SOUTHWEST ENERGY EFFICIENCY PROJECT
LEED CASE STUDY: GREYBULL ELEMENTARY SCHOOL, GREYBULL, WY

October, 2008

SUMMARY

There is growing interest nationwide by educators, school districts, and parents and students to promote green schools that provide a superior learning environment, while reducing operating costs and minimizing environmental impacts of schools. This case study describes the features, performance and cost effectiveness of the new Greybull Elementary School, located in Bighorn County School District #3, in Greybull, WY. Greybull Elementary was designed and built to achieve LEED-Silver Certification under the U.S. Green Building Council's LEED for Schools program – the first LEED Certified School in Wyoming. The school was designed to achieve nearly a 50% reduction in energy costs compared to a typical school built to current energy code requirements. It replaces the former Greybull Elementary, built in 1919, and now a historic property, which had very high energy bills (as much as $50,000 per year), poor indoor air quality and minimal daylighting.

The case study describes the process used to design and build Greybull Elementary, with emphasis on energy efficiency measures that were implemented at the school. The case study includes analysis of the modeled versus observed energy performance of Greybull Elementary School during its initial nine months of operation, estimates of the energy savings, avoided emissions and net economic benefits over the lifetime of the school, and findings and recommendations for the use of the LEED rating system in new K-12 school facilities in Wyoming. The case study also includes comparisons of Greybull to other LEED School projects nationwide.

The case study was prepared by the Southwest Energy Efficiency Project, under contract to the Wyoming Business Council, State Energy Program. The case study was prepared in consultation with the project's energy modeling team, commissioning agent, and personnel at Bighorn County School District #3 and Greybull Elementary.

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INTRODUCTION

Greybull Elementary School is located in Greybull, WY, in Big Horn County School District No. 3. Construction of the school was completed in August 2007. The new Greybull Elementary replaces the original Greybull Elementary School, which was built in 1919. The total project cost was $8 million for the 36,000 square foot facility ($222 per square foot). The additional cost for LEED certification was $114,000, or about 1.4% of total construction costs. The Wyoming Energy Office paid for the additional LEED Certification costs for Greybull Elementary School. The School was designed and constructed to achieve LEED-Silver Certification, under the LEED for New Construction, Version 2.1 Rating System.

Greybull Elementary, Greybull WY
Photo: SWEEP

In order to achieve LEED-Silver Certification, school projects must meet the requirements of the LEED for Schools Rating System, which recognizes the unique nature of the design and construction of K-12 Schools[1]. The LEED for Schools rating system includes a combination of mandatory measures required for all projects, and optional activities within the following 6 categories. In order to achieve LEED Silver Certification, a school must achieve at least 37 points under the LEED for Schools Rating System.

1. Sustainable sites (16 possible points)
   Ensure buildings are sited and use construction practices that minimize environmental impacts and promote alternative transportation, such as bicycling, public transit, and alternative fuel vehicles.

2. Water efficiency (7 possible points)
   Conserve water resources through interior and exterior water efficiency measures.

3. Energy & Atmosphere (17 possible points)
   Reduce energy demand and greenhouse gas emissions through a combination of energy efficiency measure, refrigerant management, and renewable energy (generated onsite or purchased as green power). The Energy & Atmosphere category includes the following 3 prerequisites:

   1) Fundamental Commissioning of the Building Energy Systems

   2) Minimum energy performance (14% improvement for new buildings; 7% for existing buildings renovations)

   3) Fundamental refrigerant management

[1]Greybull Elementary was designed and built to meet the LEED for New Construction requirements, Version 2.1. The LEED for Schools rating system was not implemented until April 20, 2007. A credit modification chart is available from USGBC to compare the requirements in LEED for Schools with LEED for New Construction, Version 2.2. The requirements of the new LEED for Schools rating system are shown here.

4. Materials & Resources (13 possible points)
   Designed to minimize waste generation and conserve resources through reuse of buildings and materials, diverting construction waste from landfills, incorporating recycled content products, and sourcing materials regionally or from sustainable sources. Prerequisites include providing space for storage and collection of recyclables.

5. Indoor Environmental Quality (20 possible points)
   This category establishes minimum indoor air quality (IAQ) performance criteria to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants.

6. Innovation & Design Process (6 possible points)
   This category provides design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by the LEED for Schools Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Rating System.

The certification points by category and credit option for Greybull Elementary are shown in Table 1.

ABOUT LEED FOR SCHOOLS

The LEED® Green Building Rating System™ is the national benchmark for the design, construction, and operations of high-performance green buildings. LEED for Schools is the recognized benchmark for green schools with third-party reviews to ensure that schools are healthy for students, comfortable for teachers and cost-effective to operate.

Benefits of building a LEED-Certified School include:

- A healthy, productive learning environment
- Improved teacher and staff retention
- Financial savings to the individual school, the school district and taxpayers
- Hands-on learning opportunities
- Environmentally friendly

Table 1: Summary of LEED Points by Category for Greybull Elementary

LEED Category	Prerequisites	Optional Points at Greybull Elementary
Sustainable Sites	• Erosion and Sedimentation Control	8 points
Water Efficiency		2 points
Energy & Atmosphere	• Fundamental Commissioning • Minimum Energy Performance • Fundamental Refrigerant Management	10 points
Materials & Resources	• Storage & Collection of Recyclables	4 points
Indoor Environmental Quality	• Minimum IAQ performance • Environmental Tobacco Smoke (ETS) Control	10 points
Innovation & Design Process		4 points
Total Score, Greybull Elementary		38 points

GREYBULL ELEMENTARY: LEED PROJECT INFORMATION

Description: Greybull Elementary was designed and constructed to achieve LEED-Silver Certification under LEED-NC, Version 2.1. The school features a geothermal exchange system for heating and cooling, daylighting, and a well-insulated building envelope. It provides a superior learning environment that minimizes environmental impacts from the materials and resources used in constructing the building, and from ongoing operations.

Construction and LEED Certification

- Construction: $8 million ($222 per square foot)
- LEED Certification cost: $114,000 (1.4% of total construction costs)
- LEED Points: 38 (Submitted for LEED Silver certification under LEED NC Version 2.1)

Energy performance

- Projected annual energy use: 26 kBTU per square foot
- Observed energy use, (Sept 2007 – May 2008): 51 kBTU per square foot
- Projected annual energy cost: $13,000 (43% savings versus reference building)
- Annual energy savings: $14,000 per year
- Net economic benefits (lifetime, energy savings only): $434,000

Greybull Elementary Library
Photo: SWEEP

Entrance to Greybull Elementary School
Photo: SWEEP

School and District Information

Greybull Elementary
Principal: Mr. Coley Shadrick
125 6th Avenue South, Greybull, WY 82426
Bighorn County School District #3
Superintendent: Ms. Martha Young

Facility information:

- 36,000 sq. ft., including 19 classrooms, office and staff workspace, gymnasium, multi-purpose room and cafeteria, and two outdoor playground areas.
- 242 students, 21 teachers, and 20 administrators
- Completed August 2007, and occupied September 2007

Solatubes (shown on roof) provide daylight to interior spaces at Greybull Elementary
Photo: SWEEP

GREYBULL ELEMENTARY: THE LEED CERTIFICATION PROCESS

The building was designed to maximize daylight into the building by providing a north-south exposure for the majority of classrooms. The school was oriented 15 degrees east and west of true north to take maximum advantage of solar gain. Eighty-five percent of the interior spaces have access to natural daylight. There are 135 windows and 26 skylights in the school.

Other notable features of Greybull Elementary include:

- Building materials were sourced from nearby suppliers and sustainable sources.
- Use of water conserving fixtures in bathrooms, faucets and cafeteria kitchen.
- Restricts the use of carpets, glues or other components with high quantities of certain chemicals, to protect indoor air quality.
- The school will recycle plastic, paper, glass, cardboard and metal, and serve as a drop-off point for community recyclables.
- Educational information for students, including exposed piping and labels to illustrate efficient features.

The case study focuses on the energy efficiency measures implemented at Greybull Elementary. While the non-energy LEED Categories and Credit Options are not described in detail here, they are also important components of any high performance school project.

ENERGY & ATMOSPHERE

BUILDING ENVELOPE

The following energy efficiency improvements were implemented to improve the efficiency of the building envelope:

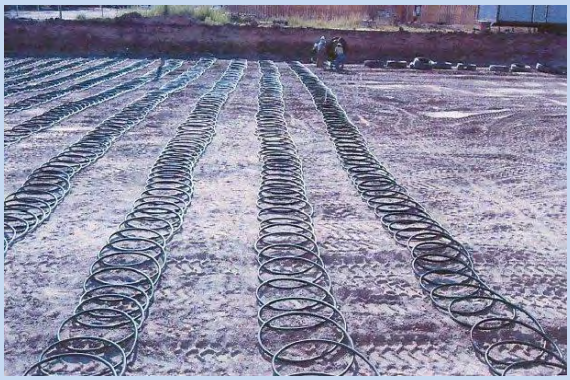
- Increased wall and roof insulation levels compared to ASHRAE 90.1 minimum requirements (R-60 in attic and R-40 in walls, with 1 ½" rigid insulation, vapor barrier, R-22 batt insulation).
- Upgraded window insulation and shading coefficients (U-value 0.26 and shading coefficient 0.44).

HEATING AND COOLING SYSTEMS

- The School uses a high efficiency ground loop heat pump system (also referred to as 'geoexchange systems') using a shallow bury horizontal loop configuration combined with high efficiency air-to-air heat recovery units to provide fresh air to the building. The enhanced energy efficiency of the building allowed a 40 percent down-sizing of the heating and air conditioning systems. Ground-source heat pumps are in use in more than 600 schools in 39 states. It is a proven technology that provides reliable heating and cooling, with lower energy and maintenance costs than conventional systems.
- Occupancy controls allow teachers and staff to disable the zone heat pump system within their classroom or office space and open windows to utilize natural ventilation.
- Use of variable air volume ventilation air control (VAV) systems to allow reduced ventilation airflow when classrooms are using natural ventilation.
- Demand controlled ventilation systems that adjust outside air ventilation levels based on the number of occupants in the building and the ventilation demands they create.

Photo: SWEEP

Exposed piping for the geothermal heat pump system. The ground loop return (yellow) and ground loop supply (red) tubes are labeled and shown here (utility closet) and in an exposed ceiling panel for use as an educational tool.



Installation of the geothermal loop field system at Greybull Elementary.
Photo: PlanOne/Architects

DAYLIGHTING DESIGN AND LIGHTING SYSTEMS

Greybull Elementary was designed to provide daylighting within the majority of interior spaces in the school. The school is oriented on an east-west axis, so that the majority of classrooms and office space receive daylight from windows, as well as solatubes placed in each classroom. Interior hallways and the library are lit using skylights, shown in Figure 1.

- Daylight harvesting using photocells and dimming ballasts was used in the classrooms, cafeteria, and multi-purpose room. The calculated indoor lighting load without reducing for daylight harvesting is less than 0.9 watts per square foot (w/sf).
- High efficiency fluorescent fixtures (T5 and T5HO indirect luminaires) are installed in classrooms, offices, and corridors with occupancy sensors and program start ballasts throughout the building.

Figure 1. Example of interior daylighting.

Example of daylighting in school corridor, Greybull Elementary. Note interior windows used to harvest exterior lighting and provide additional daylighting to the interior hallway space.
Photo: SWEEP

COMMISSIONING GREYBULL ELEMENTARY

Commissioning involves inspection, analysis and evaluation of a completed building by a third-party Commissioning Agent ("CxA") to ensure that all components and systems are installed and functioning as designed. The commissioning process includes making recommendations for correcting any deficiencies in the building envelope, controls or mechanical systems, and for improving the energy efficiency of the building operations. The commissioning process is not an energy audit, but rather a review of the building to determine if all components and systems are working as intended, and whether any modifications to procedures or component repairs are needed to ensure that each of the building systems are functioning as they were designed. Building commissioning is a cost-effective way to achieve energy savings in new and existing buildings. Studies estimate that commissioning can reduce energy use in new buildings by 6 to 12 percent, and up to 30% in existing buildings (known as retrocommissioning). Commissioning usually costs about $1 per square foot of occupied space, and short payback periods (typically 5 years or less) (Mills 2005). Commissioning also achieves significant non-energy benefits, including reduced call-backs, down-sizing of systems and equipment, and reduced maintenance costs and extended equipment life because systems are designed and operated properly.

Commissioning is a requirement for LEED for Schools Certification. The building commissioning work for Greybull Elementary was conducted by EMC Engineers.

The scope of commissioning activities included the following tasks:

- Provide commissioning specifications, which were incorporated into the General Requirements, Mechanical and Electrical systems sections.
- Development of a commissioning plan.
- Review of mechanical submittals.
- Review of control submittals, including a thorough review of the proposed control sequence.
- Perform periodical construction phase job walks and provide construction observations.
- Preparation of prefunctional checklists for the new mechanical equipment, including the ground source heating and cooling water systems, air-handling units, heat recovery units, heat pumps, duct furnaces, a gas unit heater, and exhaust fans.
- Witnessing selected startup activities for major mechanical equipment.
- Procurement and oversight of the testing, adjusting, and balancing (TAB) contractor.
- Preparation and implementation of functional test procedures to verify the proper control and operation of the mechanical systems.
- Preparation of a list of deficiencies discovered during the functional test procedures.
- Assist in preparation of systems training for school district personnel.
- Preparation of a final commissioning report.
- Review of the Operation & Maintenance (O&M) Manual.

- Preparation of a Systems Manual.
- Perform end-of-warranty walk through the building.

A copy of the commissioning progress report and final report for Greybull Elementary is provided in Appendix B.1 and B.2.

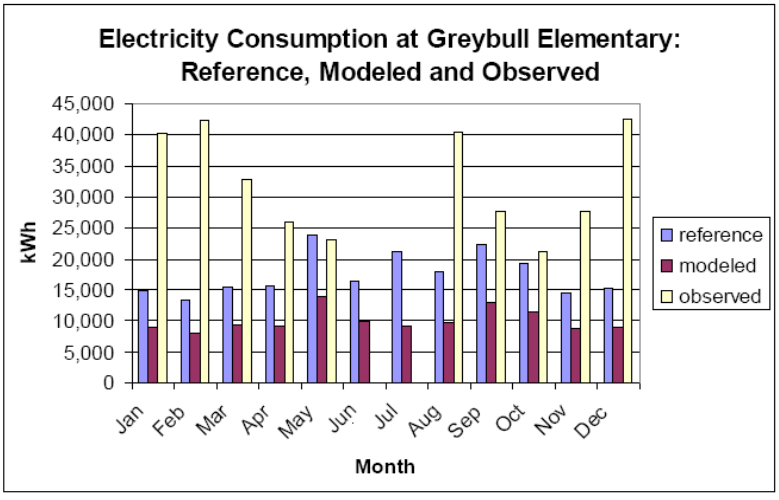
ANALYSIS OF ENERGY PERFORMANCE AT GREYBULL

This section summarizes the energy demand at Greybull during the first nine months of operations, September 2007 to May 2008. As with any new facility, the initial energy costs, particularly for electricity, are higher than expected because the building control systems and usage patterns are still being established.

The comparative electricity use for the reference building, design building as modeled, and actual observed performance for electricity is shown in Figure 2. Figures 3 and 4 show the same information for natural gas consumption, and total consumption, in kBTUs. The total building energy consumption was modeled to be 940,000 kBtu per year, compared to 1.7 million kBtu per year for the baseline/reference building, for a projected annual savings of 43%. The total actual energy consumption for Greybull Elementary during its first 9 months of operations was 1.6 million kBTUs, Primary heating is responsible for approximately one-half of total building energy consumption, followed by lighting (21%), supply fans (23%), and miscellaneous electric loads (10%). Additional information about the assumptions used for the reference building, the design building and expected energy and cost savings are provided in Appendix A.1 and A.2.

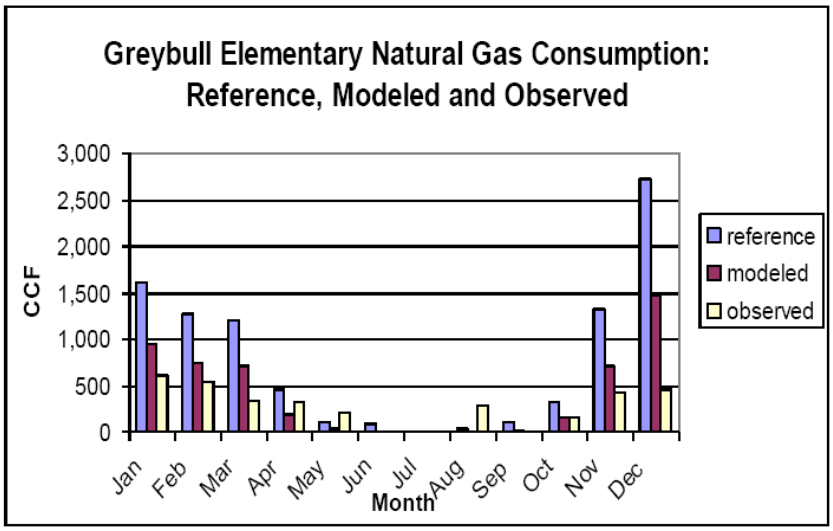
Energy costs for the initial 9-month period of operations at Greybull Elementary (September 2007 – May 2008) were $22,800 for electricity, and $2,474 for natural gas. Total energy costs, shown in figure 5, were $25,310, equivalent to an average monthly energy cost of about $2,800 per month, and $0.70 per square foot. This is approximately 50% higher than the estimated energy costs from the model building, but half of what the energy costs were for the old elementary school building, where the average monthly energy bill was $4,200 (2006 data), or $1.18 per square foot. The new elementary school also has additional technology components (110 computers versus 70 in the old school; digital whiteboards, DVD players and television units) versus the old facility. It also utilizes mechanical ventilation systems to maintain healthy indoor air quality through fresh air ventilation.

Figure 2: Electricity Consumption: Reference Case, Modeled, and Observed Performance



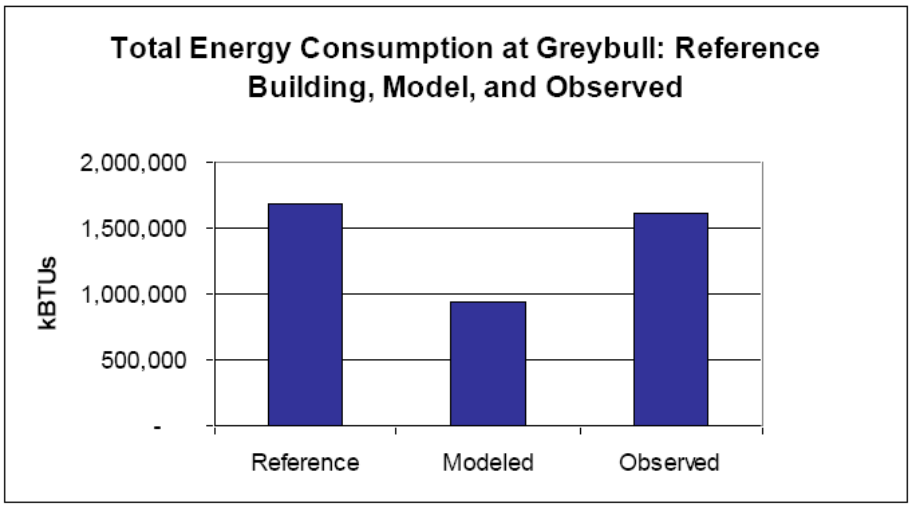
Source: SWEEP analysis of data provided by MKK Consulting Engineers and Bighorn County School District # 3.

Figure 3: Natural Gas Consumption: Reference, Modeled and Observed Performance



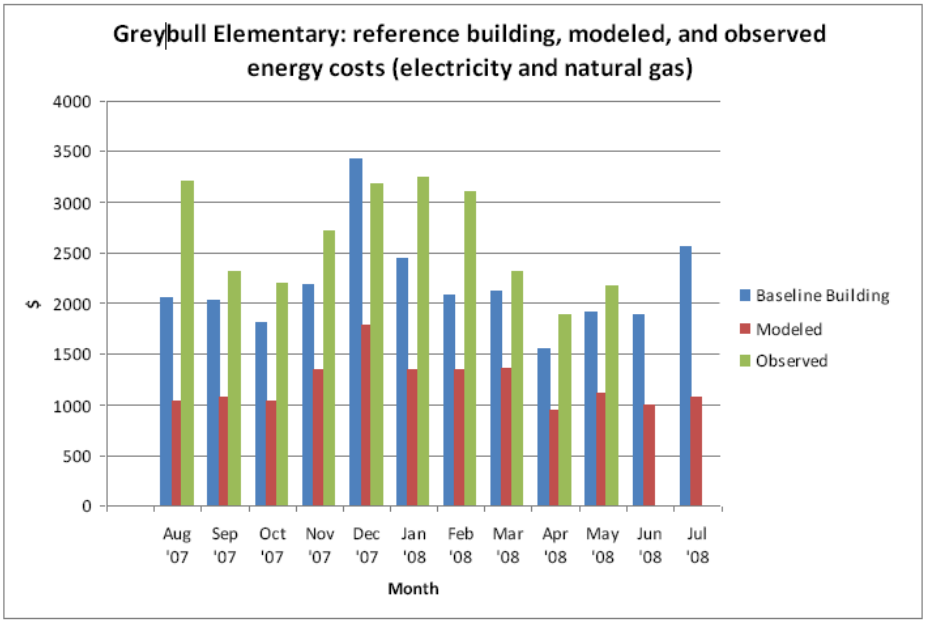
Source: SWEEP analysis of data provided by MKK Consulting Engineers and Bighorn County School District # 3.

Figure 4: Total energy consumption: Greybull Elementary Reference Case, Modeled, and Observed.



Source: SWEEP analysis of data provided by MKK Consulting Engineers and Bighorn County School District # 3.

Figure 5: Energy costs for the reference and model building versus actual energy use, electricity and natural gas: August 2007 – May 2008



Source: SWEEP Analysis of data provided by MKK Engineering and billing meter data from Rocky Mountain Power (provided by Bighorn County School District #3)

ANALYSIS OF ENERGY PERFORMANCE AT GREYBULL

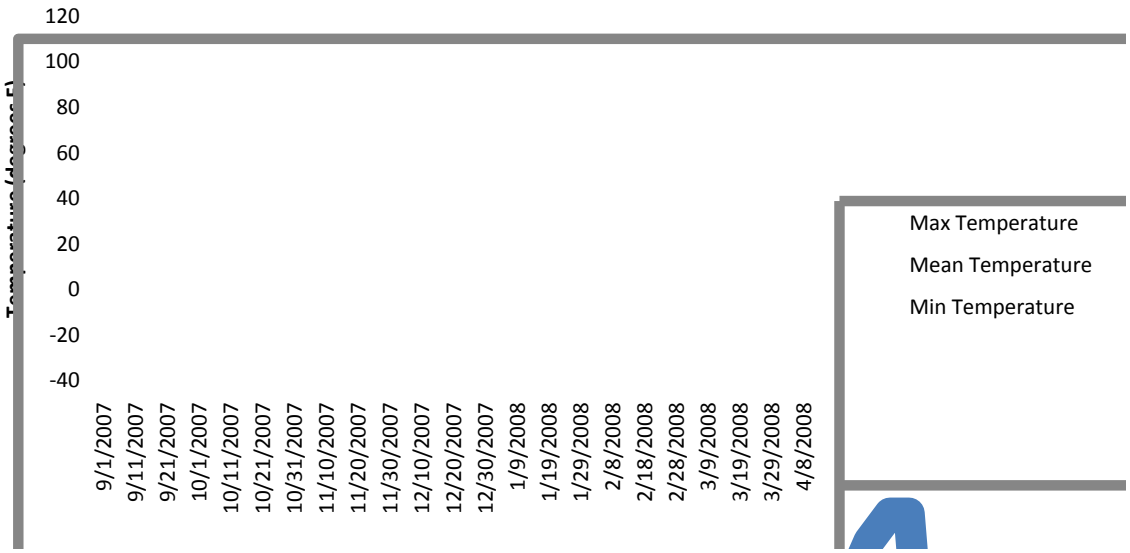
The energy usage at Greybull during its first 9 months of documented operation (September 2007 – May 2008) were higher than expected, with average energy use of approximately 45 kBTU/ft^2. The energy use is well below the energy consumption for a typical school, but well short of the 26 kBTU/ft^2 goal established in the energy design modeling. A significant portion of the higher use may be attributable to thermal bypasses in the building envelope, which may have allowed cold exterior air to infiltrate the building envelope. The same air infiltration issue is believed to be a contributing factor that caused a fire suppression line to burst during a particularly cold period during January 21 – 25, 2008, when temperatures dropped below 0 degrees Fahrenheit, shown in Figure 6. The pipe burst was unrelated to the ground source heat pump system.[2] The commissioning review found only minor deficiencies in the building mechanical systems and controls, most of which were corrected and retested. This suggests that the air infiltration into the building may be a primary cause of higher electricity demand to maintain temperatures within the building. The other factor influencing total energy use is internal loads from lighting and plug loads. Plug loads are growing universally in buildings, as more electronic devices, computers, and appliances are installed in buildings. Interior lighting loads may be higher than expected too, as the adjustable lighting controls require proper operation by teachers and staff to achieve optimum energy efficiency.

The net economic benefit of the energy efficiency improvements alone at Greybull – assuming the building energy performance improves and reaches the level of the model design, is more than $400,000 over the next three decades, in 2007 dollars. The simple payback period for the added cost of LEED Certification is less than 8 years. This does not include the additional economic benefits achieved through lower maintenance costs, increased staff

[2] Personal communication from Kevin Pope, MKK Engineering.

retention, and improved student performance. Waste minimization, water conservation, and recycling efforts may also lead to additional cost savings.

Figure 6: Daily Weather at Greybull, WY, September 2007 –April 2008.



Source: Weather Underground and National Weather Service. Data compiled by SWEEP.

COMPARISON OF GREYBULL VERSUS OTHER HIGH PERFORMANCE SCHOOLS

SWEEP collected data on the energy efficiency of other high performance schools in the same climate zone as Greybull Elementary (Climate Zone 6) and in other regions across the nation. The benchmark used for comparing energy performance is site energy use intensity, express in thousand BTUs per square foot of occupied space (kBTU/ft^2), including electricity and natural gas (all units are converted to kBTUs). Table 2 shows the national average energy use intensity (EUI) for K-12 schools, the EUI for Greybull (as modeled and observed) and other high performance schools. The data shows that Greybull Elementary is performing well below the national average (51 kBTU/ft$_2$ versus a national average of 79), and significantly better than the old Greybull Elementary. The school also compares well to other high performance schools, such as Bacon Elementary in the Poudre Valley School District. The energy performance of Greybull Elementary will likely improve as the building controls and operations are 'fine-tuned', and once the issue with the building envelope causing air infiltration into the building is resolved.

At least two of the schools shown in Table 2, Cozad Elementary and Bacon Elementary, also use geothermal heat pumps for heating and cooling, combined with a well-insulated and sealed building envelope. These schools are both performing very well, and demonstrate that substantial improvements in energy performance of schools can be achieved by coupling geothermal systems with a well designed building.

Table 2: Comparison of Energy Use Intensity: Greybull versus the National Average, and Other High Performance Schools

School	Location	Site Energy Use Intensity (kBTU / ft^2)	Notes
CBECS average (1,2)	National Average	80	Estimate from ENERGY STAR, based on national average energy performance of K-12 Schools
Rocky Mountain Elementary	Cowley, WY	98	Observed energy use (electric and natural gas) from August 2005 to March / April 2006
Old Greybull Elementary	Greybull, WY	87	Based on 2006 actual energy consumption
Greybull - reference		46	Modeled energy use for the reference building
Greybull - design		25	Modeled energy use for the building as designed
Greybull - observed		45	Based on actual energy use (Sept 2007 – May 2008)
Bacon Elementary	Fort Collins, CO	45 – 50	Bacon Elementary was built in accordance to the Poudre valley School District Sustainable Design Guidelines.
Cozard East Elementary	Cozard, NE	36.7	Retrofit project that uses a ground-source heat pump, energy recovery ventilators, and high efficiency lighting with controls.
Freedom Elementary	Colorado Springs, CO		This elementary school, built in 2000, utilizes a geoexchange system for heating and cooling. The District was recognized as ENERGY STAR Partner of the Year in 2005.
Trailblazer Elementary	Colorado Springs, CO	68	Colorado Springs School District 11 has built several high performance schools, and has developed recommendations for other school districts.

FINDINGS AND RECOMMENDATIONS

The new Greybull Elementary School provides superior learning environment for the elementary students of Bighorn County School District #3. Greybull Elementary demonstrates how a high performance school can be constructed, built and operated with reduced environmental impacts and energy costs, while offering a superior learning and work environment for students, teachers and staff. Following the LEED certification process helped achieve important energy cost savings by following best practices for the siting, orientation and design of the building, commissioning of the building's mechanical systems and controls, and post-occupancy evaluations to determine if systems and controls are functioning to their design intent. The LEED Certification process has also raised awareness among teachers, students and staff about the importance of conserving resources and protecting the environment. For example, the school only uses non-toxic cleaning supplies and has an active recycling program. Other benefits include higher teacher and staff retention rates, and fewer discipline and behavior problems (the school principal reports behavioral problems have reduced significantly in the new school). Our findings and recommendations for Greybull Elementary are summarized below.

ENERGY PERFORMANCE OF GREYBULL ELEMENTARY

- Energy use in the first six months of operations was twice as high as the modeling estimates, which may be attributable to air infiltration from the roof, which caused thermal bypass of cold air into the building. Once the infiltration issues are resolved, the performance of the building should improve significantly. Notably, the school had lower energy costs than the old facility, despite the issues with the building envelope. Furthermore, the geothermal heat pump system proved reliable and was able to maintain comfortable environment despite frigid winter temperatures that reached as low as –32 degrees Fahrenheit in late January.

- The facility's geothermal exchange system, daylighting and high efficiency lighting equipment and controls are performing well. The observed energy use in its first 9 months of operations is 34% less than a typical K-12 elementary school (51 kBTU/ft^2 at Greybull versus 78 kBTU/ft^2 for a typical elementary school). Although initial energy consumption was higher than expected, the facility's energy performance is comparable to other LEED Certified Schools.

- The mechanical systems, lighting, and electrical loads should be separately monitored for a full year, to identify further opportunities for energy savings. The electrical system was designed to facilitate such monitoring, which could be implemented without much difficulty by the controls engineer for the building, in coordination with Bighorn County School District #3.

- Additional energy savings could be achieved by implementing a coordinated strategy for managing interior electrical loads, including lighting, computers and associated electronic equipment (e.g., monitors, DVD players, printers, whiteboards and projection equipment), photocopiers and facsimile machines, vending machines, and other plug-in devices.

- Daylighting provides natural light to all occupied areas of the school, enhancing the learning environment while reducing energy consumption from interior lighting. Teachers and staff should receive information on the benefits of daylighting for improving student learning, and additional training on how to operate the lighting control system to maximize natural daylight and minimize the need for interior lighting.

RECOMMENDATIONS FOR GREYBULL ELEMENTARY

- Identify areas where thermal bypasses in the building envelope may be causing infiltration of outdoor air into conditioned spaces, thus requiring the heating (and perhaps cooling) systems to run longer than expected, particularly during extremely cold temperature conditions.

- Implement energy monitoring on primary systems within the building, including heating and cooling, lighting, and other electrical loads to compare observed and modeled performance. According to the energy modeling consultant, MKK, the HVAC, lighting and electrical systems in the building were designed to conduct ongoing monitoring of the energy use of these individual system components, so that their performance could be evaluated and improved. The monitoring has not been implemented, but could be conducted with very little difficulty by a building controls engineer.

- Educate teachers, staff and students about the energy saving features of the building, and their proper operation. Staff from Bighorn County School District #3 should continue to provide training, information and education to facilities personnel, school staff and teachers on how to adjust lighting levels, and the benefits of maximizing natural daylight in classrooms and work spaces. The Poudre Valley School District's *Sustainable Design Guidelines* provides good information on strategies for working with teachers, staff and students to develop an effective energy management plan for schools.

- Incorporate energy and environmental themes from the building into classroom activities to involve students in energy decisions. For example, the School could incorporate energy and environmental features at Greybull into the classroom curricula, provide informational displays showing daily energy use, and other energy and environmental themes. The US DOE has compiled information on educational materials for teaching students about energy and environmental topics.

- Develop and implement strategies for managing plug loads within the building, including vending machines, computers and PC workstations, classroom technology support systems (e.g., DVD players, digital whiteboards, and computers), photocopiers and other electronic devices. Potential strategies for reducing plug loads include:

    - Installing 'vending misers' on vending machines in the break room. Vending misers help manage energy consumption from soda and snack machines, which on average consume almost 3,500 kWh per year. Vending misers cost about $165 each, and can cut vending machine electricity use in half.[3]

    - Installing 'green strips' that automatically shutoff peripherals when a primary device is powered down (e.g., a PC with a monitor, printer and other equipment). These power strips cost about $25 each, and can save up to $45 annually.

    - Enabling power management software on PCs, computer monitors, copiers, fax machines, and other electronic devices. Implement a daily 'power down' policy where equipment is shutoff at the end of the school day and on weekends. ENERGY STAR provides free power management software for PCs; copiers and facsimile machines have built-in power management capabilities.

[3] For more information, see: http://www.aceee.org/ogeece/ch5_vendors.htm

  - Using traditional power strips to turn off white boards, DVD players, televisions and other classroom electronics when not in use (e.g., at end of the day, weekends, during school breaks).

- As a future step, the Bighorn County School District #3 could consider adding an integrated photovoltaic-solar thermal (known as 'PVT') system to Greybull Elementary. PVT systems combine solar photovoltaics to produce electricity with solar thermal panels that can either heat domestic hot water, or provide supplemental air heating. A PVT system could be installed to supply the schools hot water needs (currently supplied by a natural gas-fired water heater), and generate electricity to offset a portion of the school's electricity demand. It may be possible for the District to enter into a 'Power Purchase Agreement' with a commercial solar provider to install such a system at Greybull (or other location within the District) with little or no up-front cost. Rocky Mountain Power offers net metering to its electricity customers in Wyoming, which would allow the District to sell back excess power generated by the school at the retail electricity rate.

RECOMMENDATIONS FOR FUTURE WYOMING K-12 SCHOOLS

- We recommend that all future schools in Wyoming be built to achieve certification under the LEED for Schools rating system, or equivalent rating guidelines. The design standards for new schools should include minimum energy points criteria (we recommend achieving at least a 30% reduction in energy use over ASHRAE Standard 90.1, 2004), along with post-occupancy commissioning and monitoring and verification for at least 1 year to ensure that systems are functioning properly, and to identify additional energy savings opportunities related to operations and maintenance. To minimize costs, SWEEP recommends that the Wyoming School Facilities Commission (SFC) develop high performance school 'design templates', that incorporate the 'best of the best' from high performance schools built across the country. The design templates can incorporate the results of energy modeling and daylighting analyses from Greybull and other projects, which should lead to additional cost savings on future projects. Additional LEED Certified School projects are already moving forward in Wyoming, such as the new Davey Jackson Elementary School in Jackson, WY, Teton County School District Number 1.

- In order to ensure that projects receive sufficient funding to effectively implement LEED, the SFC should consider allocating 2 percent of the project budget to achieving LEED certification. A portion of the funding (.5%) could be used to fund critical post-occupancy commissioning and monitoring verification, or paid as a bonus to the project team (architect, energy modeling, general contractor, commissioning agent).

- When evaluating construction bids for new school projects, the SFC should incorporate lifecycle costing methods into its construction bidding and evaluation process. Lifecycle costing is a well established accounting methodology that has been used in the construction of new schools throughout the nation. Implementing lifecycle costing will serve two purposes: 1) it will encourage contractors to consider the cost of operations in its construction plans, and ensure that they submit proposals that are designed to minimized operating costs, and 2) it will provide a mechanism for the SFC to include operating costs as it evaluates construction bids.

- As incentive to achieve measured performance improvements, the SFC should consider offering a performance-based incentive as part of its school construction contracts. The performance incentive would only be paid after the school has been completed and occupied for one full year. If the school meets or exceeds the design objectives for energy performance (in weather-adjusted site energy use, measured in

kBTU/ft2), the architectural design, construction, and engineering teams would be eligible to receive a shared performance bonus.

- The costs of building new schools to LEED will progressively decrease as the design approaches, construction specifications and operating procedures become standardized. Other school districts (e.g., Poudre Valley School District, Fort Collins, CO) have found that they can build LEED-certified schools at no additional cost by taking advantage of design improvements that offset higher construction costs. For example, a building designed with a highly efficient envelope allows the engineering team to downsize the mechanical systems, reducing both their initial cost and operating cost.

INFORMATION RESOURCES

ARTICLES

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- Greybull school conserves energy. Billings Gazette. October 4, 2007 http://www.billingsgazette.net/articles/2007/10/04/news/wyoming/20-conserves.txt
- Wyoming School Meets LEED Standards. Environmental Leader. December 29, 2006. http://www.environmentalleader.com/2006/12/29/wyoming-school-meets-leed-standards/
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INFORMATION RESOURCES ABOUT HIGH PERFORMANCE SCHOOLS

US Green Building Council
www.usgbc.org

LEED for Schools Rating System
http://www.buildgreenschools.org/ and http://www.usgbc.org/ShowFile.aspx?DocumentID=2593

ASHRAE Advanced Energy Design Guides for K-12 Schools
www.ashrae.org/aedg/

Collaborative for High Performance Schools (CHPS)
www.chps.net

Daylighting

- Better Bricks: www.betterbricks.org
- Daylighting Collaborative: www.daylighting.org

U.S. DOE Energy Education Resources
www.eia.doe.gov/kids/onlineresources.html, and
http://www1.eere.energy.gov/education/lesson_plans.html#elementary

U.S. DOE Energy Smart Schools
http://www.eere.energy.gov/buildings/energysmartschools/

U.S. EPA. ENERGY STAR for K-12 Schools
www.energystar.gov

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http://www.buildgreenschools.org/documents/pub_Greening_Americas_Schools.pdf

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Poudre Valley School District. 2005. Sustainable Design Guidelines for the construction of new facilities and the renovation of existing structures.
http://www.psdschools.com/documentlibrary/downloads/plan_design_and_construction/sustainable_design_guidelines_2005.pdf

Washington High Performance School Buildings: Report to the Legislature. 2005. Washington State Board of Education, Olympia. http://www.k12.wa.us/SchFacilities/pubdocs/OSPIFinalReport.pdf