

*The School Diversion and Environmental
Education Law*



*Sample Campus Environmental
Audits*

September 2005

Produced under contract by

The Acorn Group



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Alan C. Lloyd, Ph.D.
Secretary, California Environmental Protection Agency

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www.ciwmb.ca.gov/Publications/
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State Board of Education

California Department of Education

State Secretary for Education

Project Director

Tricia Broddrick (September 2001–March 2004)
Office of Education and the Environment
California Integrated Waste Management Board

Joanne Vorhies (April 2004–present)
Office of Education and the Environment
California Integrated Waste Management Board

Writing Team

Lori Mann, Lead Author
Consultant

Jennifer Rigby
Director
The Acorn Group

Gerald A. Lieberman, Ph.D.
Director
State Education and Environment Roundtable

Jayne C. Henn
State Education and Environment Roundtable

Introduction

Project Background

The School Diversion and Environmental Education Law (School DEEL) was signed into law in September 2001 (SB 373, Torlakson, Chapter 926, Statutes of 2001). The law created a series of integrated waste management and 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.

The School DEEL calls for developing, implementing, and adopting a plan for elementary and secondary schools in the state that includes the following elements:.

- Coordinate instructional resources and strategies for providing active pupil participation with on-site conservation efforts.
- Promote service-learning opportunities between schools and local communities.
- Assess the impact to participating pupils on student achievement and resource conservation.
- Create models and school waste reduction tools for schools, school districts, county offices, and local agencies.
- Establish an Environmental Ambassador Pilot Program and a unified education strategy (UES).
- Provide grants to school districts to implement programs teaching source reduction, recycling, and composting.
- Identify and promote use of recycled-content materials and environmentally preferable products in the construction and modernization of public school facilities.
- Evaluate 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 ... (A) Reduce waste and conserve resources. (B) Provide pupils with a ‘hands-on’ learning experience.” (Public Resources Code [PRC] section 42630) 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.” (Education Code section 51226.4)

Overview of the Campus Environmental Audits

As part of the School DEEL Program, 13 school districts participated in the Unified Education Strategy Grant Program. These 13 districts were required to implement a campus needs assessment (CNA)—a standards-based instructional plan—to assess the current campus resource use and waste management practices. The auditing processes that were part of the CNAs provided opportunities for students to: collect data regarding their school’s resource use and waste

generation; analyze data collected during the auditing process; and evaluate results to formulate plans for service projects.

In addition to the valuable educational experiences students gained through the auditing process, the schools and districts benefited from the partnerships formed with local agencies and community groups. These partners offered expertise, provided needed materials and supplies, assisted the teachers and students during the implementation of environmental audits, and served as audiences for proposed solutions to issues students identified through the CNAs.

Purpose of the Sample Campus Environmental Audits

The intent of the audits described in this document is to provide students with the opportunity to assess resource management practices on their school campus and in their communities. The audits combine the experience of real-world investigations with standards-based learning objectives. Implementing these audits will:

- Strengthen students' investigation and experimentation skills through collection and analysis of real data.
- Further the development of their standards-based content knowledge and skills in mathematics and language arts through data analysis/representation.
- Improve students' retention of specific standards-based content.
- Reinforce understanding of California's new Environmental Principles and Concepts, a component of the Education and the Environment Initiative (AB 1548, Pavley, Chapter 665, Statutes of 2003).

Exposure to and understanding of the content contained in adopted sixth-grade science instructional materials, particularly the examination of resource use such as energy and water, and generation of waste, is fundamental to the educational success of these campus audits. Specific textbook reading assignments, along with teacher demonstrations and discussions, would provide a solid academic base for conducting the audits. As students draw conclusions from their campus studies, they should be able to connect their new understanding to the larger concepts and theoretical constructs emphasized in the adopted instructional materials.

I. Using the Audit Tools

These sample audit tools include detailed instructions for conducting assessments of solid waste generation, the use of energy and water resources, and the resource use patterns on campus or in areas of the local community. The audits presented here are only samples. Teachers may wish to use alternative audit tools or modify these to fit specific needs.

Each audit is designed to stand alone and be conducted over several 45-minute class sessions. The intention is for students to work in groups, each auditing different areas related to the particular topic (waste, energy, and water). The design is flexible so that within these groups, individual students can either complete a full section of the audit or accept a task within a section and share the results. Since the number of students participating in the audits and the location or area that is being audited will vary, the final design of the procedures and specific arrangements are left to the discretion of the teacher(s).

In addition to being stand-alone and having a flexible design, each audit assesses student and staff knowledge and behaviors related to waste, energy, and water, respectively. Sample surveys to use in an audit are included in a separate document titled *School DEEL and Environmental Service-Learning: Case Studies and Technical Support*. This document is available online from: www.ciwmb.ca.gov/Publications/default.asp?pubid=1139.

The sample audits take safety issues into consideration. Students will work at all times under the immediate supervision and control of certificated faculty, although at some times there may be parental assistance. Students will not handle waste and will not be directly exposed to any toxic substances while carrying out their investigations.

II. Solid Waste Audit Procedure

Overview

The audit requires five 45-minute class sessions, implemented as follows:

Session	Activity
1	Key Waste-Related Concepts
2	Introduction to Audit and Survey Procedures and Protocols
3	Data Collection
4	Data Analysis
5	Data Analysis, continued

Audit worksheets and handouts are provided and, in order to ensure consistency with data collection, should be used as written. Each worksheet, however, includes extra space so students may add questions tailored to individual or local matters.

Relevant student reading material is available in these State-adopted textbooks:

Science Voyages—Earth Science: Unit 1, Chapter 4—Resources, especially Section 4.4, p. 111—“Land”; **Standards**, p. 642.

Earth Science: Chapter 3—Minerals of the Earth’s Crust, especially Section 3, p. 68—“The Formation and Mining of Minerals”; **Chapter 5—Energy Resources**, especially Section 1, p. 108—“Natural Resources”; p. 130—“Eye on the Environment”; **Chapter 13—Exploring the Oceans**, especially Section 4, p. 348—“Resources from the Ocean.”

Science: Unit 4, Chapter 8—Living Things Interact, especially Topic 5, Lesson 4, p. 312—“How Do People Change the Environment?”, “Why Are These Plants Important to People?”, Topic 6, Lesson 4, p. 326—“Why Recycle? How Are Recycled Products Used?”; Topic 7, Lesson 4, p. 342—“Where Have All the Metals Gone?”; **Unit 5, Chapter 9—Resources of the Crust**, especially Topic 1, Lesson 4, p. 358—“Uses of Minerals, Are Minerals Renewable?”, Topic 2, Lesson 5, p. 376—“Forest Resources: More Than Just Timber.”

Science Explorer, Focus on Earth Science: Unit 1, Chapter 4—Minerals, especially Section 3, p. 124—“Mineral Resources”; **Unit 5, Chapter 20—Living Resources**, especially Section 1, p. 646—“Environmental Issues”; Section 2, p. 653—“Forest Resources.”

Additional background information is available for students in the waste section of the *School DEEL Resource Manual*. This manual is available online from: www.ciwmb.ca.gov/Publications/default.asp?pubid=1143.

Teacher Preparation

The following advance preparation is required before implementing this audit procedure:

- Identify your school and community waste hauler(s) and local jurisdiction waste management authority and request their assistance in tailoring your audit to reflect your local situation(s). These agencies/companies should be able to answer technical questions and may be able to assist with conducting the audit, especially if recruiting parent

volunteers is difficult. (Your school or district office should be able to provide you with the necessary contact information.)

- Ask your local waste hauler or local jurisdiction waste management authority how your campus/community's waste is disposed of, including the name and location of the local landfill and other waste management procedures in place in your city/county. (Session 1).
- Obtain the 10 5-gallon buckets and 5 30-gallon containers for use during the waste audit conducted in Session 3. Note: The 30-gallon containers are for use in the cafeteria/lunch area of the campus. (Session 2).
- Contact your local waste hauler, local waste management authority, or local recycling center and determine what can be recycled in your community. Also determine what your community's district's waste hauler will collect on its regular pick-ups. Additional information may be available on-line at www.ciwmb.ca.gov/Profiles/ or by calling 1-800-CLEANUP. (Session 2).
- Arrange for school staff members to answer audit questionnaires.
- Obtain simple campus and community maps, or modify existing ones, to use as models with students.

Session 1: Key Waste-Related Concepts

Waste Management

Introduce the concepts of “solid waste” and “waste management” by asking students what things they have already thrown away that day. Discuss what happens to materials that are thrown away (taken to a landfill, incinerated, composted, etc.). Explain that solid waste is material that we throw away. It does not include sewage or organic materials put down a garbage disposal. Waste management is the combination of practices used to reduce, reuse, recycle, and dispose of waste material.

Ask students to identify everyday practices that generate solid waste at school. Record student responses on the board. If necessary, prompt responses by naming different areas on campus: classrooms, cafeteria/lunch area, office, shops, gardens, landscaping, and science labs.

Review the list of everyday practices that the students have identified and have the students hypothesize about the areas on campus where the most waste may be generated.

Waste of Resources

Compare and contrast the concepts of “generating solid waste” and “wasting resources.” Instruct students about what happens to the waste generated on campus (for example, give them the name and location of landfill, incinerator). Have students consider how the concepts of “generating solid waste” and “wasting resources” are related to the renewability and non-renewability of resources. Brainstorm and record the connections between generating solid waste, wasting resources, renewability and non-renewability, and other community issues, such as space for landfills, resource depletion, and contamination of groundwater by landfills.

Identify and define the five ways in which the amount of solid waste can be decreased: source reduction, reuse, recycling, composting, and buying products made from recycled materials. Discuss how each of these approaches relates to the key concepts of renewable and nonrenewable resources and resource conservation. (Source Reduction: Decreasing the amount and/or toxicity of waste before it is generated or decreasing the quantity of materials that must be collected,

processed, or disposed of. Reuse: Reviving the “once is not enough” philosophy and finding creative ways to reuse items in different ways. Recycling: Collecting, extracting, and reusing materials found in waste. Composting: Converting organic wastes for use as soil replenishers. Buying products made from recycled materials: making informed purchasing decisions.)

Assessment

Teachers should use this activity to help students synthesize their understandings into a unified whole.

Students should trace the steps from manufacturing a product of their choosing to disposing of it. They should start with the collection of raw natural resources used in the product, the manufacturing and use of the product, and any waste generation or diversion that may result from each of the steps in the product’s history. Students should also identify the natural origins of the materials used to manufacture the product and classify as renewable or nonrenewable all of the natural energy and material resources (including air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests) involved in the manufacture, use, and disposal (or recycling) of their chosen object.

Session 2: Introducing the Audit and Survey Procedures and Protocols

Teacher Note: While students will always be under the supervision and control of a certificated employee, parental assistance (ideally, at least one parent per team) is required on the day the audit is conducted (Session 3). Parents should also attend the Session 2 orientation if at all possible, so they will be fully prepared to assist students during the audits. The school’s waste hauler or local jurisdiction waste management authority may be available to help students conduct the waste audit. Additionally, assistance for this type of program is frequently available from groups like the local conservation corps (www.consrv.ca.gov/DOR/grants/grant_seekers/lccc.htm) and AmeriCorps or environmental organizations.

All forms are in the section titled “Waste Audit Handouts and Worksheets.” (See Sessions 4 and 5.)

Participating students should work in four groups. Three groups audit campus waste practices. The fourth group will conduct a student survey to assess knowledge and behaviors related to waste. All parts of the data collection are designed to take place on the same day. Data is shared during Session 3, so all students have a better understanding of campus-wide practices.

Each of the three audit groups will assess one specific site and contribute its data to the overall waste audit. The three sites are:

- Cafeteria/lunch area.
- School office.
- Classroom(s).

Should you decide to monitor more than one classroom, waste audits will need to be conducted on different days due to the likely limitation of available collection buckets.

Data will be collected through observations and surveys (student and staff interviews). At least one parent, under the supervision and control of a certificated employee, will work with each team.

The audits also require gathering information from school personnel with responsibilities for managing and maintaining campus facilities. Questionnaires are provided for this purpose, or the class may design their own. Questionnaires can be completed in writing or used as the basis for interviews on the day of the audits, depending on staff availability on the audit day. If implemented as interviews, questionnaires should be distributed one week ahead of time to allow staff to prepare answers. If implemented in writing, staff should be allowed one to two weeks to complete and return the information. Written questionnaires should be completed before the other parts of the data collection are concluded (Session 3).

Student teams completing data collection are asked to make and record general observations related to their study areas on the data collection forms provided.

After conducting the audits, two class sessions will be spent analyzing the data, making any necessary calculations, and drawing conclusions about resource patterns on campus.

Reviewing Audit Procedures

Explain the purpose of the audit (to assess the quantity and type of trash collected on campus and determine what might be diverted from the waste stream).

Explain that in a larger study of the waste stream or in a different setting, more categories of trash would probably be examined. (This study has been simplified so it can be completed in one day.)

Divide the students into four groups: three observation groups and one survey/interview group.

Have the observation groups create three sets of labels for the collection buckets that will be used in the audits. (The suggested labels below assume there is no recycling program on your campus. If your campus recycles some items, you may need to adjust these labels as indicated). Suggested labels include:

- Food waste (compostable food—no meat or bones).
- Mixed recyclables (aluminum, glass, #1 and #2 plastics, and tin cans). (Note: This label reflects items commonly recycled in most communities. If your campus currently recycles some of these, adjust your label to reflect current collection practices.)
- Mixed paper (white paper, cardboard, colored paper magazines, newspaper, computer paper, and box board).
- Hard-to-recycle items (milk cartons, items made from plastics and metals other than those already noted, from polystyrene foam, and drink cartons). (Note: This category is intended to reflect items that are not commonly recycled, but for which the technology to recycle exists. If there is already a limited recycling program on campus, this category can also be adjusted to include readily recycled items listed above under “Mixed recyclables” that are not collected at your school.)
- Trash (anything non-recyclable and non-compostable, such as contaminated paper food trays, food wrappers, meat and bones, and facial tissue).

Teachers should collect and label three sets of five collection buckets and decide, with students, on a day for the data collection to take place. It is recommended that 30-gallon containers be used in the cafeteria/lunch area and 5-gallon buckets are used in all other locations. Aprons and gloves will be needed by the students who will work in the cafeteria/lunch area.

Prepare all necessary forms, such as data collection worksheet and the Solid Waste Audit Data handout.

Students should select one classroom to monitor or plan a second day of auditing. Using all three sets of buckets, up to three additional classrooms can be monitored simultaneously on this extra day.

Schedule and assign monitoring responsibilities for each site. Student monitors will empty the buckets as they are filled during the audit day and track and record the number of times each bucket is filled. (Note: the number of student monitors can be adjusted according to the number of students participating in the audits.)

- **Office:** Five students should track, pick up, empty, and record data at the end of the day. Student monitors may need to be called in before the end of the day to empty and record data from the office buckets if they become full. Designate whom office staff should contact if any of the buckets require emptying during the day.
- **Cafeteria/lunch area:** Teams of five students should monitor in 10-minute shifts throughout the lunch period, with each student monitoring one container. Provide student monitors with aprons and gloves. Monitors should stand by the buckets and assist other students in separating their refuse. As the collection buckets fill, student monitors should empty the buckets into the large trash cans and recycling bins normally used in the cafeteria/lunch area. Each time the buckets are emptied, student monitors should record the data by waste category. Parent volunteers will need to assist students with emptying the 30-gallon containers. (Note: For more accurate results, schools that serve Universal Classroom Breakfast or voluntary breakfasts can conduct an additional audit during breakfast, using the same procedures as detailed for the lunchtime audit.)
- **Classroom:** Five students should be assigned to each class period, with each student monitoring one bucket. The students should empty their buckets when they are full and record the count, by waste category, on the data collection form.

Students in the survey/interview group should review the sample survey questionnaire forms provided and decide if any changes should be made, or if the group wants to design its own survey/interview questions. If so, the teacher should take the opportunity to instruct students in the design of valid survey questions and the relationship between the questions asked and type of data collected (quantitative vs. qualitative). The students should draft, field-test, revise, and finalize a set of survey questions they will use with the school staff during the interviews.

Reviewing Audit Protocols

Review the following rules with students:

- Observations during the data collection times must be made respectfully. Students should not make disparaging remarks or accusations or engage in name-calling.
- Observations must be made unobtrusively. Explaining the purpose of the audit or discussing your observations with students not participating in conducting the audit might influence their behaviors and make data less accurate.
- Recognize that staff members are busy and have little time to assist with the campus audits. Be respectful of their time. You will have only one class period during which to make your observations and talk with staff. Interviewers should make arrangements with staff ahead of time to set up meetings at a mutually convenient time. Be sure to thank them for their participation.

Distribute a copy of the Solid Waste Audit Work Plan to each group and adult volunteer. Working with the adult assistants, allow each group to review the process outlined on the work plan and make specific plans as needed. This will include, but is not necessarily limited to, assigning specific tasks that are to be carried out on the day of the audit.

Preparing for Interviews/Surveys

Students are to conduct surveys with key staff members that have direct roles in resource use and/or waste management on campus. They should conduct surveys through face-to-face interviews on the data collection day. They may also choose to leave the surveys with the interviewees ahead of time. The survey should assess staff knowledge and behaviors about waste as they relate to the use of resources on campus. The sample survey guides in this document can be used without alteration. (Note: this survey does not gather any personal data regarding staff attitudes or what they do in their homes.) If desired, the students can construct their own surveys, with the teacher taking the opportunity to teach students about validity of survey data and how to construct “good” survey questions in order to produce “useable” data.

Have students review the survey instruments (or have students design them) and make sure the students understand each question.

Review good interview techniques with the students and clarify to them that they:

- Should ask the questions exactly as written.
- Must not influence the person they are interviewing with expressions or tone of voice.
- Are required to accept and record all answers without making any judgmental comments to those they are interviewing.
- Should thank each interviewee for their time and help.

In addition to surveying key staff members, surveyors will interview students. They will interview a minimum of 30 students selected at random from the entire student population. Given the typical class size in the upper grades, this should mean each interviewer is interviewing one other student at the school. (Note: Discuss concerns about selecting a biased sample for the survey. One way to randomly select students is to count students entering the cafeteria/lunch area for lunch and survey, for instance, every 15th student. Another method of randomizing the sample might be necessary in schools where only certain subsets of students generally eat in the cafeteria/lunch area.) These interviews should take place on the day immediately preceding or following the rest of the data collection, and the whole class should design interview questions to assess student knowledge and behaviors about waste as they relate to the use of resources on campus. (Note: the questions should not gather any personal data regarding student attitudes or what they do in their homes.) The interviewer should be assigned to an interviewee. Both the interviewer and the interviewee should arrange to meet at a mutually beneficial time.

Session 3: Data Collection

Teacher Note: Because students are divided into teams that are responsible for specific tasks, the majority of this audit can be conducted in one 45-minute period. Some tasks, as noted in the assignment sheets used in Session 2, require that students arrive early or work during a portion of their lunch period. A few tasks require monitoring throughout the day. These responsibilities are designed to be shared so that no one student works on the audit for more than one class period (45 minutes) on the actual audit day.

All forms are provided in the section titled “Waste Audit Handouts and Worksheets.”

Waste is to be sorted and collected throughout the day so students can gather data about the quantity and categories (food waste, mixed recyclables, mixed paper, hard-to-recycle items, and trash) of solid waste generated on campus. For safety reasons, students should not touch any of the waste. Student monitors in the cafeteria/lunch area should wear aprons and gloves.

Students are to deliver labeled buckets (five per site) to the waste monitoring sites (classroom, office, cafeteria/lunch area) at the end of the day preceding the audit, but the buckets should not be used until the designated collection period begins on the audit day.

On the day of the audit, student teams should monitor the buckets, emptying them into larger containers or dumpsters as they fill. Students will record the number of containers collected on the Waste Data Collection Form, to be used later in calculating volume and percentage of waste per category.

The waste monitoring sites and the degree of monitoring at each are:

- **Classroom:** Monitored throughout the day; students assigned by period.
- **Office:** Monitored at the end of the day and by students throughout the day who are on call (to be contacted by office staff as needed). A designated contact person (student) is assigned for each period.
- **Cafeteria/Lunch Area:** Monitored during the lunch period only.

Students are to prepare questionnaires (samples provided below in section titled “Waste Audit Handouts and Worksheets”) for use during interviews with kitchen/cafeteria/lunch area, facilities, and office staff on the day of the audit regarding waste management practices in designated areas on campus.

Sessions 4 and 5: Waste Data Analysis

All forms are in the section titled Waste Audit Handouts and Worksheets.

Data Compilation

Working in their groups, students use the Solid Waste Audit Data form provided to compile the data they collected in the audits and interviews and from the questionnaires.

Waste Data Analysis

Using the Solid Waste Audit Data form, have the class discuss and answer the following questions:

- How accurate was your prediction (from Session 1) about waste generation on campus? What evidence do you have to prove or disprove your prediction?
- If the school were to change its waste management practices and recycle or compost the easily managed materials on campus (compost, mixed recyclables, recyclable paper products), how much trash could be diverted from the school’s waste stream?
- How many dumpster loads could be reduced per year?

Using a sample waste bill for the school, students will determine how much money their school could save each year by diverting recyclable and compostable items from the current waste stream. Have students do the following:

- Estimate the annual waste bill for the school.

- Calculate the annual cost saving from reducing the number of dumpsters filled.
- Using the data provided, calculate the initial cost of setting up a recycling program.
- Calculate the annual costs of adding pickup of recycling to the school's waste bill.
- Figure out the overall savings per year.

If possible, students should compare sample bills from schools that have completed programs to divert waste. (Comparisons should be of annual costs before and after implementing the diversion programs.)

Students should graph the results of the audit, using grade-level-appropriate graphing strategies, to show:

- Comparisons among different locations and different types of waste.
- Number of dumpsters currently generated per type of waste, per study area, and campus-wide, versus number of dumpsters if recyclable and compostable waste were diverted (need graphic). Note: this comparison would show the amount of waste your school could prevent from going to the landfill.
- Costs of current waste management practices versus costs with recycling program.

Students should tabulate survey question results and analyze them for patterns. Exact procedures depend on the survey questions (since they may be student-designed). The class should discuss the patterns and draw any conclusions they can from the survey data.

All forms are provided in the section titled "Waste Audit Handouts and Worksheets."

Waste Audit Handouts and Worksheets

The following pages contain the handouts and worksheets described in this audit procedure.

Solid Waste Audit Work Plan

Task	Time	Student(s) Responsible
Distribute office and cafeteria/lunch area questionnaires to designated staff members, along with letter instructing how and when to return the completed questionnaire.	1–2 weeks before the audit.	
Create three sets of labels and label buckets.	Before the audit.	
Deliver instructions and labeled 5-gallon buckets to the classroom and school office. Deliver 30-gallon containers to the cafeteria/lunch area.	Delivered at the end of the school day preceding the audit.	
Designate whom the office staff should call if pickup is required during the day.	Before the audit.	Period 1: Period 2: Period 3: Period 4: Period 5: Period 6:
Empty office buckets at the end of the day. Track and record data.	End of the school day on the day of the audit.	
Possible emptying of office buckets during the day. Track and record data.	On-call basis.	
Monitor cafeteria/lunch area buckets. Assist students with disposal of trash. Empty buckets as they fill. Record count on data collection form.	10-minute shifts throughout the lunch period on the day of the audit, starting 5 minutes before lunch period and ending 5 minutes after lunch. Adjust the number of shifts to match your school lunch period. Similar assignments if a breakfast audit is added.	Shift 1: Shift 2: Shift 3: Shift 4: Shift 5:
Monitor classroom buckets each class period. Empty as needed. Track and record data.	Continuous throughout the audit day, with different students each period.	Period 1: Period 2: Period 3: Period 4: Period 5: Period 6:
Assign observers to answer the additional questions on the data collection forms.	During audit.	Cafeteria/lunch area: Office:

Task	Time	Student(s) Responsible
		Classroom:
Collect questionnaires from designated staff members.	One day before the audit.	
Write thank-you notes to staff and parents.	Immediately after the audit.	

Sample Survey Guide: Interview Questions for Facilities Manager

1. What normally happens to the trash collected from the: school office, cafeteria/lunch area, and classrooms?
2. How many dumpsters does our school have?
3. What is the capacity (by volume) of the dumpsters?
4. How often are the dumpsters emptied?
5. On average, how full are the dumpsters on pickup day?
6. Does the school recycle any materials? If yes, what materials are currently recycled?
7. How are these materials separated and collected from the school office, cafeteria/lunch area, and classrooms?
8. What size (by volume) are the recycling bins?
9. How often are these containers emptied?
10. On average, how full are the recycling containers on pickup day?
11. Does the school compost organic waste? If yes, how are these materials separated and collected from the: school office, cafeteria/lunch area, and classrooms?
12. What size (by volume) are the compost containers?
13. Is the compost used on campus? If not, how often are the compost containers emptied?
14. On average, how full are the composting containers on pickup day?
15. What improvements would you make to the school's waste management system?

Sample Survey Guide: Interview Questions for Office Manager

1. Does office paper have postconsumer recycled content?
2. Does the office purchase any other recycled-content products?
3. Can the copier do two-sided copying?
4. Are school documents routinely copied on one or both sides of the paper?
5. Do school newsletters and fliers that go home with students use paper efficiently? If so, in what ways?
6. Are memos distributed to each staff member, or are copies circulated?
7. Do you purchase new phone message pads or use scratch paper?
8. Do you purchase new or recycled printer and fax toner cartridges?
9. Does the staff break room use disposable or reusable cups, plates, and silverware?
10. Does the office participate in any school recycling programs? If yes, how are wastes separated and collected?
11. What improvements would you make to the school's waste management system?

Sample Survey Guide: Interview Questions for Kitchen/Cafeteria/Lunch Area Manager

1. What food is prepared on-site?
2. What food is brought in?
3. What items, if any, do you buy in bulk?
4. Does the cafeteria/lunch area allow students to choose the foods they desire, or does it automatically serve a prescribed meal?
5. What happens to leftover food?
6. Does the cafeteria/lunch area donate leftover food to any other organizations?
7. Do you recycle in the kitchen? If yes, how are wastes separated and collected?
8. What improvements would you make to the school's waste management system?

Waste Data Collection Form

Site: ___ Cafeteria/Lunch Area ___ School Office ___ Classroom (Room Number: _____)

Type of Waste (Sorted according to bucket labels)	Number of Buckets (Stick tally)	Time Emptied (Record time each time a bucket is emptied)
Food Waste (food)		
Mixed Recyclables (aluminum, glass, #1 and #2 plastics, tin cans)		
Mixed Paper (white paper, cardboard, colored paper, magazines, newspaper, computer paper, box board)		
Hard-to-Recycle Items (milk cartons, other plastics, other metals, polystyrene foam, drink cartons)		
Trash (non-recyclable, non-compostable, contaminated with food, facial tissues)		

Additional Observations Made During Audit (Cafeteria/Lunch Area)

1. Do students have a choice regarding quantity of food served?
2. Is there a salad bar?
3. What types of trays are used?
4. Do students have access to napkin holders, or are they given one napkin per meal?
5. Does the cafeteria/lunch area use plastic forks and spoons, plastic “sporks,” biodegradable utensils, or metal utensils?
6. Are drinking straws provided?
7. Are condiments provided in single-serve packages or in bulk?
8. Are beverages provided in single-serve packages or in bulk?
9. Did you observe any specific problems regarding management of solid waste in the school’s cafeteria/lunch area?

Waste Data Collection Form: Classroom Area

Room Number: _____

Type of Waste (Sorted according to bucket labels)	Number of Buckets (Stick Tally)	Time Emptied (Record time each time a bucket is emptied)
Food Waste (food)		
Mixed Recyclables (aluminum, glass, #1 and #2 plastics, tin cans)		
Mixed Paper (white paper, cardboard, colored paper, magazines, newspaper, computer paper, box board)		
Hard to Recycle Items (milk cartons, other plastics, other metals, polystyrene foam, drink cartons)		
Trash (non-recyclable, non-compostable, contaminated with food, facial tissues)		

Additional Observations Made During Audit (Classroom Area)

1. Does the teacher accept double-sided printing and use of scratch paper for drafts?
2. Does the class use a chalkboard, overheads, individual handouts, or an alternative approach such as PowerPoint?
3. Does the class save one-sided pages for reuse as scratch paper?
4. Is scrap paper saved and used for art projects?
5. Did you observe any specific problems regarding management of solid waste in the classroom?

Waste Data Collection Form: Office Area

Type of Waste (Sorted according to bucket labels)	Number of Buckets (Stick Tally)	Time Emptied (Record time each time a bucket is emptied)
Food Waste (food)		
Mixed Recyclables (aluminum, glass, #1 and #2 plastics, tin cans)		
Mixed Paper (white paper, cardboard, colored paper, magazines, newspaper, computer paper, box board)		
Hard to Recycle Items (milk cartons, other plastics, other metals, polystyrene foam, drink cartons)		
Trash (non-recyclable, non-compostable, contaminated with food, facial tissues)		

Additional Observations Made During Audit (Office Area)

1. Does the office staff use double-sided printing and collect scratch paper?
2. Does the office save one-sided pages for reuse as scratch paper or to send to the classrooms?
3. Did you observe any specific problems regarding management of solid waste in the office?

Solid Waste Audit Data

Calculations				
Data	Cafeteria/Lunch Area	Office	Classroom	Campus Total
No. of Buckets: Compost				
No. of Buckets: Mixed Recyclables				
No. of Buckets: Recyclable Paper Products				
No. of Buckets: Hard-to-Recycle Items				
No. of Buckets: Trash				
Total				
Percentage of Total Waste: Compost				
Percentage of Total Waste: Mixed Recyclables				
Percentage of Total Waste: Recyclable Paper Products				
Percentage of Total Waste: Hard-to-Recycle Items				
Percentage of Total Waste: Trash				
Total Percentages (should total to 100%)				
Percentage of waste that could be diverted from the waste stream with currently available methods (add composted, mixed recyclables, recyclable paper products)				

III. Energy Audit Procedure

Overview

The procedure requires five 45-minute class sessions, implemented as follows:

Session	Activity
1	Key Energy Concepts
2	Introduction to Audit and Survey Procedures and Protocols
3	Data Collection
4	Data Analysis
5	Data Analysis, continued

All audit worksheets are provided and, in order to ensure consistency with data collection, students should use them as written. Each worksheet, however, includes extra space so students may add questions tailored to individual or local matters.

Relevant student reading material is available in these State-adopted textbooks:

Science Voyages—Earth Science: **Unit 1, Chapter 4—Resources**, especially Section 4.1, p. 92—“Energy Resources”; Section 4.2, p. 98—“Alternate Energy Resources”; **Unit 5, Chapter 14—Atmosphere**, especially Section 14.1, p. 406—“Earth’s Atmosphere”; Section 14.2, p. 416—“Energy from the Sun”; **Unit 5, Chapter 16—Climate**, especially Section 16.3, p. 478—“Climate Change.”

Science Voyages—Life and Physical Science: **Unit 8, Chapter 26—Energy**, especially Section 26.1, p. 912—“Energy Changes.”

Earth Science: **Unit 2, Chapter 5—Energy Resources**, especially Section 2, p. 111—“Fossil Fuel”; Section 3, p. 118—“Alternative Resources”; **Unit 3, Chapter 9—Heat and Heat Technology**, especially Section 2, p. 219—“What is Heat?”; Section 4, p. 231—“Heat Technology”; **Unit 6, Chapter 15—The Atmosphere**, especially Section 2, p. 400—“Heating of the Atmosphere”; Section 4, p. 410—“The Air We Breathe”; **Unit 6, Chapter 17—Climate**, especially Section 3, p. 469—“Changes in Climate.”

Science: **Unit 3, Chapter 6—Energy in the Earth’s System**, especially Topic 4, Lesson 1, p. 208—“How Much Energy Comes from the Sun?”; Topic 4, Lesson 3, p. 214—“What is the Greenhouse Effect?”; **Unit 5, Chapter 10—Earth’s Air, Water, and Energy**, especially Topic 6, Lesson 1, p. 416—“Sources of Energy”; Topic 6, Lesson 2, p. 418—“How Can the Sun’s Energy Be Used?”; Topic 6, Lesson 3, p. 422—“How Can Atomic Nuclei Produce Energy?”; Topic 6, Lesson 4, p. 428—“How Can Fossil Fuels Be Used to Make Electricity?”; Topic 7, Lesson 1, p. 432—“California’s Air, Water, and Energy”; Topic 7, Lesson 2, p. 434—“What Makes California’s Air Clean or Dirty?”; Topic 7, Lesson 3, p. 440—“What Are California’s Energy Resources?”; Topic 7, Lesson 4, p. 444—“Are California’s Resource Needs Growing?”

Science Explorer, Focus on Earth Science: **Unit 4, Chapter 14—The Atmosphere**, especially Section 2, p. 446—“Air Quality”; **Unit 4, Chapter 15—Weather Factors**, especially Section 1, p. 468—“Energy in the Atmosphere”; **Unit 4, Chapter 17—Climate and Climate Change**, especially Section 4, p. 565—“Global Changes in the Atmosphere”; **Unit 5, Chapter 20—Living Resources**, especially Section 1, p. 646—“Environmental Issues”; **Unit 5, Chapter 21—Energy**

Resources, especially Section 1, p. 676—“Fossil Fuels”; Section 2, p. 683—“Renewable Sources of Energy”; Section 3, p. 693—“Nuclear Energy”; Section 4, p. 699—“Energy Conservation.”

Additional background information is available for students in the waste section of the *School DEEL Resource Manual*. This manual is available online from: www.ciwmb.ca.gov/Publications/default.asp?pubid=1142.

Teacher Preparation

The following advance preparation is required before implementing this unit:

- Locate any energy generation facilities on a regional map. This information is generally available from your local utility company (Session 1).
- Arrange for staff to answer questionnaires prior to student audits (Session 2).
- Make arrangements and obtain necessary permission for students who are monitoring traffic patterns (transportation group) to arrive early on the day of the audit (ideally, 45 minutes before school starts). (Session 3).

Session 1: Key Energy Concepts

Defining Energy Use

Ask your students to use their textbook reading to define energy. Clarify that energy is the ability to do work or produce change, and that it is involved in any and all processes, from eating, breathing, and thinking, to running computers, driving, and heating and lighting buildings.

List ways in which students use energy every day. Ask guiding questions to expand the list: How is energy used in the classroom? Was energy required to make your breakfast? How did you get to school? Where do you get the energy you need to study, talk on your cell phone, or participate in sports?

Brainstorm and record the students’ ideas regarding practices at school that might result in energy waste. Explain that this brainstorming process will be the basis for developing a hypothesis about campus energy use that they will investigate using the energy audit.

Discuss why the effects on other resources of obtaining and using energy might lead to concerns about energy use and provide reasons for minimizing energy waste and maximizing energy efficiency.

Assessment

Work with students to develop a diagram that identifies the natural and social systems, components, and relationships that connect energy use on campus and within the local community to its sources. The diagram should be used to help the students synthesize their understanding of the background information into a unified whole.

Session 2: Introduction to Audit and Survey Procedures and Protocols

Teacher Note: While students will always be under the supervision and control of a certificated employee, parental assistance (ideally, at least one parent per team) is required on the day the data collection is conducted (Session 3). It is strongly recommended that parents also attend the Session 2 orientation so they will be fully prepared to assist students during the audits. Your school energy provider or local jurisdiction may be available to help students conduct the

energy/air resources audit. Additionally, assistance for this type of program is frequently available from members of groups like the local conservation corps (www.consrv.ca.gov/DOR/grants/grant_seekers/lccc.htm), AmeriCorps, and environmental organizations.

All forms are provided in the section titled “Energy Audit Handouts and Worksheets.”

Participating students work in four groups. Three groups audit campus energy practices; the fourth group conducts a student survey to assess knowledge, attitudes, and behaviors relating to energy. All three audits and the survey are designed to take place on the same day. Data are shared so that all students end up with a better understanding of campus-wide practices.

Each of the three audit groups will assess one specific system and contribute its data to the overall energy audit. The three systems are:

- Heating and Cooling.
- Lighting and Appliances.
- Transportation.

The lighting and appliance group is further divided into three teams. Each team will be responsible for auditing lighting and appliances in one of three sites:

- Office and/or Teacher Preparation Room.
- Kitchen/Cafeteria/Lunch Area.
- Classroom(s).

Data will be collected through observations and interviews/surveys. At least one parent, under the supervision and control of a certificated employee, will work with each team.

The audit also requires gathering information from school personnel with responsibilities for managing and maintaining campus facilities. Questionnaires are provided for this purpose, or the class may design their own. Questionnaires can be completed in writing or used as the basis for interviews on the day of the audits, depending on staff availability on the audit day. If implemented as interviews, questionnaires should be distributed one week ahead of time to allow staff to prepare answers. If implemented in writing, staff should be allowed one to two weeks to complete and return the information. Written questionnaires should be completed before the other parts of the data collection are concluded. (Session 3)

Student teams completing data collection are asked to make and record general observations related to their study areas on the data collection forms provided.

After conducting the audits, two class sessions will be spent analyzing the data, making any necessary calculations, and drawing conclusions about resource patterns on campus.

Review Audit Procedures

Explain the purpose of the audit (to assess energy use on campus and identify ways to conserve resources).

Divide the students into four groups: three observation groups and one interview/survey group. Prior to Session 2, determine whether a staff member from the facilities staff will be able to meet with a student on the interview group on the day of the data collection.

Review audit procedures with each team of students.

Assign members of each group to complete the specific tasks outlined for each area. The following work plan can be used by the teacher and the students to keep track of the audit tasks.

Review Audit Protocols

Review the following rules with students:

- Observations during the data collection times must be made respectfully. Students should not make disparaging remarks or accusations or engage in name-calling.
- Observations must be made unobtrusively. Explaining the purpose of the audit or discussing your observations with students not participating in conducting the audit might influence their behaviors and make data less accurate.
- Recognize that staff members are busy and have little time to assist with the campus audits. Be respectful of their time; you will have only one class period during which to make your observations and talk with staff. Make arrangements to interview staff members and set up your meeting at a mutually convenient time. Thank them for their participation.

Distribute the Energy Audit Work Plan and the data collection worksheets to each team. With the adult assistants, allow each team to review the process outlined on their data collection worksheets and make specific plans as needed. This will include, but not necessarily be limited to, assigning specific tasks that are to be carried out on the day of the audit.

Interviews/Surveys

The survey tools that are provided can be used without alteration. The survey assesses students' knowledge and behaviors about waste as they relate to the use of resources on campus. (Note: This survey does not gather any personal data regarding students' attitudes or what they do in their homes.) If desired, the students can construct their own surveys, with the teacher taking the opportunity to teach students about validity of survey data and how to construct "good" survey questions in order to produce "useable" data.

Have students in the interview/survey group identify the staff member they will be interviewing. Review the survey instruments (or have students design them) and make sure the students understand each question.

Review the survey protocol with the students and clarify to them that they:

- Should ask the questions exactly as written.
- Must not influence the interviewee with expressions or tone of voice.
- Are required to accept and record all answers without making any judgmental comments to those they are interviewing.
- Should thank each interviewee for their time and help.

In addition, interviews are to be conducted with a minimum of 30 students who are selected at random from the student population of the whole school. Given the typical class size in the upper grades, this should mean each student is interviewing one other student at the school. (Note: Discuss concerns about selecting a biased sample for the survey. One way to randomly select students is to count students entering the cafeteria/lunch area for lunch and survey, for instance,

every 15th student. Another method of randomizing the sample might be necessary in schools where there are specific subsets of students). These interviews should take place on the day immediately preceding or following the rest of the data collection. If new survey instruments will be designed, the whole class should develop interview questions to assess student knowledge and behaviors about energy use on campus. (Note: The questions should not gather any personal data regarding student attitudes or what they do in their homes.) The students should be assigned, not selected by the other student they are to interview. Arrangements need to be made to meet at a time that is mutually beneficial to both interviewer and interviewee.

Session 3: Data Collection

Teacher Note: Because students are divided into teams that are responsible for specific tasks, the majority of this part of the audit can be conducted in one 45-minute period. Some tasks, as noted in the assignment sheets used in Session 2, require that students arrive early or work during a portion of their lunch period. A few tasks require monitoring throughout the day. These responsibilities are designed to be shared so that no one student works on the audit for more than one class period (45 minutes) on the actual audit day.

All forms are provided in the section titled “Energy Audit Handouts and Worksheets.”

Students audit three energy systems on campus: School-wide heating and cooling, lighting and appliances, and transportation, using the “Energy Data Collection” sheets to record their observations.

The heating and cooling group will use one or more classrooms as the basis for part of their audit. If more than one room is studied, results can be combined.

The lighting and appliance group will be further divided to assess energy practices in three sites: office and/or teacher preparation room, kitchen/cafeteria/lunch area, and classroom.

Accompanied by a parent, who is under the supervision and control of a certificated employee, each group will visit one site and audit energy use patterns using provided materials. The group would use a prepared questionnaire to gather information from staff. Staff can write answers in advance or students could conduct an interview during the audit, depending on availability of staff. Students should use a data collection form to guide observations during the audit itself.

Sessions 4 and 5: Data Analysis

Working in their groups or teams, students will use the data on the forms provided to compile the information they collected in the audits, interviews, and questionnaires.

When the individual teams have completed their analyses, students should compare sample bills from schools that have completed retrofitting projects to conserve energy. Comparisons will be of annual costs before and after retrofitting projects.

All forms are in the section titled “Energy Audit Handouts and Worksheets.”

Heating and Cooling

Teachers and students should review “Heating and Cooling” data from classroom observations and questionnaire responses and write two to three paragraphs that summarize your findings.

Appliances

Using the lighting and appliances data for energy use and the estimated time of use, calculate the annual use of electricity per appliance in each study area.

Using the energy data calculation form for heating and cooling, compare the amount of energy that would be used if appliances were switched to energy-saving models. Again, use the data provided and the estimated time of use to calculate the annual use of energy.

Using the energy cost calculation form, calculate the cost of energy based on the sample bill provided, calculate the annual cost of energy per appliance, and compare it to the cost savings if appliances were replaced with energy-saving models.

Lighting

Using the lighting cost calculation form, calculate the number of bulbs and the projected costs from the data provided, and calculate the energy used for lighting on campus per year. Calculate the energy and cost savings if all fixtures were changed to fluorescent bulbs. Use the percentages provided on the facilities questionnaire to determine how many fluorescent bulbs would be needed.

Transportation

Compile data from the energy data collection form for transportation. Predict changes in fuel consumption if transportation patterns were changed.

Student Survey Data Analysis

Students should tabulate survey question results and analyze them for patterns. Exact procedures depend on the survey questions.

Energy Audit Handouts and Worksheets

The following pages contain the handouts and worksheets described in this audit procedure.

Energy Audit Work Plan

Task	Time	Student(s) Responsible
Distribute facilities, office, and kitchen questionnaires to designated staff members, along with letters confirming time and date of the audit/interviews for the heating and cooling team and lighting and appliance teams. (If staff members are unable to accompany students on the audit, letter should indicate how and when the completed written questionnaire should be returned.)	1–2 weeks before the audit.	
Confirm appointment with staff members for the kitchen and office.	One week before the audit.	
Divide questionnaire questions so it is clear who will be asking which question during the heating and cooling and lighting and appliance audits/interviews.	Before the audit.	
Prepare tacky cards for particulate matter study and put them in place.	Morning before audit begins.	
Determine who will count vehicles and student riders, bicyclists, and walkers during the transportation survey.	Before the audit.	Vehicles: Bicyclists: Walkers:
Write thank-you notes to the staff and parents.	Immediately after the audit.	
Other:		

Sample Survey Guide: Interview Questions for Facilities Manager

Window Treatments and Shading

1. Are the windows single- or double-paned?
2. How are the windows used as part of the overall management of heating and cooling on campus?
3. Do the trees on campus have an impact on building temperatures?
4. How old are most of the windows on campus?

Thermostats and Timers

1. Does a thermostat control the heating/cooling system? How is the thermostat controlled?
2. At what temperature is it set?
3. Are there multiple thermostats to control different rooms or areas?
4. Are there timers?
5. How many hours per week is the heating/cooling system in use?
6. How many weeks per year is the system in use?
7. Is the system in use when students are not present?

Indoor Air Quality

1. Is indoor air quality monitored? How?
2. Do you have any specific concerns about indoor air quality?
3. Do any products used in classrooms emit volatile organic compounds (need definition)?
4. What kind of cleaning solvents are used?

Ducts and Air Vents

1. Are there adjustable air vents?
2. Are ducts routinely cleaned?
3. Are blinds cleaned?

Insulation

1. Is the heating/cooling system insulated?
2. Are walls and ceilings insulated?
3. Is the insulation made with asbestos?

Comfort Level and Noise Factor

1. Does the noise generated by the heating/cooling system pose a problem? Where?
2. Are most students and staff members comfortable with the indoor temperatures on campus? (Do you receive regular complaints?)

Lighting

1. Are incandescent light bulbs used on campus? Where? What is the average wattage? How many (and what percent of) the light bulbs on campus are incandescent?
2. How many incandescent bulbs are purchased each year?
3. Are fluorescent light bulbs used on campus? Where? What is the average wattage? How many (percentage) of the light bulbs on campus are fluorescent?
4. How many fluorescent bulbs are purchased each year?

Transportation

(Please consult your school or district fleet/transportation manager for assistance if needed.)

1. How many buses come to campus each day?
2. What kind of fuel do the buses use?
3. Does your school system provide regular maintenance and tune-ups on buses?
4. Are air filters replaced and tires kept inflated?
5. Are there adequate sidewalks for safe walking to school?
6. Are there enough crossing guards to provide safe access to campus when walking?
7. Are there bike paths leading to campus?
8. Is there adequate bike parking available?

Sample Survey Guide: Interview Questions for Office Manager

1. What office/teacher preparation room equipment requires electricity?
2. How old is the equipment?
3. Is any of the equipment designed to be energy-saving (labeled “ENERGY STAR”)?
4. Is electrical equipment kept on when not in use?
5. Are computer monitors turned off when not in use?

Sample Survey Guide: Interview questions for Kitchen Manager

1. What kitchen equipment requires electricity or gas?
2. How old is the equipment?
3. Is any of the equipment designed to be energy saving (labeled “ENERGY STAR”)?
4. Is electrical equipment kept on when not in use?
5. Do you preheat your ovens?
6. Do the ovens use gas or electricity?
7. Are there ventilating hoods or windows that can be opened during cooking time?

Energy Data Collection Form: Heating and Cooling

Use one or more classrooms to answer the following questions about heating and cooling systems on campus.

1. Can the windows be opened to help control the temperature in the room?
2. Can the blinds be adjusted to allow varying amounts of sunlight in?
3. Are the blinds closed after school to hold in heat or keep the room cooler in the evenings?
4. Are there overhangs above the windows?

Test each window and door for drafts and record your results. Create a “draft meter” by taping a piece of tissue to a pencil. Hold the meter up to the edges of the closed windows and doors. If the tissue moves, the seals on the windows are not tight. Hot or cold air can escape or seep into the room.

Window/Door Location	Are There Drafts?	
	Yes	No

Test the impact of the windows on temperature. Place thermometers in various places around the room at different distances from the windows. Draw a simple room map and indicate the placement of the thermometers. Compare and record on the map the temperatures in different locations. Describe how the windows impact the room temperature.

1. Is the room temperature generally comfortable?
2. Is noise from the heating/cooling system a problem in the room?
3. Does the room have linoleum flooring or carpeting?

Energy Data Collection Form: Lighting and Appliances

With your parent assistant and, if available, a designated staff member, visit your assigned area and answer the following questions about lighting and electrical appliances.

Question	Office/Teacher Prep Room	Kitchen/ Cafeteria/Lunch Area	Classroom
What kinds of light bulbs are used (incandescent or fluorescent)?			
Is the lighting adequate?			
Can the lights be dimmed?			
Are banks of lights controlled by separate switches?			
Are the lights left on when not in use (check during recess or lunch)?			
Are computer monitors left on when not in use?			
Is other electrical equipment left on when not in use?			

**Energy Use Calculation Form: Existing Models Compared to Energy-Saving Models
(Appliances—1)**

List Appliances Used in Each Area	Annual Energy Use of Existing Model	Annual Energy Use of Energy-Saving Model
Kitchen		
School Office		
Classroom		

**Energy Cost Calculation Form: Existing Models Compared to Energy-Saving Models
(Appliances—2)**

List Appliances Used in Each Area	Annual Cost of Existing Model	Annual Cost of Energy-Saving Model
Kitchen		
Office		
Classroom		

**Lighting Cost Calculation Form: Existing Models Compared to Energy-Saving Models
(Bulbs)**

Types of Bulbs Currently in Use	Number Used Per Year	Watts Per Bulb	Watts Per Year	Cost Per Watt	Cost Per Year
Incandescent					
Fluorescent					
Total					

IV. Water Audit Procedure

Overview

The unit requires five 45-minute class sessions, implemented as follows:

Session	Activity
1	Key Water-Related Concepts
2	Introduction to Audit and Survey Procedures and Protocols
3	Data Collection
4	Data Analysis
5	Data Analysis, continued

All audit worksheets are provided and, in order to ensure consistency with data collection, should be used as written. Each worksheet, however, includes extra space so students may add questions tailored to individual or local matters.

Relevant student reading material is available in these state-adopted textbooks:

Science Voyages—Earth Science: Unit 1, Chapter 4—Resources, especially Section 4.3, p. 104—“Water”; **Unit 2, Chapter 8—Water Erosion and Deposition**, especially Section 8.1, p. 214—“Surface Water;” Section 8.2, p. 228—“Groundwater”; **Unit 5, Chapter 14—Atmosphere**, especially Section 14.2, p. 420—“Energy from the Sun,” “The Water Cycle”

Science Voyages—Life and Physical Science: Unit 7, Chapter 23—Life and the Environment, especially Section 23.1, p. 822—“The Living and Nonliving Environment;” Section 23.3, p. 840—“Matter and Energy,” “The Water Cycle”; **Unit 7, Chapter 24—Ecosystems**, especially Section 24.3, p. 868—“Water Environments.”

Earth Science: Chapter 5—Energy Resources, especially Section 1, p. 108—“Natural Resources”; **Unit 4, Chapter 10—The Flow of Fresh Water**, especially Section 1, p. 248—“The Active River” “The Water Cycle”; Section 2, p. 255—“Stream and River Deposits”; Section 3, p. 258—“Water Underground,” Section 4, p. 263—“Using Water Wisely”; **Unit 5, Chapter 12—Interactions of Living Things**, especially Section 1, p. 306—“Everything is Connected”; **Unit 5, Chapter 13—Exploring the Oceans**, especially Section 1, p. 337—“Earth’s Oceans,” “The Ocean and the Water Cycle”; Section 5, p. 353—“Ocean Pollution.”

Science: Unit 3, Chapter 6—Energy in the Earth’s System, especially Topic 5, Lesson 3, p. 232—“What is the Water Cycle?”; **Unit 4, Chapter 8—Living Things Interact**, especially Topic 6, Lesson 2, p. 318—“What Happens to Water?”; **Unit 5, Chapter 10—Earth’s Air, Water, and Energy**, especially Topic 5, Lesson 1, p. 404—“Earth’s Water”; Topic 5, Lesson 2, p. 408—“Where Does Fresh Water Come From?”; Topic 5, Lesson 3, p. 410—“How Can Fresh Water Be Polluted?”; Topic 5, Lesson 4, p. 4—“How Can We Solve Water Problems?,” “What Can You Do?”; Topic 7, Lesson 2, p. 437—“Does California Have Enough Water?,” “How Can We Protect California’s Water?”; Topic 7, Lesson 4, p. 444—“Are California’s Resource Needs Growing?”

Science Explorer, Focus on Earth Science: Unit 3, Chapter 9—Earth: The Water Planet, especially Section 1, p. 268—“How Is Water Important?”; Section 3, p. 284—“The Water Cycle”; **Unit 3, Chapter 10—Fresh Water**, especially Section 1, p. 294—“Streams and Rivers”;

Section 5, p. 320—“Water Underground”; **Unit 3, Chapter 11—Freshwater Resources**, especially Section 1, p. 332—“Water to Drink”; Section 2, p. 342—“Balancing Water Needs”; Section 3, p. 349—“Freshwater Pollution”; **Unit 5, Chapter 19—Ecosystems and Biomes**, especially Section 2, p. 613—“Cycles of Matter”; **Unit 5, Chapter 20—Living Resources**, especially Section 1, p. 646—“Environmental Issues”; Section 3, p. 659—“Biodiversity.”

Additional background information is available for students in the waste section of the *School DEEL Resource Manual*. This manual is available online at the CIWMB’s website: www.ciwmb.ca.gov/Publications/default.asp?pubid=1142.

Teacher Preparation

The following advance preparation is required before implementing this unit:

- Obtain a regional map and be able to identify the local watershed. This information can be obtained from the local water district and is usually available online. (Session 1)
- Determine the source of your local water supply. This information can be obtained from the local water district and is usually available online. (Session 1)
- Obtain a storm water drain map from the local county jurisdiction (public works, sanitation, or county), if available, to show where water leaving the campus flows. (Session 1)
- Prepare a simple campus map, or modify an existing one, to indicate locations of buildings, pavements, lawns, and other major features. Students will use this template to document water flow on campus. (Session 2)
- Locate and identify all campus restrooms so they can be assigned to student monitoring teams. (Session 2)
- Identify staff members who can accompany students on grounds and kitchen/cafeteria/lunch area visits. (Session 3) Note: If staff members can accompany student teams on the day of the audit, the staff questionnaire will be completed as an interview. Questions will be provided ahead of time. If no staff members are available for the audit, staff should be asked to complete the questionnaire in writing and return their answers to the students before the day of the audit. (Session 2)
- Obtain plastic measuring cups for measuring leaks. (Session 4)

Session 1: Key Water-Related Concepts

Water as a Resource

Students list ways in which students use water on campus on a daily basis. Prompt additional responses by citing specific areas of campus (restrooms, landscaping, kitchen, and athletic facilities) in which water is used.

Students identify sources of water used on campus, such as municipal water supply and rainfall.

Assign student teams to various areas of the school campus and have them complete the Signs of Water Use and Waste form.

Ask students what other organisms depend on water and in what ways.

Water Quantity

Ask students whether water is a renewable, nonrenewable, or inexhaustible resource and the reasons that they categorize it in this way. (*renewable*)

Review the water cycle with students (evaporation, respiration, transpiration, and precipitation). Ask what energy source powers the water cycle (the sun).

Ask students, “If the amount of water on Earth is unchanging, how can there be water shortages?”

Have students identify ways in which people’s actions might influence the water cycle (paving areas prevents water from percolating into the soil; extracting water from underground sources [groundwater] changes the level of the water table; paving stream channels and building dams or reservoirs influences where and when water flows).

Water Flow

Explain where water goes when it flows over land. (Normally, water seeps into the ground, replenishing groundwater supplies. If surfaces are paved, or if water is flowing faster than the ground can absorb, water flows on the surface as runoff. This water could carry with it any pollutants picked up from the areas over which it travels.) Point out the effects on the water cycle of permeable surfaces (composed of material that water can drain through) and impermeable surfaces (composed of material that water cannot drain through).

Ask student to identify where their water comes from and how they think it gets there. What process does it follow from there to the tap at school?

Ask where water goes when it enters a sink or toilet drain. (Sinks and toilets generally carry water to the municipal wastewater system, where it is treated before being released back to a natural body of water. If some of your students have septic systems where they live, you may want to additionally explore where that water goes.)

Discuss where water goes when it goes down a storm drain. (Storm drains and other drains carry water directly into natural systems without treatment. This water could carry with it any pollutants picked up from the areas over which it travels.)

Consider and record reasons why water quality and quantity are important to every student and other living organism.

Assessment

Work with students to define a watershed and develop a diagram that identifies the natural and social systems, components, and relationships that connect water quality and water quantity on campus and within the local community to their sources. The diagram should be used to help the students synthesize their understanding of the background information into a unified whole.

Session 2: Introduction to Audit and Survey Procedures and Protocols

Teacher Note: While students will always be under the supervision and control of a certificated employee, parental assistance (ideally, at least one parent per team) is required on the day the audit is conducted (Session 3). It is strongly recommended that parents also attend the Session 2 orientation so they will be fully prepared to assist students during the audits. Your local water district or the regional office of the State Water Resources Control Board may be available to help students conduct the water audit. Additionally, assistance for this type of program is frequently available from members of groups like the local conservation corps

(www.consrv.ca.gov/DOR/grants/grant_seekers/lccc.htm), AmeriCorps, and environmental organizations.

All forms are provided in the section titled “Water Audit Handouts and Worksheets.”

Participating students work in four groups. Three groups audit campus water practices; the fourth group conducts a student survey to assess knowledge and behaviors relating to water use and conservation practices on campus. All three audits and the survey are designed to take place on the same day. Data are shared so that all students end up with a better understanding of campus-wide practices.

Each of the three audit groups will assess one specific site and contribute its data to the overall water audit. The three sites are:

- Kitchen/cafeteria/lunch area.
- Restrooms.
- Grounds.

Data will be collected through observations and interviews/surveys. At least one parent, under the supervision and control of a certificated employee, will work with each group.

The audits also require gathering information from school personnel with responsibilities for managing and maintaining campus facilities. Sample questionnaires are provided for this purpose, but students can also design their own, with the teacher taking the opportunity to instruct students in survey design. Questionnaires can be completed in written form or implemented as interviews on the day of the audit. If responding in writing, staff should be allowed one to two weeks to complete and return the information. Written questionnaires should be completed before students conduct the audits. (Session 3)

In addition to requiring that students collect data, teachers may choose to ask student teams to make and record general observations related to the students’ areas. Guiding questions are on the data collection forms.

After conducting the audits, two class sessions will be spent analyzing the data, making any necessary calculations, and drawing conclusions about resource practices on campus.

Review Audit Procedures

Explain the purpose of the audit (to assess the quantity and quality of water use on campus and identify possible ways to conserve resources).

Divide the students into four groups: three audit groups and one interview/survey group. Prior to Session 2, determine whether a staff member from the kitchen/cafeteria/lunch area and grounds-keeping will be able to meet with a student team on the day of the audit.

Review Audit Protocols

Review the following rules with students:

- Observations made during the data collection times must be made respectfully. Students should not make disparaging remarks or accusations, or engage in name-calling.
- Observations must be made unobtrusively. Explaining the purpose of the audit or discussing your observations with students not participating in conducting the audit might influence their behaviors and make data less accurate.

- Recognize that staff members are busy and have little time to assist with the campus audits. Be respectful of their time; you will have only one class period during which to make your observations and talk with staff. Make arrangements to visit campus facilities ahead of time and set up your meeting at a mutually convenient time. Take only one class period. Thank them for their participation.

Distribute the Water Audit Work Plan and recording sheet (Signs of Water Use and Waste) to each team. With the adult assistants, allow each group to review the process outlined on the audit worksheets and make specific plans as needed. This will include, but not necessarily be limited to, assigning specific tasks that are to be carried out on the day of the audit.

Interviews/Surveys

The survey tools that are provided can be used without alteration. The survey assesses students' knowledge and behaviors about water use as they relate to resources on campus. (Note: this survey does not gather any personal data regarding students' attitudes or what they do in their homes.) If desired, the students can construct their own surveys, with the teacher taking the opportunity to teach students about validity of survey data and how to construct "good" survey questions in order to produce "useable" data.

Have students in the interview/survey group determine the staff member they will be interviewing. Review the survey instruments (or have students design them) and make sure the students understand each question.

Review the survey protocol with the students and clarify to them that they:

- Should ask the questions exactly as written.
- Must not influence the interviewee with expressions or tone of voice.
- Are required to accept and record all answers without making any judgmental comments to those they are interviewing.
- Should thank each interviewee for their time and help.

In addition, students should conduct interviews with a minimum of 30 students who are selected at random from the student population of the whole school. Given the typical class size in the upper grades, this should mean each student is interviewing one other student at the school. (Note: Discuss concerns about selecting a biased sample for the survey. One way to randomly select students is to count students entering the cafeteria/lunch area for lunch and survey, for instance, every 15th student. Another method of randomizing the sample might be necessary in schools with specific subsets of students).

These interviews should take place on the day immediately preceding or following the rest of the data collection. If the teacher and students want to design new survey instruments, the whole class should develop interview questions to assess student knowledge and behaviors about water use on campus. (Note: The questions should not gather any personal data regarding student attitudes or what they do in their homes.) The interviewee should be assigned to, not selected by, the interviewer. Both should make arrangements to meet at a mutually beneficial time.

Session 3: Data Collection

Teacher Note: Because students are divided into teams that are responsible for specific tasks, the majority of this audit can be conducted in one 45-minute period. Some tasks, as noted in the assignment sheets used in Session 2, require that students arrive early or work during a portion of

their lunch period. A few tasks require monitoring throughout the day. These responsibilities are designed to be shared so that no one student works on the audit for more than one class period (45 minutes) on the actual audit day.

All forms are provided in the section titled “Water Audit Handouts and Worksheets.”

Students will audit quantity of water in each of three sites: kitchen/cafeteria/lunch area; restrooms; and grounds. Quantity issues include efficiency of equipment, leaks, and behaviors such as letting water run while washing dishes.

Accompanied by a parent who is under the supervision and control of a certificated employee, each group will visit one site and audit water use patterns using provided materials. Students will use a prepared questionnaire to gather information from a staff member. Answers can be written out in advance, or an interview can be conducted during the audit, depending on the availability of staff. The students will use a data collection form to guide observations during the audit.

The teacher should further divide the restroom group so that each small team monitors sink use in one restroom, during the lunch period.

The teacher can also further divide the grounds group so that each small team maps a specific area. This is necessary only if there are multiple outdoor areas with watering systems or where water is used for cleaning purposes.

Sessions 4 and 5: Data Analysis

All forms are in the section titled “Water Audit Handouts and Worksheets.”

Working in their teams and groups, students will compile the data they collected in the audits, interviews, and questionnaires.

To determine rate of flow, turn the faucet on to a normal flow. Then figure out how long it takes to fill a 1-gallon bucket. If a 1-gallon bucket does not fit, use a smaller container and calculate the flow per gallon. Measure one sink per restroom.

Calculate the average length of time per hand-washing. Multiply this amount by the flow rate to determine average water use per hand-washing.

To measure the rate of water loss from a leak, allow drops from the leak to collect in a plastic measuring cup for five minutes. Record the amount of water collected in five minutes. (Note: If your leak is so fast that the container overflows in five minutes, or so slow that you can't measure the amount of water, adjust your time accordingly.)

Water Use by Existing Equipment

Using the appropriate form (Amount of Water Used by Existing Equipment), calculate the amount of water used by existing equipment per day and per year. Also compute and compare to the amount that would be used if the school were to switch to water-saving devices as indicated on the usage chart provided.

Students should use the Costs of Water Use on Campus form to calculate the cost of water, obtain costs of water, and calculate the annual cost of water used on campus, based on the sample bill provided.

Water Costs Resulting From Dripping

If students identified any dripping faucets or hoses, they should calculate the average rate of loss from leaks using this process:

- Find the average rate of loss from all identified leaks (five-minute measurements).
- Multiply by 12 to obtain an average hourly rate of loss.
- Multiply by the total number of dripping faucets/hoses to obtain water lost per hour.
- Multiply by the number of hours per school day to measure daily loss.
- Multiply by the number of days in the school year to measure average annual loss from leaks.

Using the Drip Calculation Form, and based on the sample bill provided, students should estimate the cost of water lost due to drips.

Potential Water Cost Savings

Using information provided on water-saving equipment, calculate the amount and cost of water that could be saved annually in the kitchen if water-saving equipment was installed and any drips/leaks fixed.

Subtract the cost of the replacement equipment to show overall savings.

When the individual teams have completed their analyses, students will compare sample bills from schools that have completed retrofitting or other water management projects to conserve water. Comparisons will be of annual costs before and after retrofitting.

Student Survey Data Analysis

Students will tabulate survey question results and analyze them for patterns. Exact procedures depend on the survey questions (which may have been student-designed).

Water Audit Handouts and Worksheets

The following pages contain the handouts and worksheets described in this audit procedure.

Water Audit Work Plan

Task	Time	Student(s) Responsible
Distribute kitchen and grounds questionnaires to designated staff members, with a letter confirming time and date of the audit and interview. (If staff members are unable to accompany students on the audit, the letter should indicate how and when they should complete and return the written questionnaire.)	1–2 weeks before the audit.	
Divide questions on the questionnaire so it is clear who will be asking each question during the audit and interviews.	Before the audit.	
Assign observers in each group to answer any additional questions on data collection forms.	Before the audit.	
Prepare the restroom group to anonymously record the number of times they personally use the restroom (flush toilet or urinal) during the audit day.	Before the audit.	
Divide the restroom group into teams and assign each team one specific restroom to monitor for sink use (see next step).	Before the audit.	
Monitor restroom sinks. Track and record data on number of uses, length of time water is running, and whether water is left running or turned off while students lather their hands.	10-minute shifts throughout the lunch period on the day of the audit, starting 5 minutes before lunch period and remaining 5 minutes after lunch.	Shift 1: Shift 2: Shift 3: Shift 4: Shift 5:
Assign members of the grounds group to specific areas if the campus is large enough to warrant breaking into teams.	Before the audit.	
Write thank-you notes to the staff and parents.	Immediately after the audit.	

Signs of Water Use and Waste

Area # _____

Description of area: _____

Evidence of water use in the area: _____

Using the campus map provided by your teacher, map water distribution in your area with assistance from a staff member and parent assigned to your group. Mark all water distribution points, such as sprinklers, hoses, and outdoor faucets.

Indicate all areas that require water (landscaping, playing fields, gardens, swimming pools).

Indicate all areas from which water drains (paved surfaces such as parking lots, sidewalks, and driveways), playgrounds, and buildings.

Leaks

Do you observe:

- Drips?
- Dark spots around pipes?
- Corroding tiles?

Over-, Uneven, or Unnecessary Watering

Do you observe:

- Brittle leaves on trees?
- Wilted young shoots?
- Constantly damp soil?
- Fungus and mushrooms?
- Water flowing in gutters?
- Dry spots?
- Irregular grass height?
- Puddles?
- Flowing water on sidewalks or floors?

Sample Survey Questionnaire: Water Questions for Kitchen Manager

Washing Dishes

1. Do you use a dishwasher?

If yes:

- How often do you run the dishwasher each day?
- Is the dishwasher always run with full loads of dishes?
- How much water is used (in gallons) each time the dishwasher is run?
- Is the equipment relatively new and designed to conserve water?
- Is it checked regularly for leaks?

If no:

- How are dishes and cooking equipment washed?

Ice Maker

2. Do you use an icemaker?

3. How much water is used (in gallons) each time the icemaker is used?

4. How many times per day is the icemaker used?

5. Is the equipment relatively new and designed to conserve water?

6. Is it checked regularly for leaks?

Sinks and Faucets

7. How many faucets are in use in the kitchen?

8. Are they checked regularly for leaks?

9. Are any of the faucets hard to turn off completely?

10. How are the faucets used? Do they run continuously when washing or rinsing dishes or food?

11. Can you estimate how long the faucets run per day?

12. What is the rate of flow? (Students can conduct a rate flow test if this isn't documented.)

Water Quality

13. What substances are disposed of through the sink or floor drains or garbage disposal?

14. How is grease disposed of? (Is it dumped down a regular drain or a grease disposal?)

15. What substances are used for cleaning in the kitchen?

General

16. What improvements would you make to the school's water management system?

Sample Survey Questionnaire: Water Questions for Facilities Manager

1. How many gallons per flush do the toilets use?
2. Are the toilets relatively new and designed to conserve water (low flow or normal flow)?
3. Are they set to use the lowest effective amount of water?
4. Are the urinals low-flow, normal-flow, or constant water flow types?
5. How many gallons per flush do the urinals use?
6. Are they set to use the lowest possible amount of water?
7. Are the faucets traditional or low-flow?
8. What is the flow rate of the faucets?
9. Are they set to use the lowest effective amount of water?
10. Is the restroom equipment kept in good working order?
11. Is it checked regularly for leaks?
12. What substances are used for cleaning in the restrooms?
13. How are these substances disposed of?
14. What improvements would you make to the school's water management system?

Sample Survey Questionnaire: Water Questions for Groundskeeper

1. How often are grounds watered?
2. When are grounds watered (time of day)?
3. How do you determine where and when to water?
4. Is the schedule adjusted during the rainy season?
5. Is the turf ever aerated?
6. Does the staff monitor the irrigation system for efficiency and problems?
7. How are paved surfaces cleaned?
8. Is rainwater collected?
9. If yes, is the collected water used on campus? For what purpose(s)?
10. If the school has a swimming pool, are any steps taken to reduce evaporation?
11. Are any chemicals (pesticides, herbicides, fertilizers) used to manage the grounds?
12. If yes, what chemicals?
13. What improvements would you make to the school's water management system?

Water Data Collection Form: Restrooms

Location _____

1. Does the equipment appear to be in good working order?
2. Is any of the equipment dripping?
3. Are there any signs of leaks? If the toilets have tanks, check for leaks using food coloring. Add food coloring to the toilet tank. Wait 15 minutes. If the bowl water is colored, there is a leak.

Toilet Monitoring

Each team member should count the number of times they personally use the restroom on campus (flush toilet or urinal) during the audit day. They should then determine the total number of uses for the entire group being studied and calculate the average number of uses per student.

Team Member (do not record names)	Number of Flushes During School Hours on Day of the Audit
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total number of students:	Total number of flushes:
Average number of flushes per student:	

Sink Monitoring

During lunch, working in 10-minute shifts, students should count the number of people who wash their hands. Using a stopwatch or a watch with a second hand, students should record the time it takes each student to wash their hands. They should also check whether the water is left running while the student lathers up.

Sink Monitoring		
Number of Times Sink is Used	Length of Use	Was water left running while student washed?

Water Data Collection Form: Grounds/Stormwater Management

Location: _____

1. Do see any drains, gutters, or any other stormwater management tools?
2. Do you see any dry-weather runoff (water flowing over paved areas on a dry day)?
3. What are the sources of the runoff? Rain? Lawn watering? Surface cleaning? Other?
4. Where does the runoff go when it leaves campus?
5. Use the campus map provided to mark where the storm drains near campus are.

Use the map to mark any areas in which you observe erosion due to runoff.

School Grounds Map



Amount of Water Used by Existing Equipment

	Amount Used Per Day With Existing Equipment (Multiply gallons per use by number of uses per day)	Amount Used Per Day With Water-Saving Models (Multiply gallons per use by number of uses per day)	Amount Used Per Year With Existing Equipment (Multiple by 180, the number of days in the school year)	Amount Used Per Year With Water-Saving Models (Multiple by 180, the number of days in the school year)
Kitchen				
Dishwasher				
Ice Maker				
Sinks/Faucets (if available)				
Restrooms¹				
Toilets				
Urinals				
Sinks				
Grounds (if applicable)				
Watering lawns, playing fields				
Cleaning				

¹ Compute the average number of uses per person based on the restroom team data, and multiply by number of students in the school and based on the average use per hand-washing calculated during the audit. Base the estimates on the same number of toilet uses per person and multiply by number of students in the school.

Costs of Water Use on Campus

	Amount Used Per Day	Cost Per Day	Amount Used Per Year	Cost Per Year
Kitchen				
Dishwasher				
Ice Maker				
Sinks/Faucets (if available)				
Restrooms				
Toilets				
Urinals				
Sinks				
Grounds (if applicable)				
Watering lawns, playing fields				
Cleaning				

Drip Calculation Form

	Amount Lost to Drips Per Day	Cost of Loss Per Day	Amount Lost to Drips Per Year	Cost of Loss Per Year
Kitchen				
Dishwasher				
Ice Maker				
Sinks/Faucets (if available)				
Restrooms				
Toilets				
Urinals				
Sinks				
Grounds (if applicable)				
Watering lawns, playing fields				
Cleaning				

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