State of California **Department of Education**

Supplemental Memorandum

To: **STATE BOARD MEMBERS** **Date:** **May 28, 2003**

From: **Karen Yamamoto, Chair, Curriculum Development and Supplemental Materials Commission**
Sandra Mann, Chair, Science Subject Matter Committee
Thomas Adams, Executive Director, Curriculum Commission, CFIR Division

Re: **SUPPLEMENTAL ITEM # 26**

Subject School Campus Environmental Audit Tool

The Curriculum Development and Supplemental Materials Commission approved the School Campus Environmental Audit Tool at its meeting on May 15-16. We ask the State Board of Education to approve the School Campus Environmental Audit Tool.

School Campus Environmental Audits
Waste, Energy, and Water

A Series of Investigations Designed for
Sixth Grade Students

to
Fulfill the Requirements of
California Senate Bill 373
The School Diversion and Environmental Education Law

[pending approval by]
California Integrated Waste Management Board
California Department of Education
California Secretary for Education
California State Board of Education

Draft – May 2003

I. INTRODUCTION

The School Diversion and Environmental Education Law (School DEEL) was signed into law in September 2001 (SB373,Torlakson, Chapter 926, Statutes of 2001). The law created a series of integrated waste management and environmental education mandates for the California Integrated Waste Management Board (CIWMB). The legislation is intended to increase the presence of resource management programs, such as waste reduction, recycling, and composting on school district campuses statewide. Among other provisions, the School DEEL legislation calls for:

- Developing, implementing, and adopting a Unified Education Strategy (UES) for elementary and secondary schools in the state, to:
  - Coordinate instructional resources and strategies for providing active pupil participation with onsite conservation efforts.
  - Promote service-learning opportunities between schools and local communities.
  - Assess the impact to participating pupils of the UES on student achievement and resource conservation.
- Creating models and school waste reduction tools for schools, school districts, county offices, and local agencies.
- Establishing an Environmental Ambassador Pilot Program.
- Providing grants to school districts to implement the UES.
- Identifying and promoting use of recycled-content materials and environmentally preferable products in the construction and modernization of public school facilities.
- Evaluating the effects of school waste reduction plans and other resource conservation efforts in the state's schools.

The School DEEL specifies that "Every school district and school site in this state will be encouraged to implement source reduction, recycling, and composting programs that ... reduce waste and conserve resources [and] provide pupils with a 'hands-on' learning experience." The legislation calls for the development of "Service-learning partnerships, in which schools and communities work to provide real world experiences to pupils in areas of the environment and resource conservation, including education projects developed and implemented by pupils to encourage others to utilize integrated waste management concepts."

While these audit tools do not represent a science curriculum, they have been designed to build upon the foundation provided by the Science Framework for California Public Schools (2003) in a manner that will help students learn about source reduction and recycling, and make them effective as Environmental Ambassadors.

The Role of Campus Audits

The campus audits described in this document are an element of the CIWMB's plans for implementing the UES. The audits offer sixth-grade students an opportunity to participate in an assessment of resource management practices on their own school campus.

California State Content Standards and Adopted Instructional Materials

Fundamental to implementation of the campus audit is a thorough understanding of science concepts related to resource use and waste, water, and energy, as outlined in Grade 6 California Science Standards (1998) and the Science Framework (2003). For example, through the campus waste audit, students will assess current campus practices related to waste disposal, source reduction, materials reuse, recycling, composting, purchasing of recycled products, and pollution prevention. This audit will have a greater impact if students have already examined the natural origins of the various resources, using instructional activities outlined in the State Board of Education-adopted science instructional materials in use at the school site. As students evaluate which resources are renewable or nonrenewable, they will be able to build upon what they have already learned, and consider the environmental implications of resource use during their lifetimes.

Using the Audit Tools

The audit tools include detailed instructions for conducting assessments of waste, energy, water use patterns, and pollution prevention practices on campus. All school districts engaged in the UES grant program are required to conduct the waste audit and are encouraged, if time permits, to undertake the energy and water audits as well.

Each audit is designed as a stand-alone unit that requires four 45-minute class sessions. The intention is for students to work in groups, each auditing different areas of campus related to the particular topic (waste, energy, water). The design is flexible, however, so that within these groups, individual students can either complete a full section of the audit or tasks can be divided and results shared. (Since the number of students participating in the audits may vary widely, the design is flexible and specific arrangements are left to the discretion of the teacher.)

The specific study sites for each of the audits were selected with technical input from the boards, departments, and offices within the California Environmental Protection Agency and departments and commissions within the Resources Agency. In the waste audit, students examine the cafeteria/lunch area, and their classroom(s). The water audit calls for students to assess the restrooms and grounds. The energy audit looks at energy systems across the school: heating and cooling, lighting, and appliances.

Students work at all times under the immediate supervision and control of certificated faculty and, depending on local district policies, other adult assistants. Because students will not be handling wastes while carrying out their investigations, exposure to any potentially toxic substances in the waste is avoided.

II. WASTE AUDIT

OVERVIEW

Using campus audits and surveys as a foundation, this unit explores waste management practices on the school campus. The audit is designed to follow science instruction in weathering and soil formation. Because of the significant relationship between the waste stream and weathering and soil formation, the audit's purpose is to help students understand the magnitude and composition of major components of the school's current waste stream and how much of that waste stream could be diverted through greater efforts to reduce and reuse, recycle and compost. It should be administered after these specific chapters of State Board of Education-adopted science textbooks for grade 6:

Adopted Grade 6 Program	**Administer after:**
Glencoe	Chapter 7: Weathering and Soil
Holt	Chapter 4: Rocks and Mineral Mixtures
McGraw Hill	Chapter 3(1): Building up and Breaking Down
Prentice Hall	Chapter 7: Weathering and Soil Formation

AUDIT GOALS

The audit is designed to answer the following questions about the school site:

- What is the daily volume of the school's waste stream?
- What sites on the school campus generate the waste stream?
- What percentages and types of materials make up the waste stream: reusables, recyclables, compostables, and trash?
- What might be the overall reduction of waste volume from the school, resulting from initiating or expanding an integrated waste management program?

DATA SAMPLE AND INFORMATION COLLECTED

The following types of information and data will be collected for the purposes of the audit.

- Information collected by survey of the custodial supervisor or other school staff, regarding the average volume of wastes collected on a typical day, and the school sites from which these wastes are collected.
- Information collected by survey of the school administration regarding the frequency and volume of waste pickup and whether there is any school program to reduce wastes.
- Data samples collected in the classroom and school cafeteria/lunch area, regarding the types and volumes of recyclable and reusable materials entering the waste stream.

ADVANCE PREPARATION

- The teacher should obtain or arrange for delivery of four 5-gallon buckets for classroom material/waste, and four 30-gallon containers for cafeteria/lunch area waste, and label them appropriately. These may be obtained from the California Integrated Waste Management Board by calling (916) 341-6769 or by sending a message to uesgrants@ciwmb.ca.gov.
- Enlisting assistance from students as appropriate, the teacher should make arrangements to distribute and collect the two school site surveys included in Appendices Ia and Ib. The completed survey pages will be provided to students for analysis.

- The teacher should read the resource manual, becoming familiar with the principles of integrated waste management.
- The teacher should become familiar with the waste stream practices on campus, and give consideration to how the audit may need to be tailored to the school site.
- The teacher should obtain permission and develop a logistical plan for students to conduct the cafeteria site audit. The teacher should arrange for students to audit the cafeteria/lunch area waste material during one lunch period. Four 30-gallon containers can be obtained from the CIWMB (see above), and other containers may be used as appropriate. The containers should be used in sets of four, and should be labeled with the four waste categories outlined under Day 1. Custodial help may be required to empty waste containers as they are filled.
- The teacher should plan schedule adjustments as appropriate, since not all groups will necessarily work on the audit at the same time on a given day.
- The teacher should collect the necessary supplies for the hands-on activity.

DAY 1

1. The teacher introduces students to the audit activity, and the principles of waste reduction outlined in the resource manual. In particular, the teacher and students discuss reuse of materials, reduction of consumption, and consumer use of recycled materials to "close the loop." The teacher and students review the following categories:

<u>Reusable/reducible materials</u>

Blank or partially used paper

<u>Recyclable materials</u>

Metals - aluminum, steel "tin" cans

Paper - white paper, colored paper, magazines, newspaper, cardboard

Glass - bottles

Plastics - various types of plastic numbered according to category, for example #1, #2 plastic

<u>Compostable materials</u>

Vegetable and fruit wastes

Gardening wastes

<u>Trash (some of the following materials may be recycled in some communities)</u>

Contaminated paper food trays and wrappers

Meat and bones

Milk cartons and juice cartons

Other plastics and metals

The teacher elicits students' initial thoughts with questions such as "What areas of the school do you think generate the most waste? In each of these areas, what material categories are generated most? Do you think the school uses recycled-content products?"

2. The teacher assigns students to one of four specific task forces: Cafeteria/Lunch Area, Classroom, Custodial, or Administrative.

DAY 2

The four task forces collect data and review survey results:

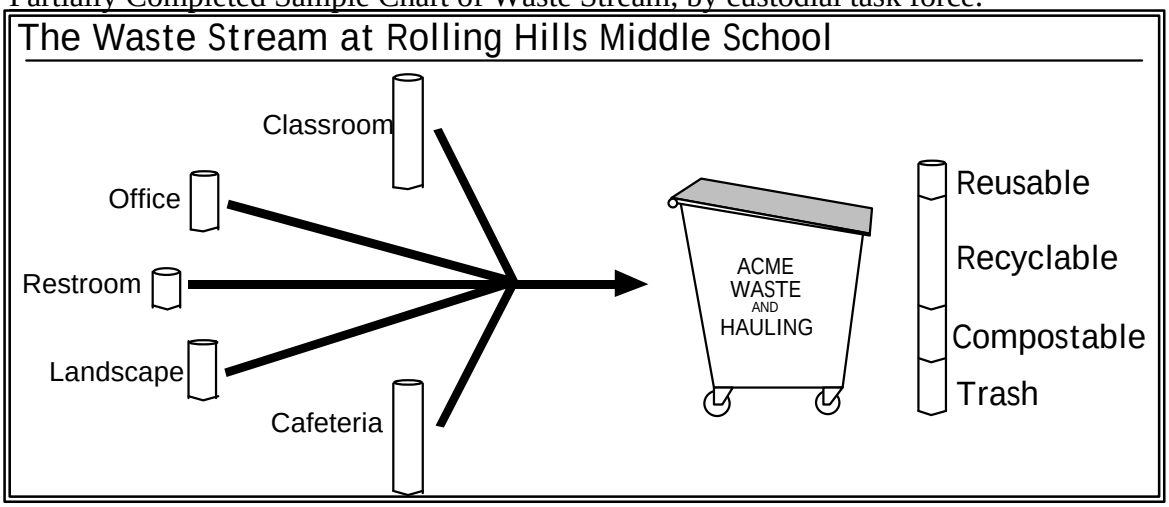
Cafeteria/Lunch Area task force: Labeled trash containers should be set out in the cafeteria/lunch area, so that all students may sort their waste material as they leave the lunch area. Labeled waste containers should be set out in sets of four, and no unlabeled waste containers should be available. At least four students with clipboards will audit food being disposed during the lunch period, by observation of waste containers. The student auditors may provide direction to students as the students sort their own waste materials, but the auditors are not to handle the wastes themselves. Student auditors will use Appendix Ic to estimate and record the percentages of material/waste that are (1) unused or reusable materials, (2) recyclable materials, (3) compostable materials, and (4) trash. The Cafeteria task force assimilates the information from all of the clipboards onto a single table, with estimates of volume percentage of each material/waste category in the sample.
Classroom task force: Students should monitor the 5-gallon buckets containing the different types of materials and trash, but should not handle the contents of the buckets. Using Appendix Ic, students will record the percentage of material/waste that is (1) unused or reusable materials, (2) recyclable materials, (3) compostable materials, and (4) trash. The Classroom task force assimilates the information onto a single table, with estimates of volume fraction of each waste category in the sample.
Custodial task force: Students will study the survey sheet completed by the custodial supervisor, and begin to develop a wall chart displaying the volumes of material/waste produced by various campus sources, and the total school waste volume (see sample, day 3). Volumes are estimated, using 30-gallon plastic bags as a unit volume (metric: 0.11 cubic meter). The histogram bars on the chart, which represent total waste volumes, will be outlined in pencil only on day 2. Each bar will become a stacked histogram on day 3, once component elements of the waste are estimated using the data collected.
Administrative task force: Students will study the survey sheet completed by the school administration, and begin to develop a wall chart displaying the landfill volume savings realized by integrated waste management (see sample, day 3). The histogram bars on the chart, which represent waste volumes, will be outlined in pencil only on day 2. Each bar will become a stacked histogram on day 3, once component elements of the waste are estimated.

DAY 3

Completion of Audit Analysis and Chart Preparation.

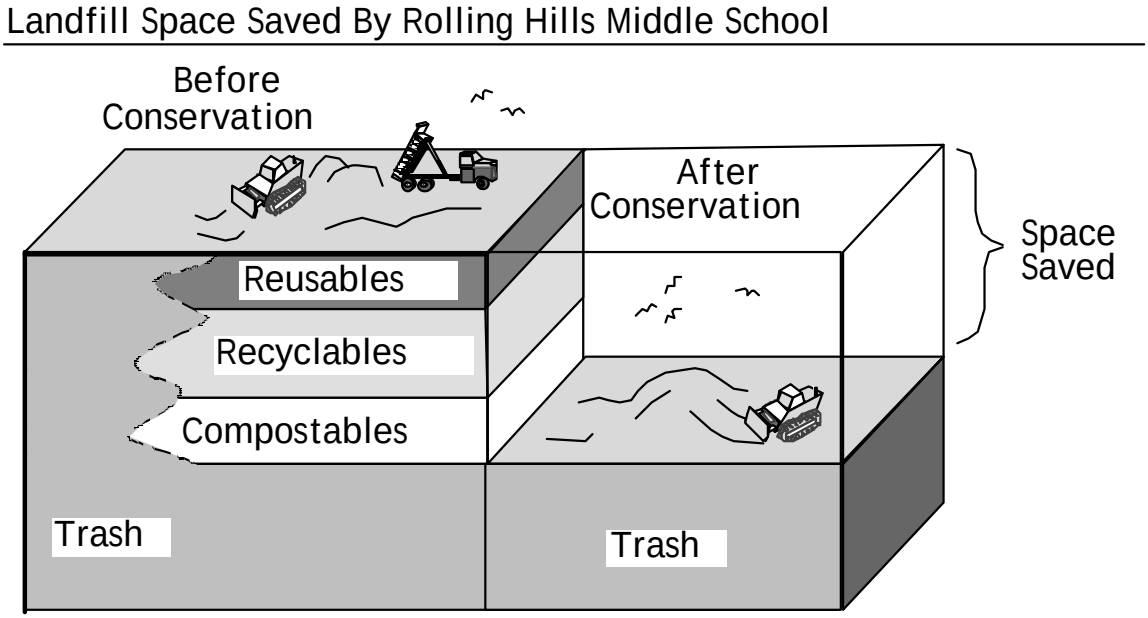
Data and information collected by the task forces are combined, using Appendix Id, and the groups work together to complete the wall charts. The histograms on the two wall charts are made into stacked histograms displaying waste components. The first chart represents the sources of the campus waste stream, by location and by composition. The second chart represents the landfill space saved by integrated waste management.

Partially Completed Sample Chart of Waste Stream, by custodial task force.



The recyclable and non-recyclable components of the waste are represented by stacked histograms, using data from the cafeteria and classroom task forces, and estimates of the composition of the other waste sources such as office, restrooms (assume all is trash), grass clippings and landscaping wastes, etc.

Partially Completed Sample Chart of Landfill Space Saved, by administrative task force.



The landfill space saved by implementation of an integrated waste management plan is indicated, by comparing the waste delivered to the landfill "before" and "after" conservation.

Once completed, these two charts can be posted and discussed.

Day 4

The audit culminates with a class discussion of the results:

- Based on the audit, what is the estimated total volume of the school's entire daily waste stream?
- Based on the number of instructional days in the school year (e.g., usually about 180 days in a traditional calendar school or 163 days in a multi-track year-round school), what is the estimated yearly volume of the entire waste stream?
- What percentage of that total volume comes from each of the categories of reusable, recyclable, compostable, and trash?
- Based upon your findings, where would it make the most sense to focus efforts on reusing/reducing materials and composting?
- Where would it make the most sense to put bins for recycling at the school, and what types of bins should be placed?
- What volume does the current waste stream add to the landfill, and how much material could you save from going to the landfill if conservation measures were implemented?
- What steps could students take personally, to reduce the waste stream?
- What might the school do to encourage reusing/reducing, recycling, and composting materials?
- Why is it important to "close the loop", and use recycled-content materials?
- What happens to materials that are sent to landfills, over time?

These discussion points and ideas generated can be written onto a third wall chart, and posted. The school principal may be invited to review the charts with the class.

APPENDIX Ia

School Site Custodial Survey

Dear Custodial Supervisor,

Our class is studying how much trash is being thrown away at the school, and how to reuse, recycle, and compost materials. We would appreciate it if you would fill out the following brief survey.

Please return it to _____ by this date: _____ .
Teacher's name

On an average school day , how many 30-gallon plastic bags of waste are usually collected from each of these campus locations?

All classrooms combined _____ bags

School offices _____ bags

All restrooms combined _____ bags

Cafeteria/lunch area _____ bags

Landscape wastes _____ bags

Other _____ bags

Total _____ bags

Additional comments:

Thank you for the information.

APPENDIX Ib

School Site Administrative Survey

Dear Administrator,

Our class is studying how much trash is being thrown away at the school, and how to reuse, recycle, and compost materials. We would appreciate it if you would fill out the following brief survey.

Please return it to _____ by this date: _____ .
Teacher's name

1. Does the campus have an integrated waste plan to divert wastes?

2. If it does, what materials are recycled and who collects those recyclables?

3. What types of recycled-content materials are purchased by the school (please be specific)?

4. What types of materials does the school reuse, rather than discard (e.g. double-sided copying, reusing binders or folders, grass composting, etc.)?

5. What company picks up waste from the school, and to which landfill is it transported?

6. What size dumpster (e.g. cubic yards) is used for trash, and how often is it collected?

7. What percentage of your administrative office waste is:

_____ % unused or reusable materials

_____ % recyclable materials

_____ % compostable materials

_____ % trash

8. How are pruning wastes and grass clippings handled at the school?

Additional comments:

Thank you for the information.

APPENDIX Ic

Student record of materials/waste

Students:

Use this form to record the volume of a specific type of materials/waste being discarded at a specific location. *Observe, but do not touch the materials.*

School site (circle one): Cafeteria/lunch area Classroom

1. Size of container (5 gal. or 30 gal.) _____

A. Material	B. Number of times filled (including fractions)	C. Volume of material (multiply # times filled X line 1)
2. Reusables		
3. Recyclables		
4. Compostables		
5. Trash		

6. Student observations:

Date _____

Student name(s) _____

(The Cafeteria/Lunch Area and Classroom task forces each need copies of this form)

APPENDIX Id

Consolidated record of materials/waste - page 1

Students:

Use this worksheet to calculate the volume percentages of each type of materials/waste being discarded at a specific location.

Task force (circle one): Cafeteria/Lunch Area Classroom

Use the volume data from Column C on each Student record of materials/waste form given to your task force to compute total volumes for each material. Then, determine the total sample waste volume, and the percentages of each material.

Material	**Volume of material recorded by each student**						
	1	2	3	4	5	Total	Percentage
Reusables							
Recyclables							
Compostables							
Trash							
					TOTAL SAMPLE:		100%

(The Cafeteria/Lunch Area and Classroom task forces each need one copy of this form)

APPENDIX Id

Consolidated record of materials/waste - page 2

1. From the Custodial Survey, what is the number of 30 gallon bags that are usually collected each day from the school site studied by your task force? _____

2. From the table on page 1, copy the percentages of each material into the column labeled "Percentage (in sample)". Then multiply each percentage times the number from line 1, and divide by 100, and enter the result in the column at right. This represents an estimate for the volumes of the four types of materials, in all of the waste from the school site studied by the task force.

Material	**Percentage** (in sample)	**Estimated volume for entire school**
Reusables		
Recyclables		
Compostables		
Trash		
TOTAL	100%	(# of bags from this site, as reported by custodian)

Date _____

Student name(s) _____

(The Cafeteria/Lunch Area and Classroom task forces each need one copy of this form)

III. ENERGY AUDIT

OVERVIEW

Using campus audits and surveys as a foundation, this unit explores energy use and conservation practices on the school campus. It also estimates motor vehicle trips to school. The audit is designed to follow science instruction in energy resources, so that students will be able to understand the sources of energy used by a community, and how energy may be conserved. It should be administered after these specific chapters of State Board of Education-adopted science textbooks for grade 6:

Adopted Grade 6 Program	**Administer after:**
Glencoe	Chapter 21: Resources
Holt	Chapter 5: Energy Resources
McGraw Hill	Chapter 10(7): California's Air, Water, and Energy
Prentice Hall	Chapter 21: Earth Resources

AUDIT GOALS

The audit is designed to answer the following questions about the school site:

- What is the energy generation facility that delivers power to the school?
- What sites on the school campus use electricity, and how might it be conserved?
- Does the school use natural gas or heating oil?
- How is energy used to maintain the temperature inside the school?
- What might be the overall benefits and savings of an energy conservation program?
- What energy sources are used to transport people to school, and what effect does this have on air quality?

DATA SAMPLE AND INFORMATION COLLECTED

The following types of information and data will be collected for the purposes of the audit.

- Information on the average daily usage of energy at the school and its cost.
- Data collected in the school classrooms, regarding the control of room temperature.
- Data collected in the school regarding lighting, and usage of electricity.
- Data and information collected on the number of motor vehicles parked at the school, and information about average energy use and emissions.
- Information on the sources of energy used at the school, and the environmental impact of energy generation.

ADVANCE PREPARATION

- The teacher should distribute and collect the two school site surveys included in Appendices IIa and IIb. The completed survey pages will be provided to students for analysis.
- The teacher should distribute staff transportation surveys (Appendix IIc) to all school staff members. These should be collected and provided to students for analysis.
- The teacher should collect the following information for the students: Where are the energy generation facilities that produce power or deliver natural gas? Is the energy used for power production a renewable or nonrenewable resource?

- The teacher should read the resource manual, becoming familiar with the principles of energy resources, transportation use, and conservation.
- The teacher should become familiar with the energy use practices on campus, types of transportation used by students and staff to get to school, and consider how the audit may need to be tailored to the school site.
- The teacher should obtain permission and develop a logistical plan for students to conduct the energy and transportation audit.
- The teacher should collect the necessary supplies, including devices for measuring air temperature.

DAY 1

1. The teacher introduces students to the audit activity, and the principles of energy and transportation use and conservation outlined in the resource manual. The teacher elicits students' initial thoughts about how energy is used at the school with questions such as: "What do we use electricity for at school? What areas of the school do you think use the most energy?" "How is energy used to get students and staff to school?" In particular, the teacher and students discuss:

- The source(s) of electrical power used on campus, and whether the energy resources used to generate the power are renewable or nonrenewable.
- The sources of natural gas and/or heating oil used on campus, if applicable.
- The way in which energy is used for electrical appliances.
- The ways in which energy is used for heating and air conditioning .
- The energy requirements for fluorescent and incandescent light fixtures.
- The energy use and air emissions of motor vehicles.

2. The teacher assigns students to one of four specific task forces: Energy Source, Transportation, Heating and Cooling, Lighting and Appliances.

DAY 2

The four task forces collect data and review survey results:

Energy Source task force: Students will study the survey sheet completed by the administration, and the local information provided by the teacher, and begin to develop a wall chart displaying the energy sources for the campus. The chart will outline the ways energy is used on campus, and the cost of the energy (see sample, day 3).
Transportation task force: Students will study and compile the staff transportation survey to determine the number of miles that staff members drive, bicycle, or walk to and from school. Students will study information regarding school bus traffic, obtained from the administrative survey. They begin to develop a wall chart (see sample, day 3) displaying fuel use and air emissions, using the worksheet provided in Appendix IId.
Heating and Cooling task force: Students will study the survey sheet completed by the facilities supervisor, and audit the room temperatures at several locations in the classroom and in several rooms throughout the school, to see if they are in an appropriate range. Students should study whether room temperature could be partially controlled by raising or lowering window blinds or shades to adjust the level of sunlight. They will begin to develop a wall chart displaying the conservation of energy on campus (see sample, day 3).

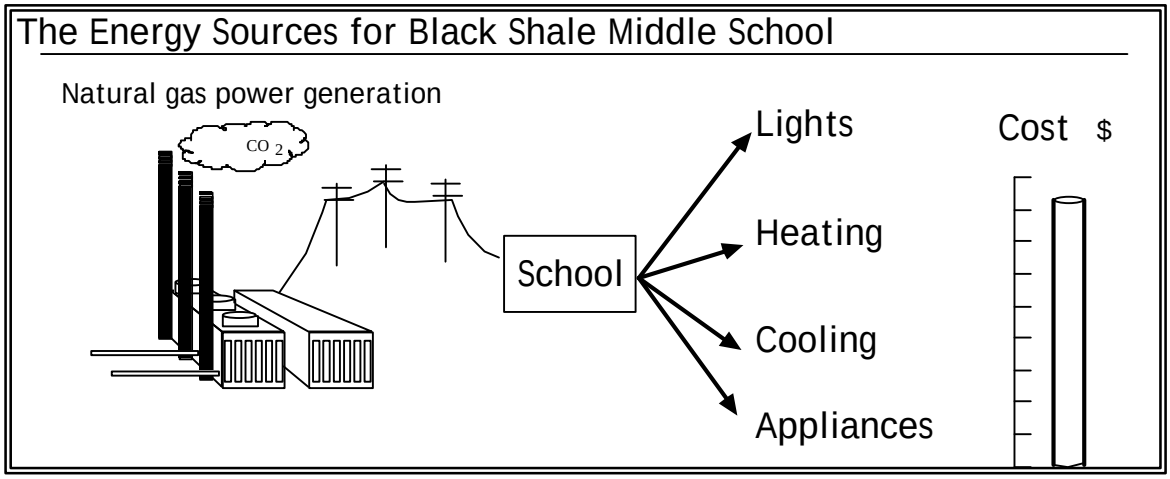
Lighting and Appliances task force: Students will audit the use of lighting on campus, determining whether the lights are fluorescent or incandescent, and whether they are left on in unoccupied areas (such as empty classrooms). They will assess the number of major appliances on campus, and whether the lighting fixtures are energy efficient, using the information provided by the facilities survey.

DAY 3

Completion of Audit Analysis and Chart Preparation.

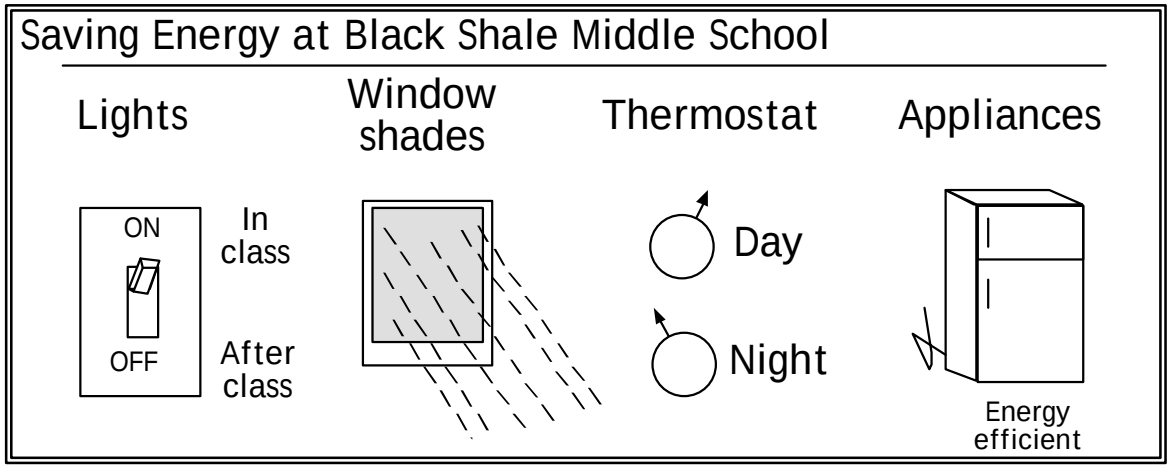
The four task forces combine their information and data to complete the three wall charts.

Partially Completed Use Chart, by the Energy Sources Task Force



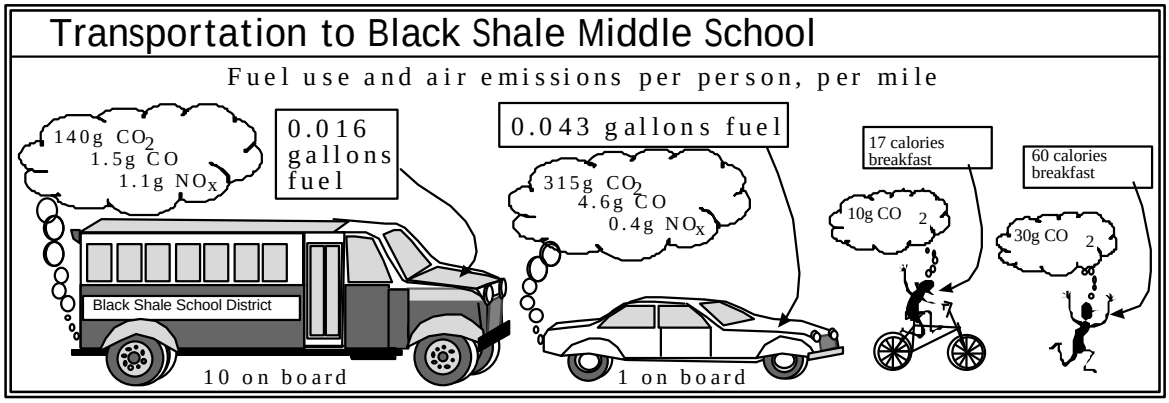
The first chart represents the energy sources for the campus, and may contain information about whether the sources are renewable or nonrenewable. The uses of energy on campus are illustrated, as is the average daily cost of the energy.

Partially Completed Use Chart, by the Heating and Cooling Task Force



The second chart represents the energy uses on the campus, and may contain information and data developed by different task forces. The four segments of the chart outline school lighting practices, use of window shades, heating and cooling system controls, and the presence or absence of energy efficient major appliances. In each case, the practices that conserve the energy are highlighted and discussed.

Partially Completed Chart, by the Transportation Task Force



The third chart provides information on energy use and air emissions from different modes of transportation, using information from the student worksheet. Summary data from the school administrative survey and student estimates may be added.

Once completed, these three charts can be posted and discussed.

Day 4

The audit culminates with a class discussion of the results:

- What is the average daily power usage by the school, and what does it cost?
- Dividing the energy cost by the number of students, what is the cost per student?
- What is the energy resource used to generate power for the school, and is it renewable?
- What sites on the school campus use energy?
- Are the rooms uniform in temperature, and are they too warm or too cool?
- Could opening or closing window blinds save energy during the day?
- Are the major appliances energy efficient? Are computers and office equipment powered down when they are not needed after school?
- Are the light fixtures energy efficient?
- Is the amount of lighting appropriate in different parts of the school, and are lights left on when classrooms are empty?
- What amount of fuel usage and air emissions are associated with getting students and staff to school?
- What steps could students take personally, to reduce energy usage?
- What might the school do to encourage less energy consumption?

These discussion points and ideas generated can be written onto a fourth wall chart, and posted. The school principal may be invited to review the charts with the class.

APPENDIX IIa

School Site Facilities Survey

Dear Facilities Supervisor,

Our class is studying how much energy is being used at the school, and how to conserve it and improve air quality. We would appreciate it if you would fill out the following brief survey.

Please return it to _____ by this date: _____ .
Teacher's name

1. What percent of the light fixtures in the school are fluorescent, and where are they located?

2. What percent of the light fixtures in the school are incandescent, and where are they located?

3. What major appliances are at the school, and are they rated as energy efficient?

4. Are computers (student and administrative), copy machines, and other electronic equipment left on after school ends, or are they powered down?

5. How is room temperature adjusted at different times of day, and in different seasons?

6. Please record readings from the school electric meter so that daytime and nighttime power use can be calculated by students. Dates chosen for meter reading: _____

- Reading before school starts on day 1 _____.
- Reading after school ends on the same day (day 1) _____.
- Reading before school starts the next day (day 2) _____.

Additional comments:

Thank you for the information.

APPENDIX IIb

School Site Administrative Survey

Dear Administrator,

Our class is studying how much energy is being used at the school, and how to conserve it and improve air quality. We would appreciate it if you would fill out the following brief survey.

Please return it to _____ by this date: _____ .
Teacher's name

1. What is the average amount of electricity used daily by the school?_____

2. What is the average daily cost of this electricity? _____

3. (If applicable) What is the average amount of natural gas or heating oil used by the school, and what are the daily costs of these fossil fuels? _____

4. How many students are enrolled at the school?

5. How many buses transport students to school?

6. How many students travel to school on a school bus?

7. How many total stops do they make, and approximately how many miles do they travel (round trip)?

8. Does the school have an energy conservation plan? If so, please describe it.

Additional comments:

Thank you for the information.

Appendix IIc

Dear Staff Member,

Our class is studying how much energy is being used at the school, and how to conserve it and improve air quality. We would appreciate it if you would fill out the following brief survey.

Please return it to _____ by this date: _____ .
Teacher's name

1. What method do you use to commute to school each day?
Train____ Bus____ Car____ Bicycle____ Walk____

Motorbike/motorcycle____ Carpool/Vanpool____

2. Approximately how many miles, round trip, do you commute each day to school?

APPENDIX IId

Transportation Worksheet - page 1

This worksheet will help you calculate the fuel usage and air emissions for different types of transportation.

Staff transportation...

1. Use the information on the staff transportation survey to determine how many staff members commute to school by each of the following methods:

Train____ Bus____ Car____ Bicycle____ Walk____

Motorbike/motorcycle____ Carpool/Vanpool____

Automobile worksheet - fuel usage

2. How many motor vehicles are driven by staff members, to and from school: _____

3. Add together all of the round trip miles driven by staff members who commute to school in motor vehicles: _____

4. Multiply line 2 times two to give the number of times these cars are started: _____

Fuel efficiency of cars...

5. The average car has a gas mileage of 23 miles per gallon (mpg), so it uses 0.043 gallons of fuel per mile. In addition, the average car uses 0.0014 gallons of fuel each time it is started. Calculate fuel usage as:

(line 3 X 0.043) + (line 4 X 0.0014) = _____ gallons

APPENDIX IId

Transportation Worksheet - page 2

Automobile worksheet - air emissions

6. **Carbon dioxide** (CO_2) is a product of burning fuel, and is an important "greenhouse gas." The average car generates 370 grams of CO_2 per mile, and an additional 77 g CO_2 each time the car is started. Calculate CO_2 emission as:

(line 3 X 370) + (line 4 X 77) = _____ grams CO_2

You may be interested to know that each gram of CO_2 takes up about 0.5 liters of volume.

7. **Carbon monoxide** (CO) is a product of burning fuel, and is poisonous. The average car generates 4.5 grams of CO per mile, and an additional 9.9 g CO each time the car is started. Calculate CO emission as:

(line 3 X 4.5) + (line 4 X 9.9) = _____ grams CO

You may be interested to know that each gram of CO takes up about 0.8 liters of volume.

8. **Nitrogen oxides** (NO_x - a family of chemicals including nitrous oxide, nitrogen dioxide, and nitric acid) are products of burning fuel, and an important source of air pollution and acid rain. The average car generates 0.47 grams of NO_x per mile, and an additional 0.57 g NO_x each time the car is started. Calculate NO_x emission as:

(line 3 X 0.47) + (line 4 X 0.57) = _____ grams NO_x

Automobile Summary

You may calculate air pollution emissions per passenger by dividing each of lines 6-8 by the number of automobile passengers, if known.

Per passenger: CO_2 emissions _____

Per passenger: CO emissions _____

Per passenger: NO_x emissions _____

You may be interested to know that there are nearly 14 million cars in California, and each day they produce 200,000 tons of CO_2, 3,000 tons of CO, and 300 tons of NO_x.

APPENDIX IId

Transportation Worksheet - page 3

School bus worksheet - fuel usage and air emissions

Bus mileage...

1. How many buses deliver students to the school?
(see Administrative survey, line 5): _____

2. How many students travel to school on a school bus?
(see Administrative survey, line 6): _____

3. How many total miles do all of the school buses travel, round trip?
(see Administrative survey, line 7): _____

4. Multiply line 1 X two to give the number of times these buses are started: _____

Fuel efficiency of school buses...

5. The average school bus has a fuel efficiency of 6.8 miles per gallon (mpg), so it uses 0.15 gallons of fuel per mile. In addition, the average school bus uses 0.14 gallons of fuel each time it is started and warmed up. Calculate fuel usage as:

(line 3 X 0.15) + (line 4 X 0. 14) = _____ gallons

APPENDIX IId

Transportation Worksheet - page 4

6. **Carbon dioxide** (CO_2) is a product of burning fuel, and is an important "greenhouse gas." The average school bus generates 1,300 grams of CO_2 per mile, and an additional 1,300 g CO_2 each time the bus is started and warmed up. Calculate CO_2 emission as:

(line 3 X 1300) + (line 4 X 1300) = _____ grams CO_2

You may be interested to know that each gram of CO_2 takes up about 0.5 liters of volume.

7. **Carbon monoxide** (CO) is a product of burning fuel, and is poisonous. The average school bus generates 14 grams of CO per mile, and an additional 13 g CO each time the bus is started and warmed up. Calculate CO emission as:

(line 3 X 14) + (line 4 X 13) = _____ grams CO

You may be interested to know that each gram of CO takes up about 0.8 liters of volume.

8. **Nitrogen oxides** (NO_x - a family of chemicals including nitrous oxide, nitrogen dioxide, and nitric acid) are products of burning fuel, and an important source of air pollution and acid rain. The average school bus generates 11 grams of NO_x per mile, and an additional 0.67 g NO_x each time the bus is started and warmed up. Calculate NO_x emission as:

(line 3 X 11) + (line 4 X 0.67) = _____ grams NO_x

School Bus Summary

You may calculate air pollution emissions per passenger by dividing each of lines 6 - 8 by the number of student passengers, on line 2.

Per passenger: CO_2 emissions _____

Per passenger: CO emissions _____

Per passenger: NO_x emissions _____

You may be interested to know that there are 26,000 school buses in California, and each day they produce 1,600 tons of CO_2, 16 tons of CO, and 13 tons of NO_x.

APPENDIX IId

Transportation Worksheet - page 5

Human-powered transportation - food usage and CO_2 emissions

When you walk or ride a bicycle to school, it takes energy, and you are burning the food that you eat as a type of fuel. Walking requires approximately 60 calories per mile, and bicycling requires approximately 20 calories per mile. When you walk or ride a bicycle, you breathe more CO_2 into the air. A student will exhale approximately 90 to 120 grams of CO_2 per hour, depending on exertion, so walking one mile at 3 mph or bicycling one mile at 15 mph will produce approximately 20 grams of CO_2 (walking) or 5 grams of CO_2 (bicycling).

1. How many round trip miles do staff members walk to and from school? _____.

2. Multiply line 1 times 60 to give the total number of dietary calories of energy (fuel) required for this walking _____

3. Multiply line 1 times 20 to give the total number of grams of CO_2 exhaled (air emission) during this walking _____

4. How many round trip miles do staff members bicycle to and from school? _____.

5. Multiply line 4 times 20 to give the total number of dietary calories of energy (fuel) required for this bicycling _____

6. Multiply line 4 times 5 to give the total number of grams of CO_2 exhaled (air emission) during this bicycling _____

You may be interested to know that there are 495,000 students in grade 6 in California. That is nearly one million feet!

IV. WATER AUDIT

OVERVIEW

Using campus audits and surveys as a foundation, this unit explores water use/conservation and pollution prevention practices on the school campus. The audit is designed to follow science instruction in water resources, so that students will be able to understand the sources of water used by the school, and how it may be conserved. It should be administered after these specific chapters of State Board of Education adopted science textbooks for grade 6:

Adopted Grade 6 Program	**Administer after:**
Glencoe	Chapter 21: Resources
Holt	Chapter 10: The Flow of Fresh Water
McGraw Hill	Chapter 10(5): Earth's Water Supply
Prentice Hall	Chapter 11: Water Resources

AUDIT GOALS

The audit is designed to answer the following questions about the school site:

- What is the natural source of water used by the school?
- What is the average daily volume of water used by the school?
- What sites on the school campus use the water, and how might it be conserved?
- How is water leaving the school campus handled as runoff or sewage?
- What might be the overall benefits and savings of a water conservation program?
- What might be the overall benefits of a storm water pollution prevention program?

DATA SAMPLE AND INFORMATION COLLECTED

The following types of information and data will be collected for the purposes of the audit.

- Information on the natural source of water used by the school, the average daily usage and cost.
- Data samples collected in the school restrooms, regarding the condition of the water fixtures, and rate of water flow.
- Data on the watering system used to maintain outdoor landscaping, and information on how storm water runoff is returned to the environment by the municipality.
- Information on how sanitary sewer water is collected and processed, and how the water is returned to the environment by the municipality.

ADVANCE PREPARATION

- The teacher should distribute and collect the two school site surveys included in Appendices IIIa and IIIb. The completed survey pages will be provided to students for analysis.
- The teacher should collect the following information for the Water Source task force: What is the source of fresh water used by the school, and how is it transported? How is water runoff collected at the school site, and how does the municipality return the water to the environment? How is sanitary sewage water treated and returned to the environment?
- The teacher should read the introduction in the resource manual, becoming familiar with the principles of water resources and conservation.
- The teacher should become familiar with the water use practices on campus, and give consideration to how the audit may need to be tailored to the school site.
- The teacher should obtain permission and develop a logistical plan for students to conduct the water audits, including water measuring and timing devices.

DAY 1

1. The teacher introduces students to the audit activity, and the principles of water use and conservation, and storm water pollution prevention outlined in the resource manual, and elicits the students' initial thoughts about how water is used on the school campus. In particular, the teacher and students discuss:

- The natural source of water used on campus, as identified by the local water district, and how it is transported from the source to the local community.
- The ways in which students use water on campus on a daily basis.
- The ways in which water is used by staff for food service and cleaning.
- The ways in which water is used for landscaping.
- Where storm water runoff from the campus is collected and how it reenters the environment.
- How the sanitary sewer water is collected, processed, and reenters the environment.
- The types of pollutants that may leave the campus through runoff, and the effect those pollutants have on lakes, rivers, streams, and oceans.

2. The teacher assigns students to one of four specific task forces: Water Source, Restroom, Grounds, and Drains.

DAY 2

The four task forces collect data and review survey results:

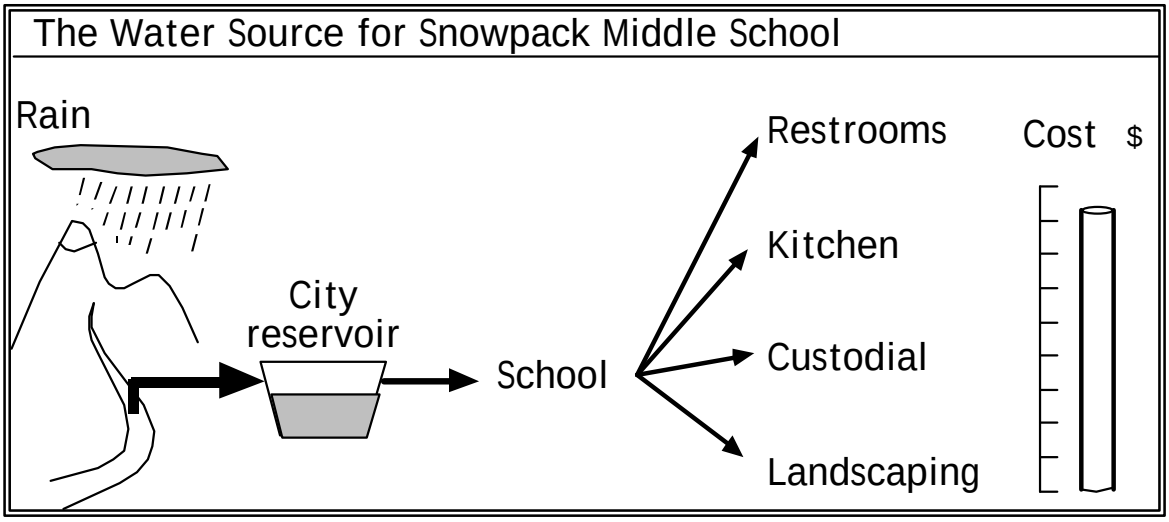
Water Source task force: Students will study the survey sheet completed by the administration, and the information provided by the teacher. They begin to develop a wall chart displaying the transportation of water from its source to the campus, the ways it is used on campus, and the cost of the water (see sample, day 3).
Restroom task force: Students should audit one or more restrooms to determine whether the water taps leak, and whether their maximal flow is excessive. Students will time the filling of a graduated container from restroom water taps at their highest flow rate, or with a "push button tap" held down. Students calculate the water volume per minute (e.g. 2 gallons per minute). They will also estimate an appropriate flow rate and time needed for hand washing, with the water turned off during lathering (e.g. 10 seconds, at a rate of 0.5 gallons per minute).
Grounds task force: Students will study the survey sheet completed by the grounds supervisor to understand the landscape watering schedule and to determine the types of pesticides and fertilizers used. Students audit the efficiency of the watering system, and search for, signs of over-watering, leaks, and other indications of outdoor water waste (e.g. puddles on paved surfaces, mud puddles in fields).
Drains task force: Students will study the local information sheet and the administrative survey and begin to develop two wall charts displaying the sanitary sewer and storm drain systems by which water leaves campus and is returned to the environment (see sample, day 3).

DAY 3

Completion of Audit Analysis and Chart Preparation.

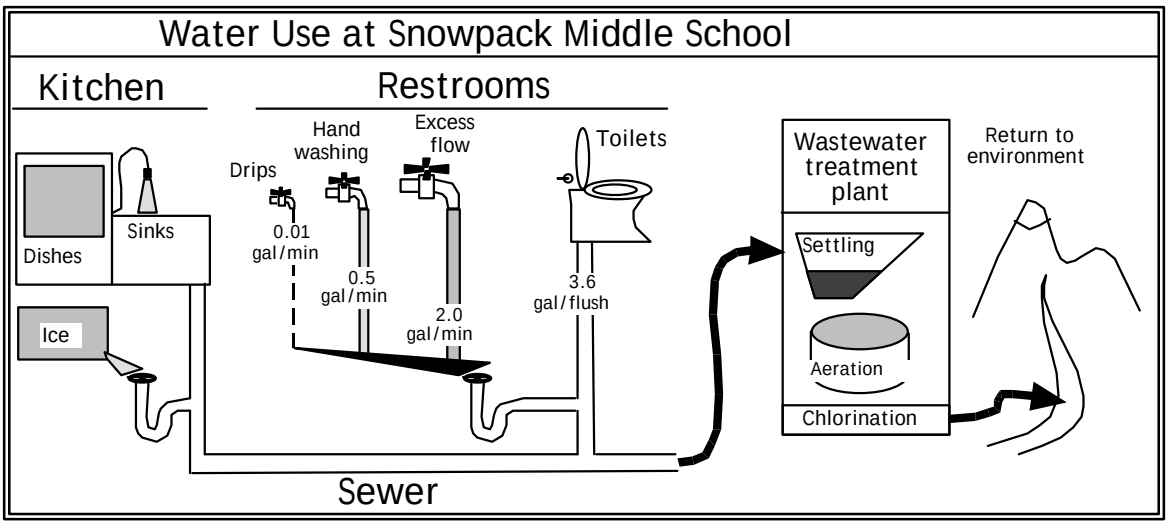
The four task forces combine their information and data to complete the three wall charts.

Partially Completed Sample Chart, by the Water Source Task Force



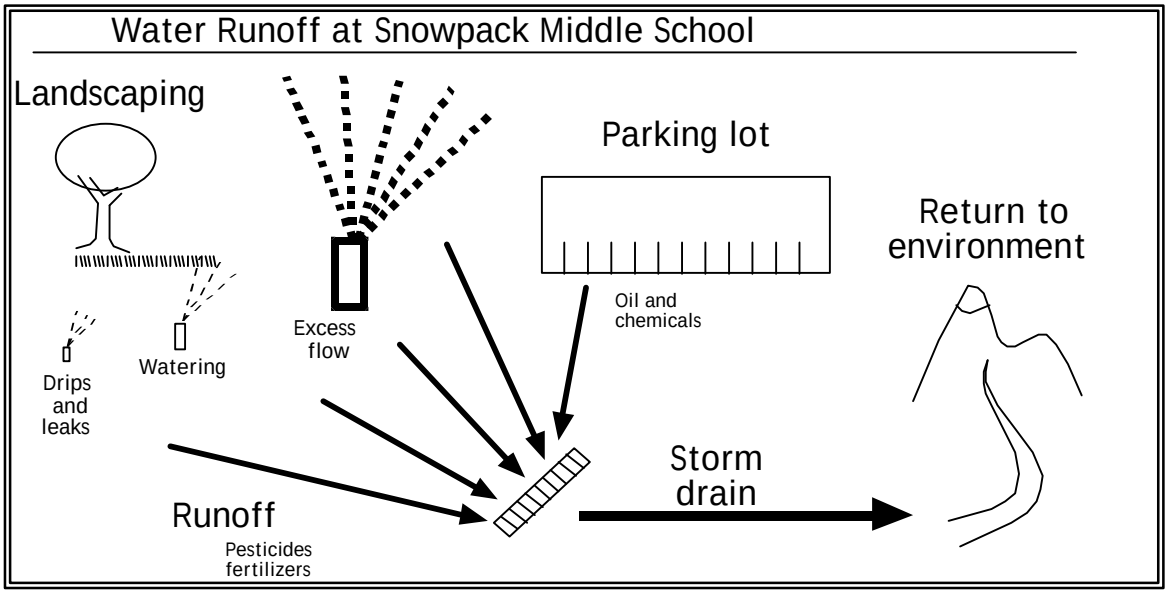
The first chart represents the fresh water entering the campus, and may contain information about the natural geographic source of the water and its transportation. The uses of water on campus are illustrated, as is the average daily cost of the water.

Partially Completed Use Chart, by the Restroom and Drains Task Forces



The second chart represents the use and misuse of water used by students, and its disposal in the sanitary sewer. It is a combined effort from the Restroom and Drains task forces, and shows data on the kitchen, restroom water taps and toilets. The "drips" data include an estimate of the waste of water from leaky or improperly turned off faucets. The "hand washing" data show an appropriate flow rate of water for hand washing (in gallons/minute) and the "excess flow" data show the maximal flow rate from water taps. The "toilets" data show an estimate of gallons per flush, based on the information provided by the administration. The method of wastewater treatment, and return of water to the environment are shown.

Partially Completed Runoff Chart, by the Restroom and Drains Task Forces



The third chart represents the use of water outdoors to maintain landscaping, and disposal of runoff water in the storm sewer. It is a combined effort from the Grounds and Drains task forces, and shows how excess watering, fertilizing, and pesticide application can wash chemicals into the storm drains, which return untreated water to the environment.

Once completed, these three charts can be posted and discussed.

Day 4

The audit culminates with a class discussion of the results:

- What is the average daily volume of water used by the school, and what does it cost?
- Dividing the water cost by the number of students, what is the cost per student?
- What is the natural source of the water, and how is it transported to the school?
- What sites on the school campus use water?
- Are the restroom water taps leaking? Are they easy to turn up too high?
- How much water do you need to wash your hands, without wasting any?
- Are the toilets "low flush"? Approximately how many gallons do they use per flush?
- What happens to water that goes down the drain in the restroom?
- When is the best time of day to water the school grounds? Is this done?
- Is the campus landscape watering system leaking?
- Is there evidence of over-watering, or watering on rainy days when it isn't needed?
- Does water run into paved areas? What happens to runoff that enters the storm drain?
- What steps could students take personally, to reduce water usage?
- What might the school do to encourage less water consumption?
- When is the best time of day to apply fertilizers and pesticides?
- What impact might excess fertilizers and pesticides have on the environment?
- What steps could students take personally to reduce water pollution?

- What might the school do to encourage water pollution prevention?

These discussion points and ideas generated can be written onto a fourth wall chart, and posted. The school principal may be invited to review the charts with the class.

APPENDIX IIIa

School Site Grounds Survey

Dear School and Grounds Supervisor,

Our class is studying how much water is being used at the school, and how to conserve, and protect it. We would appreciate it if you would fill out the following brief survey.

Please return it to _____ by this date: _____ .
Teacher's name

1. Do the school restrooms have "low flush" toilets or urinals? _____ gallons/flush____

2. What is the average number of minutes per day that the landscaping is watered? ____

3. How does the watering schedule change in different seasons?

4. If it rains on any particular day, are the plants still watered by the school? ____

5. Are the sprinklers adjusted so that there is little excess runoff of water? ____

6. Does the school use pesticides and fertilizers? _____ Is it possible that they could run off into the storm drains?

7. What are the names of the pesticides and fertilizers being used?

Additional comments:

Thank you for the information.

APPENDIX IIIb

School Site Administrative Survey

Dear Administrator,

Our class is studying how much water is being used at the school, and how to conserve and protect it. We would appreciate it if you would fill out the following brief survey.

Please return it to _____ by this date: _____ .
Teacher's name

1. What is the average daily volume of water used by the school?_____

2. What is the average daily cost of the water? _____

3. Does the school have a water conservation plan? If so, please describe.

Additional comments:

Thank you for the information.