Envelope provides the first defense against energy use. The envelope includes the roof, walls, windows and doors. Typical problems include areas that are not insulated well and areas of air leakage (infiltration).

- Roof/Attic
  - Sloped roof with gable ends and some dormers, asphalt shingles
  - All areas of the building have batt insulation installed at the bottom of the roof trusses. Insulation thickness appears to vary throughout the building
    - Original building – R-13 and R-19
    - First addition – R-38
    - Second addition – primarily R-19, some R-30 was observed. Some blown in insulation was also observed
    - The truss space above the batt insulation is unheated attic
  - The insulation barrier has been compromised in numerous areas. In some instances batts were removed to allow access for maintenance purposes and not replaced. In other areas the batts are no longer secured well to the truss framing and portions have dropped below the trusses. In a few areas batts are missing for no apparent reason.
    - Batts moved for access in Conference Room, not replaced
    - Batts dropped below trusses in south corridor, and the north corridor over the Lunch/Kitchen room
    - Batts moved for technology wiring in the closet off the original men's toilet room

        ▪ Other miscellaneous gaps in the roof/ceiling insulation barrier throughout the building

- Walls
    - The exterior is primarily brick with T-111 wood siding on the gable ends. A recessed panel of some type is installed in lieu of the brick under windows on the east façade.
    - The walls of the original building and the first addition are concrete block with brick veneer. Insulation values are unknown, but the walls are believed to contain no insulation.
    - The walls of the second building addition are stud and drywall. Drawings for the second addition show wood studs with 6" batt insulation and 1" rigid insulation sheathing.
    - Basement exterior walls are poured concrete or block. Areas below grade include exterior rigid insulation. It is unclear from the drawings whether or not there is any insulation in/on the basement walls above grade (most of the basement walls).
- Windows
    - Primarily double-pane insulated glass except for some single pane glass at the main entrance. The east façade has operable Pella windows with wood frames. Other exposures are operable Anderson windows with vinyl frames.
    - Staff report that the window openings allow significant air drafts into the building. It is not known whether the air enters through the windows themselves or between the window frames and the walls.
    - Caulking around the window exteriors has deteriorated in some areas, leading to a gap between the window frame and the brick. This may be the cause for some of the reported air drafts. Gaps were observed on three windows on the west façade, there may be more gaps on other windows.
    - The dormer above the main entry/lobby has large window areas. The lobby was originally intended to be a high ceiling space with clerestory windows to develop a spacious feeling with natural light. The clerestory concept was abandoned part way through construction, but the dormer and windows were already installed and were left in place. The dormer is now part of the unheated attic. The thermal pictures did not show unusually high heat loss from these windows.
- Doors
    - The building has four doors – the main entrance, and three exit doors. All are hollow metal door and frame construction.
    - The main entrance door includes a large pane of glass in the door and window lites on either side of the door. Glass in the door and the lites is single pane.
    - The exit door in the Meeting Room also contains glass but no side lites. The other two exit doors on the west side of the building do not have windows in them.
    - All doors have seals and sweeps that appear to be in reasonably good condition.

Mechanical systems are important because they consume a significant portion of a building's energy. The primary mechanical systems include heating, cooling, and ventilating systems and controls. Typical problems include poor insulation, equipment or systems that do not function as intended and equipment with low energy efficiency.

- Heating
    - The original building, first addition and the south portion of the second addition are heated by a hot water boiler with perimeter fintube heating elements. The balance of the second addition is heated by a gas fired furnace.
    - Fintube is installed wall-to-wall on the exterior wall in most rooms served by the boiler, and also in some interior rooms (toilet rooms, interior office, etc, which at one point in time were exterior walls). There are control valves for two separate heating zones, located in the boiler room.
    - Boiler – Slant Fin 100 Series, model 100-A-180P, 180 MBH natural gas input, 145 MBH output. The boiler appears to be in reasonably good condition, although it is quite old and possibly original to the building construction. It has a standing (continuously burning) pilot light. Boiler combustion efficiency is nominally 81%.
    - Furnace – Lennox Elite Series, model G26-Q4/5-125-2, 125 MBH natural gas input. The manufacturer's listed efficiency is nominally 90-92%. The furnace includes a cooling coil. This furnace was installed with the 1996 addition and appears to be in good condition. Filter conditions were ok.

- Electric fintube units have been installed in the offices located in the second addition (5 offices) because of continuing complaints that those offices are too cold. These are all 1500 watt units with unit-mounted controls.
- Cooling
  - Cooling is provided by three furnaces with remote condensing units. One is a heating and cooling unit, the other two are cooling only.
  - Furnaces
    - All are Lennox Elite Series, installed as part of the 1996 addition.
    - Furnaces include cased cooling coils
  - Remote condensing units
    - (1) Lennox model HS17-813-4Y, paired with a model C23-51/65-1 cased cooling coil mounted in Lennox Elite furnaces, serving the second addition. Nominal 5-6 tons cooling capacity, EER unknown, R-22 refrigerant.
    - (2) Lennox model HS29-653-2Y, paired with model CB31MV-65-IP cased cooling coils mounted in a Lennox Elite furnace, serving the original building and first addition. Nominal 5 tons cooling capacity, 9.35 EER, R-22 refrigerant.
  - Insulation on the exterior refrigerant piping has deteriorated in the UV rays from sunlight, insulation is missing in some spots.
  - Where ductwork was observed it was insulated

Plumbing Systems consume both energy and water. The primary plumbing systems include the domestic water heater and plumbing fixtures and piping. Typical problems include poor insulation, equipment or systems that do not function as intended, equipment with low energy efficiency, and fixtures with excessive water usage.

- Natural gas provider – Consumers Energy, meter #5087420
- Domestic water heater
  - Lochinvar Red Line, model E68, 50 MBH natural gas input, 50 gallons
  - Heater is quite old, possibly original to the building construction. The heater is functional and does not appear to leak.
  - Standing pilot light (continuously burning)
- Plumbing fixtures
  - 1 electric water cooler – located in the corridor outside the large Meeting Room
  - 5 water closets
    - two are newer (second addition toilet rooms), 1.6 gpf (gallons per flush)
    - thee are older (original toilet rooms), probably greater than 1.6 gpf
  - 2 urinals
    - one is newer (second addition toilet rooms), 1.0 gpf (gallons per flush)
    - one is older (original toilet room), probably greater than 1.0 gpf
  - 6 lavatories
    - two are newer (second addition toilet rooms), with single lever handles
    - four are older (original toilet rooms), with pull-on handles
  - 3 sinks
    - double bowl sink located in the Lunch/Kitchen Room
    - single bowl sink located in the Conference Room
    - service sink located in the closet in the original Men's toilet room

Electrical systems also consume a substantial part of a building's energy. Electrical systems include lighting, lighting controls and power. Typical problems include inadequate lighting control, inappropriate lamp selection and inefficient motors.

- Electric provider – Consumers Energy, meter #34640372
- One 200 amp MB panelboard near the main entry (120/240 volt, single phase), two 200 amp MB panelboards in the basement, 120/208 volt, three phase
- A schedule of light fixtures observed in the building is included in this report. Following is a summary by fixture type.

Township Hall Light Fixture Summary				
Fixture Type	Number of Fixtures	% of Total Number of Fixtures	Total Watts	Total KWH*
CFL	2	2%	36	157
Incandescent	8	7%	480	764
T12 Fluorescent	97	82%	16,840	35,924
Metal Halide	4	3%	836	3,652
Incandescent Exit	6	5%	120	1,048
LED Exit	1	1%	2	17
Total	118		18,314	41,563
* Assumed operating schedule as shown in the Light Fixture Inventory in this report				

- Lighting in the building is provided primarily by T12 fluorescent fixtures. We understand that the Township has received a grant to replace these fixtures and that plans are underway to install T8 fixtures.
- There are a few incandescent fixtures in the building
- Exit lights are incandescent except for one LED fixture in the basement
- Exterior building-mounted lights are controlled by photo-eyes
- The flagpole is lit using metal halide fixtures with a time clock
- All interior light fixtures are controlled by manual wall switches. No occupancy sensors were observed.
- Toilet room exhaust fans are controlled by light switches in the associated rooms

Plug Loads are defined as equipment in the building that is connected to power receptacles, i.e. no permanent electrical connection. Plug load equipment can consume a significant amount of electricity over the course of time. Typical plug load issues include inefficient equipment, equipment that is not turned off when not in use, and inappropriate use of equipment (e.g. electric heaters under desks).

- Multiple network servers, located in Storage room in the SW corner off the Conference Room
- Computers – Generally one located in each private office, plus additional units located in the Conference and Meeting rooms. A total of seventeen computers were observed.
- Desktop printers – four were observed
- Floor standing copiers – two were observed
- A large format printer is located in the Conference Room
- A projector is located in the Meeting Room
- An electric space heater was observed in one of the offices
- Dehumidifiers are located in the basement and the main lobby
- A mini-fridge is located in the Conference Room
- The Lunch/Kitchen room includes a residential refrigerator and stove, two microwaves, a coffee maker, and a television

<u>Occupancy / Operations / Schedule</u> – How a building is used can have a significant impact on the building's energy usage. In fact attitudes and actions of the building users and operational staff can sometimes be the biggest factor in energy waste. It is critical that building occupants are provided with information on how to minimize energy use, the proper tools to do so, and an educational process to continually remind them how to most effectively use the building.

- Schedule
  - The building is used weekdays year round with the exception of holidays
  - Hours of operation for the office areas are generally 8:30 am – 4:30 pm Monday through Friday
  - Evening meetings are held frequently, at least one night a week
- The Conference Room is used as a work space for CAD functions
- Heating in the Meeting Room is turned down only on weekends. Staff reports that if the temperature is turned down at night, the system cannot bring the room back up to the occupied temperature the next day.

Township Hall

Building Energy Cost Information – Electrical & Natural Gas

Electricity Usage

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	3,340	7.99	375	383
February	3,310	8.00	378	386
March	3,190	8.00	362	370
April	3,290	8.00	372	380
May	2,480	8.00	291	299
June	3,670	8.00	414	422
July	5,090	13.11	584	597
August	6,330	15.00	725	740
September	3,770	15.00	416	431
October	3,230	15.00	325	340
November	3,680	15.00	376	391
December	3,240	15.00	319	334
2008	**44,620**	**136**	**4,937**	**5,073**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	5,620	15.00	618	633
February	3,290	15.00	360	375
March	3,680	15.00	393	408
April	3,510	15.00	369	384
May	3,700	15.00	386	401
June	3,880	20.38	465	486
July	15,400	20.38	1,851	1,871
August	0	27.38	0	27
September	1,420	27.38	158	186
October	5,160	27.38	575	603
November	4,110	27.38	458	486
December	5,000	34.38	511	545
2009	**54,770**	**260**	**6,146**	**6,406**

Total	**99,390**	**396**	**11,083**	**11,479**
Some meter readings may be estimated				

Electricity and Gas Totals	
Square Footage	7,875
Average Annual Cost	10,827
Cost/SF/Year	1.37
EUI (MBtu/SF/Year)	87.3

Electricity Totals	
Average KWH/Year	49,695
Average MMBtu/Year	170
Average Cost/KWH	0.115
Cost/KWH w/o Fixed	0.112
Average Cost/MMBtu	33.84
Cost/SF/Year	0.73
EUI (MBtu/SF/Year)	21.5

Natural Gas Totals	
Average CCF/Year	5,031
Average MMBtu/Year	518
Average Cost/CCF	1.011
Cost/CCF w/o Fixed	0.973
Average Cost/MMBtu	9.82
Cost/SF/Year	0.65
EUI (MBtu/SF/Year)	65.8

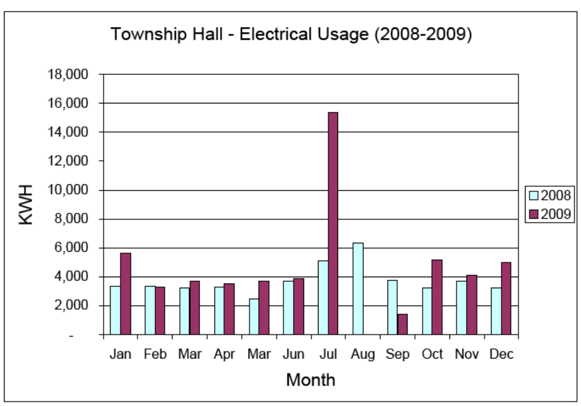
Notes
103,000 Btu/CCF
3,413 Btu/KWH
Aug-09 thru Nov-09 costs are interpolated from other data. KWH & CCF are correct from bills for this period.

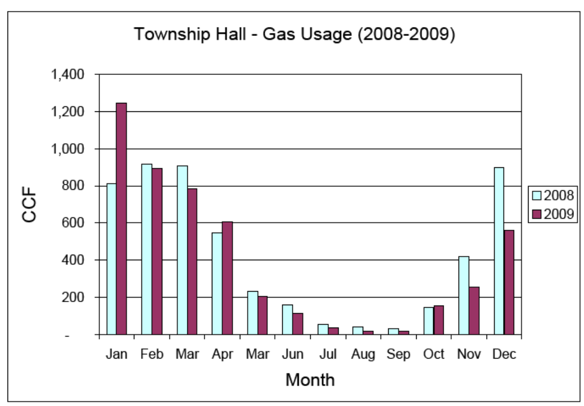
Natural Gas Usage

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	812	16.00	760	776
February	915	16.00	857	873
March	909	16.00	852	868
April	547	16.00	582	598
May	233	16.00	247	263
June	157	16.00	171	187
July	56	16.00	63	79
August	42	16.00	48	64
September	29	16.00	30	46
October	146	16.00	144	160
November	419	16.00	413	429
December	900	16.00	886	902
2008	**5,165**	**192**	**5,052**	**5,244**

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	1,246	16.00	1,233	1,249
February	896	16.00	888	904
March	784	16.00	777	793
April	609	16.00	551	567
May	203	16.00	182	198
June	112	16.00	104	120
July	36	16.00	33	49
August	20	16.00	19	35
September	20	16.00	19	35
October	154	16.00	150	166
November	255	16.00	248	264
December	561	16.00	534	550
2009	**4,896**	**192**	**4,740**	**4,932**

Total	**10,061**	**384**	**9,792**	**10,176**
Some meter readings may be estimates				





Behavioral, Operations and Maintenance Improvements (BOMIs) Narrative Descriptions

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

1. ***Check & Adjust/Repair Roof/Attic Insulation*** – Check all roof/attic insulation, and redistribute and/or secure as necessary to obtain a well insulated lid on the building. Insulation is installed at the bottom of the roof trusses, in some cases quite close to the lay-in ceiling. Loose or unsecured sections, gaps, and missing insulation were found in a number of areas. Insulation replacement may be required in some areas.
2. ***Repair Window Air Leakage*** – During the field review air drafts were not observed coming through the windows themselves (i.e. between glass units or through the frame). It is likely that the cold drafts that are reported are due to the details of the window installation methods, allowing air to pass between the windows and the frames. Three different methods are available to attempt to resolve this issue, with increasing levels of difficulty but also increasing chances of success.
    - Caulk the window exteriors, between the frame and the brick wall. Several of the windows on the west exposure have obvious gaps in the caulking, but all the windows should be checked and caulked as needed. This may eliminate some of the air infiltration problems.
    - Drill small holes through the frames and insert expandable foam insulation between the window frames and the brick/block – on the top, bottom and sides of each window. This should resolve much of the infiltration problems if they are caused by the lack of proper blocking and sealant around the window openings. This solution should be tried on one or two windows to gauge the effectiveness of the solution before proceeding with all window openings.
    - Remove the windows, attempt to determine the cause of the air infiltration, and reinstall using proper blocking and sealant. Unless the windows themselves are found to be deficient, this solution should resolve the infiltration issues.
3. ***Repair/Replace Exterior Refrigerant Line Insulation*** – Replace insulation on the refrigerant lines where the existing insulation is missing or damaged. This was observed to occur primarily on exterior lines.
4. ***Ensure Electric Fintube Shutoff at Night*** – Take steps to ensure that the electric fintube heaters that have been installed in some offices are turned off at night. This could be done by reminding the users to do so, by assigning a staff person to check all of them daily, or by some sort of automatic control such as a central time clock.
5. ***Verify Flagpole Light Controls, Modify If Needed*** – Verify the type of control used for the flagpole lights. Add timed and/or daylight control if there is none installed. These may already be controlled by a time clock or photocell, but none was observed
6. ***Replace Incandescent Lamps*** – Replace incandescent lamps with CFL lamps. In general this can be done by simply removing the incandescent lamp and screwing in a new CFL lamp.
7. ***Replace or Retrofit Incandescent Exit Lights*** – Replace incandescent exit signs with LED fixtures, or convert using retrofit kits. Since these lights are on 24 hours a day, this BOMI will significantly reduce their energy use.

Energy Conservations Measures (ECMs)
Narrative Descriptions

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

1. ***Replace Main Entry Door & Lites*** – Replace the main entrance doors and single pane window assemblies around them with a new aluminum frame entrance using insulated doors and double pane insulated glass. Also consider reducing the glass area during the replacement.
2. ***Add Vestibule at Main Entrance*** – Install an enclosed vestibule at the main entry door. This will help control the entry of large volumes of cold (or warm) air when individuals enter or exit the building.
3. ***Improve Wall Insulation –*** Add insulation to the brick exterior walls. Improvements to wall insulation are difficult because an improvement often means adding layers of some material to either the interior or exterior of the walls. This causes both practical and aesthetic issues, including detailing at window and door openings and how to incorporate objects that are in or fastened to the walls. Several insulation options are available including adding exterior rigid insulation and a new layer of brick or block to the exterior; installing an exterior insulation finish system (EIFS) over the existing brick or block; or adding furring with rigid insulation or stud walls with fiberglass insulation (and a layer of drywall) to the interior.

   Costs will also vary considerably depending on the solution chosen and the installation difficulty. A new brick or block veneer with insulation or new EIFS exterior will likely cost on the order of $15-$25/sf. An interior solution may be less expensive, particularly in larger or less finished areas (e.g. the main Meeting Room or the Basement), but durability must be considered vs. the existing block. Estimated savings and paybacks for various scenarios are shown in the table below.

Estimated Energy Savings – Additional Wall Insulation						
Type of Wall	Existing R-value	New R-Value	Energy Savings Btu/sf/yr	Estimated Cost/sf		
				Lo	Med	Hi
No Existing Insulation Block and brick, no insulation, no air gap	About 2.5	12.5	67,200	$10	$15	$25
Minor Existing Insulation E.g. insulation in block cores	About 3.5	13.5	44.450	$10	$15	$25
Savings are based on heating loads only, 7000 heating degree days, 80% boiler efficiency Buildings that are air conditioned will have more energy savings						

   Specific areas what could be addressed are as follows:

   - *Brick Walls - General* – The walls of the original building and the first addition are uninsulated or have minimal insulation only in the block cores, these walls should be considered for improvement. This should also dramatically improve comfort in the building. The walls of the last addition appear to be well insulated already and should not require additional insulation.
   - *Main Meeting Room* – See comments above. It may be easiest to insulate these walls from the inside because the space has relatively large wall areas, not broken up into smaller rooms. An added benefit to insulating these walls would be the ability to turn down the thermostat at night, which is not possible at this time because the room will not warm up during the day.

- *Exposed Basement Walls* – It is not clear from the drawings whether or not the exposed basement walls are insulated. If they are not, insulation should be added. This could be done relatively easily from the inside.
- *Below Windows* – The recessed areas below the windows on the east side could be easily insulated with a rigid board and exterior finish insulation system. This is a relatively simple way to increase insulation values at these locations without detracting from the building looks.

4. ***Replace Boiler*** – Install a new boiler that has a higher combustion efficiency and utilizes spark ignition to light the burner in lieu of the existing unit with a standing pilot light. Elimination of the pilot light will reduce the standby energy use, and the higher efficiency will reduce gas use when the boiler is able to run at lower temperatures.
5. ***Replace Condensing Units*** – Replace the individual condensing units with new, higher efficiency units. Legislation and equipment improvements in the last few years have made newer units considerably more efficient than standard units from just a few years ago. Two of the existing units are older with a relatively low efficiency rating (9.35 EER). The age and efficiency of the third unit is unknown.
6. ***Install Geothermal Heating & Cooling System*** – Install a geothermal system to heat and cool the entire building using thermal energy from the ground. The existing furnaces could be replaced with water-to-air heat pumps that utilize the existing ductwork systems. The primary energy source would be ground coupled boreholes, probably drilled in the adjacent ball field. Additional engineering design and feasibility studies should be undertaken before a final decision is made on this item. Note that the design may require the use of a dedicated outdoor air unit and/or heat recovery to meet the fresh air requirements. Also, if no wall or window improvements are done, it is likely that a perimeter heating system such as the existing finned tube will still be required. Perimeter heat could be provided using a high efficiency boiler, electric fintube, or a water-to-water heat pump.
7. ***Replace Domestic Water Heater*** – Install a new water heater that utilizes spark ignition to light the flame in lieu of the existing unit with a standing pilot light. Elimination of the pilot light will reduce the standby energy use. If this item is implemented, consideration should also be given to the incremental cost and payback of installing a higher efficiency replacement heater. It should be noted that the existing water heater is quite old and may require replacement in the near future regardless of energy concerns.
8. ***Replace or Retrofit T12 Fixtures*** – Replace existing T12 light fixtures with T8 fluorescent fixtures, or retrofit the existing T12 fixtures to utilize T8 lamps. If fixture retrofits are considered, be sure that the replacement ballasts and sockets are suitable to utilize the full energy savings of the T8 lamps.
9. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

ECM Detailed Description Forms

The following pages contain "ECM Detailed Description Forms". A page is dedicated to each ECM, and that ECM is described in detail along with some cost, savings, and payback information.

The costs to implement each ECM are based on industry cost estimating guides and on the A/E's experience with similar projects. Savings are estimated based on the best available information on energy usage and system operation. Costs or savings could vary from the figures shown above depending on market and economic conditions at the time the work is performed and depending on the validity of the assumptions used to generate these estimates. The information presented is valuable for planning purposes, but it is recommended that more detailed budgets or firm quotes be obtained for projects prior to a final decision to implement any improvement.

Based on utility bill data from 2008-2009, the following utility costs were used for the savings and payback analyses for each ECM. These unit costs are the commodity cost only, without the fixed monthly charges.

Electricity	$0.112/KWH
Natural Gas	$0.973 /CCF

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Township Hall

ECM NUMBER: 1

ECM NAME: Replace Main Entry Door & Lites

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing hollow metal door/window assembly, original to the building construction. Door is uninsulated or with minimal insulation value. Windows are single pane glass.
- One door/window assembly, comprising one door leaf (21 sf) and about 38 square feet of window surface
- Assumed existing R-value of about R-3.0 for the door, R-1.0 for the windows, including film coefficients

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Install new door/window assembly, using insulated door and double pane glass. Door may be hollow metal, fiberglass, aluminum, or other material. There are many different types available with differing qualities, aesthetics and insulation values.
- Also consider the potential to reduce glass areas when replacing the unit
- Assume a new R-value of about R-10.0 for the door and R-2.5 for the windows, including film coefficients
- Heating
  - Doors – 21 sf x [(1/3.0) – (1/10.0)] R-value x 7329 DD/year (base 65F) x 24 hr/day = 862 MBtu/year energy savings
  - Windows – 38 sf x [(1/1.0) – (1/2.5)] R-value x 7329 DD/year (base 65F) x 24 hr/day = 4,010 MBtu/year energy savings
  - Total – 4,872 MBtu/year energy savings
  - Assume 70% boiler system efficiency = 6,960 MBtu/year boiler input = 68 CCF = **$66/year savings**
- Cooling
  - Doors – 21 sf x [(1/3.0) – (1/10.0)] R-value x 492 DD/year (base 65F) x 24 hr/day = 58 MBtu/year energy savings
  - Windows – 38 sf x [(1/1.0) – (1/2.5)] R-value x 492 DD/year (base 65F) x 24 hr/day = 269 MBtu/year energy savings
  - Total – 327 MBtu/year = 27 ton-hours/year energy savings
  - Assume 9.5 EER condenser efficiency = 1.26 KWH/ton-hour = 34 KWH/year = **$4/year savings**
- Cost = 1 door leaf x $2,750 + 38 sf windows x $30 = $3,890
- Payback = 55.6 years

Cooling savings includes only conduction losses, not solar gains (direct sunlight though the glass)

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**3,890**
Total Estimated Annual Savings ($)	**70**
Simple Payback (Years)	**55.6**
Estimated Useful Life (Years)	**30**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Township Hall	
ECM NUMBER: 2	
ECM NAME: Add Vestibule at Main Entrance	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- No entry vestibule at the main entry door (or any other exterior doors on the building)
- Unconditioned air can enter the building whenever the front doors are used. More air enters on windy days than calm days. This air adds to the heating and cooling load.
- Assume 14 employees use the door an average of 4 times/workday = 14 employees x 4 uses x 250 days = 14,000 uses/year
- Assume that the door is used by the public 4 times/hour workdays and 20 times for a meeting once a week = 4 uses x 8 hours x 250 days + 20 uses x 52 weeks = 9,040 uses/year
- Total of 23,040 uses/year = 1,920 uses/month
- Assume that half of all door uses occur in calm conditions and allow minimal air entry (assume 50 cubic feet), and half occur in windy conditions and allow more significant air entry (assume 500 cubic feet)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add a vestibule at the main entry, either inside the existing building or on the exterior. Use a configuration that does not allow air to blow directly through both doors (the existing, and the new vestibule door). Install insulated door and double pane glass, same as for ECM #1 above.
- Aiflow / Air volume
  - o Assume that the vestibule cuts air entry by 75%
  - o (23,040 x 50 x ½) + (23,040 x 500 x ½) = 6,336,000 cf/year existing air entry
  - o Reduced by 75%, or 4,752,000 cf/year, equivalent to a continuous airflow of 9.04 cfm over the entire year
- Energy savings – air infiltration reduction
  - o Formula – cfm x 60 min/hour x 0.075 #/cf x 0.24 Btu/#-F x DD (degree days) x 24 hr/day / 1000= MBtu/year
  - o Heating – 7329 HDD – 1,718 MBtu/year energy savings
    Assume 70% heating system efficiency = 2,454 MBtu/year boiler input = 24 CCF = **$23/year savings**
  - o Cooling – 492 CDD – 115 MBtu/year = 9.6 ton-hours/year energy savings
    Assume 1.26 KWH/ton-hour (9.5 EER) = 12 KWH annual savings = **$1/year savings**
- Energy savings – insulated door and glass (see ECM #1 above)
  - o Heating: 4,872 MBtu/year energy savings = 6,960 MBtu/year boiler input = 68 CCF = **$66/year savings**
  - o Cooling: 34 KWH/year energy savings = **$4/year savings**
- Total Energy Savings = **$94/year savings**
- Cost = $8,000
- Payback = 85.1 years

The economic payback is quite long. If the building lobby becomes uncomfortably cold when the door is opened in the winter, it may be worthwhile to implement this ECM primarily for comfort reasons rather than energy savings.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**8,000**
Total Estimated Annual Savings ($)	**94**
Simple Payback (Years)	**85.1**
Estimated Useful Life (Years)	**30**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Township Hall

ECM NUMBER: 3

ECM NAME: Improve Wall Insulation

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- No or minimal insulation in the original building and first addition. The latest addition was designed with insulated walls, except for no apparent insulation at the exposed basement walls.
- First Floor – Block walls with brick veneer, no insulation (or minimal insulation in some block cores)
- Basement – Exposed walls appear to be poured concrete with brick veneer, no insulation
- Assumed existing R-value of about R-2.4, including film coefficients
- About 1,380 square feet of uninsulated wall surface

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation to the walls. Many different options exist, with differing insulation values, costs and aesthetics. Some of the potential options include:
  - Add rigid or spray-on insulation over the existing brick, finish with new brick veneer or EIFS (Exterior Insulation Finish System, such as Dryvit or equivalent)
  - Remove the existing brick, add rigid or spray-on insulation, reinstall the existing brick
  - Install an insulated metal panel system over the existing brick exterior
  - Add furring or stud walls on the interior with insulation between studs/furring strips, finish with drywall interior
- The aesthetics of the finished wall are a critical part of any decision on whether or not to proceed with this ECM or what type of finish to use. Costs will vary depending on the finish and the number of window/door openings and wall mounted items.
- Assume a project that adds 2" of insulation and has a cost of $15/sf
- New R-value of about R-12.4, including film coefficients
- Heating
  - 1,380 sf x [(1/2.4) – (1/12.4)] R-value x 7329 DD/year (base 65F) x 24 hr/day = 81,565 MBtu/year energy savings
  - Assume 70% heating system efficiency = 116,521 MBtu/year boiler input = 1,131 CCF = **$1,100/year savings**
- Cooling
  - 1,380 sf x [(1/2.4) – (1/12.4)] R-value x 492 DD/year (base 65F) x 24 hr/day = 5,475 MBtu/year = 456 ton-hours/year energy savings
  - Assume 9.5 EER condenser efficiency = 1.26 KWH/ton-hour = 575 KWH/year = **$64/year savings**
- Cost = 1,380 sf x $15/sf = $20,700
- Payback = 17.8 years

Cooling savings includes only conduction losses, not solar gains (direct sunlight though the glass)

This project may be implemented over the entire building or in selected sections where implementation may be easier because of the wall configuration. A cost effective exterior solution is critical to the payback.

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**20,700**
Total Estimated Annual Savings ($)	**1,164**
Simple Payback (Years)	**17.8**
Estimated Useful Life (Years)	**30**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Township Hall

ECM NUMBER: 4

ECM NAME: Replace Boiler

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing hot water boiler serving perimeter finned tube in the older sections of the building – 145 MBtu output
- Boiler has a standing pilot light, which uses gas continuously when it is lit
- Manufacturer's cataloged efficiency for this boiler is about 81%. Overall operating efficiency is assumed to be in the range of 70%, plus the year-round use of the pilot light.

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Install a new high efficiency condensing boiler.
- Operate the boiler using outdoor air reset or building demand reset to minimize system temperatures and maximize boiler efficiency. Assume an overall operating efficiency of about 85-90% at actual system temperatures, higher efficiency in milder weather. Additional savings from the elimination of the standing pilot light.
- Existing gas use
  - Existing total building use – 5,030 CCF/year (2008 – 2009)
  - Boiler gas use is estimated to be about 65% of the total gas use = 3,269 CCF/year plus year-round use of the pilot light (estimated at 1,000 Btuh, or 85 CCF/year)
- Annual boiler gas use using 87.5% efficient boiler = 3,269 x (70%/87.5%) = 2,615 CCF/year
- (3,269 – 2,615) + 85 (eliminate pilot light) = 739 CCF/year savings = **$719/year savings**
- Cost = $8,000 for boiler
- Payback = 11.1 years

- If it is assumed that the boiler is already at 80% of its life, then the cost assigned to energy efficiency upgrades is only 20% of replacement cost
- Replacement cost = $8,000
- Cost assigned to energy upgrades = $8,000 x 20% = $1,600
- Payback = 2.2 years

Additional savings will occur from the ability to heat using lower temperature water during mild weather

If this ECM is not implemented, when the boiler requires replacement a high efficiency new unit should be considered. The incremental cost for the higher efficiency will likely provide a good payback in energy savings.

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**1,600**
Total Estimated Annual Savings ($)	**719**
Simple Payback (Years)	**2.2**
Estimated Useful Life (Years)	**20**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Township Hall	
ECM NUMBER: 5	
ECM NAME:	**Replace Condensing Units**

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Three individual air cooled condensing units located on the ground, all appear to have been installed in the 1996 renovation/addition.
- Assumed that the EER for these units is 9-10.
- Two are 5 ton capacity, one is 5-6 ton capacity. Total cooling capacity of all units is assumed to be 15 tons.

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Replace the condensing units with newer units with a higher efficiency rating
- Assume that new units would have an EER of 15 (13 is the current minimum required by law)
- Assume that the units run for approximately 500 equivalent full load hours each summer
- 9.5 EER is 1.26 KW/ton x 15 tons = 18.90 KW load
- 18.90 KW x 500 hours = 9,450 KWH/year existing energy use
- 9,450 KWH x [1 – (9.5 EER / 15 EER)] = 3,465 KWH annual savings = **$388/year savings**
- Cost = 3 units x $2,500/unit = $7,500
- Payback = 19.3 years

- If it is assumed that the units are already at 2/3 of their life, then the cost assigned to energy efficiency upgrades is only 1/3 of the replacement cost
- Replacement cost = 3 units x $2,500/unit = $7,500
- Cost assigned to energy upgrades = $7,500 x 33% = $2,500
- Payback = 6.4 years

If this ECM is not implemented, when the condensing units require replacement high efficiency new units should be considered. The incremental cost for the higher efficiency will likely provide a good payback in energy savings.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**2,500**
Total Estimated Annual Savings ($)	**388**
Simple Payback (Years)	**6.4**
Estimated Useful Life (Years)	**15**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Township Hall	
ECM NUMBER: 6	
ECM NAME: Install Geothermal Heating & Cooling System	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- 15 tons cooling capacity installed (three condensing units serving three furnaces)
- 24 tons heating capacity installed (145 MBtu boiler, 112.5 MBtu furnace, 25 MBtu electric wall heaters)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Replace furnaces with water-to-air heat pumps to provide heating and cooling from all three units. Since the existing ductwork was installed for a cooling system, it is assumed that it is adequately sized and balanced to provide the necessary heat to each space.
- Replace boiler with water-to-water heat pump. Heating loop supply temperature will be lower than the existing boiler provides, but some heating will be provided by the newly heating-equipped airside systems.
- Four new heat pumps: three at 5 tons, one at 10 tons (compressor heat of 25% and load diversity of 25% taken into account)
- Ground heat exchanger consisting of seven (7) bore holes, each 280' deep.
- Heating analysis
  - Boiler gas use is estimated to be about 65% of the total gas use = 3,269 CCF/year
    - 3,269 CCF/year x 103,000 Btu/CCF x 70% efficiency = 236 MMBtu/year heating load eliminated
  - Furnace gas use is estimated to be about 25% of the total gas use = 1,257 CCF/year
    - 1,257 CCF/year x 103,000 Btu/CCF x 90% efficiency = 117 MMBtu/year heating load eliminated
  - Boiler pilot light is estimated to be 1,000 Btuh year-round = 85 CCF/year pilot light load eliminated
  - This entire load is replaced by the heat pump electrical load
    - (236 + 117) MMBtu/year thermal / 3.8 COP = 93 MMBtu/year electrical = 27,158 KWH/year added
- Cooling savings
  - Condensing unit use at 9.5 EER is estimated to be about 9,450 KWH/year eliminated
  - This load is replaced by the heat pump electrical load, 18 EER
    - 9,450 KWH x (9.5/18.0) = 4,988 KWH/year added
- Energy Summary
  - Eliminate 3,269 + 1,257 + 85 = 4,611 CCF (boiler + furnace + pilot light) = $4,487/year
  - Eliminate 9,450 KWH (condensing units) = $1,058/year
  - Add 27,158 + 4,988 = 32,146 KWH (heat pumps) = $3,600/year
  - 4,487 + 1,058 – 3,600 = **$1,945/year savings**
- Costs
  - Borefield cost $17/foot x 280 feet/bore x 7 bores = $33,320
  - Heat pumps $1,200/ton x 24 tons (heating) = $28,800 to purchase, $55,000 installed
  - Total cost = $88,320
- Payback = 45.4 years

If costs are reduced by the avoided future replacement costs for the boiler and condensing units:
Avoided cost of replacement boiler at 80% of life = $8,000 x 0.80 = $6,400
Avoided cost of replacement condensing units at 2/3 of life = $7,500 x 0.67 = $5,000
Project cost = 88,320 – 6,400 – 5,000 = $76,920
Payback = 39.6 years

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**76,920**
Total Estimated Annual Savings ($)	**1,945**
Simple Payback (Years)	**39.6**
Estimated Useful Life (Years)	**15 for heat pumps 30+ for borefield**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Township Hall	
ECM NUMBER: 7	
ECM NAME: Replace Domestic Water Heater	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing standard efficiency domestic water heater serving the plumbing fixtures in the building – 50 MBtu
- Water heater has a standing pilot light, which uses gas continuously when it is lit
- Nominal efficiency for a water heater of this type is about 78-80%, plus the year-round use of the pilot light

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Install a new high efficiency gas water heater or instantaneous gas heater
- Assume that such a heater will reduce existing water heating loads by nominally 30%, plus elimination of the standing pilot light
- Existing estimated gas use for the domestic water heater
  - Water Heater – 28 CCF/month = 336 CCF/year
  - Water Heater pilot – 1,000 Btuh year round = 8.76 MMBtu/year = 85 CCF/year
- Savings = (336 x 30%) + 85 (eliminate pilot light) = 186 CCF/year = **$181/year savings**
- Cost = $1,500 for water heater
- Payback = 8.3 years

- If it is assumed that the water heater is already at 80% of its life, then the cost assigned to energy efficiency upgrades is only 20% of replacement cost
- Replacement cost = $1,500
- Cost assigned to energy upgrades = $1,500 x 20% = $300
- Payback = 1.7 years

If this ECM is not implemented, when the water heater requires replacement a high efficiency new unit should be considered. The incremental cost for the higher efficiency will likely provide a good payback in energy savings.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**300**
Total Estimated Annual Savings ($)	**181**
Simple Payback (Years)	**1.7**
Estimated Useful Life (Years)	**10**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Township Hall	
ECM NUMBER: 8	
ECM NAME: Replace or Retrofit T12 Fixtures	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing T12 light fixtures are installed in various areas throughout the building
- 97 fixtures
- 16,840 watts of installed lighting
- 35,924 KWH estimated annual power usage, based on assumed hours of operation (see lighting schedules in this report)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Replace existing fixtures with T8 fixtures, or retrofit existing to use T8 lamps. Retrofit is to include ballast replacement.
  - o Assume a one-for-one fixture replacement, matching the number of lamps in the existing
  - o 97 fixtures
  - o 5,570 watts of installed lighting after replacement/retrofit
  - o 12,041 KWH estimated annual power usage after replacement/retrofit, based on the same assumed schedule as existing
- 35,924 KWH – 12,041 KWH = 23,883 KWH energy savings = **$2,675/year savings**
- Cost = 97 fixtures x $150/fixture = $14,550 (replacement costs, retrofit may be less expensive)
- Payback = 5.4 years

The payback for this ECM depends significantly on the assumed operating schedule, included in the Light Fixture Inventory table in this report. Assumed usage should be verified.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**14,550**
Total Estimated Annual Savings ($)	**2,675**
Simple Payback (Years)	**5.4**
Estimated Useful Life (Years)	**25**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Township Hall	
ECM NUMBER: 9	
ECM NAME: Install Occupancy Sensors	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- All lights in the building are controlled by manual on/off switches, no existing occupancy sensors were found
- 17,320 watts of existing installed lighting, not including exterior lights and exit signs
- 36,668 KWH estimated existing annual power usage, based on assumed hours of operation (see lighting schedules in this report)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Install occupancy sensors to control light fixtures throughout the building
- Most fixtures in the building could be controlled by the installation of about 30-40 sensors. Assume that 30 sensors are installed.
- Assume that lighting energy will be reduced by about 1/3
- 36,668 KWH x 1/3 = 12,223 KWH energy savings = **$1,369/year savings**
- Cost = 30 zones x $150/zone = $4,500
- Payback = 3.3 years

Combined project – T12 fixture replacement along with occupancy sensors

- 5,714 watts of installed lighting after T12 fixture replacement, not including exterior lights and exit signs
- 12,271 KWH estimated annual power usage after T12 fixture replacement, based on assumed hours of operation (see lighting schedules in this report)
- Savings
  - Occupancy sensors: 12,271 KWH x 1/3 = 4,090 KWH energy savings = $458/year savings
  - T12 fixture replacement: 35,924 KWH – 12,041 KWH = 23,883 KWH energy savings = $2,675/year savings
  - Total: 458 + 2,675 = **$3,133/year savings**
- Cost = $4,500 (occupancy sensors) + $14,550 (T12 replacement) = $19,050
- Payback = 6.1 years

The payback for this ECM depends significantly on the assumed operating schedule, included in the Light Fixture Inventory table in this report. Assumed usage should be verified.

It would be more cost effective to not install sensors in rooms where the savings are lower (e.g. rooms without much installed wattage or rooms that are not used much).

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**4,500**
Total Estimated Annual Savings ($)	**1,369**
Simple Payback (Years)	**3.3**
Estimated Useful Life (Years)	**25**

Township Hall
Light Fixture Inventory
April 2010

	Existing Fixtures				Assumed Schedule					
Room Name	**Number Of Fixtures**	**Lamp Type**	**Fixture Watts**	**Total Load (W)**	**Hours per Day**	**Days Per Week**	**Weeks Per Year**	**Hours Per Year**	**Total Energy (KWH)**	**Comments**
Exterior - Entry	2	CFL 18 W	18	36	12	7	52	4368	157	photo-eye
Exterior - flag pole	2	HID 100 Watt	130	260	12	7	52	4368	1136	time clock?
Exterior - Wall packs	2	HID 250 Watt	288	576	12	7	52	4368	2516	photo-eye
First floor - Office 1	1	Incandescent 60 Watt	60	60	8	6	52	2496	150	
First floor - Office 2	1	Incandescent 60 Watt	60	60	8	6	52	2496	150	
First floor - Women's	1	Incandescent 60 Watt	60	60	8	6	52	2496	150	
First floor - Men's	2	Incandescent 60 Watt	60	120	8	6	52	2496	300	
First floor - Mech. Room	1	Incandescent 60 Watt	60	60	1	1	52	52	3	
Basement - East Storage room	2	Incandescent 60 Watt	60	120	2	1	52	104	12	
First floor - East Corridor	2	4 foot - 1 lamp T12	50	100	12	6	52	3744	374	
First floor - North Corridor	2	4 foot - 2 lamp T12	90	180	12	6	52	3744	674	
First floor - Women's	1	4 foot - 2 lamp T12	90	90	8	6	52	2496	225	
First floor - Men's	1	4 foot - 2 lamp T12	90	90	8	6	52	2496	225	
First floor - Meeting room	12	4 foot - 4 lamp T12	180	2160	4	6	52	1248	2696	
First floor - conference room	11	4 foot - 4 lamp T12	180	1980	8	6	52	2496	4942	
First floor - Storage 1	1	4 foot - 4 lamp T12	180	180	1	6	52	312	56	
First floor - Storage 2	1	4 foot - 4 lamp T12	180	180	1	6	52	312	56	
First floor - Storage 3	1	4 foot - 4 lamp T12	180	180	1	6	52	312	56	
Stairs to Basement level	1	4 foot - 4 lamp T12	180	180	1	6	52	312	56	
First floor - Lobby	6	4 foot - 4 lamp T12	180	1080	12	6	52	3744	4044	
First floor - S. Corridor	4	4 foot - 4 lamp T12	180	720	12	6	52	3744	2696	
First floor - North Corridor	2	4 foot - 4 lamp T12	180	360	12	6	52	3744	1348	
First floor - Office 1	4	4 foot - 4 lamp T12	180	720	8	6	52	2496	1797	
First floor - Office 2	4	4 foot - 4 lamp T12	180	720	8	6	52	2496	1797	
First floor - Office 3	3	4 foot - 4 lamp T12	180	540	8	6	52	2496	1348	
First floor - Office 4	2	4 foot - 4 lamp T12	180	360	8	6	52	2496	899	
First floor - Office 5	2	4 foot - 4 lamp T12	180	360	8	6	52	2496	899	
First floor - Office 6	2	4 foot - 4 lamp T12	180	360	8	6	52	2496	899	
First floor - Office 7	2	4 foot - 4 lamp T12	180	360	8	6	52	2496	899	
First floor - Office 8	2	4 foot - 4 lamp T12	180	360	8	6	52	2496	899	
First floor - Office 9	2	4 foot - 4 lamp T12	180	360	8	6	52	2496	899	
First floor - Office 10	3	4 foot - 4 lamp T12	180	540	8	6	52	2496	1348	
First floor - Office 11	3	4 foot - 4 lamp T12	180	540	8	6	52	2496	1348	
First floor Office 12	4	4 foot - 4 lamp T12	180	720	8	6	52	2496	1797	
First floor - Work Station	6	4 foot - 4 lamp T12	180	1080	8	6	52	2496	2696	
First floor - Lunch / Kitchen	4	4 foot - 4 lamp T12	180	720	2	6	52	624	449	
First floor - small men's bath	1	4 foot - 4 lamp T12	180	180	1	6	52	312	56	
First floor - small women's bath	1	4 foot - 4 lamp T12	180	180	1	6	52	312	56	
Basement - large storage room	5	4 foot - 4 lamp T12	180	900	1	6	52	312	281	
Basement - West Storage room	2	4 foot - 4 lamp T12	180	360	1	6	52	312	112	
First floor - Exit signage	6	Exit Sign - Incandescent	20	120	24	7	52	8736	1048	
Basement - Exit signage	1	Exit Sign - LED	2	2	24	7	52	8736	17	
Totals	**118**			**18314**					**41563**	


East face


Front Entry


NW corner


SW corner

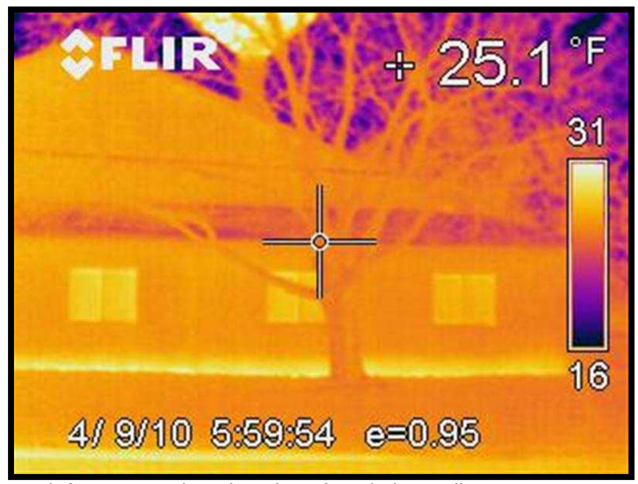

East face

East face – Note higher heat loss from entry doors/windows than from brick walls

Front dormer

Front dormer – Note no unusual heat loss

North face

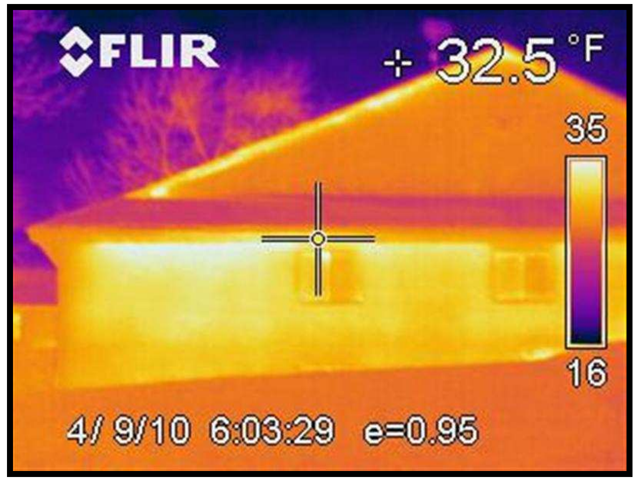


North face – Note heat loss from foundation wall

West face

West face – Note heat loss around doors and from foundation wall

South face



South face – Note heat loss at top of wall

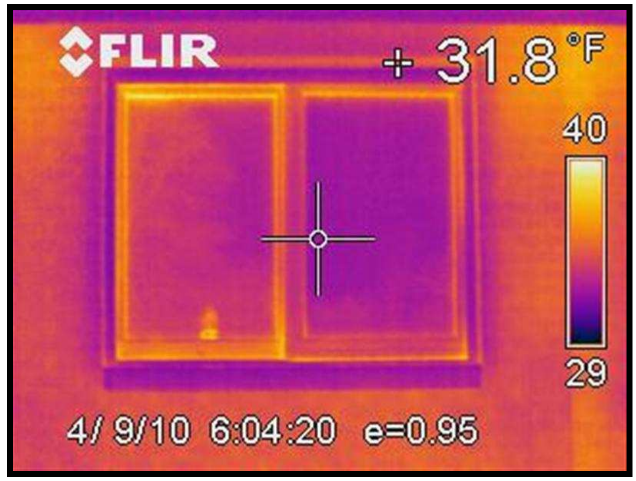
South face

South face – Note heat loss from glass egress door

Egress door

Egress door – Note heat loss around door, probably direct conduction through frame with no thermal break

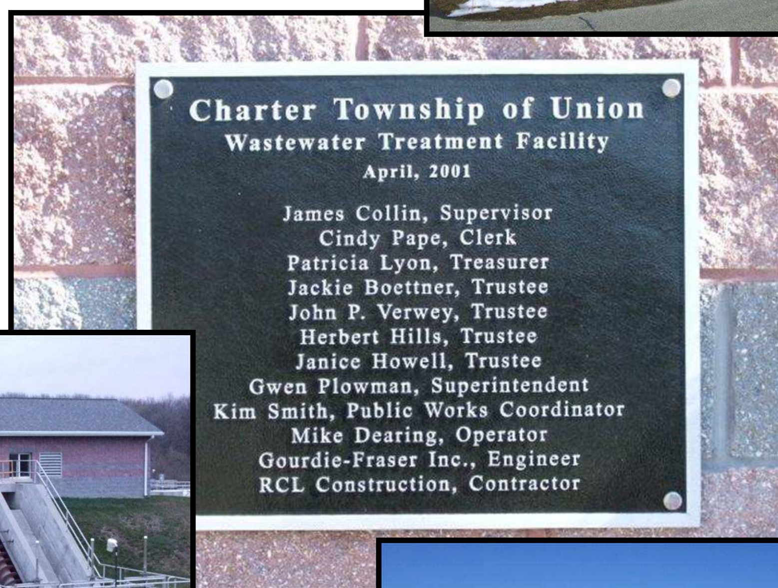
Window



Window – Note no unusually significant heat loss

Wastewater Treatment Plant

Union Township, MI



4511 E River Road

Date of Construction: 2001

Current Size: 6,880 Square Feet

Energy Performance Score

The table below is a simple metric to illustrate how well this building utilizes energy. The scores are based largely on the building performance requirements of the Michigan Energy Code, ASHRAE Standard 90.1, but also on subjective criteria from the field observations in each building.

The scoring is as follows:

- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

The following Building Overall Description and Observations section of this report provides additional insight into the factors that were used to determine these scores.

Energy Performance	
Wastewater Treatment Plant	
Description	**Score**
Envelope	
Roof	**Good**
Walls	**Good**
Windows	**Good**
Infiltration	**Fair**
Mechanical	
Heating System	**Good**
Cooling System	**Fair**
Domestic Hot Water	**Good**
Insulation	**Good**
Controls	**Fair**
Electrical	
Lighting	**Good**
Lighting Controls	**Poor**
OVERALL CONDITION	**GOOD**

Building Overall Description & Observations

The performance of this energy audit included a field assessment of the building. This section of the report discusses some of conditions that were observed. This is not intended to be a comprehensive discussion of all building deficiencies. However the items discussed represent the conditions found and the general condition of the building. Many of the potential energy improvements that are presented in this report are based on the discussions below.

The Wastewater Treatment Plant has multiple buildings on site, including three that are included in this report. The other buildings on site that are not included in this report are not heated or cooled and are used entirely for process purposes. All buildings are used continuously year round. The buildings in this report are as follows:

- Control Building – Offices, lab, garage and overall support for the entire site
- Headworks Building – Initial wastewater entry point to the site
- Solids Building – Processing of solid waste

The entire Wastewater Treatment Plant site, including all buildings on site, was built in 2001. The buildings all appear to be maintained in very good condition.

The photographs included in this report illustrate some aspects of the building construction.

General Information

- Size:
    - Total 6,880 square feet
    - Control Building – 3,040 sf
    - Headworks Building – 1,700 sf
    - Solids Building – 2,140 sf
- All buildings are single story on grade
- Schedule
    - The Control Building is occupied 8 hours/day, 7 days/week. Weekend staffing is reduced and in the Lab and Office areas only.
    - The Headworks and Solids Buildings are in use 24 hours/day year round. These buildings are occupied primarily only for monitoring and maintenance purposes.

The Building Envelope provides the first defense against energy use. The envelope includes the roof, walls, windows and doors. Typical problems include areas that are not insulated well and areas of air leakage (infiltration).

- All three buildings utilize the same construction (roof, walls, windows, doors)
- Roof
    - Sloped roof with gable ends, pre-engineered wood trusses, asphalt shingles
    - Blown-in insulation at the bottom of the truss, R-38. FRP panel at the bottom of trusses in the Control Building garage, the Headworks Building and the Solids Building. Drywall at the bottom of trusses in all other areas in the Control Building.
    - Lay-in ceiling in the Control Building offices and lab.
- Walls
    - 10” block interior and 4” split face block exterior
    - 2” of rigid insulation and an air gap between block wythes.
- Windows
    - Double-pane insulated glass. Staff report that the window openings allow significant air drafts into the building. It is not known whether the air enters through the windows themselves or between the window frames and the walls.

- Operable windows with aluminum frame in the Control Building, Solids Building and the control room in the Headworks Building (the center room).
- Fixed windows with FRP frames in the chemical storage and screening & grit rooms of the Headworks Building (rooms on each end of this building).

- Doors
  - Man doors are hollow metal construction (doors and frames) in the Control Building, Solids Building and the control room in the Headworks Building (the center room).
  - Man doors are FRP construction (doors and frames) in the chemical storage and screening & grit rooms of the Headworks Building (rooms on each end of this building).
  - Overhead doors are steel insulated construction with double pane insulated glass vision panels.
  - All doors have seals and sweeps that appear to be in reasonably good condition.

Mechanical systems are important because they consume a significant portion of a building's energy. The primary mechanical systems include heating, cooling, and ventilating systems and controls. Typical problems include poor insulation, equipment or systems that do not function as intended and equipment with low energy efficiency.

- Control Building
  - The Office & Lab area is heated and cooled by a propane gas fired furnace with a cased cooling coil and remote condenser
    - The furnace is a Reznor model CAUA150-S-2, 150 MBH propane gas input, 120 MBH output, 80% efficiency. Ventilation air is provided to the furnace system through a wall louver. All visible ductwork appears to be well insulated.
    - The condensing unit is an ICP model N2A360AKA200, nominal 5 ton cooling capacity, R-22 refrigerant, nominal 10 EER. Staff indicated that the condensing unit has been replaced since the original construction.
    - The furnace is controlled by a programmable thermostat, however it appears that the thermostat may be overridden and manually controlled. Staff indicated that the Lab must be maintained at 68F year round.
    - A single intake louver is used for both combustion air for the water heater and furnace and for outside ventilation air for the furnace system. There does not appear to be a shutoff damper on the combustion air duct from that louver.
    - The furnace system is a single zone system. Supply air dampers are shut off in the Lunch/Meeting room, staff indicated that the room gets too warm in the winter.
    - The furnace system includes economizer cooling (free cooling using outdoor air when conditions are appropriate, in lieu of mechanical cooling). However staff indicated that the economizer controls may not work properly.
  - The Garage area is heated by a propane gas fired tubular radiant heater, 75 MBH propane gas input, nominal 80% combustion efficiency. The thermostat was set at 55F during the field review.
    - The Garage area is not cooled.
    - The Garage area has no mechanical ventilation.
  - Exhaust
    - Individual exhaust fans are used to ventilate the Toilet room, Shower/Locker room and the Lab Storage room. These fans are controlled by the room light switches.
    - The Lab includes a chemical fume hood. Staff indicated that the hood is operated about 45 minutes each day.
    - The Lab includes two canopy hoods over heat-emitting equipment. Staff indicated that the hoods are operated about 20 minutes each day.
  - A time clock in the furnace room was found to be two hours slow at the time of the field review. It is not evident what this time clock controls.
  - The Lab includes a chemical fume hood.
  - The Lab includes two canopy hoods over heat-emitting equipment.

- Headworks Building
  - Each of the three rooms in this building is heated by a 7.5 KW electric heater with integral thermostat.
  - Each of the three rooms in this building is ventilated by a wall mounted intake louver and exhaust fan.
  - The louvers in the Control room have been sealed closed.
  - The Screening & Grit room is open to the outdoors through the effluent flow channel.
- Solids Building
  - The Pump room and Sludge Thickening room are heated by 7.5 KW electric heaters with integral thermostats. The Blower room does not have a heater.
  - Each of the three rooms in this building is ventilated by a wall mounted intake louver and exhaust fan. The dampers on the fan in the Blower room are stuck open with the fan off.

Plumbing Systems consume both energy and water. The primary plumbing systems include the domestic water heater and plumbing fixtures and piping. Typical problems include poor insulation, equipment or systems that do not function as intended, equipment with low energy efficiency, and fixtures with excessive water usage.

- Propane – a propane tank is located outside the building. Piping is routed underground to the building.
- Control Building
  - Domestic water heater –Lochinvar model ETL076, 76 MBH propane gas input, nominal 80% efficiency, 75 gallons.
  - A backflow preventer installed in the furnace room was weeping at the time of the field review.
  - All visible piping appears to be well insulated.
  - A water softener is installed in the furnace room
  - Plumbing fixtures
    - 2 water closets, 1.6 gpf (gallons per flush)
    - 2 lavatories
    - 1 shower, appears to be unused
    - 1 lab sink
    - 1 emergency eyewash/shower
- Headworks Building
  - Domestic water heater –Lochinvar model ETA082KK, electric, 4500 watts, 80 gallons. This heater supplies only an emergency eyewash/shower.
  - 1 emergency eyewash/shower, located in the Chemical Storage room
- Solids Building
  - Domestic water heater –Lochinvar model LSA050KK, electric, 4500 watts, 47 gallons. The temperature setting is quite high on this heater (cannot hold your hand under the hot water faucet).
  - Washer and dryer in the Sludge Thickening room
  - Laundry tub located in the Sludge Thickening room
- Wastewater effluent flow
  - Flow varies with the seasons. At the time of the field review the flow meter indicated 0.85 MGD (8:20 am on 4/15/2010).
  - Effluent temperatures vary from about 41F in the winter to 70F in the summer.

Electrical systems also consume a substantial part of a building's energy. Electrical systems include lighting, lighting controls and power. Typical problems include inadequate lighting control, inappropriate lamp selection and inefficient motors.

- Electric provider – Consumers Energy, meter #58543925
- 1600 amp MDP located in the Control Building, 277/480, 3 phase, 4-wire. This MDP feeds the entire site including the buildings, all equipment in each building and all other process equipment on the site.
    - 600 amp, 3 pole switch feeding the Control Building motor control center
    - 400 amp, 3 pole switch feeding the Headworks Building motor control center
    - 400 amp, 3 pole switch feeding the Solids Building motor control center
    - Future 600 amp, 3 pole switch feeding a future Control Building motor control center
- 350 KW backup diesel generator located outside the Control Building and connected to the MDP through an automatic transfer switch.
- This report does not address power use by the process equipment (wastewater treatment equipment). Lights at exterior process locations are controlled by manual switches and are only used when work is performed at night. The UV filter includes 80 UV lamps that operate continuously (24 hours/day, 365 days/year) and another 160 lamps that are operated as needed to disinfect the discharge water.
- A schedule of light fixtures observed in the building is included in this report. Following is a summary by fixture type for all these buildings combined.

Wastewater Treatment Plant Light Fixture Summary				
Fixture Type	Number of Fixtures	% of Total Number of Fixtures	Total Watts	Total KWH*
CFL	8	9%	200	146
T8 Fluorescent	71	76%	4,361	7,348
Metal Halide	15	16%	2,197	9,596
Total	94		6,758	17,090
* Assumed operating schedule as shown in the Light Fixture Inventory in this report				

- Exterior (site) lights are controlled by photo-eyes and a timer
- Interior lights are controlled by manual wall switches. No occupancy sensors were observed
- Toilet room exhaust fans are controlled by light switches in the associated rooms

Plug Loads are defined as equipment in the building that is connected to power receptacles, i.e. no permanent electrical connection. Plug load equipment can consume a significant amount of electricity over the course of time. Typical plug load issues include inefficient equipment, equipment that is not turned off when not in use, and inappropriate use of equipment (e.g. electric heaters under desks).

- Control Building
    - Three computers with flat screens
    - Lab equipment including two ovens (120F and 550F, operated 24 hours/day), an autoclave, two incubators, a hot plate and three environmental refrigerators.
- Headworks Building
    - General use receptacles, no significant equipment loads
- Solids Building
    - General use receptacles, no significant equipment loads

Occupancy / Operations / Schedule – How a building is used can have a significant impact on the building's energy usage. In fact attitudes and actions of the building users and operational staff can sometimes be the biggest factor in energy waste. It is critical that building occupants are provided with information on how to minimize energy use, the proper tools to do so, and an educational process to continually remind them how to most effectively use the building.

- Schedule
  - The Control Building is occupied nominally from 8 am – 4 pm Monday through Friday and 8 am – 5 pm on Saturday and Sunday. Weekend staffing is reduced.
  - The Headworks and Solids Buildings are in use 24 hours/day year round. These buildings are occupied primarily only for monitoring and maintenance purposes.

Building Energy Cost Information – Electrical & Propane Gas

Electricity Usage

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	90,400	100	7,082	7,182
February	79,200	100	6,302	6,402
March	90,554	100	7,150	7,250
April	92,995	100	7,312	7,412
May	98,885	100	8,198	8,298
June	79,842	100	6,259	6,359
July	107,243	43	9,241	9,284
August	90,705	25	7,976	8,001
September	111,189	25	9,316	9,341
October	92,947	25	7,141	7,166
November	106,952	25	8,385	8,410
December	98,657	25	7,362	7,387
2008	**1,139,569**	**768**	**91,724**	**92,493**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	117,474	25	10,113	10,138
February	102,867	25	8,805	8,830
March	104,652	25	8,690	8,715
April	131,928	25	10,906	10,931
May	113,959	25	9,064	9,089
June	108,800	477	8,612	9,089
July	100,094	477	8,079	8,557
August	106,649	477	8,608	9,086
September	106,947	477	8,633	9,110
October	109,278	477	8,821	9,298
November	121,266	477	9,083	9,560
December	104,814	477	8,099	8,576
2009	**1,328,728**	**3,466**	**107,512**	**110,977**

Total	**2,468,297**	**4,234**	**199,236**	**203,470**
Some meter readings may be estimated				

Electricity and Gas Totals	
Square Footage	6,880
Average Annual Cost	101,735
Cost/SF/Year	14.79
EUI (MBtu/SF/Year)	630.2

Electricity Totals	
Average KWH/Year	1,234,149
Average MMBtu/Year	4,212
Average Cost/KWH	0.082
Cost/KWH w/o Fixed	0.081
Average Cost/MMBtu	24.15
Cost/SF/Year	14.79
EUI (MBtu/SF/Year)	612.2

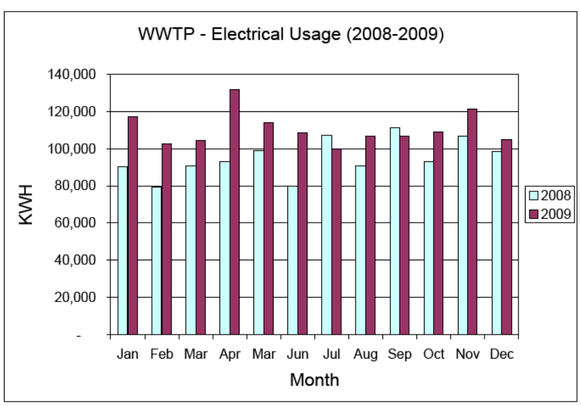
Propane Gas Totals	
Average Gal/Year	1,389
Average MMBtu/Year	127
Average Cost/Gal	1.86
Average Cost/MMBtu	20.33
Cost/SF/Year	0.37
EUI (MBtu/SF/Year)	18.5

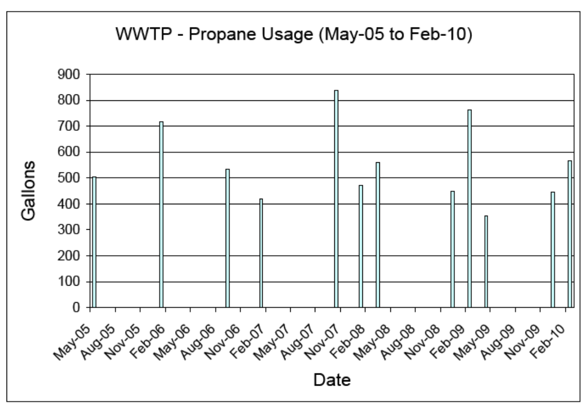
Notes

91,600 Btu/Gal
3,413 Btu/KWH
Jul-09 thru Nov-09 costs are interpolated from other data. KWH are correct from bills for this period.

Propane Gas Usage

Date	Gal	Total Cost
05/13/2005	505	no info received
01/25/2006	717	no info received
09/18/2006	533	no info received
01/24/2007	420	no info received
10/15/2007	840	no info received
01/09/2008	472	no info received
03/14/2008	559	no info received
12/01/2008	449	no info received
02/02/2009	765	1,861
04/01/2009	355	571
12/16/2009	444	674
02/24/2010	566	861
	6,625	





Behavioral, Operations and Maintenance Improvements (BOMIs) Narrative Descriptions

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

Control Building

1. ***Repair Window Air Leakage*** – During the field review air drafts were not observed coming through the windows themselves (i.e. between glass units or through the frame). It is likely that the cold drafts that are reported are due to the details of the window installation methods, allowing air to pass between the windows and the frames. Three different methods are available to attempt to resolve this issue, with increasing levels of difficulty but also increasing chances of success.
   - Caulk the window exteriors, between the frame and the brick wall. Several of the windows on the west exposure have obvious gaps in the caulking, but all the windows should be checked and caulked as needed. This may eliminate some of the air infiltration problems.
   - Drill small holes through the frames and insert expandable foam insulation between the window frames and the brick/block – on the top, bottom and sides of each window. This should resolve much of the infiltration problems if they are caused by the lack of proper blocking and sealant around the window openings. This solution should be tried on one or two windows to gauge the effectiveness of the solution before proceeding with all window openings.
   - Remove the windows, attempt to determine the cause of the air infiltration, and reinstall using proper blocking and sealant. Unless the windows themselves are found to be deficient, this solution should resolve the infiltration issues.
2. ***Verify Thermostat Operation*** – Verify space temperature settings and schedule. In many cases small adjustments in setpoints can have a significant affect on energy usage. Changes of as little as one degree to temperature settings can reduce energy use by several percent.
3. ***Rebalance Air Distribution*** – Check the air balance throughout the building. The supply diffuser in the break room was covered, indicating some dissatisfaction with the operation of the heating and/or cooling system. Adjustments in air balance may be able to make the space more comfortable, and reduce energy use.
4. ***Verify Furnace System Economizer Operation*** – Review the operation of the economizer operation for the office furnace system (an economizer mode brings in up to 100% outside air when the outdoor conditions are appropriate for cooling the building). The staff indicated that the economizer controls may not work properly. Economizer modes of operation provide “free” cooling to a building when weather conditions are appropriate, rather than energy intensive mechanical cooling.
5. ***Install Combustion Air Damper (Water Heater)*** – Install an automatic shutoff damper on the combustion air intake for the water heater. The damper would be interconnected to the heater with a proof switch to prevent operation of the heater unless the damper is open. This BOMI is not applicable if a new heater is installed that has a direct combustion air connection, the existing combustion air duct can then be capped.
6. ***Repair Backflow Preventer*** – Repair the leaking backflow preventer to eliminate water waste.
7. ***Adjust Time Clock*** – Adjust time clock to the correct time. The clock in the furnace room was observed to be incorrect by two hours. Although it was unclear what this time clock was controlling, most time errors in mechanical/electrical system can lead to wasted energy.
8. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

Headworks Building

9. ***Verify & Adjust Room Temperature Settings*** – Verify that temperature settings are appropriate for the use, and that these settings are not changed inadvertently. For the most part this building is not occupied so most of the time temperatures need only be high enough for the processes taking place inside, not for human comfort.

Solids Building

10. ***Repair Discharge Damper*** – Repair or replace the fan discharge damper that does not close properly. The damper remains open, allowing cold air to enter the building in the winter.
11. ***Verify & Adjust Room Temperature Settings*** – Verify that temperature settings are appropriate for the use, and that these settings are not changed inadvertently. For the most part this building is not occupied so most of the time temperatures need only be high enough for the processes taking place inside, not for human comfort.
12. ***Reduce Domestic Water System Temperature*** – Adjust the supply temperature of the domestic hot water heater. Supply temperature is too hot to hold your hand under the faucet. Temperatures in the range of 105F to 110F are typically adequate, and will reduce energy losses from the heater and piping.

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

Control Building

1. ***Replace Furnace*** – Install a new furnace with higher combustion efficiency. The existing furnace is listed at 80% efficiency. Furnaces with 90-98% efficiency are readily available.
2. ***Replace Condensing Unit*** – Replace the condensing unit with a new, higher efficiency unit. Legislation and equipment improvements in the last few years have made newer units considerably more efficient than standard units from just a few years ago. The existing unit is thought to have an efficiency rating of about 10 EER.
3. ***Recover Energy From Wastewater*** – Install water source heat pumps for space conditioning (heating and cooling using process effluent water as an energy source.

Headworks Building

4. ***Improve Wall Insulation*** – Add insulation to the poured concrete walls of the Chemical Storage Room. It appears from the construction drawings and the field observations and thermal images that these walls are not insulated. Several insulation options are available including adding exterior rigid insulation and a new layer of brick or block to the exterior; installing an exterior insulation finish system (EIFS) over the existing surface; or adding furring with rigid insulation or stud walls with fiberglass insulation (and a layer of FRP panel) to the interior.

   Costs will also vary considerably depending on the solution chosen and the installation difficulty. A new brick or block veneer with insulation or new EIFS exterior will likely cost on the order of $15-$25/sf. An interior solution may be less expensive, but durability must be considered vs. the existing block. Estimated savings and paybacks for various scenarios are shown in the table below.

Estimated Energy Savings – Additional Wall Insulation						
Type of Wall	Existing R-value	New R-Value	Energy Savings Btu/sf/yr	Estimated Cost/sf		
				Lo	Med	Hi
No Existing Insulation Block and brick, no insulation, no air gap	About 2.5	12.5	67,200	$10	$15	$25
Minor Existing Insulation E.g. insulation in block cores	About 3.5	13.5	44.450	$10	$15	$25
Savings are based on heating loads only, 7000 heating degree days, 80% boiler efficiency Buildings that are air conditioned will have more energy savings						

5. ***Eliminate Water Heater*** – Remove the water heater and install a large room-temperature storage tank to provide water for the emergency eyewash/shower. The water heater in this building is used exclusively to provide water to the eyewash/shower, with the hot water from the heater mixed with cold water to feed the fixture when needed. Since this application requires "tepid" water (defined as 60F – 100F by ANSI 358.1) rather than "hot" water, a large volume tank of room temperature water could serve as the source (assuming that the room temperature is kept above 60F). A significantly sized tank would be required since an emergency shower is typically required to provide a minimum of 20 gpm for 15 minutes, or 300 gallons of tepid water. Showers with higher flowrates (often 30-35 gpm depending on the supply pressure) would required an even larger tank.

ECM Detailed Description Forms

The following pages contain "ECM Detailed Description Forms". A page is dedicated to each ECM, and that ECM is described in detail along with some cost, savings, and payback information.

The costs to implement each ECM are based on industry cost estimating guides and on the A/E's experience with similar projects. Savings are estimated based on the best available information on energy usage and system operation. Costs or savings could vary from the figures shown above depending on market and economic conditions at the time the work is performed and depending on the validity of the assumptions used to generate these estimates. The information presented is valuable for planning purposes, but it is recommended that more detailed budgets or firm quotes be obtained for projects prior to a final decision to implement any improvement.

Based on utility bill data from 2008-2009, the following utility costs were used for the savings and payback analyses for each ECM. These unit costs are the commodity cost only, without the fixed monthly charges.

Electricity	$0.081/KWH
Propane	$1.86/Gallon

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Wastewater Treatment Plant	
ECM NUMBER: 1 (Control Building)	
ECM NAME: Replace Furnace	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing gas fired furnace serving the existing lab, office and support areas – 150 MBtu input
- The listed efficiency for the furnace is 80%

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Install a new high efficiency condensing furnace
- Assume an overall operating efficiency of about 95% for a new furnace
- Existing propane use appears to average about 1,389 gallons/year to serve the furnace, a radiant tube heater in the garage, and the domestic water heater.
  - Estimated use by system
    - Furnace – 50% of total propane use = 695 gallons/year
    - Garage Radiant Heater – 40% of total propane use = 556 gallons/year
    - Water Heater – 10% of total propane use = 139 gallons/year
- Annual furnace propane use using 95% efficient furnace = 695 x (80%/95%) = 585 gallons/year
- (695 – 585) = 110 gallons/year savings = **$204/year savings**
- Cost = $3,000 for furnace
- Payback = 14.7 years

Note that the price data for propane for this site is somewhat limited. It is likely that the future cost of propane will be more than the $1.86/gallon used for this analysis. Higher propane costs will increase annual savings and reduce the payback period.

If this ECM is not implemented, when the furnace requires replacement a high efficiency new unit should be considered. The incremental cost for the higher efficiency will likely provide a good payback in energy savings.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**3,000**
Total Estimated Annual Savings ($)	**204**
Simple Payback (Years)	**14.7**
Estimated Useful Life (Years)	**15**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Wastewater Treatment Plant	
ECM NUMBER: 2 (Control Building)	
ECM NAME: Replace Condensing Unit	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- One individual air cooled condensing unit located on the ground. The original unit was installed in 2001, staff reported that the currently unit is a replacement so it is presumably newer than 2001.
- Manufacturer's published EER for this unit is 10.0
- Unit is 5 ton capacity.

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Replace the condensing unit with newer unit with a higher efficiency rating
- Assume that new unit would have an EER of 15 (13 is the currently minimum required by law)
- Assume that the unit runs for approximately 500 equivalent full load hours each summer.
- 10.0 EER is 1.20 KW/ton x 5 tons = 6.00 KW load
- 6.00 KW x 500 hours = 3,000 KWH/year existing energy use
- 3,000 KWH x [1 – (10.0 EER / 15 EER)] = 1,000 KWH annual savings = **$81/year savings**
- Cost = 1 unit x $2,500/unit = $2,500
- Payback = 30.9 years

- If it is assumed that the unit is already at 1/3 of its life, then the cost assigned to energy efficiency upgrades is only 2/3 of the replacement cost
- Replacement cost = 1 units x $2,500/unit = $2,500
- Cost assigned to energy upgrades = $2,500 x 67% = $1,667
- Payback = 20.6 years

If this ECM is not implemented, when the condensing unit requires replacement a high efficiency new unit should be considered. The incremental cost for the higher efficiency will likely provide a good payback in energy savings.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**1,667**
Total Estimated Annual Savings ($)	**81**
Simple Payback (Years)	**20.6**
Estimated Useful Life (Years)	**15**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Wastewater Treatment Plant	
ECM NUMBER: 3 (Control Building)	
ECM NAME: Recover Energy From Wastewater	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Reznor furnace model CAUA150-S-2, 150 MBH propane gas input, 120 MBH output, 80% listed efficiency
- Ventilation air is provided to the furnace system through a wall louver
- ICP condensing unit model N2A360AKA200, nominal 5 ton cooling capacity, R-22 refrigerant, nominal 10 EER

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Install an extended range heat pump in place of the existing furnace/condensing unit
- Use the wastewater steam as the energy source/sink for the heat pump. Pipe a heat exchanger as a side-stream from the effluent channel. Small circulating pumps would be required on both the effluent sidestream and building heat pump loop.
- Extreme effluent temperatures are about 43F in the winter and 70F in the summer
- Heating flow required (From Kavanaugh & Rafferty equation 6.2)
  [120 MBtu/hr / (500 x (43 – 36.9))] x [(3.8 - 1) / 3.8] = 29 gpm of effluent (at 3.8 COP)
- Cooling flow required (From Kavanaugh & Rafferty equation 6.1)
  [(5 tons) x (12,000 Btu/hr/ton) / (500 x (82.5 - 70))] x [(18 + 3.41) / 18] = 11.4 gpm of effluent (at EER of 18)
- Heating analysis
  - Furnace gas use is estimated to be about 50% of the total propane use = 695 gal/year
    - 695 gal/year x 91,600 Btu/gal x 80% efficiency = 51 MMBtu/year heating load eliminated
  - This entire load is replaced by the heat pump electrical load
    - 51 MMBtu/year thermal / 3.8 COP = 13.4 MMBtu/year electrical = 3,924 KWH/year added
- Cooling savings
  - Condensing unit use at 10.0 EER is estimated to be about 3,000 KWH/year eliminated
  - This load is replaced by the heat pump electrical load, 18 EER
    - 3,000 KWH x (10.0/18.0) = 1,667 KWH/year added
- Energy Summary
  - Eliminate 695 gal/year = $1,293/year
  - Eliminate 3,000 KWH (condensing units) = $243/year
  - Add 3,924 + 1,667 = 5,591 KWH (heat pumps) = $453/year
  - 1,293 + 243 – 453 = **$1,083/year savings**
- Costs
  - Heat pumps $1,200/ton x 10 tons (heating) = $12,000 to purchase, $22,000 installed
  - Heat exchanger, pumps, piping, etc = $3,000
  - Total Cost = $25,000
- Payback = 23.1 years

If costs are reduced by the avoided future replacement costs for the furnace and condensing units:
Avoided cost of replacement furnace at 20% of life = $8,000 x 0.20 = $1,600
Avoided cost of replacement condensing unit at 1/3 of life = $2,500 x 0.33 = $833
Project cost = 25,000 – 1,600 – 833 = $22,567
Payback = 20.8 years

Note that the price data for propane for this site is somewhat limited. It is likely that the future cost of propane will be more than the $1.86/gallon used for this analysis. Higher propane costs will increase annual savings and reduce the payback period.

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**22,567**
Total Estimated Annual Savings ($)	**1,083**
Simple Payback (Years)	**20.8**
Estimated Useful Life (Years)	**30**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Wastewater Treatment Plant	
ECM NUMBER: 4 (Headworks Building)	
ECM NAME: Improve Wall Insulation	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- The lower portion of the Headworks Building Chemical Storage Room (west end of the building) is 18" thick poured concrete wall with no insulation
- Assumed existing R-value of about R-2.85, including film coefficients
- About 135 square feet of uninsulated wall surface

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation to the walls. Many different options exist, with differing insulation values, costs and aesthetics. Some of the potential options include:
  - o Add rigid or spray-on insulation over the existing, finish with new brick veneer or EIFS (Exterior Insulation Finish System, such as Dryvit or equivalent)
  - o Add rigid or spray-on insulation and install brick on the exterior
  - o Install an insulated metal panel system over the existing exterior
  - o Add furring or stud walls on the interior with insulation between studs/furring strips, finish with FRP interior
- The aesthetics of the finished wall are a critical part of any decision on whether or not to proceed with this ECM or what type of finish to use. Costs will vary depending on the finish and the number of wall mounted items.
- Assume a project that adds 2" of insulation and has a cost of $10/sf
- New R-value of about R-12.85, including film coefficients
- 135 sf x [(1/2.85) – (1/12.85)] R-value x 4800 DD/year (base 55F) x 24 hr/day = 4,247 MBtu/year energy savings
- 100% efficient electric heat = 1,244 KWH/year = **$101/year savings**
- Cost = 135 sf x $10/sf = $1,350
- Payback = 13.4 years

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**1,350**
Total Estimated Annual Savings ($)	**101**
Simple Payback (Years)	**13.4**
Estimated Useful Life (Years)	**30**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Wastewater Treatment Plant	
ECM NUMBER: 5 (Headworks Building)	
ECM NAME: Eliminate Water Heater	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing water heater used to feed only an emergency shower/eyewash in the Chemical Room
- Heater is 80 gallons, 4500 watts

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Remove the water heater and replace with a large volume tank holding water at room temperature
- Tank sized for 300-600 gallon holding capacity, to supply tepid shower/eyewash for 15 minutes minimum
- Estimated cost to operate the existing heater
  - 34 square foot of surface area on the tank
  - Estimated R-5 insulation value
  - Estimated water temperature – 110F
  - Estimated room temperature, October- March – 55F
  - Conduction losses = (34 / R-5) x (110-55) = 374 Btu/hour x 8760/2 = 1,638 MBtu/year = 480 KWH/year
- Savings = 480 KWH/year = **$39/year savings**
- Cost = $4,000
- Payback = 103 years

Although the concept of replacing the water heater with a room temperature water source seems like a sound concept, the payback is relatively long. The payback depends heavily on the cost of the installed tank. If this cost can be substantially reduced, this ECM might become more viable.

Prior to implementation it should be verified with operating staff that room temperature water is acceptable for the emergency eyewash/shower station.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**4,000**
Total Estimated Annual Savings ($)	**39**
Simple Payback (Years)	**103**
Estimated Useful Life (Years)	**30**

Wastewater Treatment Plant
Light Fixture Inventory
April 2010

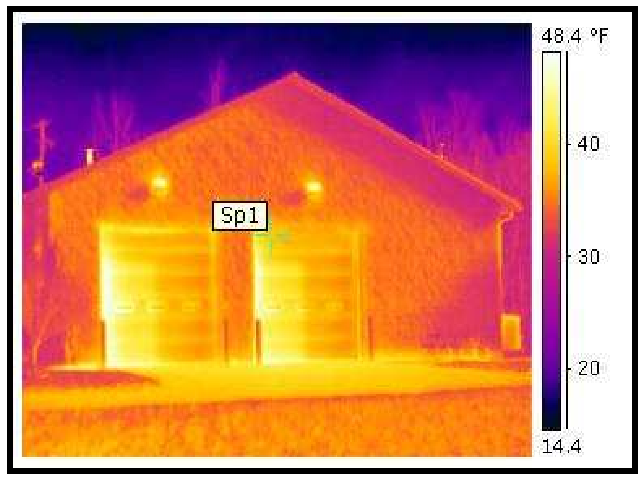
	Existing Fixtures				Assumed Schedule					
Room Name	**Number Of Fixtures**	**Lamp Type**	**Fixture Watts**	**Total Load (W)**	**Hours per Day**	**Days Per Week**	**Weeks Per Year**	**Hours Per Year**	**Total Energy (KWH)**	**Comments**
Control - shower/locker	2	4 foot - 2 lamp T8	58	116	2	7	52	728	84	
Control - toilet	1	4 foot - 2 lamp T8	58	58	2	7	52	728	42	
Control - electrical room	4	4 foot - 2 lamp T8	58	232	1	7	52	364	84	
Control - furnace room	1	4 foot - 2 lamp T8	58	58	1	7	52	364	21	
Control - garage	20	4 foot - 2 lamp T8	58	1160	4	7	52	1456	1689	
Control - lunch/meeting	7	4 foot - 3 lamp T8	85	595	10	7	52	3640	2166	
Control - lab	8	4 foot - 2 lamp T8	58	464	10	7	52	3640	1689	
Control - office	2	4 foot - 3 lamp T8	85	170	8	7	52	2912	495	
Control - storage	1	4 foot - 2 lamp T8	58	58	1	7	52	364	21	
Control - exterior	4	HID 250 Watt	288	1152	12	7	52	4368	5032	
Headworks - chemical storage	4	4 foot - 2 lamp T8	58	232	2	7	52	728	169	
Headworks - control	3	4 foot - 2 lamp T8	58	174	2	7	52	728	127	
Headworks - screen/grit	8	CFL 25 W	25	200	2	7	52	728	146	uncertain of wattage (could not see through explosion proof hardware) - possibly induction?
Headworks - exterior	6	HID 70 Watt	95	570	12	7	52	4368	2490	photo-eye
Solids - pump room	6	4 foot - 2 lamp T8	58	348	2	7	52	728	253	
Solids - sludge thickening	6	4 foot - 2 lamp T8	58	348	2	7	52	728	253	
Solids - blower room	6	4 foot - 2 lamp T8	58	348	2	7	52	728	253	
Solids - exterior	5	HID 70 Watt	95	475	12	7	52	4368	2075	photo-eye
		4 foot - 2 lamp T8								
Totals	**94**			**6758**					**17090**	

Photographs & Thermal Images


Control Building – South and West faces

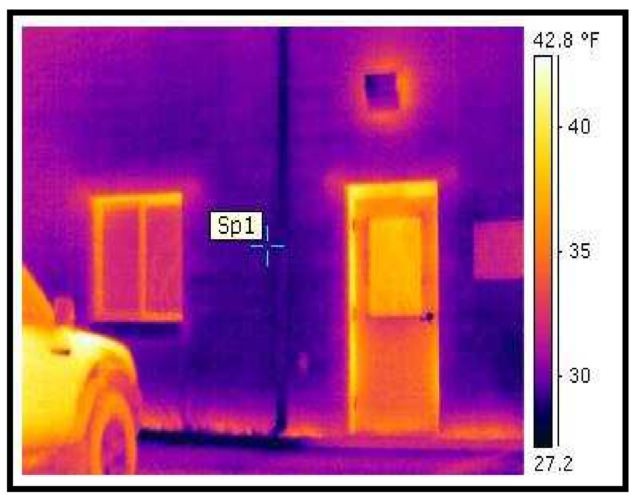

Control Building – North and East faces


Control Building



Control Building – Note heat loss between door panels (what appears to be heat loss "shadows" is sunlight)


Control Building



Control Building – Note heat loss around window and door

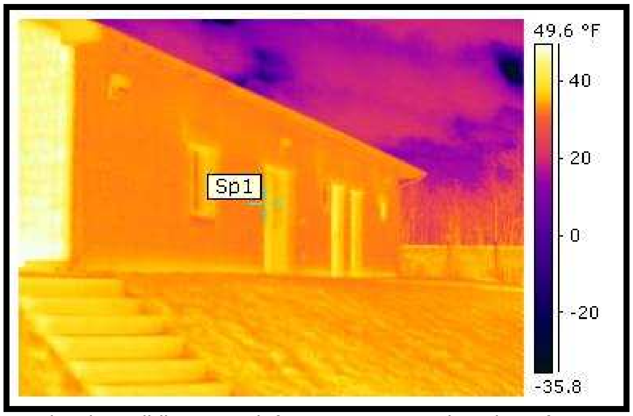
Headworks Building

Headworks Building

Headworks Building – South and West faces

Headworks Building – South and West faces – Note heat loss from foundation wall of Chemical Room

Headworks Building – North face



Headworks Building – North face – Note some heat loss from window and doors


Solids Building – South and East faces


Solids Building – South and West faces


Solids Building – South face

Solids Building – South face – Note heat loss from doors

McDonald Park
Union Township, MI

1776 & 2180 E Pickard Road

Date of Construction: Various Years

Currently Size: 7,730 Square Feet (five buildings/structures)

The table below is a simple metric to illustrate how well this building utilizes energy. The scores are based largely on the building performance requirements of the Michigan Energy Code, ASHRAE Standard 90.1, but also on subjective criteria from the field observations in each building.

The scoring is as follows:

- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

The following Building Overall Description and Observations section of this report provides additional insight into the factors that were used to determine these scores.

Energy Performance	
McDonald Park	
Description	**Score**
Envelope	
Roof	NA
Walls	NA
Windows	NA
Infiltration	NA
Mechanical	
Heating System	NA
Cooling System	NA
Domestic Hot Water	**Good**
Insulation	**Good**
Controls	NA
Electrical	
Lighting	**Poor**
Lighting Controls	**Poor**
OVERALL CONDITION	**FAIR**

The performance of this energy audit included a field assessment of the building. This section of the report discusses some of conditions that were observed. This is not intended to be a comprehensive discussion of all building deficiencies. However the items discussed represent the conditions found and the general condition of the building. Many of the potential energy improvements that are presented in this report are based on the discussions below.

McDonald Park has multiple buildings on site, including five that are included in this report. The other buildings on site that are not included in this report are ball field dugouts and press boxes. All buildings are used seasonally and are not used in the winter (with the exception of the maintenance building which may be used occasionally). The park buildings in this report are as follows

- North Restroom/Pavilion – Toilet building (one men's and one women's toilet rooms) and an open picnic shelter
- Concessions – Summer concession stand
- Park Maintenance – Central location for maintenance functions
- South Restroom – Toilet building (two men's and two women's toilet rooms)
- Picnic Shelter – Open picnic shelter

The north restroom/pavilion and south restroom buildings appear to be relatively new. The park maintenance, concessions and picnic pavilion appear to be somewhat older. The age of most of these buildings is unknown. In general the buildings appear to be maintained in good condition, particularly the newer restroom/pavilion buildings.

The photographs included in this report illustrate some aspects of the building construction.

General Information

- Size:
  - Total 7,730 square feet
  - North Restroom/Pavilion – 3,248 sf (enclosed restroom portion is 868 sf, the rest is open construction) – constructed in about 2002
  - Concessions – 470 sf – constructed in 1985
  - Park Maintenance – 1,440 sf – possibly constructed in 1985
  - South Restroom – 356 – date unknown
  - Picnic Shelter – 2,216 sf (open construction, no enclosing walls) – date unknown
- All buildings are single story on grade
- Schedule
  - Seasonal use only
  - The park is open to the public from 10:00 am – 7:00 pm every day during the summer

The Building Envelope provides the first defense against energy use. The envelope includes the roof, walls, windows and doors. Typical problems include areas that are not insulated well and areas of air leakage (infiltration).

- North Restroom/Pavilion
  - Walls are split face block, vinyl siding on gable ends. Roof is sloped with asphalt shingles. Small glass block windows. Doors are hollow metal. There is no insulation in the building (it is not heated). The picnic pavilion portion is not enclosed
  - Building appears to be in very good condition.
- Concessions
  - Walls are block, wood T-111 board on gable ends. Roof is sloped with asphalt shingles. Windows are glass block. Doors are hollow metal. There is no insulation in the building (it is not heated).

- o Building appears to be in fair condition.
- Park Maintenance
  - o Pole barn construction with metal siding and standing seam low slope metal roof. No windows. Hollow metal man-doors and sliding vehicle doors. There is no insulation in the building (it is not heated).
  - o Building appears to be in good condition.
- South Restroom
  - o Walls are split face block, vinyl siding on gable ends. Roof is sloped with asphalt shingles. No windows. Doors are hollow metal. There is no insulation in the building.
  - o Building appears to be in very good condition.
- Picnic Shelter
  - o No walls, windows or doors, the building is not enclosed. Metal siding on gable ends. Roof is sloped with metal roof.
  - o Building appears to be in good condition.

Mechanical systems are important because they consume a significant portion of a building's energy. The primary mechanical systems include heating, cooling, and ventilating systems and controls. Typical problems include poor insulation, equipment or systems that do not function as intended and equipment with low energy efficiency.

- North Restroom/Pavilion
  - o Building is not heated or cooled
  - o Rooftop exhaust fan for toilet room exhaust, operated with light switches
- Concessions
  - o Building is not heated or cooled. No mechanical system other than the AC unit listed below.
  - o Window air conditioner stored in the attic, Whirlpool model ACD052 PR1, 5,000 Btuh, R-22 refrigerant, 9.7 EER
- Park Maintenance
  - o Building is not heated or cooled. No mechanical systems.
- South Restroom
  - o Small electric heater in the Janitor/plumbing room between toilet rooms. Reportedly installed because there have been instances of frozen piping in the winter even though the piping is blown out in the fall.
  - o Exhaust fan(s), controlled by light switch
- Picnic Shelter
  - o Building is not heated or cooled. No mechanical systems.

Plumbing Systems consume both energy and water. The primary plumbing systems include the domestic water heater and plumbing fixtures and piping. Typical problems include poor insulation, equipment or systems that do not function as intended, equipment with low energy efficiency, and fixtures with excessive water usage.

- Natural gas – there is no natural gas used on site
- North Restroom/Pavilion
  - o 1 exterior drinking fountain
  - o 7 water closets with automatic flush valves – 1.6 gpf (gallons per flush)
  - o 3 urinals with automatic flush valves –1.0 gpf (gallons per flush)
  - o 6 lavatories with automatic sensor faucets
  - o 1 janitor's service sink
  - o Water heater – A.O. Smith, electric heater, 1500 watts, 5 gallon capacity
  - o 4 electric hand dryers

- Concessions
  - 1 sink
  - Water heater – Reliance model 606, electric heater, 4500 watts, 30 gallon capacity
- Park Maintenance
  - No plumbing systems
- South Restroom
  - 1 exterior drinking fountain
  - 4 water closets with automatic flush valves – 1.6 gpf (gallons per flush)
  - 2 urinals with automatic flush valves –1.0 gpf (gallons per flush)
  - 4 lavatories with automatic sensor faucets
  - 1 janitor's service sink
  - Water heater – Lochinvar model JRC012E, electric heater, 1500 watts, 12 gallon capacity
  - 4 electric hand dryers
- Picnic Shelter
  - No plumbing systems

Electrical systems also consume a substantial part of a building's energy. Electrical systems include lighting, lighting controls and power. Typical problems include inadequate lighting control, inappropriate lamp selection and inefficient motors.

- Electric provider – Consumers Energy, meter #81770526
- A schedule of light fixtures observed in the building is included in this report. Following is a summary by fixture type for all five buildings combined.

McDonald Park Light Fixture Summary				
Fixture Type	Number of Fixtures	% of Total Number of Fixtures	Total Watts	Total KWH*
Incandescent	97	93%	6,500	6,870
T12 Fluorescent	5	5%	450	806
Metal Halide	2	2%	383	1,673
Total	104		7,333	9,349
* Assumed operating schedule as shown in the Light Fixture Inventory in this report				

- North Restroom/Pavilion
  - Interior and exterior lights at the toilet rooms. Exterior lights in the open picnic area. Exterior lights are controlled by a time clock, clock is set for 6:00 pm – 1:00 am. Toilet room lights have an occupancy sensor.
- Concessions
  - 100 amp MB panelboard, 120/240 volt
  - Interior lights only. Manual control, no automatic controls
- Park Maintenance
  - 100 amp MLO panel, 8 spaces, 60A/2P main disconnect
  - Interior and exterior lights. Exterior light has an integral photo-eye. Interior lights are manual, no automatic controls.
- South Restroom
  - 100 amp MLO panel, no main disconnect
  - Interior and exterior lights. Exterior lights have a photo-eye. Interior lights are manual, no automatic controls.

- Picnic Shelter
  - "Interior" and exterior lights. Exterior light has a photo-eye. "Interior" lights are controlled by a manual switch (not keyed), no visible photocell control.

Plug Loads are defined as equipment in the building that is connected to power receptacles, i.e. no permanent electrical connection. Plug load equipment can consume a significant amount of electricity over the course of time. Typical plug load issues include inefficient equipment, equipment that is not turned off when not in use, and inappropriate use of equipment (e.g. electric heaters under desks).

- North Restroom/Pavilion
  - Receptacles for public use in the picnic pavilion area
- Concessions
  - A variety of different types of concession equipment
- Park Maintenance
  - Various power tools and a portable air compressor
- South Restroom
  - General use receptacles, no equipment loads
- Picnic Shelter
  - Receptacles for public use

Occupancy / Operations / Schedule – How a building is used can have a significant impact on the building's energy usage. In fact attitudes and actions of the building users and operational staff can sometimes be the biggest factor in energy waste. It is critical that building occupants are provided with information on how to minimize energy use, the proper tools to do so, and an educational process to continually remind them how to most effectively use the building.

- Schedule
  - Seasonal use only
  - The park is open to the public from 10:00 am – 7:00 pm every day during the summer

Building Energy Cost Information – Electrical

Electricity Usage

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	392	7.99	44	52
February	866	8.00	99	107
March	463	8.00	53	61
April	400	16.00	45	61
May	1478	8.00	174	182
June	2513	8.00	284	292
July	1890	10.95	219	230
August	2250	15.00	258	273
September	1005	15.00	111	126
October	937	15.00	94	109
November	415	15.00	42	57
December	380	15.00	37	52
2008	**12,609**	**127**	**1,422**	**1,549**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	440	15.00	48	63
February	765	15.00	99	114
March	0	15.00	0	15
April	109	15.00	11	26
May	2146	15.00	224	239
June	2554	15.96	306	322
July	1773	17.81	200	218
August	2175	17.81	246	263
September	0	17.81	0	18
October	341	17.81	39	56
November	216	17.81	24	42
December	203	19.66	21	40
2009	**11,102**	**215**	**1,256**	**1,470**

Total	**23,711**	**342**	**2,678**	**3,019**
Some meter readings may be estimated				

Electricity Totals	
Square Footage	7,730
Average Annual Cost	1,510
Cost/SF/Year	0.20
EUI (MBtu/SF/Year)	5.2

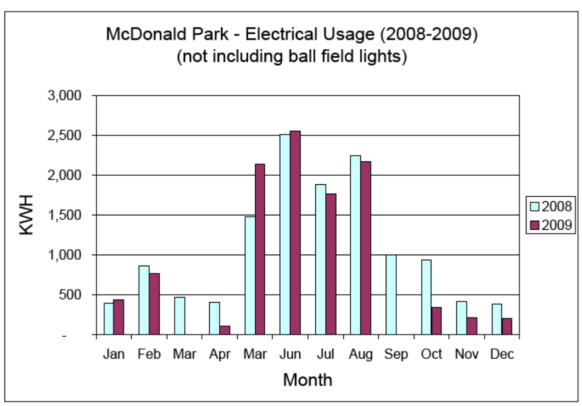
Electricity Totals	
Average KWH/Year	11,856
Average MMBtu/Year	40
Average Cost/KWH	0.127
Cost/KWH w/o Fixed	0.113
Average Cost/MMBtu	37.31
Cost/SF/Year	0.20
EUI (MBtu/SF/Year)	5.2

No gas usage at this site

Notes

3,413 Btu/KWH
Jul-09 thru Nov-09 costs are interpolated from other data. KWH are correct from bills for this period.

Does not include ball fields



Behavioral, Operations and Maintenance Improvements (BOMIs)
Narrative Descriptions

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

1. ***Install Timer on Water Heaters (Concessions & Restrooms)*** – Install a timed control that would shut off power to the water heaters when the concessions & restrooms are typically closed. It appears that at this time the heaters are on 24 hours/day even when the faucets are not in use. Typically a time clock would be used for this application, with provisions such as battery backup to prevent inaccurate timing during power outages.
2. ***Replace Incandescent Lamps (All Buildings)*** – Replace incandescent lamps with CFL lamps. In general this can be done by simply removing the incandescent lamp and screwing in a new CFL lamp.
3. ***Replace or Retrofit T12 Fixtures (All Buildings)*** – Replace existing T12 light fixtures with T8 fluorescent fixtures, or retrofit the existing T12 fixtures to utilize T8 lamps. If fixture retrofits are considered, be sure that the replacement ballasts and sockets are suitable to utilize the full energy savings of the T8 lamps.
4. ***Install Occupancy Sensors (All Buildings)*** – Install occupancy sensors where applicable throughout the buildings. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.
5. ***Install Lighting Controls (Picnic Shelter)*** – Install a timed or photosensitive control to shut off the lights when not in use. At this time the lights can be manually switched on by any member of the public, and left on all night unless manually switched off again. A time clock to prevent operation when the park is closed, a twist timer to automatically shut off the lights after a defined period of time, or a photocell to prevent operation during daylight hours, would minimize the possibility of unnecessary usage.

Energy Conservations Measures (ECMs)
Narrative Descriptions

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

1. ***Insulate Walls & Ceiling (Restroom Service Closet)*** – Insulate the walls (and roof/ceiling) of the service closet, which is reportedly heated all winter long to prevent freezing. The original design did not include heat in this room, so it appears that there is no insulation in the walls or roof. Insulation would probably be easiest to install inside the service closet rather than on the exterior, and could be installed on only the accessible portions of the walls and ceilings instead of throughout the whole room.

ECM Detailed Description Forms

The following pages contain "ECM Detailed Description Forms". A page is dedicated to each ECM, and that ECM is described in detail along with some cost, savings, and payback information.

The costs to implement each ECM are based on industry cost estimating guides and on the A/E's experience with similar projects. Savings are estimated based on the best available information on energy usage and system operation. Costs or savings could vary from the figures shown above depending on market and economic conditions at the time the work is performed and depending on the validity of the assumptions used to generate these estimates. The information presented is valuable for planning purposes, but it is recommended that more detailed budgets or firm quotes be obtained for projects prior to a final decision to implement any improvement.

based on utility bill data from 2008-2009, the following utility costs were used for the savings and payback analyses for each ECM. These unit costs are the commodity cost only, without the fixed monthly charges.

Electricity $0.113/KWH

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: McDonald Park	
ECM NUMBER: 1	
ECM NAME: Insulate Walls & Ceiling (Restroom Service Closet)	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- No insulation in building walls
- The restroom service closet is heated all winter long to prevent freezing
- Assumed existing R-value of about R-2.0, including film coefficients
- About 350 square feet of uninsulated wall surface and 50 sf of uninsulated ceiling (including exterior wall and walls exposed to the adjacent toilet rooms) – total of about 400 sf of uninsulated surface

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation to the walls. Many different options exist, with differing insulation values, costs and aesthetics. The most viable option is probably to install insulation on the interior walls with a drywall interior finish.
- Insulation and drywall can be applied to the entire room interior or to only the areas where larger areas of wall are exposed with out significant interfering objects
- Assume a project that adds 1" of rigid insulation to 75% of the interior surfaces and has a cost of $10/sf
- New R-value of about R-7, including film coefficients
- 300 sf x [(1/2.0) – (1/7.0)] R-value x 1126 DD/year (base 32F) x 24 hr/day = 2,895 MBtu/year energy savings
- 100% efficient electric heat = 848 KWH/year = **$96/year savings**
- Cost = 300 sf x $10/sf = $3,000
- Payback = 31.3 years

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**3,000**
Total Estimated Annual Savings ($)	**96**
Simple Payback (Years)	**31.3**
Estimated Useful Life (Years)	**30**

McDonald Park
Light Fixture Inventory
April 2010

	Existing Fixtures				Assumed Schedule					
Room Name	Number Of Fixtures	Lamp Type	Fixture Watts	Total Load (W)	Hours per Day	Days Per Week	Weeks Per Year	Hours Per Year	Total Energy (KWH)	Comments
North Restroom/Pavilion - toilet	18	Incandescent 60 Watt	60	1080	6	7	40	1680	1814	occ. Sensor
North Restroom/Pavilion - toilet	18	Incandescent 60 Watt	60	1080	6	7	40	1680	1814	occ. Sensor
North Restroom/Pavilion - exterior	32	Incandescent 60 Watt	60	1920	2	7	40	560	1075	time clock 6pm-1am
North Restroom/Pavilion - mechanical	2	Incandescent 100 Watt	100	200	1	7	40	280	56	
Concessions Building - interior	8	Incandescent 60 Watt	60	480	4	2	16	128	61	
Concessions Building - interior (attic)	1	Incandescent 100 Watt	100	100	1	1	16	16	2	
Park Maintenance - exterior	1	HID 70 Watt	95	95	12	7	52	4368	415	photo-eye
Park Maintenance - Interior	6	Incandescent 100 Watt	100	600	8	7	40	2240	1344	
Park Maintenance - Interior	1	4 foot - 2 lamp T12	90	90	8	7	40	2240	202	
South Restroom - toilet	1	4 foot - 2 lamp T12	90	90	6	7	40	1680	151	
South Restroom - toilet	1	4 foot - 2 lamp T12	90	90	6	7	40	1680	151	
South Restroom - toilet	1	4 foot - 2 lamp T12	90	90	6	7	40	1680	151	
South Restroom - toilet	1	4 foot - 2 lamp T12	90	90	6	7	40	1680	151	
South Restroom - exterior	4	Incandescent 60 Watt	60	240	2	7	52	728	175	photo-eye
South Restroom - mech	2	Incandescent 100 Watt	100	200	12	2	40	960	192	
Picnic Shelter - Exterior	1	HID 250 Watt	288	288	12	7	52	4368	1258	photo-eye
Picnic Shelter - interior	6	Incandescent 100 Watt	100	600	2	7	40	560	336	
Totals	104			**7333**					**9349**	


North Restroom / Pavilion


North Restroom / Pavilion


North Restroom / Pavilion


North Restroom / Pavilion


South Restroom


South Restroom


Concessions


Concessions


Park Maintenance


Park Maintenance


Picnic Shelter


Picnic Shelter


Picnic Shelter

Jameson Park

Union Township, MI

5142 & 5144 Bud Street

Date of Construction: Various Years

Current Size: 5,319 Square Feet (three buildings/structures)

The table below is a simple metric to illustrate how well this building utilizes energy. The scores are based largely on the building performance requirements of the Michigan Energy Code, ASHRAE Standard 90.1, but also on subjective criteria from the field observations in each building.

The scoring is as follows:

- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

The following Building Overall Description and Observations section of this report provides additional insight into the factors that were used to determine these scores.

Energy Performance	
Jameson Park	
Description	**Score**
Envelope	
Roof	**Fair**
Walls	**Fair**
Windows	**Good**
Infiltration	**Good**
Mechanical	
Heating System	**Good**
Cooling System	**Good**
Domestic Hot Water	**Good**
Insulation	**Good**
Controls	**Poor**
Electrical	
Lighting	**Fair**
Lighting Controls	**Poor**
OVERALL CONDITION	**FAIR**

Building Overall Description & Observations

The performance of this energy audit included a field assessment of the building. This section of the report discusses some of conditions that were observed. This is not intended to be a comprehensive discussion of all building deficiencies. However the items discussed represent the conditions found and the general condition of the building. Many of the potential energy improvements that are presented in this report are based on the discussions below.

Jameson Park has three buildings on site. Two of the buildings are used seasonally and are not used in the winter. The park buildings in this report are as follows

- Community Center – Large group gatherings
- Restroom – Toilet building (two men's and two women's toilet rooms)
- Picnic Shelter – Open picnic shelter

The restroom building appears to be relatively new. The community center and picnic pavilion appear to be somewhat older. The age of most of these buildings is unknown. In general the buildings appear to be maintained in good condition, particularly the newer restroom building.

The photographs included in this report illustrate some aspects of the building construction.

General Information

- Size:
  - Total 5,319 square feet
  - Community Center – 2,578 sf – date unknown
  - Restroom – 356 – constructed in 2000
  - Picnic Shelter – 2,385 sf (open construction, no enclosing walls) – date unknown
- All buildings are single story on grade
- Schedule
  - Community Center – Year round use, no regular schedule (as scheduled for various groups and events)
  - Restroom and Picnic Shelter – Seasonal use only
  - The park is open to the public from 10:00 am – 7:00 pm every day during the summer

The Building Envelope provides the first defense against energy use. The envelope includes the roof, walls, windows and doors. Typical problems include areas that are not insulated well and areas of air leakage (infiltration).

- Community Center
  - The building was built in two phases, with the south half built first and the north half built more recently. The original portion appears to be a pre-engineered metal building or pole barn construction with metal exterior panels. The newer portion is stud wall construction with metal exterior panels. Vinyl siding on gable ends. It is presumed that the walls are insulated with batt insulation. The thermal images clearly show the framing on the south half, there is probably no insulation covering the framing members.
  - Roof is sloped with asphalt shingles. The roof on the older half appears to have originally been a flat built-up roof but has since been covered with a new structure. Roof insulation on the older half appears to be only the original insulation in the original roof structure, batt insulation that appears to be mineral fiber or a similar material, nominally 3" thick. The roof insulation on the newer half could not be seen, there is a drywall lid installed at the bottom of the roof trusses. It is assumed that batt insulation is installed at the truss bottom.
  - One window, on the south side, double pane insulated glass. The window has a broken seal and condensation between panes.
  - Doors are hollow metal, seals appear to be in good condition.
  - Roof mounted light tubes are installed in the two toilet rooms, allowing a substantial amount of daylight into these rooms.

- Restroom
  - Walls are split face block, vinyl siding on gable ends. Roof is sloped with asphalt shingles. No windows. Doors are hollow metal. The construction drawings do not show any insulation in the building. The building is used (and heated) only seasonally.
  - Building appears to be in very good condition.
- Picnic Shelter
  - No walls, windows or doors, the building is not enclosed. Metal siding on gable ends. Roof is sloped with metal roof.
  - Building appears to be in good condition.

Mechanical systems are important because they consume a significant portion of a building's energy. The primary mechanical systems include heating, cooling, and ventilating systems and controls. Typical problems include poor insulation, equipment or systems that do not function as intended and equipment with low energy efficiency.

- Community Center
  - Heating
    - The building is heated by two gas fired furnaces.
    - Furnaces – Goodman, model GMS 90904CXA, 92 MBH natural gas input, 86 MBH output, 93% efficiency. The furnaces include cooling coils. Furnaces appear to be relatively new and in good condition.
    - Outside ventilation air is introduced through shutoff dampers.
    - Thermostats are electric, manually adjustable up and down, not programmable.
  - Cooling
    - Cooling is provided by the furnaces with cased cooling coils and remote condensing units.
    - Remote condensing units – Goodman, model GSC130481AA. Nominal 4 tons cooling capacity each, 13 EER, R-22 refrigerant. Units appear to be relatively new and in good condition.
  - Ductwork was observed in the furnace room and at one location above the ceiling in the older half of the building. Where ductwork was observed it was insulated. Insulated ductwork is run through the cold attic.
- Restroom
  - Electric heater in each of the four toilet rooms
  - Small electric heater in the Janitor/plumbing room between toilet rooms.
  - Exhaust fan(s), controlled by light switch
- Picnic Shelter
  - Building is not heated or cooled. No mechanical systems.

Plumbing Systems consume both energy and water. The primary plumbing systems include the domestic water heater and plumbing fixtures and piping. Typical problems include poor insulation, equipment or systems that do not function as intended, equipment with low energy efficiency, and fixtures with excessive water usage.

- Natural gas provider – Consumers Energy, meter #25342154
- Community Center
  - 4 water closets with automatic flush valves – 1.6 gpf (gallons per flush)
  - Sink in the kitchenette
  - 4 lavatories, older, with pull-on handles
  - Two water heaters
    - A.O. Smith, electric heater, 1500 watts, 2 or 5 gallon capacity
    - Lochinvar, electric heater, appears to be 30 gallons
  - 2 electric hand dryers

- Restroom
  - 1 exterior drinking fountain
  - 4 water closets with automatic flush valves – 1.6 gpf (gallons per flush)
  - 2 urinals with automatic flush valves –1.0 gpf (gallons per flush)
  - 4 lavatories with automatic sensor faucets
  - 1 janitor's service sink
  - Water heater – Lochinvar model JRC012E, electric heater, 1500 watts, 12 gallon capacity
  - 4 electric hand dryers
- Picnic Shelter
  - No plumbing systems

Electrical systems also consume a substantial part of a building's energy. Electrical systems include lighting, lighting controls and power. Typical problems include inadequate lighting control, inappropriate lamp selection and inefficient motors.

- Electric provider – Consumers Energy
  - Community Center – meter #81635997
  - Restroom Building – meter #81824415
- A schedule of light fixtures observed in the building is included in this report. Following is a summary by fixture type for all three buildings combined.

Jameson Park Light Fixture Summary				
Fixture Type	Number of Fixtures	% of Total Number of Fixtures	Total Watts	Total KWH*
CFL	4	6%	62	39
Incandescent	11	16%	940	1,440
T8 Fluorescent	16	24%	1,698	1,236
T12 Fluorescent	27	40%	2,430	2,046
Metal Halide	5	7%	475	2,075
High Pressure Sodium	1	1%	464	2,027
Incandescent Exit	2	3%	40	29
LED Exit	2	3%	4	3
Total	68		6,113	8,895
* Assumed operating schedule as shown in the Light Fixture Inventory in this report				

- Community Center
  - 200 amp 120/240 volt single phase MB panel with 100 amp subfeed panel.
  - Interior and exterior lights. Exterior lights are controlled by a photo-eye. Interior lights are all manual, no automatic control.
- Restroom
  - 100 amp MB panelboard
  - Interior and exterior lights. Exterior lights have a photo-eye. Interior lights are manual, no automatic control.
- Picnic Shelter
  - "Interior" lights only. Lights are controlled by a manual switch (not keyed), no visible photocell control.

Plug Loads are defined as equipment in the building that is connected to power receptacles, i.e. no permanent electrical connection. Plug load equipment can consume a significant amount of electricity over the course of time. Typical plug load issues include inefficient equipment, equipment that is not turned off when not in use, and inappropriate use of equipment (e.g. electric heaters under desks).

- Community Center
  - Residential refrigerator
- Restroom
  - General use receptacles, no equipment loads
- Picnic Shelter
  - Receptacles for public use

Occupancy / Operations / Schedule – How a building is used can have a significant impact on the building's energy usage. In fact attitudes and actions of the building users and operational staff can sometimes be the biggest factor in energy waste. It is critical that building occupants are provided with information on how to minimize energy use, the proper tools to do so, and an educational process to continually remind them how to most effectively use the building.

- Schedule
  - Community Center – Year round use, no regular schedule (as scheduled for various groups and events)
  - Restroom and Picnic Shelter – Seasonal use only
  - The park is open to the public from 10:00 am – 7:00 pm every day during the summer

Building Energy Cost Information – Electrical & Natural Gas

Electricity Usage
Community Center & Picnic Shelter

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	806	8.01	92	100
February	749	8.00	87	95
March	423	8.00	49	57
April	624	8.00	72	80
May	473	8.00	57	65
June	361	8.00	41	49
July	763	11.50	85	96
August	810	15.00	94	109
September	569	15.00	63	78
October	440	15.00	45	60
November	597	15.00	62	77
December	546	15.00	54	69
2008	**7,161**	**135**	**800**	**934**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	951	15.00	106	121
February	211	15.00	23	38
March	471	15.00	52	67
April	323	15.00	34	49
May	293	15.00	31	46
June	432	15.96	52	68
July	372	15.96	45	61
August	828	17.81	92	110
September	153	17.81	17	35
October	411	17.81	46	63
November	234	17.81	26	44
December	661	19.66	62	82
2009	**5,340**	**198**	**586**	**784**

Total	**12,501**	**332**	**1,386**	**1,718**

Some meter readings may be estimated

Electricity and Gas Totals	
Square Footage	4,963
Average Annual Cost	2,144
Cost/SF/Year	0.43
EUI (MBtu/SF/Year)	24.3

Electricity Totals	
Average KWH/Year	6,251
Average MMBtu/Year	21
Average Cost/KWH	0.137
Cost/KWH w/o Fixed	0.111
Average Cost/MMBtu	40.26
Cost/SF/Year	0.17
EUI (MBtu/SF/Year)	4.3

Natural Gas Totals	
Average CCF/Year	964
Average MMBtu/Year	99
Average Cost/CCF	1.334
Cost/CCF w/o Fixed	1.207
Average Cost/MMBtu	12.95
Cost/SF/Year	0.26
EUI (MBtu/SF/Year)	20.0

Notes

103,000 Btu/CCF
3,413 Btu/KWH
Aug-09 thru Nov-09 costs are interpolated from other data.
KWH & CCF are correct from bills for this period.

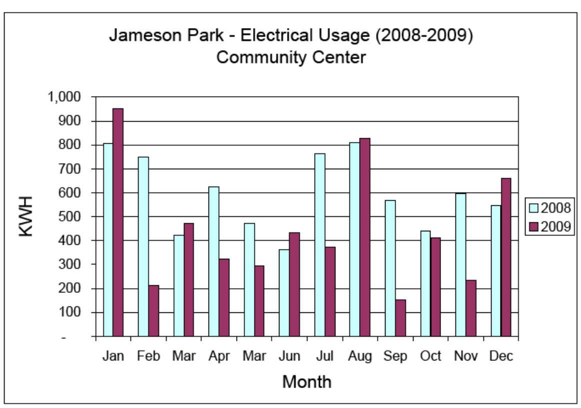
Natural Gas Usage
Community Center & Picnic Shelter

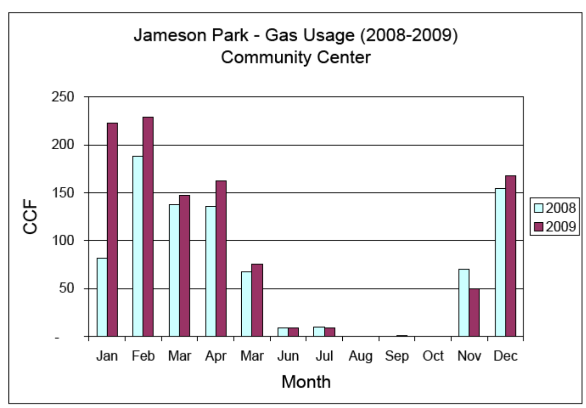
Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	82	10.00	78	88
February	188	10.00	180	190
March	138	10.00	132	142
April	136	10.00	147	157
May	67	10.00	72	82
June	9	10.00	10	20
July	10	10.00	12	22
August	0	10.00	0	10
September	0	10.00	0	10
October	0	10.00	0	10
November	70	10.00	70	80
December	154	10.00	155	165
2008	**854**	**120**	**856**	**976**

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	223	10.32	225	235
February	229	10.50	231	242
March	147	10.50	177	188
April	162	10.50	150	160
May	75	10.50	69	79
June	9	10.50	8	19
July	9	10.50	9	19
August	0	10.50	0	11
September	1	10.50	1	12
October	0	10.50	0	11
November	50	10.50	60	71
December	168	10.50	539	550
2009	**1,073**	**126**	**1,469**	**1,595**

Total	**1,927**	**246**	**2,325**	**2,571**

Some meter readings may be estimated





Electricity Usage
Restroom Building

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	0	15.99	0	16
February	18	8.00	2	10
March	0	16.00	0	16
April	21	8.00	2	10
May	12	8.00	1	9
June	19	8.00	2	10
July	154	11.50	17	28
August	136	15.00	16	31
September	153	15.00	17	32
October	136	15.00	14	29
November	100	15.00	10	25
December	84	15.00	8	23
2008	**833**	**150**	**90**	**241**

Electricity Totals	
Square Footage	356
Average Annual Cost	249
Cost/SF/Year	0.70
EUI (MBtu/SF/Year)	6.6

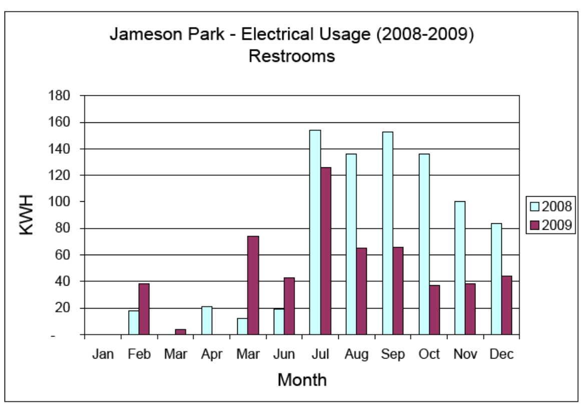
Electricity Totals	
Average KWH/Year	684
Average MMBtu/Year	2
Average Cost/KWH	0.365
Cost/KWH w/o Fixed	0.110
Average Cost/MMBtu	106.84
Cost/SF/Year	0.70
EUI (MBtu/SF/Year)	6.6

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	0	15.00	0	15
February	38	15.00	4	19
March	4	15.00	0	15
April	0	15.00	0	15
May	74	15.00	8	23
June	43	15.96	5	21
July	126	15.96	15	31
August	65	17.81	7	25
September	66	17.81	7	25
October	37	17.81	4	22
November	38	17.81	4	22
December	44	19.66	5	24
2009	**535**	**198**	**60**	**258**

Total	**1,368**	**348**	**151**	**499**
Some meter readings may be estimated				

No gas usage at this building

Notes
3,413 Btu/KWH Aug-09 thru Nov-09 costs are interpolated from other data. KWH & CCF are correct from bills for this period.



Behavioral, Operations and Maintenance Improvements (BOMIs) Narrative Descriptions

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

Community Center

1. ***Replace Thermostats*** – Install programmable thermostats to index the furnaces to a setback (winter) or setup (summer) temperature when the building is not in use. The existing thermostats are manually controlled, making it more difficult to match the temperature settings to the building use. This setback/ setup function could also be accomplished by installing a twist timer to set the occupied temperature, automatically reverting to the setback/ setup temperature after a defined period of time.
2. ***Install Timer on Water Heater*** – Install a timed control that would shut off power to the water heaters when the building is typically closed. It appears that at this time the heaters are on 24 hours/day even when the faucets are not in use. Typically a time clock would be used for this application, with provisions such as battery backup to prevent inaccurate timing during power outages.
3. ***Replace or Retrofit Incandescent Exit Lights*** – Replace incandescent exit signs with LED fixtures, or convert using retrofit kits. Since these lights are on 24 hours a day, this BOMI will significantly reduce their energy use.

Restrooms

4. ***Install Timer on Water Heater*** – Install a timed control that would shut off power to the water heater when the restrooms are typically closed. It appears that at this time the heater is on 24 hours/day even when the faucets are not in use. Typically a time clock would be used for this application, with provisions such as battery backup to prevent inaccurate timing during power outages.
5. ***Replace Incandescent Lamps*** – Replace incandescent lamps with CFL lamps. In general this can be done by simply removing the incandescent lamp and screwing in a new CFL lamp.

Picnic Shelter

6. ***Replace Incandescent Lamps*** – Replace incandescent lamps with CFL lamps. In general this can be done by simply removing the incandescent lamp and screwing in a new CFL lamp.
7. ***Install Lighting Controls (Picnic Shelter)*** – Install a timed or photosensitive control to shut off the lights when not in use. At this time the lights can be manually switched on by any member of the public, and left on all night unless manually switched off again. A time clock to prevent operation when the park is closed, a twist timer to automatically shut off the lights after a defined period of time, or a photocell to prevent operation during daylight hours, would minimize the possibility of unnecessary usage.

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

Community Center

1. ***Improve Wall Insulation*** – Add insulation to the exterior wall, particularly the south half of the building where the thermal images show the wall framing. Improvements to wall insulation are difficult because an improvement often means adding layers of some material to either the interior or exterior of the walls. This causes both practical and aesthetic issues, including detailing at window and door openings and how to incorporate objects that are in or fastened to the walls. Several insulation options are available including adding exterior rigid insulation and a new layer of brick or block to the exterior; installing an exterior insulation finish system (EIFS) over the existing; or adding furring with rigid insulation or stud walls with fiberglass insulation (and a layer of drywall) to the interior. In the case of this building, the best solution is probably removal of the exterior siding, the addition of a layer of continuous rigid insulation, and the installation of new, or replacement of the existing, siding material.

   Costs will also vary considerably depending on the solution chosen and the installation difficulty. A new brick or block veneer with insulation or new EIFS exterior will likely cost on the order of $15-$25/sf. An interior solution may be less expensive, particularly in larger or less finished areas, but durability must be considered vs. the existing block. Estimated savings and paybacks for various scenarios are shown in the table below.

Estimated Energy Savings – Additional Wall Insulation						
Type of Wall	Existing R-value	New R-Value	Energy Savings Btu/sf/yr	Estimated Cost/sf		
				Lo	Med	Hi
No Existing Insulation Block and brick, no insulation, no air gap	About 2.5	12.5	67,200	$10	$15	$25
Minor Existing Insulation E.g. insulation in block cores	About 3.5	13.5	44.450	$10	$15	$25
Savings are based on heating loads only, 7000 heating degree days, 80% boiler efficiency Buildings that are air conditioned will have more energy savings						

2. ***Add Roof Insulation*** – Add insulation to the roof on the south half of the building, which appears to have only a nominal 3” layer of older (rock wool?) insulation. The roof insulation on the north half is thought to be much higher R-value, but this insulation should also be verified and improved upon if appropriate.
3. ***Replace or Retrofit T12 Fixtures*** – Replace existing T12 light fixtures with T8 fluorescent fixtures, or retrofit the existing T12 fixtures to utilize T8 lamps. If fixture retrofits are considered, be sure that the replacement ballasts and sockets are suitable to utilize the full energy savings of the T8 lamps.
4. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

Restrooms

5. ***Replace or Retrofit T12 Fixtures*** – Replace existing T12 light fixtures with T8 fluorescent fixtures, or retrofit the existing T12 fixtures to utilize T8 lamps. If fixture retrofits are considered, be sure that the replacement ballasts and sockets are suitable to utilize the full energy savings of the T8 lamps.
6. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

The following pages contain "ECM Detailed Description Forms". A page is dedicated to each ECM, and that ECM is described in detail along with some cost, savings, and payback information.

The costs to implement each ECM are based on industry cost estimating guides and on the A/E's experience with similar projects. Savings are estimated based on the best available information on energy usage and system operation. Costs or savings could vary from the figures shown above depending on market and economic conditions at the time the work is performed and depending on the validity of the assumptions used to generate these estimates. The information presented is valuable for planning purposes, but it is recommended that more detailed budgets or firm quotes be obtained for projects prior to a final decision to implement any improvement.

based on utility bill data from 2008-2009, the following utility costs were used for the savings and payback analyses for each ECM. These unit costs are the commodity cost only, without the fixed monthly charges.

Electricity	$0.111/KWH
Natural Gas	$1.207/CCF

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Jameson Park	
ECM NUMBER:	**1 (Community Center)**
ECM NAME:	**Improve Wall Insulation**

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing stud and pre-engineered metal structure with insulation and siding. It appears that the original construction (south half) is pre-engineered metal building and that the addition (north half) is stud construction.
- Batt insulation, thickness and R-value unknown. Thermal bridging is apparent at the structural members. The original portion of the building, on the south half, shows more heat loss than the north half.
- Assumed existing R-value of about R-12.0 in the cavities between structural elements, including film coefficients
- Approximately overall R-value is assumed to be about R-9.0 with the structural bridging, including film coefficients
- About 2,330 square feet of wall surface

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation to the walls. Many different options exist, with differing insulation values, costs and aesthetics. Some of the potential options include:
  - o Add rigid or spray-on insulation, finish with new brick veneer or EIFS (Exterior Insulation Finish System, such as Dryvit or equivalent)
  - o Remove the existing metal siding, add rigid or spray-on insulation, reinstall the existing siding
  - o Install an insulated metal panel system over the existing exterior
  - o Add furring or stud walls on the interior with insulation between studs/furring strips, finish with drywall interior
- The easiest and most cost effective solution is probably removal and replacement of the existing siding with new insulation board underneath.
- The aesthetics of the finished wall are a critical part of any decision on whether or not to proceed with this ECM or what type of finish to use. Costs will vary depending on the finish and the number of window/door openings and wall mounted items.
- Assume a project that adds 2" of insulation and has a cost of $10/sf
- New R-value of about R-19.0, including film coefficients
- 2,330 sf x [(1/9.0) – (1/19.0)] R-value x 7329 DD/year x 24 hr/day = 23,967 MBtu/year energy savings
- Assume 90% heating system efficiency = 26,630 MBtu/year boiler input = 259 CCF = **$312/year savings**
- Cost = 2,330 sf x $10/sf = $23,300
- Payback = 74.7 years

This project may be implemented over the entire building or in selected sections where implementation may be easier because of the wall configuration. A cost effective exterior solution is critical to the payback.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**23,300**
Total Estimated Annual Savings ($)	**312**
Simple Payback (Years)	**74.7**
Estimated Useful Life (Years)	**30**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Jameson Park	
ECM NUMBER: 2 (Community Center)	
ECM NAME: Add Roof Insulation	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Older mineral fiber insulation batts at the original flat roof of the original building (south half). No other roof insulation apparent on this portion of the building.
- Assumed existing R-value of about R-12.0
- About 1,600 square feet of surface on the south half
- The R-value of the building addition (north half) is unknown

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation in the attic on the south half, either blown or batts
- Assume a project that adds 6" or more of insulation and has a cost of $1/sf
- New R-value of about R-30.0, including film coefficients
- 1,600 sf x [(1/12.0) – (1/30.0)] R-value x 7329 DD/year x 24 hr/day = 14,072 MBtu/year energy savings
- Assume 90% heating system efficiency = 15,635 MBtu/year boiler input = 152 CCF = **$183/year savings**
- Cost = 1,600 sf x $1/sf = $1,600
- Payback = 8.7 years

This project may be implemented over the entire building or in selected sections where implementation may be easier because of the wall configuration. A cost effective exterior solution is critical to the payback.

Verify insulation values in the attic on the north half, add insulation to that ceiling/attic space if appropriate.

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**1,600**
Total Estimated Annual Savings ($)	**183**
Simple Payback (Years)	**8.7**
Estimated Useful Life (Years)	**30**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Jameson Park	
ECM NUMBER: 3 (Community Center)	
ECM NAME: Replace or Retrofit T12 Fixtures	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing T12 light fixtures are installed in various areas throughout the building
- 23 fixtures
- 2,070 watts of installed lighting
- 1,441 KWH estimated annual power usage, based on assumed hours of operation (see lighting schedules in this report)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Replace existing fixtures with T8 fixtures, or retrofit existing to use T8 lamps. Retrofit is to include ballast replacement.
    - o Assume a one-for-one fixture replacement, matching the number of lamps in the existing
    - o 23 fixtures
    - o 1,334 watts of installed lighting after replacement/retrofit
    - o 929 KWH estimated annual power usage after replacement/retrofit, based on the same assumed schedule as existing
- 1,441 KWH – 929 KWH = 512 KWH energy savings = **$57/year savings**
- Cost = 23 fixtures x $150/fixture = $3,450 (replacement costs, retrofit may be less expensive)
- Payback = 60.5 years

The payback for this ECM depends significantly on the assumed operating schedule, included in the Light Fixture Inventory table in this report. The payback is long because the schedule does not show very many hours of operation in a year. Assumed usage should be verified. More usage will significantly reduce the payback.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**3,450**
Total Estimated Annual Savings ($)	**57**
Simple Payback (Years)	**60.5**
Estimated Useful Life (Years)	**25**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Jameson Park

ECM NUMBER: 4 (Community Center)

ECM NAME: Install Occupancy Sensors

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- All lights in the building are controlled by manual on/off switches, no existing occupancy sensors were found
- 3,804 watts of existing installed lighting, not including exterior lights and exit signs
- 2,704 KWH estimated existing annual power usage, based on assumed hours of operation (see lighting schedules in this report)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Install occupancy sensors to control light fixtures throughout the building
- Most fixtures in the building could be controlled by the installation of about 8-9 sensors. Assume that 9 sensors are installed.
- Assume that lighting energy will be reduced by about 1/3
- 2,704 KWH x 1/3 = 901 KWH energy savings = **$100/year savings**
- Cost = 9 zones x $150/zone = $1,350
- Payback = 13.5 years

<u>Combined project – T12 fixture replacement along with occupancy sensors</u>

- 2,298 watts of installed lighting after T12 fixture replacement, not including exterior lights and exit signs
- 1,631 KWH estimated annual power usage after T12 fixture replacement, based on assumed hours of operation (see lighting schedules in this report)
- Savings
    - Occupancy sensors: 1,631 KWH x 1/3 = 544 KWH energy savings = $60/year savings
    - T12 fixture replacement: 1,441 KWH – 929 KWH = 512 KWH energy savings = $57/year savings
    - Total: 60 + 57 = **$117/year savings**
- Cost = $1,350 (occupancy sensors) + $3,450 (T12 replacement) = $4,800

Payback = 41.0 years

The payback for this ECM depends significantly on the assumed operating schedule, included in the Light Fixture Inventory table in this report. The payback is long because the schedule does not show very many hours of operation in a year. Assumed usage should be verified. More usage will significantly reduce the payback.

It would be more cost effective to not install sensors in rooms where the savings are lower (e.g. rooms without much installed wattage or rooms that are not used much).

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**1,350**
Total Estimated Annual Savings ($)	**100**
Simple Payback (Years)	**13.5**
Estimated Useful Life (Years)	**25**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Jameson Park	
ECM NUMBER: 5 (Restrooms)	
ECM NAME: Replace or Retrofit T12 Fixtures	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing T12 light fixtures are installed in various areas throughout the building
- 4 fixtures
- 360 watts of installed lighting
- 605 KWH estimated annual power usage, based on assumed hours of operation (see lighting schedules in this report)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Replace existing fixtures with T8 fixtures, or retrofit existing to use T8 lamps. Retrofit is to include ballast replacement.
  - Assume a one-for-one fixture replacement, matching the number of lamps in the existing
  - 4 fixtures
  - 232 watts of installed lighting after replacement/retrofit
  - 390 KWH estimated annual power usage after replacement/retrofit, based on the same assumed schedule as existing
- 605 KWH – 390 KWH = 215 KWH energy savings = **$24/year savings**
- Cost = 4 fixtures x $150/fixture = $600 (replacement costs, retrofit may be less expensive)
- Payback = 25.0 years

The payback for this ECM depends significantly on the assumed operating schedule, included in the Light Fixture Inventory table in this report. The payback is long because the schedule does not show very many hours of operation in a year. Assumed usage should be verified. More usage will significantly reduce the payback

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**600**
Total Estimated Annual Savings ($)	**24**
Simple Payback (Years)	**25.0**
Estimated Useful Life (Years)	**25**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Jameson Park

ECM NUMBER: 6 (Restrooms)

ECM NAME: Install Occupancy Sensors

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- All lights in the building are controlled by manual on/off switches, no existing occupancy sensors were found
- 360 watts of existing installed lighting, not including exterior lights and exit signs
- 605 KWH estimated existing annual power usage, based on assumed hours of operation (see lighting schedules in this report)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Install occupancy sensors to control light fixtures throughout the building
- Fixtures in the building could be controlled by the installation of about 4 sensors
- Assume that lighting energy will be reduced by about 1/3
- 605 KWH x 1/3 = 202 KWH energy savings = **$22/year savings**
- Cost = 4 zones x $150/zone = $600
- Payback = 27.8 years

<u>Combined project – T12 fixture replacement along with occupancy sensors</u>

- 232 watts of installed lighting after T12 fixture replacement, not including exterior lights and exit signs
- 390 KWH estimated annual power usage after T12 fixture replacement, based on assumed hours of operation (see lighting schedules in this report)
- Savings
    - Occupancy sensors: 390 KWH x 1/3 = 130 KWH energy savings = $14/year savings
    - T12 fixture replacement: 605 KWH – 390 KWH = 215 KWH energy savings = $24/year savings
    - Total: 14 + 24 = **$38/year savings**
- Cost = $600 (occupancy sensors) + $600 (T12 replacement) = $1,200

Payback = 31.6 years

The payback for this ECM depends significantly on the assumed operating schedule, included in the Light Fixture Inventory table in this report. The payback is long because the schedule does not show very many hours of operation in a year. Assumed usage should be verified. More usage will significantly reduce the payback.

COST SUMMARY TABLE

Total Estimated Cost to Implement ($)	**600**
Total Estimated Annual Savings ($)	**22**
Simple Payback (Years)	**27.8**
Estimated Useful Life (Years)	**25**

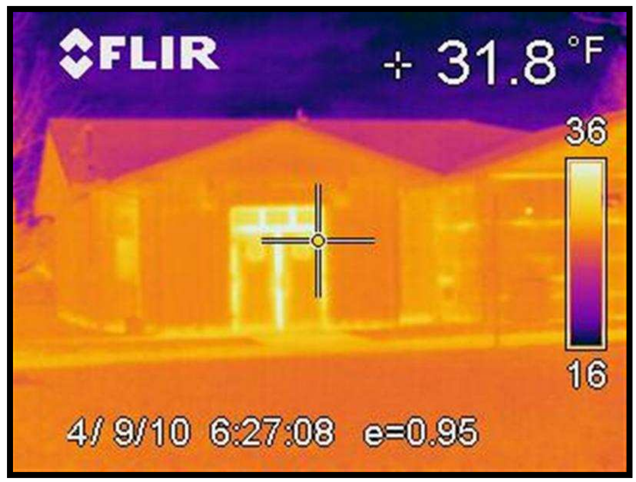
Jameson Park
Light Fixture Inventory
April 2010

	Existing Fixtures				Assumed Schedule					
Room Name	**Number Of Fixtures**	**Lamp Type**	**Fixture Watts**	**Total Load (W)**	**Hours per Day**	**Days Per Week**	**Weeks Per Year**	**Hours Per Year**	**Total Energy (KWH)**	**Comments**
Community Building - entry/storage	3	4 foot - 2 lamp T12	90	270	2	7	52	728	197	manual switch
Community Building - exterior	5	HID 70 Watt	95	475	12	7	52	4368	2075	photo-eye
Community Building - exterior	1	HPS 400 Watt	464	464	12	7	52	4368	2027	photo-eye
Community Building - gathering room	14	4 foot - 4 lamp T8	113	1582	2	7	52	728	1152	manual switch
Community Building - gathering room	12	4 foot - 2 lamp T12	90	1080	2	7	52	728	786	manual switch
Community Building - gathering room	2	Exit Sign - Incandescent	20	40	2	7	52	728	29	manual switch
Community Building - gathering room	2	Exit Sign - LED	2	4	2	7	52	728	3	manual switch
Community Building - kitchen	4	4 foot - 2 lamp T12	90	360	2	7	52	728	262	manual switch
Community Building - mechanical/stor	2	4 foot - 2 lamp T12	90	180	1	7	52	364	66	manual switch
Community Building - toilet	1	CFL 18 W	18	18	2	7	52	728	13	manual switch
Community Building - toilet	1	CFL 18 W	18	18	2	7	52	728	13	manual switch
Community Building - toilet	1	4 foot - 2 lamp T8	58	58	2	7	52	728	42	manual switch
Community Building - toilet	1	4 foot - 2 lamp T8	58	58	2	7	52	728	42	manual switch
Community Building - toilet	1	4 foot - 2 lamp T12	90	90	2	7	52	728	66	manual switch
Community Building - toilet	1	4 foot - 2 lamp T12	90	90	2	7	52	728	66	manual switch
Restroom Building - toilet	1	4 foot - 2 lamp T12	90	90	6	7	40	1680	151	manual switch
Restroom Building - toilet	1	4 foot - 2 lamp T12	90	90	6	7	40	1680	151	manual switch
Restroom Building - toilet	1	4 foot - 2 lamp T12	90	90	6	7	40	1680	151	manual switch
Restroom Building - toilet	1	4 foot - 2 lamp T12	90	90	6	7	40	1680	151	manual switch
Restroom Building - mechanical	2	CFL 13 W	13	26	6	2	40	480	12	
Restroom Building - exterior	4	Incandescent 60 Watt	60	240	12	7	52	4368	1048	photo-eye
Picnic Shelter	7	Incandescent 100 Watt	100	700	2	7	40	560	392	manual switch
Totals	**68**			**6113**					**8895**	

Community Center – Main entry

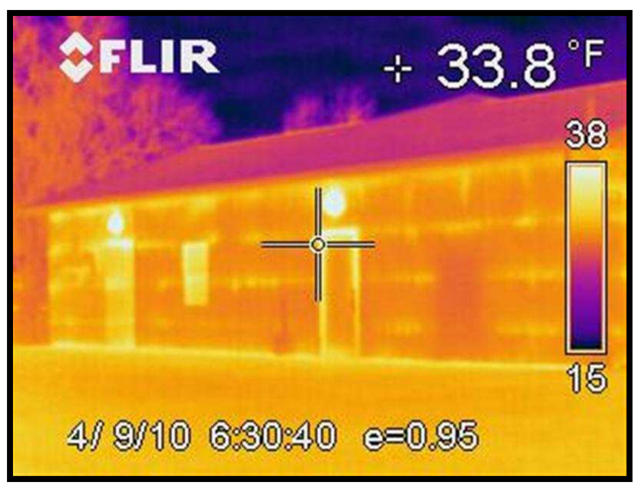
Community Center – South face

Community Center – Main entry



Community Center – Main entry – Note heat loss from window and door frame

Community Center – South face

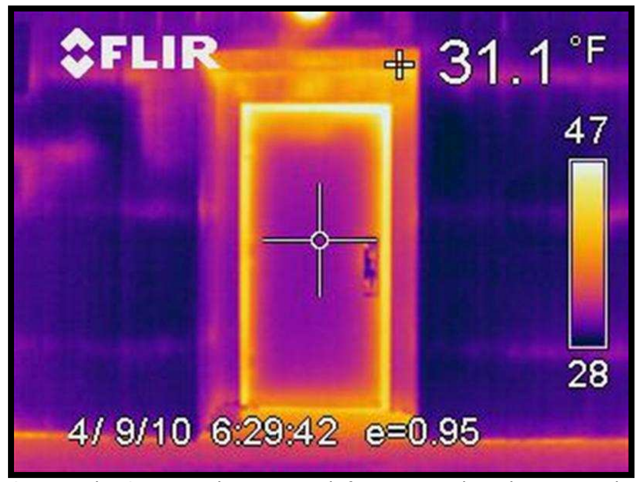


Community Center – South face – Note heat loss at framing

Community Center – South & East faces

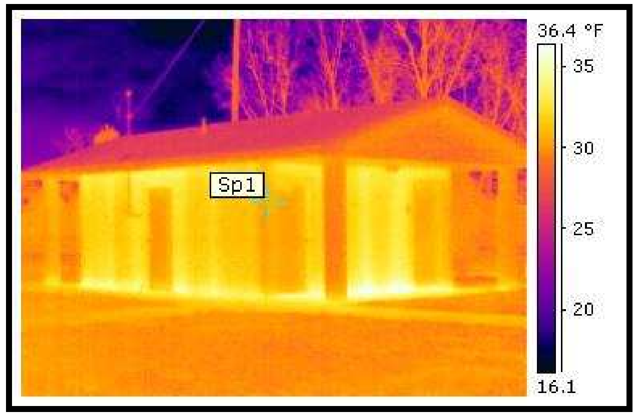
Community Center – South & East faces – Note heat loss at framing

Community Center – Door on south face



Community Center – door on south face – Note heat loss around door

Restroom



Restroom – Note heat loss at foundation wall and at grouted cores in the block wall, no insulation value at these locations

Restroom

Restroom – Note heat loss at foundation wall and at grouted cores in the block wall, no insulation value at these locations. Note that wall has more heat loss than doors.

Picnic Shelter

Picnic Shelter

5228 S Isabella Road

Date of Construction: 1986

Current Size: 1,152 Square Feet

Energy Performance Score

The table below is a simple metric to illustrate how well this building utilizes energy. The scores are based largely on the building performance requirements of the Michigan Energy Code, ASHRAE Standard 90.1, but also on subjective criteria from the field observations in each building.

The scoring is as follows:

- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

The following Building Overall Description and Observations section of this report provides additional insight into the factors that were used to determine these scores.

Energy Performance	
Isabella Well (#1 & #2)	
Description	**Score**
Envelope	
Roof	**Good**
Walls	**Poor**
Windows	NA
Infiltration	**Good**
Mechanical	
Heating System	**Good**
Cooling System	NA
Domestic Hot Water	NA
Insulation	NA
Controls	**Fair**
Electrical	
Lighting	**Fair**
Lighting Controls	**Fair**
OVERALL CONDITION	**FAIR**

The performance of this energy audit included a field assessment of the building. This section of the report discusses some of conditions that were observed. This is not intended to be a comprehensive discussion of all building deficiencies. However the items discussed represent the conditions found and the general condition of the building. Many of the potential energy improvements that are presented in this report are based on the discussions below.

This building is used to house equipment associated with municipal wells and connection to the municipal water supply. The building consists of a single room. A significant addition is planned for 2010 to house additional filtration equipment, and some demolition work had begun at the time of the field review. In general the building appears to be maintained in good condition.

The photographs included in this report illustrate some aspects of the building construction.

General Information

- Size – 1,152 square feet
- Single story
- Schedule – The wells and associated equipment are used continuously year round. The building is occupied primarily for monitoring and maintenance purposes.

The Building Envelope provides the first defense against energy use. The envelope includes the roof, walls, windows and doors. Typical problems include areas that are not insulated well and areas of air leakage (infiltration).

- Roof
  - Flat, rubber membrane.
  - The ceiling is a drywall surface mounted directly to the roof structure. 8” thick batt insulation is installed above the ceiling.
  - There are three skylights in the building, providing a significant amount of daylight to the space. There appears to be some mold on surfaces around the skylights.
- Walls
  - Scored block.
  - The insulation values could not be determined. It is presumed that there is no or very little insulation installed.
- Windows – There are no windows in the building.
- Doors
  - Man doors are hollow metal. Doors have seals and sweeps except for the back door which has no sweeps.
  - The building includes one overhead garage door. That door appears to be relatively new and is an insulated garage door. Seals appear to be good.

Mechanical systems are important because they consume a significant portion of a building’s energy. The primary mechanical systems include heating, cooling, and ventilating systems and controls. Typical problems include poor insulation, equipment or systems that do not function as intended and equipment with low energy efficiency.

- Heat is provided by a single propane fired unit heater, nominal 80% efficiency. The thermostat was set for 63F at the time of the field review. The building is not cooled.
- The above-ceiling space appears to be ventilated using roof mounted gooseneck ducts for air intake and rotating gravity ventilators for exhaust.

Plumbing Systems consume both energy and water. The primary plumbing systems include the domestic water heater and plumbing fixtures and piping. Typical problems include poor insulation, equipment or systems that do not function as intended, equipment with low energy efficiency, and fixtures with excessive water usage.

- Propane – a propane tank is located outside the building. Piping is routed underground to the building.
- There are no plumbing fixtures other than a few wall hydrants/hose bibs, and no domestic water heater.

Electrical systems also consume a substantial part of a building's energy. Electrical systems include lighting, lighting controls and power. Typical problems include inadequate lighting control, inappropriate lamp selection and inefficient motors.

- Electric provider – Consumers Energy, meter #99865259
- 200 amp main panel, 480 volt, 3 phase.
- A schedule of light fixtures observed in the building is included in this report. Following is a summary by fixture type.

Isabella Well (#1 & #2) Light Fixture Summary				
Fixture Type	Number of Fixtures	% of Total Number of Fixtures	Total Watts	Total KWH*
T12 Fluorescent	5	71%	1,215	885
Metal Halide	2	29%	190	830
Total	7		1,405	1,714
* Assumed operating schedule as shown in the Light Fixture Inventory in this report				

- Exterior lights are controlled by integral photo-eyes.
- Interior lights are manual, no automatic control.
- Frequency drives are installed on the well pumps and "high source" pumps.

Plug Loads are defined as equipment in the building that is connected to power receptacles, i.e. no permanent electrical connection. Plug load equipment can consume a significant amount of electricity over the course of time. Typical plug load issues include inefficient equipment, equipment that is not turned off when not in use, and inappropriate use of equipment (e.g. electric heaters under desks).

- Many monitoring and control devices related to the well system.
- A personal computer is present in the room.

Occupancy / Operations / Schedule – How a building is used can have a significant impact on the building's energy usage. In fact attitudes and actions of the building users and operational staff can sometimes be the biggest factor in energy waste. It is critical that building occupants are provided with information on how to minimize energy use, the proper tools to do so, and an educational process to continually remind them how to most effectively use the building.

- Schedule
    - The wells and associated equipment are used continuously year round
    - The building is occupied primarily for monitoring and maintenance purposes.

Isabella Well (#1 & #2)

Building Energy Cost Information – Electrical & Propane Gas

Electricity Usage

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	12,971	8	1,262	1,270
February	10,944	8	1,064	1,072
March	12,016	8	1,169	1,177
April	13,109	8	1,275	1,283
May	11,912	8	1,159	1,167
June	12,946	8	1,259	1,267
July	18,698	13	1,851	1,864
August	7,666	15	786	801
September	14,489	15	1,425	1,440
October	9,790	15	868	883
November	12,646	15	1,141	1,156
December	10,568	15	937	952
2008	**147,755**	**136**	**14,196**	**14,331**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	10,785	15	1,057	1,072
February	11,454	15	1,116	1,131
March	11,500	15	1,091	1,106
April	10,851	15	1,011	1,026
May	10,533	15	966	981
June	16,290	47	1,758	1,806
July	16,459	47	1,781	1,828
August	18,644	47	1,813	1,861
September	19,501	47	1,897	1,944
October	20,528	47	1,997	2,044
November	16,566	47	1,611	1,659
December	12,267	47	1,135	1,182
2009	**175,378**	**406**	**17,234**	**17,640**

Total	**323,133**	**542**	**31,430**	**31,972**
Some meter readings may be estimated				

Electricity and Gas Totals	
Square Footage	1,152
Average Annual Cost	15,986
Cost/SF/Year	13.88
EUI (MBtu/SF/Year)	622.6

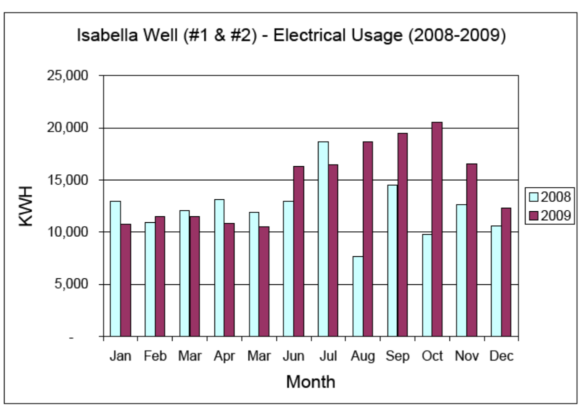
Electricity Totals	
Average KWH/Year	161,567
Average MMBtu/Year	551
Average Cost/KWH	0.099
Cost/KWH w/o Fixed	0.097
Average Cost/MMBtu	28.99
Cost/SF/Year	13.88
EUI (MBtu/SF/Year)	478.7

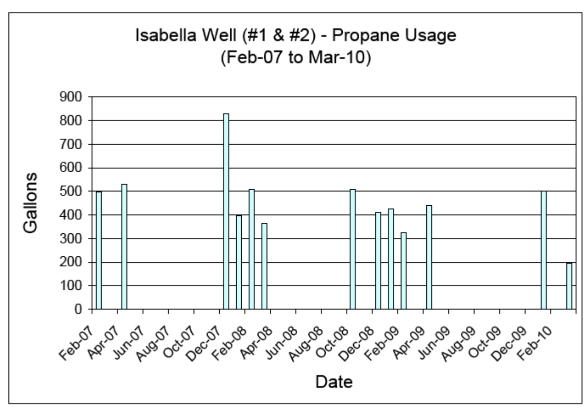
Propane Gas Totals	
Average Gal/Year	1,810
Average MMBtu/Year	166
Average Cost/Gal	2.07
Average Cost/MMBtu	22.63
Cost/SF/Year	3.26
EUI (MBtu/SF/Year)	143.9

Notes
91,600 Btu/Gallon
3,413 Btu/KWH
Aug-09 thru Nov-09 costs are interpolated from other data. KWH & CCF are correct from bills for this period.
Electrical includes well pumps

Propane Gas Usage

Date	Gal	Total Cost
02/14/2007	497	No info received
04/18/2007	529	No info received
12/13/2007	830	No info received
01/11/2008	395	No info received
02/19/2008	508	No info received
03/26/2008	365	No info received
10/29/2008	509	No info received
12/12/2008	410	No info received
01/17/2009	425	1,033
02/16/2009	325	790
04/09/2009	440	708
01/14/2010	500	990
03/02/2010	194	384
	5,927	





Behavioral, Operations and Maintenance Improvements (BOMIs)
Narrative Descriptions

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

1. ***Add Sweeps to Back Door*** – Install door sweeps to minimize cold air infiltration.
2. ***Replace Unit Heater*** – Replace the unit heater with a more high efficiency sealed combustion unit (Reznor model UEAS or equivalent, nominal 93% efficiency). The existing heater is nominally 80% efficient.
3. ***Verify & Adjust Room Temperature Settings*** – Verify that temperature settings are appropriate for the use, and that these settings are not changed inadvertently. For the most part this building is not occupied so most of the time temperatures need only be high enough for the processes taking place inside, not for human comfort. (The thermostat was set for 63F during the field review)
4. ***Replace or Retrofit T12 Fixtures*** – Replace existing T12 light fixtures with T8 fluorescent fixtures, or retrofit the existing T12 fixtures to utilize T8 lamps. If fixture retrofits are considered, be sure that the replacement ballasts and sockets are suitable to utilize the full energy savings of the T8 lamps.
5. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

Energy Conservations Measures (ECMs)
Narrative Descriptions

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

1. ***Improve Wall Insulation*** – Add insulation to the exterior walls. Improvements to wall insulation are difficult because an improvement often means adding layers of some material to either the interior or exterior of the walls. This causes both practical and aesthetic issues, including detailing at window and door openings and how to incorporate objects that are in or fastened to the walls. Several insulation options are available including adding exterior rigid insulation and a new layer of brick or block to the exterior; installing an exterior insulation finish system (EIFS) over the existing brick or block; or adding furring with rigid insulation or stud walls with fiberglass insulation (and a layer of drywall) to the interior.

   Costs will also vary considerably depending on the solution chosen and the installation difficulty. A new brick or block veneer with insulation or new EIFS exterior will likely cost on the order of $15-$25/sf. An interior solution may be less expensive, particularly in larger or less finished areas, but durability must be considered vs. the existing block. Estimated savings and paybacks for various scenarios are shown in the table below.

Estimated Energy Savings – Additional Wall Insulation						
Type of Wall	Existing R-value	New R-Value	Energy Savings Btu/sf/yr	Estimated Cost/sf		
				Lo	Med	Hi
No Existing Insulation Block and brick, no insulation, no air gap	About 2.5	12.5	67,200	$10	$15	$25
Minor Existing Insulation E.g. insulation in block cores	About 3.5	13.5	44.450	$10	$15	$25
Savings are based on heating loads only, 7000 heating degree days, 80% boiler efficiency Buildings that are air conditioned will have more energy savings						

ECM Detailed Description Forms

The following pages contain "ECM Detailed Description Forms". A page is dedicated to each ECM, and that ECM is described in detail along with some cost, savings, and payback information.

The costs to implement each ECM are based on industry cost estimating guides and on the A/E's experience with similar projects. Savings are estimated based on the best available information on energy usage and system operation. Costs or savings could vary from the figures shown above depending on market and economic conditions at the time the work is performed and depending on the validity of the assumptions used to generate these estimates. The information presented is valuable for planning purposes, but it is recommended that more detailed budgets or firm quotes be obtained for projects prior to a final decision to implement any improvement.

based on utility bill data from 2008-2009, the following utility costs were used for the savings and payback analyses for each ECM. These unit costs are the commodity cost only, without the fixed monthly charges.

Electricity	$0.097/KWH
Propane	$2.07/Gallon

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Isabella Well (#1 & #2)	
ECM NUMBER: 1	
ECM NAME: Improve Wall Insulation	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Scored block walls, no insulation (or minimal insulation in some block cores)
- Assumed existing R-value of about R-2.0, including film coefficients
- About 1,470 square feet of brick wall surface

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation to the walls. Many different options exist, with differing insulation values, costs and aesthetics. Some of the potential options include:
  - Add rigid or spray-on insulation over the existing, finish with new brick veneer or EIFS (Exterior Insulation Finish System, such as Dryvit or equivalent)
  - Install an insulated metal panel system over the existing exterior
  - Add furring or stud walls on the interior with insulation between studs/furring strips, finish with drywall interior
- The aesthetics of the finished wall are a critical part of any decision on whether or not to proceed with this ECM or what type of finish to use. Costs will vary depending on the finish and the number of window/door openings and wall mounted items.
- Assume a project that adds 2" of insulation and has a cost of $15/sf
- New R-value of about R-12.0, including film coefficients
- 1,470 sf x [(1/2.0) – (1/12.0)] R-value x 5323 DD/year (base 60F) x 24 hr/day = 78,248 MBtu/year energy savings
- Assume 75% heating system efficiency = 104,331 MBtu/year heater input = 1,139 gal/year = **$2,358/year savings**
- Cost = 1,470 sf x $15/sf = $22,050
- Payback = 9.4 years

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**22,050**
Total Estimated Annual Savings ($)	**2,358**
Simple Payback (Years)	**9.4**
Estimated Useful Life (Years)	**30**

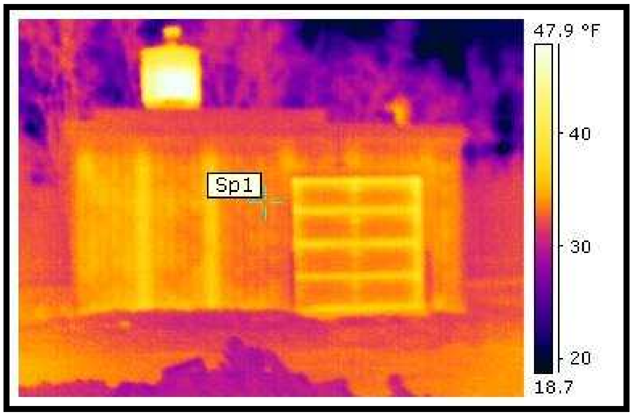
Isabella Well (#1 &#2)
Light Fixture Inventory
April 2010

	Existing Fixtures				Assumed Schedule					
Room Name	**Number Of Fixtures**	**Lamp Type**	**Fixture Watts**	**Total Load (W)**	**Hours per Day**	**Days Per Week**	**Weeks Per Year**	**Hours Per Year**	**Total Energy (KWH)**	**Comments**
Exterior	2	HID 70 Watt	95	190	12	7	52	4368	830	
Interior	5	8 foot - 2 lamp T12	243	1215	2	7	52	728	885	photo-eye
Total	**7**			**1405**					**1714**	

East face – overall

East face – overall – Note heat loss at grouted cores in the bock wall, no insulation value at these locations

North face



North face – Note heat loss at grouted cores in the block wall, no insulation value at these locations, Note heat loss between overhead door panels

2279 S Meridian Road

Date of Construction: 1999

Current Size: 912 Square Feet

The table below is a simple metric to illustrate how well this building utilizes energy. The scores are based largely on the building performance requirements of the Michigan Energy Code, ASHRAE Standard 90.1, but also on subjective criteria from the field observations in each building.

The scoring is as follows:
- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

The following Building Overall Description and Observations section of this report provides additional insight into the factors that were used to determine these scores.

Energy Performance	
Meridian Well (#3 & #4)	
Description	**Score**
Envelope	
Roof	**Good**
Walls	**Poor**
Windows	NA
Infiltration	**Good**
Mechanical	
Heating System	**Good**
Cooling System	NA
Domestic Hot Water	**Good**
Insulation	NA
Controls	**Fair**
Electrical	
Lighting	**Fair**
Lighting Controls	**Fair**
OVERALL CONDITION	**FAIR**

Building Overall Description & Observations

The performance of this energy audit included a field assessment of the building. This section of the report discusses some of conditions that were observed. This is not intended to be a comprehensive discussion of all building deficiencies. However the items discussed represent the conditions found and the general condition of the building. Many of the potential energy improvements that are presented in this report are based on the discussions below.

This building is used to house equipment associated with municipal wells and connection to the municipal water supply. The building consists of a single room. In general the building appears to be maintained in good condition.

The photographs included in this report illustrate some aspects of the building construction.

General Information

- Size – 912 square feet
- Single story
- Schedule – The wells and associated equipment are used continuously year round. The building is occupied primarily for monitoring and maintenance purposes.

The Building Envelope provides the first defense against energy use. The envelope includes the roof, walls, windows and doors. Typical problems include areas that are not insulated well and areas of air leakage (infiltration).

- Roof
  - Sloped with asphalt shingles.
  - The ceiling is a drywall surface mounted directly to the roof structure. 9” thick batt insulation is installed above the ceiling (per the construction drawings).
- Walls
  - Scored block with vinyl siding on gable ends. Poured insulation in the block cavities (per the construction drawings).
  - An overhead door has been removed on the north wall and the space infilled with 8” block. The thermal images show a significant difference in heat loss between this area and the original block walls. It appears that the infill block has no insulation.
- Windows – There are no windows in the building.
- Doors
  - One hollow metal man door. The seals around the door are poor, daylight is visible around the door.
  - The building includes one overhead garage door. That door appears to be relatively new and is an insulated garage door. Seals appear to be good.

Mechanical systems are important because they consume a significant portion of a building’s energy. The primary mechanical systems include heating, cooling, and ventilating systems and controls. Typical problems include poor insulation, equipment or systems that do not function as intended and equipment with low energy efficiency.

- Heat is provided by a single natural gas fired unit heater, nominal 80% efficiency. The thermostat was set for 55F at the time of the field review. The building is not cooled.
- Ventilation is provided by a wall fan and intake louver. The shutoff damper on the intake louver does not close completely.

Plumbing Systems consume both energy and water. The primary plumbing systems include the domestic water heater and plumbing fixtures and piping. Typical problems include poor insulation, equipment or systems that do not function as intended, equipment with low energy efficiency, and fixtures with excessive water usage.

- Natural gas provider – Consumers Energy, meter #25387303
- There are no plumbing fixtures other than a few wall hydrants/hose bibs.
- Domestic water heater – Ariston model GL4, 1500 watts, 3.85 gallons.

Electrical systems also consume a substantial part of a building's energy. Electrical systems include lighting, lighting controls and power. Typical problems include inadequate lighting control, inappropriate lamp selection and inefficient motors.

- Electric provider – Consumers Energy, meter #76785497
- 200 amp main panel, 480 volt, 3 phase, with 100 amp 120/240 volt sub-panel.
- A schedule of light fixtures observed in the building is included in this report. Following is a summary by fixture type.

Meridian Well (#3 & #4) Light Fixture Summary				
Fixture Type	Number of Fixtures	% of Total Number of Fixtures	Total Watts	Total KWH*
T12 Fluorescent	3	75%	729	5,535
Metal Halide	1	25%	95	415
Total	4		824	5,950
* Assumed operating schedule as shown in the Light Fixture Inventory in this report				

- Exterior lights are controlled by integral photo-eyes.
- Interior lights are manual, no automatic control.
- Frequency drives are installed on the well pumps.

Plug Loads are defined as equipment in the building that is connected to power receptacles, i.e. no permanent electrical connection. Plug load equipment can consume a significant amount of electricity over the course of time. Typical plug load issues include inefficient equipment, equipment that is not turned off when not in use, and inappropriate use of equipment (e.g. electric heaters under desks).

- Many monitoring and control devices related to the well system.
- Portable commercial dehumidifier, Hi-E Dry model 195. Reportedly used continuously all summer long. Rated for 183 pints/day, power usage is 5.9 pints/KWH.

Occupancy / Operations / Schedule – How a building is used can have a significant impact on the building's energy usage. In fact attitudes and actions of the building users and operational staff can sometimes be the biggest factor in energy waste. It is critical that building occupants are provided with information on how to minimize energy use, the proper tools to do so, and an educational process to continually remind them how to most effectively use the building.

- Schedule
  - The wells and associated equipment are used continuously year round
  - The building is occupied primarily for monitoring and maintenance purposes.

Meridian Well (#3 & #4)

Building Energy Cost Information – Electrical & Natural Gas

Electricity Usage

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	8,425	8.00	806	814
February	8,135	8.00	778	786
March	7,962	8.00	762	770
April	9,006	8.00	862	870
May	8,753	8.00	837	845
June	15,464	8.00	1,479	1,487
July	16,506	12.73	1,635	1,648
August	14,813	15.00	1,518	1,533
September	14,631	15.00	1,439	1,454
October	20,478	15.00	1,816	1,831
November	22,265	15.00	2,010	2,025
December	21,000	15.00	1,816	1,831
2008	**167,438**	**136**	**15,758**	**15,894**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	21,636	15.00	2,119	2,134
February	19,135	15.00	1,865	1,880
March	18,040	15.00	1,712	1,727
April	18,207	15.00	1,697	1,712
May	18,986	15.00	1,742	1,757
June	15,572	47.27	1,681	1,728
July	11,967	47.27	1,295	1,342
August	23,228	47.27	2,222	2,269
September	17,119	47.27	1,638	1,685
October	12,587	47.27	1,204	1,251
November	8,646	47.27	827	874
December	10,347	47.27	958	1,005
2009	**195,470**	**406**	**18,960**	**19,366**

Total	**362,908**	**542**	**34,718**	**35,260**
Some meter readings may be estimated				

Electricity and Gas Totals	
Square Footage	912
Average Annual Cost	17,630
Cost/SF/Year	19.33
EUI (MBtu/SF/Year)	679.1

Electricity Totals	
Average KWH/Year	181,454
Average MMBtu/Year	619
Average Cost/KWH	0.097
Cost/KWH w/o Fixed	0.096
Average Cost/MMBtu	28.47
Cost/SF/Year	19.33
EUI (MBtu/SF/Year)	679.1

Natural Gas Totals	
Average CCF/Year	
Average MMBtu/Year	
Average Cost/CCF	
Cost/CCF w/o Fixed	
Average Cost/MMBtu	
Cost/SF/Year	
EUI (MBtu/SF/Year)	

Notes

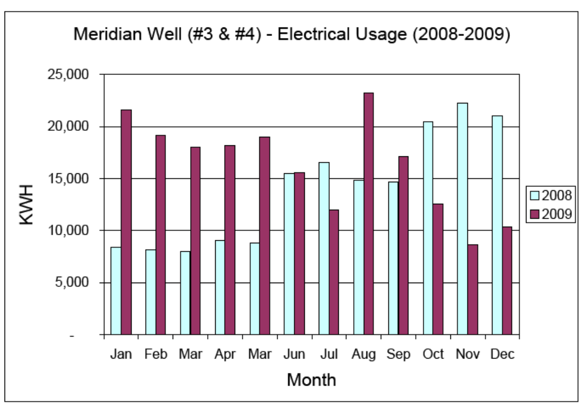
103,000 Btu/CCF
3,413 Btu/KWH
Aug-09 thru Nov-09 costs are interpolated from other data. KWH & CCF are correct from bills for this period.
Electrical includes well pumps

Natural Gas Usage

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				
2008				

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				
2009				

Total				
Meter is installed – no data received				



Behavioral, Operations and Maintenance Improvements (BOMIs)
Narrative Descriptions

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

1. ***Repair Door Seals & Sweeps*** – Repair or replace the door seals and sweeps to reduce the amount of cold air that enters the building during the winter.
2. ***Replace Unit Heater*** – Replace the unit heater with a more high efficiency sealed combustion unit (Reznor model UEAS or equivalent, nominal 93% efficiency). The existing heater is nominally 80% efficient.
3. ***Repair Damper on Intake Louver*** – Modify, repair or replace the intake damper to obtain a better blade seal and reduce the amount of cold air that enters the building through this damper.
4. ***Verify & Adjust Room Temperature Settings*** – Verify that temperature settings are appropriate for the use, and that these settings are not changed inadvertently. For the most part this building is not occupied so most of the time temperatures need only be high enough for the processes taking place inside, not for human comfort.
5. ***Install Timer on Water Heater*** – Install a timed control that would shut off power to the water heater when the hot faucet is typically not used. It appears that at this time the heater is on 24 hours/day even when the faucet is not in use. Typically a time clock would be used for this application, with provisions such as battery backup to prevent inaccurate timing during power outages.
6. ***Replace or Retrofit T12 Fixtures*** – Replace existing T12 light fixtures with T8 fluorescent fixtures, or retrofit the existing T12 fixtures to utilize T8 lamps. If fixture retrofits are considered, be sure that the replacement ballasts and sockets are suitable to utilize the full energy savings of the T8 lamps.
7. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

1. ***Improve Wall Insulation*** – Add insulation to the exterior walls. Improvements to wall insulation are difficult because an improvement often means adding layers of some material to either the interior or exterior of the walls. This causes both practical and aesthetic issues, including detailing at window and door openings and how to incorporate objects that are in or fastened to the walls. Several insulation options are available including adding exterior rigid insulation and a new layer of brick or block to the exterior; installing an exterior insulation finish system (EIFS) over the existing brick or block; or adding furring with rigid insulation or stud walls with fiberglass insulation (and a layer of drywall) to the interior.

   Costs will also vary considerably depending on the solution chosen and the installation difficulty. A new brick or block veneer with insulation or new EIFS exterior will likely cost on the order of $15-$25/sf. An interior solution may be less expensive, particularly in larger or less finished areas, but durability must be considered vs. the existing block. Estimated savings and paybacks for various scenarios are shown in the table below.

Estimated Energy Savings – Additional Wall Insulation						
Type of Wall	Existing R-value	New R-Value	Energy Savings Btu/sf/yr	Estimated Cost/sf		
				Lo	Med	Hi
No Existing Insulation Block and brick, no insulation, no air gap	About 2.5	12.5	67,200	$10	$15	$25
Minor Existing Insulation E.g. insulation in block cores	About 3.5	13.5	44.450	$10	$15	$25
Savings are based on heating loads only, 7000 heating degree days, 80% boiler efficiency Buildings that are air conditioned will have more energy savings						

   Specific areas what could be addressed are as follows:

   - *Brick Walls - General* – The walls of most of the building are uninsulated or have minimal insulation only in the block cores, these walls should be considered for improvement.
   - *Door Infill Area* – The thermal images show more heat loss from the door infill area than from the rest of the building. Therefore there would also be more energy savings per square foot over this area than the rest of the building.

ECM Detailed Description Forms

The following pages contain "ECM Detailed Description Forms". A page is dedicated to each ECM, and that ECM is described in detail along with some cost, savings, and payback information.

The costs to implement each ECM are based on industry cost estimating guides and on the A/E's experience with similar projects. Savings are estimated based on the best available information on energy usage and system operation. Costs or savings could vary from the figures shown above depending on market and economic conditions at the time the work is performed and depending on the validity of the assumptions used to generate these estimates. The information presented is valuable for planning purposes, but it is recommended that more detailed budgets or firm quotes be obtained for projects prior to a final decision to implement any improvement.

based on utility bill data from 2008-2009, the following utility costs were used for the savings and payback analyses for each ECM. These unit costs are the commodity cost only, without the fixed monthly charges.

Electricity	\$0.096/KWH
Natural Gas	\$0.989/CCF (average of other Township facilities)

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Meridian Well (#3 & #4)	
ECM NUMBER: 1	
ECM NAME: Improve Wall Insulation	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Scored block walls, loose fill insulation in the block cores
- Assumed existing R-value of about R-2.85, including film coefficients
- About 1,300 square feet of wall surface

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation to the walls. Many different options exist, with differing insulation values, costs and aesthetics. Some of the potential options include:
  - Add rigid or spray-on insulation over the existing, finish with new brick veneer or EIFS (Exterior Insulation Finish System, such as Dryvit or equivalent)
  - Install an insulated metal panel system over the existing exterior
  - Add furring or stud walls on the interior with insulation between studs/furring strips, finish with drywall interior
- The aesthetics of the finished wall are a critical part of any decision on whether or not to proceed with this ECM or what type of finish to use. Costs will vary depending on the finish and the number of window/door openings and wall mounted items.
- Assume a project that adds 2" of insulation and has a cost of $15/sf
- New R-value of about R-12.85, including film coefficients
- 1,300 sf x [(1/2.85) – (1/12.85)] R-value x 5323 DD/year (base 60F) x 24 hr/day = 45,349 MBtu/year energy savings
- Assume 75% heating system efficiency = 60,465 MBtu/year boiler input = 587 CCF = **$581/year savings**
- Cost = 1,300 sf x $15/sf = $19,500
- Payback = 33.6 years

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**19,500**
Total Estimated Annual Savings ($)	**581**
Simple Payback (Years)	**33.6**
Estimated Useful Life (Years)	**30**

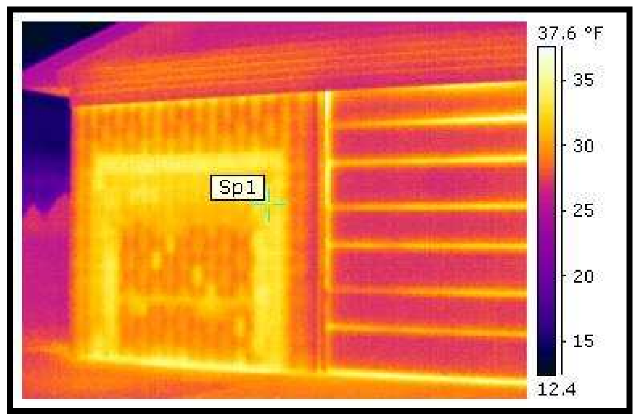
Meridian Well (#3 &#4)
Light Fixture Inventory
April 2010

	Existing Fixtures				Assumed Schedule					
Room Name	**Number Of Fixtures**	**Lamp Type**	**Fixture Watts**	**Total Load (W)**	**Hours per Day**	**Days Per Week**	**Weeks Per Year**	**Hours Per Year**	**Total Energy (KWH)**	**Comments**
Exterior	1	HID 70 Watt	95	95	12	7	52	4368	415	photo-eye
Interior	3	8 foot - 2 lamp T12	243	729	2	73	52	7592	5535	
Total	**4**			**824**					**5950**	

North and West faces

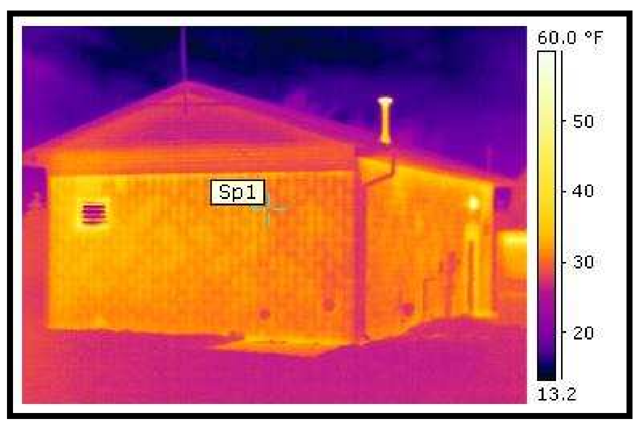
North and West faces – Note heat loss between door panels'

North race



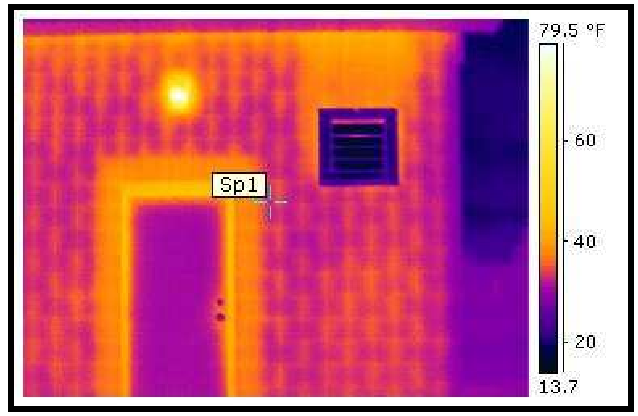
North face – Note heat loss from block infill at former door, no insulation in this section of wall

South and East faces



South and East faces

East face



East face – Note heat loss around door and above exhaust fan, possibly due to grouted block cores at these locations

4795 & 4797 S Mission Road

Date of Construction: Various Years

Current Size: 8,720 Square Feet (four buildings)

Energy Performance Score

The table below is a simple metric to illustrate how well this building utilizes energy. The scores are based largely on the building performance requirements of the Michigan Energy Code, ASHRAE Standard 90.1, but also on subjective criteria from the field observations in each building.

The scoring is as follows:

- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

The following Building Overall Description and Observations section of this report provides additional insight into the factors that were used to determine these scores.

Energy Performance	
Wells #5 7 #6 & Shops	
Description	**Score**
Envelope	
Roof	**Fair**
Walls	**Poor**
Windows	**Good**
Infiltration	**Poor**
Mechanical	
Heating System	**Good**
Cooling System	NA
Domestic Hot Water	**Good**
Insulation	**Fair**
Controls	**Fair**
Electrical	
Lighting	**Poor**
Lighting Controls	**Poor**
OVERALL CONDITION	**FAIR**

Building Overall Description & Observations

The performance of this energy audit included a field assessment of the building. This section of the report discusses some of conditions that were observed. This is not intended to be a comprehensive discussion of all building deficiencies. However the items discussed represent the conditions found and the general condition of the building. Many of the potential energy improvements that are presented in this report are based on the discussions below.

There are four buildings on this site (two are attached to each other), as follows

- Office/Shop – Used as offices for water department workers, and as a parking and repair garage. Some materials are also stored in this building. The building is directly attached to the Well Building.
- Well Building – Used to house equipment associated with municipal wells and connection to the municipal water supply. The building consists of a single room. The building is directly attached to the Office/Shop Building.
- Garage – Used for parking and storage.
- Pole Barn – Used for maintenance and storage.

The ages of these buildings is unknown. In general the buildings appear to be maintained in good condition.

The photographs included in this report illustrate some aspects of the building construction.

General Information

- Size:
    - Total 8,720 square feet
    - Office/Shop – 1,600 sf – constructed 1990
    - Well Building – 1,200 sf – date unknown
    - Garage – 3,520 sf – constructed 1999/2000
    - Pole Barn – 2,400 sf – date unknown
- All buildings are single story on grade
- Schedule
    - The wells and associated equipment are used continuously year round. The building is occupied primarily for monitoring and maintenance purposes.
    - The other buildings are also used year round. Occupancy varies depending on daily schedules, but the Office/Shop building will often be occupied weekdays during first shift hours.

The Building Envelope provides the first defense against energy use. The envelope includes the roof, walls, windows and doors. Typical problems include areas that are not insulated well and areas of air leakage (infiltration).

- Office/Shop
    - Walls are scored block construction for the first eight feet and framed construction with metal exterior above. Batt insulation is installed in the framed construction, insulation at the block walls could not be determined. Batt insulation was missing in some areas.
    - Roof is sloped with asphalt shingles. There appears to be a layer of rigid insulation at the ceiling level, thickness could not be determined.
    - Man doors are hollow metal, seals appear to be adequate.
    - There is one insulated overhead door. There was some light visible around the door seals.
    - Windows are double pane insulated glass.
- Well Building
    - Walls are scored block. Roof is flat with a rubber membrane. The ceiling is a drywall surface mounted directly to the roof structure. Insulation values could not be determined, but the thermal images indicate that there is possibly some insulation in the block cores.

- There are no windows in the building. There are three skylights in the building, providing a significant amount of daylight to the space.
- Doors are hollow metal. Doors have seals and sweeps.

- Garage
  - Only a portion of the building is heated, 1,120 square feet on the south end. The rest of the building is unheated.
  - The building is pole barn construction with metal exterior siding and a sloped roof with asphalt shingles.
  - The walls of the heated portion of the building are insulated with batt insulation. The roof of the heated portion (bottom of trusses) is insulated with blown-in insulation. Thicknesses could not be determined.
  - Man doors are hollow metal. The door in the south end (in the heated portion of the building) has seals which appear to be in fair condition. However light is visible at air gaps between the door frame and the wall framing.
  - There are seven overhead garage doors, two of which are in the heated portion of the building. These doors are insulated, but with loose polystyrene inserts rather than expanded foam insulation. There was some visible light around the garage door seals.
- Pole Building
  - Pole barn construction with metal siding and a sloped asphalt shingle roof. No windows. Hollow metal man-doors and sliding vehicle doors. There is no insulation in the building (it is not heated).

Mechanical systems are important because they consume a significant portion of a building's energy. The primary mechanical systems include heating, cooling, and ventilating systems and controls. Typical problems include poor insulation, equipment or systems that do not function as intended and equipment with low energy efficiency.

- Office/Shop
  - Heat in the shop area is provided by a natural gas fired unit heater, nominal 80% efficiency.
  - Heat in the office area is provided by a wall furnace, Dayton model 3E473B, 32 MBH natural gas input, nominal 80% efficiency.
  - Ventilation is provided by a residential style exhaust fan with a manual wall switch.
- Well Building
  - Heat is provided by a single natural gas fired unit heater. The building is not cooled.
  - Ventilation is provided by a roof fan and intake louver. The shutoff damper on the intake louver does not close completely.
- Garage
  - Only a portion of the building is heated, the rest is used for cold storage. The building is not cooled.
  - Heat is provided by a single natural gas fired unit heater, nominal 80% efficiency. The thermostat was set for 49F at the time of the field review.
  - There is no mechanical ventilation.
- Pole Building
  - Building is not heated or cooled. No mechanical systems.

Plumbing Systems consume both energy and water. The primary plumbing systems include the domestic water heater and plumbing fixtures and piping. Typical problems include poor insulation, equipment or systems that do not function as intended, equipment with low energy efficiency, and fixtures with excessive water usage.

- Natural gas provider – Consumers Energy
  - Office/Shop & Well Building meter #21391155
  - Garage meter #21978767
- Office/Shop
  - Toilet room with water closet and lavatory.
  - Domestic water heater – electric, about 2-5 gallons.

- Well Building
  - o There are no plumbing fixtures other than a few wall hydrants/hose bibs.
  - o Water heater – Ariston model GL4, 1500 watts, 3.85 gallons.
- Garage
  - o No plumbing fixtures
- Pole Building
  - o No plumbing fixtures

Electrical systems also consume a substantial part of a building's energy. Electrical systems include lighting, lighting controls and power. Typical problems include inadequate lighting control, inappropriate lamp selection and inefficient motors.

- Electric provider – Consumers Energy
  - o Office/Shop & Well Building meter # 97871339
  - o Garage meter #87560484
- A schedule of light fixtures observed in the building is included in this report. Following is a summary by fixture type for all five buildings combined.

Wells #5 & #6 & Shops Light Fixture Summary				
Fixture Type	Number of Fixtures	% of Total Number of Fixtures	Total Watts	Total KWH*
CFL	2	5%	26	7
Incandescent	11	26%	1,020	250
T12 Fluorescent	25	60%	5,274	8,506
Metal Halide	3	7%	624	130
High Pressure Sodium	1	2%	464	2,027
Total	42		7,408	10,919
* Assumed operating schedule as shown in the Light Fixture Inventory in this report				

- Office/Shop
  - o 480 volt three phase service for the Office/Shop and Well Building
  - o Interior lights only with manual control, no automatic controls.
- Well Building
  - o Interior lights only with manual control, no automatic controls.
  - o Frequency drives are installed on the well pumps and "high source" pumps.
- Garage
  - o 200 amp panelboard, 120/240 volt, single phase.
  - o Interior and exterior lights (parking lot light). Exterior light has an integral photo-eye. Interior lights are manual, no automatic controls.
- Pole Barn
  - o Interior lights only with manual control, no automatic controls.

Plug Loads are defined as equipment in the building that is connected to power receptacles, i.e. no permanent electrical connection. Plug load equipment can consume a significant amount of electricity over the course of time. Typical plug load issues include inefficient equipment, equipment that is not turned off when not in use, and inappropriate use of equipment (e.g. electric heaters under desks).

- Office/Shop
  - Various tools and equipment
- Well Building
  - Many monitoring and control devices related to the well system
- Garage
  - General use receptacles, no significant equipment loads
- Pole Building
  - General use receptacles, no significant equipment loads

Occupancy / Operations / Schedule – How a building is used can have a significant impact on the building's energy usage. In fact attitudes and actions of the building users and operational staff can sometimes be the biggest factor in energy waste. It is critical that building occupants are provided with information on how to minimize energy use, the proper tools to do so, and an educational process to continually remind them how to most effectively use the building.

- Schedule
  - The wells and associated equipment are used continuously year round. The building is occupied primarily for monitoring and maintenance purposes.
  - The other buildings are also used year round. Occupancy varies depending on daily work schedules, but the Office/Shop building is typically occupied from 8 am – 4 pm Monday through Friday.

Building Energy Cost Information – Electrical & Natural Gas

Electricity Usage
Office/Shop & Well Building & Pole Barn

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	26,475	8.00	2,891	2,899
February	17,587	8.00	1,920	1,928
March	21,867	8.00	2,388	2,396
April	27,457	8.00	2,998	3,006
May	23,320	8.00	2,546	2,554
June	20,679	8.00	2,258	2,266
July	31,905	12.49	3,665	3,677
August	33,766	15.00	3,865	3,880
September	36,059	15.00	3,978	3,993
October	23,657	15.00	2,382	2,397
November	20,108	15.00	2,002	2,017
December	17,479	15.00	1,721	1,736
2008	**300,359**	**135**	**32,616**	**32,752**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	22,798	15.00	2,507	2,522
February	7,637	15.00	836	851
March	15,440	15.00	1,651	1,666
April	13,929	15.00	1,465	1,480
May	14,262	15.00	1,480	1,495
June	22,978	47.27	2,756	2,803
July	20,264	47.27	2,436	2,483
August	24,371	55.56	2,661	2,717
September	23,838	55.56	2,603	2,659
October	26,842	55.56	2,931	2,987
November	19,827	55.56	2,165	2,221
December	19,956	63.85	2,040	2,104
2009	**232,142**	**456**	**25,531**	**25,987**
Total	**532,501**	**591**	**58,147**	**58,738**

Some meter readings may be estimated

Electricity and Gas Totals	
Square Footage	5,200
Average Annual Cost	33,143
Cost/SF/Year	6.37
EUI (MBtu/SF/Year)	247.6

Electricity Totals	
Average KWH/Year	266,251
Average MMBtu/Year	909
Average Cost/KWH	0.110
Cost/KWH w/o Fixed	0.109
Average Cost/MMBtu	32.32
Cost/SF/Year	5.65
EUI (MBtu/SF/Year)	174.8

Natural Gas Totals	
Average CCF/Year	3,678
Average MMBtu/Year	379
Average Cost/CCF	1.026
Cost/CCF w/o Fixed	0.993
Average Cost/MMBtu	9.96
Cost/SF/Year	0.73
EUI (MBtu/SF/Year)	72.9

Notes

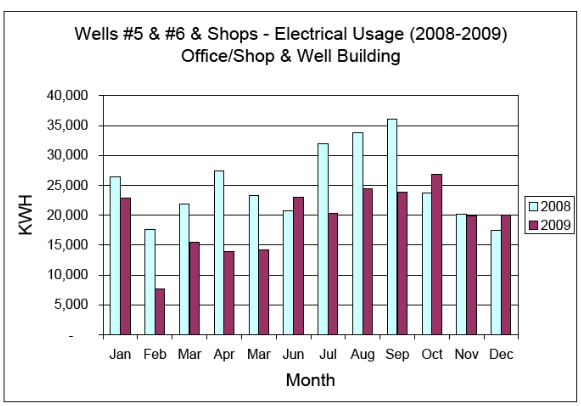
103,000 Btu/CCF
3,413 Btu/KWH
Aug-09 thru Nov-09 costs are interpolated from other data. KWH & CCF are correct from bills for this period.
Electrical includes well pumps

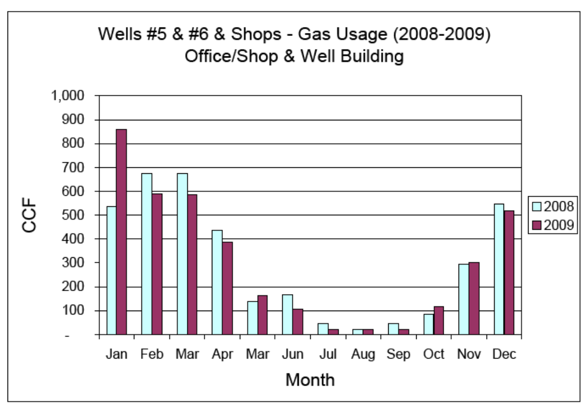
Natural Gas Usage
Office/Shop & Well Building & Pole Barn

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	537	10.00	533	543
February	674	10.00	669	679
March	673	10.00	668	678
April	436	10.00	433	443
May	137	10.00	136	146
June	165	10.00	164	174
July	45	10.00	51	61
August	21	10.00	24	34
September	45	10.00	48	58
October	86	10.00	86	96
November	296	10.00	297	307
December	547	10.00	549	559
2008	**3,662**	**120**	**3,658**	**3,778**

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	860	10.34	866	877
February	589	10.50	594	605
March	587	10.50	592	603
April	386	10.50	356	367
May	163	10.50	149	160
June	107	10.50	101	111
July	22	10.50	21	31
August	21	10.50	21	31
September	20	10.50	20	30
October	116	10.50	115	126
November	303	10.50	301	311
December	520	10.50	507	518
2009	**3,694**	**126**	**3,644**	**3,770**
Total	**7,356**	**246**	**7,302**	**7,548**

Some meter readings may be estimated





Wells #5 & #6 & Shops

Building Energy Cost Information – Electrical & Natural Gas

Electricity Usage
Garage Building

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	2,418	8.00	260	268
February	2,377	8.00	256	264
March	2,619	8.00	282	290
April	2,012	8.00	217	225
May	1,068	8.00	115	123
June	1,626	8.00	175	183
July	1,095	12.49	127	140
August	680	15.00	79	94
September	1,238	15.00	138	153
October	1,334	15.00	136	151
November	1,751	15.00	181	196
December	2,231	15.00	222	237
2008	**20,449**	**135**	**2,188**	**2,323**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	3,081	15.00	339	354
February	1,779	15.00	195	210
March	2,162	15.00	231	246
April	1,753	15.00	184	199
May	1,387	15.00	144	159
June	1,220	20.38	146	167
July	968	20.38	116	137
August	1,048	27.38	113	140
September	1,157	27.38	125	152
October	1,680	27.38	181	208
November	1,914	27.38	206	233
December	2,557	34.38	261	296
2009	**20,706**	**260**	**2,241**	**2,501**

Total	**41,155**	**395**	**4,429**	**4,824**
Some meter readings may be estimated				

Electricity and Gas Totals	
Square Footage	3,520
Average Annual Cost	3,497
Cost/SF/Year	0.99
EUI (MBtu/SF/Year)	48.4

Electricity Totals	
Average KWH/Year	20,578
Average MMBtu/Year	70
Average Cost/KWH	0.117
Cost/KWH w/o Fixed	0.108
Average Cost/MMBtu	34.34
Cost/SF/Year	0.69
EUI (MBtu/SF/Year)	20.0

Natural Gas Totals	
Average CCF/Year	972
Average MMBtu/Year	100
Average Cost/CCF	1.116
Cost/CCF w/o Fixed	0.990
Average Cost/MMBtu	10.84
Cost/SF/Year	0.31
EUI (MBtu/SF/Year)	28.4

Notes

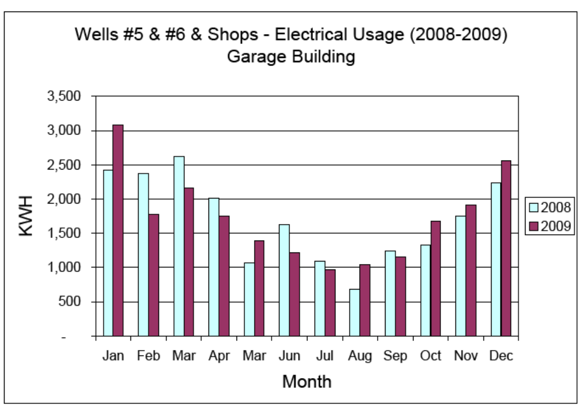
103,000 Btu/CCF
3,413 Btu/KWH
Aug-09 thru Nov-09 costs are interpolated from other data. KWH & CCF are correct from bills for this period.

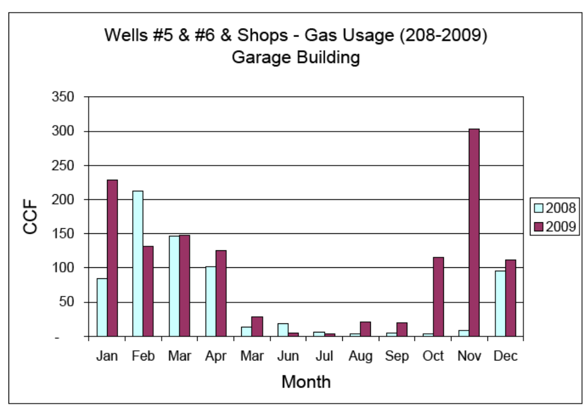
Natural Gas Usage
Garage Building

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	84	10.00	83	93
February	213	10.00	211	221
March	146	10.00	145	155
April	102	10.00	101	111
May	14	10.00	14	24
June	19	10.00	19	29
July	6	10.00	7	17
August	3	10.00	3	13
September	5	10.00	5	15
October	4	10.00	4	14
November	8	10.00	8	18
December	96	10.00	96	106
2008	**700**	**120**	**696**	**816**

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	229	10.34	231	241
February	132	10.50	133	144
March	148	10.50	149	160
April	126	10.50	116	127
May	28	10.50	26	36
June	5	10.50	5	15
July	4	10.50	4	14
August	21	10.50	21	31
September	20	10.50	20	30
October	116	10.50	115	125
November	303	10.50	300	310
December	112	10.50	109	120
2009	**1,244**	**126**	**1,228**	**1,354**

Total	**1,944**	**246**	**1,924**	**2,170**
Some meter readings may be estimated				





Behavioral, Operations and Maintenance Improvements (BOMIs)
Narrative Descriptions

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

Office/Shop

1. ***Verify Roof Insulation, Add as Needed*** – Verify the amount of roof insulation installed, the insulation levels were not apparent during the field review. Install additional insulation if the existing R-value is not very high.
2. ***Repair Wall Insulation*** – Repair the wall insulation where damaged or missing insulation is evident. Where the insulation was visible, mostly on the upper mezzanine, some areas of insulation appeared to be missing or damaged.
3. ***Repair Overhead Door Seals*** – Repair or replace the overhead door seals to reduce the amount of cold air that enters the building during the winter.
4. ***Replace Unit Heater*** – Replace the unit heater with a more high efficiency sealed combustion unit (Reznor model UEAS or equivalent, nominal 93% efficiency). The existing heater is nominally 80% efficient.
5. ***Install Timer on Water Heater*** – Install a timed control that would shut off power to the water heater when the building is typically not used. It appears that at this time the heater is on 24 hours/day even when the fixtures are not in use. Typically a time clock would be used for this application, with provisions such as battery backup to prevent inaccurate timing during power outages.
6. ***Replace Incandescent Lamps*** – Replace incandescent lamps with CFL lamps. In general this can be done by simply removing the incandescent lamp and screwing in a new CFL lamp.
7. ***Add Controls to Ventilation Fan*** – Control the ventilation fan by wiring it with the light switch or by installing a twist timer. The fan is currently manually switched, and could be left on when the building is unoccupied.

Well Building

8. ***Verify Roof Insulation, Add as Needed*** – Verify the amount of roof insulation installed, the insulation levels were not apparent during the field review. Install additional insulation if the existing R-value is not very high.
9. ***Replace Unit Heater*** – Replace the unit heater with a more high efficiency sealed combustion unit (Reznor model UEAS or equivalent, nominal 93% efficiency). The existing heater is nominally 80% efficient.
10. ***Verify & Adjust Room Temperature Settings*** – Verify that temperature settings are appropriate for the use, and that these settings are not changed inadvertently. For the most part this building is not occupied so most of the time temperatures need only be high enough for the processes taking place inside, not for human comfort.
11. ***Repair Fan Shutoff Damper*** – Modify, repair or replace the intake damper to obtain a better blade seal and reduce the amount of cold air that enters the building through this damper.
12. ***Install Timer on Water Heater*** – Install a timed control that would shut off power to the water heater when the hot faucet is typically not used. It appears that at this time the heater is on 24 hours/day even when the faucet is not in use. Typically a time clock would be used for this application, with provisions such as battery backup to prevent inaccurate timing during power outages.

Garage

13. ***Seal Air Leakage, Man Door*** – Seal the air leakage around the man door on the side of the building to reduce the amount of cold air that enters the building during the winter. Light is visible between the door jamb and the building framing.
14. ***Repair Overhead Door Seals*** – Repair or replace the overhead door seals to reduce the amount of cold air that enters the building during the winter.

15. ***Replace Unit Heater*** – Replace the unit heater with a more high efficiency sealed combustion unit (Reznor model UEAS or equivalent, nominal 93% efficiency). The existing heater is nominally 80% efficient.
16. ***Verify & Adjust Room Temperature Settings*** – Verify that temperature settings are appropriate for the use, and that these settings are not changed inadvertently. For the most part this building is not occupied so most of the time temperatures need only be high enough for stored materials and equipment, not for human comfort.
17. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

Pole Barn

18. ***Replace Incandescent Lamps*** – Replace incandescent lamps with CFL lamps. In general this can be done by simply removing the incandescent lamp and screwing in a new CFL lamp.

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

Office/Shop

1. ***Replace or Retrofit T12 Fixtures*** – Replace existing T12 light fixtures with T8 fluorescent fixtures, or retrofit the existing T12 fixtures to utilize T8 lamps. If fixture retrofits are considered, be sure that the replacement ballasts and sockets are suitable to utilize the full energy savings of the T8 lamps.
2. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

Well Building

3. ***Improve Wall Insulation*** – Add insulation to the exterior walls. Improvements to wall insulation are difficult because an improvement often means adding layers of some material to either the interior or exterior of the walls. This causes both practical and aesthetic issues, including detailing at window and door openings and how to incorporate objects that are in or fastened to the walls. Several insulation options are available including adding exterior rigid insulation and a new layer of brick or block to the exterior; installing an exterior insulation finish system (EIFS) over the existing brick or block; or adding furring with rigid insulation or stud walls with fiberglass insulation (and a layer of drywall) to the interior.

   Costs will also vary considerably depending on the solution chosen and the installation difficulty. A new brick or block veneer with insulation or new EIFS exterior will likely cost on the order of $15-$25/sf. An interior solution may be less expensive, particularly in larger or less finished areas, but durability must be considered vs. the existing block. Estimated savings and paybacks for various scenarios are shown in the table below.

Estimated Energy Savings – Additional Wall Insulation						
Type of Wall	Existing R-value	New R-Value	Energy Savings Btu/sf/yr	Estimated Cost/sf		
				Lo	Med	Hi
No Existing Insulation Block and brick, no insulation, no air gap	About 2.5	12.5	67,200	$10	$15	$25
Minor Existing Insulation E.g. insulation in block cores	About 3.5	13.5	44.450	$10	$15	$25
Savings are based on heating loads only, 7000 heating degree days, 80% boiler efficiency Buildings that are air conditioned will have more energy savings						

4. ***Replace or Retrofit T12 Fixtures*** – Replace existing T12 light fixtures with T8 fluorescent fixtures, or retrofit the existing T12 fixtures to utilize T8 lamps. If fixture retrofits are considered, be sure that the replacement ballasts and sockets are suitable to utilize the full energy savings of the T8 lamps.

Garage

5. ***Replace Overhead Doors*** – Replace the overhead doors in the heated portion of the garage with better insulated doors. The existing doors are insulated using loose fiberglass board insulation inserted into the door panels, which does not provide a very good insulation barrier. Doors insulated with foamed panels have a much better overall R-value and would reduce the heating loads.

ECM Detailed Description Forms

The following pages contain "ECM Detailed Description Forms". A page is dedicated to each ECM, and that ECM is described in detail along with some cost, savings, and payback information.

The costs to implement each ECM are based on industry cost estimating guides and on the A/E's experience with similar projects. Savings are estimated based on the best available information on energy usage and system operation. Costs or savings could vary from the figures shown above depending on market and economic conditions at the time the work is performed and depending on the validity of the assumptions used to generate these estimates. The information presented is valuable for planning purposes, but it is recommended that more detailed budgets or firm quotes be obtained for projects prior to a final decision to implement any improvement.

based on utility bill data from 2008-2009, the following utility costs were used for the savings and payback analyses for each ECM. These unit costs are the commodity cost only, without the fixed monthly charges.

Electricity	$0.109/KWH
Natural Gas	$0.993/CCF

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Well #5 & #6 & Shops	
ECM NUMBER: 1 (Office/Shop)	
ECM NAME: Replace or Retrofit T12 Fixtures	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing T12 light fixtures are installed in various areas throughout the building
- 18 fixtures
- 3,573 watts of installed lighting
- 7,268 KWH estimated annual power usage, based on assumed hours of operation (see lighting schedules in this report)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Replace existing fixtures with T8 fixtures, or retrofit existing to use T8 lamps. Retrofit is to include ballast replacement.
  - Assume a one-for-one fixture replacement, matching the number of lamps in the existing
  - 18 fixtures
  - 1,649 watts of installed lighting after replacement/retrofit
  - 3,324 KWH estimated annual power usage after replacement/retrofit, based on the same assumed schedule as existing
- 7,268 KWH – 3,324 KWH = 3,944 KWH energy savings = **$430/year savings**
- Cost = 18 fixtures x $150/fixture = $2,700 (replacement costs, retrofit may be less expensive)
- Payback = 6.3 years

The payback for this ECM depends significantly on the assumed operating schedule, included in the Light Fixture Inventory table in this report. The payback is long because the schedule does not show very many hours of operation in a year. Assumed usage should be verified. More usage will significantly reduce the payback

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**2,700**
Total Estimated Annual Savings ($)	**430**
Simple Payback (Years)	**6.3**
Estimated Useful Life (Years)	**25**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Well #5 & #6 & Shops	
ECM NUMBER: 2 (Office/Shop)	
ECM NAME: Install Occupancy Sensors	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- All lights in the building are controlled by manual on/off switches, no existing occupancy sensors were found
- 3,719 watts of existing installed lighting, not including exterior lights and exit signs
- 7,337 KWH estimated existing annual power usage, based on assumed hours of operation (see lighting schedules in this report)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Install occupancy sensors to control light fixtures throughout the building
- Most fixtures in the building could be controlled by the installation of about 7 sensors
- Assume that lighting energy will be reduced by about 1/3
- 7,337 KWH x 1/3 = 2,446 KWH energy savings = **$267/year savings**
- Cost = 7 zones x $150/zone = $1,050
- Payback = 3.9 years

<u>Combined project – T12 fixture replacement along with occupancy sensors</u>

- 1,711 watts of installed lighting after T12 fixture replacement, not including exterior lights and exit signs
- 3,350 KWH estimated annual power usage after T12 fixture replacement, based on assumed hours of operation (see lighting schedules in this report)
- Savings
  - Occupancy sensors: 3,350 KWH x 1/3 = 1,117 KWH energy savings = $122/year savings
  - T12 fixture replacement: 7,268 KWH – 3,324 KWH = 3,944 KWH energy savings = $430/year savings
  - Total: 122 + 430 = **$552/year savings**
- Cost = $1,050 (occupancy sensors) + $2,700 (T12 replacement) = $3,750

Payback = 6.8 years

The payback for this ECM depends significantly on the assumed operating schedule, included in the Light Fixture Inventory table in this report. The payback is long because the schedule does not show very many hours of operation in a year. Assumed usage should be verified. More usage will significantly reduce the payback.

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**1,050**
Total Estimated Annual Savings ($)	**267**
Simple Payback (Years)	**3.9**
Estimated Useful Life (Years)	**25**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE:	**Well #5 & #6 & Shops**
ECM NUMBER:	**3 (Well Building)**
ECM NAME:	**Improve Wall Insulation**

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Scored block walls, possibly loose fill insulation in the block cores
- Assumed existing R-value of about R-2.85, including film coefficients
- About 1,275 square feet of wall surface

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation to the walls. Many different options exist, with differing insulation values, costs and aesthetics. Some of the potential options include:
  - o Add rigid or spray-on insulation over the existing, finish with new brick veneer or EIFS (Exterior Insulation Finish System, such as Dryvit or equivalent)
  - o Install an insulated metal panel system over the existing exterior
  - o Add furring or stud walls on the interior with insulation between studs/furring strips, finish with drywall interior
- The aesthetics of the finished wall are a critical part of any decision on whether or not to proceed with this ECM or what type of finish to use. Costs will vary depending on the finish and the number of window/door openings and wall mounted items.
- Assume a project that adds 2" of insulation and has a cost of $15/sf
- New R-value of about R-12.85, including film coefficients
- 1,275 sf x [(1/2.85) – (1/21.85)] R-value x 5323 DD/year (base 60F) x 24 hr/day = 44,476 MBtu/year energy savings
- Assume 75% heating system efficiency = 59,302 MBtu/year boiler input = 576 CCF = **$572/year savings**
- Cost = 1,275 sf x $15/sf = $19,125
- Payback = 33.4 years

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**19,125**
Total Estimated Annual Savings ($)	**572**
Simple Payback (Years)	**33.4**
Estimated Useful Life (Years)	**30**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Well #5 & #6 & Shops	
ECM NUMBER: 4 (Well Building)	
ECM NAME: Replace or Retrofit T12 Fixtures	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing T12 light fixtures are installed in various areas throughout the building
- 7 fixtures
- 1,701 watts of installed lighting
- 1,238 KWH estimated annual power usage, based on assumed hours of operation (see lighting schedules in this report)

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Replace existing fixtures with T8 fixtures, or retrofit existing to use T8 lamps. Retrofit is to include ballast replacement.
  - o Assume a one-for-one fixture replacement, matching the number of lamps in the existing
  - o 7 fixtures
  - o 791 watts of installed lighting after replacement/retrofit
  - o 576 KWH estimated annual power usage after replacement/retrofit, based on the same assumed schedule as existing
- 1,238 KWH – 576 KWH = 662 KWH energy savings = **$72/year savings**
- Cost = 7 fixtures x $150/fixture = $1,050 (replacement costs, retrofit may be less expensive)
- Payback = 14.6 years

The payback for this ECM depends significantly on the assumed operating schedule, included in the Light Fixture Inventory table in this report. The payback is long because the schedule does not show very many hours of operation in a year. Assumed usage should be verified. More usage will significantly reduce the payback

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**1,050**
Total Estimated Annual Savings ($)	**72**
Simple Payback (Years)	**14.6**
Estimated Useful Life (Years)	**25**

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Well #5 & #6 & Shops	
ECM NUMBER: 5 (Garage)	
ECM NAME: Replace Overhead Doors	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Existing overhead doors with loose rigid insulation inserts
- Two doors on the heated portion of the garage, each about 12'W x 22'H
- Total door area about 528 sf
- Assumed R-value of about R-3.0, including film coefficients

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

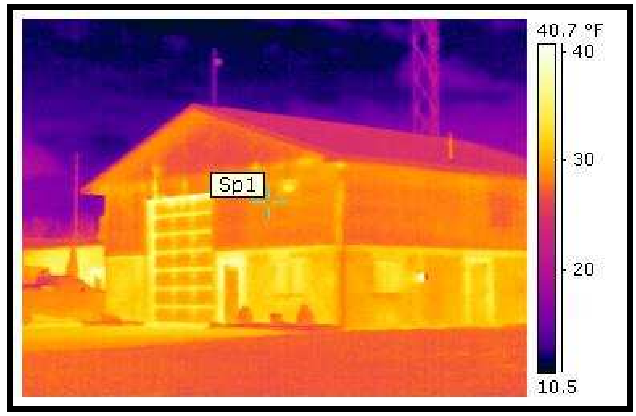
- Install new overhead doors with foamed insulation
- Assume a new R-value of about R-10.0, including film coefficients
- Doors – 528 sf x [(1/3.0) – (1/10.0)] R-value x 5323 DD/year (base 60F) x 24 hr/day = 15,739 MBtu/year energy savings
- Assume 80% heating system efficiency = 19,674 MBtu/year boiler input = 191 CCF = **$190/year savings**
- Cost = 528 sf x $10 = $5,280
- Payback = 27.8 years

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**5,280**
Total Estimated Annual Savings ($)	**190**
Simple Payback (Years)	**27.8**
Estimated Useful Life (Years)	**20**

Wells #5 & #6 & Shops
Light Fixture Inventory
April 2010

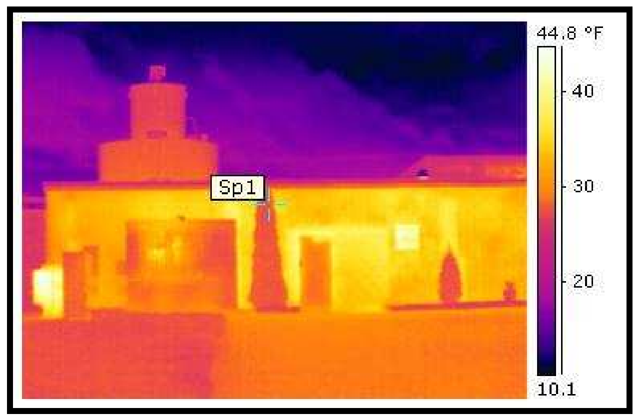
	Existing Fixtures				Assumed Schedule					
Room Name	**Number Of Fixtures**	**Lamp Type**	**Fixture Watts**	**Total Load (W)**	**Hours per Day**	**Days Per Week**	**Weeks Per Year**	**Hours Per Year**	**Total Energy (KWH)**	**Comments**
Office/Shop - garage	3	4 foot - 2 lamp T12	90	270	8	5	52	2080	562	
Office/Shop - garage	11	8 foot - 2 lamp T12	243	2673	8	5	52	2080	5560	
Office/Shop – mezzanine office	1	4 foot - 2 lamp T12	90	90	1	5	52	260	23	
Office/Shop - mezzanine toilet	2	CFL 13 W	13	26	1	5	52	260	7	
Office/Shop - office	3	4 foot - 4 lamp T12	180	540	8	5	52	2080	1123	
Office/Shop - toilet	2	Incandescent 60 Watt	60	120	2	5	52	520	62	
Well Building	7	8 foot - 2 lamp T12	243	1701	2	7	52	728	1238	
Garage	3	HID 175 Watt	208	624	2	2	52	208	130	
Pole Barn	9	Incandescent 100 Watt	100	900	2	2	52	208	187	
Parking Lot	1	HPS 400 Watt	464	464	12	7	52	4368	2027	photo-eye
Totals	**42**			**7408**					**10919**	

Office / Garage



Office / Garage – Note heat loss between overhead door panel and around man door

Well Building



Well Building – Note heat loss from fan damper

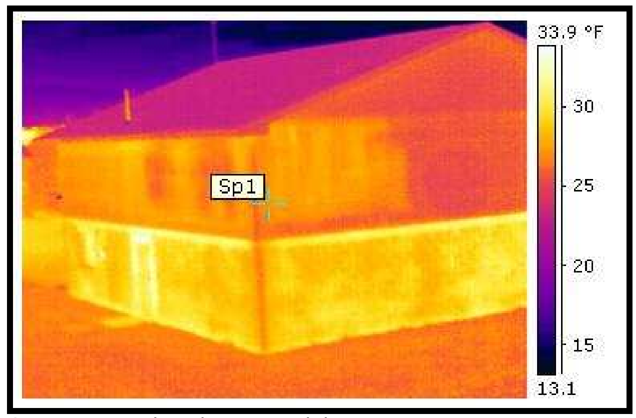
Back of Office / Garage & Well Building

Back of Office / Garage & Well Building – Note heat loss from what appears to be grouted cores in the block wall

Garage

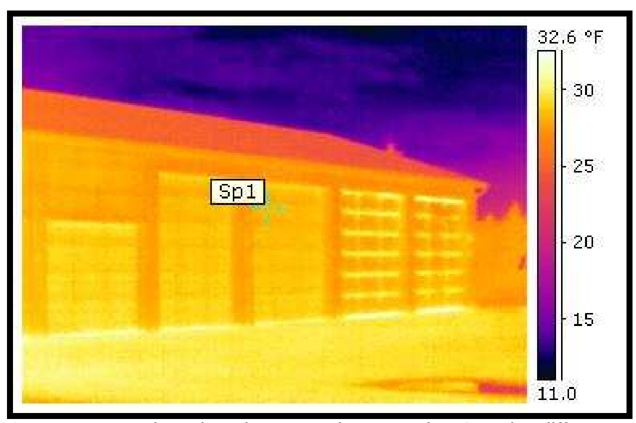
Garage

Garage



Garage – Note heat loss around door

Garage



Garage – Note heat loss between door panels. See the difference between doors on heated spaces (two south doors) and unheated spaces (three north doors)

3998 E Deerfield Road

Date of Construction: 1979

Current Size: 528 Square Feet

Energy Performance Score

The table below is a simple metric to illustrate how well this building utilizes energy. The scores are based largely on the building performance requirements of the Michigan Energy Code, ASHRAE Standard 90.1, but also on subjective criteria from the field observations in each building.

The scoring is as follows:

- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

The following Building Overall Description and Observations section of this report provides additional insight into the factors that were used to determine these scores.

Energy Performance	
Deerfield Lift Station #6	
Description	**Score**
Envelope	
Roof	**Good**
Walls	**Poor**
Windows	NA
Infiltration	**Poor**
Mechanical	
Heating System	**Good**
Cooling System	NA
Domestic Hot Water	NA
Insulation	NA
Controls	**Fair**
Electrical	
Lighting	**Poor**
Lighting Controls	**Fair**
OVERALL CONDITION	**FAIR**

Building Overall Description & Observations

The performance of this energy audit included a field assessment of the building. This section of the report discusses some of conditions that were observed. This is not intended to be a comprehensive discussion of all building deficiencies. However the items discussed represent the conditions found and the general condition of the building. Many of the potential energy improvements that are presented in this report are based on the discussions below.

This building is used to house equipment associated with a municipal lift station. The building consists of a single room and has a permanent generator inside the building, storage space, and space for a vehicle and/or portable generator to park inside the building. In general the building appears to be maintained in fair condition.

The photographs included in this report illustrate some aspects of the building construction.

General Information

- Size – 528 square feet
- Single story
- Schedule – The lift pumps and associated equipment are used continuously year round. The building is occupied primarily for monitoring and maintenance purposes.

The Building Envelope provides the first defense against energy use. The envelope includes the roof, walls, windows and doors. Typical problems include areas that are not insulated well and areas of air leakage (infiltration).

- Roof
  - Sloped with asphalt shingles.
  - The ceiling is a drywall surface mounted directly to the roof structure. Batt insulation is installed above the ceiling, 8" thickness.
- Walls
  - Block with face brick, vinyl siding on the fascia and gable ends. Insulation value is unknown, but the walls are believed to contain no insulation.
- Windows – There are no windows in the building.
- Doors
  - One hollow metal man door. The seals around the door are poor, daylight is visible around the door.
  - One overhead garage door. The seals around the door are poor, daylight is visible around the door.

Mechanical systems are important because they consume a significant portion of a building's energy. The primary mechanical systems include heating, cooling, and ventilating systems and controls. Typical problems include poor insulation, equipment or systems that do not function as intended and equipment with low energy efficiency.

- Heat is provided by a single natural gas fired unit heater, nominal 80% efficiency. The thermostat was set at it's lowest setting at the time of the field review. The building is not cooled.
- There is a large intake and exhaust louver for the generator set in the building. The intake louver includes a motorized damper and the exhaust louver includes a gravity backdraft damper. The generator is ducted from its radiator discharge directly to the exhaust louver. The intake damper does not close completely, there is daylight visible between damper blades. Neither damper has blade or edge seals.

Plumbing Systems consume both energy and water. The primary plumbing systems include the domestic water heater and plumbing fixtures and piping. Typical problems include poor insulation, equipment or systems that do not function as intended, equipment with low energy efficiency, and fixtures with excessive water usage.

- Natural gas provider – Consumers Energy, meter #22267145
- There are no plumbing fixtures other than a wall hydrant/hose bib.

Electrical systems also consume a substantial part of a building's energy. Electrical systems include lighting, lighting controls and power. Typical problems include inadequate lighting control, inappropriate lamp selection and inefficient motors.

- Electric provider – Consumers Energy, meter #93857980 (changed from #94054880 in April 2009)
- 480 volt, 3 phase main service, with a 100 amp 120/240 volt sub-panel.
- A schedule of light fixtures observed in the building is included in this report. Following is a summary by fixture type.

Deerfield Lift Station #6 Light Fixture Summary				
Fixture Type	Number of Fixtures	% of Total Number of Fixtures	Total Watts	Total KWH*
Incandescent	4	57%	600	125
Metal Halide	3	43%	864	3,774
Total	7		1,464	3,899
* Assumed operating schedule as shown in the Light Fixture Inventory in this report				

- Control for the exterior lights was not apparent.
- Interior lights are manual, no automatic control.

Plug Loads are defined as equipment in the building that is connected to power receptacles, i.e. no permanent electrical connection. Plug load equipment can consume a significant amount of electricity over the course of time. Typical plug load issues include inefficient equipment, equipment that is not turned off when not in use, and inappropriate use of equipment (e.g. electric heaters under desks).

- General use receptacles, no significant equipment loads

Occupancy / Operations / Schedule – How a building is used can have a significant impact on the building's energy usage. In fact attitudes and actions of the building users and operational staff can sometimes be the biggest factor in energy waste. It is critical that building occupants are provided with information on how to minimize energy use, the proper tools to do so, and an educational process to continually remind them how to most effectively use the building.

- Schedule
  - The lift pumps and associated equipment are used continuously year round
  - The building is occupied primarily for monitoring and maintenance purposes.

Deerfield Lift Station #6

Building Energy Cost Information – Electrical & Natural Gas

Electricity Usage

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	5,347	7.99	474	482
February	3,138	8.00	284	292
March	4,156	8.00	374	382
April	4,968	8.00	445	453
May	4,010	8.00	377	385
June	2,646	8.00	237	245
July	3,597	12.67	356	369
August	2,546	15.00	261	276
September	3,501	15.00	344	359
October	4,022	15.00	357	372
November	3,895	15.00	352	367
December	4,352	15.00	376	391
2008	**46,178**	**136**	**4,237**	**4,372**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	3,679	15.00	360	375
February	6,415	15.00	625	640
March	5,654	15.00	537	552
April	4,703	15.00	438	453
May	4,938	15.00	453	468
June	3,005	20.38	324	345
July	3,236	20.38	350	371
August	2,458	20.38	231	252
September	4,362	20.38	410	431
October	3,682	20.38	346	367
November	4,587	20.38	431	452
December	4,484	20.38	415	435
2009	**51,203**	**218**	**4,922**	**5,140**

Total	**97,381**	**353**	**9,159**	**9,512**
Some meter readings may be estimated				

Electricity and Gas Totals	
Square Footage	528
Average Annual Cost	5,440
Cost/SF/Year	10.30
EUI (MBtu/SF/Year)	425.1

Electricity Totals	
Average KWH/Year	48,691
Average MMBtu/Year	166
Average Cost/KWH	0.098
Cost/KWH w/o Fixed	0.094
Average Cost/MMBtu	28.62
Cost/SF/Year	9.01
EUI (MBtu/SF/Year)	314.7

Natural Gas Totals	
Average CCF/Year	566
Average MMBtu/Year	58
Average Cost/CCF	1.209
Cost/CCF w/o Fixed	0.992
Average Cost/MMBtu	11.74
Cost/SF/Year	1.29
EUI (MBtu/SF/Year)	110.3

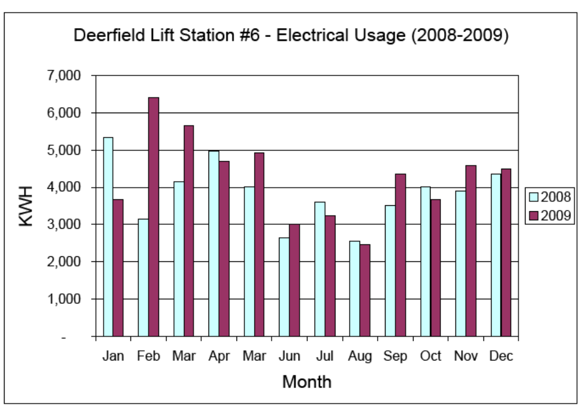
Notes
103,000 Btu/CCF
3,413 Btu/KWH
Aug-09 thru Nov-09 costs are interpolated from other data. KWH & CCF are correct from bills for this period.
Electrical includes lift pumps

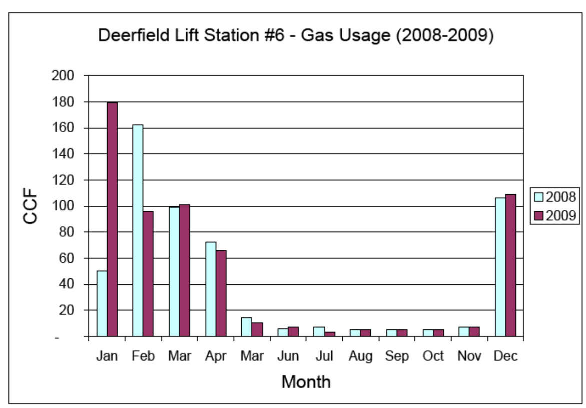
Natural Gas Usage

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	50	10.00	48	58
February	162	10.00	155	165
March	99	10.00	95	105
April	72	10.00	78	88
May	14	10.00	15	25
June	6	10.00	7	17
July	7	10.00	8	18
August	5	10.00	6	16
September	5	10.00	5	15
October	5	10.00	5	15
November	7	10.00	7	17
December	106	10.00	106	116
2008	**538**	**120**	**534**	**654**

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	179	10.34	180	191
February	96	10.50	97	107
March	101	10.50	102	112
April	66	10.50	61	71
May	10	10.50	9	20
June	7	10.50	7	17
July	3	10.50	3	13
August	5	10.50	5	15
September	5	10.50	5	15
October	5	10.50	5	15
November	7	10.50	7	17
December	109	10.50	107	117
2009	**593**	**126**	**587**	**713**

Total	**1,131**	**246**	**1,122**	**1,367**
Some meter readings may be estimated				





Behavioral, Operations and Maintenance Improvements (BOMIs)
Narrative Descriptions

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

1. ***Install Door Seals & Sweeps (Man Door)*** – Repair or replace the door seals and sweeps to reduce the amount of cold air that enters the building during the winter.
2. ***Install Door Seals (Overhead Door)*** – Repair or replace the overhead door seals to reduce the amount of cold air that enters the building during the winter.
2. ***Replace Unit Heater*** – Replace the unit heater with a more high efficiency sealed combustion unit (Reznor model UEAS or equivalent, nominal 93% efficiency). The existing heater is nominally 80% efficient.
3. ***Repair Damper on Intake Louver*** – Modify, repair or replace the intake damper to obtain a better blade seal and reduce the amount of cold air that enters the building through this damper.
4. ***Replace Incandescent Lamps*** – Replace incandescent lamps with CFL lamps. In general this can be done by simply removing the incandescent lamp and screwing in a new CFL lamp.
5. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

Energy Conservations Measures (ECMs)
Narrative Descriptions

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

1. ***Improve Wall Insulation*** – Add insulation to the brick exterior walls. Improvements to wall insulation are difficult because an improvement often means adding layers of some material to either the interior or exterior of the walls. This causes both practical and aesthetic issues, including detailing at window and door openings and how to incorporate objects that are in or fastened to the walls. Several insulation options are available including adding exterior rigid insulation and a new layer of brick or block to the exterior; installing an exterior insulation finish system (EIFS) over the existing brick or block; or adding furring with rigid insulation or stud walls with fiberglass insulation (and a layer of drywall) to the interior.

   Costs will also vary considerably depending on the solution chosen and the installation difficulty. A new brick or block veneer with insulation or new EIFS exterior will likely cost on the order of $15-$25/sf. An interior solution may be less expensive, particularly in larger or less finished areas, but durability must be considered vs. the existing block. Estimated savings and paybacks for various scenarios are shown in the table below.

Estimated Energy Savings – Additional Wall Insulation						
Type of Wall	Existing R-value	New R-Value	Energy Savings Btu/sf/yr	Estimated Cost/sf		
				Lo	Med	Hi
No Existing Insulation Block and brick, no insulation, no air gap	About 2.5	12.5	67,200	$10	$15	$25
Minor Existing Insulation E.g. insulation in block cores	About 3.5	13.5	44.450	$10	$15	$25
Savings are based on heating loads only, 7000 heating degree days, 80% boiler efficiency Buildings that are air conditioned will have more energy savings						

ECM Detailed Description Forms

The following pages contain “ECM Detailed Description Forms”. A page is dedicated to each ECM, and that ECM is described in detail along with some cost, savings, and payback information.

The costs to implement each ECM are based on industry cost estimating guides and on the A/E’s experience with similar projects. Savings are estimated based on the best available information on energy usage and system operation. Costs or savings could vary from the figures shown above depending on market and economic conditions at the time the work is performed and depending on the validity of the assumptions used to generate these estimates. The information presented is valuable for planning purposes, but it is recommended that more detailed budgets or firm quotes be obtained for projects prior to a final decision to implement any improvement.

based on utility bill data from 2008-2009, the following utility costs were used for the savings and payback analyses for each ECM. These unit costs are the commodity cost only, without the fixed monthly charges.

Electricity	$0.094/KWH
Natural Gas	$0.992/CCF

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Deerfield Lift Station #6	
ECM NUMBER: 1	
ECM NAME: Improve Wall Insulation	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Block walls with brick veneer, no insulation (or minimal insulation in some block cores)
- Assumed existing R-value of about R-2.4, including film coefficients
- About 630 square feet of uninsulated wall surface

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation to the walls. Many different options exist, with differing insulation values, costs and aesthetics. Some of the potential options include:
  - Add rigid or spray-on insulation over the existing brick, finish with new brick veneer or EIFS (Exterior Insulation Finish System, such as Dryvit or equivalent)
  - Remove the existing brick, add rigid or spray-on insulation, reinstall the existing brick
  - Install an insulated metal panel system over the existing brick exterior
  - Add furring or stud walls on the interior with insulation between studs/furring strips, finish with drywall interior
- The aesthetics of the finished wall are a critical part of any decision on whether or not to proceed with this ECM or what type of finish to use. Costs will vary depending on the finish and the number of window/door openings and wall mounted items.
- Assume a project that adds 2" of insulation and has a cost of $10/sf
- New R-value of about R-12.4, including film coefficients
- 630 sf x [(1/2.4) – (1/12.4)] R-value x 5323 DD/year (base 60F) x 24 hr/day = 27,044 MBtu/year energy savings
- Assume 75% heating system efficiency = 36,059 MBtu/year boiler input = 350 CCF = **$347/year savings**
- Cost = 630 sf x $10/sf = $6,300
- Payback = 18.2 years

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**6,300**
Total Estimated Annual Savings ($)	**347**
Simple Payback (Years)	**18.2**
Estimated Useful Life (Years)	**30**

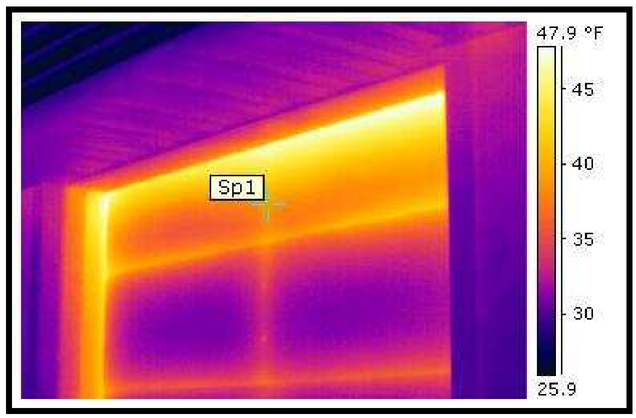
Deerfield Lift Station #6
Light Fixture Inventory
April 2010

	Existing Fixtures				Assumed Schedule					
Room Name	**Number Of Fixtures**	**Lamp Type**	**Fixture Watts**	**Total Load (W)**	**Hours per Day**	**Days Per Week**	**Weeks Per Year**	**Hours Per Year**	**Total Energy (KWH)**	**Comments**
Exterior	3	HID 250 Watt	288	864	12	7	52	4368	3774	mercury vapor…uncertain of wattage
Interior	4	Incandescent 150 Watt	150	600	2	2	52	208	125	
Totals	**7**			**1464**					**3899**	


North face

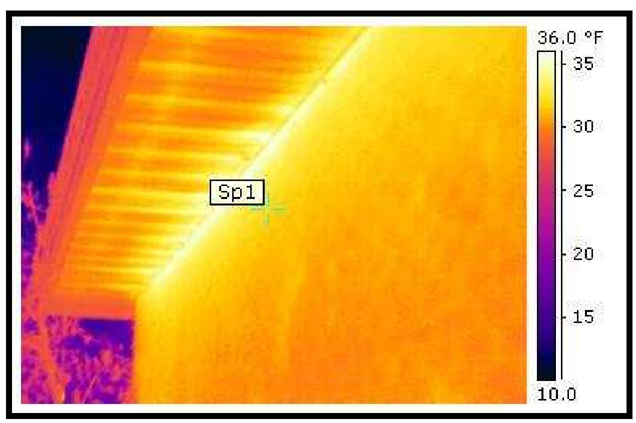
North face – Note heat loss from overhead door


North face overhead door



North face overhead door – note heat loss between door panels and around top and sides of door


North soffit



North soffit – Note heat loss where the wall meets the soffit

Isabella Lift Station #2

Union Township, MI

1933 S Isabella Road

Date of Construction: 1979/1980

Current Size: 792 Square Feet

Energy Performance Score

The table below is a simple metric to illustrate how well this building utilizes energy. The scores are based largely on the building performance requirements of the Michigan Energy Code, ASHRAE Standard 90.1, but also on subjective criteria from the field observations in each building.

The scoring is as follows:

- **Poor** does not meet the Standard
- **Fair** generally meets the Standard, but has deficiencies in some areas
- **Good** generally meets or exceeds the Standard

The following Building Overall Description and Observations section of this report provides additional insight into the factors that were used to determine these scores.

Energy Performance	
Isabella Lift Station #2	
Description	**Score**
Envelope	
Roof	**Good**
Walls	**Poor**
Windows	NA
Infiltration	**Poor**
Mechanical	
Heating System	**Good**
Cooling System	NA
Domestic Hot Water	NA
Insulation	NA
Controls	**Fair**
Electrical	
Lighting	**Poor**
Lighting Controls	**Fair**
OVERALL CONDITION	**FAIR**

Building Overall Description & Observations

The performance of this energy audit included a field assessment of the building. This section of the report discusses some of conditions that were observed. This is not intended to be a comprehensive discussion of all building deficiencies. However the items discussed represent the conditions found and the general condition of the building. Many of the potential energy improvements that are presented in this report are based on the discussions below.

This building is used to house equipment associated with a municipal lift station. The building consists of two rooms – primarily a room with a permanent generator inside the building, storage space, and space for a vehicle and/or portable generator to park inside the building; and a small entry room. In general the building appears to be maintained in fair condition.

The photographs included in this report illustrate some aspects of the building construction.

General Information

- Size – 792 square feet
- Single story
- Schedule – The lift pumps and associated equipment are used continuously year round. The building is occupied primarily for monitoring and maintenance purposes.

The Building Envelope provides the first defense against energy use. The envelope includes the roof, walls, windows and doors. Typical problems include areas that are not insulated well and areas of air leakage (infiltration).

- Roof
    - Sloped with asphalt shingles.
    - The ceiling is a drywall surface mounted directly to the roof structure. Batt insulation is installed above the ceiling, thickness unknown.
    - Daylight is visible at some locations around the building soffit, indicating air leakage. One section of the soffit is missing on the front of the building.
- Walls
    - Block with face brick, vinyl siding on the fascia and gable ends. Insulation value is unknown, but the walls are believed to contain no insulation.
- Windows – There are no windows in the building.
- Doors
    - One hollow metal man door. The seals around the door are poor, daylight is visible around the door.
    - Two insulated overhead garage doors. The seals around the doors are poor, a significant amount of daylight is visible around the door and between door panels.

Mechanical systems are important because they consume a significant portion of a building's energy. The primary mechanical systems include heating, cooling, and ventilating systems and controls. Typical problems include poor insulation, equipment or systems that do not function as intended and equipment with low energy efficiency.

- Heat in the garage area is provided by a single unit heater, 105 MBH natural gas input, 84 MBH output, 80% efficiency. The building is not cooled.
- Heat in the entry area is provided by an electric strip heater. The thermostat for this heater was set at it's lowest setting at the time of the field review.
- There is a large intake and exhaust louver for the generator set in the building. The intake louver includes a motorized damper and the exhaust louver includes a gravity backdraft damper. The generator is ducted from its radiator discharge directly to the exhaust louver. The intake damper does not close completely, there is daylight visible between damper blades. Neither damper has blade or edge seals.

Plumbing Systems consume both energy and water. The primary plumbing systems include the domestic water heater and plumbing fixtures and piping. Typical problems include poor insulation, equipment or systems that do not function as intended, equipment with low energy efficiency, and fixtures with excessive water usage.

- Natural gas provider – Consumers Energy, meter #3404014
- There are no plumbing fixtures other than a wall hydrant/hose bib.

Electrical systems also consume a substantial part of a building's energy. Electrical systems include lighting, lighting controls and power. Typical problems include inadequate lighting control, inappropriate lamp selection and inefficient motors.

- Electric provider – Consumers Energy, meter #40027152
- 480 volt, 3 phase main service.
- A schedule of light fixtures observed in the building is included in this report. Following is a summary by fixture type.

Isabella Lift Station #2 Light Fixture Summary				
Fixture Type	Number of Fixtures	% of Total Number of Fixtures	Total Watts	Total KWH*
Incandescent	5	63%	750	156
T12 Fluorescent	2	25%	180	37
High Pressure Sodium	1	13%	295	1,289
Total	8		1,225	1,482
* Assumed operating schedule as shown in the Light Fixture Inventory in this report				

- Control for the exterior lights was not apparent.
- Interior lights are manual, no automatic control.

Plug Loads are defined as equipment in the building that is connected to power receptacles, i.e. no permanent electrical connection. Plug load equipment can consume a significant amount of electricity over the course of time. Typical plug load issues include inefficient equipment, equipment that is not turned off when not in use, and inappropriate use of equipment (e.g. electric heaters under desks).

- General use receptacles, no significant equipment loads

Occupancy / Operations / Schedule – How a building is used can have a significant impact on the building's energy usage. In fact attitudes and actions of the building users and operational staff can sometimes be the biggest factor in energy waste. It is critical that building occupants are provided with information on how to minimize energy use, the proper tools to do so, and an educational process to continually remind them how to most effectively use the building.

- Schedule
  - The lift pumps and associated equipment are used continuously year round
  - The building is occupied primarily for monitoring and maintenance purposes.

Isabella Lift Station #2

Building Energy Cost Information – Electrical & Natural Gas

Electricity Usage

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	4,299	8.01	380	388
February	3,839	8.00	348	356
March	5,083	8.00	457	465
April	4,649	8.00	417	425
May	5,913	8.00	555	563
June	4,469	8.00	399	407
July	3,651	12.50	426	438
August	3,183	15.00	326	341
September	3,044	15.00	299	314
October	3,183	15.00	282	297
November	3,793	15.00	342	357
December	4,011	15.00	347	362
2008	**49,117**	**136**	**4,579**	**4,715**

Month	KWH	Fixed Cost	Energy Cost	Total Cost
January	4,692	15.00	460	475
February	4,291	15.00	418	433
March	5,110	15.00	485	500
April	4,622	15.00	539	554
May	4,468	15.00	408	423
June	4,340	20.38	506	526
July	3,618	20.38	391	412
August	3,062	20.38	357	377
September	4,141	20.38	483	503
October	2,971	20.38	346	367
November	4,528	20.38	528	548
December	4,399	20.38	2,084	2,104
2009	**50,242**	**218**	**7,005**	**7,223**

Total	**99,359**	**353**	**11,585**	**11,938**
Some meter readings may be estimated				

Electricity and Gas Totals	
Square Footage	792
Average Annual Cost	7,553
Cost/SF/Year	9.54
EUI (MBtu/SF/Year)	405.1

Electricity Totals	
Average KWH/Year	49,680
Average MMBtu/Year	170
Average Cost/KWH	0.120
Cost/KWH w/o Fixed	0.117
Average Cost/MMBtu	35.20
Cost/SF/Year	7.54
EUI (MBtu/SF/Year)	214.1

Natural Gas Totals	
Average CCF/Year	1,469
Average MMBtu/Year	151
Average Cost/CCF	1.079
Cost/CCF w/o Fixed	0.995
Average Cost/MMBtu	10.47
Cost/SF/Year	2.00
EUI (MBtu/SF/Year)	191.0

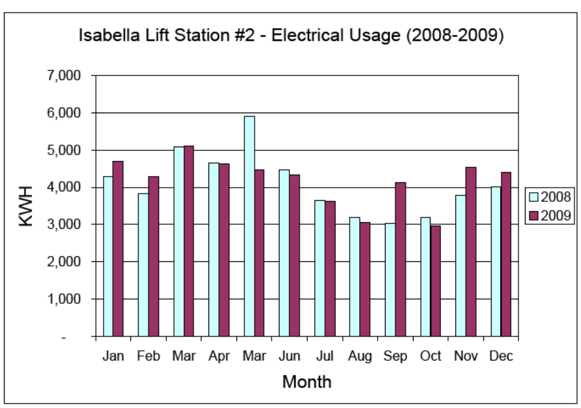
Notes
103,000 Btu/CCF
3,413 Btu/KWH
Aug-09 thru Nov-09 costs are interpolated from other data. KWH & CCF are correct from bills for this period.
Electrical includes lift pumps

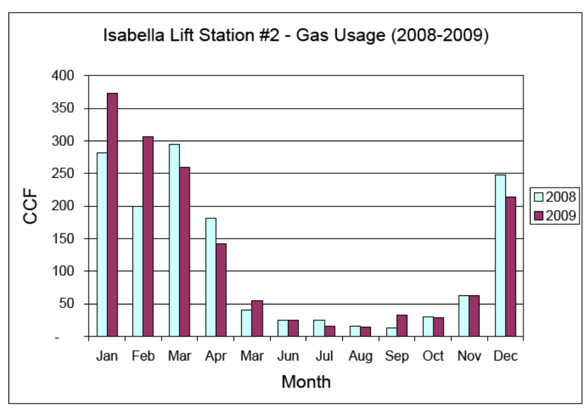
Natural Gas Usage

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	281	10.00	268	278
February	199	10.00	190	200
March	294	10.00	281	291
April	181	10.00	196	206
May	40	10.00	43	53
June	25	10.00	28	38
July	24	10.00	24	34
August	15	10.00	17	27
September	13	10.00	14	24
October	30	10.00	30	40
November	62	10.00	62	72
December	248	10.00	249	259
2008	**1,412**	**120**	**1,402**	**1,522**

Month	CCF	Fixed Cost	Energy Cost	Total Cost
January	373	10.32	376	386
February	307	10.50	310	320
March	259	10.50	261	272
April	142	10.50	141	152
May	54	10.50	49	60
June	25	10.50	25	35
July	15	10.50	14	25
August	14	10.50	14	24
September	32	10.50	32	42
October	28	10.50	28	38
November	62	10.50	62	72
December	214	10.50	208	218
2009	**1,525**	**126**	**1,520**	**1,645**

Total	**2,937**	**246**	**2,922**	**3,168**
Some meter readings may be estimated				





Behavioral, Operations and Maintenance Improvements (BOMIs)
Narrative Descriptions

BOMIs (Building Operation & Maintenance Improvements, or low-cost energy improvements) require little or no cost to implement and generate immediate energy savings. Generally, these items are less complex and could be implemented by existing facility staff. The implementation costs are usually absorbed by or budgeted within operating funds.

1. ***Seal Air Infiltration*** – Seal the air infiltration that is evident at the top of the wall. Daylight was visible from inside the building, indicating an air gas that allows cold air to enter the building during the winter.
2. ***Install Door Seals & Sweeps (Man Door)*** – Repair or replace the door seals and sweeps to reduce the amount of cold air that enters the building during the winter.
3. ***Install Door Seals (Overhead Door)*** – Repair or replace the overhead door seals to reduce the amount of cold air that enters the building during the winter.
4. ***Replace Unit Heater*** – Replace the unit heater with a more high efficiency sealed combustion unit (Reznor model UEAS or equivalent, nominal 93% efficiency). The existing heater is nominally 80% efficient.
5. ***Repair Damper on Intake Louver*** – Modify, repair or replace the intake damper to obtain a better blade seal and reduce the amount of cold air that enters the building through this damper.
6. ***Replace Incandescent Lamps*** – Replace incandescent lamps with CFL lamps. In general this can be done by simply removing the incandescent lamp and screwing in a new CFL lamp.
7. ***Replace or Retrofit T12 Fixtures*** – Replace existing T12 light fixtures with T8 fluorescent fixtures, or retrofit the existing T12 fixtures to utilize T8 lamps. If fixture retrofits are considered, be sure that the replacement ballasts and sockets are suitable to utilize the full energy savings of the T8 lamps.
8. ***Install Occupancy Sensors*** – Install occupancy sensors where applicable throughout the building. Occupancy sensors automatically shut lights off when people are not present in the room. This report assumes that to some extent the lights are currently left on when people leave the room, even if many of the building users are somewhat diligent about turning off lights. It should be noted that if the occupants always turn off the lights when exiting a room, there will be no energy savings from this item.

Energy Conservations Measures (ECMs)
Narrative Descriptions

ECMs (Energy Conservation Measures, or capital energy improvements) are more complex or costly than BOMIs. Generally, these items require more planning and resources and may require contracted workers to implement. Some additional technical and/or economic evaluation may also be necessary during the decision-making process. The funds for implementation are often obtained through longer term budgeting, grants, bonds or other financing methods.

1. ***Improve Wall Insulation*** – Add insulation to the brick exterior walls. Improvements to wall insulation are difficult because an improvement often means adding layers of some material to either the interior or exterior of the walls. This causes both practical and aesthetic issues, including detailing at window and door openings and how to incorporate objects that are in or fastened to the walls. Several insulation options are available including adding exterior rigid insulation and a new layer of brick or block to the exterior; installing an exterior insulation finish system (EIFS) over the existing brick or block; or adding furring with rigid insulation or stud walls with fiberglass insulation (and a layer of drywall) to the interior.

   Costs will also vary considerably depending on the solution chosen and the installation difficulty. A new brick or block veneer with insulation or new EIFS exterior will likely cost on the order of $15-$25/sf. An interior solution may be less expensive, particularly in larger or less finished areas, but durability must be considered vs. the existing block. Estimated savings and paybacks for various scenarios are shown in the table below.

Estimated Energy Savings – Additional Wall Insulation						
Type of Wall	Existing R-value	New R-Value	Energy Savings Btu/sf/yr	Estimated Cost/sf		
				Lo	Med	Hi
No Existing Insulation Block and brick, no insulation, no air gap	About 2.5	12.5	67,200	$10	$15	$25
Minor Existing Insulation E.g. insulation in block cores	About 3.5	13.5	44.450	$10	$15	$25
Savings are based on heating loads only, 7000 heating degree days, 80% boiler efficiency Buildings that are air conditioned will have more energy savings						

   Specific areas what could be addressed are as follows:

   - *Brick Walls - General* – The walls of most of the building are uninsulated or have minimal insulation only in the block cores, these walls should be considered for improvement.
   - *Door Infill Area* – The thermal images show more heat loss from an area on the south side of the building where there is no interior masonry than from the rest of the building. Therefore there would also be more energy savings per square foot over this area than the rest of the building.

ECM Detailed Description Forms

The following pages contain “ECM Detailed Description Forms”. A page is dedicated to each ECM, and that ECM is described in detail along with some cost, savings, and payback information.

The costs to implement each ECM are based on industry cost estimating guides and on the A/E’s experience with similar projects. Savings are estimated based on the best available information on energy usage and system operation. Costs or savings could vary from the figures shown above depending on market and economic conditions at the time the work is performed and depending on the validity of the assumptions used to generate these estimates. The information presented is valuable for planning purposes, but it is recommended that more detailed budgets or firm quotes be obtained for projects prior to a final decision to implement any improvement.

based on utility bill data from 2008-2009, the following utility costs were used for the savings and payback analyses for each ECM. These unit costs are the commodity cost only, without the fixed monthly charges.

Electricity	$0.117/KWH
Natural Gas	$0.995/CCF

ECM DETAILED DESCRIPTION FORM

BUILDING / SITE: Isabella Lift Station #2	
ECM NUMBER: 1	
ECM NAME: Improve Wall Insulation	

DESCRIPTION OF PRE-INSTALLATION CONDITIONS:

- Block walls with brick veneer, no insulation (or minimal insulation in some block cores)
- Assumed existing R-value of about R-2.4, including film coefficients
- About 760 square feet of uninsulated wall surface

DESCRIPTION OF POST-INSTALLATION CONDITIONS:

- Add insulation to the walls. Many different options exist, with differing insulation values, costs and aesthetics. Some of the potential options include:
  - o Add rigid or spray-on insulation over the existing brick, finish with new brick veneer or EIFS (Exterior Insulation Finish System, such as Dryvit or equivalent)
  - o Remove the existing brick, add rigid or spray-on insulation, reinstall the existing brick
  - o Install an insulated metal panel system over the existing brick exterior
  - o Add furring or stud walls on the interior with insulation between studs/furring strips, finish with drywall interior
- The aesthetics of the finished wall are a critical part of any decision on whether or not to proceed with this ECM or what type of finish to use. Costs will vary depending on the finish and the number of window/door openings and wall mounted items.
- Assume a project that adds 2" of insulation and has a cost of $10/sf
- New R-value of about R-12.4, including film coefficients
- 760 sf x [(1/2.4) – (1/12.4)] R-value x 5323 DD/year (base 60F) x 24 hr/day = 32,625 MBtu/year energy savings
- Assume 75% heating system efficiency = 43,500 MBtu/year boiler input = 422 CCF = **$420/year savings**
- Cost = 760 sf x $10/sf = $7,600
- Payback = 18.1 years

COST SUMMARY TABLE	
Total Estimated Cost to Implement ($)	**7,600**
Total Estimated Annual Savings ($)	**420**
Simple Payback (Years)	**18.1**
Estimated Useful Life (Years)	**30**

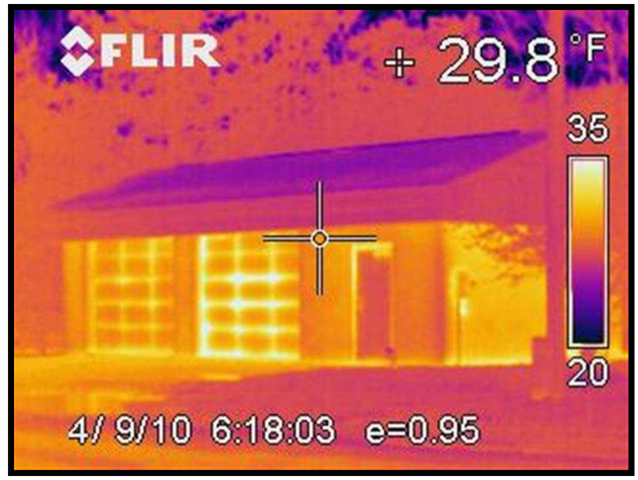
Isabella Lift Station #2
Light Fixture Inventory
April 2010

	Existing Fixtures				Assumed Schedule					
Room Name	**Number Of Fixtures**	**Lamp Type**	**Fixture Watts**	**Total Load (W)**	**Hours per Day**	**Days Per Week**	**Weeks Per Year**	**Hours Per Year**	**Total Energy (KWH)**	**Comments**
Interior	5	Incandescent 150 Watt	150	750	2	2	52	208	156	mercury vapor…uncertain of wattage
Interior	2	4 foot - 2 lamp T12	90	180	2	2	52	208	37	
Exterior	1	HPS 250 Watt	295	295	12	7	52	4368	1289	
Totals	**8**			**1225**					**1482**	

Isabella Lift Station #2

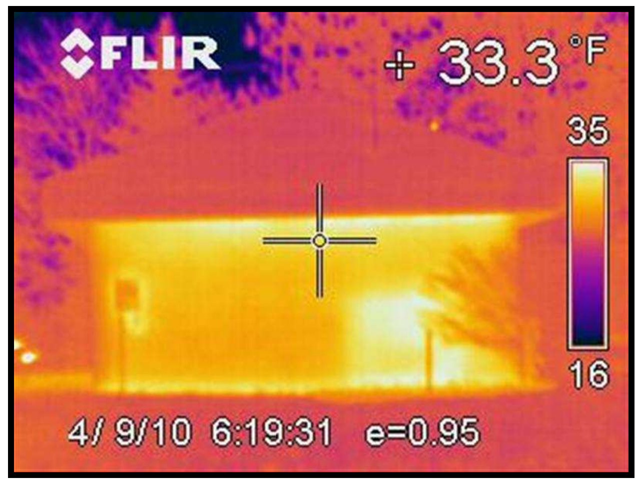
Photographs & Thermal Images

West face



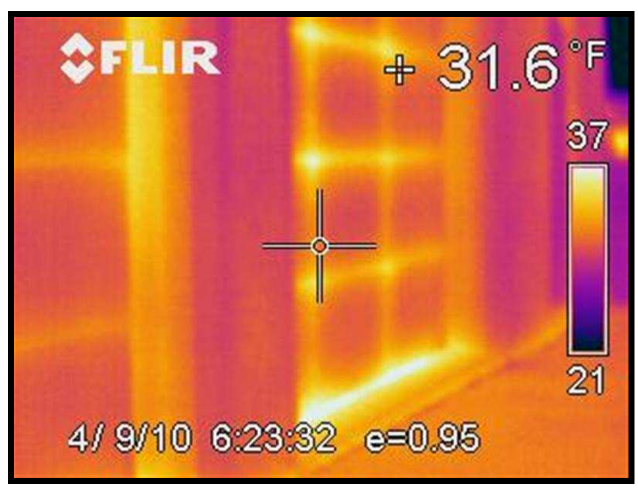
West face – Note heat loss between overhead door panels

South face



South face – Note heat loss from top of wall and from section of wall where interior block is removed

Overhead doors

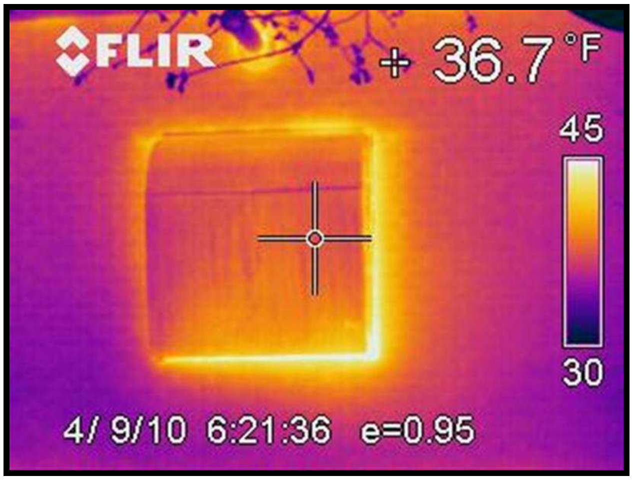


Overhead doors – Note heat loss at bottom of door


Overhead doors

Overhead doors – Note heat loss from seal on side of door


East face



East face – Note heat loss around hood