Date: 4/11/2011

To:

Mr. Keith Sinor, Principal of Deer Creek High School

Mr. Sean McDaniel, Superintendent of Deer Creek Public Schools

Mr. John Robertson, President, and members of Deer Creek School Board

Gathered Guests

Presented by:

Mrs. Deborah Adams, Miss Anna Knight, Miss Bailee Steele, Mr. Graham Rawls, Mr. Alex Holland (instructor and four members of the Environmental class)

Premise:

This fall, Deer Creek High School was enrolled by Deborah Adams in the Oklahoma Green Schools Program. As participants in the Green Schools Program, one of the criterions is to perform a school energy audit. This program offers suggestions, tools, and informational resources to help schools identify and correct (if possible) environmental issues in and around the school. The idea of performing this audit and pursuing the Green Schools flag fit perfectly into the environmental class curriculum. It was intended to make the students, who were not environmentally aware, somewhat energy conscious. While the findings of the class audits are totally the work of students in the class, therefore subject to student error, the findings are still compelling in some areas and worthy of review. The recommendations are also derived by our students which serve as evidence that they did realize areas where the school community could save or conserve. Some of the ideas put forth may be impractical to implement in existing schools and other suggestions might be appropriate for any future building plans. Some of the ideas are simply good conservation practices that we should all follow and will be forwarded to the faculty and staff. This was not meant to be an indictment of any particular group or to serve as a complaint of some form; it was more to raise awareness for energy conservation among current and future citizens of our community.

Credits:

Oklahoma Green Schools Program

O G & E

Project Learning Tree

Students of Environmental Classes

Teachers of Deer Creek High School

Introduction:

The audit consisted of the monitoring of the power that certain electronic devices pull, surveying the appliances used in a classroom and the power they draw, and testing and recording the lighting and temperature in each classroom. There was also opportunity to check air quality (for CO_2 mainly). The tools we used were on loan from OG&E and involved a light meter, a CO_2 monitor, a spring scale, Kill-A-Watt meters and an infrared thermometer. Student groups were assigned different sections of the school and given an audit form to complete for each room tested. A sample of this form is included in this packet (Sample A). Each area of study will be put forth separately with student data, observations and recommendations.

Appliances:

The thrust of this portion of the audit was to identify appliances used in the classroom and the energy they each drew. Volunteer teachers placed Kill-A-Watt meters on their energy strips containing their devices. They were instructed to place it between their strip and the outlet and leave it overnight (just as they would normally), then leave it on the entire next day. They were to take two readings: one in the morning after their set-up and another at the end of the class day. The table below indicates the findings. While the amounts are interesting, the data was completely voluntary and does not indicate total school wattage and is dependent on the teacher reading the meter correctly. The students also surveyed each room to identify the appliances used in them. The equipment in the classrooms on average consisted of a hard drive, flat top monitor, a printer, a Smart board and a projector. In some rooms a small refrigerator, microwave, CD player, television, extra computers, or overhead projector could be found, but not in appreciable amounts to warrant limiting their use. The average wattage for the main appliances was estimated (by manufacturer's standards) to be 558.5 watts/hour per room based on one of each per room. The students were aware that this is a cost of doing business, so to speak, and other than raising awareness on how much they pull, there is not much to be done to control or lessen this cost. They did point out though that the projector for the Smart board pulls 270 watts per hour itself, so raising teacher awareness to turn this off when not in use is good conservation practice. Also, the idea of turning off the power strip each evening could eliminate the wattage used overnight as reflected by the data table for Sleeping mode.

Kill-A-Watt Data Collected from Teacher Volunteers

Teacher	Sleeping mode in kwh	After a workday
1	0.119	1.20
2	1.90	3.22
3	--	0.137
4	0.20	0.26
5	0.38	1.13
6	0.41	1.23
7	0.22	1.23
8	0.98	2.06
9	0.00	0.12
10*	3.04	7.87
11*	2.79	32.79
12	0.22	1.23
13	0.156	0.246
14	0.92	2.09
Total	11.335	54.813

*Greater than 1 computer in room

Lighting:

This portion involved surveying the type and number of light bulbs being used in a classroom and calculating average wattage. A light meter was employed to determine total illumination for each classroom surveyed. The table below reveals the data as well as one of the concerns students shared after completing this portion.
It was found that many rooms are considered over-illuminated and that the lighting is inconsistent from room to room and places in the room as well. They found that some rooms have split circuitry capability (can use half the lighting) and others do not. Each room had fluorescent lights that contain three-50 watt fluorescent bulbs each. The rooms ranged from having 25.5 average bulbs to 58.5, depending on the size of the room. The rooms with split circuitry can utilize just one of the three bulbs, which is more than adequate lighting; those that do not, can't. A reading of 50 – 75 foot candles of light are recommended for a classroom, with many sources stating 50 fc being the better lighting. The effects of over-illumination include headaches, eye strain, fatigue, stress, anxiety, and triggering of migraines. There were a few rooms that measured in the "high end" and others were adequate. The table indicates the averages for particular rooms with readings taken at several points throughout the room.

Average Illumination in Classrooms (measured in foot candles)

Group 1	3 high : 81.87	5 adequate : 45.53
Group 2	2 high : 81.24	2 adequate : 47.62
Group 3	2 high : 70.83	2 adequate : 30.90
Group 4	-----	6 adequate : 44.58
Group 5	-----	4 adequate : 41.07
Group 6	-----	-----
Group 7	2 high : 63.2	2 adequate : 41.22
Group 8	----	5 adequate : 43.30
Group 9	----	4 adequate : 39.43

These readings are probably not as accurate as they could be; the students were instructed not to disturb the teachers or the class so the protocol might not have been followed as completely as it should have been in many instances. Also, one area of the room might register a high reading while another was adequate or low. In any event, the overall consensus among students was that many rooms "seem" too bright. It was thought just lowering the wattage of the bulbs purchased could save energy. Also, for future building considerations, consider lessening the amount of lights per classroom or allowing for split circuitry so 'half lighting' instead of all or nothing could be utilized. Another observation made by students and offered as an aside, is the bathroom lighting. One bathroom (east band/office girl's room) was found to have a broken switch so the lights cannot be turned off at all and it was suggested that any future bathroom construction incorporate motion detector switches instead of the standard on/off switch. On many occasions over the weekend these on/off switches are left on, drawing energy for no reason. The teachers' lounges/workrooms could be handled in the same way, since not everyone is conscientious about turning on and off switches.

Temperature:

Temperature readings were taken in 4 or 5 places throughout the classroom using an infrared thermometer. The thermostat was read and deviation from the thermostat setting was determined. There were no student complaints about the classrooms being uncomfortable even though there were some deviations between the thermostat and the actual temperature in the room. There did not seem to be enough consistency in the data to

make any generalizations. Most areas seemed fairly accurate which would indicate adequate insulation and caulking since the readings taken near the windows did not deviate considerably from the other room readings.

Temperature Reading Averages Per Group Survey

Group #	Average thermostat reading	Average room temperature (in degrees F)	Temperature deviation (in degrees F)	Location
1	69.5	71.0	+ 1.53	C hall
2	73.65	72.4	-1.25	Senior hall
3	66.5	69.9	+ 3.40	B hall
4	73.4	70.3	-3.10	Central back
5	70.35	70.7	+0.35	Central east
6	71.3	64.7	-6.60	Central west
7	72.3	70.8	-1.50	Freshman mid
8	71.3	73.1	+1.80	Freshman east
9	70.7	70.5	-0.21	Freshman west

Ventilation:

This was not actually part of the audit, but a CO_2 monitor was included in the kit so volunteer teachers placed it in their rooms continuously for an entire class day. A student also carried it with him one day and performed spot checks of the rooms he had class in. This area of study revealed the most compelling data. While there is not a large volume of data to base the conclusion from, in every instance but one, the levels are above the OSHA standard of 1000 ppm. The readings fluctuated with the size of the class. An exposure above 1000 ppm for any period of time causes drowsiness, fatigue, and can impair learning. The high readings are not considered a health threat, but it could indicate why students or teachers report feeling tired or get headaches in certain rooms. The high levels are indicators of poor ventilation, which could be remedied in some instances by keeping a classroom door open more often, adjusting the dampers on the air conditioning system, providing fans to move the air, or even adding a pollution friendly plant to the classrooms such as Weeping Fig, Dracaena, English Ivy, Devil's Ivy, or Peace lily. It is also a testament to the good insulation mentioned in the temperature section of this report. A suggestion for future building is to provide classroom doors with vents in the bottom, or more outtake vents per classroom. On average, each classroom had 2 intake vents compared to 9 outtakes.

Carbon Dioxide Monitoring (measured in ppm)

	Room 1	Room 2	Room 3	Room 4	Student carried
First hour	1688	1356*	1026	1124	1521
Second hour	3154	1374	1729	1003	1480
Third hour	3737	1592	2375*	1526*	2000
Fourth hour	2046	1926	1452	1474	2926
Fifth hour	1778	1874	2202	1320	1948
Sixth hour	1571	2152	2565	1222	2575
Seventh hour	916*	1552	E03 (above upper limit)	1186	3000

*Indicates teacher's planning hour

Sources:

"Average Power Consumption of Household Appliances." *ABS Alaskan*. Web. 28 Mar. 2011.

Bounds, Gwendolyn. "A Superhero Scrubs the Air: The Mighty Houseplant." *Wall Street Journal*. 15 Mar. 2011. Web. 6 Apr. 2011. <http://online.wsj.com/article/SB10001424052748704893604576200423930895948.html

Bulbology - Incandescent vs Fluorescent Bulbs and Globes. Web. 28 Mar. 2011.

Dell Client Energy Savings Calculator. Web. 30 Mar. 2011.

"Lighting Level Recommendations." Oregon Office of Energy. Web. 30 Mar. 2011.

"Over-illumination." *Over Assertion Encyclopedia Topics*. Web. 4 Apr. 2011.

"Recommended Light Levels." *Power Sleuth: Maine Energy Education Curriculum*. Web. 30 Mar. 2011.

"Toxicity of Carbon Dioxide Gas Exposure." *InspectAPedia*. Web. 4 Apr. 2011