UNIVERSITY OF CALIFORNIA
Santa Barbara

GREENING UCSB: DEVELOPMENT OF AN ASSESSMENT PROTOCOL AND POLICY STATEMENT TO IMPROVE CAMPUS SUSTAINABILITY

A Group Project submitted in partial satisfaction
of the requirements for the degree of

Master's in Environmental Science and Management

for the

Donald Bren School of Environmental Science & Management

by

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Greening UCSB: Development of an Assessment Protocol and Policy Statement to Improve Campus Sustainability

As authors of this Group Project report, we are proud to archive it in Davidson Library so the results of our research are available for all to read. Our signatures on the document signify our joint responsibility to fulfill the archiving standards set by Graduate Division, Davidson Library, and the Donald Bren School of Environmental Science & Management.

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This mission of the Donald Bren School of Environmental Science & Management is to produce professionals with unrivaled training in environmental science and management who will devote their unique skills to the diagnosis, assessment, mitigation, prevention, and remedy of the environmental problems of today and the future. A guiding principal of the School is that the analysis of environmental problems requires quantitative training in more than one discipline and an awareness of the physical, biological, social, political, and economic consequences that arise from scientific or technological decisions. The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

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Professor Jeff Dozier

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Dean Dennis Aigner

April 2001

DEDICATION

When we first embarked on this project, we had no real inkling of the complexities of the organism that is UCSB. Like most students, we were unaware of the tremendous amount of equipment and resources required to make the campus run. Nor did we have any concept of the number of creative and dedicated people who work behind the scenes to bring the campus to life. In many ways the real work involved in making a sustainable campus will rest on their shoulders, and will come from their hearts. We are indebted to them for all of their patient help with our research for this project, and for the jobs they do everyday to make our education possible. It is to them that we dedicate this report.

ACKNOWLEDGEMENTS

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GREENING UCSB: DEVELOPMENT OF AN ASSESSMENT PROTOCOL AND POLICY STATEMENT TO IMPROVE CAMPUS SUSTAINABILITY

Group Members
Tarlie Harris, Jeff Meiser, Heather Rosenberg and Autumn Salamack

Faculty Advisor
Professor Jeff Dozier

This project provides a framework for increasing the sustainability of UCSB and the UC system, and is composed of two core components: an environmental assessment and a policy framework. The environmental assessment contains both an environmental survey of campus operations and an analysis of the subsequent findings in six core areas: building design, energy, waste management, air quality and transportation, water management and landscape management. The results of this assessment were then converted into a subjective grading scheme to identify the progressiveness of each campus sector and to provide recommendations for improvement. The final component of this report, the policy framework, contains a draft policy statement on sustainability and a feasibility study for policy adoption. The policy framework identifies both institutional and external barriers to campus sustainability and provides a sense of the feasibility of the adoption and implementation of such a policy at UCSB. This framework is transferable to other universities as a model for hands-on application of sustainability principles. It is our hope that this work will spur a dedicated commitment to sustainability by the UC system and result in improved environmental performance.

EXECUTIVE SUMMARY

Introduction

The design and construction of *Bren Hall* may herald a new era of sustainability for the University of California, Santa Barbara and the UC system. This "green" building incorporates the fundamental principles of sustainability: waste minimization, conservation of the natural environment and minimization of resource consumption. However, the Bren building represents only one building on a campus with many buildings, in a system of nine campuses. Thus, the greening of *Bren Hall* is important and useful only if the lessons learned apply to the UCSB campus and the UC system in general. Two important questions arise: (1) What is the overall environmental performance of the campus? (2) How do we adhere to these principles of sustainability, whose definitions and metrics change over time? With these questions in mind, *Greening UCSB* was commissioned as a graduate project for the Bren School of Environmental Science and Management.

Bren Hall has opened a window of opportunity for the University to address the issue of campus sustainability. The University educates not only in the classroom, but also through physical and social interactions within and outside the campus community. Therefore, the University is uniquely positioned to influence the behaviors and values of individuals both on campus and in the surrounding community by demonstrating its commitment to sustainability. UCSB is located in the center of a diverse and sensitive ecological area that is surrounded by wetlands and coastal bluffs and impacted by the large number of people and the range of activities carried out on campus. Thus, actions taken by the University can have important implications for the surrounding habitat.

In addition to environmental benefits, campus greening efforts often result in substantial cost savings, although in many cases, substantial capital investments are required. The principles of sustainability must become a focus of campus operations and policy for the campus to realize concurrent environmental and economic benefits. Greening efforts will require changes in campus planning, operations, and practices. Increased spending associated with these changes can be justified in two ways:

- Technology that is more efficient results in lower operating and maintenance costs over time. When initial design and construction costs are the primary consideration, inefficient design, materials or equipment may be chosen to ensure that projects remain within allotted budgets. However, life cycle cost analysis validates investment in more efficient options that conserve both financial and environmental resources.

- Universities have a responsibility to promote social welfare. The mandate of a university is to invest in the future through research, education and training. Efforts to increase sustainability complement this mandate.

We structured this report to highlight the environmental and economic impacts associated with campus operations, and to identify targets and means for improvement. This report consists of two core components: a comprehensive environmental assessment and a policy framework.

Comprehensive Environmental Assessment

The environmental assessment contains both an environmental survey of campus operations and an analysis of the subsequent findings. The survey is composed of a series of questions and answers centered on the principles of sustainability that characterize campus operations in six key areas: Building Design, Energy Use, Waste Management, Air Quality and Transportation, Water Management and Landscape Management. The analysis evaluates the environmental performance of UCSB and makes recommendations for improvement. The information obtained from the assessment provides baseline data that can be used for future evaluations and serves as the justification for potential changes in policy and operations. The indicators of sustainability that surface in this assessment are consistent with previous research done on campus sustainability.

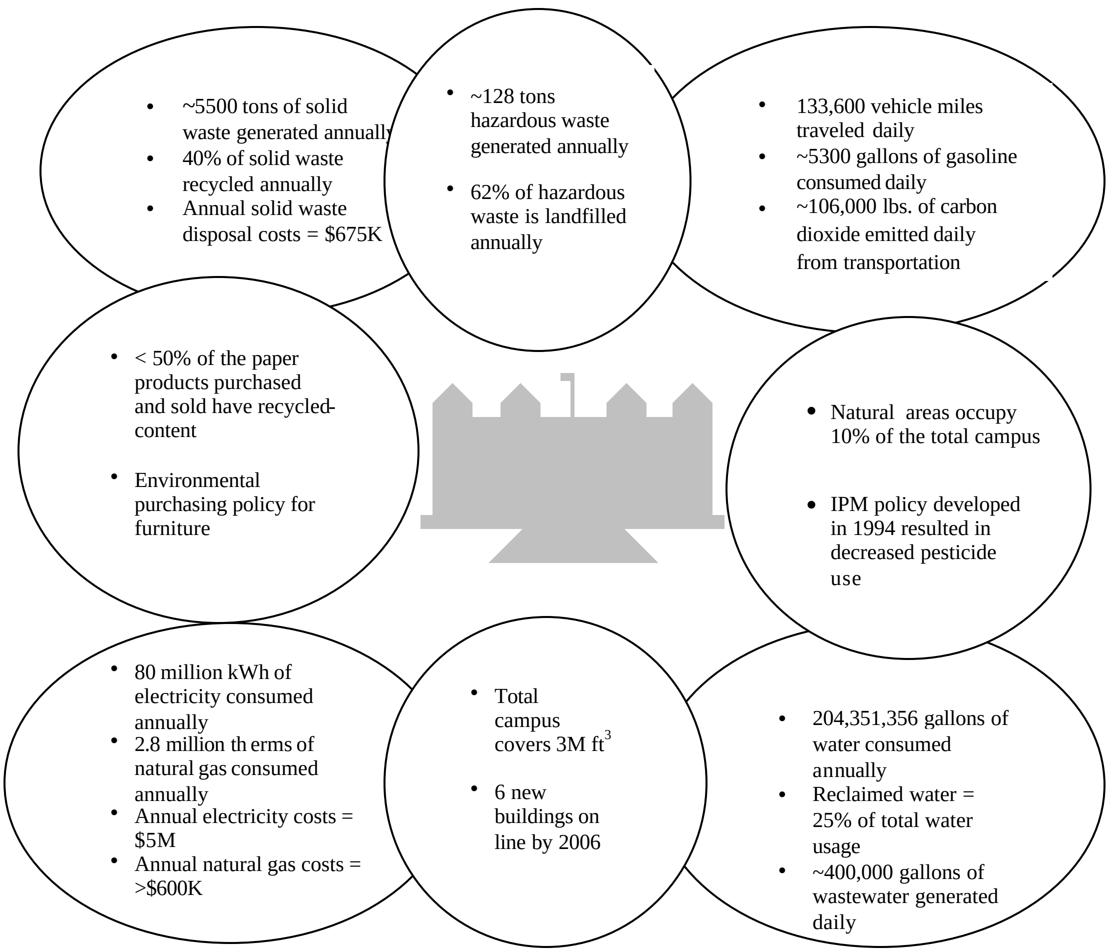
These indicators surfaced from our environmental assessment and were put into a 'test' format. This 'test' used a binary grading scheme (yes or no), so that if the indicator was present on campus, it received a point, and if it was not present it did not receive a point. The percentage of indicators present on campus correlated to a grade, which was then assigned to each key area of campus operations. We designed this indicator framework for determining the level of sustainability on a college campus to be flexible and adjustable for changing priorities in evaluating environmental responsibility. In addition, this framework is transferable to other institutions. It is important to recognize that our evaluative indicators used in this report are oriented towards determining a measure of *proactive* efforts to embrace sustainability that are currently underway on campus. The absence of these efforts does not that mean that the campus is a poor environmental performer; rather, it suggests that the campus is not especially progressive in incorporating the principles of sustainability into operations.

Policy Framework

The policy framework contains a draft policy statement on sustainability and a feasibility study for policy adoption. The draft policy statement identifies overarching goals of campus sustainability, identifies corrective actions the University could undertake to improve the "trouble areas" identified by the environmental assessment, and serves to generate discussion of such issues at all levels of the University. The feasibility study contains a brief analysis of institutional and external barriers to campus sustainability and provides potential strategies for overcoming these barriers. This framework is transferable to other universities as a model for hands-on application of sustainability principles.

Campus Assessment Results

The campus has noted an increase in resource use in all campus sectors over the past decade. The major quantitative and qualitative findings from our environmental survey are listed below by campus sector. The figure below describes quantitative findings. A qualitative analysis of the assessment follows.



Environmental survey results: Quantitative summary of campus environmental performance

Building Design

Since the establishment of the Bren project, the Office of Design and Construction has added a statement to all "requests for qualifications" from architects expressing the campus's commitment to sustainability. Several upcoming new building projects, including the new engineering and life sciences buildings, will incorporate green building features. However, demand for green features in these projects has come from the future occupants; no current policies mandate green building practices. A campus wide commitment to sustainability is required to ensure that greening efforts will continue in a cost-effective manner on all future campus projects.

Energy

The campus Energy Team has been working to reduce energy demand and to maximize the efficiency of campus systems. However, more could be done to limit the overall environmental impact of the campus from energy use by continuing investment in system upgrades, increasing investment in on-site co-generation through alternative sources (solar, wind and fuel cells), providing training to staff on the proper use of efficiency equipment, and increasing user awareness on ways to limit energy demand. Energy Team staff can also increase their involvement in the building design process to ensure that energy efficiency is incorporated into all new campus structures. In order for full energy savings to be realized, investment in energy projects must be prioritized.

Waste Management

Solid Waste and Recycling

UCSB has focused intensively on recycling efforts, with only a minimal effort directed towards source reduction. The University could work to alleviate the environmental and financial costs associated with solid waste disposal by: maximizing paper reuse, establishing a formal budget for the recycling program, increasing the use of recycled paper on campus, and undertaking a massive source reduction campaign. In addition, substantial source reduction could allow the University to reclaim a significant share of its $675,000 annual costs for solid waste disposal.

Hazardous Waste

The University has implemented a hazardous waste reduction program, although a vital component of this program, the Chemical Exchange Program (CEP), has been stymied due to a lack of funding. The University could decrease impacts associated with hazardous waste by: seeking means for fully developing the CEP and the accompanying on-line hazardous waste management program, reviewing the current hazardous waste pick-up system, developing a tracking system for wastes exiting the system, and providing guidelines and management for hazardous waste and chemical purchases to ensure that no more is purchased than is actually needed.

Purchasing

Improved environmental performance could be achieved with respect to all University purchases by: incorporating environmental/sustainable criteria into purchasing contracts, devising minimum recycled content criteria for all University emblematic paper products, contacting suppliers to gain awareness of recycled content product offerings beyond paper, and increasing education of University personnel. In addition, cost savings on recycled content products could be realized via membership in the Recycled Products Purchasing Cooperative.

Transportation and Air Quality

The parking and transportation department at UCSB has a well-developed *Transportation Alternatives Program* (TAP) to provide alternative commuting options for UCSB faculty, staff, and students. Participation in TAP has been steadily increasing over the past few years. However, the two necessary aspects of environmentally friendly transportation policy on campus – influencing individual behavior from the bottom up (TAP) and setting campus priorities from the top down (Budget and Planning) – are not well coordinated. The environmental impact of transportation to/from UCSB could be reduced through revised parking permit designations, pertinent use of the permit revenues to subsidize alternative transportation, an employee and student MTD subsidy, a stabilized TAP budget and administration, and coordinated efforts between TAP and campus budget and planning to curb single occupancy vehicle commuting to/from campus.

Water Management

Water Use

Water conservation is acknowledged as an important campus goal of Facilities Management but is not encoded in specific policy directives. Possible improvements in water management include reducing or ending the use of potable water for irrigation, tracking water use by building and by use categories to identify areas for improvement, ensuring the use of water efficient appliances in all new buildings, and developing a schedule for retrofitting all existing water appliances.

Water Pollution

Storm water runoff is generated in unknown quantities with an unknown environmental impact on local ecosystems. Storm water, which is primarily untreated, runs directly into the Pacific Ocean, Campus Lagoon, and Goleta Slough. UCSB established an integrated pest management policy (IPM) in 1995, which reduced pesticide use on campus. UCSB could further reduce its environmental impact by assessing and treating the water quality effects of storm water runoff.

Landscape Management

UCSB is a highly developed campus, with only 10% remaining as natural areas. Landscaped portions of campus are populated by a wide variety of native and exotic plant species. There is no campus policy guiding the vegetative components of campus; rather, the "taste" of the campus is determined on a project-by-project basis. Improvements in landscape management could be made by establishing a set of criteria for new projects, developing a long-term vision for the campus landscape, and increasing cooperation with local conservation groups to integrate UCSB natural areas with the regional ecology.

Campus Environmental Report Card

Using the binary grading scheme previously described, we evaluated each key campus sector and obtained the following grades measuring campus environmental performance.

Campus environmental report card

Sector	Grade
Building Design	C
Energy Use	B-
Waste Management	C-
Air Quality & Transportation	C+
Water Management	D
Landscape Management	C-

The Policy Statement

The final component of our report is a draft policy statement and a general feasibility study for increasing the sustainability of University operations. The draft policy provides language to make sustainability a core priority of the campus and identifies ways that this priority can be incorporated into all campus operations. In the process of conducting our campus audit, it became clear that any sustainability goals met on a project-by-project basis result mainly from the effort of dedicated staff members, rather than from a broad campus initiative or intent. Assurance that sustainability measures will continue to be maximized and prioritized over time requires a comprehensive top-down/ bottom-up policy.

Our goal is to offer a springboard for the development of such a campus-wide sustainability policy to be adopted by the Chancellor and Academic Senate. The policy statement addresses energy conservation, building design, water conservation, waste minimization and alternative transportation, and provides a starting point for implementing ideas and creating departmental procedures. The draft was discussed with several key personnel in the upper and lower tiers of the University to determine the feasibility of such a policy at UCSB. By evaluating assessment and policy on a campus-wide scale, we add to the growing body of campus greening literature and develop a model for the hands-on application of sustainability in other large institutions.

Conclusion

Our study of the environmental performance of UCSB highlights two major trends: (1) an increased use of our natural resources, waste generation, and pollution of the environment, and (2) the development of important innovations in some areas of campus operations. These innovations, such as the IPM policy, the use of reclaimed water, the formation of the Energy Team and the Recycling Committee, and the TAP program, have all had positive impacts on campus sustainability. We hope that these innovations mark the beginnings of a campus-wide move toward sustainability. However, to date, the first trend has been dominant. As a result, UCSB scored fairly low marks on our sustainability scorecard: one B-, one C+, one C, two C-'s, and one D. Individuals with a vision of cost savings, efficient operations and environmental performance are leading the progressive effort toward sustainability. However, their ability to significantly increase the sustainability of the campus is severely hampered by a lack of overall, institutional support. We have identified two core institutional barriers to sustainability at UCSB:

- **Lack of a clear commitment to sustainability**. There currently exists no clear commitment to sustainability in the institutional framework of the University, as is demonstrated by the absence of a policy statement on sustainability. Although efforts undertaken by individuals within the University are important for initiating and sustaining environmental initiatives, they cannot replace a commitment from the president or chancellor of a university (Smith, 1993).

- **Lack of funding for environmental technologies and initiatives**. Funding is a clear barrier to sustainability efforts, given that more efficient technologies generally have higher up-front costs. For example, conservation projects must compete with capital projects (i.e. new buildings, parking lots) for funding and are rarely given priority. However, this report demonstrates that installing such equipment and funding environmental initiatives can result in drastic savings over time. The need to fully consider life-cycle costs should thus become a core component of all campus operations.

It is our contention that these barriers will continue to hinder sustainability efforts on campus unless adequately dealt with. Our policy statement provides a building block for addressing these issues by establishing sustainability as a priority in all campus operations. Adopting this policy statement may have repercussions beyond the UCSB campus, given that UC Santa Barbara may serve as a model for the entire UC system. In addition, a new UC campus will be completed in 2004 in Merced. This policy statement could have a profound influence on the sustainability of this campus by ensuring green building design, an environmentally friendly campus lay out and the installation of the most efficient equipment right from the start.

The University of California, Santa Barbara is facing a choice that is analogous to the famous poem by Robert Frost: *The Road Not Taken*. Two roads *do* diverge ahead of us, one path leads to an acknowledgement of our responsibility to both present and future generations to take action to protect our natural resources and establish a society that is truly sustainable. The other is the well-worn path resistant to change, leading to a future of dwindling resources and possible drastic changes to the natural environment. When we “shall be telling this with a sigh, somewhere ages and ages hence” will we be secure in the knowledge that we made the correct choice or will we regret the lost opportunities of the past?

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1. INTRODUCTION

The accelerating forces of over-consumption and waste generation worldwide have led to looming environmental threats that are unprecedented within the history of the human race. In order to limit the damage to Earth's ecosystems, we will have to identify and move towards ways of living that are in balance with the Earth's ability to provide resources and absorb waste. Universities can play an integral role in helping to achieve this balance. On the one hand, universities are microcosms of society, in that they are not only places where people learn, but also where they work, live and play. On the other hand, universities play a special role in addressing the issue of sustainability given their focus on education, both inside and outside the classroom. By acknowledging the limits of our planet and addressing head-on the environmental challenges that the world currently faces, universities can become living laboratories leading the way toward environmental sustainability.

1.1. The Concept of Sustainability

The concept of sustainability has gained attention in recent years on many college and university campuses, complemented by a growing body of literature addressing this issue. However, sustainability itself is still somewhat of a difficult concept to fully define. There are various definitions of sustainability in the literature ranging from the purely technical to the purely philosophical, and focusing on environmental, economic and social factors (Goodland and Daly, 1996). The most often cited definition, developed by the Brundtland Commission in 1987, describes sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Although this is a generally accepted definition of sustainability, there is no clear consensus as to what it may mean in practical terms. There are no clearly defined numbers or goals to be achieved, nor is there a clear-cut end goal for what constitutes "sustainability." In addition, the definition changes as a function of place, time and setting. Thus, sustainability is most useful when thought of not as an end goal, but as a mindset, a way of thinking holistically and responsibly when we approach new projects or issues. We can identify ways to improve sustainability, even without a goal that tells us when we can stop. Given this approach, we determined the most important principles to be:

- **Enhanced environmental performance:** This involves minimizing the major sources of anthropogenic impact on the environment. Mitigation of these impacts underlies the framework for more expansive definitions of sustainability.

- **Emphasis on Environmental Education:** Educational experiences that foster an understanding and appreciation of the natural world can serve to emphasize the power of a focused, collective effort. Thus, schools, literature and awareness groups will all play important roles in pursuing sustainability. However, the types of problems that we currently face cannot be solved by traditional, single-disciplinary education. Education that crosses departmental boundaries is needed to foster increased environmental education. Ecological literacy involves systems thinking, being able to see a range of problems and solutions, and should be stressed as a clear goal in all educational institutions.
- **Thinking in terms of generations:** The word sustainability implies that we sustain something over time. The way that we define the time component affects the types of decisions that we make. Thinking in terms of generations rather than years reminds us that the people who have to deal with the consequences of our actions are our own descendants, and therefore an extension of ourselves. This helps us personalize our considerations and encourages us to act responsibly, providing motivation beyond short-term financial gain.
- **An expanded sense of community:** Not only should we consider the impacts of a project on our own community, we should also be aware of the impacts it has around the world. Looking through the lens of sustainability, we see our connections not just to people around us or to future generations, but also to people and places far away. A sustainable project should not benefit one community at the cost of another. One key element of achieving this expanded sense of community lies in education.

The determination of what constitutes a "sustainable" campus is still not a straightforward task. We considered each principle of sustainability in the evaluation of campus environmental performance. In particular, we focused on the three most measurable aspects of campus sustainability: minimization of resource consumption, minimization of waste and pollution, and conservation of the natural environment. Therefore, our assessment focuses on analyzing campus infrastructure and operations and the institutional and financial provision for those operations, rather than on issues such as educational curriculum. The consideration of an expanded sense of community, environmental education and thinking in terms of generations all dictate how well each of the three core components of sustainability can be realized in our assessment. We defined a sustainable campus as one that incorporates sustainability into all of its practices and policies, and by doing so cultivates a faculty and student body that is mindful of how these principles can be translated into everyday actions and attitudes.

1.2. Role of Universities in Sustainability

Sustainability is an important issue for universities to tackle for a number of reasons. University and college campuses consume large amounts of natural resources, while also creating significant quantities of waste and pollution. The diverse range of activities carried out on university campuses result in the consumption and disposal of a wide variety of resources, with significant environmental impacts. This is an especially worrisome factor for a campus such as the University of California, Santa Barbara (UCSB), which is adjacent to diverse and rich marine, aquatic and terrestrial ecosystems. These factors make the campus ideal for the study of sustainability, while also presenting some of the greatest challenges.

Universities influence a wide variety of surrounding entities including: the surrounding community, local businesses, government organizations, industry, environmental professions, contractors and consultants, other universities, employers, large organizations and the international community (Sharp, 1998). Therefore, a clear commitment to sustainability at the university level will influence sectors far beyond the boundaries of a single university. Universities can extend this web of influence via education, research and development partnerships, the development and distribution of case studies, publications and presentations, conferences and seminars, consulting partnerships, training programs, and economic drivers.

1.3. Project Overview

The design and construction of *Bren Hall*, to house the Donald Bren School of Environmental Science and Management, heralds a new era of sustainability for the University of California, Santa Barbara and the UC system. This "green" building incorporates fundamental principles of sustainability: waste minimization, conservation of the natural environment and minimization of resource consumption. However, the Bren building represents only one building on a campus with many buildings in a system of nine campuses. Thus, the greening of Bren Hall is important and useful only if the lessons learned apply to the UCSB campus and the UC system in general. Two important questions arise: (1) What is the overall environmental performance of the campus? (2) How do we adhere to principles of sustainability whose definitions and metrics change over time?

Our report, *Greening UCSB*, evaluates these questions in order to prompt institutional change that empowers graduates with the values, knowledge, and skills to realize the principles and practices of environmental sustainability in their professional and civic lives. This project targets sustainability on both a campus and system wide level. We hope to ignite this process by first, clearly portraying University policies and practices as they impact the environment and relate to the principles of sustainability and second, by proposing a policy statement on sustainability to be adopted by the University.

There are a growing number of resources available for college and university campuses tackling the issue of sustainability. One such resource is the Campus Ecology program, established in 1989 by The National Wildlife Federation (NWF). Campus Ecology provides outreach to campuses via publications and conferences addressing environmental issues and practices that are specific to universities and colleges. One important component of this program is the environmental audit, which provides information for assessing, recommending and implementing sustainable practices (Smith, 1993). UCSB participated in a general environmental audit administered by the NWF Campus Ecology program in 1989. However, the information obtained was scant at best and provides a limited view of the sustainability of campus operations. No comprehensive assessment of campus operations, infrastructure or areas for improvement was obtained. Given this lack of a detailed assessment of campus operations and infrastructure, we hope our research, methodology and conclusions will contribute to the growing body of available resources for universities wishing to undergo a similar process.

By developing a series of directed questions in six topic areas of campus infrastructure and operation—Building Design, Energy Use, Waste Management, Air Quality and Transportation, Water Management and Landscape Management—we attempted to identify areas where and to what extent the principles of sustainability are being incorporated into campus operations, and areas where significant change is desirable. Some of these questions focused on obtaining straightforward information such as the amount of solid waste generated and carbon dioxide emitted on campus, while other questions attempted to get at the more fundamental issues of institutional and financial support of sustainable practices. Figure 1-1 depicts the conceptual framework for our project, including the principles of sustainability as we defined it, the topic areas of our environmental assessment and how those relate to the formation of the policy statement.

We structured this report to highlight the environmental and economic impacts associated with campus operations, identify means for improvement and develop indicators of campus sustainability. It consists of two core components: a comprehensive environmental assessment and a policy framework.

1.3.2 Comprehensive Environmental Assessment

The information obtained from the assessment provides baseline data that can be used for future comparisons with other universities and serves as the justification for potential changes in policy and operations. The assessment is organized as follows:

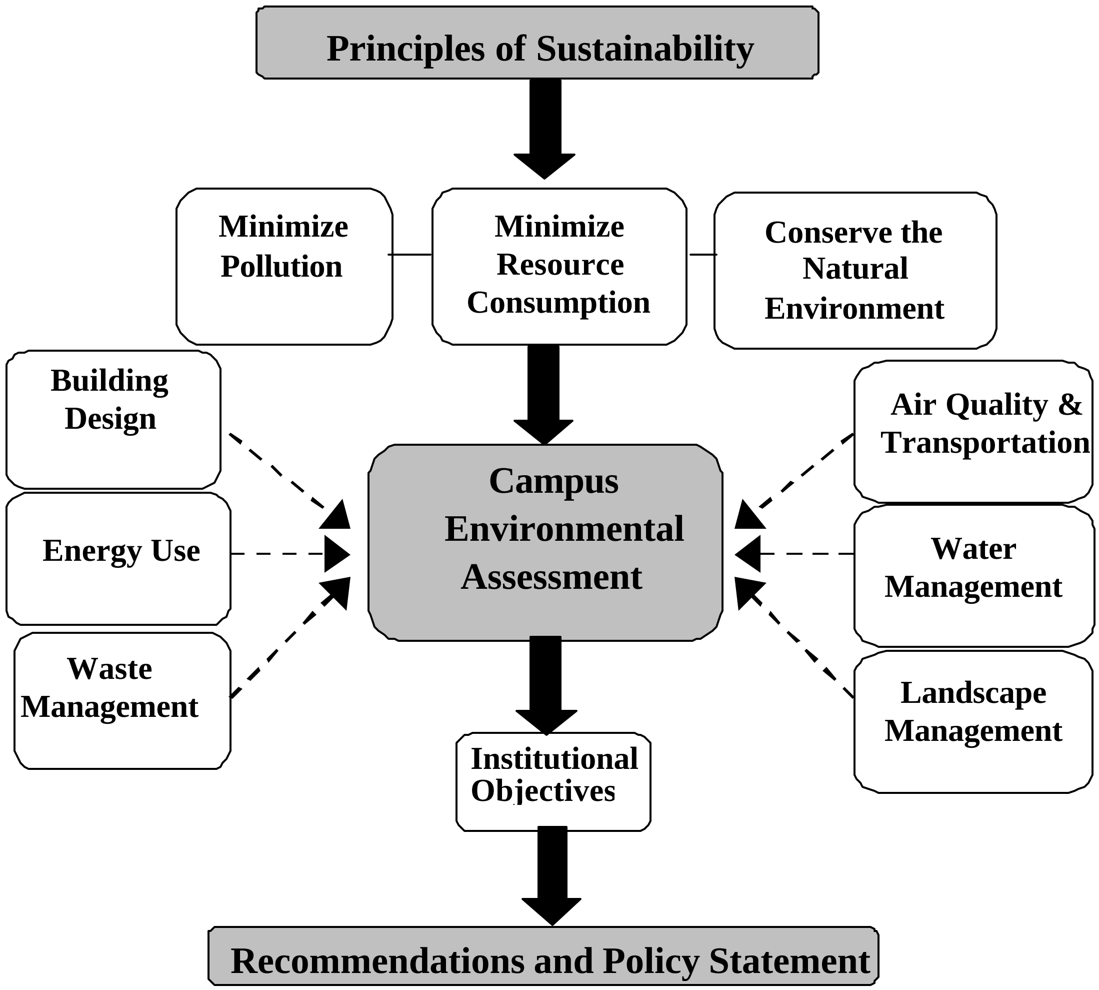


Figure 1-1. Project framework

- **A survey of campus environmental performance:** A series of questions and answers centered on the three principles of sustainability to characterize campus operations in six key areas: Building Design, Energy Use, Waste Management, Air Quality and Transportation, Water Management and Landscape Management.
- **An analysis of the subsequent findings:** A qualitative evaluation of the environmental performance of UCSB in terms of trends, environmental impacts, financial and institutional issues, innovativeness and community outreach in each key area. Each evaluation is followed by a list of recommendations for improvement.
- **A grading scheme for campus performance:** A grading scheme to measure campus sustainability. These indicators surfaced from our

environmental assessment and were put into a “test” format. This “test” used a binary grading scheme (yes or no), so that if the indicator was present on campus, it received a point, and if it was not present it did not receive a point. The percentage of indicators present on campus correlated to a certain grade, which was then assigned to each key area of campus operations.

Table 1-1. Grading scheme

Percentage	Grade
100-94	A
93-90	A-
89-83	B+
82-75	B
76-70	B-
69-63	C+
62-57	C
56-50	C-
49-43	D+
42-37	D
36-30	D-
29-0	F

Any indicator framework for determining the level of sustainability on a college campus should be flexible and adjustable for changing priorities in evaluating environmental responsibility. In addition, this framework was designed to be transferable to other institutions. It is important to recognize that our evaluative indicators used in this report are oriented towards determining the measure of *proactive* efforts to embrace sustainability that are currently underway on campus. The absence of these efforts does not reflect poor performance by individuals on campus; rather, it suggests that the campus is not especially progressive in incorporating the principles of sustainability into operations.

1.3.3 Policy Framework

The policy framework developed in this report is transferable to other universities as a model for hands-on application of sustainability principles. The framework is organized as follows:

- **A draft policy statement on sustainability:** This statement identifies overarching goals of campus sustainability, identifies corrective actions the University could undertake to improve the "trouble areas" identified by the environmental assessment and justifies prioritizing sustainability principles at the university level.
- **A discussion of the feasibility of policy adoption**: A brief analysis of institutional and external barriers to campus sustainability is provided along with a discussion of the conditions conducive to the adoption of such a policy at UCSB. The feasibility study also provides potential strategies for overcoming these barriers.

1.4. Importance of Research

Greening efforts on the UCSB campus are important for a many reasons. First, the number of people and the range of activities carried out on university campuses result in a significant amount of environmental stress. UCSB is located in the center of a diverse and sensitive ecological area that is surrounded by wetlands and coastal bluffs. Therefore, actions taken by the campus can have important implications for the surrounding habitat. In addition to environmental benefits, campus greening efforts can result in substantial cost savings. However, innovative technologies or practices often require an initial capital investment before savings can be realized. Increased use of public funds for green technology and practices must be justified in order to reach environmental goals in a cost-effective manner. Thorough documentation of cost savings and environmental protection will help set a precedent for future greening efforts in public institutions.

A policy that promotes environmental protection can have substantial environmental benefits, while also setting a positive example for student, staff and faculty. As a public university, UCSB can help set a new standard for making environmental concerns a core priority of all campus operations, while stimulating the market for green technologies. The methodology that we have developed is transferable to other universities and institutions, enabling greening practices to become more easily implemented in other places. An early commitment to sustainability can put UCSB at the forefront of the greening movement, while also aiding in the development of a more sustainable campus.

2. CAMPUS CONTEXT

In order to understand the details of an environmental assessment of UCSB, it is important to recognize the role of the physical setting, site history, current infrastructure, and population and development pressures. These characteristics form the foundation of Campus activity, and provide both opportunities and constraints for achieving sustainability. This chapter provides basic background information on the UCSB campus in order to provide a context for our assessment and to allow for comparisons with other institutions. The majority of information for this section was obtained from the 1990 Campus Long Range Development Plan*, which was created by the Campus Planning Committee to guide future campus development through 2005/6.

2.1. Location

The UCSB campus is located along the Pacific Ocean, 10 miles west of the city of Santa Barbara and less than 1 mile south of the community of Goleta, in an unincorporated area of Santa Barbara County. Three sections of the campus (Main Campus, Storke Campus, and West Campus) border Isla Vista, where most of the students live. The area surrounding the Campus contains a mixture of suburban residential, agricultural and commercial areas, with the Santa Barbara Municipal Airport directly to the north.

2.2. Natural Setting

The natural setting of coastal bluffs, lagoons, marshes and wetlands, comprises the campus's most striking feature. Wetland and coastal backwater areas, including Goleta Slough to the north and Devereux Slough on West Campus, provide habitat for a wide range of native plants and animals, and a high diversity of migratory and coastal bird species. In fact, the area has the highest richness of bird species of any area in California of similar size (Ferren and Thomas, 1995). Coal Oil Point Reserve on West Campus is home to many indigenous populations, including federally listed threatened and endangered species. Due to the campus' coastal location and the number of sensitive ecosystems, development on campus is subject to review by the California Coastal Commission.

* For more information, please see the Campus Planning, 2000b. UCSB Long Range Development Plan at http://bap.ucsb.edu/planning/3.planning.stuff/lrdp/01.Preface&Intro.pdf.

2.3. Site History

Before World War II, the site that now houses UCSB was used primarily for agriculture, with some asphalt mining occurring near the lagoon (Campus Planning, 2000a). At that time, rows of Eucalyptus trees were planted as wind breaks. These trees form a major feature on campus today, and play an important role in orienting the physical design and development of the campus. During World War II, the site functioned as a marine air base on Goleta Point. The Campus was designated as a "general campus" of the University of California in 1958. At that point, it contained 75 mostly wood frame structures, many of which are still part of the campus today (Campus Planning, 2000b).

2.4. The Campus Today

UCSB is a California public university and is part of the larger UC System. The campus is divided into three main sections. Main Campus occupies 405 acres and contains the majority of campus development. Storke and West Campuses together comprise another 410 acres, which includes playfields and open spaces, as well as 165 acres of sloughs, wetlands and wooded slopes (Campus Planning, 2000b).

The campus contained close to 360 buildings and nearly 5 million total square feet of building space in 1999[*], with additional buildings being added every year. Campus buildings serve a broad range of functions including academic instruction, scientific research, office space, computer facilities, library space, food service, residences, parking structures, and sports and recreation facilities. Seventy-five percent of the existing instructional buildings are 25 years or older and 25 percent are more than 40 years old (Campus Planning, 2000b). The deferred maintenance backlog of the campus now totals more than $149 million in estimated costs, and includes projects ranging from energy retrofits, building repairs, seismic retrofits and a replacement of the entire campus sewer system, according to Physical Facilities Director David Gonzales.

2.5. Planning Goals

The mandate of the University is to provide excellence in academic instruction and research. Academic planning goals include "improving instructional resources, development of undergraduate and graduate programs, and expanding and improving the quality of research" according the Campus Planning and Physical Development Guidelines. Physical planning goals include upgrading aged facilities and "preserving

[*] Estimate includes Managed Gross Square Footage plus all on-campus dormitories, the Marine Research Laboratory and ITP.

and enhancing [the campus's] unique environment, architecture and open space," (Campus Planning, 2000c).

2.6. Development Pressures

Since opening its doors in 1956, enrollment at UCSB has increased from 2,500 to more than 20,000 students. While the number of students has remained relatively constant for the past several years, increasing population in California is expected to put severe pressures on the entire UC system. Campus growth has been capped at the current level due to the sensitivity of the campus site. In order for UCSB to meet the needs of both undergraduate and graduate students and to achieve its academic goals, the number of faculty and staff will also have to increase. Thus, additional building space is needed for housing, offices and research facilities.

In addition to the demands for more space, the University also faces demands for higher quality facilities. Advances in technologies and expansion in research activities necessitate the development of laboratories that are more sophisticated along with other resources. In addition, many of the existing facilities are in need of upgrades and repairs.

Some of the departments that are growing most quickly are also the departments that put the most strain on the environment. In particular, the engineering department is in the process of planning two new buildings, an Engineering Sciences building and a Nano-Sciences building. The new Engineering II building, which was completed in 1996, currently accounts for almost 12% of total campus energy use. The addition of these two new buildings, along with several other buildings that are currently being planned, will dramatically increase the environmental impact of the campus in all categories.

3. BUILDING DESIGN AND CONSTRUCTION

3.1. Introduction

Most buildings are made to last—to withstand earthquakes, resist fires and maintain structural integrity. However, most buildings do not meet the sustainability goals that we have outlined in this report. Buildings require huge amounts of materials, cause ecological damage, and require inputs of resources over time. In this section, we examine current building design, construction, use, operation and upgrading practices, and then make recommendations to make campus buildings better for the environment, as well as for the people who live and work in them.

3.2. Background

Environmental impacts can be traced to all phases of building construction, as well as to building use, operation and maintenance. Buildings require enormous inputs of resources. Each year, building construction requires the use of 25% of the global wood harvest and 40% of all the materials entering the global economy (Sharp, 1998). Approximately 136 million tons of building material becomes waste from construction, renovation and demolition projects (U.S. EPA, 1998). In addition, building operations account for 35% of total energy consumption (Sharp, 1998).

Virtually all buildings, new and old, commercial and domestic, put some strain on the environment. There are major impacts associated with a building's footprint, direct ecological disruption from construction and use, energy demand, materials consumption and indoor air quality. While there is no way to construct a building that has no impact, the techniques of "green building" can be used to decrease their severity.

> **Green Building:** the use of efficient designs and technologies to decrease the total environmental impacts of construction, operation and maintenance of a building.

Green building techniques can be used on both new and existing buildings. If a new building can be designed and constructed as a green building, a great deal can be done to limit its environmental impact by orienting the building in ways that utilize the heating, cooling and ventilation properties of the natural setting, and by choosing materials that are the least demanding of natural resources (e.g. recycled and non-toxic materials, sustainably grown wood, alternative energy systems, etc.). However, a great deal can also be done in existing buildings, particularly through energy retrofits, which can reduce the energy demand of a building dramatically.

Due to the economic and environmental benefits associated with green building, many cities have mandated green building practices for all government buildings. While no such mandate currently exists in Santa Barbara, California Governor Gray Davis issued Executive Order D-16-00 last summer to establish a "state sustainable building goal." This order states that it is the goal of the administration to "site, design, deconstruct, construct, renovate, operate, and maintain state buildings that are models of energy, water, and materials efficiency; while providing healthy, productive and comfortable indoor environments and long-term benefits to Californians." Buildings in the UC system are primarily state funded and therefore are encouraged to incorporate such green building practices.

In order to verify that buildings do in fact meet greening goals, the United States Green Building Council has developed the Leadership in Energy and Environmental Design (LEED) rating system. The LEED system is a "voluntary, consensus-based, market-driven building rating system based on existing proven technology (U.S. Green Building Council, 2001)." It is designed to evaluate projects from a "whole building perspective" and to reward institutions that invest in green building features. Buildings earn points for each feature that they incorporate, and receive medals corresponding to different point levels. Bren Hall will be the first building in the UC system to receive LEED certification and on completion will receive a minimum of a gold medal.

In addition to certification through the LEED system, greening goals can be assured by the use of third party building commissioning. Building commissioners are contracted to inspect building projects periodically and to verify that greening and efficiency features are being installed properly. The combination of third party certification (such as through the LEED system) and building commissioning can ensure that the resulting building will achieve the greening objectives of resource conservation, energy efficiency and indoor air quality.

3.2.1 Environmental Impacts

All phases of a building's life—including construction, use, operation and management—can cause some environmental impacts. Buildings consume space, materials and energy over time.

Building Footprint

The construction of any building on previously undeveloped land will have an ecological impact. The physical footprint of a building (the number of square feet of ground that the building covers) not only destroys any habitat that once occupied the area, but also permanently creates a surface that is impermeable to water. Because rainwater can no longer percolate into the ground, groundwater recharge can be reduced, and flooding and water pollution can potentially increase. These effects are exacerbated by walkways, roads and parking lots associated with new buildings.

Building Materials

Buildings use large quantities of resources such as metals, wood, concrete, drywall and finishing materials. Each year, buildings consume 3 billion tons of raw materials (Sharp, 1998). The extraction, processing, manufacturing, transportation, and disposal of these materials can put a significant strain on the environmental (see Figure 3-1). The components of building materials are derived from natural (often non-renewable) resources, which must be mined or logged and then shipped to manufacturing or processing plants. Manufacturing generally requires large energy and resource inputs and often produces large quantities of waste. In addition, some building materials, including concrete and finishing materials, contain components that are toxic or otherwise environmentally destructive. After the manufacturing process is complete, materials must be transported to the building site, which requires the use of fossil fuels. During building construction, excess materials must be transported to landfills,

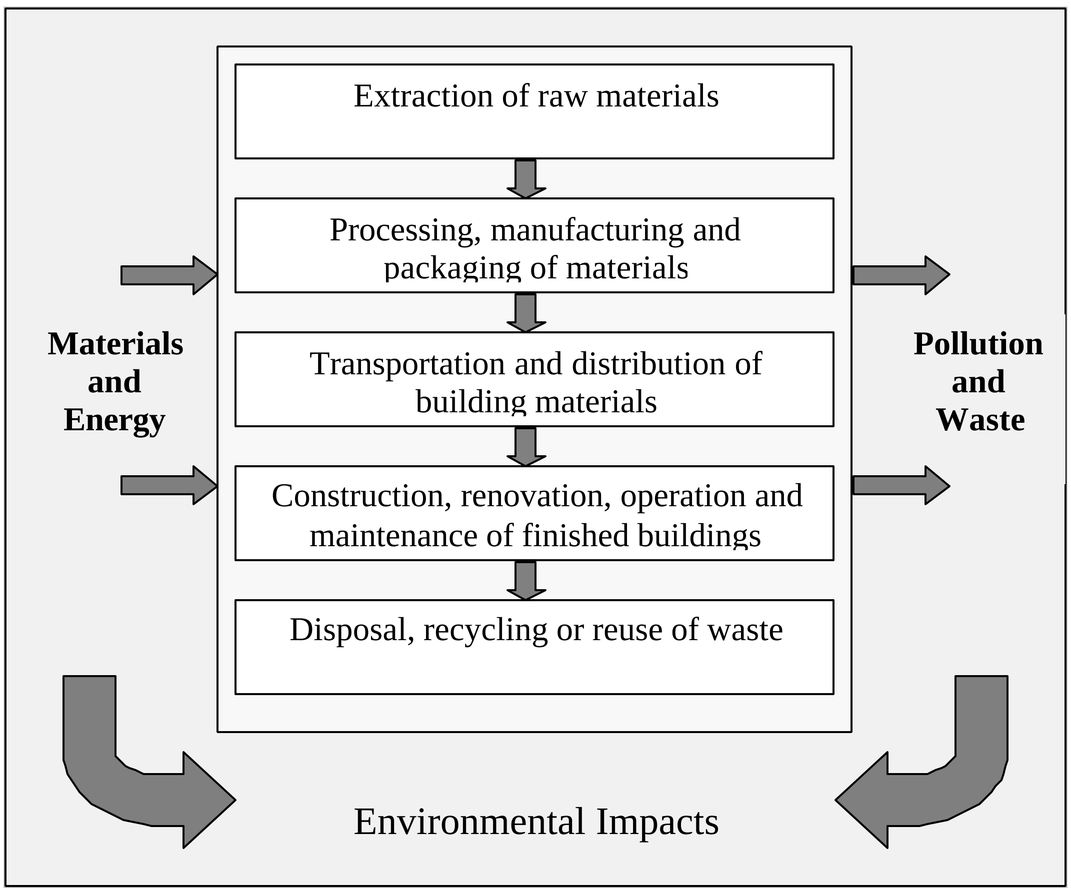


Figure 3-1. Environmental impacts from building materials

where they make up 25% of total solid waste. Once a building is completed, many of the toxins contained within building materials continue to off-gas, causing indoor air pollution.

The analysis of the total environmental impact of a material or product over its entire lifetime (as described above) is known as "cradle to grave" analysis. This technique can be used to sum all of the sources of environmental harm from the time the material is extracted to the time it is finally disposed of. Cradle to grave analysis can also be used to determine the amounts of "embodied energy" of different materials—that is, the total amount of energy the material requires over its lifetime for extraction, manufacturing, transportation, installation, use, etc. Comparison between materials is often difficult due to the variety and complexity of processes involved. Third party certification provides an important way to identify materials that are the least damaging. Other factors to consider in evaluating materials include the distance the product had to travel to reach the building site, how long the material will last before it needs to be replaced, and whether the material is actually necessary in the first place.

Energy

Buildings require large energy inputs in order to maintain comfortable indoor conditions. The largest energy consuming building component is the HVAC (heating, ventilation and air conditioning) system. Most large buildings draw in outside air, which is then heated, cooled, humidified or dehumidified depending on conditions, and then transported throughout the building. The biggest determinant of HVAC requirements is the type of building. Commercial buildings, which include offices, classrooms and laboratories, are generally occupied during the day and can contain a range of lighting and electrical demands. Therefore, these buildings generate a large amount of heat, which must be dealt with through operation of the HVAC system combined with any natural ventilation. Residential buildings such as houses and dormitories, on the other hand, are generally occupied from evenings to mornings, and tend to have less lighting and electrical equipment as well as lower densities of occupants (number of people per square foot of building space). Thus, residential buildings have higher heating requirements than commercial buildings. (See Chapter 4 for more information).

Indoor Air Quality

Indoor air pollution can result from the off-gassing of building materials, from mold or dust accumulation, combined with a lack of proper ventilation. Impaired indoor air quality may cause a range of human illnesses, decrease worker productivity, and leak pollutants into the outdoor environment. Indoor air pollutants include volatile organic compounds (VOCs), formaldehyde, lead, asbestos, combustion products, radon, mold and dust. Pollution levels can reach up to 100 times higher indoors than out, posing a particularly high health risk, since most people spend up to 90% of their time indoors (U.S. EPA, 2001a). According to Occupational Health and Safety Organization, more than 20 million office workers in the U.S. are exposed to unhealthy levels of indoor air pollution (OSHA, 2000.)

3.2.2 Economics

As with most environmental issues, the ecological costs of buildings are largely externalized—that is, they are not born by the suppliers of building components, the makers of the building, or the building occupants. For this reason, environmentally responsible building alternatives that require additional expense have often been viewed as luxuries that yield little return on investment. However, when the costs over the full life of the building are considered, economic and environmental goals become highly compatible. The key to meeting both sets of goals in buildings is to decrease consumption of natural resources throughout the life of the building.

Life-Cycle Cost Analysis

Building costs can be divided into two main categories—initial and long-term costs. Initial costs are the one-time expenditures on design, construction and materials. Long-term costs include money spent on building operation and maintenance over the lifetime of the building. When initial costs are the primary consideration, inefficient design, materials or equipment may be chosen to ensure that a project remains within its allotted budget. However, when the full cost of the building over time is considered, investment in more efficient options can be rationalized. This type of accounting is called life-cycle cost analysis or life-cycle costing.

> **Life-cycle costing**—an analysis of the full cost of a product, including the initial purchase price and the costs of usage over time.

Life-cycle costing for buildings can ensure that economic and environmental goals are met in three main ways—by reducing energy consumption, by reducing material requirements, and by increasing worker productivity. In many cases, these three benefits can be achieved simultaneously. For example, passive solar design reduces not only energy consumption, but also reduces the need for extensive HVAC (heating, ventilation and air conditioning) systems and ducting, which reduces both initial and long term costs. In addition, proper ventilation, lighting and reduced mechanical equipment can improve indoor air quality, which has been shown to increase worker productivity (Romm and Browning, 1994). Employees who work in environments with optimal air quality and lighting have been shown to have a faster productivity rate, higher quality of production, and fewer sick days. All of these economic benefits can be gained most effectively when life cycle costing is incorporated into the early design stages, before the building has been constructed.

However, life cycle costing can also be used to maximize returns on investments in building renovation and retrofit projects.

Value Engineering

Because each building project generally has a fixed budget, decisions must be made to avoid the over-allocation of funds. In order to do this, representatives of building projects will meet and find ways to cut costs. These meetings are known as value engineering sessions, and they are an important part of project planning and design. Unfortunately, the result of these sessions is often the elimination of greening or efficiency elements of the building. Green building elements may require initial investments that cannot be covered by the project budget. Therefore, even if greening features are cost-effective in the long run, typical value engineering sessions do not take into account life cycle costs, since they are concerned primarily with the bottom line. Greening and efficiency attributes can only be protected in value engineering sessions if they are established as priorities from the inception of the project. Only when value-engineering sessions incorporate life cycle costing into the decision making process can economic and environmental goals be met over the long run.

3.2.3 Campus Issues

With population growth and advances in technology, university campuses across the country face strong development pressures. Increases in student and faculty numbers necessitate expanded classroom, research, office and housing facilities. Thus, the need for new buildings, with their associated space, material and electrical demands, will create additional environmental impacts and higher utility bills. Green building practices offer campuses methods for limiting both impacts and costs.

Several campuses have made early commitments to green building and design practices, and are already reaping the benefits. For example, Oberlin College in Ohio has established green building criteria for all campus projects, and has completed construction on an emission-free environmental studies center (NWF, 1998). Energy retrofits at SUNY Buffalo cut costs by $3 million per year, or 15% of the total electricity bill. Payback on initial investments was only 3.76 years (Keniry and Eagan, 1998). UCSB is joining in this movement toward efficient buildings with the construction of Bren Hall and other green projects planned on campus.

3.3. Results

A series of questions were taken and adapted from the campus environmental audit format in April Smith's book, "Campus Ecology." Interviews were held with Energy Program Manager Jim Dewey, Director of Facilities Management David Gonzalez and Zone Leader Paul Gritt, Assistant Dean of Planning & Administration Mo Lovegreen, Professor and former Bren School Dean Jeff Dozier, Industrial Hygienist

Kevin Kaboli and others. All data included were derived from these sources, although additional library and Internet research was also performed regarding specific issues. The following questions were asked to gauge UCSB's status with respect to building design and construction efforts.

1. Is the University subject to local governmental building codes?
UCSB is subject to state and federal regulations, but is not subject to city or county codes and regulations. UCSB is responsible for writing its own codes.

2. Are there any campus-wide policies that encourage environmentally sound building? Are there any such policies at the University of California level?
Currently there are no such regulations on the campus or government levels. However, this year California Governor Gray Davis issued an Executive order calling for all state buildings to be designed according to "a sustainable building goal" (Executive Order D-16-00). The University of California is currently considering similar initiatives.

3. Are there any "green" buildings on campus?
The Bren Building will be the first green building on campus and the greenest building in the UC system when it is completed.

4. What are the current procedures used to select architects and contractors? Are environmental issues considered during the selection process?
When architects are required for campus projects, the campus advertises a Request for Qualifications and interested architects respond by submitting proposals. The Design Review Committee (DRC) then puts these proposals through a rigorous evaluation process. The DRC makes it's final decision based on "Responsiveness of presentation to campus and project; experience of candidates who will be responsible for project; and appropriateness of design professional team for campus and project "(Executive Architect Selection Process, January 1993).

In the past year, a clause has been added to all Requests for Qualifications stating that sustainability is a priority on campus and will be considered in the selection process. Architects must respond to this statement in their proposals, indicating the experience they have had with green building and demonstrating how they will incorporate sustainability into their project proposal. By law, the campus is required to select contractors that have the lowest bid. Therefore, firms that use environmentally responsible construction practices cannot be given priority on these criteria.

5. How are building materials, finishing materials and mechanical systems selected?

Building materials, finishing materials and mechanical systems are selected by contractors in accordance with specifications outlined in project proposals. Because the law requires the campus to select contractors with the lowest bid, it is difficult to ensure that the most efficient/environmentally sound/sustainable products are chosen. Contractors have an incentive to choose materials with the lowest initial cost, rather than those with the lowest life-cycle costs, unless required by project specifications.

Indoor Air Pollution

6. What indoor air pollutants have been identified on campus?
Indoor air pollutants have occasionally caused problems in some campus buildings. The Office of Environmental Health and Safety has been working with Physical Facilities to respond to occupant complaints and remove pollution sources.

Mold—There was a major problem with mold in the HVAC system of the library in 1993, which resulted in several workers compensation claims. A few other buildings have also had mold problems in the last several years.

Radon—The Environmental Health and Safety Radiation Safety Office began testing for radon in 1997. So far no building has been found to have radon levels in excess of EPA standards.

Asbestos and Lead—Both asbestos and lead exist in many of the older buildings on campus. Inspections are conducted regularly and required precautions are taken to avoid air quality problems.

VOCs—There have been complaints about VOCs and other toxic fumes from carpet and finishing materials in several buildings. In one case, recently installed carpeting had to be removed and replaced due to fumes from the adhesives that were used.

Dust—Dust has occasionally been a problem in buildings undergoing renovations.

7. What are the policies or guidelines regulating the use of indoor air pollutants?
The Campus Integrated Pest Management Policy was signed by the Vice Chancellor of Administrative Services in 2000. This policy prohibits the use of toxic pesticides indoors, limits the amounts of pesticides used outside, and calls for least toxic methods of pest control on campus.

In addition, the EPA has specific guidelines for the handling and removal of asbestos and lead, and for testing and handling radon contamination that the University must comply with. The Office of Environmental Health and Safety (EH&S) oversees such procedures to ensure that EPA guidelines are followed and indoor air pollution is minimized. Although no formal campus-wide policies exist for other indoor pollutants, EH&S does have guidelines for handling most indoor air pollutants, and requires that their office be notified when polluting material is used. There are no official guidelines or procedures for limiting the amount of indoor air pollution sources from building and finishing materials or furniture.

3.4. Analysis of Results

3.4.1 Current Progress/Trends

Bren Hall

With the completion of plans for a green building to house the Bren School of Environmental Science and Management, UCSB ushered in what could be a new era in environmentally responsible building development. The greening of Bren Hall occurred due to demand from the campus community, which called attention to the irony of an Environmental Sciences and Management building that was not itself environmentally sound. The administration responded to this demand by establishing sustainability goals as a top priority for the project, and revamping the initial designs despite the added expense of change orders. This change was an important pioneering step in the right direction.

Student Affairs and Administrative Services Building

The Student Affairs and Administrative Services Building (SAASB) was completed in 1996 and has had problems since then. Instead of utilizing the natural features of the site for heating, cooling and ventilation, the building is pressurized and relies on mechanical systems for these functions. In addition, in order to accommodate certain design features, the architect sacrificed sufficient space for the HVAC system. Thus, the existing mechanical systems require enormous amounts of energy to run and are still not sufficient to meet the air requirements of the building. This has resulted in decreased occupant comfort and $500,000 in maintenance costs. The UC Regents are currently suing the architect for damages.

The SAASB stands in stark contrast to the future Bren Hall, and underscores the need for an institution-wide commitment to sustainability. The problems associated with SAASB could have been avoided if sustainable building practices, particularly the use of passive solar design, had been utilized. Unfortunately, once a building is constructed it cannot easily be remade. SAASB will continue to consume large amounts of energy and will to require excessive maintenance for years to come.

Future Projects

Fortunately, other building projects that are currently in the planning phases seem to be following in the footsteps of Bren Hall. Two new building projects, Engineering Science and Life Sciences, are incorporating green elements into their design. This is particularly significant given that engineering and life sciences are the two most energy consumptive departments on campus. It is important to note that the addition of these new buildings will increase the overall energy demand of the campus significantly. However, green building features can limit this increase dramatically.

Other changes on campus also indicate that UCSB is on the right track. Retrofits and upgrades of older buildings to increase energy efficiency are well underway, and calls for proposals ("Requests for Qualifications") from architects now contain a clause stating that sustainability is a priority on campus.[1] However, because there is no official commitment to green building, uncertainty remains as to the future of green building on campus. There is a growing consensus that green building practices and retrofits make sense for environmental as well as economic reasons. However, without high-level support, the possibility remains that other buildings could face similar problems to SAASB, and that Bren Hall could become merely a demonstration building, rather than the beginning of a broader campus-wide movement.

3.4.2 Environmental Impact

Campus development is slow, and the introduction of greening principles to UCSB is relatively recent. Therefore, it is too soon to determine to what degree these efforts have affected the environmental impact of the campus. The construction of any new building, no matter how green, involves at least some environmental impact through the building footprint and the resources consumed in construction. Greening efforts for new buildings therefore serve primarily to limit environmental degradation as much as possible compared to conventional buildings. Plans for development in currently undeveloped areas around the campus periphery have the greatest potential to increase environmental degradation, particularly on a local level, while retrofits of inefficient equipment in older buildings have the greatest potential for reducing environmental degradation, both locally and globally.

[1] This clause is clearly a step in the right direction. However, because this inclusion is so new, its impact on the selection of architects or on the development of projects remains unclear. No new architects have been selected since the clause was added.

3.4.3 Institutional Framework

Green Building

Although green building practices have gained in popularity in recent years, there is currently no campus-wide policy supporting these efforts. Thus, the overall campus commitment to environmentally sound design and construction could become a passing fad. According to both the Director of Facilities Management, David Gonzales, and Campus Architect, Jack Wolever, the future of green buildings rests with the end users. Only if future building occupants continue to express interest in—and pursue funding for—green buildings will the current trend toward sustainability continue. Without user demand or a campus wide mandate, support for greening efforts will likely fall by the wayside, leaving the Bren Building as a sole demonstration building.

Campus Zone System

In 1998, Physical Facilities divided the campus into four zones in order to better meet the needs of building occupants. Zones are divided geographically, and each has its own maintenance team, which sets priorities based on requests from users. This customer service approach ensures that complaints and concerns are responded to efficiently, and allows individual staff members to become intimately familiar with particular buildings. This structure may also allow for better identification of improvements that would increase individual buildings' environmental performance.

Because users set priorities, building occupants could be a driving force in environmental retrofits. In addition to the campus zoning structure, Physical Facilities also has an energy team, which is responsible for identifying and implementing improvements to energy systems (See Chapter 4). It appears that the current institutional framework is well suited to meeting sustainability goals, provided that these goals become institution-wide priorities and that sufficient funding is secured for improvements and investment in environmentally sound/energy efficient materials, equipment and design.

3.4.4 Financial Support

Lessons from the Bren Building

The Bren building illustrates two main financial issues involved with greening efforts. The first is that green building can be accomplished economically, and can produce considerable savings over the life of the building. Many of the efficiency features of the building could be achieved at little or no additional cost, and the investment in energy saving equipment will save the campus thousands of dollars each year on utility bills. The second lesson is that for green building to be accomplished in the most cost-effective manner, greening must be established as a priority from the initial design stages. Because architects were hired and plans were established before the decision to green the building, all improvements had to be made through change orders. Change order costs for Bren Hall totaled over $686,000, a cost that could have been avoided if green features had been incorporated into initial specifications. In general, green building affects the cost of building projects in the following ways:

- If goals and priorities are made explicit from the inception of the project, green design should not result in any additional cost.
- The cost of construction and materials cost could increase, due to the demand for higher quality and efficiency, and to the fact that many green materials are still considered specialty items and are therefore more expensive at this point.
- Investment in efficiency features such as insulation, window glazing, and mechanical equipment should produce cost savings as well as social benefit over time.
- Hiring consultants for modeling, commissioning, and certification documentation results in additional cost, which may be offset by the insurance of an efficient building.
- Additional investment in training for building occupants and managers may be necessary in order to receive full cost savings over time

Life Cycle Costing

While life cycle costing illustrates that investment in energy efficient equipment saves money over time, building projects generally have fixed budgets and therefore may lack the ability to cover the costs of larger initial investments. Because mechanical equipment and other energy conserving or environmentally sound materials are installed later in the construction on a building, they are more likely to be cut or reduced through the practice of value engineering if a building is in danger of exceeding its budget. In such cases, initial costs outweigh life cycle cost savings. Building planners have no way of integrating life cycle cost savings into the initial budget. The extent to which this has been a serious factor in preventing maximum efficiency at UCSB remains controversial. However, flexibility in this area could ensure that sustainability goals are met if they are established as core priorities of the campus.

3.4.5 Innovativeness

The entire field of green building is spawning new and innovative technologies that reduce environmental impact. The incorporation of innovative features requires a careful balance between selecting proven systems and experimenting with new technologies. The designers of Bren Hall have selected a number of new and innovative features that have been well tested to ensure that they are highly functional as well as resource conserving. Some of these features include:

- Passive solar design and natural ventilation in offices.
- Fly ash, an industrial waste product, in the concrete.
- Reclaimed water in the first floor toilets and waterless urinals.

Innovation spurred by buildings such as Bren Hall could provide UCSB with an opportunity to be on cutting edge of the green building movement. By experimenting with new technologies, the campus can serve as a living laboratory for sustainable design.

3.4.6 Community/Education

Not only did the greening of Bren Hall open the door to green building on campus, it also created an opportunity to create bridges to the community. The initial demand for greening came from the surrounding community, and the administration was responsive to this demand. In the process of greening the building plans, experts from a range of non-profit groups such as the Rocky Mountain Institute and the Santa Barbara Sustainability Project were called in for consultation. These connections offer new opportunities for partnerships between the University and the surrounding community, which can be called on for developing future projects.

Because the field of green building is relatively new, Bren Hall also is functioning as a living laboratory of green design, and is itself an educational resource. Efforts are being made to incorporate monitoring and evaluation capabilities into the building itself, so that it can provide information on what works and doesn't work in reaching sustainability goals. The actual construction process of Bren Hall is being broadcast over the Internet from two live video cameras. Other greening features of the building are also published on the Bren School website. In addition, the Sustainability Project will feature Bren Hall as one of its case studies in its forthcoming green building guidelines for Santa Barbara County. Because the push for a green building came from the community, there is reason to believe that there is interest in the green features of the project, suggesting that more could be done to improve the website and provide more information to the public about the decision making processes involved.

Beyond Bren Hall, more could be done on campus to promote awareness of conservation issues relating to buildings. For example, efficiency features in existing buildings could be labeled with educational signs. In addition, building occupants can be better educated as to how to minimize the resource consumption resulting to building use, particularly in terms of energy and water.

3.5. Environmental Report Card

Question	Answer	Score
Does the campus have a long-range development plan?	Yes	1
Does the development plan explicitly state any environmental or sustainability goals?	No	0
Are there any campus policies that mandate green building practices?	No	0
Are there any completed buildings on campus that incorporate any green building attributes?	Yes	1
Are there any campus buildings that are third party certified green buildings? (LEED or other program)	Yes	1
Are any of the buildings in construction or planning phases green buildings?	Yes	1
Are there any requirements for green building expertise in requests for qualifications from architects?	Yes	1
Are there any required specifications for green building materials for new buildings or renovation projects?	No	0
Does the campus ever use building commissioning to ensure that sustainability goals are met?	Yes	1
Is building commissioning required by any campus policy or guideline?	No	0
Do any policies govern the introduction of indoor air pollutants from building materials?	No	0
Have there ever been any serious air quality problems on campus?	Yes	1
	Total:	**7/12**
	Percentage:	**58%**
	Grade:	**C**

3.6. Recommendations:

3.6.1 Infrastructure

- Prioritize funding for energy conservation efforts.
- Use "life-cycle costing" and "cradle to grave analysis" when deciding which materials, mechanical and electrical equipment to use.
- Incorporate life-cycle analysis into value engineering sessions.
- Provide continuing educational opportunities for campus staff on sustainable operations and maintenance.
- Provide easy to use manuals for building occupants that outline proper use of building features for optimal environmental performance.
- Label environmentally sound building features with educational signs wherever possible to increase education and awareness of these features on campus.

3.6.2 Building Construction

- Select architects with experience in green building.
- Utilize passive solar techniques in building design, taking advantage of the mild coastal climate of Santa Barbara for natural lighting, heating, cooling and ventilation needs.
- Use computer models to maximize efficiency features of building design.
- Utilize third party building commissioning to ensure that buildings meet standards for quality, efficiency and sustainability throughout all stages of construction.
- Consider building smaller buildings that use space more efficiently to minimize building footprint, materials consumption and energy demand.
- Use permeable surfaces instead of concrete or asphalt in walk ways, fire roads or other paved surfaces.
- Include specifications for green building materials when requesting bids for building contractors.

3.6.3 Indoor Air Quality

- Prioritize indoor air quality in building design.

- Specify low emission alternatives for building and finishing materials, furniture and carpeting.
- Conduct periodic checks of exhaust systems of all machinery and appliances regularly to make sure that all vents are working properly and that no back-drafting is occurring. Check regularly for leaks, standing water, mold growth or damaged insulation material within HVAC systems.

(For Recommendations regarding energy use related to buildings, see Chapter 4.)

4. ENERGY USE AT UCSB

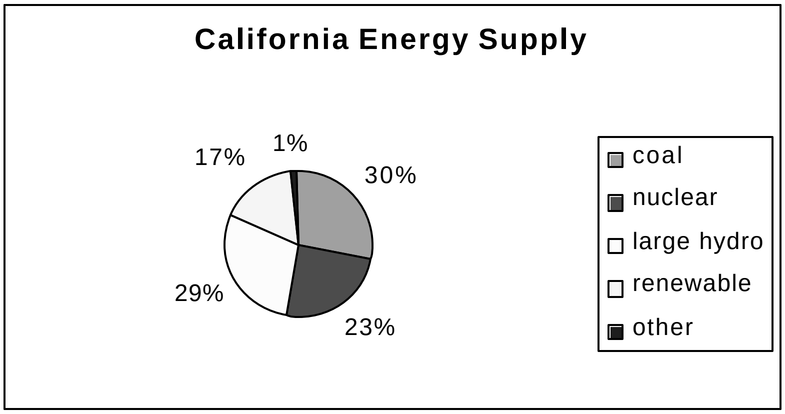
4.1. Introduction

Energy forms the backbone of modern society in many respects. A reliable and affordable supply of energy is necessary to support the existing global economy, and it plays an integral role in our daily lives. Without energy, the University would be unable to meet its mandate of supplying world-class academic instruction and research. At the same time, energy use is associated with some of the world's most pressing environmental problems. This section examines the environmental and economic costs of energy production, transportation, and usage. In the assessment and analysis sections we explore the ways that energy is used on campus and the measures that are being taken to conserve energy. Finally, we make recommendations on how the environmental and economic costs of energy consumption on campus can be limited.

4.2. Background

According to the Energy Information Administration, the United States is the world's largest energy producer, consumer and net importer (U.S. EIA, 2000a). The average American consumes 1.15 trillion kilowatt-hours of energy each year, 85% of which is derived from fossil fuel sources (U.S. EIA, 2000b). In California, a smaller percentage of energy comes from fossil fuels. California has the most diverse electricity generation system in the world, with power generated from a range of sources including coal, natural gas, nuclear power and hydroelectric plants (California Energy Commission, 2001). Each source is associated with different types and degrees of environmental impact and economic cost. Overall, California consumes approximately 600 million barrels of petroleum, 2 million short tons of coal and 1.9 trillion cubic feet of natural gas per year (U.S. EIA, 2001) (see Figure 4-1).

The management and distribution of energy resources is complex. Over the past century, an energy infrastructure based on large centralized power plants and distribution systems has lead to the establishment of regulated monopolies. Because power cannot be stored, a match must be made between the amount of demand at any given time and the amount of power released onto the distribution grid. Energy deregulation in California, which began in 1998, has allowed for an open market in energy production, but not in energy distribution. Under this current system, the wholesale price of electricity has risen sharply, but the retail price for consumers has been capped by regulations. This discrepancy has plunged California's electric utilities into economic hardship, leaving them on the verge of bankruptcy.



Source: Wetherall, 2000

Figure 4-1. Sources of California's energy supply

At the same time, energy demand has increased considerably throughout the Western U.S. over the past few decades due to increases in population and the growth of the high-tech industry. However, generating plants and distribution lines have not increased at the same rate. Energy in California is now being consumed at the maximum rate that it can be supplied. The combination of economic consequences of deregulation and a lack of sufficient production and distribution capacities have thrown California into an energy crisis. The number of emergencies declared by the California Independent Operating System (CAISO) can illustrate the degree of crisis. Emergencies indicate that the state is operating at close to full capacity, with only a very small reserve of electricity.

Table 4-1. CAISO declared emergencies

Year	Stage 1 days	Stage 2 days	Stage 3 days
1998	7	5	0
1999	4	1	0
2000	55	36	1
2001 (as of 2/13)	36	35	31
Stage 1 indicates that power supplies are below Minimum Operating Reliability Criteria.			
Stage 2 indicates that operating reserve is less than 5%.			
Stage 3 indicates that operating reserve is less than 1.5%.			

When reserves fall below 1.5%, the state is at risk of rolling blackouts. The presence of sensitive research equipment on college campuses such as UCSB makes them vulnerable to such losses in power. College campuses are large consumers of energy, which is required for virtually all campus functions. Therefore, Governor Gray Davis has called on schools in the UC and Cal State systems to reduce both energy consumption and demand drastically by summer 2001.

Consumption vs. Demand

When calculating the amount of energy used, there are two main aspects to consider. The first is energy consumption, or the total number of kilowatt-hours used over a give period. The second is energy demand, which refers to the maximum amount of energy consumed at any one point within a given time period. Demand is important to consider because it determines the amount of generating capacity that is required to meet energy needs. Peak demand occurs during the times of day and year when the most energy is used (e.g. on hot summer weekdays, when both electrical equipment and air conditioning are most needed). During off-peak demand times, only the most efficient generating facilities can be used to supply power to the grid. However, during peak hours, all generating facilities, including the most polluting plants, must be on line to provide enough power to the grid. Therefore, peak demand times are associated with the greatest amount of environmental impact, due both to the total amount of energy consumed, and to the use of polluting sources. Load management (the shifting of demand from peak to off-peak times) can be an important part of energy-related pollution prevention, even though the total consumption of kilowatt-hours remains the same.

Electricity vs. Gas

Power is supplied to buildings in two ways—through electricity and through natural gas. The biggest difference between the two is where the fuel is burned. Electricity, measured in kilowatt-hours, is produced through the burning of fossil fuels (including natural gas) or other sources and is transmitted to the site where it will be used via power lines. Natural gas, on the other hand, is measured in therms and is transmitted through underground pipelines, and is burned on site. Natural gas produces far fewer emissions of CO_2 and other pollutants, and is therefore considered a better choice environmentally for powering mechanical equipment. Supplies of natural gas were thought to be cheaper and more plentiful than other power sources. However, recent shortages have caused rates to increase from an average of $0.33/therm in 2000 to $1.85/therm in January 2001. Conservation efforts often encourage the conversion from electric to gas power where possible, but the conservation of natural gas itself is also important.

Energy Conservation

In order for institutions to both decrease their environmental impact and ensure the availability of clean, reliable and affordable electricity, a number of measures can be taken. There are three main means of reducing reliance on non-renewable energy sources:

- **Incorporate energy efficiency into building design.** Low energy prices over the past several decades have taken focus away from energy efficiency. The trend has been toward buildings that rely on mechanical systems rather than sound design principles. Rising environmental and economic costs are causing builders to question these practices and to find ways to utilize the natural properties of the site to meet energy demands. Energy efficiency can be achieved most effectively when integrated into the initial building plans. Passive solar design principles incorporate the natural heating, cooling and lighting capabilities of sun and wind to minimize reliance on mechanical equipment.[2]

> **Passive solar design**—building orientation and design that utilize the natural lighting, heating and cooling properties of sun and wind instead of or supplemental to mechanical systems.

- **Retrofit existing equipment.** Even in existing buildings, efficient and appropriately sized appliances, lighting and machinery can significantly reduce energy demand. Many buildings that were constructed even a few years ago contain equipment such as chillers and boilers that are much bigger than required to effectively cool or heat the building. In addition, these machines often only operate at a single speed or setting, and therefore consume large amounts of energy even when it is not required. Retrofits of excessive or inefficient equipment and the installation of variable speed capacities and remote monitoring and control systems allow building operators to run systems optimally to meet the building's needs, and at the same time reduce both energy consumption and cost.
- **Generate electricity on-site from renewable sources.** On-site power generation from renewable sources has become increasingly feasible due to advances in technology and increases in production. Commonly referred to as "micropower," these small-scale technologies rely on solar or wind power, fuel cells or geothermal energy. The cost of renewable energy equipment has decreased dramatically over the past

[2] Consideration of many aspects of building layout and structure play a role in passive solar design. For example, the orientation of the building itself and the location of the windows determine how much wind, heat and light can enter the building. The types of building insulation and window glazing used, as well as the amount of thermal mass in the physical structure, determine the amount of heat the building will retain. Landscaping outside the building also plays a role. Deciduous trees provide shade in summer and sunlight in winter, which can help regulate building temperature, while evergreen trees provide year round shade and may be appropriate in areas with high heat loads. Computer models can help builders estimate the impacts of various design features.

five years, and is likely to continue decreasing as demand increases (Dunn, 2000). Funding from utilities and tax incentives can further reduce first costs of purchasing equipment. In addition, net metering agreements can be established with power companies so that electricity in excess of what is needed on site can be sold back onto the power grid to reduce electric bills. Another way that efficiency of on-site systems can be maximized is through "co-generation," the trapping and reuse the waste heat for building heating or hot water.

It should be noted that just because electricity is generated on-site does not mean that it is cleaner or more environmentally sound. On-site generation does eliminate losses associated with transmission over power lines, but an on-site generator that burns fossil fuels and is inefficient can be just as polluting as a centralized plant. Therefore, the emphasis in terms of sustainability is generally on generation through renewable sources.

Micropower—the small-scale generation of electrical power closer to where it is used through renewable energy sources.

Net metering—an agreement with a utility company to sell power from on site generators in excess of what is needed back onto the power grid. When power is supplied onto the grid, electricity meters run backwards and result in an offset of electricity bills equal to a maximum of what the customer would normally use without the use of on-site generation.

Co-generation—the trapping and utilization of waste heat from on-site generation systems for supplying heat or hot water to buildings.

4.2.2 Environmental Impacts

Energy Consumption

According to a World Watch Institute report, energy use is one of the largest causes of global environmental impact (Brown and Ayres, 1998). Impacts result from all phases of energy production and consumption, including extraction, processing, generation, transportation, utilization and waste. Different sources cause different types and amounts of damage. In order to compare the impacts of the various sources (such as fossil fuels, nuclear power, hydroelectric power, and renewable sources) a cradle to grave analysis must be conducted. Each energy source used in California has its own set of environmental impacts. A few of these are listed below.

Table 4-2. Energy and pollution

Source	Pollution	Habitat Destruction	Global Warming
Coal	High emissions of SO_x, NO_x and particulates	Strip mining	High CO_2 emissions
Oil	High emissions of SO_x, NO_x and particulates	Drilling, oil spills	High CO_2 emissions
Natural Gas	Some emissions of SO_x, NO_x and particulates. Lowest of the fossil fuels.	Extraction and pipelines	Some CO_2 emissions
Hydro-electric	None	Lost river systems and riparian areas	None
Nuclear	Production of nuclear waste, thermal pollution of water ways	Plutonium mining, waste storage	No GHGs, Possibly some increase in thermal energy
Solar	None	None. Large generating facilities have high space requirements	None
Wind	None	None. Large generating facilities have high space requirements. Windmills may be threat to birds.	None

Calculating the overall environmental impact of energy consumption of a particular set of buildings is quite complicated. The same amount of energy for the same activity in the same location can have different levels of impact depending on the time of day and year. For example, on summer nights, when total demand of electricity from the grid is low, only the most efficient power plants are running. On the other hand, on hot summer days or cold winter evenings, when people require the most energy, all power plants, even the most polluting ones, will be on line to meet the demand. In order to determine the amount of carbon dioxide or other pollutants resulting from energy consumption, it is important to consider when the energy is used (see Appendix A). In addition, an important part of reducing the environmental cost of energy demand for large institutions means shifting demand from peak to non-peak hours.

The amount of emissions from the burning of all fossil fuels has decreased considerably over the past few decades as emission control technologies have been developed and enforced. In addition, many power plants have switched from oil to natural gas. However, overall energy consumption has increased, and so the amount of energy-related environmental impact is still enormous.

4.2.3 Economic Issues

Cost of Fossil Fuels

Since the end of the oil crisis of the 1970's, the economic cost of non-renewable fossil fuel-based energy has remained relatively inexpensive. The assumption has long been that supplies of fossil fuels are virtually unlimited and that energy prices will remain low. Under these assumptions, energy conservation became a low priority in most sectors. The California energy crisis calls the assumption of an unlimited supply of inexpensive fuel into question. While rising energy prices have frustrated many consumers, the current economic costs of fossil fuels do not internalize the true cost to human health and environmental degradation.

The future of fossil fuel prices will depend largely on a number of factors, including international politics, the construction of new power plants, and the potential for taxes from fees for carbon dioxide emissions under the Kyoto Protocol. Current estimates predict that today's elevated prices of both electricity and natural gas will remain high for at least several years. The impact of these energy price increases can be profound at the local level. The high level of energy consumption at large institutions makes them vulnerable to availability and price fluctuations at the international level as well as the state level. Therefore, there is a strong incentive to explore ways to reduce energy consumption and utilize alternative sources.

Cost of Renewable Energy Sources

According to the Union of Concerned Scientists, California is one of the states with the highest amount of funding dedicated to renewable energy sources (Clemmer et. al., 2000). Still, the majority of energy in the state comes from fossil fuels. There have been several barriers to development of renewable energy sources. The first has been that investment in renewable sources has been cost prohibitive when compared to relatively inexpensive fossil fuels. As long as there has been a steady supply of coal, oil and natural gas from both domestic and international sources, there has been little financial incentive to invest alternative sources. In addition, subsidies for fossil fuel energy, which total at least $120 billion annually, make it difficult for alternative sources to compete (Dunn, 2000).

Another barrier to alternative energy sources has been the adherence to the traditional centralized monopoly of power generation and distribution (Dunn, 2000). This model was adopted at the beginning of the 1900s because it was the most efficient way to produce large quantities of energy at the lowest cost. Larger plants could produce more electricity at a lower marginal cost, the so-called "economies of scale." When compared at these large scales, solar and wind power have the disadvantage of requiring large amounts of space to provide the same levels of electricity. However, environmental regulations, construction costs and rising fuel prices have caused the reduction in marginal cost to level off over the past two decades. At the same time, the equipment required for on-site generation from solar, wind, fuel cells or microturbines, has been cost prohibitive for many consumers. However, with advances in technology, combined with increased consumer demand, the cost per unit of small-scale equipment has dropped dramatically over the past five years, and prices are expected to continue decreasing through "economies of production." On-site generation provides an alternative to this model, which is advantageous not only because it is cleaner and more reliable, but also more efficient, as no power is lost in transmission over long distances. Thus, experts are predicting a replacement of economies of scale with economies of production and a movement away from a large centralized electricity system to a decentralized system of micropower (Dunn, 2000).

4.2.4 Campus Issues

Every campus activity—from laboratory research and theater productions to showers in the dorm rooms and light in the classrooms—requires energy. An enormous amount of energy is needed to meet the research, computing, teaching and residential needs of a campus, resulting in significant local and global environmental impacts. On any campus, providing and managing energy is a huge and multi-faceted task, typically consuming about 30 percent of an institution's operations budget (Keniry and Eagan, 1998). Energy costs account for almost 80% of the total campus expenditure on utilities (Design, Construction and Physical Facilities, 2001). Laboratories, essential to the research capabilities of universities, are particularly high energy users, with energy demands as much as 4-5 times higher than office buildings. Clean rooms have energy demands that can be 10-100 times higher than offices (Mills et. al, 1996).

As energy market deregulation goes into full effect in California, campus managers are faced with the task of ensuring that there is a sufficient power supply at an affordable cost to keep the campus running. Uncertainty in the energy market, resource scarcity and environmental concerns make the need for energy conservation measures and alternatives crucial for the long-term life any institution.

4.3. Results

A series of questions were taken and adapted from the campus environmental audit format in April Smith's book, "Campus Ecology." Energy Program Manager Jim Dewey, Director of Facilities Management David Gonzalez and Zone Leader Paul

Gritt, and from Facilities Maintenance historical utility bill records. Additional information comes from the California Energy Commission, and from a draft energy audit conducted by the Enron Corporation in 1999. Energy data for the UC system campuses is provided courtesy of Gary Matteson. All data included were derived from these sources, although additional library and Internet research was also performed regarding specific issues. The following questions were asked to gauge UCSB's status with respect to energy use.

1. How much energy does the campus use each year? What is the amount of energy used each year per square foot of building space? Per capita of campus population?

The campus consumes more than 80 million kilowatt-hours of electricity and about 2.8 million therms of natural gas each year. This equals approximately 25 kWh of electricity and 0.8 therms of natural gas per square foot of managed building space.

Table 4-3. Summary of campus electricity consumption

Fiscal Year	MGSF*	Campus Population	Electricity (KWH)	KWH/ MGSF	KWH/ person
1999/ 2000	3,191,000	25,387	83,014,663	25.78	3270

Includes recharge amounts
*MGSF: Managed gross square feet of building space.

Table 4-4. Summary of campus natural gas consumption

Fiscal Year	MGSF*	Campus Population	Natural Gas (Therms)	Therms/ MGSF	Therms/ person
1999/ 2000	3,191,000	25,387	3,031,218	949.9	119.4

2. What are the main sources of electricity on campus? What percentages come from each source?

All of the schools in the UC and Cal State system, including UCSB, buy energy from the Enron Corporation under a 4-year contract that expires in 2002. The precise amount of energy consumed by the campus that is derived from different types of power plants is difficult to determine precisely due to the inherent complexities of the energy grid. See Figure 4-1 for power received from each source are based on

California statewide averages (Wetherall, 2000). The campus also has 37 diesel generators, which only supply energy during emergencies.

3. How much money does the campus spend on energy each year?

Costs associated with annual energy expenditures are listed in Table 4-5.

Table 4-5. Summary of campus energy costs

Year	Electricity (KWH)	Electricity Cost*	Natural Gas (therms)	Natural Gas Cost
1999/ 2000	83,014,663	$5,487,911	3,031,218	$1,050,112

*Includes recharge costs

4. Does the campus have any on-site generation facilities? If so, what is the energy source? Do these facilities use co-generation capabilities?

Only a minimal amount of energy is produced on site using solar panels. No other on-site generation occurs, and therefore no co-generation facilities exist. The only on-site energy source is the solar array located on top of one of the dormitories for supplying domestic hot water. The solar panels significantly reduce the amount of natural gas required for this purpose.

Other attempts at installing alternative energy sources on campus have been less successful. UCSB, in partnership with Southern California Edison, installed a 200 kW fuel cell behind the old Gym pool to supplement energy demands. Because high maintenance costs made the unit inefficient to run, the unit was retired in 1998, and was removed from the campus in 2000.

Proposals have been approved for State funding to purchase a new 200 kW fuel cell for Bren Hall. The fuel cell uses natural gas and will serve Bren Hall exclusively, although a co-generation system to recover the waste heat to provide hot water to the dorms has been proposed. There is currently no funding available for the co-generation system. In addition, State funding for the purchase of a 40 kW photovoltaic array for Bren Hall has also been approved.

5. How much carbon dioxide is emitted into the atmosphere from campus energy consumption?

Calculation of CO_2 emissions that the campus is responsible for is complicated by the fact that the amount of emissions varies with time or day and year and with the efficiencies of individual power plants.[*] The following numbers are rough estimations that are most useful for suggesting orders of magnitude rather than actual amounts (see Appendix A for calculations and assumptions).

CO_2 emissions from electricity:	68,146,736 lbs CO_2 /year
CO_2 from natural gas:	36,071,494 lbs CO_2/year
Total:	104,218,230 lbs CO_2/year

In addition, we calculated the marginal amount of CO_2 emissions, or the amount of CO_2 emission reduction that would occur from the reduction of energy use by 1 kWh during peak loads (see Appendix B for assumptions and calculations). Reducing electricity demand by 1 kWh would reduce CO_2 emissions by: 1.79 lbs/kWh in the summer, and 1.31 lbs/kWh in the winter. In other words, if UCSB reduced its energy demand by 1 kW during peak demand in the summer, it would prevent 1.79 lbs of CO_2 from being emitted every hour.

6. What are the main uses of energy on campus?

The biggest use of energy on campus is the operation of HVAC (heating, cooling and air conditioning) systems, and the second largest (non-HVAC) use is lighting. These uses are typical or commercial buildings.

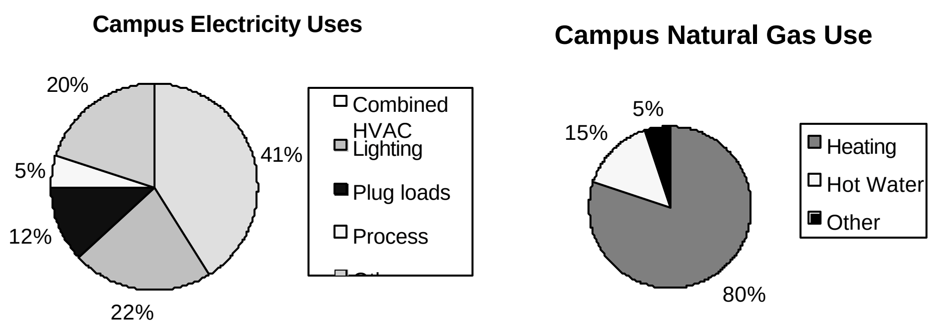


Figure 4-2. Partitioning of campus energy use

7. What buildings on campus use the most energy? The least?

[*] It is possible to determine emissions with more precision using sophisticated computer models. However, these models are generally quite expensive, and were therefore not used for this project.

The engineering buildings are by far the largest consumers of energy on campus. Two new engineering buildings are scheduled for construction in the next 5 years, which will have a large impact on total campus energy consumption. Engineering II uses the most energy (10% of total campus power demand). Other science buildings including Physical Sciences North, Physics and Biology II also have high energy demands. Humanities and Social Sciences Building, which is one of the newest buildings on campus, uses the least amount of energy of all the major campus buildings.

8. How does UCSB's energy consumption compare to other UC campuses?

UCSB ranks 6th among the UC campuses in electricity consumption. Both UC Riverside and UC Santa Cruz consume less electricity (See Figure 4-3). In addition, UCSB uses the least amount of natural gas of any UC campus (See Figure 4-4).

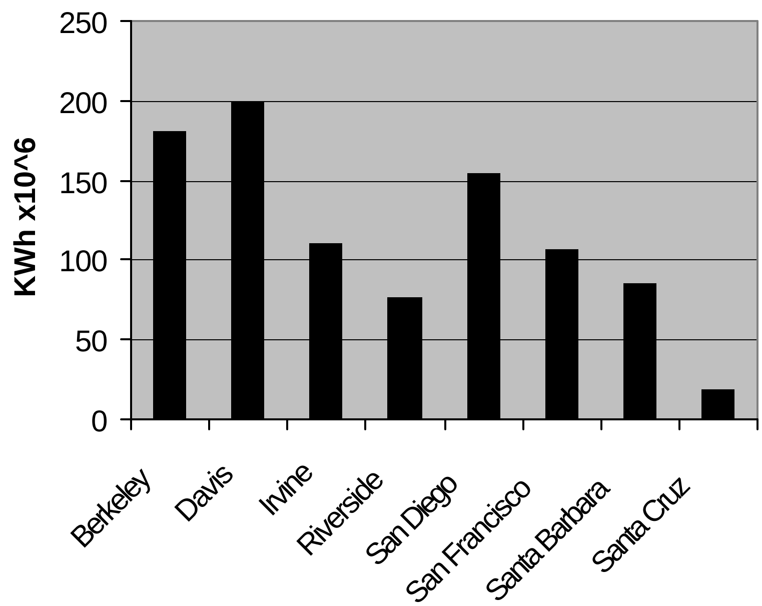


Figure 4-3. Electricity use among the UC campuses

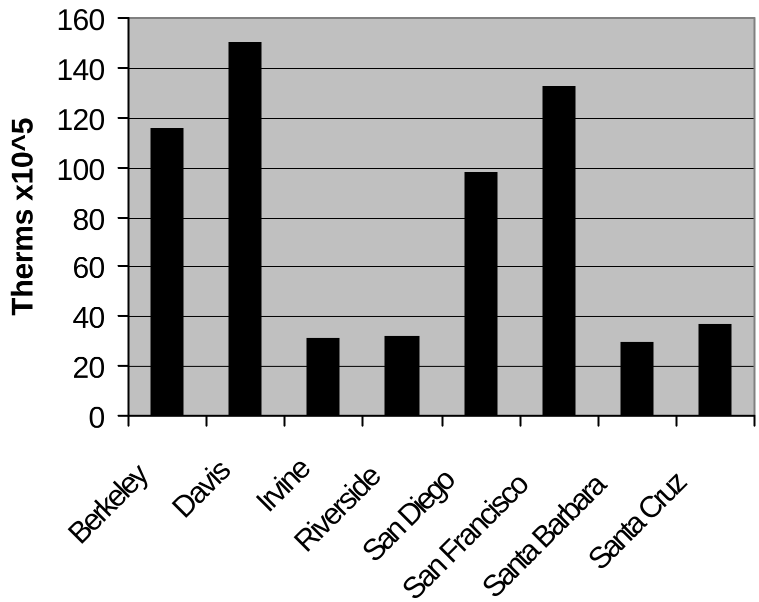


Figure 4-4. Natural gas consumption among the UC campuses

9. What campus programs or policies (if any) exist to encourage energy conservation? When were these policies implemented?

Energy efficiency in California is mandated through Title 24 Section 6, which was implemented in 1978 and updated most recently in 1998. There is currently no campus-wide policy that is backed by the Administration or the Academic Senate to encourage energy efficiency at UCSB. An Energy Program, run by the Energy Team, was established in 1998 through Facilities Management to find ways for the campus to increase energy efficiency, manage peak demands and reduce costs. Energy efficiency measures taken on campus have been the result of efforts by Facilities staff, funded by bonds from the State.

10. What types of energy conservation projects have been completed on campus? How are these projects funded?

The Energy Team has completed a range of conservation and efficiency retrofits, including:

- Installation of a central chilled water loop to meet the cooling needs of 7 campus buildings.

- Installation of a computerized Energy Management Control System for effective management of energy loads.
- Replacement of inefficient mechanical equipment such as pumps and fans with high efficiency models.
- Replacement of two-thirds of campus lighting with high efficiency fluorescent lighting.

Other projects are currently underway or are planned for the near future:

- Expansion of the central chilled water loop to service the majority of the buildings on the main campus, and to switch demand times by producing ice at night for daytime cooling.
- Expansion of the Energy Management Control System.
- Retrofits of the remaining one-third of campus lighting.
- Installation of efficient fume hoods in campus laboratories.

State bonds, through the Energy Efficiency Revenue Bond Program, have funded campus energy-conservation projects. So far, conservation projects prevent the use of more than approximately 43 million kWh and save the University more than $3 million annually in avoided utility costs.

4.4. Analysis of Results

4.4.1 Current Progress/Trends

UCSB currently uses more than 86 million kilowatt-hours of electricity per year at a cost of more than $5,000,000. The majority of this energy comes from coal and natural gas sources, with additional power derived from nuclear and hydroelectric power. Estimates based on projected infrastructure and population increases predict that the campus will be using 135,572,000 kilowatt-hours per year by 2020, a 64% increase (Enron, 2000). As we have seen from rising energy costs in the past year, fossil fuel supply is finite and low energy costs are not guaranteed. Therefore, the University has a strong incentive to invest in both conservation measures and alternative sources.

Strategic Energy Plan

UCSB served as a pilot campus for the development of a Strategic Energy Plan prepared by Enron Energy Services. This alone indicates that UCSB is preparing to address its energy situation in a proactive way, according to Karl Brown, Deputy Director of the California Institute for Energy Efficiency.

According to the Strategic Energy Plan Report (the Report), the current peak demand of the campus is 14 megawatts. With projected growth in campus population and facilities, that level is projected to increase to 22 mw by 2010 using a "business as usual" scenario. However, the report outlines a series of strategies for reducing energy demand, and predicts that demand could actually be reduced to as little as 12 mw by 2010 (Enron, 2000). While the Report does take into account the majority of planned future campus development, it does not consider several projects. Therefore, demand will likely be higher than the estimates predict. However, the potential for drastic improvement still exists in the areas discussed in the Report.

Conservation Projects

Projects that have been completed or are in progress to improve energy efficiency at UCSB indicate that the school is on the right track. The Energy Project staff has completed retrofits on a number of buildings and has recently installed the chilled water loop in the library to serve the majority of campus buildings with efficient cooling capabilities. Energy efficient lighting upgrades have been completed on two-thirds of the campus so far, and efforts are continuing to upgrade the remaining third. The computerized Energy Management Control System has been installed in many areas of campus, and it is in the process of being expanded so that eventually the entire energy system of the campus will be automated. The results of these efforts have been a significant avoidance of energy usage and cost.

Electricity Consumption

While conservation projects are effective, they must be viewed in context with the increasing energy demands of the campus as a whole. Figure 4-7 shows that the total amount of energy consumed per person increased steadily, indicating that the driving force behind increasing energy demand is from building space and plug load rather than rising campus population. The decreasing trend in energy consumption, beginning in 1997-98, noted in all three energy figures correlates with the onset of conservation measures described above, particularly the new chilled water loop and the lighting retrofits. While the trend of the last few years is promising, more must be done to limit energy consumption form non-renewable sources on campus.

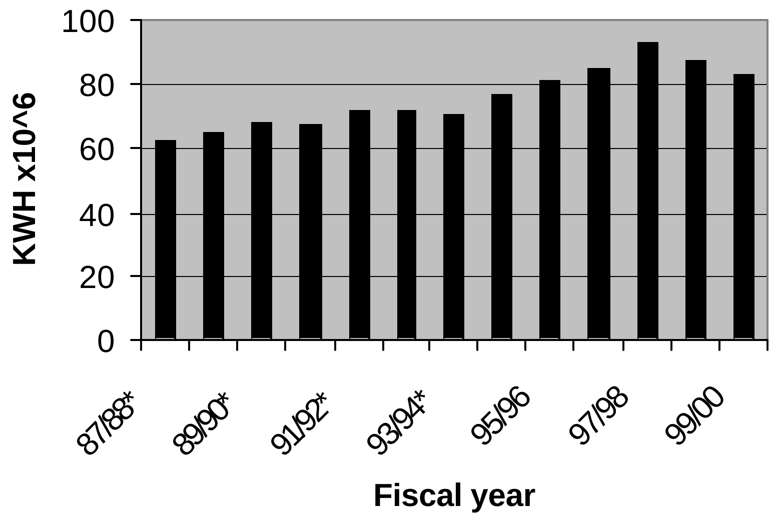


Figure 4-5. UCSB annual electricity consumption.

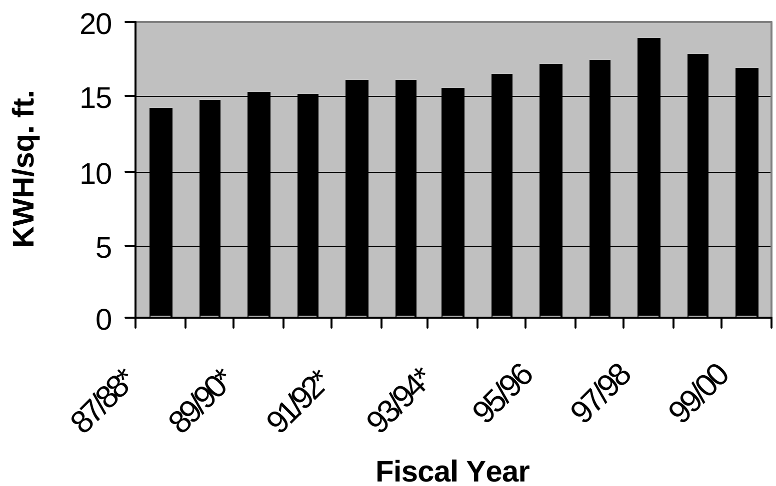


Figure 4-6. UCSB annual energy consumption per square foot.

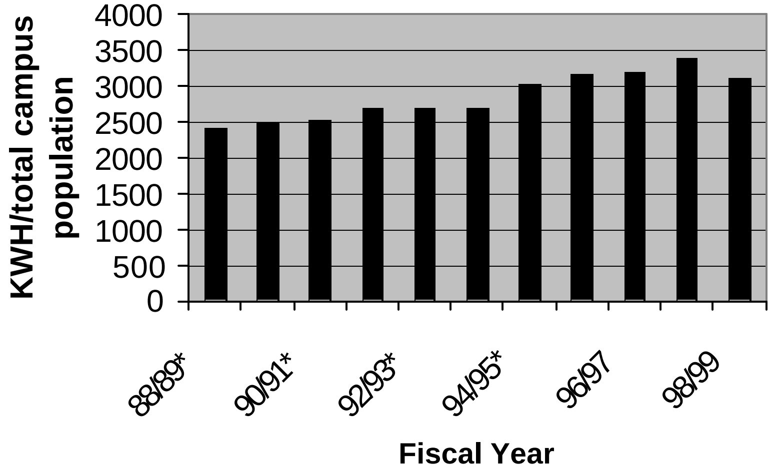


Figure 4-7. UCSB annual energy consumption per capita.

Natural Gas Consumption

Most of the conservation projects on campus have focused on electricity rather than natural gas. Natural gas consumption remained nearly constant between 1988 and 1993, when it averaged around 2,390,000 therms per year. In 1995 gas consumption peaked and has remained high since then, averaging around 2,870,000 per year (see Figure 4-8). This is about 20% higher than previous years. Gas consumption per square foot of building square footage has remained relatively constant (Figure 4-9). Figure 4-10 shows that per capita consumption of natural gas on campus also increased over the past decade. This increase is primarily attributed to the additional heating loads associated with new buildings.

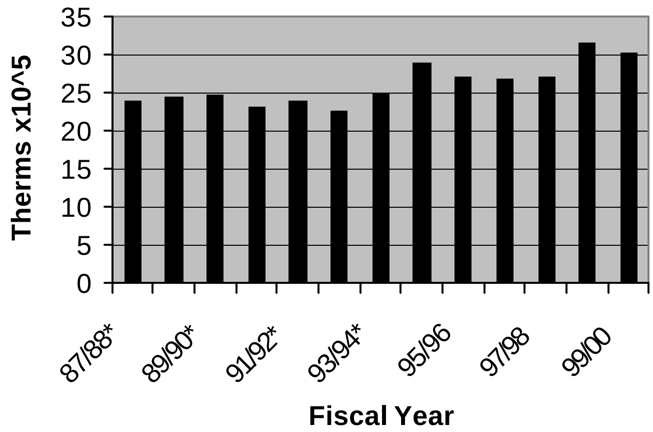


Figure 4-8. UCSB natural gas consumption

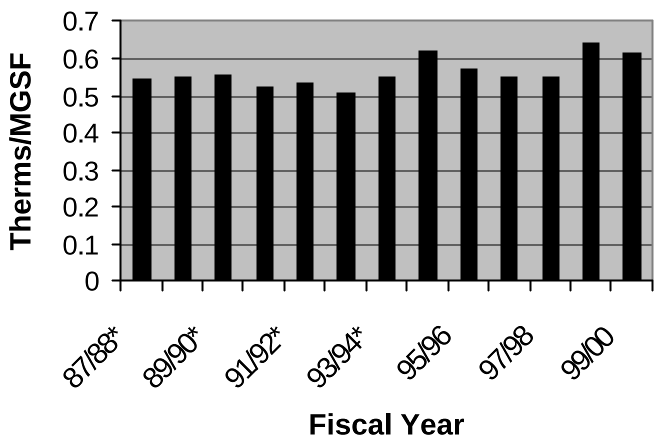


Figure 4-9. UCSB natural gas consumption per unit area

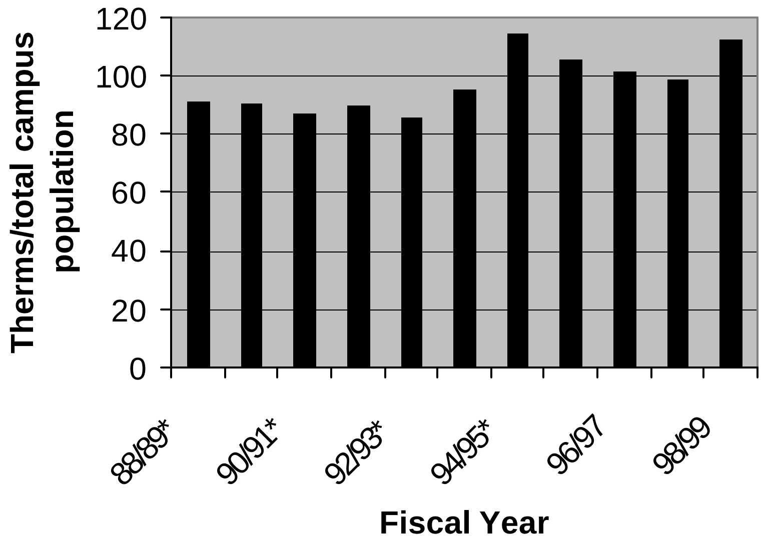


Figure 4-10. UCSB natural gas consumption per capita

Although natural gas is less environmentally destructive than electricity generated by other fossil fuels, it still does have an environmental impact. Furthermore, the economic cost of using natural gas has skyrocketed unexpectedly over the past year, with rates increasing more than 500% between 1999 and 2000, according to the California Energy Commission. Therefore, the University should consider ways to reduce natural gas consumption by making systems more efficient and possibly installing alternative heat generating sources. Some solar panels have been installed on the roofs of dormitories to provide domestic hot water, which has decreased the amount of natural gas consumption. While these panels are a good first step in using solar power, much more can be done in this area.

Future Projects

It is promising that conservation measures have in fact begun to bring consumption levels down. However, consumption is still high, and will continue to rise still higher in the next several years as at least four new buildings come on line. According to a recent survey by Gary Matteson, electricity demands are scheduled to increase by 29% over the next five years (Matteson, 2001). Thus, the University is going to need to expand the types of conservation projects it invests in order to ensure the reliable and affordable electricity supply that is essential for achieving the University's mandate of academic excellence.

The California energy crisis may provide both the impetus and opportunity for investment in such projects. Gov. Davis has emphasized the role of State colleges in conserving energy, and has identified funds through the California Energy Commission to finance projects that could result in energy savings by summer 2001. UCSB has submitted proposals for a broad range of energy projects including improvements in infrastructure, expanded equipment and lighting retrofits, and installation of fuel cells and photo voltaic cells for on-site power generation.

4.4.2 Environmental Impact

Despite the fact that campus electricity consumption has begun to decrease over the past few years in response to conservation projects, the total amount of consumption has remained high. Campus electricity use alone causes around 63 million tons of CO_2 emissions each year, which contributes to global warming. In addition, the campus contributes to some extent to all of the environmental impacts that were previously outlined in Table 4-2.

It is important to note that most of these impacts do not occur on campus directly, and are therefore not within direct control of the University. Instead, the Campus puts demand on a larger system of energy provision, which causes both global and local environmental impacts. Some of these impacts have direct impacts on UCSB's campus, such as oil spills in the Santa Barbara Channel, while others do not directly affect the campus at all, but harm places in other parts of the world. By reducing energy demand and investing in alternative forms of energy production, the University lessons impacts at all scales and also helps open up markets for less environmentally damaging technologies.

4.4.3 Institutional Framework

Funding

The main obstacles associated with energy efforts on campus result from a lack of funding. Unless paid for by bonds, energy projects must compete for funds with other campus projects, including new building construction and an extensive deferred maintenance budget. Alternative energy source equipment generally requires higher first costs than traditional equipment. Therefore funding is often difficult to obtain for these types of projects when life cycle costs are not prioritized.

Energy Team

In 1989, UCSB took over the responsibility of campus energy management from the UC Office of the President. Since that time it has conducted a complete energy survey and begun a series of conservation projects. UCSB's Energy Team, comprised by six full time staff members, is able to look comprehensively at energy use on Campus in order to identify the most effective ways to improve on all energy issues. The goals of the Energy Team are to increase efficiency and reliability while reducing costs and promoting awareness across Campus. No environmental goals are specifically identified, but many of the methods for increasing energy efficiency also yield environmental benefits.

The Energy Team at UCSB is well structured to work toward sustainability on Campus. The main constraint that they face is lack of funds, which often get channeled to other projects because of a lack of a clearly stated commitment to sustainability from the administration.

Zone Structure

Facilities Management has divided Campus operations into separate Zones (Chapter 3 for more details). Zones allow managers to become familiar with specific parts of campus in order to ensure the most efficient operations. This system is also well suited to optimizing energy efficiency, as long as staff members are properly trained in efficiency measures. The fact that some staff members do not feel comfortable with the new computerized Energy Management Control System prevents the potential advantages of this system to be realized.

4.4.4 Financial Support

Energy Contract

The UC and Cal State systems signed a four-year electricity contract with Houston-based Enron Energy Services in 1998. According to the LA Times (Peabody, 2001), the deal has buffered the schools from rate increases and therefore has saved them at least $20 million across all schools over the four-year period. While signing a long-term contract was seen as somewhat of a risk because it could have prevented savings if rates had dropped significantly, it was signed to bring security to these large energy consumers in the face of uncertainty under deregulation. The California university system (including both UC and Cal State schools) consumes 1% of the state's electricity (Peabody, 2001). The deal with Enron represents one of the few cases of users taking advantage of direct access to energy providers under State energy deregulation.

Availability of Funds

One of the main reasons that the most energy efficient equipment is not always used on campus is lack of funding for initial investment. Because new building projects have fixed budgets, value engineering is often required to ensure that projects do not overspend. Energy efficiency is not a primary priority in value engineering efforts;

thus, efficient equipment is sometimes eliminated form projects, even though the initial investment could result in cost savings over time. Energy conservation projects must compete with other capital projects for funding, and priority is often given to new buildings and construction, rather than energy retrofits or equipment upgrades.

Cost Savings

Because energy bills constitute such a large expense for the campus (more than $5 million per year), the campus does have a strong incentive to reduce energy consumption. Projects that increase energy efficiency make sense economically as well as environmentally. For example, energy retrofits on campus (including lighting and mechanical equipment upgrades) save the campus more than $3 million per year in avoided utility costs. Energy saving features of Bren Hall will save $32,000 per year. A cost benefit analysis of the Bren Hall features reveals an initial investment of $148,000, which should yield a net present value benefit of $88,000 over 10 years (Dozier, 2000).

On-Site Generation

Investment in on-site energy generation can be more difficult to justify on economic grounds. Up front costs of fuel cells and photovoltaic cells can be quite high, although these costs are quickly declining in the face of increased demand. While investment in solar water heaters and photovoltaic arrays can pay for themselves in energy savings within 3-7 years, investment in fuel cells still have a longer payback time. For example, the 200-kilowatt fuel cell being considered for Bren Hall will cost approximately $950,000 to install, including infrastructure. The unit would save the campus $46,000 in electricity costs each year based on 1999 electricity prices. At that rate, it would take more than 20 years for the campus to earn back its investment. In an institution where funds are limited and competition for resources is intense, this type of investment is unlikely to be prioritized. However, there are considerations that make investments in on-site generation more attractive.

First, the onset of the California energy crisis will undoubtedly result in energy price increases that could be as much as 40% higher. Natural gas prices have already shot up by approximately 200%. Thus, the payback time for investments in alternative source on-site generation could have dramatically lower payback times. Second, alternative energy sources such as fuel cells and PV cells are clean running, resulting in very little pollution or CO_2 emissions. Current economic evaluations do not consider these advantages, but there is still some value for the university to limit its overall contribution to environmental problems, and this alone could justify the expense. Third, by utilizing co-generation technologies, waste heat can be harnessed to provide heat or hot water to other buildings, thus increasing total annual savings, particularly because of the rise in natural gas prices. Fourth, if the campus is able to generate more electricity than needed to meet its own needs, it can sell the excess back onto the grid at market price. In addition, organizations such as the California Energy Commission and Southern California Edison often provide direct funding or financing programs in order to bring down the initial price of on-site generation equipment. Lastly, advances in technology and increases in consumer demand are continuing to bring the price for alternative energy sources down, making things like fuel cells more affordable.

Other campuses in the UC system have already begun to benefit from on-site power generation. UCLA, UC Davis, UC San Francisco, UC Berkeley and UC San Diego all have on-site co-generation plants, which generate a total of 100 megawatts plus additional building heating (Peabody, 2001). Several funding sources, which have been created since the onset of the California energy crisis, will likely provide opportunities to schools to increase power-generating capacity. Most notably, Assembly Bill 970, passed by the California Legislature and signed by Gov. Gray Davis in November 2000, makes available $50 million to the California Energy Commission to fund projects that reduce peak energy demands by summer 2001. The Energy Team at UCSB has written proposals for 12 projects to be submitted, which would fund a range of projects ranging from continued lighting retrofits to the purchase of fuel cells and PV cells. If funded, these projects could significantly reduce both the financial burdens and environmental impacts of campus operations from energy use.

4.4.5 Innovativeness

UCSB's Energy Team and other Physical Facilities staff members have been hard at work for the past few years identifying efficient ways of reducing energy demand. The two largest areas in this endeavor represent innovative uses of new technologies. The new chilled water loop allows for effective cooling of many campus buildings with a minimal amount of energy input. The system was designed specifically for the campus.

The campus energy team has embarked on a number of projects to increase energy efficiency. Projects include the installation of energy-efficient lighting, the replacement of old motors with energy efficient models, the installation of variable air volume HVAC capabilities, the modification and/or replacement of laboratory fume hoods with energy efficient models, the increase of thermal energy storage capacity, and other miscellaneous projects.

One of the most ambitious energy saving projects on campus has been the installation of a highly efficient chilled water loop in the basement of the library. The chiller currently provides cooling for 7 buildings, and several more will be added to the system in the next few years. When the new chiller became operational, it replaced 13 older and less efficient chillers, as well as associated pumps and fans. New, efficient, variable-frequency models replaced old pumps, so that building temperature can be controlled most efficiently. Plans to expand the system include extending the loop to the majority of buildings on campus, and to use the chiller to make ice at night in order to provide cooling during the day while shifting high demand to off-peak hours.

Another important energy project on campus is the installation of an Energy Management Control System. This system provides real-time data and allows energy managers to assess and control operating systems around campus by computer in order to manage energy loads. This tool has become important during the California energy crisis, when the school has been called on to reduce energy demands in order to prevent rolling blackouts in the State.

The installation of the Energy Monitoring Control System represents another important innovation for the campus. The system allows energy managers to have a level of precise control that was never possible in the past. The system has played an extremely important role during the energy crisis, when campuses were called on to limit energy consumption by up to 7%. Energy managers have been able to shut off different HVAC systems on a rolling basis to cut down on consumption without building users even noticing. By carefully balancing energy decreases with occupant comfort levels, the campus has been able to reduce demands dramatically. This has enabled UCSB energy managers to volunteer to reduce power by 1,750 kilowatts at the request of the California Independent Systems Operator under the ISO Demand Relief Program, one of the highest levels committed by any UC school.

4.4.6 Community/Education

Staff Training

One major area in need of improvement for campus energy operations is continuing education for energy personnel on effective ways to operate new computer-based monitoring equipment. No amount of investment in high-tech equipment can be worthwhile without a staff that is trained to take advantage of it. In addition, training can help boost moral of the staff and encourage them to actively engage with and find ways to maximize sustainability on campus.

Campus Outreach

During the recent energy crisis, Facilities Management sent out emails to all departments on campus notifying them of the ISO declared emergencies and requesting assistance in conserving energy. Many departments have responded by turning off hallway lights and computer monitors in order to decrease energy demand. Other outreach projects include presentation to campus departments and administration, and the formation of a campus energy committee. These efforts are in the process of being expanded in order to increase conservation by campus users.

4.5. Environmental Report Card

Question	Answer	Score
Does the University have an energy conservation program?	Yes	1
Is the total amount of energy consumption decreasing?	Yes	1
Is the amount of energy per square foot building space decreasing?	Yes	1
Is the amount of energy use per capita decreasing?	Yes	1
Does the University meet at least 10% of its energy needs from the use of alternative sources on-site?	No	0
Has the University begun to replace lighting fixtures and bulbs to increase energy efficiency?	Yes	1
Has at least 75% of inefficient lighting been replaced?	No	0
Has the campus begun replacement of inefficient mechanical equipment?	Yes	1
Has at least 75% of inefficient mechanical equipment been replaced?	Yes	1
Do new buildings exceed Title 24 standards for energy efficiency?	Yes	1
Is there a campus-wide policy on energy conservation?	No	0
Are there any outreach programs to increase energy conservation on campus?	Yes	1
	Total:	**9/12**
	Percentage:	**75%**
	Grade	**B-**

4.6. Recommendations

4.6.1 Promote Outreach, Education and Innovation

- Increase continuing education for campus energy managers.
- Encourage energy managers to find innovative ways to conserve energy.
- Educate building occupants, especially office, laboratory, and computer center staff, on ways to conserve energy.
- Use information reporting of departmental performance on energy conservation by publishing consumption statistics on a campus web site.
- Provide incentives for departments to conserve energy.
- Educate students living in dorms on the importance of energy conservation.

4.6.2 Use Energy Efficient Equipment and Alternative Sources of Energy

- Adopt campus-wide building standards for energy efficiency that exceed Title 24 standards.
- Conduct a comprehensive study on the feasibility of alternative energy (solar, wind, fuel cell, microturbines, geothermal, etc.) generation on campus. Employ these options wherever possible.
- Require a minimum percentage of electrical generation purchased from the provider to come from renewable sources (must be UC and Cal State system wide.)
- Require that all campus appliances and electrical equipment have Energy Star labels or meet minimum energy efficiency standards (as outlined by the American Council on an Energy Efficient Economy's annual publication on appliance ratings.)

4.6.3 Continue Energy Retrofits

- Continue efforts to upgrade aging mechanical and electrical equipment such as chillers, boilers, fans, pumps, lighting, etc. with high efficiency alternatives.

- Use high efficiency lighting and fixtures and bulbs (including outdoor lighting and exit signs.)
- Use task lighting to supplement ambient daylighting in work areas. Provide variable and automated daylight-actuated controls so that only the amount of light needed is used.
- Replace older laboratory fume hoods with energy efficient models.

5. WASTE MANAGEMENT

5.1. Introduction

This chapter investigates waste management efforts focusing on: solid waste management, recycling efforts, hazardous waste management, and purchasing practices. The background, environmental impacts, economic issues and campus issues are investigated for each topic. The solid waste, recycling and purchasing practices sections focus primarily on paper and paper goods and office supplies, given their immense presence on university campuses. Although it would be quite useful to look at the environmental standards surrounding the purchase of non-paper items such as computers, photocopiers and other electronic equipment in more detail, it was beyond the scope of the present report.

5.2. Background

Americans generate approximately 208 million tons of trash each year, or more than 4.3 pounds of solid waste per person, per day (U.S. EPA, 1996a). This figure is twice as much as any other country, and waste generation in the US is expected to increase further due to increased population and reliance upon disposable goods. The U.S. EPA predicts that waste generation will increase to 253 million tons of waste by the year 2010 (U.S. EPA, 1996a). There are two primary sources of solid waste in the US: residential waste (which includes single and multi-family dwellings) and commercial waste (which includes schools, industrial sites and some businesses). College campuses primarily fall in the commercial waste sector, with waste generated from a diverse array of activities, including scientific research, the food sector, and office operations. Although the commercial waste sector generated less than half of all U.S. municipal solid waste in 1995, reductions here can still have a major impact on the surrounding ecological integrity.

5.2.2 Waste Management

Communities all over the country generate large amounts of waste, much of which could be prevented, reused or recycled. Effective waste management is a vital function for any community given concerns regarding environmental harm associated with the generation and disposal of waste, limited landfill space, and economic factors. There are three primary steps involved in successful waste management: reduction, reuse and recycling.

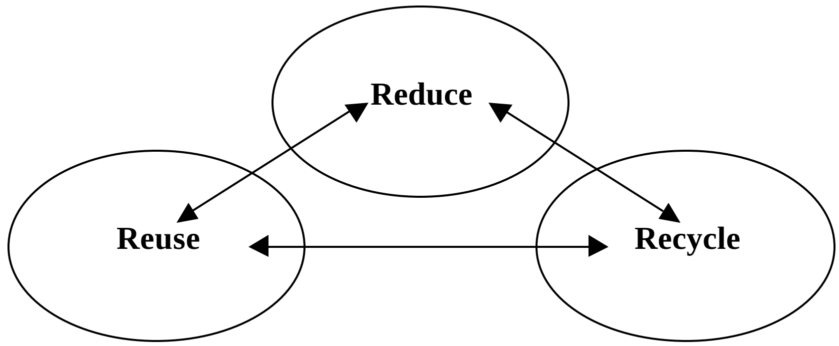


Figure 5-1. Principles of waste management

- **Step One: Waste prevention**: *"Any action undertaken by an individual or organization to eliminate or reduce the amount or toxicity of materials before they enter the municipal waste stream. This action is intended to conserve resources, promote efficiency, and reduce pollution (CIWMB, 1995)."*

Waste prevention (also referred to as source reduction) includes a range of activities, from reduced packaging to preferential purchasing. Waste prevention plays an important role in waste management efforts as it has the potential to reduce the volume of solid waste generated, and thus the amount of waste that needs to be disposed of. This could result in substantial environmental and economic gains for communities at all levels. Waste prevention is generally considered the most important step in waste management, as there will be less need for recycling and disposal if there is less waste generated to begin with.

- **Step Two: Reuse**: *"The recovery or reapplication of a package or product for uses similar or identical to its originally intended application, without manufacturing or preparation processes that significantly alter the original package or product (CIWMB, 1995)."*

The concept of reuse is extremely important as a means for aiding in waste prevention/ minimization programs, as people can reuse products rather than disposing of them. There are numerous opportunities for reuse to occur, given that many products are simply thrown away before they reach the end of their useful lifespan. However, at some point these products will still need to be disposed of, which suggests that reuse should be paired with other steps to ensure for effective waste management.

- **Step Three: Recycling**: *"The process of collecting, sorting, cleansing, treating and reconstituting materials that would otherwise become solid waste, and returning them to the economic mainstream in the form of raw material for new, reused, or reconstituted products which* *meet the quality standards necessary to be used in the marketplace (CIWMB, 1995).*"

Recycling is a two-toned issue, for which both positive and negative arguments have been made. On the one hand, recycling conserves resources by decreasing reliance upon virgin materials. However, recycling is not an entirely 'clean' process, as it still requires the use of significant quantities of resources and energy. Recycling is a beneficial way to manage materials that would otherwise become waste, and for waste that cannot be prevented, recycling is the next best choice.

This discussion suggests that an effective waste management strategy will typically incorporate one or more of these steps. However, experts agree that waste prevention is the most effective way to control municipal solid waste, and thus all waste management programs should begin with a focus here.

5.2.3 Legislation

Solid waste legislation has been implemented on both the federal and state level. Of utmost importance to UCSB is State Legislature Bill AB675 (AB75), which took effect on January 1, 2000. This bill states that municipalities, including UCSB, must reduce landfill weights by: 25% by the year 2002, and 50% by the year 2004. This bill is a continuation of AB 939, which called for similar landfill reductions by 1995 and 2000. Many communities in California failed to meet regulated waste reduction levels mandated by AB939, and had to ask for extensions to avoid $10,000/day fines. Therefore, a new challenge now lies in meeting solid waste reduction levels as mandated by AB75.

Over the years, the disposal of hazardous materials has become more stringently regulated. UCSB currently has two key legislative considerations: RCRA and California SB-14. The Resource Conservation and Recovery Act (RCRA), managed by federal authorities, requires 'cradle to grave' tracking of hazardous wastes. In 1991, the U.S. EPA authorized the State of California to implement RCRA in this state. In fact, the California program is more stringent than the federal program in many respects. Lastly, "right-to-know" laws at both the federal and state levels require users of hazardous materials to submit information regarding materials used and accidental releases of hazardous substances to regulatory agencies (Smith, 1993).

5.2.4 Environmental Impacts

The high energy and materials requirements of today's industrial societies may seriously impact the environment over time, both in terms of product manufacturing (use of non-renewable resources) and product disposal. Universities have an important relationship with these two areas, given the large amount of goods purchased and disposed of by students, faculty and staff. However, the true environmental impacts associated with the use of a product from cradle to grave are not fully understood. An overall assessment of environmental impacts associated with both waste generation and disposal is outlined below.

Waste Generation

There are significant environmental costs associated with the extraction of materials and the manufacturing of products that are used in substantial quantities by large institutions. The manufacturing of products and materials results in the depletion of minerals, the use of large quantities of energy, the depletion of native forests, the non-renewable use of petroleum, and water and air pollution. The environmental concerns associated with the continued increase in waste generation spill over into any future waste-management efforts. With less generation of waste to begin with, there is less of a need to address treatment and disposal issues. Therefore, taking steps to target the waste problem at the first step, waste generation, will yield the greatest future returns.

Waste Disposal

The generation of large quantities of waste subsequently makes it necessary for more means of waste disposal to be identified, which in itself is an extremely time consuming, controversial and costly activity. Each year, approximately 130 tons of municipal solid waste (MSW) ends up in landfills across the country (Earth Work's Group, 1990). There are great uncertainties regarding the effects/impacts of the disposal of such large quantities of waste. No one knows what kinds of hazards we will face in the future from the garbage, some of it toxic, that is already buried in the ground (Rafthje and Murphy, 1992). In addition, landfill space is limited and other disposal methods have not proven popular. Landfill disposal is dangerous for many reasons:

- Landfills commonly release gasses that consist of naturally occurring methane and carbon dioxide. These gases form inside the landfill as the waste decomposes. As the gases form, pressure builds up inside a landfill, forcing the gases to move. Some of the gases escape through the surrounding soil or simply move upward into the atmosphere, where they drift away. Typically, landfill gases that escape from a landfill will carry along toxic chemicals from sources such as paint thinner, solvents, pesticides and other hazardous volatile organic compounds (VOCs), many of them chlorinated (Montague, 1998). While there are no solid data regarding the true amount of greenhouse gasses emitted by landfills, EPA models estimate that they may contribute as much as 35% of total U.S. greenhouse gas emissions, thus posing a significant threat (Phillips, 1998). The release of methane gas, in particular, is a serious issue, as methane has been recognized as a greenhouse gas contributing to global climate change.

Landfills typically generate methane for decades, gradually releasing the gas into the atmosphere. Although technological innovations have been designed to deal with this problem in new landfills, existing landfills are still a potential source of danger.

- In addition to gas emissions, landfills also have the potential to contaminate groundwater supplies due to leakage contaminated with toxic materials. The U.S. EPA estimates that approximately 75% of the 55,000 landfills in the U.S. are polluting groundwater reserves (Jones-Lee and Lee, 1993). Municipal solid waste (MSW) landfill leachate contains a wide variety of hazardous chemicals, conventional contaminants, and non-conventional contaminants. Contamination of groundwater by such leachate renders it, and the associated aquifer, unreliable for domestic water supply and other uses (Jones-Lee and Lee, 1993). Numerous studies have revealed a significant correlation between the contamination of groundwater supplies and public health risks, such as cancer, birth defects, and mutations. Thus, great attention must be placed on the prevention of groundwater pollution by MSW landfill leachate.

5.2.5 Economics

In general, economics provide a common forum for the discussion of costs and benefits associated with environmental issues. However, deriving the true costs and benefits associated with any activity is rarely a straightforward activity. For example, measuring the costs associated with purchasing recycled-content products may be easier to determine than the benefits associated with the decreased use of virgin products. The waste sector, however, does provide some useful sources for measuring economic impacts such as the price of disposal (land filling vs. recycling) for various goods and materials.

Cost of Waste and Waste Management

As was noted with respect to the environment, there are significant fiscal costs associated with the extraction of materials and the manufacturing of products. Waste generation results in large fiscal costs, due to the increased use of non-renewable energy and material sources, resulting business inefficiencies, and the mere fact that by wasting more, you get less out of what you produce and/or purchase. Waste management itself is an activity that amounts in significant costs for individuals, communities and regional authorities due to labor, equipment, facility and temporal costs.

Municipal Solid Waste

Waste collection is the single most expensive component of a solid waste management system, representing ~2/3's of the cost of managing MSW (APWA, 1976). By decreasing the amount of waste generated to begin with and concurrently increasing recycling efforts, there exists a great possibility to note significant monetary savings. Although recycling is more expensive than traditional solid waste management methods, many industry leaders have proven that it is possible to do right by the environment and still make a profit. For example, the nations' three largest solid waste companies, which offer collection, hauling and disposal services, produced total revenues in excess of $17 billion in 1994 (Phillips, 1998).

Hazardous Waste

Hazardous waste notes fiscal issues similar to those of MSW, although the majority of costs here relate to disposal. Hazardous waste is very expensive to dispose of, given the serious environmental and health impacts associated with exposure. Finding an area to dispose of hazardous waste is a difficult, costly and time-consuming task in itself. Most hazardous waste is disposed of in states such as Arkansas, Louisiana and Utah. The safe transport of hazardous waste across thousands of miles to these areas results in large fiscal costs. In addition, there are significant liability concerns for those who use and dispose of hazardous waste. Should hazardous waste leak from its disposal site to contaminate the surrounding air, water or soil, those who sent their waste to the disposal site could face large monetary fines. Although these costs may not be incurred for several years, they could cause great financial stress for an institution such as a university, and should thus be considered carefully. By reducing an institution's reliance upon and quantitative use of hazardous materials, there is thus a great opportunity to reduce that institution's fiscal burdens.

Costs Associated with Recycled-Content Products, etc.

In the past, most companies that shied away from the use of recycled-content products did so for economic reasons (i.e., recycled-content goods cost significantly more than virgin goods). However, in recent years, the market has noted a smaller price difference between these goods. In addition, many programs have now been instituted to encourage the use of recycled goods. Although recycled-content goods still cost more than virgin goods for most products, the economic theory of economies of scale suggests that as demand for a product grows, supply will grow, thereby lowering the price. Thus, increased demand for recycled-content goods by institutions with great purchasing power (such as universities) will likely help drive the price down for such goods.

5.2.6 Campus Issues

Solid Waste

Waste management is a serious issue at institutions such as universities, where thousands of people live and visit daily. The average college student produces 640 pounds of solid waste each year, including 500 disposable cups and 320 pounds of paper (Earth Works Group, 1990). Given this average, UCSB alone is estimated to generate more than 16.2 million pounds of waste each year.[3] Serious human health and ecological threats may be associated with the generation and disposal of such large quantities of waste.

Hazardous Waste

Americans discard more than 2 million tons of hazardous waste each year, approximately 2/3 of which makes its way to a landfill. This is a serious concern given that significant environmental and human health hazards may be associated with landfill leakage. Although educational institutions typically produce less hazardous waste than industrial facilities, a 1990 EPA report estimated that colleges and universities generate 4,000 metric tons of a wide variety of hazardous substances each year (Keniry and Egan, 1998). Large universities offer a diverse array of academic programs, many of which are rooted in the sciences and include the use of hazardous chemicals and substances in laboratories. Laboratory chemicals create the largest category of university hazardous waste, although toxic substances are also used in art, architecture, photography and theatre departments (Smith, 1993). In addition, maintenance work, grounds keeping and university research activities also add to the mix. Most chemical use in laboratories is tightly regulated, while miscellaneous use for arts-and-crafts and maintenance may lack proper handling and disposal procedures. In general, the disposal of hazardous materials has become more stringently regulated and more expensive in recent years. This trend, combined with the notion that hazardous waste found on college campuses may pose a significant threat to both the natural environment and to human health, demonstrates the need for proper hazardous waste management.

Waste Management Efforts

There are two clear solutions to the waste dilemma faced on university campuses. One solution involves generating less waste to begin with, while the other emphasizes diverting waste from landfills via reuse and recycling. Reduced waste generation is typically achieved in conjunction with recycling efforts, indicative of a strong partnership between the two waste management efforts. By reusing and recycling old materials, there will be less of a need to procure new ones. Thus, the depletion of

[3] Calculated as 640 pounds multiplied by approximately 25,000 students.

non-renewable resources may be lessened in accordance with the principles of sustainability.

Recycling

Recycling on college campuses has grown tremendously in recent years in an effort to protect natural resources via the transformation of solid waste into a valuable commodity. There are currently four "R's" associated with campus recycling efforts to "close the loop": Reduce, Reuse, Recycle and Buy Recycled. Recycling is often seen as an extremely viable option for campuses, as many goods may be sold for a small monetary gain. In addition, recycling is a highly visible activity that is relatively easy for people to engage in. This makes the chance of success more likely than for other less tangible aspects of waste management. Although recycling has served a vital role in waste management efforts to date, there is a growing sense that recycling efforts may have reached their peak capacity. While recycling is an essential part of any campus waste management plan, a stronger focus on waste prevention and reuse to begin with would greatly reduce the amount of materials to be recycled.

Purchasing

Although recycling has made great headway in recent years, it is clear that recycling alone will not ensure sustainability. There is a great need to 'close the loop', by creating a demand for recycled products. Purchasing marks the entry of most goods and services into the campus system, making this gateway one of the best sites for environmental innovation. Through careful purchasing policies, university procurement staff can support a range of environmental practices, while also closing the recycling loop. Due to the large amount of money spent and the large quantities of goods purchased, institutions of higher education can play a key role in developing the market for environmentally friendly goods and services. Higher education expenditures in the U.S. exceeded $186 billion in 1992-93; college students spent another $45 billion and college bookstore sales in the U.S. reached $6.5 billion in the same year (Keniry, 1995). Although these figures are somewhat outdated, it is clear that college campuses engage in large amounts of purchasing which could drive the market for recycled products via their exercising of "purchasing power." There are many economical options available today for the use of recycled products, which will greatly complement waste prevention efforts.

Inherent in purchasing decisions is not only recycled-content, but also general environmental concerns. For example, the transport of products from far away has significant environmental costs. By choosing to purchase goods from local vendors, universities can cut down on the transport of goods from far away. This will thus reduce emissions of CO_2, a significant contributor to the greenhouse effect and global warming. These problems, with both local and global implications, need to be seriously considered when making purchasing decisions.

Recycled-content products are made from materials that would otherwise have been discarded. Items in this category are made totally or partially from material destined for disposal or recovered from industrial activities.	**Post-consumer content** refers to material from products that were used by consumers or businesses and would otherwise be discarded as waste.	**Recyclable products** can be collected and remanufactured into new products after they've been used. These products do not necessarily contain recycled materials and only benefit the environment if recycled after their use.

5.3. Results

A series of questions were taken and adapted from the campus environmental audit format in April Smith's book, "Campus Ecology." Interviews were held with members of Mary Ann Hopkins from Facilities Management, Steve Howson and Jeri DuBoux from Central Stores, Ken Bowers from the UCen Bookstore, Bruce Carter from Environmental Health and Safety, Lara Jensen from Associated Students Recycling and the Santa Barbara Community Environmental Council. All data included were derived from these sources, although additional library and Internet research was also performed regarding specific sections. The following questions were asked to gauge UCSB's status with respect to waste management efforts.

5.3.2 Solid Waste

1. How much solid waste does UCSB generate annually?

In 1999, UCSB disposed of 5,536.19 tons of solid waste.

2. What are the sources and types of this waste?

According to a waste-composition-study administered by Facilities Management, the types of waste generated at UCSB may be classified in Table 5-1. However, it is not possible to break down trash generation by source at this time.

Table 5-1. Types of waste at UCSB

Material	
Cardboard	Chairs
Office Pack	Wooden Pallets
Shredded Paper	Electric Motors
Newspress	AC & Concrete
Aluminum	Computers
Clear Glass	Wire
Brown Glass	Antifreeze
Green Glass	Batteries
Mixed Glass	Radiators
Co-mingled	Tires
Magazines	Metal
Steel Cans	Green Waste
Masonry Blocks	Recycle Refuse*

3. How much solid waste was landfilled last year and what were the associated costs?

UCSB landfilled approximately 3,299.35 tons in 1999-00. Although no specific costs are available for landfilled waste, associated costs for total trash services provided by Marborg totaled $675,000/year, and Facilities Management considers this a good estimate for the cost of landfilled waste.

5.3.3 Hazardous Waste

4. How much hazardous waste does the campus generate annually?

Approximately 128 tons of hazardous waste were generated in 1999-2000. This consisted of 42 tons of laboratory waste and 86 tons of asbestos abatement.

5. How is the hazardous waste disposed of?

Table 5-2 shows the breakdown hazardous waste disposal.

6. What are the total hazardous-waste disposal costs in a single academic year?

Costs associated with the disposal and transport of hazardous wastes on campus amount to approximately $106,600 / year, excluding asbestos. Most University

Table 5-2. Hazardous waste disposal

Material	Amount Disposed (lbs)	Disposal Method
Flammable Liquid	31302	Reused as fuel
Flammable Liquid/ Corrosive	3842	Incinerated / Treated
Corrosive	6377	Incineration
Oxidizer	1386	Incineration
Toxic Organic	3638	Incineration
Toxic Inorganic	2731	Incineration
Flammable Solid	207	Incineration
Misc, non-RCRA[1]	5053	Recycled / Landfilled
Batteries	1023	Recycled / Landfilled
Photo Waste	1679	Recycled / Treated
Mercury	184	Recycled
Gas Cylinders	231	Treated
Oil	805 gallons	Recycled
PCB	33999	Incinerated / Landfilled
Asbestos	102936	Landfilled
Scintillation Fluid[2]	3058	Recycled / Poured down drain

[1] This category includes waste subject to California state regulations, but not to federal regulations.
[2] Scintillation fluid is used as a medium to detect radiation and is typically one of two types; one is an alcohol and the other is biodegradable.

wastes average about $2.82/lb. with the more reactive or toxic chemicals reaching as much as $45/lb.

7. Does the campus have a history of violating hazardous waste disposal regulations?

The campus does not have a history of any hazardous waste violations.

8. Has the campus initiated a hazardous waste reduction program?

Yes, Senate Bill SB-14 outlines the need to reduce waste. On campus, Environmental Health and Safety makes an effort to educate people as well in the following areas: conducting microscale experiments, using less hazardous chemicals, purchasing only what is needed, and participating in the campus Chemical Exchange Program.

9. When was the hazardous waste reduction program implemented and what have savings been to date?

The program was established in 1989 in response to SB-14. It is not possible to obtain data on savings generated.

10. Is there a system in place for tracking and inventorying hazardous chemicals bought and used? If so, please describe.

UCSB developed a tracking system for chemicals and hazardous waste brought into the campus system in 1989. This system has since undergone two new versions; however, it does not have capabilities for tracking waste exiting the UCSB system.

5.3.4 Recycling

11. Does the University currently have a recycling program?

Yes, the UCSB Recycling Committee was formed by Vice Chancellor David Sheldon in 1989. This committee brought together the key players that were affected by recycling and committed to its success on campus. The Committee was created in response to the need for a coordinated program or collection strategy to handle the large volumes of recyclable material generated on campus. The committee is composed of staff, faculty, and students; representatives from the offices of Budget and Planning, Facilities Management, University Center (UCen) Dining Services, UCen Operations, Central Stores, Housing Environmental Office, A.S. Recycling Program, Community Environmental Council, and the County of Santa Barbara. Associated Students (AS) recycling is also involved in the collection of waste from recycling bins around campus, as well as outreach to faculty, staff and other campuses.

12. What is the budget for the UCSB recycling program? How is it funded?

There is no official budget in place for Facilities Management and the UCSB Recycling Program; however, and some money is obtained from the Refuse Bill and the Grounds Department (total amount not specified). In addition, A.S. recycling receives ~$0.75 per student per quarter, for an annual budget of approximately $15,750.

13. What types of goods are recycled on campus? How many tons of each material were recycled during the last year? What are the associated costs?

See Table 5-3.

Table 5-3. Quantities recycled in 1999

Material	Tons Recycled in 1999	Cost of Recycling
Cardboard	250.02	**FREE**
Office Pack	158.75	**FREE**
Shredded Paper	2.64	**FREE**
Newspress	135.93	**FREE**
Aluminum	0.26	**FREE**
Clear Glass	4.76	**FREE**
Brown Glass	2.07	**FREE**
Green Glass	3.05	**FREE**
Mixed Glass	27.67	**FREE**
Co-mingled	18.94	**FREE**
Magazines	0.44	**FREE**
Steel Cans	10.53	**FREE**
Telephone Directories	4.15	**FREE**
Masonry Blocks	8.65	**FREE**
Chairs	1.86	**FREE**
Wooden Pallets	15.28	**FREE**
Electric Motors	7.64	**FREE**
AC & Concrete	264.00	**FREE**
Computers	9.67	**FREE**
Paint	1.05	**FREE**
Wire	615 (lb.)	**FREE**
Antifreeze	220 (gallons)	**FREE**
Batteries	480 (lb.)	**FREE**
Radiators	200 (lb.)	**FREE**
Tires	1,820 (lb.)	**FREE**

Material	Tons Recycled in 1999	Cost of Recycling
Metal	314.32	**$125 per ton + Dumpster Rental**
Green Waste	96.22	**$33 per ton**
Recycle Refuse*	896.86	**$45 per ton**

*Recycle refuse includes both trash and recyclables that are sorted through at Marborg's Material Reclamation Facility for recycling.

14. How does this compare to past performance?

The Campus recycled 40.4% of its solid waste in 1999, which is an increase of ~2000% since 1992-93. However, the Campus has also noted a 7.4% increase in landfilled waste from 1993-1999.

5.3.5 Procurement

15. What percentage of recycled paper and goods does the university currently purchase? What are the associated costs?

Table 5-4. Central stores recycled product purchasing

Year*	Virgin Paper**	Recycled Paper
1997-1998	59,073	11,028
1998-1999	52,934	20,297
1999-2000	48,305	25,739
Change 97-00	**- 18.23%**	**+ 133.40%**
Cost 1999	**$3.26/ream**	**$3.56/ream**

*July 1 – June 30.
** All information presented in reams of paper (~500 sheets per ream).

Central Stores: Central Stores purchased 25,739 reams of recycled paper in 1999-00. Costs, which includes price with tax and delivery, are slightly higher for recycled paper vs. virgin paper.

University Bookstore: The Bookstore does not have a tracking system in place for purchases of individual items, which makes it difficult to quantify the amount of recycled content goods purchased by the Bookstore. The head of recycled product purchasing estimates that recycled content products occupy approximately 10% of total Bookstore shelf space for paper products. In addition, the gifts department's shelves contain ~20% recycled content cards.

16. What types of recycled paper products does the campus purchase?

Central Stores: Central Stores purchases recycled paper for photocopiers, writing needs, printers, etc.

The University Bookstore: The Bookstore offers a variety of recycled paper products, including notebooks, loose-leaf paper, sketchbooks, note cards, greeting cards and some stationary. In general, the Bookstore attempts to offer at least one recycled alternative for each paper product it sells.

17. Who are the University's major suppliers?

Central Stores: Office Supplies: Central Stores purchases office supplies from a variety of sources including: Boise Cascade, Corporate Express, and Office Depot. Paper: Central Stores gets the best price on paper directly through manufacturers. UCSB has been using Xerox for the last 8-10 years (#3R2047). However, all departments have funds at their discretion that allow them to purchase from any outside vendor without tracking.

University Bookstore: The Bookstore is composed of three main sectors: 1) the core academic department (managing textbooks, supplies, computers and general books), 2) the gift department (offering cards, stationary, wrapping paper, etc.) and 3) the emblematic department (which offers clothing, stickers, mugs, etc. with the UCSB insignia). The core academic department is fed by a variety of suppliers including: McGraw Hill, Prentice Hall, Thompson, Ampad, Top Flight, Esselte, Strathmore and Macintosh. The gift department is supplied by ~250 vendors including Hallmark, Sherman and the Recycled Content Paper Company. Finally, the emblematic department is fed by 20-50 different suppliers.

18. Do suppliers offer any products made from post-consumer recycled materials?

***Central Stores*:** Boise offers many recycled products for departments to buy from. 3M also offers a recycled post-it-note pad, although high costs now preclude Central Stores from purchasing them. Xerox offers a 30% post consumer waste recycled content paper, which appears to be as high as they go right now. They recently upgraded from 20% about 6-8 months ago without even telling their customers about it.

University Bookstore: Paper product suppliers Ampad, Top Flight, Esselte and Strathmore all offer recycled content products. In general, approximately 75-80% of Bookstore paper suppliers offer recycled content products, although suppliers for other products do not. The gift department was unaware of any suppliers offering recycled content products.

19. What is the campus purchasing policy for furniture?

UCSB is part of a UC system-wide agreement for purchasing furniture, which has a current contract with Steelcase. Thus, departments are supposed to buy all furniture through Central Stores. This agreement significantly lowers the costs of purchases. In fact, we get lower prices on furniture purchases than anyone else in the nation. However, this contract is due to expire on 12/31/00. The contract will then be put out to bid and the results of that bid will determine the next contract vendor. (The Bren School was able to get out of this contract by demonstrating their need to purchase environmentally sound materials).

5.4. Analysis of Results

5.4.1 Current Progress / Trends (Solid Waste)

In general, material consumption and disposal on campus has increased over the past 7 years (see Figure 5-2). Solid waste to be disposed of on campus has increased by 74% since 1993, although some of this may be attributed to an increase in population and construction on campus. It is encouraging to note that although solid waste generation has increased in the past decade, the amount of solid waste being recycled has also increased by ~2000%.

The overall increase in waste generation from 1992-93 on may be partially attributed to increased construction on campus, large volumes of green waste resulting from El Niño events during that period, and a 10% increase in campus population. It is unclear why 1997-98 registered a dip for both waste generation and recycling.

Per capita waste generation has increased by ~57% since 1993 or an average of 8% per year (See Figure 5-3). However, there was only a 10% increase in campus population during this time period. This suggests an overall trend towards increased per capita waste generation, and points to the need for a strong source reduction campaign at UCSB. There are three primary components of source reduction:

1. Create products that use fewer material and energy resources.
2. Design merchandise for longer life and greater durability.
3. Reuse materials rather than discarding them.

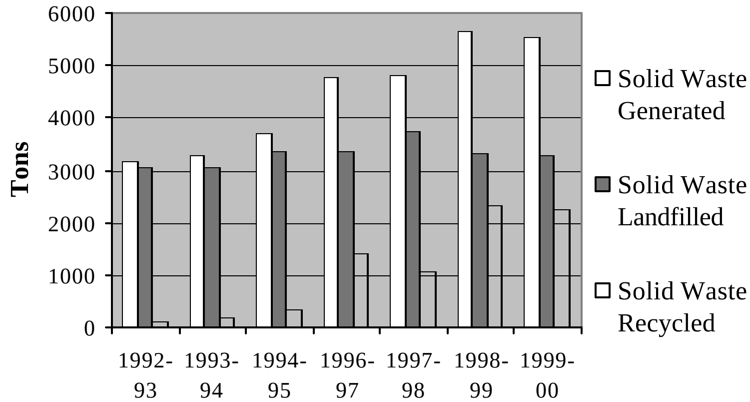


Figure 5-2. Waste generation, landfilling and recycling (92-93 to 99-00).

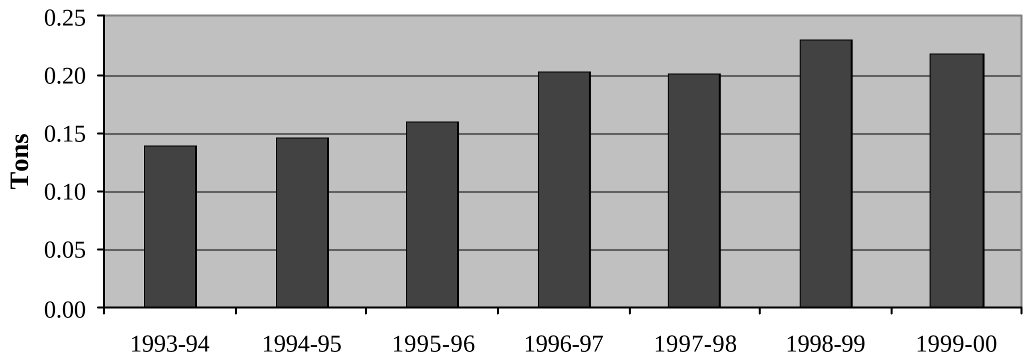


Figure 5-3. Waste generation per person at UCSB

Although some of these components will have to be addressed at the point of product design and manufacturing, UCSB can strive to selectively contract with vendors that adhere to these principles whenever possible. Consumers (such as universities) have an opportunity to drive the marketplace due to the large influence of "consumer purchasing power." Students, faculty and staff can choose to purchase those products that are manufactured in an environmentally conscious manner and to boycott those products that are not (See Purchasing Practices). Such actions would result in an increased presence of products on campus with lesser environmental impacts.

Legislative Issues

Many terms of regulation have been created in recent years to deal specifically with the issue of waste reduction. In 1990, State Legislature Bill AB939 was put into effect. This bill required all municipalities to reduce landfill weights by 25% by 1995 and by 50% by the year 2000. This deadline has come and gone, leading to the formation of State legislature bill AB675 (or AB75), which took effect on January 1, 2000. This bill states that municipalities must reduce landfill weights by:

- 25% by the year 2002;
- 50% by the year 2004.

Although Santa Barbara as a whole failed to meet regulated waste reduction levels mandated by State Legislature Bill AB939, UCSB exceeded AB939 levels by 10.1% from 1995-1999. However, a new challenge now lies in meeting solid waste reduction levels as mandated by State Legislature Bill AB75. Although this law is not entirely understood by members of the solid waste community, it is generally believed to pertain to waste reduction with respect to landfill weights from the year 2000. Thus, current landfill weights will serve as a baseline for improvement over the next four years. Although UCSB has made great strides in terms of reducing the amount of trash making its way to the landfill, the amount of waste generated on campus is still increasing. It is clear that solid waste is still a major issue on this campus, and that material consumption needs to be cut drastically in order for sustainable efforts to proceed.

5.4.2 Environmental Impacts (Solid Waste)

Office Pack – A Never Ending Challenge

In 1999, UCSB kept 161.39 tons of 'office pack' from the landfill. However, a 1999 waste stream audit showed that office pack is the main ingredient (~67%) of our landfilled trash. This is a serious concern, given that the items falling under the office pack category are fully recyclable. In addition, preventing office pack from entering the landfill results in significant savings across many realms. The 161.39 tons of 'office pack' that UCSB kept from the landfill in 1999 (via recycling) saved:

- 1,106,00 gallons of water
- 316 gallons of oil,
- 9,400 pounds of air pollution,
- 474 cubic yards of landfill space,
- 663,600 hours of electricity (about 79 years of electricity for a two bedroom house,)

- 2,686 trees, and
- more recycled paper products were produced (Facilities Management, 2001).

Although we are recycling more office pack today than ever before, it is important to remember that there is still room for great improvement by further reducing the 67% of office pack making its way into the landfill each year. Office pack can be recycled back to its high quality content many times. For example, a piece of un-shredded paper can be recycled back to paper seven times before being recycled to a lesser grade of product such as cardboard fill (Facilities Management, 2001). In general, although we have done a good job in the recycling arena, we are simply going to have to do better.

Landfill Issues

UCSB currently sends its waste to be landfilled to Tajiguas Landfill. This 80-acre landfill, located in a confined canyon, provides landfill disposal for the unincorporated areas of the south coast of Santa Barbara County, the City of Santa Barbara, and the Cuyama Valley. The Tajiguas Landfill is located 26 miles west of Santa Barbara, immediately north of Highway 101 along the California coast, and began accepting waste in the late 1960's as a County-owned and operated venture. It was slated to reach its permitted capacity early in the year 2000 unless measures are taken to extend its life and usefulness. This date has come and gone, and the County is still investigating an expansion of the current landfill space or a move to an alternate location. The County must prepare an Environmental Impact Report (EIR) to initiate either of the proposed expansion projects or an alternative project. However, either choice raises objection from interested parties and will result in significant fiscal costs. Both the expansion of the existing landfill or the move to an alternate site will result in environmental damage. Therefore, any efforts undertaken by UCSB to reduce its amount of landfilled waste could result in a substantial environmental gain.

5.4.3 Institutional Framework (Solid Waste)

Committees & Partnerships

Recycling efforts at UCSB have increased drastically since the creation of the Recycling Committee in 1989. These efforts are primarily responsible for the decreased landfill loads noted in recent years. There are many key personnel involved in the actual pick-up and management of recyclable goods disposed of on campus. The A.S. Recycling staff collects materials from the exterior recycling clusters, custodians collect 'office pack' from the interior of the buildings, and groundskeepers collect trash in the fourth section of the recycling clusters. The A.S. Recycling staff also provides educational outreach to University departments regarding purchasing practices, by promoting the following ideals: purchase recycled paper, look for "post-consumer content" when making a purchase, and support recycling by initiating a buy-recycled policy throughout the department. The networking of many key players on campus has contributed to the formation of a strong recycling program.

University Focus

Most waste management efforts undertaken by UCSB to date have focused on the end products (i.e., product disposal). While the University has a strong recycling program in place, no such source reduction campaign has yet to be developed. This is a serious omission on the part of the University given that waste prevention is generally viewed as the most effective way to control municipal solid waste. With the generation of less waste to begin with, the University could note the following benefits: decreased disposal weights, reduced environmental impacts associated with manufacturing and disposal, reduced waste disposal costs, savings in material and supply costs, savings from more efficient work practices, and the use of fewer resources in dealing with waste disposal issues. Therefore, a strong source reduction campaign would result in decreased environmental damage as a direct result of University operations.

5.4.4 Financial Issues (Solid Waste)

In 1994, the Associated Students (A.S.) Recycling Committee, which is a member of the UCSB Recycling Committee, brought momentum to campus recycling by successfully presenting the spring (1994) General Elections ballot with a lock-in fee of $.75 per student per quarter. This now funds the A.S. Recycling Program. In just two years, the A.S. Recycling Program was able to provide the campus with a grant to purchase much needed outdoor containers for collecting glass, newspaper, aluminum, and plastic. This grant has also provided jobs and invaluable experience for many interested students. However, no formal budget is in place for recycling efforts undertaken by Facilities Management on campus. They receive some money from the Grounds budget, but this is a very negligible and inconsistent amount. In addition, it is unclear if monies exist to aid in the promotion of a strong source reduction campaign on campus.

Monies Saved

By increasing recycling and diverting wastes from the landfill, UCSB has avoided the cost of disposal, which is linked to the tipping fees that are paid to landfill operators when waste is disposed of. Based on this assumption, the University could potentially save $150,000 on disposal costs by increasing the use of recyclable products on campus. Since recycling is basically a free-of-charge service for the University, and land filling costs $45/ton, substantial gains could be realized by increased recycling efforts.

Recycling **Free**	**Green Waste** **$33/ton**	**Landfill** **$45/ton**

The development of an on-site composting facility could also result in financial savings for the University. Green waste currently costs $33/ton to haul off campus for composting. Given that UCSB disposed of 96.22 tons of green waste in 1999-2000, there exists a potential savings of ~$3200. However, the greatest financial gains for the University would likely stem from a successful source reduction campaign, resulting in less waste to be disposed of to begin with. The completion of a successful source reduction campaign could allow the University to reclaim a significant share of its current $675,000 annual waste disposal costs.

5.4.5 Innovativeness (Solid Waste)

BERTHAS

Facilities Management and the UCSB Recycling Committee designed recycling bins, commonly known as BERTHAs, in 1995. These bins have four compartments for the disposal of trash, paper, plastic & aluminum and newspaper. There are ~61 BERTHA bins located at various, convenient locations around campus. The contents of these recycling bins are picked up and hauled by A.S. Recycling bicycle riders. This innovative recycling bin design has been purchased by Ventura County and many other UC schools (such as UC San Diego and UC Davis), pointing to UCSB's role as a leader in the university recycling movement.

WasteWise

UCSB joined the EPA's WasteWise program in 1999. WasteWise is a free, voluntary, EPA program that aids U.S. organizations in the elimination of costly municipal solid waste, resulting in both economic and environmental benefits. WasteWise is a flexible program that allows partners to design their own solid waste reduction programs tailored to their needs, focusing on reducing, reusing, and recycling solid waste materials. The University has not reported to the WasteWise program for this year, although it is expected that the results of the year 2000 waste stream audit will soon be sent out for analysis. Waste stream audits undertaken by the University are extremely beneficial, as they can aid in improved waste management efforts by identifying the percentage of waste in campus dumpsters destined for the landfill that could be recycled.

Associated Student Recycling

The Associated Student Recycling Program has designated outreach coordinators that are responsible for waste management education on campus. The outreach coordinators are responsible for educating the incoming staff and students as well as keeping in touch with the more resident population at the University. These outreach coordinators administer the Green Awards Program to promote their waste goals and to recognize departments and campus organizations that strive to improve their waste prevention methods, increase their use of recycled content materials, and participate in recycling efforts (Andrande et al., 2000). This program began in 1997 and serves several purposes: it acts as a form of internal recognition, stimulates competition among departments and other organizations such as the copy centers that produce quarterly readers for students, and results in increased awareness of waste management efforts and responsibilities. The awards are administered based on the results of a detailed questionnaire documenting department waste management practices, and the winners are publicized via e-mail and in campus publications, such as the Daily Nexus newspaper. The questionnaires serve a dual role: (1) they help to determine which departments are worthy of a Green Award, and (2) they provide information for focusing outreach efforts, by highlighting opportunities for improvement. In addition, A.S. Recycling uses specially designed bicycles for the collection of recyclable materials from BERTHAs around campus. The use of these bikes demonstrates A.S. Recycling's commitment to the environment, as they emit none of the traditional pollutants associated with automobile transportation and provide high visibility for campus education.

On-Site Recycling Refuse Facility

Facilities management recently completed a design for, and received approval for, a recycling refuse facility on University grounds. This facility will cover ~40,250 ft^2 and will feature six main components:

- Worm composting bins (using reclaimed wood and some pre-consumer food waste).
- Recycled-concrete bins (for the reuse of small pieces of concrete on-site).
- Two 40-yard green waste bins (collection area of green waste to be composted off site).
- A 25-yard bin for recycled refuse (this refers to all trash collected on campus, not in a BERTHA bin, that is sorted through for recyclables before disposal).
- Three 4-yard recycle containers (to house recyclable materials from the surrounding area for pick-up by CEC).

- Mulch storage (for reuse on campus).

The presence of this facility will make a small dent on compost production for use on-site by the campus. However, it will divert a significant amount of green waste from the landfill. In addition, the presence of this facility on-site serves as an opportunity to educate the campus community about composting, green waste and opportunities for the reuse of such materials on campus. Similar experiments with such a facility at UC Berkley resulted in the generation of very fine compost, which is currently sold by UC Berkley for $3 a bag. Given time to develop, this facility on the UCSB campus may yield similar outputs and produce compost good enough to be used on campus.

University Bookstore

The University Bookstore does its own recycling of cardboard boxes at the UCen. The Bookstore also offers a container for the recycling of plastic shopping bags in the front of the store. The Bookstore started to let people bring backpacks a couple of years ago in order to cut back on the use of plastic, petroleum-based shopping bags. This has worked better than they ever imagined, with an estimated 75% decrease in the use of these bags and no need to reorder for quite some time. In line with this activity, the Bookstore also trains cashiers to always ask if customers actually need a bag. This activity has also proven overwhelmingly positive, as a majority of consumers choose to place their purchases in their backpacks.

5.4.6 Community & Education (Solid Waste)

In 1986, UCSB recycling formed a relationship with the Santa Barbara Community Environmental Council (CEC). Once discarded items make their way into the appropriate recycling receptacles, they are taken to the blue recycling dumpsters located on campus, which are provided and serviced by the CEC. The CEC is a non-profit environmental organization based in Santa Barbara that sells recyclable materials collected from UCSB. If the proceeds generated by the sale of the recyclable materials exceed the cost of service (which is completely covered by the CEC), the surplus is returned to UCSB. However, this typically does not amount to a large sum of money. Although UCSB does not reap the traditional benefits associated with the collection of recyclable materials (i.e., the funds from their sale), neither do they bear the traditional costs associated with the transport and disposal of these materials. This has proven an efficient community partnership, aided by open lines of communication and equal trade offs between benefits and costs.

Facilities Management

Facilities management donates building materials such as paint, tiles and flooring to Habitat for Humanity. Other items are also donated to the Santa Barbara Community Environmental Council and Art from Scrap, a local art studio.

5.4.7 Current Progress / Trends (Hazardous Waste)

Unfortunately, reliable data regarding hazardous waste purchasing is only available for two years, 1998 and 1999. No data were available for tracking the disposal of hazardous waste off of the UCSB campus. The current head of the campus hazardous waste program came onboard in 1998, and he was unable to verify computer records (many of which were quite discombobulated) prior to that date. A 16.4% increase was noted in the purchase of hazardous material liquids in liters from 1998 to 1999, along with a 61.6% increase in the purchase hazardous waste solids. In 1999, hazardous waste disposal was broken down as shown in Figure 5-4.

5.4.8 Environmental Impacts (Hazardous Waste)

UCSB currently disposes of the majority of its hazardous waste via transport to states such as Utah and Arkansas for land filling. Hazardous waste generation and disposal has negative environmental impacts, as does improper handling. As was mentioned previously, hazardous waste could potentially leak from its disposal site to contaminate the surrounding air, water or soil. Although this could result in irreparable damage to the surrounding environment and community, no clear link to UCSB has been noted with respect to these activities.

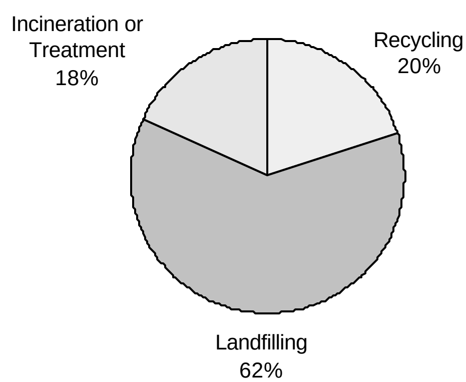


Figure 5-4. Disposal of hazardous waste

5.4.9 *Institutional Framework (Hazardous Waste)*

The hazardous waste facility was built in 1993, making it a relatively new structure/program. Through a partnership with the CEC, this center has also been used to host a household hazardous waste program. In terms of campus operations, the hazardous waste stream may be broken down as follows: 1) solvents (acetones, ethanols, etc.) used in experiments and for cleaning glassware in labs; 2) lab waste (ex. specimen preservation in the biology department); 3) other categories (ex. spray paint cans, organic debris from mechanical engineering, pump oil, gas, and water contaminated with ether).

The hazardous waste program recently switched their pickup procedure, which has had a large impact on the amount of hazardous waste now being disposed of. Prior to July of 2000, EH&S had a recharge basis for all labs, whereby labs were charged a gross amount of money for material pickup ($40/gallon) regardless of the material type. Labs now pay indirectly for pickup service via grant money received by each department. This change may be viewed as both an aid and a hindrance to hazardous waste management efforts on campus. On the one hand, departments now pay for the true costs associated with their trash disposal. Researchers now have no excuse to illegally dispose of hazardous waste or store it indefinitely to avoid financial costs. On the other hand, these researchers now have no incentive to minimize the amount of waste generated since the cost of disposal no longer hits them directly in the pocket book. However, EH&S thinks that this new collection system is much better for the local environment and the safety of employees in the laboratories.

Chemical Exchange Program (CEP)

Chemical exchange programs on other UC campuses have proven quite successful in recent years in terms of reusing chemicals and reducing the amount of hazardous waste and chemicals making their way to disposal. Unfortunately, this program has not yet met with such success at UCSB. Currently, other UC websites provide a means for viewing what chemicals people are offering or people can offer something themselves. All UC schools were required to participate in the CEP or similar program because of SB-14, written in the late 1980s. This bill states that large hazardous waste generators such as universities need some waste minimization program in place. Another catalyst for the development of the CEP at UCSB was the realization of the extremely high cost of hazardous waste disposal. Engaging in more reuse at the University level could significantly cut these high costs (See Table 5-5).

Table 5-5. Hazardous waste disposal costs

Material	Disposal Costs
55 gallon drum of paint	$270 / drum
Flammable paint	~$200 / drum
Mercury	~$35 / pound
Ordinary chemicals	~$2.50 / pound

5.4.10 Financial Issues (Hazardous Waste)

General Issues

As was stated in the preceding survey, disposal of hazardous waste from the UCSB campus costs ~$106,000 a year. Land filling hazardous waste is the cheapest root for disposal; however it typically is not a popular disposal option given that most chemicals are restricted from being landfilled. In addition, land filling is quite risky due to the potential for future liability if the landfill leaks or if public buildings are built on top of it after closure. Recycling and incineration cost roughly the same, ~$2.82/lb., with the more reactive or toxic chemicals reaching as much as $45/lb. Although many costs associated with the use and disposal of hazardous waste may not be incurred for several years, they could cause great financial stress for UCSB, and should thus be considered carefully. Reduced reliance upon and quantitative use of hazardous materials could thus greatly reduce UCSB's future fiscal burdens.

Chemical Exchange Program (CEP)

The detriment of the Chemical Exchange Program (CEP) at UCSB may be primarily attributed to a lack of funding and staffing for the CEP website. This website is a vital component of a successful program, as it allows people to easily post and view materials available for exchange. Although this website is not up and running yet, EH&S has attempted to provide some of these services themselves. For example, if EH&S notices a reusable chemical placed out for disposal and pickup, they will contact the Chemistry department regarding reuse. However, this is only a small effort that likely has a small impact on waste minimization. The formal development of the CEP at UCSB will prove necessary for any significant improvements to occur, improvements that could significantly decrease UCSB's annual hazardous waste disposal costs.

5.4.11 Innovativeness—Microscale Experiments with Hazardous Waste

Science labs are the main generators of hazardous waste and chemicals on campus, pointing to the need to address issues at this scale. EH&S estimates that they currently pick up ~30 gallons of waste from Chemistry each week, composed of solvents and solvents mixed with toxic materials. However, this likely represents an improvement over past performance as at least one series of the undergraduate chemistry program has been converted to microscale experiments. Microscale experiments were developed in the late 1970's, and are expanding in their use around national colleges and universities. These experiments are miniaturized versions of standard laboratory experiments, using quantities a hundred to a thousand times smaller than before. Benefits associated with the use of microscale experiments include improved laboratory air quality, overall lab safety, better, more consistent results, and lesser time requirements. In addition, the cost of purchasing chemicals and disposing of wastes are also greatly reduced (Smith, 1993). UCSB currently uses microscale experiments in Methods of Organic Lab Chemistry 6A and 6B, and in many biochemistry labs. The use of this technique has occurred primarily in large labs containing hundreds of students. Smaller, upper level courses do not use microscale techniques, given that these students need more practical lab scale experience and there is less material used overall. Thus, it is unclear how effective or realistic the future expansion of these techniques would be in the Chemistry department. However, there may be an opportunity to further this practice in the Biology department.

5.4.12 Community & Education (Hazardous Waste)

EH&S has formed a successful relationship with the CEC. The EH&S facility is open on Fridays for use by small businesses and on weekends for use by the Santa Barbara community. Approximately 7000 people a year dump hazardous waste (typically photowaste, paint and batteries) via the CEC household hazardous waste program.

EH&S' number one stated goal is to reuse and recycle hazardous waste and chemicals on campus whenever possible. This has been accomplished, in part, by giving away items in good condition through CEC's household hazardous waste program. This materials exchange program provides goods for free to the public. In addition, when large quantities of a reusable product are generated on campus, EH&S may attempt to solicit interest from businesses. For example, Facilities Management recently had a large reserve of tar available for disposal. EH&S contacted a local contractor/ company that could use the tar. This resulted in a large cost savings of ~$4,000 for the department. This is an example of an ideal partnership for the campus. Unfortunately, however, savings of this magnitude tend to be recognized only once every few years. More common is the reuse and recycling of lab waste (which represents the majority of hazardous waste on campus), which accounts for little cost savings.

5.4.13 Current Progress / Trends (Procurement Practices)

Paper & Paper Products – Central Stores

Purchasing of recycled content paper by departments at UCSB has increased a hundred-fold in the past decade, from 0 reams in 1988-89 to 25,739 reams in 1999-00. However, the amount of virgin paper purchased has increased over this time period as well, by ~28%. Given that the University's population has only increased ~10% over this time period, it appears that paper use per person has increased on campus, indicating increased reliance on paper products in general. However, figures from recent years paint a positive picture for environmentally conscious purchasing at UCSB. From 1997-2000, virgin paper purchases decreased by ~18% and recycled-content paper purchases increased by ~133%. This may be partially attributed to specific steps taken by Central Stores and by increased quality of recycled-content paper and paper products in general.

Paper & Paper Products – UCSB Bookstore

It's difficult to quantify the amount of recycled content paper and paper products purchased and sold by the Bookstore or to compare current performance with past performance due to a lack of available data. However, it is clear that the Bookstore has steadily increased their recycled content product offerings. These efforts have been aided by the fact that increased competition in the recycled paper goods market has led to decreased prices. However, the gift department has noted that the recycled content craze of past years has started to die down, resulting in fewer advertised products for them to purchase. The Bookstore currently attempts to offer at least one recycled option for each major paper product the Bookstore offers, and to bring in new recycled content products whenever possible. However, recycled products currently occupy only ~10% of total shelf space for paper goods, and ~20% of total shelf space for greeting cards, which suggests that their presence, while growing, is still quite small. This is of concern given that general supplies (which include paper products) account for $4.03M of annual sales, and greeting cards account for $150,000 of annual sales. Changes in these relatively large areas could significantly impact UCSB's environmental impact. In addition, the Bookstore does not offer recycled content products for anything outside of paper and paper products, which points to the fact that the environmental movement in this area is only in the beginning stages of success.

5.4.14 Environmental Impacts (Procurement Practices)

In order to accurately measure the environmental impacts associated with a product, it is useful to consider the environmental costs of material extraction, manufacturing, product use and disposal. Virgin products often require the extraction of non-renewable materials from the earth, significant energy and resource requirements during manufacturing and use, large emission of pollutants into the environment and the permanent loss of land to land filling. In general, the production of recycled-content products is less polluting, cheaper and more energy-efficient than taking new material from the environment. For example, one ton of 100 percent post-consumer recycled paper saves 20 trees, 7,000 gallons of water, and enough energy to power a typical home for six months (Green Seal, 1995). In addition, 60 pounds of air pollutants are eliminated and three cubic yards of landfill space are spared. This is just one example in a series of many that points to the significant savings to be realized by the production and purchase of recycled-content products.

5.4.15 Institutional Framework (Procurement Practices)

Central Stores

Although the increase in recycled content product offerings and sales noted by Central Stores are encouraging, these numbers do not tell the whole story, as over 200 departments engage in purchasing via an independent route. Approximately half of the campus has a delegation to spend $500/day per vendor (any vendor they choose), while the other half has a delegation to spend $2500/day per vendor. Those with a higher delegation simply have more ‘purchasing’ training, and can also purchase from any vendor they choose. Central Stores would only get involved for ‘equipment’ purchases – i.e., a free standing object, with a one year life-span and a cost of $1500 or more (so the supplier of a PC under $1500 is up to the department’s discretion). This creates somewhat of a problem, as it is virtually impossible to track department spending under this arrangement. In addition, departments simply choosing to purchase cheaper, virgin paper at another outlet may negate any good moves made on Central Stores behalf. Thus, any sort of an environmentally conscious purchasing policy developed through Central Stores for departments at UCSB would likely meet with limited success. A change in the institutional mindset is needed to make environmentally conscious purchasing practices a priority regardless of the point of sale.

Furniture

Central Stores at UCSB is just beginning to get involved with recycled-content furniture, in part due to the Bren School’s request for recycled furniture in their new building. However, recycled-content is only one facet of sustainable furniture. Pollution prevention, waste prevention, energy conservation, regulatory compliance and educational outreach are also extremely important factors to consider when choosing a furniture vendor. The UC system currently has a contract with Steelcase furniture for all campus furniture purchases. However, this contract is due to expire on 12/31/00. The contract will be put out to bid and the results of that bid will determine the next contract vendor. During a system-wide meeting in the spring of 2000, buyers from the UC campuses met to discuss the elements of the bid document, and it was decided that a section would be included to address the issue of recycled content. Most of the large companies the UC system has dealt with in the past offered refurbished furniture within their line; however, this type of product was not traditionally part of the contract due to the large discounts dictated by the vendor's contract for traditional furniture. In addition, most of the companies that offer recycled-content furniture are not large enough to handle the volume generated by the University system. There are currently four primary companies capable of handling the UC system bid: Steelcase, Haworth, Herman Miller and Knoll (Westinghouse). Although each company has a different focus in terms of their environmental efforts, all are committed to environmental issues and have the ability to serve the UC system as a practical contract vendor. Cost issues here should not be of a 'non-environmental vendor vs. and environmental vendor' type, given that the UC system has decided that environmental concerns should be a part of the vendor's contract. Rather, cost comparisons here should only be made between the four companies presented.

University Bookstore

The Bookstore has demonstrated a pretty proactive stance in seeking to enlarge current recycled content product offerings. The Bookstore looks at the UCSB student body as a very defined and exclusive audience with whom they need to make a strong link with their values and interests. In this spirit, the Bookstore has been quick to change when student concern and voices have been raised. In addition, extensive donation regimes have been established by the Bookstore throughout all of its departments, which aids substantially in the campus' connection with the surrounding community. However, no policies are in place at this point to ensure for the continued purchasing of recycled content products in the future. Although there are a number of dedicated personnel heading Bookstore operations, a stated environmental purchasing policy that could be demonstrated at all levels of the Bookstore would substantially aid in sustainability efforts. This is a great pitfall of the Bookstore, especially given that they have a very large impact on campus with ~$14M in annual sales.

5.4.16 Financial Issues (Procurement Practices)

Recycled paper currently costs more than virgin paper for one simple reason: economies of scale. The production of recycled paper is actually a less expensive process than non-recycled papermaking (Davis and Kinsella, 1990). However, recycling mills are small compared to traditional paper mills, resulting in a higher comparative production cost, and thus a higher price for the consumer. With increased demand (and increased technologies) for recycled products, more suppliers will enter the market, resulting in lower prices as a result of increased competition. Thus, it is clear that buying recycled products also creates a demand, lowering the price difference between recycle and non-recycled goods. This financial factor, along with increased environmental awareness, will undoubtedly greatly aid the sustainability movement.

Recycled Products Purchasing Cooperative

Although recycled paper is still slightly more expensive than virgin paper, new initiatives have been developed to encourage increased use of recycled paper. The Recycled Products Purchasing Cooperative (RPPC) is an example of one such entity. The RPPC is a collaborative non-profit effort aimed at increasing the amount of recycled paper used by businesses and public entities. Membership in the program is free, and members receive recycled paper at prices that often meet or beat the price on non-recycled or virgin fiber paper. The RPPC states that 2000 member purchases are expected to reach over 50,000 cases, saving water, energy, and the equivalent of 10,000 full grown trees (RPPC, 2001). The RPPC currently provides 30% post-consumer recycled copy paper that is thoroughly tested and recommended by the US Government Printing Office. The RPCC plans to carry higher post-consumer paper in the near future as well.

Central Stores

Table 5-6 displays the cost of all paper purchases at Central Stores in 1998-99. Paper here includes envelopes, paper, tablets and padded envelopes. Spending on recycled-content paper has clearly increased in recent years, and as a result of the annual 'May sale' (see innovation section below), recycled-content paper purchases as a percent of total paper purchases, have increased from ~33% in 1997-98 to ~46% in 1998-99.

Table 5-6. Central Stores paper purchases for 1998-1999

Year	Spending – Virgin	Spending - Recycled	Percent Recycled
1998-1999	$ 302,921	$ 263,342	46.5%

University Bookstore

As was previously mentioned, increased competition in the recycled goods market has led to decreased prices overall. Although recycled content products are still more expensive to purchase than traditional products, the Bookstore will often consider taking a smaller profit margin in order to make them available at a price that will sell. The retail pricing decision at the Bookstore is always tied to an awareness of the consumer and what they will spend to acquire a product. As for items in the gifts department, the Recycled Content Product line comes from Utah with a very high price point. This is a poor seller among students, as are handmade cards and stationary, which also garner a higher price. The head of the gifts department stated that they may be willing to take a profit cut here and offer more of these types of goods if given some sense of overall dedication to sustainability by the Bookstore as a whole.

5.4.17 Innovativeness (Procurement Practices)

Central Stores

Central Stores has held a large May sale for recycled paper the past two years. This sale is intended to convert virgin paper users, and actually costs Central Stores money as they sell the recycled-content paper at a lower mark-up price. Central Stores currently charges a smaller markup for recycled-content paper than for virgin paper, although they could charge a much higher markup for their recycled paper. This decreased price (which took effect last year) was for socially conscious reasons, and it demonstrated a measure of goodwill on the behalf of Central Stores.

University Bookstore

Every February the Bookstore has a big sale where customers who trade in old sweatshirts get $10 off a new sweatshirt. They then donate these used sweatshirts to local charities. Over the past couple of years, the Bookstore has faced problems regarding the manufacturing of their emblematic line and other accessories (ex, backpacks) due to sweatshop concerns associated with their ~20-50 vendors. The Bookstore is currently working with sociology professor Rich Appelbaum to perform an experiment testing if students really will prefer to buy clothes made domestically. They are trying to find two shirts of the same quality and features to sell side-by-side: one made from all-union production and one made in a sweatshop. The Bookstore has taken the initiative here and is committed to working with the community to find an equitable solution for this problem.

General Campus Issues

There are several campus issues regarding purchasing practices that may not fall entirely within either Central Stores' or the Bookstore's jurisdiction. One such example is the purchase of photocopier machines. Photocopiers potentially have a large impact on the environment given the large amount of electricity they use, the consistency of their use, and the large quantities of paper passing through a photocopier per day. UCSB currently has 14 active vendors for copiers that cost more than $2,500, including Konica, Sharp, Minolta, Xerox, Linear, Toshiba, Aficio and others. Individual departments put out some general specifications tailored to their needs and present these to the bidders with the help of Central Stores. The library recently completed a bidding process for a new fleet of copiers for a total copy center that will all use recycled paper. A new vendor, using Konica copiers, stepped in in September to handle the transition to all recycled paper photocopiers. Each of these machines will cost 10 cents per copy, which is less than it cost in previous years to copy on the two recycled paper photocopiers previously offered in the library. The switch to recycled-paper copiers has been hampered by concern regarding the performance of recycled vs. virgin paper in photocopiers. However, a recent Garbage magazine article stated that more than 80 percent of the commercial printers polled reported that recycled paper's performance was equal to or better than that of non-recycled paper (Davis and Kinsella, 1990). In order to deal with these concerns head on at UCSB, A.S. Recycling is currently undertaking a study to test the performance of recycled paper vs. virgin paper in multiple copiers around campus. Positive results will hopefully provide an impetus for dissuading performance fears in the community.

Although this report focuses primarily on paper and paper products and office supplies, the U.S. EPA is creating a growing market for environmentally friendly goods such as electronic products and building materials via their Energy Star program. UCSB could potentially reap substantial financial rewards from a conversion to these products by joining the Energy Star Purchasing Initiative.

5.4.18 Community & Education (Procurement Practices)

University Bookstore

The Bookstore provides bins for people to donate used clothing and goods, which are then donated to the Unity Shoppe, the Santa Barbara Rape Crisis Center and transition homes in the area. Paper goods that cannot be sold by the Bookstore due to a small amount of damage are donated to local schools, along with computer products that are donated for reuse. In addition, seasonal greeting cards that are not sold are donated to local schools and educational organizations around Santa Barbara for arts and crafts activities. Backpacks that are returned to the bookstore are also donated, further expanding the Bookstore's idea that 'nothing should ever get thrown away.'

5.5. Environmental Report Card

Indicator	Answer	Score
Solid Waste		

Has solid waste generated per capita decreased over the past 7 years?	No	0
Does the University currently have a waste management policy in place?	No	0
Has this policy been effective in decreasing waste generation?	NA	
Does the University currently have a source reduction program?	No	0
Has this program been effective in decreasing waste generation?	NA	
Does the University currently have a reuse program?	No	0
Has this program been effective in decreasing the amount of waste to be disposed of?	NA	
Does the University currently have a recycling program?	Yes	1
Has this program been effective in increasing recycling rates on campus?	Yes	1
Does the University provide public information regarding solid waste statistics?	Yes	1
Has the University increased the amount of waste being recycled in the past 7 years?	Yes	1
Has the University decreased the amount of waste being landfilled in the past 7 years?	Yes	1
Does the University have any community partnerships in place related to waste management?	Yes	1
Hazardous Waste		
Has hazardous waste generated per capita on	No	0

campus decreased over the past 3 years? (Data were not available for 7 year time span)		
Has the campus initiated a hazardous waste reduction program?	Yes	1
Has this program been effective in decreasing waste generation?	No	0
Does the University provide public information regarding hazardous waste statistics?	No	0
Does the University focus on means other than land filling for hazardous waste disposal?	Yes	1
Does the University dispose of less than 50% of hazardous waste via land filling?	No	0
Does the campus have a history of violating hazardous waste disposal regulations?	No	1
Purchasing Practices		
Does the University have criteria for purchasing paper and paper products according to environmental standards/ requirements?	No	0
Does the University have criteria for purchasing furniture according to environmental standards/ requirements?	Yes	1
Does the University purchase any products made from post-consumer recycled materials?	Yes	1
Does the University purchase at least 50% of all products purchased that are made from post-consumer recycled materials?	No	0
Does the University sell any products made from post-consumer recycled materials?	Yes	1
Does the University offer at least 50% of all products for sale that are made from post-	No	0

consumer recycled materials?		
	Total:	**12/23**
	Percentage:	**52%**
	Grade:	**C-**

5.5. Recommendations for Improvement

5.5.1 Solid Waste

- Reduce the amount of materials used and the amount of waste generated on campus by developing a strong source reduction campaign for all campus operations. This activity should take priority over other waste management efforts, as it has been successfully documented that success in this arena will decrease the need for future waste management efforts. A successful source reduction campaign could be developed with the assistance of the NWF Campus Ecology Program or the EPA Waste Minimization Program.
- Decrease the use of paper on campus by establishing an office electronic mail system and using communications networks for the dissemination of information to students, faculty and staff.
- Eliminate paper forms and critically review the use of all standard forms for routine operations. Forms should be provided on the web and accepted by electronic submission.
- Gradually replace all copiers and printers with those capable of handling recycled content paper and double sided printing.
- Decrease reliance on disposable items. Make durability and ability to recycle key components of all purchasing decisions.
- Develop a composting facility on campus for green waste, which takes up valuable landfill space and costs the University money to compost off-site.
- Develop a system for segregating waste generation by source, in order to identify those areas of campus generating the largest amounts of waste. Based on these results, an incentive mechanism could be developed to promote waste prevention measures.

- Get involved with resource-renewal programs for replacing the resources used by the University. Plant enough trees to replace the paper used annually on campus.
- Provide a symposium on alternative paper products such as kenaf, bamboo, and straw/hemp paper. These materials produce more product per acre than do trees, alleviating the pressure to replace forest habitat worldwide with tree farms.
- Print all recruitment materials on recycled letterhead.
- Require that all professors accept double sided papers.
- Require that the campus newspaper, the NEXUS, print all copies on recycled newspaper.

5.5.2 Hazardous Waste

- Reduce the toxicity of materials entering the campus waste stream.
- Eliminate or reduce the use of hazardous materials on campus. Identify and use suitable substitutes for these materials.
- Expand the use of microscale experiments to all scientific labs on campus.
- Increase funding and website development for the Chemical Exchange Program.
- Require that all new paint purchased be water-based, as this can be recycled back into a new paint product.
- Care should be taken not to purchase more of a material than is actually needed for a project.
- Increase training for proper lab techniques and handling of hazardous waste in all University labs. Provide a group of seminars on proper lab handling and disposal procedures.
- Develop a system for tracking the amounts and types of hazardous waste leaving UCSB. Identify the sources of this waste and means for correcting inefficiencies.
- Inform departments of the costs associated with the disposal of hazardous waste they generate and provide incentives for decreased waste generation.

5.5.3 Recycling Efforts

- Establish a formal and adequate budget for the recycling program. The fact that UCSB has no formal budget in place signifies the lack of a strong commitment on the part of the University as a whole to waste management efforts on campus.
- Substitute non-recyclable materials on campus with recyclable ones.
- Establish a closed loop system for products such as white and mixed paper in which recyclable items are collected and recycled by a manufacturer who then sells the recycled product back to the University.
- Increase the use of recycled content copier paper.
- Place two boxes next to every copier on campus: one for recycling and the other for use as scrap paper that has only been printed on one side.
- Print out all class handouts double-sided on recycled paper for distribution to students whenever possible.
- Require that double-sided, recycled paper be used for all class readers.
- Allow students to hand in assignments on scrap paper (i.e., printed on one side), double-sided and electronically whenever feasible.
- Take all newspaper, aluminum, plastic #1 and 2, and glass to nearest BERTHA bin.
- Equip all buildings with easy access to and an adequate supply of recycling containers in order to increase the ease of recycling on campus.
- Develop a program to monitor which departments are generating the most waste and which departments have the highest levels of contamination.
- Fine departments with high levels of contamination of recyclable materials in their trash.
- Develop a seminar regarding the amount of waste generated and disposed of on campus, along with disposal trends during freshman orientation. This will help to highlight recycling efforts on campus and give new students a sense of place in the recycling program.

5.5.4 Procurement Practices

- Consumers at all levels of the University should engage in precycling, i.e., making purchasing decisions that will reduce waste such as buying goods with less packaging (e.g., goods in bulk or concentrated form), choosing products that will last longer, and avoiding single-use or disposable products.
- Require that all paper purchased by University departments contain 30% post-consumer recycled content (the best available on the market). By increasing recycled-content paper purchases, the market will react by decreasing prices, and UCSB can have a significant, positive impact on the environment.
- Require that all emblematic paper products offered by the University contain at least 30% post-consumer recycled content (i.e. notebooks, journals, planner, etc.). This would point to a clear commitment on the Bookstore's behalf to increase sustainability in their operations.
- Increase purchases of recycled-content goods in general by Central Stores, the Bookstore and all campus departments.
- Become a member in the Recycled Products Purchasing Cooperative (RPPC) as a means for increasing the use of recycled paper on campus.
- Require that the University purchase only Energy Star approved office supplies and equipment.
- Establish an eco-labeling purchasing initiative, in which the University preferentially purchases goods from suppliers that have received an acknowledged eco-seal demonstrating their environmental friendliness.
- Centralize all department purchases through Central Stores. This would allow departments to ask for specific vendors or they could ask Central Stores to find them the best deal. In either case, this would provide a mechanism for tracking purchasing practices and ensure that minimum recycled content purchase guidelines are adhered to.
- Alternatively, a monitoring system could be put in place to determine where departments are spending money on supplies outside of Central Stores, and perhaps guidelines could be enforced regarding the types of products that may be purchased (ex. only buy recycled content paper or some certain percentage).

- Convert department ordering through Central Stores to an all on-line system in order to cut down on paper waste associated with orders.
- Care should be taken to purchase products that are sturdy and capable of repeated use.
- Require that all University purchasing contracts adhere to a sustainability policy as implemented by the campus (and include specific environmental specs).
- Purchases should be made from local vendors whenever justified by a cost-benefit analysis (or whenever possible – wording choice). This reduces environmental pollution associated with the transport of goods from far away, and by increasing the demand for such products, the price of those goods will be effectively lowered.
- Seek vendors and companies with good environmental and social track records.
- Undertake research by all bookstore departments to determine if current vendors offer recycled content products, as there appears to be somewhat of an overall weakness in this knowledge. For example, Bookstore gift department staff were unaware of any vendors other than 'Recycled Content Cards' offering recycled content greetings cards. However, when contacted, Hallmark stated that at least 50% of the cards they produce and sale for retail stores contain at least 10% PCR content.
- Increase student awareness of current bookstore practices. Recycled products should be marketed at the front of the store continuously.
- Increase the marketing of recycled content products by both Central Stores and the Bookstore.
- In order to increase campus education, the Bookstore could host a week long lunch hour special in which Environmental Studies, Bren and other professors could conduct an informational lecture series. These could include different topics each day designed to increase campus environmental awareness. The bookstore is a good forum given that it is a very social and intimate gathering place during the lunch hour.

6. AIR QUALITY AND TRANSPORTATION AT UCSB

6.1. Introduction

Automobiles are inextricably linked to air pollution, although the quality of the air surrounding us is also diminished by other factors such as stationary sources of pollution, and heating and cooling equipment in buildings. The major portion of this chapter will address transportation practices and policies on campus with the intention of describing inputs to the local air and how those inputs could be lessened or better controlled. This is the best way to describe the campus air quality, given that there is currently no monitoring of pollutant concentrations on campus. In addition, it is more useful to characterize the potential sources of air pollutants on campus than the condition of the air so that improvements can be directly linked to campus operations and policy. The smaller portion of this chapter will then cover the environmental impacts of the emissions generated by heating and cooling equipment on campus and describe the extent to which these items are utilized on campus.

6.2. Background

Air quality in the US has improved in the last decade in terms of concentrations and emissions of the EPA's six criteria pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, particulate matter (PM) and sulfur dioxide (U.S. DOT, 1999). However, it is important not to lose sight of the magnitude of the air pollution problem that still remains. The Office of Air Quality Planning and Standards' (OAQPS) National Toxics Inventory (NTI) estimates that 75% of the 3.7 million tons of air toxics that are released to the air annually are from mobile and area sources. On road vehicles alone produce 57% of total CO emissions, 31% of total NO_2 emissions, and 29% of total VOC (volatile organic compounds) emissions in the nation. The EPA reports that approximately 100 million people in the US still reside in counties that did not meet the air quality standard for at least one of the criteria pollutants in 1996 (U.S. EPA, 1996b). In 1998, California had the highest emissions of CO in the country, the second highest emissions of nitrogen oxides (NO_x) and VOCs, and the third highest emissions of PM_{10} and $PM_{2.5}$ (U.S. EPA, 1996b). Most of the state of California including Santa Barbara County, as shown in Figure 3-1, was in non-attainment for federal ozone standards in 2000 as well (CARB, 2000).

In 1997 the EPA revised the standard for PM and ozone because neither existing standard was regarded as adequately protecting people from the negative health effects associated with the pollutants. It is estimated that these standard revisions will prevent approximately 15,000 premature deaths, 350,000 cases of aggravated asthma, and 1 million cases of significantly decreased lung function in children.

Figure 6-1. California Air Resources Board air quality zones

Automobiles and other vehicles are far more efficient today than at the start of the energy crisis of 1973 due to manufacturing and technological improvements such as improved combustion control by fuel injection engines instead of carburetors. However, since 1988, essentially all of the gain in new motor vehicle efficiency has been offset by increases in weight and power within classes, and by consumer shifts to lower economy vehicles, especially light duty trucks (SUVs, minivans, and pickup trucks). This trend in consumer preference has serious implications for energy consumption due to the lower fuel economy of light duty trucks. Compounding the impact of this trend on energy consumption, vehicle miles traveled has increased over 100% and real gasoline prices have decreased 17% since 1970 (U.S. DOT, 1999).

On a more global level, ozone depletion and global warming have also become serious air quality concerns in the last twenty years. The Montreal Protocol was adopted in September 1987 in an international effort to phase out the production of the most damaging ozone depleting chemicals, chlorofluorocarbons (CFCs) by 1996 and HFCFs by deadlines ranging from 2003 to 2030. Similarly, the Kyoto Protocol was internationally agreed upon in 1997 (although no binding agreements have been ratified by the US) to reduce the emissions of the major global warming gases: carbon dioxide, nitrous oxide, methane, perfluorocarbons (PFCs), sulfur hexafluoride, and hydrofluorocarbons (HFCs). Under Section 608 of the CAA, EPA has established regulation that requires service practices to maximize recycling of ozone-depleting compounds (both chlorofluorocarbons [CFCs] and hydrochlorofluorocarbons [HCFCs] and their blends) during the servicing and disposal of air-conditioning and refrigeration equipment. This is achieved by adhering to the following five guidelines:

1. Set certification requirements for recycling and recovery equipment, technicians and reclaimers.
2. Restrict the sale of refrigerant to certified technicians.
3. Require persons servicing or disposing of air-conditioning and refrigeration equipment to certify to EPA that they have acquired recycling or recovery equipment and are complying with the requirements of the rule.
4. Require the repair of substantial leaks in air-conditioning and refrigeration equipment with a charge of greater than 50 pounds.
5. Prohibit individuals from knowingly venting ozone depleting compounds (generally CFCs and HCFCs) used as refrigerants into the atmosphere while maintaining, servicing, repairing, or disposing of air-conditioning or refrigeration equipment.

6.2.1 Environmental Impacts

Transportation practices, policies and infrastructure have significant environmental impacts on both the local and global environment in terms of air quality, resource consumption and land use. Heavy dependence on petroleum is the root of most environmental problems related to the transportation sector with respect to both petroleum extraction and the emissions associated with fuel combustion by automobiles. Compounds with ozone depleting and global warming potential used as coolants in chillers and carbon dioxide and NO_x emissions from boilers are the main source of harmful emissions to the air associated with institutional buildings. An overall assessment of the environmental impacts associated with the use of automobiles and HVAC systems in buildings is outlined below.

Petroleum Extraction

Oil drilling and pipelines directly harm the habitat and ecosystem in which they are located. The roads and infrastructure that accompany them also disrupt the local setting, attract poachers and facilitate increased traffic. In addition, spills and leaks in the transport and nearby storage of petroleum are common, contaminating the soil and disrupting the food chain.

Emissions from Automobiles and Boilers

Despite major improvements in emission rates over the last two decades, automobiles continue to be the primary source of pollutants that diminish air quality. Boilers burn natural gas to heat water used to heat buildings and therefore emit the burnt fuel as CO_2, small amounts of CO, NO_x and water vapor.

- Ground level ozone, commonly known as smog, is the most common local environmental problem resulting from the combination of several pollutants caused by the combustion of fuel. Smog is produced when nitrogen oxides and volatile organic compounds react chemically in the presence of sunlight. The formation of smog remains a local/regional air quality problem because it is not stable in the lower atmosphere, and therefore exists as smog for only a short period of time without global dispersion. Smog damages infrastructure, especially rubber and some plastics, and causes serious reductions in visibility and therefore local aesthetic quality (Byrd, 1999).
- Since carbon dioxide is a light and well dispersed molecule, there is a direct link between local automobile and boiler operations and the global build up of carbon dioxide in the atmosphere. The carbon dioxide created by the combustion of petroleum in the transportation sector comprised about 26% of all greenhouse gases emitted in the US, which in turn accounts for about one quarter of all anthropogenic emissions of greenhouse gases in the world (U.S. DOT, 1999). Carbon dioxide, the most abundant greenhouse gas, acts as an insulator of long wave thermal radiation. Global climate change is potentially a serious result of heat insulated near the earth's surface. The effects of global climate change are widely variable, but revolve around the fact that all areas will experience *different* climate conditions than the inhabitants of those areas are currently accustomed and adjusted. Some potential impacts include changes in sea level and precipitation patterns, and increased temperatures at high altitude.
- Nitrogen oxides are an important precursor to acidic deposition, which can lead to eutrophication of water bodies and leaching of forest soils. Eutrophication can make water bodies extremely unhealthy as a result of toxic algal blooms, excessive phytoplankton growth, low or no dissolved oxygen in bottom waters, and losses in submerged aquatic vegetation. Forest soils exposed to acidic deposition will be deficient

in the vital minerals necessary to support healthy vegetation and animal ecosystems.

Transportation Infrastructure

- Environmental impacts associated with automobile infrastructure relate primarily to the construction of roadways and parking lots requires moving extremely large amounts of landmass and disrupts and/or destroys the local habitat and ecosystem.

Heating and Cooling Equipment

- Environmental impacts associated with machinery and research labs relate to the refrigerants used in chillers and the chemicals released through laboratory fume hoods. Refrigerants are ozone depleting and global warming compounds that escape into the atmosphere from the cooling system regularly via leaks, servicing and accidents. Ozone depletion is harmful to humans and ecosystems because less ozone allows more damaging UV sunlight to reach the earth's surface. Currently, we are experiencing annual ozone depletion of approximately 5 percent at mid-latitudes (U.S. EPA, 2001b). Virtually all chemicals used in scientific laboratories are released in very low concentrations via fume hoods. These concentrations do not cause an air quality problem unless the mechanics of the hood are operating substandard, in which case the concentrations of chemicals released through the hood could be high, causing local health hazards and damage to landscaping.

6.2.2 Economic Impacts

Poor air quality and transportation practices have significant economic impacts on two fronts: 1) the costs of mitigating negative effects or decreased value absent mitigation and 2) US dependence on a resource that we are not naturally endowed with and the ways in which we choose to use that resource.

Mitigation of Negative Impacts

Private and governmental expenditure to mitigate the negative effects of poor air quality is a good indicator of the magnitude of the problem and an expenditure that could be avoided if the environmental impacts of air pollution were lessened. If mitigation efforts are not undertaken, either a social or private loss occurs in the value of public or private lands or health.

- Nitrogen oxides contribute to pollutant haze, which impairs visibility and can reduce residential property values and revenues from tourism.

They also cause acid deposition that corrodes buildings and infrastructure, in turn requiring more intensive maintenance and frequent replacement.

- Ozone is responsible for several billion dollars worth of agricultural crop loss and causes noticeable foliar damage in many crops and species of trees (U.S. EPA, 1996b).
- There are adverse health affects associated with all of the main pollutants in automobile emissions pertaining to breathing difficulties and lung tissue damage. Health care spending can be considered a signal for the necessity for abatement of these adverse health affects. Meta-analysis of time series studies suggests that for each 50-ppb increase in peak ozone levels, hospitalization rates increase 6-10% for asthma, pneumonia, and chronic obstructive pulmonary disease. Ozone air pollution episodes have been associated with increases in emergency department use from 8 - 15% (New Jersey) to 43% (Mexico City) (Dickey, 1996).
- Ozone depletion could lead to higher rates of skin cancer, premature aging of the skin, cataracts and other eye damage and immune system depression. Therefore spending to either protect oneself from the sun or to treat skin/eye afflictions related to UV exposure is an economic impact of ozone depletion. A United Nations Environment Programme (UNEP) study shows that a sustained 1 percent decrease in stratospheric ozone will result in about a 2 percent increase in the incidence of non-melanoma skin cancer, which can be fatal. With the successful phase-out of CFCs, however, EPA expects 295 million fewer cases of this form of skin cancer over the next century (U.S. EPA, 2001b).

Dependence on Foreign Petroleum

The transportation sector uses over 65% of all the petroleum consumed in this country, while over half of the petroleum used in the US must now be imported. Currently, the United States gets half of its oil imports from OPEC and half of that amount - a quarter overall - from the Persian Gulf. Worldwide, OPEC accounts for 43% of world oil production and 60% of the oil traded internationally, but holds 75% of the world's proven oil reserves. The Persian Gulf alone has 30% of world production, 45% of exports, and 63% of proven reserves. That OPEC holds larger shares of reserves than of current production and exports means that its share of production and exports is likely to increase over time (Holdren, 2000). This suggests that the US is vulnerable to the political instability of these nations and the supply shocks that may accompany that instability. US 1999 foreign-oil expenditures totaling

0.6% of GDP are by no means an upper limit: if oil prices stayed near the $34 per barrel figure they reached in early 2000 and U.S. oil imports nonetheless did not decline, U.S. oil-import costs would reach about 1.3% of GDP.

6.2.3 Campus Issues

College campuses play a significant role in local, regional and global air quality problems due to a concentrated area of energy consumption, the operation of heating and cooling equipment, and the generation of densely populated residential space and traffic commuting to/from campus on a daily basis.

Air Quality

Universities must be especially aware and proactive in maintaining healthy local air quality because of the large proportion of students living and working in the relatively small space of campus grounds. This involves investment in efficient technology for boilers, chillers and ventilation systems and constant re-evaluation of how best to maintain the life and usefulness of this machinery without simply purchasing more equipment.

Transportation

Unlike small universities where most of the students live on campus, large universities usually do not house the majority of students, faculty or staff. Therefore, large universities must accommodate commuters to and from campus on a daily basis in order to make the commute convenient, manageable, and environmentally and economically efficient. Since 35% of the student body and almost 100% of the faculty/staff of UCSB live beyond a two-mile radius from campus, UCSB must deal with the large amount of people commuting to/from campus each day. This involves providing parking, roadways, bike paths and racks, adequate walkways into campus, and a mass transit system. In order to keep UCSB's and the local community's environment healthy, the University must also take into account the effects of its commuters and attempt to mitigate them. This involves designing transportation policy to manage the demand and supply of parking and single occupancy vehicle commutes to/from campus. For example, high parking permit prices will limit the willingness of people to drive an automobile to school and therefore influences their behavior. The environmental impact of automobile use also requires that environmental goals be incorporated into campus planning for new parking lots and infrastructure.

6.3. Results

A series of questions were taken and adapted from the campus environmental audit format in April Smith's book, "Campus Ecology." Interviews were held with or information was obtained from members of Parking Services, Environmental Health & Safety, Transportation Alternatives Program, Facilities Management and the Office of Budget & Planning. All data included were derived from these sources, although additional research was obtained from the US EPA and US Department of Energy web sites. The following questions were asked to gauge UCSB's current status with respect to campus air quality and transportation practices and policies.

1. What are the campus' stationary sources of pollution and does the campus monitor these emissions? "Pollution" in this question refers to the six pollutants for which the EPA has set federal air quality standards.

Although there are no boiler plants on campus, every large building (approximately 20 to 30) has a boiler to heat the building. These boilers all burn natural gas to heat water or steam to heat the buildings. In this area, the natural gas burned has trace amounts of sulfur in it, which when mixed with water becomes sulfuric acid, which is released through the flues in campus buildings. The other emissions are carbon dioxide, NO_x and water vapor. There are sometimes small amounts of carbon monoxide released, but there were no visible signs of CO release (black smoke) when the flues were observed for this survey. Some boilers on campus are low NO_x burners, which are more expensive to purchase and operate, but have a better impact on the environment. Actual concentrations of pollutants in the flue emissions are not monitored. Most of the boilers on campus have been running for at least 20 years.

2. What equipment on campus uses ozone depleting or global warming compounds? Are the emissions monitored?

Chillers are used for cooling in almost every large building on campus. These chillers use refrigerants (coolants) to remove heat from the circulating water that cools the buildings. Coolant emissions are not directly monitored, but the replacement rate is approximately equal to the leak rate. Only approximately 100 lbs. of refrigerant has had to be added to the highly efficient chillers in the last four years. The 1200 Ton chiller in the main library is the largest chiller in Santa Barbara County. All of the high efficiency chillers have been on line for slightly less than a year.

3. What percent of the campus is devoted to vehicular transportation such as parking spaces and roadways? Does this supply meet demand for parking?

The total acreage of the UCSB campus is 815 acres, 52 of which are devoted to parking spaces. This means that 6.4% of the campus is covered with parking areas, which translates into 6,185 parking spaces available to the over 20,000 students and faculty commuting to the campus on a daily basis. It is campus policy that undergraduates and graduates not employed by the University living within a two mile radius of campus are not eligible to obtain a parking permit to drive to campus, which technically eliminates 65% of the student body from demanding a parking space resulting in enough spaces to meet about half of the daily demand for parking.[4] There is not an available statistic regarding the acreage covered by roadways on the campus.

4. What is the average daily commute to campus by automobile? How does this translate into carbon dioxide and nitrogen oxide emissions?

There were 8,907 annual and quarterly parking permits issued for the 1999-2000 school year. This may be a slight overestimate of the number of people owning a parking permit at any one point in time because there is no distinction between quarterly and annual permits in this count. Of the total 8,907, only a set of 4,652 could be used to calculate the average daily commute to campus because not every permit provided a local address. The number of permits issued in each location was counted in the set of 4,652 permits and then used to estimate the total number permits in each location. Then, the rest of the calculations (total **V**ehicle **M**iles **T**raveled (VMT), gas consumption and CO_2 emissions) were based on that estimate of the total number of permits issued in each location.

Table 6-1. Location of UCSB parking permits issued

Location	# Permits Counted	Portion of Sample
Santa Barbara	2,603	56%
Goleta	1950	42%
Carpinteria	86	1.8%
Summerland	13	0.2%

[4] There are approximately 18,000 students, 35% of which are eligible for a permit (6,300). There is roughly the same number of faculty/staff (6,300) resulting in a total of 12,600 people commuting to campus to park in 6,185 parking spaces.

Table 6-2. Estimated emissions from automobile transportation to UCSB

Location	Estimated # of Permits	Driving Distance to campus[1]	Total VMT[2]	Total Gas Consumption[3]	Total CO_2 emissions[4]	Total NO_x emissions[5]
SB	4,987	9.9	98,742	3,950 gal.	78,994 lbs.	217 lbs.
Goleta	3,740	3.9	29,172	1,167 gal.	23,338 lbs.	64 lbs.
Carp.	161	23.6	7,599	304 gal.	6,079 lbs.	17 lbs.
Summ.	19	17.5	655	26 gal.	524 lbs.	1.5 lbs.

[1]One Way (miles)
[2]Round Trip
[3]Using average mileage of 25 miles/gallon
[4]20 lbs. of CO_2/gallon gasoline burned
[5]1 gram of NO_x/mile traveled

It is useful to understand these data in terms of daily averages (Table 6-3) — i.e. if the average person commutes 15 miles round trip to/from campus per day, the total VMT, gallons of gas consumed, and emissions generated by the UCSB campus.

Table 6-3. Average daily emissions from automobile transportation

Round Trip Commute	15 miles
VMT Total	133,605 miles
Gas Consumption	5,344 gallons
CO_2 Emissions	106,884 lbs.
NO_x Emissions	294 lbs.

5. Does the university operate any vehicles that use alternative fuels?

The campus vehicle fleet consists of 295 vehicles on campus. Nine of those are electric vehicles and ten operate on natural gas. There are also 36 campus owned vehicles that operate off campus, none of which use alternative fuels.

6. How do the parking permit prices compare with other UC campus parking prices?

The parking prices at UCSB are about average within the UC system. This can partially be explained by the local surroundings of the campus, and therefore the supply of parking space, as compared to more urban settings such as Los Angeles or

San Francisco. It should be noted that there is no special carpool rate and parking after 5pm and on weekends is free at UCSB.

Table 6-4. Parking fees on UC campuses

Campus	Average Monthly Parking Rate ($)
UCSB	45
UCI	35
UCR	24
UCD	38
UCSC	38
UCSD	50
UCLA	54
UCB	52

7. What are the other options to commute to campus and how does the University promote these options?

The parking and transportation department at UCSB founded a well-developed ***T**ransportation **A**lternatives **P**rogram* (TAP) in the 1992-93 school year to provide alternative commuting options for UCSB faculty, staff, and students. It strives to conserve energy, reduce campus parking demand, traffic congestion, air pollution, and global warming. Alternative transportation includes the use of vanpools, carpool, bicycles, and transit buses. Anyone who qualifies for a parking permit but does not own one can register with TAP to get six free days of parking per quarter and benefit from an emergency ride home program, monthly drawings for gift certificates, and special 3+ person carpool parking spaces.

Vanpool Program

The vanpool program provides inexpensive transportation for long-distance commuters, from Santa Maria, Lompoc, the Santa Ynez Valley, Carpinteria, Ventura, and Camarillo. Monthly fares are $75-$90 with an option to ride stand-by for $2.50 each way. Monthly fares fluctuate depending on van ridership and the distance each van travels. In March 2001, there were 119 members of the vanpool program.

Carpool Program

There is an option to purchase a carpool parking pass, by which the purchasers split the price of the permit between them and the passes are distributed so that only one car can actually display the pass at a time. If there are three or more people sharing a pass they able to park in carpool parking spaces which are more ideally located and readily available than the student "C" parking spaces. The parking and transportation office also maintains a database of people interested in carpooling for the purpose of matching potential car-poolers. In March 2001, there were 185 members of the carpool program.

Bicycle Programs

There is an intricate system of bicycle paths approximately 9 miles long within the UCSB campus where bicyclists almost always have the right of way to pedestrians. There were several bicycle facility improvements over the 1999/2000 school year including repair and resurfacing of the north UCen lot, the Campbell Hall lot and the path to that lot from the north, the Bus Loop path and lot, and the path intersections southwest and southeast of the library. There was also the expansion of several lots, curb cuts at path intersections with roads, and sign installations. The near future goals of the bicycling program are to expand and repair the bike lot north of the Music building and construct two new bike circles at Pardall at the border of Isla Vista and at the SAASB building.

The TAP program provides a comments form on the web for anyone to fill out regarding bicycle paths, lots, or policy suggestions to further improve the system to make biking to school a realistic option for as many commuters as possible. Biking is the main form of transportation to/from campus for the students that are not eligible for parking passes because they live within a two-mile radius of campus. While the University maintains a well-kept and practical bike path system, the reality of students biking to school is also improved because the city of Santa Barbara maintains bike paths from the campus along the coastline. TAP estimated 14,000 bicycle commuters to UCSB in March 2001, 625 of whom were registered with TAP to reap the benefits of the TAP program.

Bus Programs

There are nearly 300 buses per day connecting the UCSB campus with Goleta, Isla Vista, Santa Barbara, and Carpinteria. The MTD bus ride is free for USCB students who can provide proof of current registration. This is accomplished by a $7.50 a quarter lock in fee through the Associated Students, where students pay the fee with tuition fees even if they do not ride the bus. This fee is periodically voted on by the students to keep it in place. An occasional two-day MTD Survey is done on lines that serve UCSB to determine UCSB ridership. The last survey took place during the 1999/2000 school year and showed an average of 6,000 student rides per day. This number is an estimate based on that two-day survey. In addition, MTD tracks the actual number of students using bus passes on a monthly basis. The most recent one available was for March of 2000 showing that students used their bus passes 67,000 times during that month.

8. How is the TAP funded? How is it administratively supported?

The TAP program is funded by the reserves from the fines and forfeiture budget of parking services. According to California Codes Education Code, Section 89700-89710, these reserves may not be utilized to purchase land or to construct any parking facility. Instead they must be used for the development, enhancement, and operation of alternative methods of transportation of students and employees of UCSB and the mitigation of the impact of off-campus student and employee parking in University communities. The amounts added to the Fines and Forfeitures were $25,000 for 1999-2000, $46,000 for 1998-1999, and $61,000 for 1997-1998 demonstrating that the reserves fluctuate considerably from year to year based on factors completely out of the hands of the TAP staff. The TAP staff consists of a program manager who works within the parking services division, and a half time vanpool coordinator.

9. What are the procedures for hood vent usage for laboratories on campus?

There are 450 (+/- 5%) fume hoods on campus. Only16-20 stacks are higher than 7 feet (ranging from 10-40 feet), while the rest of the stacks are 7 feet high in accordance with the minimum height standard. In the 1999-2000 school year, approximately 15-25 hoods were identified slightly above or below UCSB performance criteria and facilities adjusted those hoods accordingly. These hoods are used for exhausting any volatile substance to maintain healthy indoor air quality within the lab.[5] The hoods are maintained by campus facilities management and annually inspected and certified by EH&S. The most common defect of the fume hoods results in either not enough air combined with the substance or a low velocity of air flowing through the hood. These defects are usually simple to repair. As a result, it is common practice to repair the existing technology instead of replacing it with more energy efficient structures.

[5] The fume hood simply combines the volatile substance with enough air at a high enough velocity to dispel the substance out of lab through the hood to reach outside at a low enough concentration to meet standards.

6.4. Analysis of Results

6.4.1 Current Progress and Trends

Transportation

Enrollment at UCSB has not increased enough in the last decade to cause a drastic increase in commuting rates to and from campus due to simple enrollment increases. However, the bus subsidy has decreased single occupancy vehicle travel to and from campus. Therefore the impact of automobile transportation generated by UCSB has decreased somewhat in the last decade.

The trends for bike path use are more difficult to assess. The bike path infrastructure has essentially remained consistent over the last decade and therefore the travel to/from campus using bike paths could be assumed to be close to what it was ten years ago. Yet, the TAP has undoubtedly had some positive influence in encouraging commuting by bicycle because of the additional perks the program provides for bike riders such as rainy day driving passes and emergency ride home services. The number of bike racks has also increased over the last decade, presumably because the demand for bike racks was increasing. However, there are still not enough bike racks to meet demand, which could suggest that the demand for bike racks, and therefore bike ridership, is still increasing.

Parking supply will increase along with the parking permit prices over the next decade. Since these are two opposing forces when it comes to parking supply and demand management, it is difficult to predict whether the outcome will be more or less single occupancy vehicle commuting to/from campus. There are currently six plans for increasing parking supply under consideration by UCSB budget and planning. For each of the six options, there are a different number of final parking spaces available on campus and an accompanying parking permit price. The two options with the lowest increase in parking spaces, and therefore the lowest increase in permit prices, would result in 7,366 parking spaces in the 2014-15 school year. That is an increase of 1,185 spaces over a fourteen-year period. The accompanying permit price in 2014-15 would be $87/month as opposed to the current price of $45/month. The two plans with the highest increase in parking spaces would result in 9,033 parking spaces in the 2014-15 school year and a permit price of $150 or $154/month depending on the option. This is a net increase of 2,852 parking spaces over the same fourteen-year period.

Heating and Cooling Equipment

There currently are or are expected to be seven chillers that are high efficiency (.46 to .49 kW/Ton) on campus. There are a couple chillers that still use a CFC (CFC-11/R-11), but these are expected to go off line in the next six months so that no chiller on campus will operate with CFCs. The fact that no chillers on campus will use CFCs by the end of 2001 is a good sign of the campus' commitment to abiding by the "spirit" of the Montreal Protocol.

The high efficiency chillers are also low-pressure chillers, meaning that if there is a leak, mostly air escapes instead of refrigerant. The rate of replacement of low efficiency chillers by high efficiency chillers could be increased; only about 28% of all chillers on campus are high efficiency chillers that conserve energy and limit emissions.

6.4.2 Environmental Impacts

Transportation

As a large public institution, UCSB should be highly concerned with its contribution to the high ozone and particulate matter concentrations that currently plague the air quality of Santa Barbara County. Since automobile emissions are the main cause of the air quality problems and UCSB generates approximately 71,082 VMT per day, there is a strong connection between the air quality problems of the county and the travel generated by campus commuters. Simply altering the methods of transportation used by University students, faculty and staff to commute to/from campus could significantly reduce the current daily emissions of approximately 106,884 lbs. of carbon dioxide and 294 lbs. of nitrogen oxides. Taking into account all of the negative environmental and economic impacts from automobile emissions and the scale of the emissions generated by UCSB, the environmental impact of transportation policies and practices related to UCSB contribute largely to local, regional and global environmental degradation.

Heating and Cooling Equipment

HCFCs (R-123 and R-22), the refrigerants used in all chillers on campus, are contributors to global warming and ozone depletion; however, there is a significant trade off between chiller efficiency and the use of these compounds. If FHCs (fluoro-hydrocarbons – no chlorine) are used as refrigerants, the chillers operate at a much lower efficiency and therefore require more energy to operate, which contributes to global warming as well. HCFCs have much less potential for global warming and ozone depletion than CFCs but are much more efficient coolers than FHCs, and therefore the gradual (five year) switch from chillers using CFCs on campus has inevitably lessened the impact of the campus on global warming and ozone depletion. The other source of emissions is in the operation of the purge. The purge removes air that gets inside the chiller, and when it is full it will discharge the air, where some coolant may escape simultaneously.

6.4.3 Institutional Framework

Transportation

Overall, it seems that the TAP has been successful in utilizing parking demand management fundamentals to lower the impact of automobile commuting to/from campus on the environment. This is especially impressive considering the institutional constraints the program faces. One person runs the entire program with a half time assistant to aid in vanpool coordination. The details of operations on a daily basis limit the time and resources available to implement innovative and effective ideas. The program makes very slow to no progress in terms of adding new priorities and methods to pursue those priorities. Aside from the issue of "personpower" dedicated to run the TAP, there is also the issue of support of TAP priorities from campus "higher ups" and within the institution itself. There is a disconnect between what the TAP attempts to accomplish in the everyday aspects of transportation policy and what the campus budget and planning office attempts to accomplish in the long range planning of transportation policy. The two necessary aspects of transportation policy on campus – influencing individual behavior from the bottom up and setting campus priorities from the top down – are not well coordinated in an effort to really mitigate the environmental impact of commuting to/from campus every day. The fact that the number of parking spaces added and permit prices are positively correlated in the parking expansion options demonstrates that the priority for choosing an option is paying for the construction of the parking spaces and not squeezing the supply and demand of parking spaces to influence commuting to/from campus. To effectively squeeze the demand and supply for spaces, the permit rates should be higher when there is a lower supply of spaces, yet this is clearly not the priority in designing the parking supply options. The fundamentals of parking supply management (i.e. keep the additions of parking spaces to a minimum while increasing permit prices to lessen the demand) are not fully incorporated into the priorities of UCSB's transportation policy.

With regards to parking permit designation, the way in which permits are distributed is not highly successful. Permits are technically only available to those living outside of a two-mile radius of campus, yet this is not always the case and often people living within the two-mile radius obtain parking permits. In addition, alternate permit designation patterns such as differential rates depending on location or **I**n **V**ehicle **P**arking **M**eters (IVPM) could increase the number of commuters accommodated by each existing parking space.

Heating and Cooling Equipment

Facilities management (FM) is in charge of heating and cooling systems for all buildings on campus. FM personnel are divided into zones depending on geographic location on campus. There does not seem to be any organizational problems within

FM that impede the campus' ability to appropriately operate all heating and cooling systems on campus.

6.4.4 *Financial Issues*

Transportation

The budget of the TAP program is highly variable because it does not have its own set budget based on needs and expenses. Rather, it has a budget based on the expenses and income of the parking services department of which TAP is a part. Thus, when the reserves of the parking services fines and forfeitures change, the resources available for TAP spending change as well. In addition, there is constant negotiation regarding whether TAP, AS Bikes, parking services, or facilities management pays for bike path, bike parking lot and bike rack improvements. Financial issues of maintaining and promoting TAP priorities on campus are not clearly delineated between departments. Each project is a negotiation to elicit ample funding from a department outside of the TAP whether it be parking services or facilities management. The bulk of the income from parking permits goes to "operations" and "reserves" (savings for more parking structure construction) for parking services, and is not directed towards TAP. This is formerly set forth in the Parking Principles of UCSB's Parking Facilities Replacement Policy which states that funds from parking permits should not be used for new roads, bike parking and paths, ceremonial places of arrival, pedestrian plazas etc. The Parking Principles were promulgated by the UC-wide Faculty Welfare Committee. They were not further acted on or accepted, so they have no "official" status in the UC system or UCSB, but they continue to influence how parking funds are thought appropriately spent. The permit fees should be treated as a Pigouvian tax, which is a tax levied on an agent causing an environmental externality (environmental damage) as an incentive to avert or mitigate such damage. In this case, the purpose of the permit fee should be to deter individuals from driving to campus. Therefore, a portion of the revenues from the permit fees should fund the transportation alternatives program, as the active office on campus in deterring individuals driving to campus, instead of funding operations and reserves for the parking services department.

The reserves from fines and forfeitures account for about 15% of parking services income and about the same proportion of its expenses. Permit sales are 60% of the parking services revenues, but only 14% of the department's expenditure. In addition, only about 4% of total expenditure for parking services is spent on the TAP program although TAP brings in about 3% of its revenues. Thus, the TAP is basically self sufficient – its revenues bring in almost enough to maintain the bare minimum of activity, but there is no room for program growth. Since administration of the parking permits is carried out by parking services, enough revenue from the permits should go to parking services to fund the administration of the permits and the amount sent to reserves should be substantially decreased. This would leave a large portion of the revenue from permit fees as a permanent source of income for the TAP, which would greatly enhance its ability to innovatively and effectively manage parking demand. If the TAP were more aptly funded and therefore more successful, it could be argued that there would be less need for spending on future parking lots.

Heating and Cooling Equipment

The high efficiency chillers and low NO_x boilers are much more expensive (upfront) than the lower efficiency alternatives. However, facilities management takes the savings in operating costs for high efficiency equipment into account when considering purchasing new equipment. It is not financial constraints that are preventing old chillers from being replaced with more efficient ones; it is more a matter of not needing to replace the old equipment yet because it still runs relatively well.

6.4.5 Innovativeness

Transportation

The policy makers at UCSB have basically done two things to innovatively influence transportation policy: 1) create the TAP and 2) regulate eligibility for parking permits. Since the TAP was created, it has been faced with institutional and financial constraints limiting its ability to continually be effective. Buses and carpooling are pretty standard methods for lessening automobile use, yet vanpools from longer distances are less common. Bike paths, which are not in themselves innovative, are so on UCSB's campus because of the extent to which they dominate the campus in terms of right of way over pedestrians, and the physical convenience of the bike lots, racks and paths. However, there are many campuses, such as University of Colorado at Boulder and University of Washington, that are much more innovative in their methods of reducing single-occupancy vehicle commuting to/from campus.

The rule that students living within a two-mile radius are not eligible for a parking permit is innovative and technically eliminates approximately 65% of the student body from driving to campus. This significantly affects individual transportation practices and the associated environmental impacts. This rule is considered an innovative step in the right direction. Obviously, the VMT is not a big issue with people commuting to/from campus from within a two-mile radius; the problem is that those people take up valuable parking spaces, which makes parking supply tighter than it should be.

Lastly, it is a start in the right direction that a small fraction of the campus vehicle fleet operates using natural gas or electricity, yet the University should move towards operating the majority of campus vehicles on alternative fuels.

Heating and Cooling Equipment

A huge chiller loop has recently been installed on campus to cool several large buildings on campus with one central chiller and cooling tower. This is more efficient than each building cooling itself because of economies of scale and eliminating the need to shut down and start up the equipment periodically.

6.4.6 Community/Education

Transportation

The TAP promotes community awareness through a well developed and maintained website and constant information provision via flyers etc. on campus. The Santa Barbara Air Quality Control District has occasionally funded various projects at UCSB to "green" transportation on campus. The subsidy of MTD fares by students has demonstrated a commitment by the students who voted to enact the lock in fee and the University who allowed it to be incorporated into the tuition to reducing single occupancy vehicle commutes to/from campus.

6.5. Environmental Report Card

Question	Answer	Score
Transportation		
Is there an alternative transportation program?	Yes	1
Does the alternative transportation program offer special benefits to participants?	Yes	1
Has participation in the alternative transportation program been increasing?	Yes	1
Is there preferential parking for carpoolers?	Yes	1
Is the alternative transportation program adequately supported (administratively and financially)?	No	0
Do any campus fleet vehicles operate on alternative fuels?	Yes	1

Is a substantial portion (>50%) of the campus vehicle fleet operated on alternative fuels?	No	0
Does a substantial portion (>50%) of the student body commute to campus by methods other than vehicles?	Yes	1
Is there a highly developed and well-maintained bike path system on campus and in the local community?	Yes	1
Are student rides on local mass transportation subsidized?	Yes	1
Are employee rides on local mass transportation subsidized?	No	0
Does the current system of parking permit designation maximize use of existing spaces?	No	0
Are the revenues from parking permits directed towards encouraging alternative transportation?	No	0
Is construction of new parking spaces the absolute last resort to managing parking supply and demand?	No	0
Is less than 10% of the campus devoted to parking lots/structures?	Yes	1
Air Quality		
Are the laboratory fume hoods well maintained and in accord with University EH&S policy?	Yes	1
Has all equipment using CFC's been (or planned to be) replaced/ retrofitted?	Yes	1

Is efficiency and global warming/ozone depletion potential the priority in purchasing new chillers?	Yes	1
Are a substantial portion (>50%) of the chillers high efficiency, low-pressure chillers?	No	0
Are a substantial portion (>50%) of the boilers low NO_x burners?	No	0
Is life cycle costing taken into account when making HVAC purchasing decisions?	Yes	1
Is the oversight department for HVAC systems well organized?	Yes	1
	Total:	**14/22**
	Percentage:	**64%**
	Grade:	**C+**

6.6. Recommendations

6.6.1 Transportation

- Direct parking permit revenues towards alternative transportation measures.
- Restructure the funding available to the TAP so that it is less variable and more clearly itemized.
- Subsidize faculty and staff MTD rides.
- Increase MTD capacity for bicycles to more completely integrate the two travel options.
- Create real time car pool matching on the TAP website.
- Integrate TAP priorities into campus budget and planning priorities so that new parking structures are not the main form of parking supply management.
- Squeeze parking demand by increasing parking prices.

6.6.2 Air Quality

- Continue to replace low efficiency chillers with high efficiency chillers.
- Invest in chillers that do not use HCFCs.
- Invest in low NO_x boilers.
- Invest in more energy efficient fume hood technology.
- Form a partnership with the Santa Barbara Air Pollution Control District for community programs, bicycle subsidies, and additional vanpools.
- Invest in alternative fuel vehicles for campus fleet.

7. WATER MANAGEMENT

7.1. Introduction

As a basic element of everyday life, a reliable supply of freshwater is commonly taken for granted. The ease at which most Americans can access a seemingly endless water supply stands in stark contrast to the complex reality of water policy. The U.S. is the largest user of water in the world (WRI, 2001) and California is the largest user in the U.S. (Solley et. al, 1998). The history of water management in California has been a cycle of surplus and shortage. A constant struggle has been underway to maintain the necessary resources for the ever-growing state. Currently, the California Department of Water Resources (CDWR) estimates shortages in six of the ten water regions in the State. The Central Coast Region[6] (CCR), which includes Santa Barbara County, is one such region. Estimates of current and future water use suggest that the CCR is facing a water shortage[7] that is expected to exist well into the future (CDWR, 1998). Water use also has impacts on the landscape, as water withdrawals used for irrigating non-native vegetation takes water away from environmental uses, such as maintaining aquatic ecosystems. Lastly, universities generate large quantities of wastewater that can impact the quality of surface and coastal waters. Thus, mitigation of these impacts is a crucial step in the path toward a more sustainable university.

7.2. Background

7.2.1 Water

Water management can be discussed at different levels of resolution. Many globally oriented governmental and non-governmental organizations have produced comprehensive studies of global water use, mostly in response to growing scarcity in many areas of the globe. At the national level, the United States Geological Society (USGS) has produced an estimate of water use every five years beginning in 1950, in order to “collect reliable and uniform information on the sources, uses, and dispositions of water in the United States” in order to “assess the effectiveness of alternative water-management policies, regulations, and conservation activities, and to make projections of future demands” (Solley et. al, 1998). The EPA has a variety of programs and studies directed toward water management issues (see U.S. EPA, 2000). The careful management of water resources also takes place at state, regional, and local levels. The Background section of this chapter introduces the major issues

[6] This region includes parts of San Mateo, Santa Clara, San Benito, and Ventura Counties and all of Santa Cruz, Santa Barbara, San Luis Obispo, and Monterey Counties.
[7] Shortage is defined by CDWR as the difference between water supply and demand.

involved in water management: water supply, user demand, water quality, and water rights.

Supply

Water originates as either groundwater or surface water. An estimated 20 percent of water used in the United States comes from groundwater (Solley et. al, 1998) that is stored in aquifers—layers of rock and soil that contain enough space in the form of pores and fractures to hold large amounts of water. Since recharge rates are normally very slow, groundwater is only renewable if the withdrawal rates are very slow as well (to match the recharge rates). Non-renewable or "fossil water" is contained in underground aquifers that are recharged at rates that make them available for sustainable use only at small rates of withdrawal (Ashley and Smith, 1999). In California, groundwater withdrawals account for over 30 percent of water use, with over 75 percent of the water used in the CCR obtained from groundwater sources (CDWR, 1998). Historically, the Goleta North/Central Groundwater Basin has been in a severe state of overdraft. The Wright Judgment of 1989 mandated the Goleta Water District (GWD) to bring the basin into hydrological balance by 1998. This was accomplished through the importation of water through the State Water Project and other supplemental sources (Rodriguez and Lang, 2000).

Surface water is contained in streams, rivers, and lakes and is useable by trapping or diverting runoff in reservoirs, canals, and aqueduct piping systems. Surface water can be used at more rapid rates than groundwater due to its much faster recharge rates. In California, as in the rest of the country, the majority of the water used is surface water. Delivery of surface water in California is complicated by the fact that the majority of the people live in the southern half of the state, while the majority of the water falls in the northern half, "necessitating an extensive system of dams, reservoirs, pipelines, and aqueducts to service these areas" (Schamandt et al., 1988, 58). It was for this purpose that the State Water Plan was initiated. The year 1933 saw the beginnings of the State Water Plan with the passage of the Central Valley Project Act by the California Legislature, designed to transport water from the Sacramento River to the San Joaquin Valley and Los Angeles (Schamandt et al., 1988, 60). The last major project of the State Water Plan was the 1960 State Water Project (SWP), which, according to the Metropolitan Water District, is "the largest aqueduct system in history." This system transfers water from the "Sacramento and San Joaquin rivers through a network of dams, reservoirs, six power plants, and 58 miles of aqueducts," to satisfy the needs of agricultural and urban interests to the south (Gottlieb, 1988, 6-8). In 1991, Santa Barbara, Goleta and several other communities voted to begin importing their allocation of State Water and the SWP Coastal Branch began delivery in 1997 (CDWR, 1998).

Offstream use: water diverted or withdrawn from a surface- or ground water source and conveyed to a place of use (Solley et. al, 1998).

Demand

The United States is the largest consumer of water in the world (WRI, 2001). Total water withdrawals (fresh and saline) in the United States in 1995 equaled 402,000 Mgal/d or 1,500 gal/d per capita for *offstream uses* (Solley et. al, 1998). This signifies a 2 percent decrease in use since 1990 and a 10 percent decline since 1980. The decrease in water use is even more significant in light of the 16 percent increase in population from 1980 to 1990 (Solley et. al, 1998). As the USGS states in its 5-year compilation series of estimated water use, "[t]his decline signals that we are

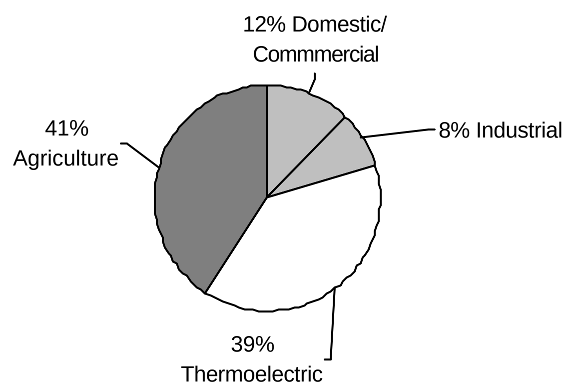


Figure 7-1. U.S. water use for 1995

managing our water resources more effectively, that water use does respond to economic and regulatory factors, and that the general public has an enhanced awareness about water-resources and conservation issues" (Solley et. al, 1998). California has the highest offstream withdrawals in the nation at 45,900 Mgal/d, although the state has seen a decrease since 1980, the peak year in water usage (Solley et. al, 1998). Despite this decrease in use, California is projected to face future water shortages. The CDWR estimates water shortages of between 2.4 and 6.2 million acre-feet by 2020 (CDWR, 1998). In the Central Coast Region[8] there is a current shortage of 214 thousand acre-feet (taf) during an average year and 282 taf in

[8] According to the California Department of Water Resource, the Central Coast Region extends from southern San Mateo County in the North to the northwestern tip of Ventura County in the south and includes all of Santa Cruz, Monterey, San Luis Obispo and Santa Barabara Counties. Also included are parts of San Mateo, Santa Clara and San Benito Counties (CDWR, 1998).

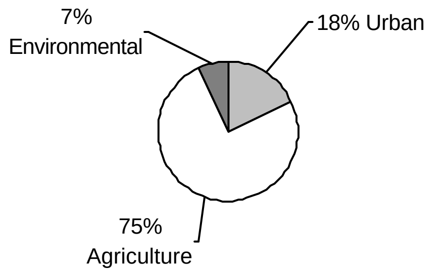


Figure 7-2. South Coast water use for 1995

a drought year (CDWR, 1998). Therefore, by CDWR estimates, water use in California must decrease or supplies must increase in order to avoid major shortages in the future. Expected increases in state population of 15 million (a 46% increase) over the next 20 years will require more conservation.

Water Quality

Water quality has been a salient national issue since the 1960s. However, strong federal regulation did not emerge until the 1972 Federal Water Pollution Act (Switzer, 1998). This Act was passed following a major public policy queuing event: the Cuyahoga River in Ohio caught fire in 1969. In 1977 groundwater pollution gained national attention with the discovery of contamination of soil and groundwater at Love Canal, New York although no federal groundwater regulations were subsequently developed[9] (Rosenbaum, 1998). Currently "nearly 40 percent of the nation's assessed waters are not meeting the standards states have set for them," potentially resulting in significant harm to both environmental and human health. (U.S. EPA, 2000).

Pricing and Property Rights

Allocation of water property rights has historically had an enormous impact on the price and use of water across the United States (Cahn, 1995; Haddad, 2000; Ashley and Smith, 1999). In the agrarian societies water was seen as a community resource where everyone had common access and equal right. This "system of riparian rights" was common in early American society (Cahn, 1995). As the United States developed into an industrial society, water was increasingly viewed as private property similar to land or minerals (Cahn, 1995). In most of the West, the doctrine of prior

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[9] Although the Safe Drinking Water Act was passed in 1974, and CERCLA in 1980-both of which address groundwater contamination.

appropriation or "first in time, first in right" is dominant. It assigns rights to the first user to put the water to beneficial use (Ashley and Smith, 1999; Cahn, 1995). In California there is a "hybrid doctrine" that includes both riparian and appropriative rights (Haddad, 2000; Ashley and Smith, 1999). The doctrine of prior appropriation encourages over consumption of water resources because users that have a "prior right" are "required to use the water available to them or else lose it" (Hartwick and Olewiler, 1998). This can lead to a situation where farmers are flooding their fields to grow water intensive crops such as rice or alfalfa while urban areas are struggling to meet basic demand. Hartwick and Olewiler state:

> "In times of shortfall in water supply, prior appropriative rights indicate that those users who acquired rights first in time may draw on the supply ahead of subsequent users…[e]conomic waste occurs because urban users have higher values of the water for amounts [wasted by rural users] (Hartwick and Olewiler, 1998)."

7.2.2 Environmental Impacts

Environmental impacts relating to water use fall under the two broad categories of withdrawal and inputs:

Withdrawals: Impacts from water withdrawals have several causes, such as water supply development projects and the overdrafting of aquifers. Water development projects such as dams and canals disrupt the natural flow of rivers, which changes the natural characteristics of aquatic ecosystems. Studies of salmon populations on dammed rivers show major impacts on the migrating fish (Raymond, 1979; Lichatowich et al., 1999). Diverting flows from surface waters leave less available for the maintenance of natural systems, thus changing the physical characteristics of the ecosystem. Postel and Carpenter state: "Freshwater remaining in its natural channels helps keep water quality parameters at levels safe for fish, other aquatic organisms, and people" (Postel and Carpenter, 1997). A clear example is Mono Lake in Southern California. Beginning in 1940, the city of Los Angeles began to redirect the water flows from four of the five streams feeding Mono Lake. As a result, "the level of the lake has dropped and increased salinity levels, which threaten the entire food chain" (Switzer, 1998). Alterations in the flow of rivers and the drainage or drowning of wetlands affect aquatic ecosystems, with consequences for environmental quality and human well-being that are diverse and not yet fully understood. "During the era of major water development, the US lost over 60% of its inland wetlands, polluted half of its streams and lost or badly degraded many major fish runs" (Hawken et al., 1999). In addition, overdrafting of groundwater can lower water tables, cause land subsidence, and reduce storage capacity (Ashley and Smith 1999). Lower water tables can be especially harmful in coastal areas due to saltwater intrusion that can pollute the remaining resource (Ashley and Smith, 1999).

Inputs: We use water for waste removal and as a sink for wastes. There are two main types of pollution sources, point and nonpoint. Point sources include "hazardous waste sites, landfills, wastewater-disposal sites, and leakage of refined petroleum products (Ashley and Smith, 1999). Nonpoint sources include agricultural, urban and mining runoff; seepage septic tanks; salt from road de-icing and acid precipitation (Ashley and Smith, 1999; Cahn, 1995; Switzer, 1998). Table 7-1 summarizes types of pollutants, their sources and impacts. Point and nonpoint sources pollute both ground and surface water. Nonpoint pollution "is estimated to be the major cause of pollution in 65 percent of the stream miles not meeting state standards" and the EPA has identified nonpoint sources as "actual or potential sources of groundwater contamination" (Rosenbaum, 1998, 210 and 214). In addition, the U.S. releases an estimated 41,000 Mgal/d of treated wastewater per year, typically into surface waters (Rosenbaum, 1998).

Table 7-1. Water pollution categories

Category	Contaminants	Source	Impact
Organisms	Biological contaminants including bacteria, parasites and viruses	Sewage discharge, cattle feedlots, leaching septic tanks	Human health
Suspended and Dissolved Solids	Soil particles, inorganic salts	Agricultural and urban runoff	Increased turbidity and may carry bacteria
Nutrients	Phosphates, nitrates, etc.	Agricultural and urban runoff, septic systems	Eutrophication and human health
Metals and Toxics	Lead, aluminum, cadmium, mercury, arsenic, radioactive minerals, chemical solvents, sulfur and nitrogen oxides, trihalomethanes, PCBs or synthetic organic compounds, radioactive waste, and metallic compounds	Pesticides from agricultural and urban runoff and landfill leaks; chemical solvents from industrial sources; underground petroleum storage tanks; nuclear testing and medical waste	Reproductive and endocrine disorders; nervous system damage and cancers
Physical	Increased temperature	Manufacturing and power generation	Aquatic life

Sources: Ashley and Smith, 1999; Cahn, 1995; Switzer, 1998; Sampat, 2000.

7.2.3 Economics

There are significant costs associated with all phases of water management. Since 1960 the US has spent over $114 billion on wastewater treatment facilities and $400 billion on water resources overall in the last 100 years. In 1960 California voters approved $1.75 billion to build the State Water Project, signally the large capital expenditures required to develop water management systems (Rodriguez and Lang, 2000). Water is used for several different economic activities: to create hydropower, for irrigation, for waste disposal, for various industrial purposes, and for various household uses. In fact, every sector of our industrial economy is directly dependent on sources of clean water and all sectors of our economy is dependent on the power generated by water flowing through our rivers (U.S. EPA, 2000). For example:

- $197 billion worth of food and fiber comes from irrigated crops and livestock each year;
- $44 billion is spent by Americans visiting coastal areas each year;
- industry uses an estimated nine trillion gallons of fresh water per year; and
- commercial fishing depends on functioning wetlands and coastal waters (U.S. EPA, 2000).

However, freshwater resources are often “overexploited relative to economic efficiency” (Cohen, 1995). This may be partially attributed to the use of subsidies in the form of pricing structures that benefit irrigated agriculture (Hartwick and Olewiler, 1998). Agricultural interests enjoy a substantial price advantage over urban and industrial users, leading many to critics to charge that great waste occurs in some agricultural areas. In the CCR agriculture is the largest user of water and is expected to stay that way for the foreseeable future—CDWR estimates a loss of less than one percent of irrigated crop acreage in CCR over the next 20 years (CDWR, 1998). The pricing structure of local purveyors gives irrigated agriculture a significantly reduced price (Goleta Water District, 2001).

Economically efficient allocation of water is hampered by what economists call a market-failure. In theory, the market should allocate water at low cost to those who need it most, i.e. those who have the highest willingness to pay. For the market system to function correctly the commodity must exhibit the characteristics of a private good: “rivalry in consumption and excludability of ownership” (Weimer and Vining, 1999). Water is generally considered an open-access public good because it is nonexcludable—more than one individual may have the right to use the same water resource (Weimer and Vining, 1999). This can lead to a “tragedy of the commons” scenario where users of a public good see it as being in their self-interest to degrade the commons (Hardin, 1968).

Beyond the realm of economic efficiency, values and politics also play a role in determining the distribution of water. As Hartwick and Olewiler state:

> "Governments are unlikely to allow the market to reach equilibrium where a group of people cannot afford water. Markets are therefore not necessarily the ideal mechanism for distributing an essential good such as water (Hartwick and Olewiler, 1998)."

The government has responded by assigning property rights to some water resources—riparian and appropriative—and they have established public control of other water supplies as well as delivery systems. Neither response has established economic efficiency and over consumption has continued.

The problem is also relevant with respect to pollution, given that water pollution is an externality (i.e., polluters do not have to pay for damage they cause to the environment). Dirty water is costly in terms of lost ecosystem services and in health treatment costs. Water pollution may be termed an externality or situation "in which the actions of one individual (perhaps a person, perhaps a firm or government) affect the welfare of another" without the full cost of those actions being realized (Stokey and Zeckhauser, 1978). For example:

> "Externalities, and the market failures they generate, are a major reason for government intervention in private markets. The most familiar and most widely discussed externalities relate to the environment. Given present pricing arrangements, we cannot expect market processes to yield air and water that are sufficiently pure (Stokey and Zeckhauser, 1978)."

The cost of lost ecosystem services is unknown and difficult to measure. However, the U.S. Environmental Protection Agency has put together information on some of the health effects associated with water pollution:

- "In 1998 about one-third of the 1,062 beaches reporting to the EPA had at least one health advisory or closing.
- In 1998 2,506 fish consumption advisories or bans were issued in areas where fish were too contaminated to eat.
- Seventeen states reported 37 recreational water outbreaks caused by microorganisms in the latest (1995-1996) available data from the Center for Disease Control.
- The EPA currently estimates that at least a half-million cases of illness annually can be attributed to microbial contamination in drinking water."

- "Over a trillion dollars…has been spent to upgrade and expand wastewater treatment facilities" (U.S. EPA, 2000).

7.2.4 Campus Issues

Water Use

Water use is an important issue on college and university campuses. Current campus greening literature identifies water use and water quality as important factors in determining the environmental impact of universities (Green Destiny Council, 1995; Thurlow, 1999a,b; Fetter and Mudd, 1993). University water use includes: irrigation, water appliances (toilets, showers, clothes and dishwashers), chillers, cooling towers, and food preparation (Fetter and Mudd, 1993). Depending upon regional or local abundance or scarcity, universities can have a large impact on water supplies. However, even in regions where water is usually abundant, shortages and droughts can occur. Cost savings are often possible from the implementation of water conservation strategies. In their book *Green Investment, Green Return*, the National Wildlife Federation lists the cost savings and use reductions after conservation measures were taken at several universities. Two examples highlight the possible benefits of conservation programs. Columbia University noted the following savings after retrofitting the campus with water conserving showerheads, toilets and facets:

- 25-30% reduction in water use
- Annual savings of $203,000
- Payback period of 1.8 years

In addition, Brown University noted the following savings after retrofitting residence halls with low flow showerheads:

- 50% reduction in water use
- Annual savings of $45,800
- Payback period of 8 months

Water Quality

Critical water quality issues on university campuses include runoff from impermeable surfaces and the generation of wastewater (NWF, 1996). Runoff either is connected to wastewater and goes to the treatment plant or is separated into its own drainage system that empties into nearby surface water. At coastal campuses like UCSB, the majority of the runoff empties into the Pacific Ocean. Runoff can pollute lakes, rivers, wetlands, and sensitive coastal habitats and potentially contributes to health risks for surfers and other beach goers. Wastewater generation is another issue that is important for campuses to consider. The amount of wastewater generated depends upon the amount of water that comes into campus. In ecologically sensitive areas, wastewater generation and treatment can have significant environmental impacts. Both water use and wastewater generation can be reduced through conservation measures like low flow showerheads, ultra low flush or composting toilets, and automatic faucets. The amounts of water used for everyday activities are summarized in Table 7-2.

Table 7-2. Water requirements for common campus activities

Brushing Teeth	2 gallons
Shower	25-50 gallons
Shave with water running	10-15 gallons
Flush a Toilet	5-7 gallons
Run a dishwasher	12 gallons
Hand wash dishes	20 gallons
Wash a load of clothes	59 gallons

Source: Switzer, 1998

7.3. Results

A series of questions were taken and adapted from the campus environmental audit format in April Smith's book, "Campus Ecology". Interviews were held with Jon Cook and David Inouye in Facilities Management, Jim Dewey in Physical Facilities, and Ali Aghayan from Environmental Health and Safety. All data included were derived from these sources, although additional research was obtained from U.S. EPA, CDWR and Santa Barbara County resources. The following questions were asked to gauge UCSB's current status with respect to campus water management practices and policies.

1. How much water is used by UCSB per year? Over the past 10 years?

Table 7-3. Historical UCSB annual water use

Year	Total Water Used (gallons)
1993	194,091
1994	216,827
1995	234,140
1996	283,011
1997	240,608
1998	264,832
1999	273,197
Change	**+41%**

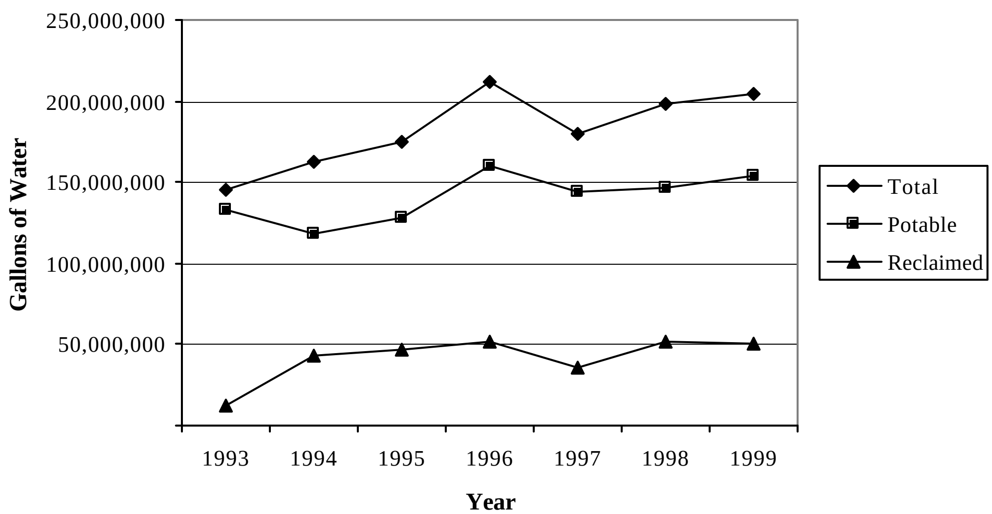

Figure 7-3. Historical UCSB annual water use

2. How much water is used indoors? Outdoors (irrigation)?

About one third of use is for irrigation and two thirds for indoor use. Some irrigation areas are not hooked up to reclaimed water (Residence Halls, University Center, and Parking areas). However, areas that use reclaimed water use it exclusively.

Table 7-4. Potable and reclaimed water use

Year	Potable (Indoor and Outdoor)	Reclaimed (Outdoor only)
1993	177,260	16,831
1994	158,745	58,082
1995	170,858	63,282
1996	214,183	68,828
1997	192,294	48,314
1998	196,020	68,812
1999	204,995	68,202
Change	**+16%**	**+305%**

3. How much reclaimed water is used? What percent of outdoor use? What percent of total use?

Reclaimed water came online in 1993-94. Reclaimed water use as a percent of outdoor use is not known. See Figure 7-4 for more information.

Table 7-5. Historical use of reclaimed water

Year	Reclaimed (gallons)	% of Total Water Used
1993	16,831	8.67%
1994	58,082	26.79%
1995	63,282	27.03%
1996	68,828	24.32%
1997	48,314	20.08%
1998	68,812	25.98%
1999	68,202	24.96%
Change	**+305%**	**+16%**

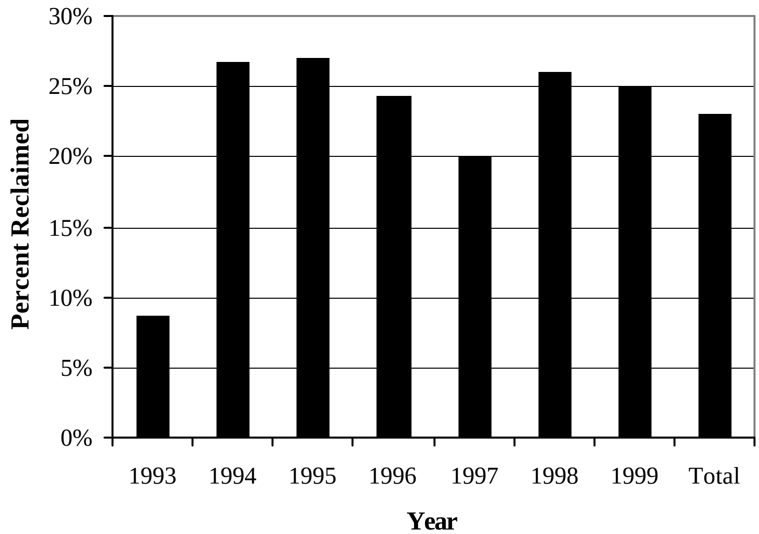

Figure 7-4. Reclaimed water use as a percent of total use

4. How much was spent on water over the past 7 years?

See Figure 7-5.

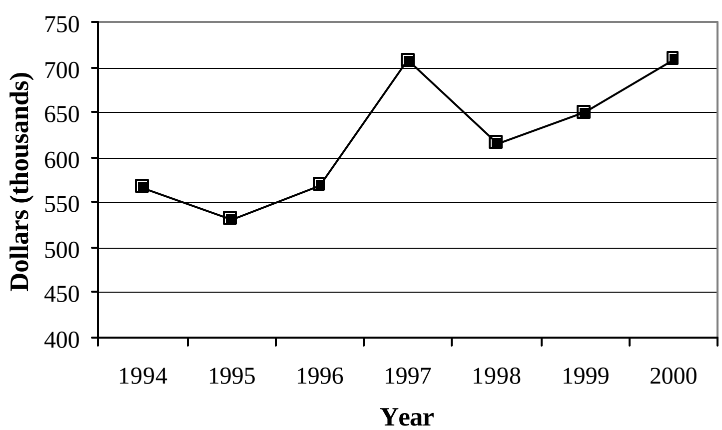

Figure 7-5. Total Water Expenditures: 1994-2000

5. How much wastewater is produced per year? Over the last 5 years?

An estimated 400,000 gallons of wastewater is produced per day, for a total of 146,000,000 gallons a year. See Figure 7-6.

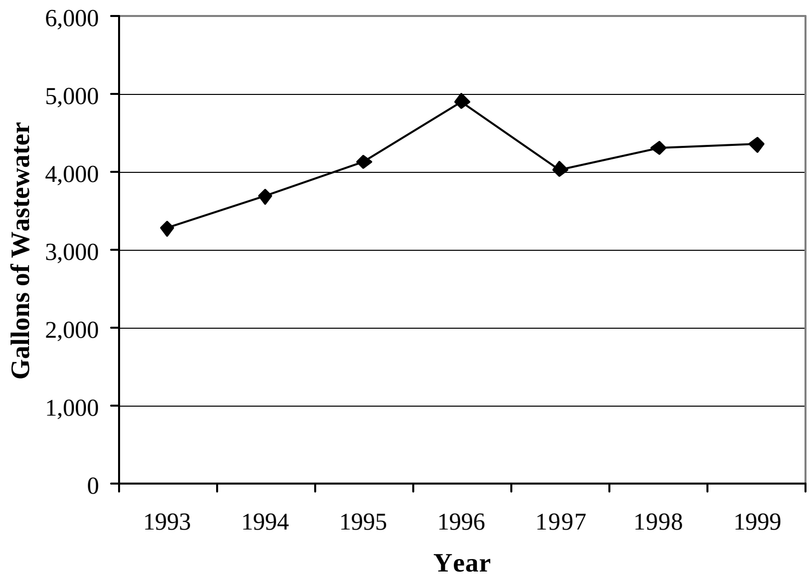

Figure 7-6. Total annual wastewater generation at UCSB

6. Is storm water runoff measured? If so, how much?

No, storm water runoff on campus is not currently measured.

7. Are there any mitigation measures in place?

All newly constructed drains must have oil filters. An estimated 25 percent of storm drains have mitigation measures currently in place.

8. Where does the runoff go?

Campus runoff proceeds to the Pacific Ocean (I.V. Beach and Goleta Beach), Goleta Slough, Campus Lagoon, and meadows north of campus.

9. What water conservation strategies are in place?

The major conservation measure is the use of reclaimed water. Outdoor watering is only performed from 7pm to 7am.

10. Where does UCSB get its water?

UCSB obtains water from the following sources: Lake Cachuma, the California State Water Project, and local groundwater sources.

11. What regulations apply to water issues on campus?

There are four main government agencies that regulate either water supply or water pollution at UCSB. Water supply (including reclaimed water) is under the auspices of Goleta Water District. Water pollution is regulated by the U.S. Environmental Protection Agency (EPA), State Water Resources Board (SWRB), and the Regional Water Quality Control Board (RWQCB). SWRB is the lead state agency, while the RWQCB is the primary point of contact for UCSB for compliance, enforcement, permits, etc. The primary statutes of concern are the federal Clean Water Act and California Water Code.

12. What is the relationship between land use and water use on campus?

The amount and type of plants used for landscaping determines how much water is used for irrigation purposes. More specifically, the horticultural requirements of the plants must be met. Not only is water a physiological necessity in itself, it is also the medium that allows nutrients to pass into the plant.

7.4. Analysis of Results

7.4.1 Current trends

Water Use: Water use has increased steadily over the past six years (both per capita and total use). Water use has increased 40% overall since 1993, but has decreased from a high in 1996. Potable and reclaimed water uses have shown similar increases. The most troubling aspect noted with respect to water use is that potable water use has increased even as reclaimed increased. Over the same six-year period per capita potable water use has increased by almost ten percent and total per capita use has increased by 33 percent (see Figure 7-7). When reclaimed water came online in fully in 1994, there was a noticeable decrease in potable water use. However, this decrease was subsequently accompanied by a steady increase to a level well above pre-reclaimed usage levels. Expenditures for water have increased by 25% since 1994 (see Figure 7-5).

Runoff: An estimated 25% of storm water drains have mitigation measures in place. It is now a requirement that all new construction that includes storm drains must have mitigation measures. However, the direct impacts on water quality associated with runoff are difficult to measure. In the past year the Shoreline Preservation Fund has funded water quality testing in Campus Lagoon and along the shore around UCSB.

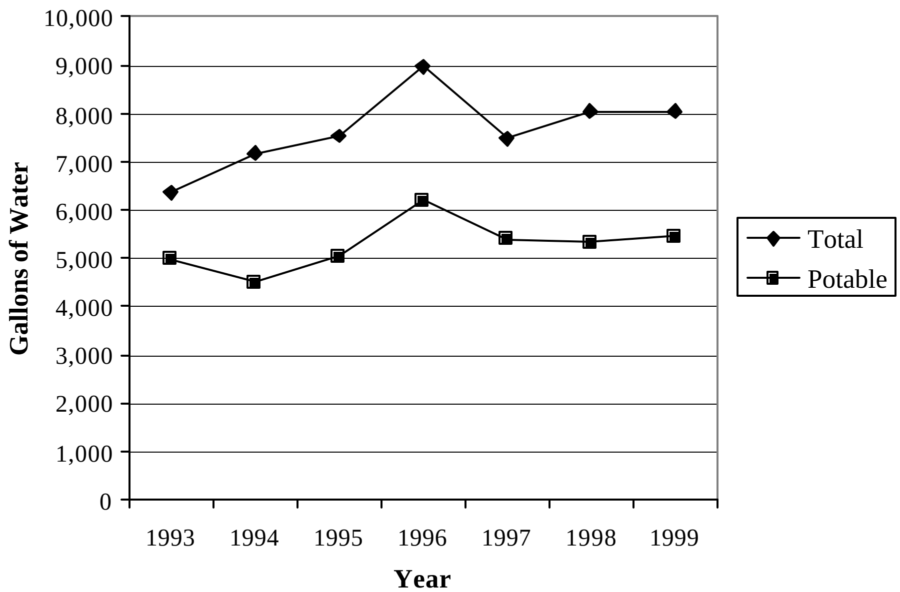

Figure 7-7. Per capita water use

Local and state agencies test ocean water quality regularly. Runoff from UCSB adds to runoff from local streams and other urban runoff. It is likely that impacts have increased as UCSB has become more developed (see Chapters 2 and 3 of this report for more on campus development).

***Wastewater**:* Trends in wastewater match trends in water use; total wastewater generation has increased by approximately 40 percent since 1993. Wastewater outflow from campus is generally 60 percent of total water use. In other words 40 percent of water that is used on campus is consumed—evaporated, transpired, incorporated into products or plants, consumed by humans—and 60 percent leaves campus to be treated as wastewater.

7.4.2 Environmental Impact

Water Use: Data from UCSB shows a trend of increasing water use over the past seven years. This is troubling in the face of growing water scarcity in the Central Coast Region of California. Local groundwater basin overdraft is not a problem for GWD sources because of adjudication of the North/Central Goleta Groundwater Basin in 1989. The Wright Judgment established a safe-yield and allocations for the basin as well as requiring "a state of hydrologic balance by 1998" (Rodriguez and

Lang, 2000). The GWD "has achieved compliance with this order through importation of State Water and the development of other supplemental supplies" (Gibbs, 2001). The supplemental supplies are surplus allocations from the Cachuma Project purchased from the City of Santa Barbara, which may or may not be available in the future. Thus, the GWD will have to rely on regional and statewide surface water supplies adding to the already substantial burden on these sources. Several other area groundwater basins are in a state of overdraft including Santa Maria Valley, San Antonio Valley, Santa Ynez Uplands, Lompoc Uplands, and Cuyama Valley. Since supplies are limited, any use takes away from other potential uses including environmental and reduction of groundwater overdraft in other basins. Everybody has a responsibility to conserve to help mitigate the current shortages across the region and state.

Runoff: The impact of storm water runoff is difficult to measure. Several public and private agencies measure water quality in the coastal waters around UCSB and even at the campus lagoon. The Shoreline Preservation Fund considers runoff from campus and Isla Vista to be harmful to coastal water quality north of campus. The major impacts for coastal water quality are considered to be streams during the rainy winter, although extensive data are not available for the comprehensive assessment of environmental impacts resulting from runoff at UCSB.

Wastewater*:* Wastewater from UCSB is treated at the Goleta Sanitary District (GSD) plant and discharged into the Pacific Ocean approximately one mile from shore at a depth of 92 feet. The GSD takes monthly water quality profiles of coastal waters at eight ocean stations and they run bacteria tests weekly in the "surf zone" from Isla Vista to Moore Mesa. The Pursuant to their NPDES permit authorized by the EPA and Regional Water Quality Control Board the GSD have effluent limits for grease and oil, suspended solids, biological oxygen demand, ammonia, turbidity, and fecal coliform. They have had no permit violations since at least 1996.

7.4.3 Institutional Framework

The Grounds Department, a subsection of Facilities Management, manages outdoor water use. There is no committee or department on campus that manages overall water use. Indoor water conservation is on a project-by-project basis. The Goleta Water District (GWD) supplies water for the University of California, Santa Barbara and the surrounding area. Goleta Water District serves approximately 75,000 people. Water supplies include Goleta North/Central Groundwater Basin, the Cachuma Project and the State Water Project. Cachuma Project built in early 1950s to deliver water to South Coast and Santa Ynez Valley. Total water use in the GWD is estimated at 8,863 acre-feet per year, per capita use is 103 gallons per day (Rodriguez and Lang, 2000). UCSB used 627 acre-feet of water in 1999 or seven percent of total use in the Goleta Water District.

7.4.4 Financial Issues

Water is purchased from the Goleta Water District, the local water purveyor, as part of the utilities budget. Water purchases from this source accounts for 10-12 percent of total utility expenditures. Improvements to water conservation and mitigation for pollution do not have separate budgets. Rather, most improvements at this time must come from new capital projects.

The GWD has a tiered pricing structure that gives a significant price advantage for agricultural irrigation and a smaller advantage for recreational irrigation as presented in Table 7-6 below. In the past ten years, UCSB has paid anywhere from two dollars to well over five dollars per hundred cubic feet of water supplied.

Table 7-6. Water pricing according to use

Type of Use	Water Rates (per hundred cubic feet)
Urban	$3.13
Reclaimed Irrigation	$1.74
Recreation Irrigation	$1.74
Agricultural Irrigation	$0.90

7.4.5 Innovation

The major water innovation noted at UCSB is the use of reclaimed water. The use of reclaimed water has resulted in initial drops in water use and may have averted even greater increases. Reclaimed water is treated wastewater that can "legally be substituted for drinking water in agriculture, landscape irrigation, and flushing toilets" (GWD, 2001). The water is treated at the Goleta Sanitary District (GSD) water reclamation plant where it undergoes tertiary treatment and is distributed to UCSB for irrigation purposes. The plant was built in 1993 in a partnership between GWD and GSD and supplies approximately 1,000 acre-feet per year for irrigation at "Goleta Beach, UC Santa Barbara, Goleta's post office, and various parks and golf courses" (GWD, 2001). Reclaimed water meets bathing water standards but is high in nitrogen content. It is not very dangerous but could be harmful if a person drank a lot. Reclaimed came online in 1994 at UCSB. Reclaimed areas are isolated from other areas, human contact is minimized, and all reclaimed water lines are marked in purple. The amount of area irrigated has remained constant since 1994, while approximately 1-1.5 million gallons of water gets reclaimed per day.

In addition to the use of reclaimed water, UCSB has increased the use of oil filters on storm water drains for new construction with significant amounts of paved surface. All construction in the past seven years required that storm drains have filters. UCSB has also attempted to use the natural filtration of the landscape. There are monitoring wells in catch basins near buildings that use chemicals that test for pollution, and there have been retro fittings of some water appliances and buildings.

Lastly, there have been retrofittings of some water appliances on campus. For example, in 1989, campus residence halls were retrofitted with 100 low flush toilets.

7.4.6 Community/Education

Groups such as the Surfrider Foundation, Environmental Defense Center, and the Earth Action Board Heal the Ocean and Shoreline Preservation Fund are active on campus and in the community promoting environmental issues and conducting studies regarding water use and water quality issues.

7.5. Environmental Report Card

Indicator	Answer	Score
Is there a University water conservation policy?	No	0
Has per capita water consumption decreased in the since 1993?	No	0
Has absolute water use decreased?	No	0
Is there any water quality monitoring by the University?	No	0
Is reclaimed water used on campus?	Yes	1
Does a majority of the water used for irrigation come from reclaimed water?	Yes	1
Has wastewater generation per capita decreased in the past since 1993?	No	0
Have there been any water conservation retrofits?	Yes	1
	Total:	**3/8**
	Percentage:	**38%**
	Grade:	**D**

7.6. Recommendations

7.6.1 Water Use

- Monthly data should be generated and easily accessible by building and by use category (irrigation or indoor).
- Extend the use of reclaimed water to the entire campus.
- Use drip irrigation along sidewalks and buildings.
- Mandate high efficiency appliances in new buildings.
- Set schedule for eventual retrofitting of all "inefficient" water appliances.
- Conduct a water audit.

7.6.2 Water Pollution

- Calculate storm water runoff on campus.
- Test water quality near storm drain outfall.
- Place oil filters on all drains.

8. LANDSCAPE MANAGEMENT

8.1. Introduction

The term landscape can apply to several different levels of analysis. At its broadest level landscape is defined as the “heterogeneous mosaic of habitat patches created by variations in topography and soils” within a region at the kilometer scale (Ricklefs, 1997, 91). More often in common usage, terms like urban landscape or natural landscape are used to signify different types of land use (Perry, 1992). At an even smaller scale are managed landscapes such as corporate and university campuses, parks, and personal gardens. The concept of sustainable landscaping refers primarily to these types of managed landscapes (Perry, 1992; Corbett and Corbett, 2000). Sustainable landscaping is consistent with the principles sustainability defined in the introduction of the paper: minimize the use of resources (such as water, fertilizers and pesticides), minimize waste (in the form of contaminated runoff); and conserve the natural environment by using native plants that fit with the natural landscape of the region. This section then investigates landscape management at UCSB with an assessment, analysis and recommendations.

8.1.2 Background

A growing population in California and the development that accompanies such growth are putting increasing pressure on the natural environment. According to estimates by the California Department of Finance, by 2020 California population will grow by almost 11 million people, an increase of almost 31 percent (California Department of Finance, 1998). Over the same time period Santa Barbara County is expected to grow by 34 percent, from 412 thousand people to 553 thousand (California Department of Finance, 1998). Such population growth will lead to a more developed landscape and make habitat preservation an even more important goal. As Lester Brown of the Worldwatch Institute states: “Our numbers continue to expand, but Earth’s natural systems do not” (Brown, 2000).

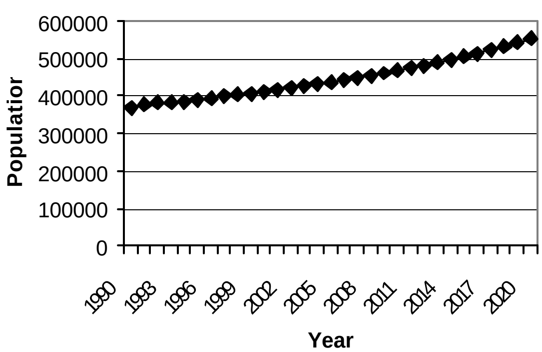

Figure 8-1. Population of Santa Barbara County.

Source: California Department of Finance, 1998.

Ecosystems are being threatened by habitat loss, the introduction of alien species, and the fragmentation of natural areas caused by "bulldozing, paving, plowing, draining, dredging, trawling, dynamiting, and damming" (Baskin, 1998, 9). For example, as of 1991, wetlands in the United States had been reduced from an original 221 million acres in the lower forty-eight states, to 103.3 million acres (Switzer, 1998, 153). At least one in eight plant species in the world—and nearly one in three in the United States—is already threatened by extinction (Vig and Kraft, 2000, 374). By 1980, 85 percent of the virgin forests throughout the U.S. had been destroyed, with losses estimated at 95-98 percent in the lower 48 states (Sierra Club, 1998). The state of California's landscape is also troubling and has experienced the following habitat losses:

- 99 percent of its native grasslands
- 70-90 percent of coastal sage scrub
- Over 85 percent of coastal redwoods
- 91 percent decline of all wetland types, a 94 percent loss of inland wetlands, and a 66-88 percent loss of Central Valley vernal pools.
- 80 percent of the coastal wetlands have been converted to urban or agricultural uses and 62 percent of the salt marshes are gone (Sierra Club, 1998).

The new field of invasion ecology has developed to assess the impacts of the anthropocentric introduction of exotic or invasive species (Cox, 1999). According to George W. Cox: "Deliberate introductions for biological control have led to the establishment of over 237 exotic insects and several plant pathogens in the United States" (Cox, 1999). The National Parks Service calls the invasion of exotic species, "one of the most serious threats that parks face today" because "exotic species disrupt complex ecosystems, reduce biodiversity, jeopardize endangered plants and animals an degrade habitats" (National Parks Service, 1997). Humans have introduced exotic plant species intentionally for use as agricultural crops, forages, medicinal uses, and horticultural uses (Cox, 1999). "Many of the same traits that make a plant a highly desirable ornamental, such as prolific flowering and seeding or cold and heat tolerance, also may make them ideal weeds. Every new plant introduction is an experiment with an unknown outcome" (Westbrooks, 1998).

8.1.3 Environmental Impacts

Landscape management can have serious environmental impacts through the introduction of invasive species, the pollution of water bodies from pesticide and fertilizer use, the fragmentation of natural habitats, water use, and soil impaction.

Pesticides are a leading stressor and cause water quality impairment in11% of U.S. lakes (Rosenbaum, 1998). Nonpoint pollution is estimated to be the major cause of pollution in 65% of the stream miles not meeting state standards for their designated use (Rosenbaum, 1998, 210). Agriculture is the largest contributor to nonpoint pollution (metabolic wastes from animals, sediment, fertilizers, pesticides, and dissolved solid), accounting for and estimated one-third of pollution to the nation's streams (Rosenbaum, 1998, 211). Nutrients from nonpoint sources can lead to eutrophication. Many managed landscapes often use large inputs of pesticides and fertilizers. The most extreme cases are for agriculture but large areas of managed landscapes can also have impacts. Private gardens and lawns can also add up to a large impact. Scholars have found evidence of anthropogenic change in the global carbon and phosphorus cycles (Schlesinger, 1997).

Landscape management commonly requires inputs of pesticides, herbicides and fertilizers. These inputs can lead to water pollution from storm water runoff, commonly referred to as non-point pollution. Runoff collects pollutants from managed landscapes and oil and chemicals from urban landscapes and bacteria. Nonpoint pollution is the most common source of surface water pollution. It can impact both surface and groundwater; its sources are urban and agricultural runoff. Runoff is the largest contributor because of animal wastes, sediment, fertilizers, pesticides, dissolved solids, etc., is the major cause of the eutrophication of lakes and wetlands. An extreme example of the damage caused by runoff is the 7,000-square-mile "dead zone" off the coast of Louisiana. Agricultural fertilizers are washed down the Mississippi River and end up in the Gulf of Mexico and cause a depletion of oxygen in the coastal waters (Hawken et al., 1999, 149). "But the majority pollution problems are caused by runoff from city streets, rural areas and other diffuse sources" (U.S. EPA, 2000).

8.1.4 Economics

Ecosystems play a crucial role in sustaining our health and well-being. They provide clean air for us to breathe, clean water to drink, productive soils to grow our food, sinks for our wastes, and many other services (Hawken, 1997; Daily, 1997; Prugh et al., 1999). Most importantly, all these services are rendered at almost no cost to humans. Recent scholarship estimating the monetary value of ecosystem services is contained in the book *Nature's Services: Societal Dependence on Natural Ecosystems* (Daily, 1997). Dollar values are estimated for the services provided by "major biomes" (marine, freshwater, forest, and grassland ecosystems) and "overarching services" (climate stabilization, genetic variation, productive soils, pollinators, and natural pest control). Costanza uses these studies and others to estimate an aggregate value for "17 ecosystem services for 16 biomes" at $33 trillion per year (Costanza, 1997). In comparison, the "[g]lobal gross national product total is around US $18 trillion per year" (Costanza, 1997). Humankind cannot reproduce most of these services at any price (Hawken, 1997). Some of the services the natural environment provides are summarized in Table 8-1.

Table 8-1. Nature's services

- Production of oxygen
- Maintenance of biological and genetic diversity
- Purification of water and air
- Storage, cycling, and global distribution of freshwater
- Regulation of the chemical composition of the atmosphere
- Maintenance of migration and nursery habitats for wildlife
- Decomposition of organic wastes
- Sequestration and detoxification of human and industrial waste
- Natural pest and disease control by insects, birds, bats, and other organisms
- Production of genetic library for food, fibers, pharmaceuticals, and materials
- Fixation of solar energy and conversion into raw materials
- Management of soil erosion and sediment control
- Flood prevention and regulation of runoff
- Protection against harmful cosmic radiation
- Regulation of the chemical composition of the oceans
- Regulation of the local and global climate
- Formation of topsoil and maintenance of soil fertility
- Production of grasslands, fertilizers and food
- Storage and recycling of nutrients

Source: Hawken et al., 1999.

8.1.5 Campus Issues

The major landscaping issues that must be addressed at the campus level are resource consumption (water and fertilizers), loss of natural habitat, and water pollution from the runoff of fertilizers and pesticides and herbicides. These problems are addressed through new approaches to landscaping such as "greenscaping" (NWF, 1996) and "sustainable landscaping" (Perry, 1992). These terms have come to describe the growing trend of valuing both aesthetic and ecological benefits in designing and maintaining landscapes (Corbett and Corbett, 2000). Sustainable landscaping places an emphasis on protecting native organisms, preserving natural habitat, reducing the use of resources and viewing the landscaped campus as part of the local or regional ecosystem (Keniry, 1995; Lerner, 1994).

In addition, sustainable landscape can have the significant side benefit of reducing landscaping costs while helping to protect the environment (Keniry, 1995). Reducing pesticides and fertilizers reduce pollution of surface and groundwater from storm water runoff. Pesticides can also be harmful to humans, and beneficial organisms. Therefore, inclusion of water conservation in landscape planning can reduce water costs and reduce demand of a scarce resource.

Techniques for reducing pesticide use include "planting appropriate native species which are naturally pest resistant; pulling weeds by hand; and introducing appropriate native predators like bats, birds, reptiles, other insects, and amphibians to eliminate problem insects" (NWF, 1996). Fertilizers can often be reduced or eliminated through the use of compost or mulch. Water conservation is also a crucial part of sustainable landscaping. Water savings can be realized by using mulch to increase water retention, using grey water and/or reclaimed water for irrigation, and the development of a drip irrigation system (NWF, 1996).

Sustainable landscaping has become a salient issue at many universities across the United States (see Green Destiny Council, 1997; Keniry, 1995; Lerner, 1994). In the book, *Ecodemia: Campus Environmental Stewardship*, Julian Keniry provides several examples of universities that are moving towards sustainable landscaping via the following means: the use of native plants, integrated pest management, and community outreach (Keniry, 1995). The use of native plants is a step in the right direction as they are adapted to natural conditions without the need of lots of inputs, and can be used to gradually replace exotic and annual vegetation with perennial and native plants (Keniry, 1995). For example, Wesleyan Nebraska University has realized significant gains from the use of native plants including reducing fertilizer use, avoiding cost of nursery bought plants, increased habitat for birds, and educational opportunities (Keniry, 1995).

Integrated Pest Management (IPM) is another strategy for decreasing the intensive use of pesticides on campus. This approach uses spraying only as a last resort, when other strategies have been ineffective and pests threaten to damage economically valuable vegetation (Keniry, 1995). For example, strategies include exchanging blanket spraying for spot spraying and increased use of mechanical controls (i.e. sticky traps and eliminating pests by hand), and better planning (choosing plants with natural resistance and putting them in the proper place). Biological controls are also often utilized such as insect diseases and "beneficial insects" that prey on or parasitize pests (Keniry, 1995). Examples of beneficial insects are ladybugs, lacewings, assassin bugs, parasitic wasps, and praying mantises (Keniry, 1995). IPM policies on many campuses have enjoyed considerable success, as demonstrated by the drastic reduction of spraying practices.

Community building and education can also be an important tool in sustainable landscaping through horticultural lectures and hands-on programs for students and staff. For example, Texas Southern University gives students and faculty a chance to participate in managing the campus landscape through an "Adopt-a-Plot" program where participants develop and mange their own pieces of the campus landscape (Keniry, 1995). This program encourages the use of native and other well-adapted plants and works to develop and expand drip irrigation under sidewalks and around buildings. Drip irrigation is often considered to be more specific and efficient than typical sprinkler systems, "which often water sidewalks and buildings and everything but their intended sites" (Keniry, 1995). Participants in the Adopt-a-Plot program use mulching and composting instead of fertilizers. Campus generated compost is used and participants also contribute their organic debris to the compost pile.

8.2. Results

A series of questions were taken and adapted from the campus environmental audit format in April Smith's book, "Campus Ecology". Interviews were held with David Inouye, Jon Cook and Mary Ann Hopkins from Facilities Management and Ray Aronson, Ali Aghayan and Wayne Ferren. All data included were derived from these sources, although additional research was obtained from library and Internet resources. The following questions were asked to gauge UCSB's current status with respect to campus landscape management practices and policies.

1. What plants are used for landscaping on the UCSB campus?

A wide variety of vegetation is used on campus—everything from turf to palm trees.

2. What are the criteria for choosing landscaping materials? Is preference given to drought tolerant or native plants?

Visual impact is of primary concern, although criteria have varied over time. There are no formally specified criteria for landscaping at UCSB.

3. What is the process by which lands caping materials are chosen for new projects?

The *Design and Review Committee* dictates what plants are used for landscaping of new construction projects. The Committee is a Chancellor's committee staffed on a rotating basis.

4. What type of landscape region is UCSB in?

UCSB is located in a Southern Coastal Edge landscape region with a Mediterranean climate. Mild weather is common for both winter and summer months. The majority of rainfall in Santa Barbara (average of 18.67 inches) is during the winter months, December through March (City of Santa Barbara, 2000). Temperature varies from an average high of 75.4° F in August to an average low of 40.1° F in December. There is "virtual year round moisture stress on landscape plants" with annual evapotranspiration of 40 inches (Perry, 1992, 20). "Natural vegetation is dominated by coastal strand, coastal sage scrub, and chaparral plant communities" (Perry, 1992, 20). The South Central Coast region provides habitat for 1,400 native species, with 140 endemic to the region (CCP, 2000).

5. What connection does UCSB campus have with regional ecology? Is UCSB a rural or urban campus? Are there natural areas?

UCSB is primarily an urban campus and becoming more so as campus development increases. UCSB manages a number of natural areas including Environmentally Sensitive Habitat areas (as designated by the Coastal Commission). The primary natural areas include Campus Lagoon, North, South, East, and West Bluffs, Storke Wetland and Coal Oil Point Reserve. The Museum of Systematics and Ecology (MSE) within the Department of Ecology, Evolution, and Marine Biology (EEMB) manages these projects with the exception of Coal Oil Point reserve, which is managed by the University of California Natural Reserve System. MSE also has a Restoration Intern Program, Restoration Ecology Seminar, a course entitled *Field Work in Restoration*, and this fall it started work on the Lagoon Park Enhancement Plan in association with the new student housing project, Manzanita Village

6. Have campus natural areas been maintained over the past 10 years?

No, the Coast Live Oak Grove near the Recreational Center was removed to make way for the Environmental Health and Safety building.

7. Are there any programs to connect the campus with the region ecologically?

Groups such as the Surfrider Foundation, Audubon Society, Environmental Defense Center, and the Earth Action Board are active on campus and in the community promoting environmental issues. Other groups such as the Conception Coast Project (CCP) and the Gaviota Coast Conservancy (GCC) are focused on protecting and restoring ecological integrity to the region (CCP, 2000).

8. What University departments are active in landscaping?

The majority of landscaping is managed by Physical Facilities, although University Housing, the University Center, and Parking also manage some landscaped areas.

9. What is the pest management strategy?

UCSB has an Integrated Pest Management policy (IPM). The IPM uses a "common sense and environmentally sensitive approach to managing pests and minimizing pest damage while causing the least possible hazard to people and environment" and doing it economically (UCSB Policy 5435).

10. What pesticides are used on campus? In what quantities?

Roundup is used in small quantities for spot treatment for weeds. Total quantities used are not known.

11. Is there any treatment for storm water runoff? Where does the outflow go?

Storm water runoff from campus drains directly into the Pacific Ocean, Campus Lagoon, and Goleta Slough. All storm drains installed in the past 7 years have oil filters and filters are required for all future drains. An estimated 25 percent of the total storm drains on campus have filters measures.

12. Are there any endangered species on campus (state and federal)?

Yes: Brown Pelicans, Coulter's Saltbush, Coastal Bluff Herbs, Dune Scrub, Least Tern, Bald Eagle, Willow Flycatcher, Peregrine Falcon, White-tailed Kite, Golden Eagle and Snowy Plover. An additional 22 species are listed as Species of Concern by the California Department of Fish and Game (Ferren and Thomas, 1995).

8.3. Analysis of Results

8.3.1 Current trends

Campus Development: The UCSB campus has a total area of approximately 980 acres. Of that total area, 100 acres are considered environmentally sensitive habitat, 160 acres are considered undeveloped and the remaining 720 acres are classified as managed landscape, buildings, roads and parking lots. The square footage of campus has not changed significantly since the 1960s; however, there have been trade offs between developed and undeveloped areas on campus.

Pest Management: Since UCSB instituted its IPM in 1985 (which was subsequently signed by Chancellor Yang in 2000, Policy 5435) it has seen a decrease in the use of pesticides. Pesticide use has been almost phased out as a means for protecting the campus from insects as a result of this policy.

Runoff*:* An estimated 25% of storm water drains on campus have mitigation measures in place. It is now a requirement that all new construction that includes storm drains must have mitigation measures.

8.3.2 Environmental Impact

Habitat Loss: Development pressure on campus is putting strains on the natural areas that surround campus (Campus Planning, 2000b). There has been significant fragmentation of habitat, resulting in potential ecological deterioration. However, the extent of environmental impact associated with habitat loss on campus is not known.

Runoff: Storm water runoff may have significant environmental impacts on the natural areas surrounding UCSB campus. Although local and state agencies test ocean water quality regularly, the direct impacts on water quality associated with campus runoff are difficult to measure. The Shoreline Preservation Fund (the Fund) has recently contributed resources for the testing of the Campus Lagoon and the shoreline near UCSB. The Fund studies consider runoff from campus and Isla Vista to be harmful to coastal water quality north of campus.

The *University of California, Santa Barbara Natural Areas Plan* (the Plan), completed in 1995, discusses the negative impact of storm water runoff on Campus Lagoon. According the Plan, Campus Lagoon receives water from three sources:

- "General storm water run-off from ground surfaces surrounding the lagoon.
- Outfall from eight storm drains. This outfall originates as perched groundwater discharged from building sub-drains and vault sump pumps, storm water from roof drains, lawns, parking lots and streets, and irrigation water from sprinkler systems.
- Discharge from Biological Sciences Seawater System (BSSS). This includes surplus seawater and wastewater. Surplus seawater comes from overflow from the head tanks near the Marine laboratory…Waste filtered seawater is piped from the aquaria and holding tanks in the Marine Laboratory and the Marine Biotechnology Laboratory" (Ferren and Thomas, 1995).

These inputs are thought to have negative impacts on the water quality of the lagoon. As stated in the Plan: "Storm drain discharge was shown to carry contaminants into

Campus Lagoon from roads, parking areas, and landscape grounds" (Ferren and Thomas, 1995). Inputs of nutrients come from "bird droppings, aquaria wastewater, fertilizer-enriched runoff, and organic matter from surrounding vegetation (Ferren and Thomas, 1995). Also stated in the Plan: "Compared with coastal seawater samples, lagoon water was highly enriched in phosphate, nitrates, nitrites, and silicates and generally low in salinity and oxygen" (Ferren and Thomas, 1995). Due to these factors, Campus Lagoon has noted many of the characteristics of eutrophication: "massive algal growths and die-off…accompanied by die-off of fish and aquatic organisms and generation of hydrogen sulfide" and a low diversity of zoological species (Ferren and Thomas, 1995). Other impacts to the lagoon area are degraded habitats by exotic species such as "Hottentot, Fig, Sea Fig, New Zealand Spinach, and Giant Reed" (Ferren and Thomas, 1995). Endangered species found in this area include Coulter's Saltbrush, Spiney Tarweed, the Brown Pelican, and California Least Tern (Ferren and Thomas, 1995). Various other birds, insects, mammals, reptiles, plants, and benthic organisms also inhabit the Campus Lagoon area.

8.3.3 Institutional Framework

The Long Range Development Plan (LRDP) for UCSB sets several physical planning principles for maintaining quality of life on campus:

- "Retain the unique sense of place of the campus by preserving and enhancing its environmental quality".
- "Opportunities for interaction for all members of the campus community" should be strengthened.
- UCSB should "engage the surrounding communities" in campus life.
- Growth on campus should not degrade the quality of life for its occupants (Campus Planning, 2000b).

There are several campus committees on campus that are responsible for upholding these goals. The most important with respect to landscape management is the Design and Review Committee (DRC). It is charged with "achieving architectural and landscape design of the highest possible quality for UCSB" (UCSB, 1998). Specifically, the DRC "reviews" landscape and environmental matters and "campus design guidelines and master planning" (UCSB, 1998). The DRC reports to the Chancellor and Campus Planning Committee and is responsible for what plants are used for landscaping of new construction projects and the overall landscaping theme on campus. The committee membership consists of consulting architects, faculty members, one undergraduate student, one graduate student, one staff member, and several members of the Committee on Capital Projects (UCSB, 1998). The committee is required to consult at least one landscape architect but the membership requirements make no mention of consulting with an ecologist or any physical scientists or members of Facilities Management. In contrast, the Subcommittee on Campus Landscape (SCL) is co-chaired by Bruce Tiffney from Geological Sciences. The subcommittee includes several representatives from Facilities Management and a representative from Santa Barbara Botanic Garden, Geological Sciences, Housing and Residential Services, Budget and Planning, as well as student and community representatives (Wallace et al., 1992). The SCL was charged with developing a "more comprehensive planning approach and maintenance of our campus landscape…[and] will be responsible for reviewing landscape plans" for new campus development (Ferren and Thomas, 1995).

The *Campus Landscape Plan* (the Plan) was commissioned by the SCL in 1992 to study the horticultural areas on Main Campus. This plan delineated goals to inform future landscaping at UCSB.

> "The Plan is not intended to be a constraining or explicit planning document. The Plan is intended to act as an outline for detailed landscape projects. It is to be used as a guide for designing and implementing a more cohesive and practical landscape" (Wallace et al., 1992).

The primary focus of the Plan is on creating an aesthetically pleasing campus landscape. However, the Plan outlines several other important goals including "reflecting the influences of the regional landscape—the *man-made, urban garden landscape of Santa Barbara*; the natural landscape of ocean, mountains, wetlands and marine shelf" (emphasis added), and recommends maintaining the "urban, cultivated character" in the center of Main Campus (Wallace et al., 1992). The Plan designates the center of campus as a "garden zone" where the use of non-native, resource intensive plants is possible because of "a higher level of irrigation and maintenance allocated to this zone," though drought resistant and low-maintenance plants are encouraged (Wallace et al., 1992.) The Plan also encourages the development of "theme areas" where plant selection should represent a "regional, climatic, taxonomic or aesthetic theme" (Wallace et al., 1992). In addition, the Plan suggests using plants from Australian, Africa, California, South America, and European Mediterranean climate regions.

There are two sections of the Plan that provide examples of what should be the focus of a sustainable landscaping policy: Resource Conservation and Environment and Educational use. The Plan states: "The campus landscape should be responsive to the regional natural landscape and conserve scarce natural resources" and "should function as an arboretum, displaying a diverse collection of plant species as an educational resource for the campus and community" (Wallace et al., 1992). The Plan suggests the following goals:

- "Restore natural areas, primarily on the perimeter of campus development.
- Preserve and enhance wildlife habitats.
- Consider micro-habitats when selecting plants.
- Use water-conserving plants.
- Consider long-term maintenance requirements
- Collections of species native to California and other Mediterranean climates…should be developed for reference and teaching. Collections may illustrate natural plant associations, regionally rare and endangered taxa, taxonomic relationships and landscape themes" (Wallace et al., 1992).

The *Campus Landscape Plan* shows encouraging signs of a willingness to include sustainability in landscape management. However, many of the goals stated in the Plan are not consistent with the principles of sustainability, including the use of more resource intensive plants at the campus core and the use of non-native vegetation throughout the main campus. In addition, the Plan is not a detailed document and does not provide criteria for plant selection or a coherent campus-wide unifying landscape theme. Sustainable landscaping could provide the criteria and guide the future of landscape management at UCSB.

8.3.4 Financial Issues

Facilities Management is in charge of most maintaining the campus landscape including pest management. Areas not managed by Facilities Management are managed by either the Parking Department or Housing and Residential Services. Most improvements at this time must come from new capital projects or Facilities Management maintenance budget. At this time sustainable landscaping is not a priority on campus. It is possible that more sustainable practices could result in considerable cost savings. For example, native plants generally require smaller inputs of labor, irrigation water, fertilizers and pesticides. The Integrated Pest Management Policy is thought to have reduced pesticide expenses since its inception in 1985 (as well as reducing environmental and human health hazards). After an initial expense of approximately $150,000 the current yearly expense for pest management is near $22,000.

8.3.5 Innovation

The Integrated Pest Management Policy (Policy 5432) is the first signed by a chancellor of a University of California campus. The policy has been in effect since 1985 and was signed by Chancellor Yang in 2000. The IPM policy is described as:

> [A]n effective common sense and environmentally sensitive approach to managing pests and minimizing pest damage. The approach causes the least possible hazard to people and the environment and employs the most economical means. This ecosystem (the relations between organisms and their environment) based strategy employs a combination of tactics including, but not limited to, sanitation, monitoring, habitat modification, biological control, and modification of cultural practices…[p]est control materials are selected and applied in a manner that minimizes risks to human health, other creatures, and the environment (Policy 5435).

Human health concerns were a major catalyst for instituting the IPM policy, as this policy has significantly decreased the use of chemicals on campus. The IPM strategy employed at UCSB assumes that the human occupants of the campus must live with some amount of pests and focuses on controlling, rather than eradicating, such pests. The UCSB campus is surrounded by heavy nature areas that provide natural harborage for many types of wildlife including raccoons, skunks, mosquitoes, and many other types of rodents and insects. In this environment eradication of pests is impossible.

Pest problems are prioritized in terms of public health risk and threat to campus structures. Different places on campus need different levels of control (for example it is less important to strictly control insects in a classroom than in the Student Health Center). A large part of IPM is based on prevention and a focus on the structure and sanitation of buildings and their immediate surroundings. For example, it is imperative to eliminate insect "runways" into buildings. For this reason, all foliage is kept a minimum of three feet from buildings. The key to sanitation is to make the habitat inside buildings less inviting than the habitat outside. Natural ingredients, oil based soap, and a large amount of man-hours are the main tactics used for dealing with unwanted insects and animals. Pesticides are now the last option for controlling pests on campus, not the first. Under the IPM philosophy, the best way to do anything is to let nature take care of it. UCSB has been experimenting with biological management methods such as releasing predator insects to control insect pest populations. A recent example on campus of insect treatment is the use of white flies and ladybugs to control aphid populations.

8.3.6 Community/Education

There is considerable outreach from the campus to the community through the Museum of Evolution and Systematics. Groups such as the Audubon Society, Environmental Defense Center, and the Earth Action Board are active on campus and in the community promoting environmental issues. Other groups such as the Conception Coast Project (CCP) and the Gaviota Coast Conservancy (GCC) are focused on protecting and restoring ecological integrity to the region (CCP, 2000) and have connections to the campus community.

8.4. Environmental Report Card

Indicator	Answer	Score
Is there long-range landscaping plan?	No	0
Are there specific criteria for selecting landscaping plants?	No	0
Do those criteria include energy conservation characteristics?	No	0
Do those criteria include water conservation characteristics?	No	0
Do those criteria include exclusion of non-native plants?	No	0
Are there natural areas on campus maintained by the University?	Yes	1
Is there a natural areas conservation plan?	Yes	1
Are there any programs to connect the campus with the region ecologically?	Yes	1
Is there an IPM policy?	Yes	1
Has the IPM policy reduced the use of pesticides?	Yes	1
	Total:	**5/10**
	Percentage:	**50%**
	Grade:	**C-**

8.5. Recommendations

- Develop a campus-wide landscaping policy/plan.
- Implement pro-native criteria for all landscaping projects.
- Orient landscape towards the regional ecological setting.
- Replace invasive plants with natives in non-developed areas.
- Integrate the IPM and plant selection process.
- Integrate water conservation with the plant selection process.
- Utilize landscaping for climate control.
- Increase cooperation with local conservation groups.
- Update the campus plant inventory.
- Enhance educational opportunities by cultivating endemic vegetation.
- Increase funding for the “greening” of the campus landscape.
- Conduct a study of ways to increase habitat quality and connectivity through campus landscaping (perhaps as a student research project).

9. POLICY FRAMEWORK

The final component of this report is the policy framework, composed of a draft policy statement and a general feasibility study for increasing the sustainability of University operations. The draft policy statement provides a foundation for establishing sustainability as a core priority of the campus and identifies ways that this priority can be incorporated into all campus policies and practices. In the process of conducting our campus assessment, it became clear that while sustainability goals may be met on a project-by-project basis, this results mainly from the effort of dedicated staff members, rather than from a broad scale campus initiative. In order to ensure that sustainability measures will continue to be prioritized over time, a top-down comprehensive policy is needed.

Our goal is to offer a springboard for the development of such a campus-wide sustainability policy to be adopted by the Chancellor and Academic Senate. The policy statement contains information regarding energy conservation, water conservation, waste minimization, green building practices and alternative transportation, and provides a starting point for implementing ideas and creating departmental procedures. The draft policy was then discussed with several key personnel in the upper and lower tiers of the University to determine the feasibility of such a policy at UCSB. This feasibility study identified both institutional and external barriers to change of this scale at the University and offered some suggestions for aiding the adoption and implementation of such a policy at UCSB.

9.1. Empirical & Theoretical Rationale

Research has shown that the formation and publishing of an environmental policy in corporations is a necessary step in the quest for improved environmental performance (Ramus and Steger, 2000). The university is a large institution that shares many attributes with corporations: universities provide a service for a fee, employ specialists and generalists throughout the system and are influenced by stakeholders and the regulatory sector. Thus, research documenting the importance of corporate environmental policies on sustainability may be applied to the university setting.

Research investigating the relationship between environmental policy and employee environmental initiatives provides some interesting insights that can be applied in the university context. An "ecoinitiative" is defined as any action taken by an employee that she or he thought would improve the environmental performance of the company. Ecoinnovation is a means for corporations to become more environmentally and economically sustainable in their activities (Davis, 1991 and Fussler, 1996). Previous research has suggested that business' transition towards sustainability would be enhanced by their ability to implement employee's creative environmental solutions (Fussler, 1996). Further research has supported the assertion that the ecological sustainability of businesses depends on innovative solutions (such as ecoinitiatives (World Business Council for Sustainable Development, 1996a, 1996b). Thus, it is clear that a strong link exists between institutional sustainability and employee innovation.

The role of a published environmental policy in enhancing the link between sustainability and employee ecoinitiatives is significant. Barret and Murphy (1996) suggest that the degree of organizational support for employee actions determines the success of environmental efforts. In the absence of supportive management behaviors and/or the organization's communication of a corporate vision of sustainable activities as signaled by an environmental policy, research has found few employee generated eco-initiatives (Ramus and Steger, 2000). In addition, a number of researchers have shown that environmental policy is an important precursor to employee engagement in environmental activities (Brophy, 1996; Barret and Murphy, 1996). Ramus and Steger (2000) noted the following conclusions regarding the role of an environmental policy in increasing an institution's environmental performance:

- The presence of a published environmental policy positively impacts the presence of employee environmental initiatives.
- Employees who perceive strong signals of organizational supervisory encouragement are more likely to develop and implement creative ideas that positively affect the natural environment than employees who do not perceive such signals.
- The strong link between the existence of a published environmental policy and the willingness of employees to attempt self-described environmental initiatives demonstrates that employees responded positively with creative ideas in the environmental area if they perceive a strong organizational commitment to the environment. In fact, the presence of an environmental policy triples the probability of employee eco-initiatives.

There are thus two main conclusions to draw from this body of empirical and theoretical research: (1) employees are more likely to perform in a positive, environmental manner when the company's environmental policies are known, and (2) it is important for an institution to have a published environmental policy as it has a direct impact on the level of eco-innovation. These findings acted as a catalyst for our draft policy on sustainability.

9.2. UCSB Draft Policy

We drafted a campus policy for sustainability that encompasses the primary principles of sustainability outlined in the introduction (see Appendix C for policy text):

1. The minimization of resource consumption.
2. The minimization of waste/pollution.
3. The conservation of the natural environment.
4. The promotion of environmental education.
5. An expanded sense of community.
6. The need to think in terms of generations.
7. The need to think holistically.

UCSB has taken some preliminary steps towards sustainability, although more are greatly needed. UCSB signed the Talloires Declaration of 1990, which is an agreement between University Leaders for a Sustainable Future and 279 universities worldwide. This declaration calls for a commitment to furthering environmental education and promoting sustainable development (see Appendix D). However, this initiative has not been very well publicized and has not spurred a meaningful discussion regarding the steps to be taken at UCSB to further sustainability.

Our policy was designed to enhance sustainability efforts by UCSB and the UC system and to instigate action on sustainability issues. This policy calls for UCSB to be a leader in environmental stewardship, environmental research and environmental education, and complements the University's Academic Planning Statement (APS). The APS "establishes goals and objectives for UCSB to assume a position of greater leadership among state, national and world academic communities." It is intended to serve as the standard against which to assess progress toward the fulfillment of three primary missions ensuring:

- strong programs of research that adhere to high standards of academic excellence while addressing the changing needs of society,
- an outstanding environment for teaching and learning in which students will acquire life-long habits of learning, thus providing an excellent basis for their future role in the world community, and
- a faculty, student body, and staff characterized by diversity and exceptional quality" (UCSB, 1993).

The components of sustainability defined in our report could all easily be incorporated into these three core components of the APS. In fact, the omission of such a discussion runs contrary to the University's stated goals of teaching people to improve their ability to influence the world after graduating, and to focus research efforts to reflect the changing needs of society. The goals of the APS cannot be accomplished without addressing sustainability. We believe our draft policy statement on sustainability enhances the missions outlined in the APS, while also outlining a more definitive plan for action.

This policy calls for action by the University to acknowledge and work to reduce the impacts of its activities on the environment at a local, national and global level. This policy outlines solutions to environmental problems by adopting sound principles and best practice, and calls for the University to demonstrate environmental protection and enhancement through appropriate operational, educational, research and institutional practices. The specific aims of the policy are categorized as follows:

1. To maximize campus energy efficiency.
2. To engage in green building practices in campus development.
3. To reduce solid waste generation.
4. To reduce hazardous waste generation.
5. To implement an environmentally responsible purchasing and campus stores policy.
6. To reduce air pollution associated with transportation.
7. To maximize alternative transportation efficiency.
8. To optimize and control the use of water on campus.
9. To reduce impacts associated with landscaping in the built environment.
10. To enhance natural areas on and around the campus.
11. To increase communication between individuals and departments working toward sustainability.

In addition, this policy calls for the maintenance of a balance between ecosystem well-being, economic viability and human health as a means for progressing towards enduring sustainability (Figure 9-1). To this end, all University departments and individuals are asked to incorporate ideals of sustainability into everyday decisions and actions, including purchasing, transportation, energy and water usage, and waste disposal practices. The University has a responsibility to teach environmental stewardship, not only in the classroom, but also in all campus operations. By striving to make University operations and policies more efficient and environmentally-sound, UCSB can increase its environmental performance while also saving money and resources.

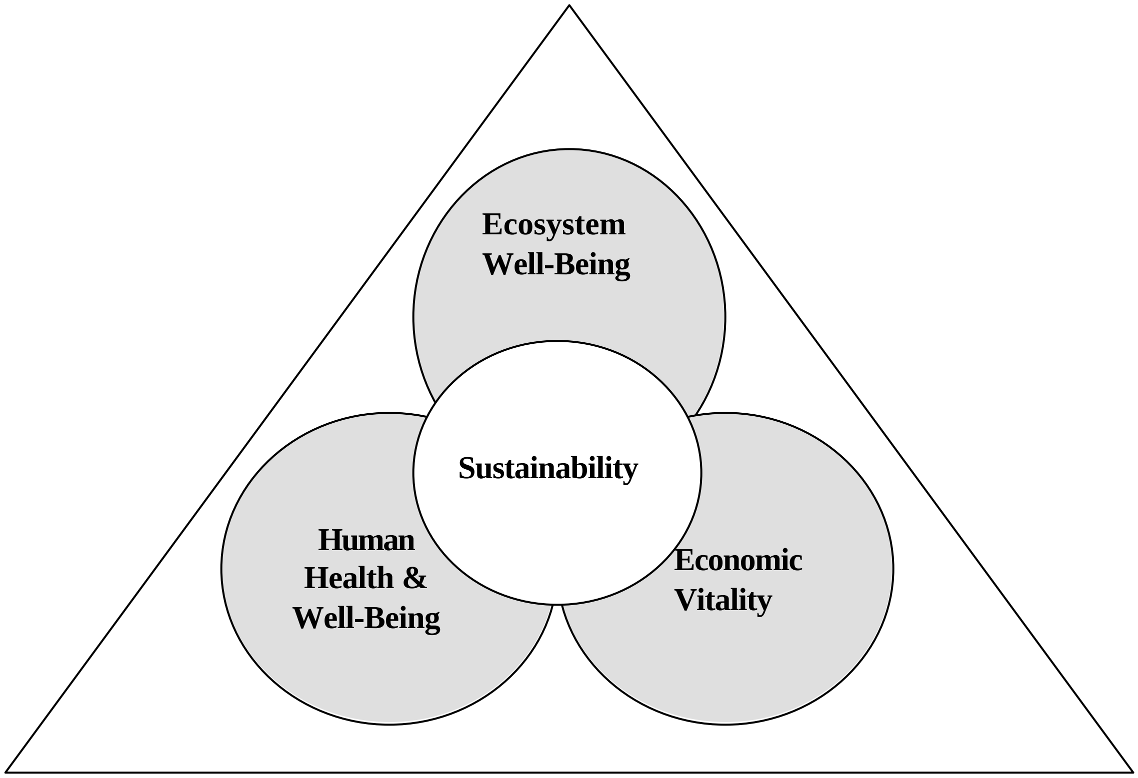

Figure 9-1. Balanced view of sustainability

9.3. Feasibility & Institutional Barriers

A series of interviews with University personnel in Facilities Management, Environmental Health and Safety (EH&S), The Campus Energy Team, the Office of the Chancellor and Vice Chancellor, AS Recycling, the Transportation Alternative Program (TAP), the Office of Budget and Planning (BAP), and numerous faculty, staff and students from various campus departments provided us with information regarding the feasibility of adopting such a policy on the UCSB campus. The main institutional barriers to environmental change, as determined from the interviews, are:

- **Institutional and organizational barriers:** This includes the lack of a campus sustainability policy, a lack of communication and advocacy from the top down and the lack of a clear environmental leader on campus.
- **Financial barriers:** This refers to the lack of adequate resource allocation for environmental programs and initiatives. In addition, the typical manner in which the University's financial framework is designed does not consider the potential long-term savings to offset

high up-front costs for environmentally sound technologies and systems.

- **Informational barriers:** There is a lack of readily available information measuring campus environmental performance in many key campus sectors. In addition, analyses of available information are not made readily available to the community at large.
- **Organizational Culture barriers:** Sustainability is currently not a top priority for the entire campus community.

In addition, the following external factors were noted as barriers to environmental change:

- **Resource barriers:** This refers to a lack of environmentally-sound resources, such as large quantities of renewable energy for purchase by the University.
- **Technological barriers:** Environmentally-sound alternatives to inefficient or polluting products and systems may not exist, are of lower quality, or are financially prohibitive.
- **Supply barriers:** In some cases, it is difficult to find suppliers for environmentally sound products and to change your relationship with them.

9.4. Successful Policy Adoption & Implementation

A full discussion outlining a strategy for the adoption and implementation of this policy was beyond the scope of the current report. However, it is clear from both literature reviews and discussions with the campus community that a combination, top-down/bottom-up approach will be needed. There is clearly a strong impetus for top-down support of environmental issues, as noted in the empirical research literature (Ramus and Steger, 2000). Likewise, there is a strong argument for the upwelling of environmental support from students, faculty and staff, as they will be the ones to implement the directives of sustainability on a day-to-day basis. As we gathered information for our environmental assessment, we observed that the majority of sustainability efforts on campus to date have stemmed from concerned staff members, suggesting the presence of bottom-up support. In order to allow this support to reach its full potential, it needs be met by a stated commitment to sustainability from the highest levels of University administration.

In order to facilitate the adoption and implementation of our draft policy statement on sustainability, we have compiled the following tips:

- Provide a campus community review of policy statement for public commentary before policy adoption.
- Make the policy statement available to the public, and hold regular meetings to inform the public regarding progress.
- Provide a means for effectively communicating the policy statement to all campus employees.
- Provide training for staff to learn how to adhere to policy statement goals, and how to use new equipment mandated by the policy statement.
- Encourage staff initiatives for environmental improvement and provide a forum for these ideas to be discussed and adopted.
- Establish a documenting and monitoring system so that adherence to the policy can be marked and easily accessible. In addition, a system should be developed for measuring the campus' progress in accomplishing the goals set by the policy statement.
- Establish a protocol for detecting and addressing unmet policy imperatives.
- Establish an information reporting system. The amount of resources used by campus as well as notes on increased environmental performance by the campus should be published on a public website.
- Periodically review the policy statement for necessary changes in scope due to changing environmental conditions and available technologies.
- Focus on continual improvement and changing levels of what's considered a good environmental goal for the campus based on societal and environmental shifts.

10. CONCLUSION

10.1 Overall Campus Assessment

Our study of the environmental performance of UCSB highlights two major trends: (1) an increased use of our natural resources, waste generation, and pollution of the environment, and (2) the development of important innovations in some areas of campus operations. These innovations, such as the IPM policy, the use of reclaimed water, the formation of the Energy Team, the recycling committee, and the TAP program, have had positive impacts on campus sustainability. We hope that these innovations mark the beginnings of a campus-wide move toward sustainability. However, to date, the first trend has been dominant. As a result, UCSB scored fairly low marks on our sustainability scorecard: one B-,one C, one C, two C-'s, and one D. Individuals with a vision of cost savings, efficient operations and environmental performance are leading the progressive effort toward sustainability. However, their ability to significantly increase the sustainability of the campus is severely hampered by a lack of overall, institutional support. We have identified two core institutional barriers to sustainability at UCSB:

- **Lack of a clear commitment to sustainability**. There currently exists no clear commitment to sustainability in the institutional framework of the University, as is demonstrated by the absence of a policy statement on sustainability. Although efforts undertaken by individuals within the University are important for initiating and sustaining environmental initiatives, they cannot replace a commitment from the president or chancellor of a university (Smith, 1993).
- **Lack of funding for environmental technologies and initiatives**. Funding is a clear barrier to sustainability efforts, given that more efficient technologies generally have higher up-front costs. For example, conservation projects must compete with capital projects (i.e. new buildings, parking lots) for funding and are rarely given priority. However, this report has demonstrated that installing such equipment and funding environmental initiatives can result in significant savings over time. The need to fully consider life-cycle costs should thus become a core component of all campus operations.

It is our contention that these barriers will continue to hinder sustainability efforts on campus unless adequately dealt with. Our policy statement provides a building block for addressing these issues by establishing sustainability as a priority in all campus operations. Adopting this policy statement may have repercussions beyond the UCSB campus, given that UC Santa Barbara may serve as a model for the entire UC system.

In addition, a new UC campus will be completed in 2004 in Merced. This policy statement could have a profound influence on the sustainability of this campus by ensuring green building design, environmentally friendly campus lay out and the installation of the most efficient equipment right from the start.

10.2 Research in Campus Greening

The field of campus greening has grown in recent years, resulting in a variety of campus audits. We believe that our research compliments scholarship previously undertaken by students and faculty at institutions such as Penn State, UC San Diego and Brown, as well as the Campus Ecology Program sponsored by the National Wildlife Federation. Similar to these earlier studies, we developed a methodology for assessing the sustainability of UCSB across a wide range of campus operations, educational efforts, and the University's role in creating a sense of community. However, the scope of our project went beyond these studies to develop and incorporate the principles of sustainability into a campus policy on sustainability.

Although we analyzed a wide variety of issues relating to campus environmental performance, there were several areas of campus operations that were omitted from our study as they were beyond our scope. These areas include: food services, operations of the University Center, residence halls, university curriculum, off campus land holdings, University business and research ties and sources of University funding. Future research targeting these issues would greatly compliment this piece of research while also ensuring for a broader view of sustainability at the campus level.

In addition, this research was undertaken without the assistance of any clearly defined indices or measures of sustainability. Although it is possible to track improvements in any one area of campus operations, it is not clear what actions or numbers would actually constitute a sustainable campus. The University of Michigan's Center for Sustainable Systems (CSS) is currently working to advance these efforts by developing metrics for quantifying and assessing campus environmental performance (NWF, 1999). This research is intended to create a template for use by campuses nationwide to measure environmental performance in terms of standardized metrics so that we may characterize campus sustainability on a functionally relative scale (NWF, 1999). Future environmental assessments at UCSB would be greatly aided by the use of such a tool, which would allow for more comparison between UCSB and other campuses.

10.3 General Recommendations

During the course of this research we came across a variety of resources designed to aid campuses in the quest for sustainability. It is our belief that adherence to the following recommendations could greatly compliment the present research and develop the path for future sustainability endeavors.

- **Join the Campus Ecology program**. This program is a component of the National Wildlife Federation that assists students, faculty, staff and administrators in transforming colleges and universities into learning and teaching models of environmental sustainability, by assisting with the design and implementation of practical conservation projects, providing training and incentives, and by helping to document and share lessons learned nationally and beyond (Nicholson et al., 2000). This is achieved through the maintenance of a database of campus environmental audits and policies, seminars and training programs. In addition, although we have completed an environmental assessment of UCSB's environmental performance, it is difficult to view UCSB in the context of nationwide campus environmental performance. Campus Ecology is developing a new large-scale environmental performance survey of U.S. colleges and universities, which could provide UCSB with a point of comparison for measuring progress.
- **Engage Participation from the Campus Community on this Issue**. Members of the immediate and surrounding campus community need to have input on this move towards sustainability to prevent future roadblocks. Enlisting support and participation from a diversity of campus stakeholders will help legitimize environmental efforts, while also ensuring their survival.
- **Establish an Environmental Fund.** Lack of financial resources is the most commonly sighted barrier to sustainability initiatives on campus. Therefore, an environmental fund should be established at UCSB to aid in the purchasing of efficient technologies, pay for training and seminars, fund environmental programs on campus, and provide for future research on environmental issues. Examples of projects that could be implemented include energy and water conservation retrofits, mitigation measures for storm drains, landscape restoration projects.
- **Develop a Mechanism for Monitoring Progress.** During our research we interviewed a variety of staff members interested in working toward a more sustainable campus. It is crucial that these people have the opportunity to exchange information and ideas. To this end we recommend the establishment of a campus committee on sustainability. This committee would monitor campus sustainability and prioritize research needs and changes in policy, operations, and infrastructure.

- **Compile and publish data on sustainability.** There is a significant information deficit on campus sustainability issues. Data on resource use should be readily available to students and members of the community and monitored over time. Proposals such as a frequently updated website containing energy use data by building are a step in the right direction.

10.4 Choosing a Path

This project's vision extends beyond the border of the UCSB Campus. We believe the concept of sustainability is the future of environmental policy-making at the local, state, national, and global level. This report seeks to contribute to the recent literature on the development of sustainable communities (See Mazmanian and Kraft, 1999 and Kamieniecki et al., 1997). Ever since the issuing of the Brundtland Commission report, sustainability has been part of the discourse. However, now it is time to advance the theoretical discussion into a functional idea of how sustainability can be applied in the real world. We took on the extraordinary task of analyzing all the major issues involved with sustainability—Building Design, Energy Use, Waste Management, Air Quality and Transportation, Water Management and Landscape Management—with the hope of evaluating the current situation at UCSB and developing recommendations and policy that will lead the University in the right direction, while also establishing a model for other universities to follow in the future.

The University of California, Santa Barbara is facing a choice that is analogous to the famous poem by Robert Frost: *The Road Not Taken*. Two roads *do* diverge ahead of us, one path leads to an acknowledgement of our responsibility to the present and future generations to take action to protect our natural resources and establish a society that is truly sustainable. The other is the well-worn path resistant to change, leading to a future of dwindling resources and possible drastic changes to the natural environment. When we "shall be telling this with a sigh, somewhere ages and ages hence" will we be secure in the knowledge that we made the correct choice or will we regret the lost opportunities of the past?

GLOSSARY

Co-generation: the trapping and utilization of waste heat from on-site generation systems for supplying heat or hot water to buildings.

Green Building: the use of efficient designs and technologies to decrease the total environmental impacts of construction, operation and maintenance of a building.

Hazardous Waste: waste which because of its quantity, concentration, or physical, chemical or infectious characteristics may either: (1) cause or significantly contribute to an increase in mortality or serious illness, or (2) pose a substantial present or potential hazard to human health or the environment if it is improperly managed.

Life-cycle costing: an analysis of the full cost of a product, including the initial purchase price and the costs of usage over time.

Micropower: the small-scale generation of electrical power closer to where it is used through renewable energy sources.

Municipal Solid Waste: discarded material including garbage, refuse, and sludge that can be solid, semisolid, liquid or contain gaseous materials.

Net metering: an agreement with a utility company to sell power from on site generators in excess of what is needed back onto the power grid. When power is supplied onto the grid, electricity meters run backwards and result in an offset of electricity bills equal to a maximum of what the customer would normally use without the use of on-site generation.

Non-point pollution: pollution arising from diffuse, multiple sources rather than from a point source.

Off-stream use: water diverted or withdrawn from a surface- or ground water source and conveyed to a place of use.

Passive solar design: building orientation and design that utilize the natural lighting, heating and cooling properties of sun and wind instead of or supplemental to mechanical systems.

Post-consumer content: material from products that were used by consumers or businesses and would otherwise be discarded as waste.

Precycling: making purchasing decisions that will reduce waste such as buying goods with less packaging (e.g., goods in bulk or concentrated form), choosing products that will last longer, and avoiding single-use or disposable products.

Recyclable products can be collected and remanufactured into new products after they've been used. These products do not necessarily contain recycled materials and only benefit the environment if recycled after their use.

Recycled-content products are made from materials that would otherwise have been discarded. Items in this category are made totally or partially from material destined for disposal or recovered from industrial activities.

Recycling: the process of collecting, sorting, cleansing, treating and reconstituting materials that would otherwise become solid waste, and returning them to the economic mainstream in the form of raw material for new, reused, or reconstituted products which meet the quality standards necessary to be used in the marketplace.

Reuse: the recovery or reapplication of a package or product for uses similar or identical to its originally intended application, without manufacturing or preparation processes that significantly alter the original package or product.

Waste Prevention: any action undertaken by an individual or organization to eliminate or reduce the amount or toxicity of materials before they enter the municipal waste stream. This action is intended to conserve resources, promote efficiency, and reduce pollution.

Wastewater: water that carries wastes from homes, businesses, and industries.

APPENDIX A: ENERGY CONSUMPTION CALCULATIONS

To estimate the total amount of CO_2 that campus energy consumption is responsible for, we used two methods outlined by David Vitaver of the California Energy Commission (personal communication).

Assumptions:

1. A kWh consumed at UCSB is representative of a kWh consumed in the rest of California.
2. Energy consumption in California comes from the following sources:
   - 31% natural gas
   - 20% coal
   - 20% hydroelectric
   - 16% nuclear
   - 12% renewable
   - 1% other
3. The only sources of electricity-related CO_2 in the California are natural gas and sub-bituminous coal (a tenuous assumption).
4. Natural gas is burned on average at 10,000 Btu/kWh and has a CO_2 content of 119 lbs/mBtu.
5. When natural gas is used directly on-site, it burns at 100,000Btu/therm.
6. Sub-bituminous coal is burned on average at 9,500 Btu/kWh and has a CO_2 content of 238 lbs/mBtu.
7. The electricity consumption of UCSB was 83,014,663 kWh in fiscal year 1999-2000.
8. The total direct consumption of natural gas at UCSB was 3,000,000 therms in fiscal year 1999-2000.
9. For reference, 1 therm = 29.3 kWh.

Based on these assumptions and approximations, we can calculate the amount of CO_2 emissions per kWh and per therm and then multiply by the total campus consumption:

Electricity:

CO_2 /kWh = (0.20 * 2.26 lbs CO_2 /kWh) + (0.31 * 1.19 lbs CO_2 /kWh) = .8209 lbs CO_2 CO_2 /kWh

.8209 lbs CO_2 /kWh * 83,014,663 kWh/year = 68,146,736 lbs CO_2 /year

Natural gas:

CO_2 /therm = 11.9 lbs CO_2/therm

11.9 lbs CO_2 /therm * 3,031,218 therms/year = 36,071,494 lbs CO_2/year

Total energy related CO_2 emissions:
68,146,736 lbs CO_2 /year + 36,071,494 lbs CO_2 /year = 104,218,230 lbs CO_2/year

Appendix B: Carbon Dioxide Emission Calculations

Marginal Method for estimating the amount of CO_2 emission reductions that would be achieved by reducing campus demand by 1 kWh during peak demand (winter and summer).

Marginal emission reduction is determined by the type of plant that would most likely be turned off if campus demand were reduced. General rules of thumb about which plants are on margin in California at different times are as follows:

1. Hydroelectric plants are generally the cheapest and cleanest to run, and so they remain on more of the time. Therefore they are on margin at the times when the least amount of energy is being used (e.g. in the middle of the night.)
2. Natural gas powered plants vary in efficiency. Those with least efficiency are on margin only during the most consumptive times of summer peaks, while slightly more efficient plants are on margin during winter peaks. Because natural gas plants cost more to run than some other types of facilities and because natural gas plants can be easily shut off, natural gas plants are on margin whenever they are running.
3. Coal plants take time to start and stop, and so they are often let to run all of the time, rather than coming on line solely for peak demand service.
4. Because uranium is relatively inexpensive and nuclear plants cannot easily be switched on and off, functioning nuclear plants are never on margin.
5. Wind generators are never on margin since they cost virtually nothing to run.

Thus we can assume that reducing peak electricity demand at UCSB will most likely result in the shutting down of a natural gas powered generating facility. The efficiency of the facilities that would be shut down first depends on the season.

To calculate the marginal CO_2 reduction from reduced power demand on campus, we assumed that:

- Natural gas plants running during peak demand in the summer range in efficiency from 14-16 million BTUs/kWh.
- Natural gas plants running during peak demand in the winter range in efficiency from 10-12 million BTUs/kWh.
- Natural gas emits 119 lbs of CO_2/mBTU.

Therefore we estimate that the marginal amount of CO_2 emission reduction is:
1.79 lbs/kWh in the summer and 1.31 lbs/kWh in the winter.

APPENDIX C: DRAFT POLICY ON SUSTAINABILITY FOR UCSB

The University of California at Santa Barbara recognizes that the principles of sustainability and environmental stewardship are not only compatible with the goals of academia, but are essential to the long term existence of this institution.

For the purposes of this document, we used the word sustainability to refer to all projects that reduce environmental impact by:

1. Minimizing resource consumption
2. Minimizing pollution, and
3. Conserving the natural environment.

In order to encourage such efforts, the University adopts the following objectives as core priorities:

Increase energy efficiency:

- Replace inefficient equipment with energy conserving alternatives.
- Install monitoring and control systems to reduce energy demand.
- Reduce peak energy demand.
- Exceed title 24 specifications whenever feasible based on life cycle cost analysis.
- Incorporate energy efficiency into new building design.
- Purchase energy efficient electrical equipment, appliances and mechanical systems.

Increase use of renewable/green energy sources:

- Incorporate requirement for a minimum percentage of renewable energy sources in contractual agreements with energy suppliers.
- Increase use of on-site power generation.

Engage in green building practices in campus development:

- Adopt LEED Silver Medal standards as minimum criteria for all new buildings.
- Incorporate sustainable building practices into all new development and construction:
- Examine local, regional and global impacts of campus planning and development.
- Incorporate green building requirements into contracts with architects and contractors.
- Use environmentally sound building materials.
- Manage existing building for sustainability.

Engage in waste reduction efforts:

- Exceed AB675 levels for waste prevention when justified by a cost benefit analysis.
- Engage in source reduction at all levels of the University (administration, faculty, staff, students, etc.).
- Reduce the use of, reuse and recycle materials.
- Incorporate sustainability goals into purchasing contracts.
- Close the recycling loop by purchasing recycled-content products.
- Appropriately manage solid and liquid wastes, especially hazardous wastes.

Reduce pollution sources on-site:

- Minimize campus atmospheric emissions of toxics, greenhouse gases, criteria pollutants, and ozone depleting chemicals through efficient design and operations of laboratory chemical fume hoods and building heating/cooling systems.
- Reduce sources of indoor air pollution.

Reduce environmental impact associated with transportation to and from campus:

- Increase the availability and effectiveness of alternative forms of transportation.
- Minimize the number of parking permits sold to individual users.
- Construct new parking structures only when it is clearly established that parking demand or supply cannot be sufficiently altered by other means.
- Restrict vehicular traffic to the perimeter of campus to keep the interior safe and accessible to pedestrians and bicycles.

Conserve water:

- Replace inefficient equipment with water conserving alternatives.
- Maximize use of reclaimed water.
- Maximize efficiency of irrigation systems.

Reduce impacts associated with landscaping in the built environment:

- Minimize soil erosion and manage runoff.
- Minimize the total area of impermeable surfaces.
- Avoid the use of invasive plant species.
- Give preference to vegetation native to the region or adapted to the Mediterranean climate.
- Utilize integrated pest management strategies to reduce or eliminate the need for pesticides and chemical fertilizers.

Enhance natural areas on and around the campus:

- Maintain the campus non-built environment in its natural state.
- Restore degraded natural areas on campus to increase the quality of wildlife habitats.
- Maximize connectivity between campus natural areas and the regional ecology.

Increase communication between individuals and departments working toward sustainability:

- Incorporate operations and maintenance staff into the decision making process.
- Increase communication between Budget and Planning, Design and Construction and Maintenance departments.
- Educate faculty, staff and students about campus sustainability efforts.

Appendix D: Talloires Declaration: University Presidents for a Sustainable Future

We, the presidents, rectors, and vice chancellors of universities from all regions of the world are deeply concerned about the unprecedented scale and speed of environmental pollution and degradation, and the depletion of natural resources. Local, regional, and global air pollution; accumulation and distribution of toxic wastes; destruction and depletion of forests, soil, and water; depletion of the ozone layer and emission of "green house" gases threaten the survival of humans and thousands of other living species, the integrity of the earth and its biodiversity, the security of nations, and the heritage of future generations. These environmental changes are caused by inequitable and unsustainable production and consumption patterns that aggravate poverty in many regions of the world.

We believe that urgent actions are needed to address these fundamental problems and reverse the trends. Stabilization of human population, adoption of environmentally sound industrial and agricultural technologies, reforestation, and ecological restoration are crucial elements in creating an equitable and sustainable future for all humankind in harmony with nature. Universities have a major role in the education, research, policy formation, and information exchange necessary to make these goals possible.

The university heads must provide the leadership and support to mobilize internal and external resources so that their institutions respond to this urgent challenge. We, therefore, agree to take the following actions:

1. Use every opportunity to raise public, government, industry, foundation, and university awareness by publicly addressing the urgent need to move toward an environmentally sustainable future.

2. Encourage all universities to engage in education, research, policy formation, and information exchange on population, environment, and development to move toward a sustainable future.

3. Establish programs to produce expertise in environmental management, sustainable economic development, population, and related fields to ensure that all university graduates are environmentally literate and responsible citizens.

4. Create programs to develop the capability of university faculty to teach environmental literacy to all undergraduate, graduate, and professional school students.

5. Set an example of environmental responsibility by establishing programs of resource conservation, recycling, and waste reduction at the universities.

6. Encourage the involvement of government (at all levels), foundations, and industry in supporting university research, education, policy formation, and information exchange in environmentally sustainable development. Expand work with nongovernmental organizations to assist in finding solutions to environmental problems.

7. Convene school deans and environmental practitioners to develop research, policy, information exchange programs, and curricula for an environmentally sustainable future.

8. Establish partnerships with primary and secondary schools to help develop the capability of their faculty to teach about population, environment, and sustainable development issues.

9. Work with the UN Conference on Environmental and Development, the UN Environment Programme, and other national and international organizations to promote a worldwide university effort toward a sustainable future.

10. Establish a steering committee and a secretariat to continue this momentum and inform and support each other's efforts in carrying out this declaration.

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California Department of Water Resources

http://rubicon.water.ca.gov/b16098.htm

California Integrated Waste Management Board

http://www.ciwmb.ca.gov

College and University Recycling Council

http://earthsystems.org/curc/curc.html

U.S. EPA

http://www.epa.gov/ttn/oarpg/naaqsfin/o3fact.html

http://www.epa.gov/ttn/oarpg/naaqsfin/pmfact.html

Institute for Sustainable Development on Campus: Tools for Campus Decision Makers

http://iisd1.iisd.ca/educate/

National Wildlife Federation: Campus Ecology Program

http://www.nwf.org/nwf/campus

Princeton Environmental Review Committee

http://www.perc.edu

Tulane University Environmental Audit

http://www.tulane.edu/~greenclb/audit/

UCSB Budget and Planning

http://bap.ucsb.edu/planning/4.parking.stuff/images/rate1.gif

http://bap.ucsb.edu/planning/4.parking.stuff/pages/costs.site.html

http://bap.ucsb.edu/planning/4.parking.stuff/images/supply.html

http://bap.ucsb.edu/planning/4.parking.stuff/images/rates.html

http://bap.ucsb.edu/planning/4.parking.stuff/pages/parking.drc.html

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UCSB, Environmental Health and Safety

http://ehs.ucsb.edu/

UCSB, Facilities Management

http://facilities.ucsb.edu/

University of South Carolina

http://www.fmc.sc.edu/recycle/env.htm