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THE SUSTAINABLE GRAND CANYON WORKSHOP

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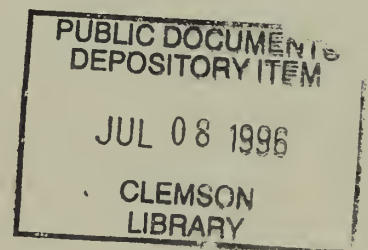
THE SUSTAINABLE GRAND CANYON WORKSHOP

December 1995



WORLD HERITAGE SITE

GRAND CANYON
National Park • Arizona
United States Department of the Interior
National Park Service
Denver Service Center





*Leave it as it is. You cannot improve on it.
The ages have been at work on it, and man can only
mar it. . . . keep it for your children,
your children's children, and for all who
come after you, as one of the great sites which
every American . . . should see.*

— Theodore Roosevelt
at the Grand Canyon, May 6, 1903

quoted in *The Wilderness World of the Grand Canyon: "Leave It as It Is,"*
by Ann and Myron Sutton (Philadelphia: Lippincott, 1971)



THE SUSTAINABLE GRAND CANYON WORKSHOP

SPONSORS

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A “SUSTAINABLE” GRAND CANYON

GRAND CANYON NATIONAL PARK

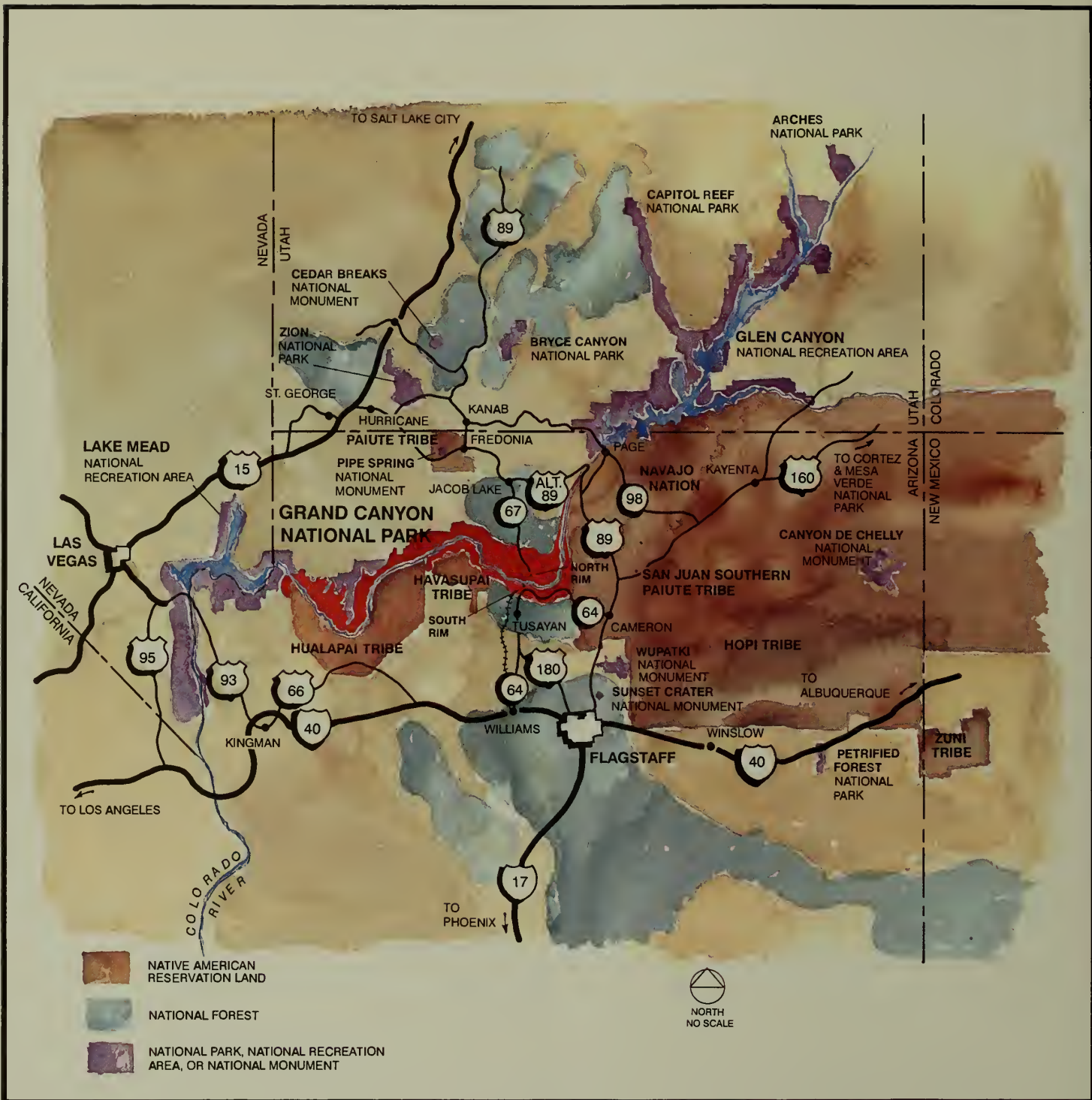
With extraordinary beauty and cultural and natural resources, Grand Canyon National Park merits the title of a world heritage site. The Grand Canyon itself spans 1.2 million acres and contains five of the seven life zones, including three of the four desert habitats in North America. The park is simultaneously a living science laboratory, an ecological refuge, the sacred ancestral homeland of Native Americans, and a pilgrimage site for five million international and national visitors each year.

NATIONAL PARK SERVICE CHALLENGES

The Grand Canyon was set aside in 1919 as “a public park for the benefit and enjoyment of the people.” It is managed in accordance with the National Park Service’s 1916 organic act, which states that the purpose of each unit of the national park system is

to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

However, as visitation to Grand Canyon National Park and the surrounding region continues to increase dramatically, the demand for new roads, lodging, commercial and retail services, and infrastructure also increases. As a consequence, extreme pressure is put on existing infrastructure and facilities, and additional energy demands and waste by-products are created. The National Park Service, U.S. Department of the Interior (NPS), has recently published a general management plan (GMP) for Grand Canyon National Park and thus has an unprecedented opportunity to demonstrate sustainable development by preserving resources while simultaneously accommodating increasing visitation.



LOCATION

GRAND CANYON NATIONAL PARK • ARIZONA
U.S. DEPARTMENT OF THE INTERIOR • NATIONAL PARK SERVICE

113 / 20102B / DSC / 2*96



GLEN CANYON NATIONAL
RECREATION AREA
LEES FERRY

MARBLE
CANYON

BOUNDARY

TUWEEP

KANAB CREEK
COLORADO RIVER

NORTH RIM

BOUNDARY

LAKE MEAD NATIONAL
RECREATION AREA

BRIGHT ANGEL
POINT

PHANTOM
RANCH

EAST
RIM

WEST
RIM

HERMITS
REST

DESERT
VIEW

SOUTH
RIM

LOWER GORGE



NORTH
NO SCALE

DEVELOPED AREAS

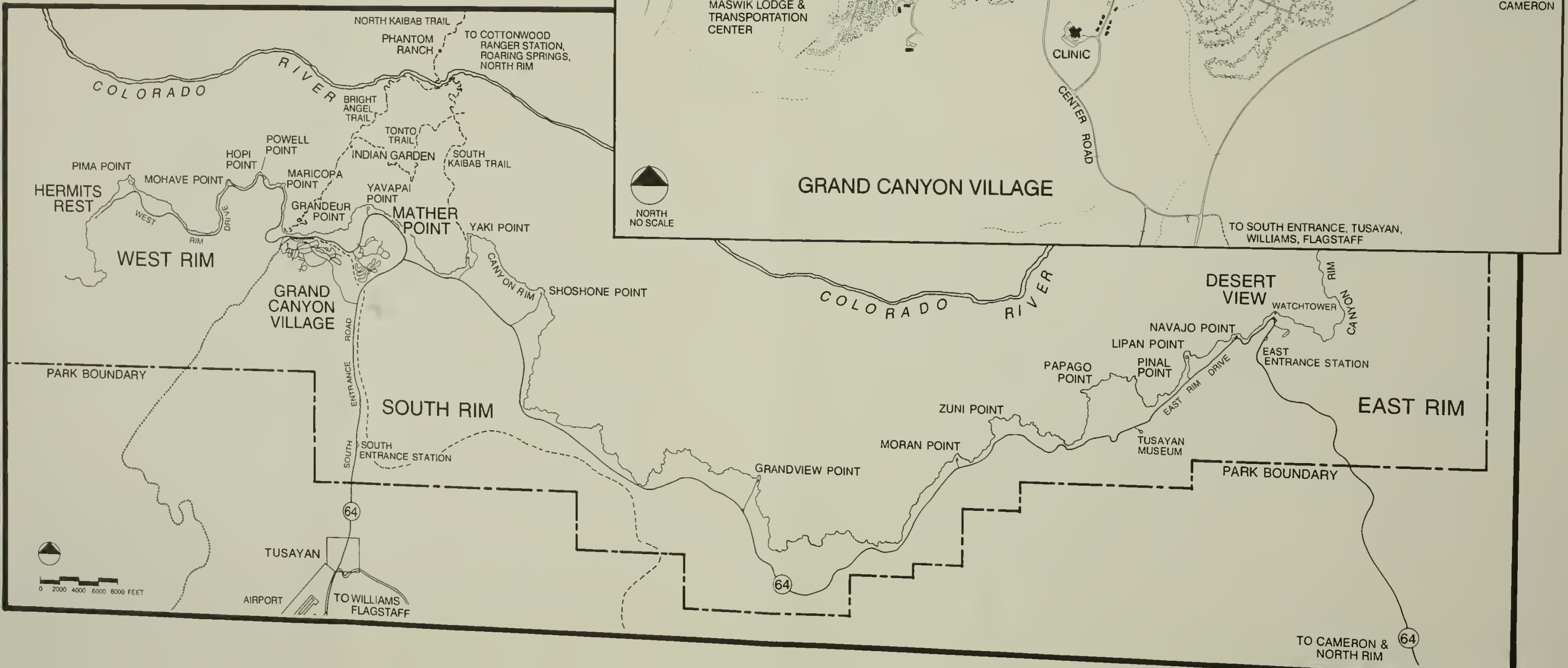
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WEST RIM
SOUTH RIM
EAST RIM
GRAND CANYON VILLAGE

GRAND CANYON NATIONAL PARK • ARIZONA
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WHAT IS SUSTAINABILITY?

What did the workshop participants understand *sustainability* to mean? The group as a whole subscribed to the ideas found in *Guiding Principles of Sustainable Design*, published by the National Park Service (1993), and in the *Hannover Principles*¹ developed by William McDonough Architects as the guiding principles for the planning, design, and construction activities of EXPO 2000, a world exposition to be held in Hannover, Germany, in the year 2000. These ideas provide a framework for the principles and practices of the actions recommended by the "Sustainable Grand Canyon" workshop.

The following description of sustainability and sustainable design was developed by the National Park Service:

[Sustainability] is a concept that recognizes that human civilization is an integral part of the natural world and that nature must be preserved and perpetuated if the human community is to sustain itself indefinitely. Sustainable design is the philosophy that human development should exemplify the principles of conservation, and encourage the application of those principles in our daily lives.

According to *Guiding Principles of Sustainable Design* (NPS 1993), sustainable design must

- Include a professional understanding of the natural and cultural resources involved and clearly state that people must be subordinate to (or in harmony with) nature.
- Give the development a special sense of place based on the resources of the site.
- Provide education about the natural and cultural environments and the support systems that sustain development while bringing visitors and resources together whenever possible.
- Allow visitors to experience nature in an intimate, sensory fashion, providing opportunities for private moments in natural settings.
- Incorporate the living culture as a significant part of the visitor experience and encourage opportunities for visitors and local residents to interact and share their values and experiences.

1. *The Hannover Principles*, ©1992, William McDonough Architects, Charlottesville, VA 22902. All rights reserved. Used by permission.

The Hannover Principles define sustainability from a global perspective. To understand the "Sustainable Grand Canyon" vision, it is essential to know about the Hannover Principles, which are as follows:

1. **Insist on the rights of humanity and nature to co-exist** in a healthy, supportive, diverse and sustainable condition.
2. **Recognize interdependence.** The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to recognize even distant effects.
3. **Respect relationships between spirit and matter.** Consider all aspects of human settlement including community, dwelling, industry and trade in terms of existing and evolving connections between spiritual and material consciousness.
4. **Accept responsibility for the consequences of design** decisions upon human well-being, the viability of natural systems and their right to co-exist.
5. **Create safe objects of long-term value.** Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creations of products, processes or standards.
6. **Eliminate the concept of waste.** Evaluate and optimize the full life-cycle of products and processes to approach the state of natural systems in which there is no waste.
7. **Rely on natural energy flows.** Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.
8. **Understand the limitations of design.** No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not as an inconvenience to be evaded or controlled.
9. **Seek constant improvement by the sharing of knowledge.** Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity.

With these principles in mind, workshop participants concentrated their efforts on developing sustainable management, design, and interpretation strategies for the future of Grand Canyon National Park.





EXECUTIVE SUMMARY: THE SUSTAINABLE GRAND CANYON WORKSHOP

The Sustainable Grand Canyon Workshop, a collaborative weeklong session in late September 1994, brought together regional and national environmental leaders; representatives of governmental, utility, and community interests; private developers; and Native Americans to discuss how to make Grand Canyon National Park more environmentally and economically sustainable. Using the *Draft General Management Plan* as a foundation, the workshop participants worked with professionals from the National Park Service, U.S. Department of the Interior; the Western Area Power Administration, and the Federal Energy Management Program, U.S. Department of Energy; and the U.S. Army Corps of Engineers to find sustainable solutions to issues presented in the plan.

The goal of the workshop was to encourage access to Grand Canyon National Park while building a sustainable vision for future generations as part of the park's 75th anniversary celebration. The workshop participants worked to develop a methodology that would foster appropriate visitation and operational practices while sustaining the integrity of natural and cultural resources for future use. The participants divided into four subgroups to seek sustainable visions and solutions in the following topic areas: (a) resource efficiency, (b) visitor experience, (c) information management, and (d) implementation and partnering plans. The topics discussed in these workgroups included education and interpretation, information dissemination, economic and community development, cultural change and human interaction with the land (resources), energy efficiency, land use, transportation, water use, and wastewater, building materials and use, and indoor air quality. The group's recommendations, in conjunction with the *General Management Plan*, seek to build a globally recognized model that can be translated to parks and communities worldwide.

RECOMMENDATIONS AND ACTIONS

Each workgroup developed specific action items that would make Grand Canyon National Park more sustainable in terms of information management, visitor experience, resource use, and implementation and partnerships. These actions seek to lead by example and promote changes in park management and in visitor lifestyle choices. The following are highlights for each topic area.

Resource Efficiency

- Avoid costly improvements to water infrastructure by promoting water efficiency.

- Develop clean mass transportation alternatives to the private automobile and eliminate its intrusion into the park experience.
- Reduce development areas near the canyon rim; instead, cluster development.
- Implement more sustainably based energy sources such as sun, wind, and biomass.
- Build all new housing outside the park.
- Help make regionally grown food, products, and services environmentally and economically sustainable.
- Use indigenous building materials and true life-cycle costing when designing new construction.
- Establish monitoring systems, and document the results.
- Perform energy-efficient retrofits of existing facilities.
- Strive for the highest level of indoor air quality when choosing building materials and systems.

Visitor Experience

- Clearly convey to visitors the stewardship ethic of the National Park Service and their responsibilities to the park.
- Explain the interconnectedness of the region to the park and the visitor to the park.
- Provide information to “hub cities” as a first staging area before visitors enter the park and the region.
- Establish park host communities; that is, a destination point that is an extension of the park environment.
- Communicate the past and present cultures in the region to visitors.
- Establish strong volunteer programs.
- Interpret demonstration projections and restoration efforts.
- Establish strong interpretive themes that communicate a sense of the Grand Canyon’s history and place.

Information Management

- Establish an information management “point person” who possesses practical knowledge and a sustainable vision.
- Continually monitor the use of visitor information.
- Simplify and condense existing trip planning information.
- Establish a central reservation system.
- Make trip planning and regional information easily accessible.
- Make current information on sustainability available to visitors.
- Provide a mechanism for visitors to obtain immediate feedback on their resource use at Grand Canyon.

Implementation and Partnering Plan

- Form a Grand Canyon marketing group or association to coordinate park and gateway community hospitality business, recreational, and educational services.
- Partner with concessioners to upgrade accommodations to sustainable standards.
- Create a network of partners for regionally produced foods and for excess food.
- Partner with national conservation foundations and become an international center for experiencing and teaching sustainable living.
- Form partnerships to develop indigenous cultural, educational, and arts programs.
- Develop and finance all employee and visitor housing through a regionally based professional housing provider.
- Develop a strategy to transfer sustainable development and building principles to the Colorado Plateau.
- Partner with regional utilities to identify conservation and renewable opportunities.

- Establish a regional transit and parking authority to build and manage regional parking structures and transportation systems.
- Use Grand Canyon National Park as a catalyst to develop a regional waste management industry with source reduction, reuse, and recycling strategies.

All the measures listed above are steps toward a “greener” Grand Canyon. By showcasing new environmental technologies and practical applications of sustainable principles, the National Park Service can use its public popularity and its purchasing power to support startup sustainable initiatives and demonstrate their use and benefits to all who visit Grand Canyon National Park.

There are immediate steps that can be taken to move operations in Grand Canyon National Park in a more sustainable direction. These are classified as short-term actions or recommendations, to be implemented within one year. Medium-term actions or recommendations would occur within one to five years; long-term actions take place by the year 2010. The following chapters describe in more detail the recommendations and actions for topics in all three timeframes.

WORKSHOP-RELATED INITIATIVES

At the Sustainable Grand Canyon Workshop it was made clear that defining and implementing a bold integrated vision for the future of the Grand Canyon region would require developing inclusive partnerships. A model partnership proposal based on the recommendations of the workshop is included as appendix A of this document. The proposal is intended to be used as a foundation for a greater Grand Canyon partnership as well as for further partnership proposals and design development. It is hoped that this proposal and other concepts and actions that evolved from the workshop may contribute to realizing a sustainable vision for Grand Canyon National Park and other national treasures.





TOPIC 1: RESOURCE EFFICIENCY

Sustainable design balances human needs (rather than human wants) with the carrying capacity of the natural and cultural environments. It minimizes environmental impacts, importation of goods and energy, as well as generation of waste. The ideal situation would be that if development was necessary, it would be constructed from natural sustainable sources such as solar or wind, and manage its own waste . . . As a tool to understanding this principle, a metaphoric example is drawn using an organism to symbolize functional appropriateness, habitat harmony, and survival based on adaptation and cultivation.

— *Guiding Principles of Sustainable Design*, 55
National Park Service, 1993

Recommendations from the resource efficiency workgroup range from “low tech” to “high tech,” yet all presume a change in public attitude toward waste and embrace the cyclical concept of using waste as the raw materials for another process. Specific recommendations are detailed below.

LAND USE AND BUILDING USE

Several problems in the use of land and facilities have been identified that adversely affect visitor experiences, living conditions for employees, and the efficient use of resources. The natural tendency to allow visitors and employees easy access to the canyon has resulted in a great deal of development and infrastructure near the rim.

Facilities and functions that do not directly contribute to a positive visitor experience should be removed from the rim vicinity wherever possible, consistent with the principles of sustainable design and preservation policies. Recommendations for the use of land and buildings are offered for topics that are not necessarily covered in the *General Management Plan*.

The question of locating employee housing on park land has become significant at Grand Canyon National Park because community development lands may become available through a proposed land exchange or a cooperative development with Kaibab National Forest. While it is convenient, energy efficient, and necessary in some cases to house employees within walking distance of their workplace, this practice sometimes uses land that is valuable for other purposes and creates a heavier demand on infrastructure and for community services in sensitive areas.

The basic principles of land use must reflect the integrity, values, and objectives of the principles for sustainable design as presented in *Guiding Principles of Sustainable Design* and *The Hannover Principles*. The environmental impacts to be considered for land use assessments need to include macro environment, energy, waste, and health and welfare. Therefore, the solutions for land use decisions must adhere to the following objectives:

- Limit automobile traffic in the park and establish clean, efficient mass transit alternatives.
- Reduce development areas near the rim to improve visitors' experience of the Grand Canyon.
- Move employee housing away from the rim and make the residential community embody the principles of sustainability.
- Reuse and renovate existing building resources in a sustainable way.
- Concentrate developed areas to enhance pedestrian opportunities and mass transit connections.

Short-term Actions

Maximize the advantage of the renovation of the visitor center and addition by the following practices:

- establishing aggressive design criteria toward sustainability in architecture/engineering contracts
- encouraging design priority toward environmental quality versus the quantity of additional space
- maximizing opportunities for natural lighting, climate-responsive design, and environmental quality
- Develop and establish specific planning and design guidelines for any building renovation and all new structures within the park.

Medium-term Actions

Reuse the powerhouse as a "showcase" learning center by carrying out the following actions:

- Redesign the building to maximize the energy efficiency of the building envelope (natural lighting, thermal performance, glazing

strategies) and the mechanical systems (HVAC, hot water, and electrical lighting systems).

- Exhibit the park's energy and power issues.
- Demonstrate environmental quality and appropriate indigenous building materials.

Consider reusing dormitories that are being abandoned as "ecolodge" accommodations (for visitors) or "ecolodge" style housing (for employees).

Redevelop the industrial area in the park and propose new functions.

Long-term Actions

Consider alternatives to existing suburban type housing. Clustering multifamily, ecologically friendly designs should be required when striving for sustainability. Consider co-housing clusters.

Coordinate comprehensive planning with neighboring partners to truly meet the sustainability objectives set forth in the workshop.

The fundamental barriers to these actions are financial, political, and institutional. When sustainable solutions for the use of land and buildings are exhibited in Grand Canyon National Park, visitors will be able to take home tangible information, gain a better appreciation of the Grand Canyon, and reinforce the plea for individual environmental stewardship.

TRANSPORTATION

As a world heritage site, Grand Canyon National Park should have a model transportation system that focuses on providing access in a quick, efficient, and clean manner. Any effort regarding the provision of transportation services to park visitors must address both outside access to the region and mobility inside the park.

Energy and environmental impacts of transportation to and within Grand Canyon National Park extend far beyond the park: more than eight million gallons of gasoline per year is consumed getting to and from Grand Canyon. More private automobiles come to the park than can be accommodated with the existing infrastructure, leading to long delays, significant congestion, gridlock, and severely degraded local air quality.

Transportation strategies should focus on prevention, rather than accommodation of ever-increasing numbers of private automobiles. Information can act as a big deterrent to congestion. For example, people could be warned at Williams or

Flagstaff that they are likely to encounter delays and traffic congestion. With this information, visitors can determine how to proceed to the park in terms of scheduling and lodging.

The transportation system, similar to the information system (to be discussed under “Topic 3: Information Management”), can be thought of as a series of concentric circles. The outermost circle represents the thousands of separate origins of park visitors. The next inner circle represents the visitor collection points at such major regional transportation hubs as Phoenix and Las Vegas. The inner circle represents the staging areas of Flagstaff, Williams, and Cameron.

The staging areas are the most logical origin points for mass transit to the park, especially for visitors who do not have reserved lodging. Cameron and Tusayan are gateways that would function as major multimodal collection points for delivering people from outside the park to the transportation system inside the park. The South Rim area is the core or destination spot for these concentric transportation systems.

The following key points should be considered.

- Access to and mobility within the park is a peak problem, not a total volume problem.
- The current levels of traffic are not sustainable either from an environmental perspective or as a positive visitor experience.
- Mass transit should be encouraged.
- The entry of automobiles into the park should be minimized and discouraged. The only cars allowed (except on the East Rim Drive) should be those carrying residents and guests with reservations.
- Access to in-park features should be exclusively by transportation other than automobiles; for example, in-park transit, walking, bicycles, and pedicabs. (Possible exceptions are some East Rim overlooks.)
- A long-term sustainable transportation program should focus on renewable fuel sources.

A transportation program can either accommodate current mode splits (70% auto, 15% bus, 10% air, 5% train) or attempt to create a more favorable split by a combination of service increases and economic incentives and disincentives. It is strongly recommended that a variety of means be used to reduce the number of people leaving the staging communities by private automobile.

Short-term Actions

Develop an inventory of transportation resources. Consolidate this information into bulletins to be included with information packets.

Have a transportation hotline that can be accessed by the general information line.

Hire a transportation coordinator (could be an employee of a concessioner).

Place electronic early-warning roadside signs about transportation and lodging outside of Flagstaff and Williams to alert visitors on the way to the canyon.

Identify park resources that are being significantly degraded by off-road parking, and install barriers with “no parking” signs.

Experiment with closure of parking lots already proposed for closure (such as Yaqui Point) while simultaneously increasing transit service.

Work with a regional council of governments transportation subcommittee to prepare applications for grants from Intermodal Surface Transportation Efficiency Act (ISTEA) transportation demonstration programs for developing multimodal and in-park transit facilities.

Dramatically alter the park's entry fee structure to incorporate peak pricing for visitors and vehicles. Prices for automobiles should be higher than those charged for buses, and entry during peak times should be more expensive than off-peak times.

One possible system would be to charge \$10 per person for visitors arriving in automobiles and \$5 per person for those arriving by transit or bicycle during the peak season. In the off-peak season (September to May) the charge could be \$6 per person for those arriving in automobiles and \$3 per person arriving by transit or bicycle.

An alternative would be to charge the same price per person for everyone, but add a per-car charge. For example, the peak season charge per person might be \$5, with \$10 per auto added or \$30 per bus. Charges for the off-peak season might be \$3 per person, plus \$8 per car and \$25 per bus.

To deemphasize the use of private automobiles, a significant portion of the fees should be used to capitalize improvements in transit infrastructure, including bike and pedestrian paths. As discussed in the “Topic 4” chapter a portion of the fees should be used to guarantee a revenue stream for a transit concessioner.

Parking in the village core should be on a fee basis in attended parking lots. Part of the revenues collected could be used for the eventual restoration of

the lots as they were gradually phased out. Fee parking would educate visitors that parking is not a free resource and should not be overconsumed.

Medium- to Long-term Actions

Develop a multimodal regional transportation center at the airport. This center would be a hub for visitors arriving by plane, bus, and automobile, incorporating air traffic with other modes. Orientation to the visitor experience could begin at this multimodal system.

From the airport, visitors would be conveyed into the park by renewable-fuel bus. Several alternatives should be explored for fueling these buses: photovoltaic charging stations located at covered bus stops, electricity (however, producing sufficient electricity from renewable energy would be problematic), or a hybrid system using a small steady-state combustion engine to generate electricity for small drive motors in the wheels. The fuel for this engine could be gasoline or propane initially, but eventually it should be converted into a biofuel from local biomass.

Phase-in for the transport system should parallel the schedule for the intrapark system.

Greatly expand in-park transit, as described in the *General Management Plan*. It is recommended that it be phased in according to the alternative 2 schedule in the *General Management Plan*. Funding for this would be done through private concessioners, as described under “Topic 4: Implementation and Partnering Plan.” Concession contracts should specify that buses must be renewably fueled and employ consumption-reducing measures such as regenerative braking. It is estimated that 80,000–100,000 kilowatt hours (kWh) per day would be needed to power this intrapark transit system.

Integrate the intrapark system with the multimodal transfer system. This would simplify the coordination and management of the entire system. Financing an out-of-park connection might require some legislative changes.

ENERGY

The ready availability of energy is responsible for many of our advances in modern society. However, this benefit comes with a cost: the production and consumption of energy poses major problems for both humans and the environment. The various resources commonly used to produce electricity and other transportation fuels (such as coal, oil, and natural gas) are finite — they will not last long into the future. Nuclear power has a rather abundant fuel source, but problems with safety, waste, and proliferation have plagued this technology. Inefficiencies that occur at each stage of extraction, transportation, conversion, and ultimate end-use of these

natural resources require that more of the resource be consumed than is actually needed. Finally, each of these processes creates pollution, a problem that the world has yet to fully understand and contend with.

For the above reasons, it is imperative that society begin to understand more completely the role that energy plays in our long-term survival. There are two major components to the amount of energy we consume: the technical component, which requires that equipment and technologies be developed that use energy in the most efficient manner possible, and the human component — energy is not consumed by buildings and equipment, but by people. The education and awareness of our society to the connection between energy use and the quality of the environment is crucial to any long-lasting solutions we may seek.

This plan for addressing energy use in Grand Canyon National Park mirrors the solutions required for society as a whole. We start with a substantial built environment, about 700 energy-consuming buildings in the park that reflect the history of our use and understanding of energy. Out of necessity, buildings built before the Industrial Revolution used resources and the forces of nature creatively. After that time, society began to take the newfound sources for granted, a fact that is unfortunately reflected in most of the buildings and infrastructure in use today. Therefore, we must begin on a path to reverse this trend. Such a path should be the model for the energy strategy at Grand Canyon National Park. This plan consists of the actions detailed in the following paragraphs.

Short-term Actions

Reduce costs, save energy, and enhance productivity through cost-effective retrofit of inefficient energy technologies.

Begin energy awareness education of energy users (residents, workers, visitors) and those who make decisions affecting energy use (the design and construction of buildings and the purchase of equipment).

Use true life-cycle costing practices when designing new construction projects to ensure that proper consideration is given to the resource implications of the energy and materials required.

Long-term Actions

Plan for the eventual implementation of more sustainably based energy sources such as solar energy, wind, and biomass.

Develop more stringent guidelines for the design and construction of the built environment with the understanding that these buildings will far outlast those who designed them.

Current Energy Use

Energy is used in Grand Canyon National Park by (a) buildings, (b) infrastructure, and (c) transportation systems. While an energy audit and analysis was not available in the short time of this study, enough insights into the building stock, infrastructure, and energy flows were gleaned to allow an engineering estimation of short-term and long-term solutions. The current energy use in the park is outlined in this section, and specific recommendations are described thereafter.

Buildings. Buildings impact the environment throughout their life cycle, from initial groundbreaking to demolition. Energy, materials, and water are expended throughout this process and never recovered. The concept of waste is unknown in natural systems, but humans and their resultant settlements and cities produce prodigious amounts of waste.

Grand Canyon National Park contains about 950 buildings and other significant structures, ranging in size from the classic El Tovar Hotel (47,000 square feet) to trailside comfort facilities, which can be as small as 16 square feet. The earliest surviving buildings at the park date back to 1895, and groundbreaking is scheduled for more buildings in 1995 and beyond. For the purposes of this study, the building stock has been categorized according to function. Breakouts of the building stock are provided in appendix B, including the square footage associated with the various functions. Here are a few highlights worth noting:

- The total square footage in the park is more than 1,370,000.
- More than 55% is housing or lodging (788,000 square feet).
- 625,000 square feet is in buildings owned by The Fred Harvey Company.
- 444,000 square feet is in National Park Service buildings.

Building energy use depends on the building's function, its physical characteristics and equipment, and local weather and climatic conditions. The climate at the park (almost 7,000 heating degree-days per year) dictates that most buildings be heated.

Source fuels for *building space heating* are electric resistance, fuel oil, and LPG (propane). Natural gas is not available. An estimate from NPS personnel indicates about 60% of housing uses fuel oil, versus 40% LPG. Lodging has a much higher incidence of electric space heating, perhaps 50%, versus 25% each for oil and LPG. Data on space heating fuels and penetrations of heating technologies were not readily available, but there are indications that enough end-use data might be available to energy auditors.

Building space cooling has far less penetration than heating because of the relatively mild summer temperatures (cooling degree-days per year are about 150). However, cooling technologies are more prevalent in the park than one would expect. This probably is because (a) there is a large diurnal temperature swing in the summer months, and (b) visitors to the numerous hotels, motels, and restaurants expect total comfort in their visit. Most cooling is achieved through the use of evaporative coolers or window units. There are only a few large chillers (in the 40- to 60-ton range) at some of the large hotel and motel complexes. These chillers all use R-12 refrigerant, a substance that has severe environmental impacts and is being closely regulated by the Environmental Protection Agency (EPA).

Electricity. Arizona Public Service provides the electricity in Grand Canyon National Park. Records of the electricity drawn from the Grand Canyon Village substation for the two-year period ended October 1992 indicate a peak power of almost 6.5 megawatts (MW) (Christmas 1990) and an average use of about 4.25 MW. Baseline (not temperature dependent) energy consumption, which appears to occur during summer, sits at about 3.7 MW. The annual energy consumed is about 37,000 megawatt hours (MWh) or 126×10^9 Btu. The average price of electricity is about \$0.10 per kWh, resulting in an annual electricity bill of about \$3.7 million.

Examination of the electricity use for the one-week period of September 7–15, 1994, along with known weather and building functions, allows an estimate of the disaggregation of electricity by end use. The load shape is indicative of a heavy residential mix. A characteristic weekday profile shows a steep rise in energy use (about 750 kW; 3,000 kWh per day) from about 5 A.M. to 9 A.M., which can be attributed mainly to electric resistance water heating used for morning showers. The load settles to a daytime steady state of about 2,500 kW. This is attributed to weekday interior lighting, equipment, and ventilation across the building stock on the grid.

Two smaller rises are observed starting at about 6 P.M. (100 kW) and again at about 9 P.M. (500 kW). These represent morning and evening cooking and evening lighting, television and entertainment. The load declines rapidly between 9 P.M. and 1 A.M. to the nighttime baseload of about 1,800 kW, where it remains until the 5 A.M. rise the following day. The shape of the weekend load is similar except that the Saturday and Sunday daytime loads (at 500 kW or higher) are relatively flatter than the weekday load. This indicates the heavier visitor population on the weekend. It can also be noted that this elevated daytime use begins to decrease after lunch on Sunday to the weekday cycle. Further disaggregation would be possible with a limited energy audit, further Arizona Public Service electricity data, and discussions with concessioner personnel on operation and maintenance practices.

Domestic Water Heating. Water heating is accomplished primarily through the use of electric resistance technologies. In a few instances LPG boilers are used (as in the laundry and some lodging and apartment units). The

use of electricity to heat water is a particularly wasteful practice, burning fuel to produce high-grade electricity (at only 30% efficiency), which is then dissipated back to its lowest useful form: heat. The high incidence of electric water heating is an example of an excellent opportunity for improvement by using solar thermal energy as a primary energy source for water heating. This topic is discussed further in the section on renewable energy use.

Infrastructure. The major infrastructure operations that use energy are (a) the pumping of potable water from Indian Garden to Grand Canyon Village, (b) wastewater treatment and transport, and (c) exterior lighting. More than 3 million kWh are used annually to pump 163 million gallons of water to the South Rim. Pumping contributes almost 700 kW to the energy profile of the canyon. Pumping and moving water costs more than \$250,000 per year.

The operation of the wastewater treatment facility at the Grand Canyon Village costs over \$115,000 and consumes 1,500,000 kWh annually. In addition, sewage is treated at Phantom Ranch, and there are numerous lift stations throughout the park. There is relatively little exterior lighting in the developed areas of the park; however, efforts are underway to address the exterior lighting issue from a light pollution point of view.

Transportation. A quick analysis shows the relative partitioning of energy between transportation systems and buildings. Available data allow a direct comparison of automobiles driven within the park and the electricity used by the park. Automobile traffic in the park consumes an estimated 250×10^9 Btu (assuming the average auto trip within Grand Canyon National Park is about 20 miles per car). This is twice the total energy use of electricity at its end-use (126×10^9 Btu). From a resource perspective, if we take into account the energy used to generate the electricity at its source, electricity is responsible for 442×10^9 Btu, almost twice that of the automobile. Neglected in this analysis is other transportation (primarily buses) and building energy used (heating fuels).

Recommendations

Energy Efficiency Retrofits of Existing Facilities. The high cost of electricity provides an exceptional opportunity to save money, energy, and its associated pollution in virtually all building sectors throughout the park. A very conservative rule of thumb often used for federal facilities would indicate that one year's energy cost (in this case about \$4 million) could save a minimum of 25% per year, resulting in a simple payback in four years. This estimate is conservative in that it assumes that many "low-cost/no-cost" energy conservation measures have been completed and in that the rule of thumb was developed using the lower energy costs to which military facilities are subject. "Low-cost/no-cost" measures include weatherization techniques such as caulking and weatherstripping and a

variety of simple operations and maintenance procedures such as coil-cleaning and gross building envelope maintenance.

Energy efficiency opportunities exist parkwide. Observations made by engineers during the course of this study indicate that the concessioner buildings and operations offer the greatest opportunity for savings. The company would have two very strong incentives to invest in energy efficiency because (a) the company has the most energy-consumptive (by function) and least efficient (by design) square footage in the park, and (b) money saved translates directly into profit. This should be particularly important to the concessioner since there are some inherent limitations on pricing of their goods and services for sale in the park.

NPS buildings also present opportunities for saving energy and costs by retrofitting older technologies. It appears that some effort toward energy efficiency was attempted on NPS buildings. Examples include older buildings with retrofit insulation, homes with older solar energy systems, and some use of photocell and occupancy control of interior lighting. Discussions with NPS personnel indicate that energy conservation efforts have indeed been made at various times over the past 20 years (as is the case with other government agencies) but that these efforts have been inconsistent and the quality and persistence of the technologies is unknown.

Energy Audit and Analysis — As a short-term action, a complete energy audit of Grand Canyon National Park should be undertaken to verify the investment needed and the savings to be achieved through energy efficiency measures. This must include the concessioner's operations in addition to NPS facilities. The restructuring of the database and electricity profiles, plus analysis, would provide an excellent start to such an audit. Audit procedures should include the integration of utility bills into the database and the restructuring of the database into a form that can be used as an audit and scale-up tool. A statistical sample of buildings can be selected from analysis of the database to allow an accurate scaling of the energy used. The audit should focus on the following areas:

- analysis of building envelopes, including insulation levels and construction quality through the use of infiltration measuring devices and infrared imaging
- spot tests of the performance of space conditioning equipment
- lighting design and equipment verification
- interviews with building occupants and operations and maintenance staff
- disaggregation of energy flows in Grand Canyon National Park by end-use technologies

- evaluation of energy efficiency and reduction measures to be implemented, including investment cost, energy saved, economic payback criteria, and environmental benefits achieved through energy reduction efforts

Residential Energy Use — Information on fuel use for space heating was not available for this study. On the basis of information from NPS personnel and personal observation, it is recommended that the following opportunities be investigated further:

- High efficiency heating and setback thermostats. Old, inefficient oil-fired units should be replaced with high-efficiency LPG furnaces. Specifically, replacement of a 60% unit with a 95% condensing unit would save about 37% annually. Assuming a \$1,000 per year, 166 MBtu heating season per household, and a \$1,300 new unit, the change would result in a 3.5 year payback. Use of a \$60 digital thermostat that could be set for a cooler temperature in the evening (and perhaps in daytime for working families) could have a payback of less than one year.
- Duct sealing and weatherization. Leaky ducts and building envelopes are responsible for energy lost from the HVAC system to unconditioned spaces. Duct sealing is inexpensive and could save from 10% to 30% of HVAC costs. Envelope sealing could result in even bigger savings. More exact savings can be determined after a complete envelope energy audit.
- Refrigerator replacement. Aside from instances of electric water or space heating, refrigerators consume the most energy in households. The efficiency of refrigerators has been improved dramatically in the past few years. New refrigerators could save 50% of the energy consumed by a unit 5 to 7 years old, or older.
- Solar water heating systems. There are currently some active solar water heating systems in single-family residences in the park. The predominance of electric water heating provides an excellent opportunity to use solar energy to heat water. A preliminary assessment indicates that residential-scale active solar water heating would pay back in slightly more than three years.
- A residential energy awareness program. The education of residents to energy issues is perhaps the most cost-effective option available for achieving energy efficiency at Grand Canyon National Park. Energy use could be improved by more judicious use of washing machines and dryers, stoves, microwave ovens, refrigerators, televisions, and even water beds and by the purchase of more energy-efficient appliances when replacement is necessary.

Commercial Spaces: Retail, Administrative, Dining — The lighting arena is a prime source for savings in energy, resources, and costs for commercial and retail spaces. Lighting technologies have improved dramatically in the past few years. Lighting technologies in place in the Grand Canyon buildings (particularly the concessioner buildings) are perhaps older than the national average. Old, inefficient, incandescent luminaires should be replaced with efficient compact fluorescents. Lighting levels need to be revisited — proper design of ambient lighting often reduces energy levels while increasing occupant visibility, comfort, and productivity. Old fluorescent fixtures should be replaced with new efficient technologies. Exit lighting should be replaced. Occupancy sensors are used by NPS facilities but are absent from concessioner buildings.

A quick analysis of lighting opportunities indicates simple payback times of three months to four years. This does not include the corresponding maintenance savings. Since estimates of luminaire counts and actual lighting levels are unavailable, an investment cost is not provided in this study.

High-efficiency specialty equipment is currently available. The following items should be investigated further:

- commercial refrigeration
- kitchen cooking
- dishwashing
- chiller modifications (including replacement of chlorofluorocarbons)
- laundry facilities
- photocopiers, computers, laser printers

Use profiles of these items would determine the exact amount of energy consumed. In many cases it could be cost-effective to replace equipment immediately, even if it is functioning well. Even if the economic criteria are not favorable for replacement, such equipment must be investigated and noted for inclusion in the normal replacement schedule of park operations. In addition to energy efficiency, criteria for appliances must also take into account the ability to repair or at least recycle broken equipment and appliances.

Lodging at Grand Canyon National Park uses a large amount of energy. Occupant energy education is difficult; therefore, technical solutions may be more appropriate. Lodging is a specialized field; more effort would be needed to properly study the work previously done on energy efficiency in lodging. The following areas need to be researched.

- occupancy sensors for visitors' quarters
- HVAC controls for visitors' quarters
- compact fluorescent lamp (CFL) lighting
- elimination of electricity as a heating source ("fuel switching," a medium-term solution)
- investigating the energy used by appliances, scheduling efficient replacement, revising purchasing decisions, and implementing energy-smart purchasing
- heat pump water heating technologies (a specialized technology now emerging in the hotel/motel sector)

Three other specialized areas have potential for energy savings: comfort stations, laundry facilities, and wastewater treatment facilities.

Education and Awareness. Energy efficiency could be improved by educating users (residents and workers). Operations and maintenance staff are crucial to obtaining energy-efficient technologies that will persist over time. Schoolchildren should be included in this effort.

There could be barriers to the implementation of all these recommendations for action. Little money is available for implementation. Although the payback times are short, the first-cost issues must be met. Potential solutions could include looking into "cost-shared" energy measures with a third party and revising contracts with concessioners to require that energy-efficient measures be instituted. Another barrier is the fact that in some instances (particularly where residences are concerned) the government owns the building, but the occupant pays the utility bill. In such cases there is no direct incentive for the government to invest in energy savings.

Renewable Energy Opportunities. A cornerstone of sustainability is the use of renewable energy. Grand Canyon National Park is particularly suited to make use of renewable energy opportunities because of its high energy costs (described in the previous section) and the availability of solar energy.

A significant number of potential renewable technologies and new construction design applications were identified. These technologies include photovoltaics (PV) and solar thermal applications. PV projects include remote, grid-connected technologies with educational/interpretive applications. A photovoltaics survey that was conducted by the National Park Service identified potential PV projects to be completed within five years. Solar thermal applications were identified for residential and

multifamily preheating of domestic water. Passive design applications for new construction are primarily focused on residential applications.

Specific projects where renewable applications have been applied are identified and discussed in this section. As available, preliminary project economics and implementation issues, particularly strategies for implementation, are presented. Where this information is not available, it is recommended that followup audits be pursued to complete the assessment. The projects that have been proposed can be implemented in the short- and medium-term timeframes.

Photovoltaics — Remote application of photovoltaic opportunities would be possible in several areas, as described in the following paragraphs.

- Remote facility power for Cottonwood ranger station: Cottonwood ranger station is a combined residence and ranger station (approximately 1,000 square feet) located in the inner canyon. At present the station uses a small Pelton wheel to generate power, which has been recommended for replacement because it is noisy and there are operational problems. If a PV system was installed, the system would be sized to carry the additional load of a computer and fax machine. The total load is projected to be less than 50 amperes.
- Remote facility power, communication, and monitoring for Pasture Wash, South Rim: Although an application for Pasture Wash was reported in the NPS photovoltaic survey, Grand Canyon National Park maintenance and engineering personnel were not aware of PV opportunities for Pasture Wash. It is recommended that the survey information be checked.
- Composting, pit toilet fans, resource monitoring, and water pumping for South Rim and Inner Canyon: There are 35 candidate toilets on the South Rim and 10 in the inner canyon, some of which have already been converted to photovoltaics, which are used for ventilation and pumping in the composting process. The estimated cost for the PV component of composting toilets at South Rim locations is \$12,839; for the inner canyon, \$8,559. The cost estimate for completed toilets is \$15,000 to \$18,000 per unit.

Additional PV applications that are not remote are described below.

- Lighting for pathways, trails, and walkways at Grand Canyon Village and on the rims: The appropriate first step for lighting paths and trails would be to assess their configurations and functions; however, funding for this assessment needs to be found. Important considerations include "invisibility" from the North Rim and the need

to use indigenous materials for the lighting bollards. It is estimated that bollards as described would cost \$250 to \$300 per unit.

- Street lights, exterior buildings, and parking lots for Grand Canyon Village: An assessment of lighting needs should be done, but funding is a barrier to this first step. PV lighting of this nature is generally cost-effective when line extension beyond 300 feet is required. This is also the NPS guideline for consideration of PV alternatives. There are currently four to six PV powered, low-pressure sodium fixtures in surplus at Grand Canyon National Park.
- Grid-connected applications: Land availability is a prerequisite for a grid-connected application. Approximately 20 acres of land is available at the wet landfill site, with the grid being around 0.25 mile to 0.5 mile from the site. A grid-connected application is estimated to be marginally viable at the park's composite electricity cost of \$0.11 per kWh. However, a demonstration project, where benefits other than cost savings are a consideration, is an option. For a solar thermal electric application using low-cost parabolic trough technologies, 20 acres would support an application of 250,000 square feet. This system could produce about two MW of power. The cost estimate is \$2.5 million per megawatt, and the cost per kWh of generated power would be approximately \$0.15. It is estimated that the simple payback, at 2,400 operating hours per year, would be 15 to 20 years.
- Educational and interpretive applications: An excellent educational opportunity exists for PV-powered lighting and audiovisual equipment at the visitor center amphitheater. At the end of the slide show or film being presented, an announcement would be made to visitors that the amphitheater was powered by photovoltaics. This application could be considered a part of the scheduled renovation of the existing visitor center. This application is being considered at 17 other national parks.

Personnel at the North Rim contact station support the use of PV lighting and audiovisual equipment and its use for educational purposes. Garkane Power, the utility that serves the North Rim, is interested in funding projects demonstrating renewable energy. Because the contact station is being designed now, it is important that this potential project be brought to the attention of the design team soon to ensure its implementation.

Electric carts for maintenance use is a possible action. At present maintenance personnel at Grand Canyon National Park use three gasoline-fueled Cushman-type carts. An opportunity exists to change to electric-powered modes of transportation and to interpret their environmental benefits. The existing carts could be retrofitted, or new PV-powered carts could be purchased, depending on the age and condition

of the existing carts. It is estimated that a recharging station for the electric carts would cost \$22,000.

PV information and traffic warning signs could be considered for the park's entrance station. Entrance stations offer highly visible educational opportunities for PV-powered information and traffic warning signs are either under consideration or installed at 15 other national parks.

Solar Domestic Hot Water Applications — Electric costs at \$0.11 per kWh make solar thermal applications for domestic water heating cost-effective. Propane cost at a seasonal average of \$0.49 per gallon does not support cost-effective solar thermal applications. To establish the economics of solar thermal applications, the cost benefits of these systems for a four-person single family residence and a resident dormitory for 100 people (such as Brandt Hall) were estimated. The solar thermal systems that were analyzed use commercially available flat-plate collector technology.

Type of Residence	Size (sq. ft.)	Cost	Annual Savings	Payback (years)
Single-family residence	64	\$ 3,000	\$ 515	5.8
Dormitory for 100 persons	750	\$37,500	\$6,028	6.2

Given the economic viability of these systems, it is anticipated that the utilities serving Grand Canyon National Park, the Federal Energy Management Program, the Federal Energy Efficiency Fund, and the private sector will be interested in funding or cost-sharing these projects. Given also the number of single-family and multifamily residences at the park, the primary funding alternative might be to procure these systems on an energy savings performance contract (ESPC) with the private sector. Private sector funding of these systems under an ESPC also would shift the responsibility for system operation and maintenance to the contractor. Thus, the financial, operational, and maintenance risks would be the responsibility of the contractor, not the National Park Service.

New Construction Passive Design — Integrating the design strategies of passive solar heating, natural cooling, and daylighting are critical to reducing the inherent energy use of new construction. This strategy could be characterized as maximizing conservation and subsequently “sun tempering” the design. The National Park Service has initiated two exemplary home projects to implement this strategy.

Grand Canyon National Park's exemplary house is one of 59 new employee houses planned for the South Rim. The house is designed to use 90% less

energy for space heating and 63% less for water heating than a home built to existing codes. A superinsulated envelope is combined with simple passive solar features, including a Trombe wall and windows that provide high solar transmission and minimal heat loss through the use of special gas fills and coatings.

Because of budgetary restraints, the new employee homes that are being built have only key features exhibited in the exemplary home. Although these homes are not identical to the exemplary home, they will use less energy than the same homes designed to the current applicable energy code.

The current federal energy code designation is 10CFR435, which is the basis for the NPS *Housing Design and Rehabilitation Guidelines* (NPS-76). The second NPS activity involving the use of passive strategies in residential new construction is the adoption of an upgrade of 10CFR435. It is recommended that Grand Canyon National Park adopt the upgraded NPS-76 guidelines for its residential new construction activities. It is expected that the incremental first cost investment required to implement the recommendations of the upgraded guidelines would be relatively small and the life cycle would be cost-effective.

WASTE MANAGEMENT

Sources of Waste

Waste at Grand Canyon National Park comes from two major "waste streams," *operations* waste and waste from *construction and demolitions*. Only a small portion of either waste stream is recovered and recycled. Babbitt's store deserves credit for recycling cardboard, showing that recycling can be accomplished. It is projected that the present landfill will be filled within three years. After that, private commercial waste collection is planned at a cost estimated to be about twice the current cost. There is great potential for a substantial increase in the amount of material recovered from both waste streams.

Waste from Park and Building Operations. The waste stream from park and building operations is 4,054 tons per year, or about two pounds per visitor. The origins of the stream of commingled waste on the South Rim are as follows:

Restaurants	35%
Campgrounds and trailer parks	17%
Viewpoints and roadside	14%
Hotel and motel rooms	14%
Housing units	12%
Administrative offices	4%

Commingled recyclables consist of aluminum, glass, plastic, paper, and cardboard. There is no provision in Grand Canyon National Park for separation of the various types of recyclables at collection points. Some post-collection separation takes place, but only about 5% to 10% of the total operations waste stream is recovered and recycled; the rest is placed in landfill.

Waste from Construction and Demolition. A substantial amount of existing building renovation and new building construction is recommended in the *General Management Plan*. Conventional construction practices generate a commingled stream of waste that cannot be effectively separated and recovered. The construction of a typical single-family house generates about four tons of waste. Renovation of existing buildings also generates large amounts of waste. If existing building renovation is properly managed, a stream of reusable/recyclable materials can be generated, reducing construction costs and the quantity of material that must be landfilled.

Recommendations

Short-term Actions. Initiate a program to separate building operations waste at the point of generation or collection. Recover and recycle aluminum, steel, glass, plastic, paper, and other materials.

Medium-term Actions. Establish a program of separating and recovering construction and demolition wastes. Work with concessioners and suppliers to initiate the use of reusable shipping containers, returnable pallets, bulk packaging, and other elements that would reduce the stream of materials.

Long-term Actions. Consider establishing local industries that make products from the recovered elements of the operations and construction/demolition waste streams.

Benefits, Costs, and Barriers

The reduction of waste from operations and construction or demolition would save money, lengthen the useful life of landfills, and create jobs. Philosophically, it would place Grand Canyon National Park in harmony with the forces of nature. It also would provide an educational opportunity for park visitors who do not usually consider the benefits of reducing the waste stream.

The separation of operations waste from buildings and grounds would require the use of multiple containers. Employees and visitors would need to be educated about the reasons for and benefits of recycling. Establishing a regional network for recovery and reuse of the materials would involve management costs.

Separating construction and demolition waste would add little or nothing to the cost of building. Contractors and suppliers would have to be educated. Some additional space would be required for multiple containers for separating materials and for storage of recovered materials until they could be reused in construction.

As a major regional entity, Grand Canyon National Park should take the lead in setting up a regional network of private sector businesses that recover and resell the construction and demolition materials. This would be necessary to achieve effective reduction of waste stream materials; without such a network, the potential for effective recovery is limited.

Strategies for Implementation

Use effective programs for recovering waste from operations, construction, and demolition. Such programs are in place in many municipalities; these could be used as a model for programs at Grand Canyon National Park.

As a major entity in the region, Grand Canyon National Park should take a leadership role in working with other communities to establish waste reduction programs.

WATER RESOURCES

Current Situation

The existing water supply system for Grand Canyon National Park does not demonstrate the principles of sustainable design. It is complex, expensive, and difficult to maintain. The system encourages waste and affects not only the spring where water is removed, but also Garden Creek, where water is discharged.

The transcanyon pipeline was completed in 1971 to bring water by gravity 14 miles across the canyon from Roaring Springs to Indian Garden, where it could be pumped to the South Rim. In 1985 larger pumps and a directional drill line were added between Indian Garden and the South Rim. The system provides adequate water, but much of the pipeline has reached its designated lifetime and needs to be replaced. Maintaining the transcanyon line costs \$50,000 per year.

To keep the line pressure at a low level, water is overflowed directly to Garden Creek at Indian Garden when water is not being pumped to the South Rim. This spills surges of chlorinated water from Roaring Springs into Garden Creek, altering the chemistry and flow regime of the smaller stream and creating an unnatural riparian waterway on Garden Creek below Indian Garden.

The cost of replacing the transcanyon pipeline is estimated at \$20 million, and the replacement would cause impacts on resources and visitors in the heavily used hiker corridor along Bright Angel Creek. The high cost makes this an excellent time to take a close look at alternative water sources and conservation measures.

The potable water supply for the park is taken from the Roaring Springs cave north of Bright Angel Point below the North Rim, 17 miles from the main use point. Sixty percent of the flow is diverted for potable uses throughout the park. The water flow rate and water quality are variable throughout the year. Heavy flows occur in spring, and turbidity is high at that time. During the rest of the year flows from the source average 1,500 gallons per minute (gpm). Of this, 900 gpm is extracted for potable domestic water use at the following locations: North Rim, 100 gpm; South Rim, 650 gpm; Phantom Ranch, 50 gpm; and other inner canyon supplies, 100 gpm.

The state of Arizona has classified Roaring Springs as a surface water source. The potable water used at Grand Canyon is disinfected but not filtered; expensive filtration equipment would need to be constructed.

Pumping water from Indian Garden to the South Rim is extremely energy consumptive: 3,069,000 kWh are used annually to pump 163 million gallons of water. Water consumption by thousands of gallons (kgal) and by location is as follows: 2,144 kgal to the Forest Service, 4,474 kgal to Tusayan, and 156,441 kgal used in Grand Canyon National Park. Within-park use is broken down as follows:

Where Used	Thousands of Gallons
Lodging	26,250
Day visitors (restrooms)	27,000
Residents (housing)	32,000
Campsites	25,000
Permanent trailers	5,512
Laundry	7,000
Losses (10%)	16,300
Miscellaneous (restaurants, bus wash, staff)	21,259

The total annual water consumption is 163,059 kgal. The current water cost is \$5.96 per kgal, making the annual cost for water \$972,000.

The cost for 3,069 MWh to pump water to Indian Garden is \$210,850 per year. The annual cost for 105 MWh for the other pumps is \$10,941.

The scarcity of water was recognized in 1925 when one of the first reclaimed water plants in the United States was constructed on the South Rim. Unfortunately, each new technological improvement in the park's water supply system has been made during a period when water was relatively plentiful, and efforts to conserve and reuse have been curtailed. The use of low-flow fixtures or other water-conserving devices is mostly limited to the North Rim and Phantom Ranch, where wastewater treatment plants are over capacity.

A new reclaimed water plant replaced the original one in 1988. It produces 500,000 gallons per day (gpd), but only 150,000 gpd of reclaimed water is used, with the rest discharged to Bright Angel Wash. New houses in the park are constructed with dual plumbing to accommodate a "gray water" system, but reclaimed mains do not reach this area.

Water harvesting has been used in the park in only two places. Rainwater is the only water source at Tuweep Ranger Station in western Grand Canyon. A system consisting of a rainshed and cisterns performs adequately in all but the driest years, when water must be hauled to the site. Another ranger station at Pasture Wash (now abandoned) also used water harvested from the roof as its primary supply.

Recommendations

Three concepts are critical for evaluating and understanding water supply alternatives.

- All water removed from springs, streams, or groundwater in the vicinity of the park is water that would otherwise flow naturally into the canyon and sustain ecosystems there. The area's hydrogeology is such that the Grand Canyon acts as the ultimate drain for all groundwater and surface water in the area.
- In this water-scarce environment, there needs to be a strong emphasis on conservation and reuse because whatever the origin, water will be a scarce and expensive commodity.
- Any water not absolutely necessary for the operation of the park should remain in its original source. Specifically, the overflow of water brought from Roaring Springs at Garden Creek should be eliminated by leaving that water in Roaring Springs, and the discharge of excess reclaimed water should be minimized through greater use.

Short-term Actions. The following short-term actions should be instituted to improve water use in Grand Canyon National Park.

Replace Plumbing Fixtures — Install ultra-low-flow toilets (1.6 gallons per flush), low-flow shower heads (2.5 gpm), and faucet aerators (0.5 gpm for public use lavatories and 2.2 gpm for all others). This would save approximately 40% of the water consumed on the South Rim, or about 65 million gallons. To replace plumbing fixtures in 958 residential units, 1,041 lodging units, and all public restrooms would cost approximately \$949,000. This would result in an annual saving of \$1.5 million and a simple payback of eight months. Installing low-flow plumbing fixtures makes sound financial sense when the payback is eight months or less, and it should be considered mandatory from an environmental standpoint.

The savings quoted represent reductions in water costs, sewage treatment costs, and energy costs (from reducing hot water use). The cost avoidance for environmental emissions was calculated for reductions in electrical use of water pumps at Indian Garden. This reduction was calculated at \$40,000 per year, but this information was not included in the payback calculation. The *General Management Plan* identifies a need to construct additional storage for 5 millions gallons of potable water on the South Rim at a cost of \$3,700,000. The additional storage was required to satisfy water demand associated with projected increased visitor use.

The high costs of implementation might be a slight barrier, but this should be mitigated by the high return on investment. The NPS share of the investment could be obtained through federal initiatives such as the Federal Energy Management Program or the Federal Energy Efficiency Fund. As a last resort, park operations or repair and rehabilitation funds could be used. The concessioner could use a utility rebate, if available, to retrofit the facilities.

Perform Water Audits — Water audits should be made of other water-using activities such as laundry, bus washing, and food preparation. Water savings of 10% to 15% could be realized by implementation of the recommendations from a comprehensive water audit.

A brief observation of the commercial laundry indicated that daily usage is about 20,000 gallons of water and 2,000 kWh. The laundry also uses an unknown amount of propane for its boilers. This laundry washes all the bed linens, towels, and tablecloths for the concessions operations. Bed linens are changed daily, even for multiday guests. Notices could be placed in guest rooms indicating that linens would be changed every fourth day unless requested otherwise. This could lead to substantial savings of water and energy. Interpretive materials in the rooms would be necessary to educate guests on the conservation effects of these actions.

Medium-term Actions. The following actions would help to save water.

Use of Reclaimed Water — Expand the use of reclaimed water from sewage treatment plant effluent.

With the use off-the-shelf water conservation technology, as previously described, and increased use of reclaimed water for toilet flushing in public buildings, potable water consumption at the South Rim could be reduced from the current 500,000 gpd to 200,000 gpd. Normally, 40% of interior water use is devoted to flushing toilets. It is estimated that constructing an additional 125,000-gallon reclaimed water tank, adding 18,000 feet of reclaimed water distribution line, and replumbing heavily used public buildings would cost \$1 million. These funds could be obtained by reprogramming the \$3.7 million saved from the proposed potable water storage tank to this activity.

Alternative Sources — Evaluate alternative water supply sources. With a smaller volume of potable water required as a result of water conservation and maximum use of reclaimed water for toilet flushing, the park should continue to explore options such as water harvesting from impervious surfaces and deep well construction south of the park.

Some benefits to be gained from using a South Rim source are returning the Bright Angel and Garden Creek drainages to their natural state, decommissioning the Transcanyon waterline (thus avoiding substantial operating and maintenance costs), and eliminating the \$20 million cost to reconstruct the Bright Angel section of the line. Barriers to this proposal are that hydrological data for the areas south of the park are unavailable, and it might not be possible to harvest sufficient water of high quality from impervious surfaces. In addition, inner canyon developments would also need to find and develop new water supply systems.

The feasibility and design of a groundwater supply for the South Rim have not been developed enough to provide a reliable cost estimate. Wells to a depth of 3,000 to 4,000 feet would cost \$350,000 to \$450,000 each. Laying buried pipeline in this vicinity costs about \$350,000 per mile. Therefore, the overall cost should be comparable to replacement of the transcanyon pipeline, with significant benefits of easier access for maintenance and repair. Water rights and other legal questions would need to be answered, and further geohydric investigations would be necessary before well drilling could proceed.

Long-term Actions. The following long-term actions are recommended.

Continue implementation of the latest proven water conservation technologies.

Implement alternate source actions.

WASTEWATER

Current Situation

Most of the wastewater generated at the South Rim is stabilized at the extended aeration treatment plant just south of the village. Its capacity is 750,000 gpd. At present, the use during the average day of the peak month is 500,000 gpd. The treatment plant produces a high-quality effluent with biological oxygen demand (BOD) suspended solids values less than 10 milligrams per liter (mg/L). This is suitable for reuse.

Reclaimed water is pumped to a 125,000-gallon storage tank. Because of the small distribution system, the use of reclaimed water is limited to irrigation of grass at the school and hotel areas. Treated wastewater not used for such purposes is discharged for ground infiltration. Currently 150,000 gpd is used for irrigation.

The current cost for wastewater treatment is \$4.75 per kgal. The annual operation for the wastewater treatment plants and lift stations is as follows:

Location	MWhr	Cost
South Village treatment plant	1,459	\$115,052
Phantom Ranch treatment plant	79	8,419
Lift stations	12	2,125

The annual air pollution impact from water consumption and sewage treatment (based on electrical usage) is as follows: 5.7 tons of oxides of sulfur, 10 tons of oxides of nitrogen, and 2,934 tons of carbon dioxide.

Wastewater collection and flow through the plant are mainly by gravity. The large energy users are the blowers that provide air to the aeration basins. The return activated sludge pumps are equipped with variable frequency drives, which enhance energy efficiency. The implementation of low-flow plumbing fixtures would greatly reduce the hydraulic load on the wastewater treatment plant. However, the organic loadings would remain basically the same.

Historically, dried sludge has been buried at the landfill. Sludge composting with wood chips and/or solid wastes has been started recently. Preliminary results are encouraging that this disposal method should be continued.

The wastewater treatment plant would benefit from an energy audit to fine-tune energy conservation at this location.

INDOOR AIR QUALITY

In the topics described above, human actions have a direct result on the environment. Indoor air quality directly influences human health and is a byproduct of the materials that are chosen for building construction. Poor indoor air quality can cause illness, disease, and discomfort on either an acute or a chronic basis, reducing the general quality of life, visitor enjoyment of the park, and park and concessioner staff productivity. To achieve a more sustainable park operation, it is important to strive for benign indoor air quality in park buildings.

Causes

Poor indoor air quality results from inadequate control of the sources of indoor air pollution, insufficient ventilation, or a combination of the two. Many sources of pollution can be eliminated or minimized by careful consideration of materials and other design aspects during the design and construction of buildings. Other pollution of indoor air can result from building use, operation, and maintenance.

Recommendations

The recommendation of this workshop is to develop a process for auditing indoor air quality in park facilities and to address indoor air quality concerns during the design and construction or renovation of park facilities. Attention to the selection and use of building maintenance products and to the maintenance of building equipment would also help to ensure good indoor air quality.

The following actions are recommended to achieve optimum indoor air quality.

Conduct Audits of Indoor Air Quality. Initiate a process to develop and conduct an audit of existing park facilities. Priority should be given to facilities with the highest occupant duration, including certain public spaces and residential properties. This process should be initiated within the next year and can be completed in five years. Where possible, indoor air quality audits should be an integral part of energy auditing.

Consider Indoor Air Quality in New Building Design and Renovation of Existing Facilities. Consideration should begin in the feasibility and project planning phase and be continued through project development. Indoor air quality considerations can eliminate many costly problems by identifying and mitigating potential problems before they develop.

Consider Indoor Air Quality in Selecting Building Materials. New building materials can be strong sources of indoor air pollution. Materials that are installed wet (such as paints, adhesives, caulks, and sealants) can be

particularly strong sources, emitting toxins, odorants, and irritants. Dry products do not have as large initial emissions as wet ones, but their emissions may continue for long periods of time. Examples are pressed wood products, whose emissions of formaldehyde and volatile organic compounds have been blamed for many episodes of serious indoor air pollution. Preferred building materials are those that are stable, durable, and do not emit harmful substances to the environment. These materials are more easily cleaned, and little to no use of harmful chemicals is required for their maintenance and periodic renewal.

Ensure Adequate Ventilation. Several ways to improve ventilation are detailed below.

Provision of Adequate Outdoor Air — Indoor air quality can be improved by ensuring the presence of an adequate outside air supply at all times. Spaces may be ventilated intermittently if their occupancy is intermittent, but adequate lead time ventilation should be provided before enclosed spaces are occupied after a vacant period.

Exhaust Ventilation — Emissions from strong sources of pollutants or sources of very harmful or noxious pollutants should be directly exhausted to the outdoors without recirculation by the ventilation system. Common examples of this are direct exhausts from bathrooms, kitchens, darkrooms, and smoking areas.

Maintenance of Ventilation Equipment — Maintenance of mechanical ventilation equipment in a building is critical to the provision of good indoor air quality. Equipment designs and construction must provide for accessibility of equipment (filters, fans, coils, heat exchangers, humidifiers, dampers, controllers, sensors, ductwork, diffusers) for inspection, cleaning, maintenance, and repair or replacement. Periodic inspection and documentation of maintenance activities are important to providing those responsible for building air quality with access to the information they require to assess system and equipment adequacy, condition, and performance.

Commissioning of New or Renovated Facilities — Facilities that have been newly constructed, renovated, or refurbished should be commissioned; that is, tested against the design performance criteria to which they are designed, before being put into use. This is particularly important for mechanical equipment, but it can be applied to all building systems.

Control of Moisture — Microbial contamination can be minimized by controlling moisture on building surfaces. Moisture intrusion through building envelopes, leaks from water pipes, condensation on cold surfaces, and other sources of excess moisture should be avoided. Saturated materials should be removed and discarded, and the source of moisture should be eliminated if possible.



CRITERIA FOR SUSTAINABLE INDOOR AIR QUALITY AND BUILDING MATERIALS

The following criteria should be used in choosing building materials to ensure the best indoor air quality possible and to have the least impact on the environment.

Materials should have low embodied energy.²

Materials should be durable and require minimal maintenance. This would extend their useful life, reduce the depletion of natural resources required to replace them, and decrease the need to use maintenance materials that emit organic chemicals into the air. (Such chemicals can contribute to the formation of photochemical smog outdoors and can pollute indoor air.)

Hard, smooth-surfaced materials are preferred wherever practical to reduce the need for cleaning and refinishing. Smooth surfaces also have less potential to provide substrates for the growth of harmful or noxious microbial contaminants such as mildew, mold, bacteria, and protozoa.

Materials should have minimal offgassing of volatile organic compounds, particulate matter, or other hazardous or noxious substances to minimize the impact on indoor air quality and (for solvent-based applications) outdoor air pollution.

Materials based on recycling of their constituents should be considered wherever they are available. Their previous uses should be examined in the context of reprocessing and intended application to determine whether contaminants from previous uses or processes may pose a hazard to indoor air quality.

Recycled materials as well as new materials should be selected on the basis of their maximum projected useful life and for their potential for recycling at the end of their useful life. This would decrease the demand for new materials for replacement products.

Materials should be suitable for recycling at the end of their useful life, and where practical they should be installed to facilitate that recycling. Materials with limited lives (such as carpets) should be purchased from vendors who contract to take back the product for recycling at the end of its useful life.

Emphasize acquisition of materials from local and regional sources to the extent that they are available. Examples include stone and other available earth-based materials, excavated waste from construction or landfill, and wood from northern Arizona forests and mills.

2. Embodied energy is the total energy required to extract the raw materials, process and manufacture the products, transport them, and install them into the facility.

Massive materials such as stone, brick, and concrete should be used where thermal storage potential is greatest and where thermal loss through the materials is minimal (as a result of the placement of thermal insulation outside the mass).

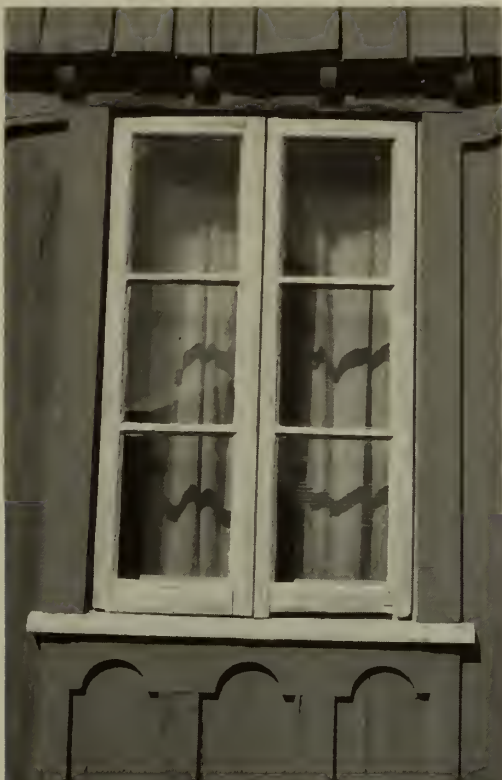
Floor coverings in public access spaces with high traffic should be hard surfaces, where routine cleaning with water should be adequate. They should require a minimum of maintenance through the use of solvent-based products such as waxes, wax strippers, or other coatings.

Fibrous insulation materials should be protected from moisture and contaminants wherever they are used. These should include both thermal and sound insulations, whether used in the building envelope or in mechanical equipment such as air handling systems, cooling towers, ductwork, heat exchangers, and window air conditioning units.

To prevent the development of microbial growth, carbonaceous materials should not be used in locations where they can become damp, especially in concealed spaces such as suspended ceilings or walls, unless they are easily accessible for inspection, maintenance, and cleaning.

Pressed wood products should be used sparingly in locations where ventilation rates will not be consistently above 0.5 to 1.0 air change per hour, or an equivalent rate on a daily basis.

Materials used for maintenance and refinishing should be selected carefully to minimize the use of products that emit substances that can contaminate indoor air or contribute to the formation of photochemical smog. The content of products must also reflect the balance between initial and overall emissions so that the number of reapplications results in a net reduction of total emissions.





TOPIC 2: VISITOR EXPERIENCE

Interpretation provides the best single tool for shaping experiences and sharing values. By providing an awareness of the environment, values are taught that are necessary for the protection of the environment. Sustainable design should seek to affect not only immediate behaviors but also the long-term beliefs and attitudes of visitors. . . . Visitor experiences must be planned to provide actual knowledge of resources and to influence human values, thus leading to the protection of the overall environment.

– *Guiding Principles of Sustainable Design*
National Park Service, 1993

Perpetuating the original intent of the 1916 organic act will depend on building a constituency that will support the conservation of its principles. Potentially, the primary group forming this constituency would be the visitors to the park.

If the visitor experience at Grand Canyon National Park continues as it is today, this constituency will become discontented and their visitation and support will diminish. The alternative is to provide a satisfying visitor experience that is rich in sensation, emotion, and learning, unhampered by current frustrating situations such as confusing navigation and overburdened services. This alternative experience would redefine a visitor as someone personally invested in the park, not a pampered guest. The visitor would be a steward connected to the nature and culture of the park and region.

TWO VISITS TO GRAND CANYON NATIONAL PARK

We present two stories involving travelers to the park. In the first story, the characters are fictional, but the situations, realistically portrayed, will continue to occur in the future if nothing changes. The characters in the second story also are imaginary, but what they encounter is entirely possible if ideas being discussed for the *General Management Plan* and the Sustainable Grand Canyon workshop are implemented.

The Jones Family

August 7, 1993. Paul and Maryanne Jones and their kids, Jeff, 11, and Robin, 9, are driving from their home in Kansas City to Maryanne's mother's home in Los Angeles. They arrive in Flagstaff around two in the afternoon and decide on the spur of the moment to drop in at Grand Canyon and spend the night.

"The canyon must be right over there," says Maryanne.

"Joe from work went to the Grand Canyon last year," says Paul. "I remember he said you turn off I-40 at Williams. It'll be easy to find."

They are not aware that the canyon actually is 90 miles beyond Flagstaff. They forgot to bring their map of Arizona, and Paul doesn't want to get off the highway and go into town to ask for directions. When they see a rest area outside of Flagstaff, Maryanne looks for a map, but there is none. Nothing about the Grand Canyon at the off-ramp at Williams, either. Driving along U.S. 180, they cross the grasslands of the plateau and pass some commercial development that seems out of place and awkward.

"This is taking forever," Jeff complains.

"Are we there yet?" wails Robin as they enter Kaibab National Forest.

Around three-thirty they come to a town with motels and helicopter rides. Beyond that is the park gate. They are surprised to have to pay ten dollars to enter. They get a pamphlet with the receipt, but it's hard to understand where they are supposed to go, so they just drive on. They pass the turn to East Rim. "Should we go there?" asks Maryanne.

"I'm not sure where we are," says Paul. He hates to admit to feeling confused and lost.

As they pass a large parking lot filled with cars and tour buses, Robin yells, "There it is!"

Paul turns the car around, looking for a place to park. He circles the lot twice before he sees someone pulling out. He parks quickly and they all get out. "Lock your doors, kids," he says, "and look out! There's a bus coming!"

They cross the asphalt and find themselves in the midst of large throngs of people. There's a group Paul knows are Korean from the sign on their bus, a dressed-up Japanese family listening to a tour guide, and small clusters of people speaking German. Three athletic-looking guys jog by.

Jeff and Robin run ahead to the edge of the canyon. "Look! Let's go out on that point!" yells Jeff.

Paul and Maryanne go to the edge more slowly. Maryanne sighs. The vast canyon spreads out below them.

"Well, now we've seen it," says Paul. He takes two quick pictures. "Come on, kids," he calls. "It's four-thirty. We need to find a room."

They get back in their car. "It looks like all the lodging is in the village," Maryanne says, studying the brochure. "I think we turn here."

Paul makes three wrong turns before they find a parking spot along the road near the El Tovar hotel.

"I'm sorry, sir, but we're full."

"Really? Do you know if any other places in the park have rooms?"

"All the rooms in the park are booked months in advance," says the clerk.

"But I've got my wife and kids in the car, and they're really tired," says Paul.

"Well, sir, I suggest you try Tusayan, the town just outside the park."

Paul strides out angrily. He hears thunder, and before he gets to the car, he is soaked. But Maryanne and the kids aren't sympathetic; they were hot waiting in the car.

They stop twice to ask for directions to get out of the park. Around five-fifteen they reach Moqui Lodge, outside the park gate.

"Sorry, sir, we're full. You can try the Best Western down the road, but they're probably full, too. Your best bet is probably Williams out on Interstate 40."

"We came through there. But we didn't know we couldn't stay in the park!" Paul is too tired to be angry now.

The Joneses drive back to Williams, with the kids complaining most of the way. Maryanne refuses to talk to Paul. They don't find a room in Williams either. Now it's almost seven, and everyone is hungry and cross. They stop at a fast-food restaurant before getting back on I-40. After eating, Jeff complains less, and Robin soon falls asleep. Paul and Maryanne drive on in silence until they finally find a room in Kingman around ten-thirty.

"What a nightmare! That was terrible! Let's never do that again!" says Paul as they collapse for the night.

Three Indiana Friends

April 20, 2000. Carlos, Jack, and Frieda are watching TV in Indiana. Inspired by a public service announcement, they decide to call the "800" number and plan a trip to the Grand Canyon. "Let's get a room with a view!" says Jack.

"Let's rent a car and drive up from Phoenix!" suggests Frieda.

"I'd like to hike the canyon!" says Carlos, who is wiry and athletic.

"And I'd love to see the Navajo Nation and the parks in Utah," adds Frieda. "I'll see what's on the 'net' and download some information."

The friends decide to stay at Tusayan even though it's outside the park. The friendly person who answers the telephone helps them decide what their options are and enters their names for all the reservations they'll need. Jack and Frieda are surprised that they need a reservation to hike into the canyon, but the operator explains that hiking is much nicer when you aren't fighting crowds on the trail. She also helps them figure out how much time each part of their adventure will take and directs them to further resources for their research.

When the confirmations arrive, planning guides are included. These have guidelines for preparation for the dangers and rewards of their hike into the canyon. The three start jogging every day to get in shape, and Frieda buys special backpacks for all of them to carry the water they'll need to survive the long desert trek to the bottom of the canyon.

Carlos finds a CD-ROM and begins to learn to identify the plants and birds (his special passion) that they may encounter in the canyon. Frieda uses the CD-ROM to explore the area's cultural history. Jack won't listen to their excited descriptions; he says he'd rather "just soak it all in" after he gets there.

August 7, 2000. Finally, the day arrives to start their adventure. The three friends fly from Indianapolis to Phoenix. They stop to reconfirm their reservations at the NPS orientation center in the Phoenix airport. Then they pick up their rental car and drive to the Flagstaff airport, where they leave the car at the multimodal transportation center and get on the high-speed train to Tusayan.

A presentation about the Grand Canyon on the train helps the friends understand their special responsibilities as humans visiting this special place. They arrive in Tusayan after thirty minutes. They stash their gear at the hotel and grab the shuttle to Mather Point. In ten minutes they are walking on stabilized earthen paths through the piñon forest.

Like the indigenous people who lived here centuries before, and like the more recent European explorers, Carlos, Jack, and Frieda emerge from the forest to see the most spectacular, awe-inspiring view ever! The Grand Canyon falls away beneath their feet and the space expands to unbelievable distances.

Returning to the shuttle dropoff, they notice some Japanese travelers using a computer kiosk to orient themselves in their own language to the services, events, and possibilities of the park. Carlos and Frieda find another kiosk and query it in English to find a medium-priced restaurant on the rim with a view of the sunset. They enter their reservation for three

at eight-fifteen. That will give them time go look at the paintings of the canyon at the Kolb Studio on the rim at the village.

The friends hike along the rim trail, greeting the other travelers. They strike up a conversation with a German couple and hear about watching the sunset from the West Rim, and they vow they will do that one evening during their stay. A harsh chattering in some brush attracts Carlos's attention, and he recognizes a group of scrub jays from his earlier study of Grand Canyon area birds. Then a large bird riding an updraft attracts his attention, and he lingers behind to watch the turkey vulture as it soars majestically, seeming never to move its wings.

The friends arrive at the village in time to see the last steam engine of the day arrive at the historic depot below El Tovar. They explore the village down by the depot and find the magnificent stone building that once supplied power to the village but now contains a wonderful museum about the park. Beside the powerhouse is an open-air market with American artists working and selling the products of their skills. Frieda leaves the guys behind as she goes in to explore the Native American center, where she becomes involved in a conversation with a tribal elder about the stories and lessons the summer season brings.

Frieda rejoins her friends and they climb up the hill through the native woodlands, arriving again at the rim. They pass the old 1930s hotel, the Bright Angel Lodge, where cars from the 1930s are displayed outside. Then they go to look at the paintings at the Kolb Studio.

At dinnertime they walk right into the steakhouse and sit down without any wait. They turn to see the magical colors of the sunset paint the canyon cliffs. After dinner they walk over to Maswik transportation center, where they decide to take a light rail train back to Tusayan.

As they say goodnight in Tusayan, they reflect on what a wonderful day they had and agree to get an early start on their hike down to Phantom Ranch the next morning.

It seems their introduction to the park has been nearly perfect — well organized and easy — but even with all their good preparation, nothing has prepared them for the magic they will find on their hike into the canyon the next day.

THE STAGES OF VISITOR EXPERIENCE

The second story illustrates how organized, successful, and powerful a visit to Grand Canyon National Park can be. For this to happen, a visitor's experience must be planned in advance, using the tools delineated by the information management workgroup in the "Topic 3" chapter.

Traditionally, a visit to Grand Canyon National Park is an experience filled with awe. Experiencing the rim for the first time is breathtaking, with a noticeable hush. Too often, the view from the rim is the only experience a visitor has. The park's goal is to extend the Grand Canyon visit to a series of experiences, each contributing to a richer visitor experience and deeper understanding of the history, culture, and ecosystems of the park. Visitors should discover a variety of experiences that combine to create a memorable educational visit, leaving them more aware of their relationship to and impact upon nature.

Currently many visitors treat the park with disrespect, expecting the park to provide all the amenities of urban and suburban life. This is an attitude of *taking*, which leads to destruction. Changing the visitor experience to one of *giving* will lead to preservation, reconstruction, and greater appreciation of the natural and cultural environment. This attitude change needs to begin at home, or at the conception of the trip. Attitude development continues to occur during travel, arrival, education, and experience. If the workshop participants and the National Park Service are successful, visitors will take this experience home with them, incorporating these concepts into their daily lives.

Important goals for making visitors' experience more successful include eliminating or minimizing frustrating conflicts in travel, arrival, and park experience; providing immediate "man to nature" and "man to culture" experiences; and facilitating "man to spirit" connections. Overall, the theme of the human connection to the environment should be carried away by each visitor. The recommendations from this workgroup provide numerous opportunities for fulfilling personal experiences.

This series of experiences begins at home and continues through transportation hub cities, regional host communities, park host communities, and Grand Canyon rim and village areas. Recommendations for achieving the best possible visitor experience are outlined in the next section, as are barriers to and strategies for implementation.

THE EXPERIENCE BEGINS AT HOME

It is especially important that each visitor begin the experience with as much information as possible about the park. A sense of place and responsibility and an understanding of what the park has to offer to visitors must be clearly conveyed to maximize the experience. This does not seem to be taking place now. Without having had this information conveyed to them, visitors can find the experience frustrating and inadequate.

The delivery mechanisms for all Grand Canyon National Park information to be disseminated were developed by the information management workgroup and are described in the next chapter. However, no matter what mode of delivery is used, the following visitor experience messages must pervade all information and interpretation.

- Relay the vision of a healthy, sustainable, and enjoyable Grand Canyon National Park through all material.
- Show the visitor's relationship to the environment of the park and the region.
- Explain the relationship of the park to the region and the greater Colorado Plateau.
- Help visitors plan ahead for the trip by clearly defining the services that are and are not offered at the park.

ACCESS TO INFORMATION

Recommended actions for access to information are closely linked to those made by the information management workgroup; however, they are tailored more toward the visitor experience. This workgroup recommends that there be access to information in a variety of settings, such as the following:

Short-term and Medium-term Actions

Text and computer terminal access at libraries (Internet, Mosaic, etc.)

Local Travel Agencies

Home computer access (Compuserve, Prodigy, America On Line, Delphi)

Long-term Action

A television advertisement campaign that lists one telephone number with automated touch-tone service tailored to a variety of needs.

Cultural and language barriers that exist because of the international makeup of the park's visitors may hamper the implementation of these recommendations. In addition, many potential visitors may not have access to computers; some may not feel comfortable using computers to get information. However, efforts to mitigate these barriers would pay dividends by helping visitors plan for their specific needs, prepare for their park experience, and foster a stewardship ethic.

TRANSPORTATION HUB CITIES

Many visitors enter the Colorado Plateau through “hub cities” (major ports of entry into the region). The hub cities for Grand Canyon National Park are Phoenix, Los Angeles, and Las Vegas. Visitors’ experience could be greatly enhanced by maximizing opportunities in hub cities to obtain a clear understanding of the region and timely and accurate information. Recommendations for disseminating this information are delineated below.

Short-term Action

Collaborate with the visitors’ bureaus of Grand Canyon National Park’s hub cities to have questions answered quickly and accurately.

Medium-term Action

Create displays in airports that focus on the Colorado Plateau and the Grand Canyon. These could be passive, traditional displays, or interactive displays such as multimedia kiosks.

These actions would generate revenue for hub cities due to visitor preparations for trips to the Grand Canyon area. The barriers to implementation would be language and cultural ones, as well as the logistical barrier of keeping display information current. As a strategy for implementation, the National Park Service should seek a partnership with airline companies or large corporations (such as Dow Chemical, IBM, AT&T) for airport displays.

REGIONAL HOST COMMUNITIES

As visitors enter the region near Grand Canyon there are several “regional host communities” — towns and cities that offer a final chance to purchase supplies and provisions needed on their trip and inquire about lodging, tours, and the general region. Some communities adjacent to the park boundary — for example, Flagstaff, Kingman, and Fredonia, Arizona, and Kanab, Utah — are regional host communities.

Without knowing that some amenities may not be available in park host communities (described below), visitors can encounter disruptions that tarnish their Grand Canyon experience. With this in mind, the visitor experience workgroup recommends the following actions for regional host communities.

Short-term Actions

Regional host communities must be the first staging areas for very specific and current information on the services the park has to offer.

Information should be as comprehensive as possible, addressing the following topics:

- services offered inside the park area
- recreational opportunities and their requirements: duration, fitness level, equipment
- resource sensitivities and carrying capacities

Medium-term Actions

The National Park Service could develop an “associate ranger” program in regional host communities (as well as in park host communities). The “associate rangers,” from a pool of community volunteers, would be the visitor’s first park-related contact. Wearing ranger-type uniforms, they would function as the purveyors of the park’s message of natural and cultural resource preservation.

Pamphlets, maps, and general information should be made available at rest stops along major highways leading into the regional communities.

Long-term Actions

The National Park Service could develop an “Arrowhead Seal of Approval” program for service organizations in the regional host communities. The arrowhead seal would have a specific set of criteria or standards that must be met, such as environmental compliance in the areas of resource conservation and waste reduction.

These actions could provide an improved sense of community and enhanced visibility. Barriers to implementation would be obtaining funding, support, and a volunteer base for the “associate ranger” program; maintaining ample information at rest stops during busy seasons; and gaining community support, funding, and partnerships to assist in the “Arrowhead Seal of Approval” program.

Community organizations could assist in providing the volunteer base and activity sites and could help by acting as liaisons between volunteers and the National Park Service. The Arizona Department of Transportation could work with the National Park Service to keep information available and current at rest stops.

PARK HOST COMMUNITIES

The goal of park host (gateway) communities is to be a destination point that is an extension of the park environment. These communities, which are near the park, would be responsible for enhancing visitors' experience and preparing visitors to be stewards of the park. Park host communities such as Tusayan, Cameron, and Williams (for the South Rim) and Jacob Lake (for the North Rim) would have a direct association with the natural and cultural context as well as offering housing and community services.

Park host communities would offer visitors a secure, unique environment and orientation to park opportunities and transportation. The National Park Service should partner with park host communities and developers to make the communities reflect the values of sustainability as exhibited in the park. Recommendations for actions to be taken by park host communities are listed in table 1.

CANYON RIM EXPERIENCE: "MAN TO NATURE"

The goal of the "man to nature" element of the visitor experience is to carefully prepare visitors for the dramatic, breathtaking rim experience, maximizing the anticipation and realization of the canyon, then offering appropriate options while meeting basic needs. Specific recommendations are listed below.

The following actions would protect resources, reduce impacts, or improve the visitor experience. These actions either could be done at no additional cost or are already included in the budget estimates of the *General Management Plan*.

- Minimize impacts on the natural environment. This action would be appropriate to the area. A benefit would be resource protection.
- Provide access to appropriate, sustainable transit (shuttle, bikes, footpath). This would improve safety and reduce impacts on the park.
- Provide a pathway from the shuttle to Mather Point that connects visitors with the natural environment and increases the drama of the view from the overlook.
- Keep facilities visually integrated and of a human scale. This would reduce visual intrusions and increase visitor comfort.

The main barrier to the above actions is lack of commitment to the plan. An effective strategy for implementing these actions would be to adopt the *General Management Plan* and appropriate design guidelines.

Table 1: Recommendations for Park Host Communities

Recommendation /Term	Action	Benefit	Cost	Barrier	Strategy for Implementation
<i>Provide a sense of welcoming</i>					
Short term	Add gateway feature and sign	Would mark as point of arrival	\$2,500,000	Arizona Department of Transportation (ADOT) regulations	Partner with ADOT
Medium term	Provide parking by type (cars, buses, RVs)	Security	(included in GMP estimates)	Land exchange, Forest Service, availability of land	Partner with Forest Service
<i>Provide a unique sense of place</i>					
Short term	Educate residents about sustainable lifestyles	Resident "buy-in" to park's approach	20,000	Lack of funds	Pursue grants
Short/medium term	Produce design guidelines	Rational land use and environmentally responsible design	35,000	Lack of funds and obtaining consensus among constituents	Partner with community and owners of adjacent property
Medium term	Organize service layout in a manner that demonstrates a balance between human needs and resources	Guidance for all development	50,000	Lack of funds and land	Partner with Forest Service, U.S. Department of Energy, and Arizona Department of Environmental Quality (ADEQ)
Short/medium/long term	Convey a sense of human scale and pedestrian environment	Connection to place; energy savings	250,000	Landowners	Partner with landowners
Medium/long term	Demonstrate sustainable design in facilities and landscape	Sustainability	2,500,000	Existing inertia	Partner with all involved parties
<i>Provide a stimulating transition to the park</i>					
Short/medium/long term	Slow or stop automobile traffic	Increased human experience	250,000	ADOT regulations	Partner with ADOT
Medium term	Reorient traffic/pedestrian flow (traffic circle)	Reduction of number of cars in park	2,000,000	ADOT regulations	Partner with ADOT
	Expand information and educational programs focusing on the canyon	Better-informed visitors	10,000	Lack of commitment to GMP	Influence NPS partners
	Introduce inviting, low-energy, comfortable public transportation to park	Reduction of impacts on park	(included in GMP estimates)	Lack of commitment to GMP	Influence NPS partners
Long term	Present inspirational message to be heard by visitors traveling into the park	Inspired visitors; respect for park	10,000	Lack of commitment to GMP	Influence NPS partners

Several recommended actions related to the South Rim also are included in the *General Management Plan* or could be implemented at no additional cost. Benefits from these actions would be a focus on natural resource protection, heightened visitor experience and appreciation of resources, and decreased intrusion.

- Explain the natural environment, progressing toward the South Rim.
- Maximize sensory experiences while moving toward the rim.
- Have interpretation end before the actual South Rim experience.
- Disperse visitors along the South Rim.
- Provide natural walks with defined edges. An added benefit would be the avoidance of “social” paths.

The main barrier to these actions is the same as that discussed for the previous group of actions: lack of commitment to the *General Management Plan*; similarly, an effective strategy for these actions would be adoption of the plan.

The following actions would involve additional costs.

- Offer seasonal nighttime programs to increase visitors’ appreciation of their environment and offer diversified opportunities. The cost would be \$8,000. A barrier to implementation would be scheduling and staffing.
- Provide orientation to visitation options in a location apart from the South Rim. Benefits would be a maximized canyon experience and reduction of use conflicts. The barrier to implementation of this action is lack of funding. A strategy would be to partner with groups providing visitor information in regional hubs and host communities.
- Improve the railing and step design at Mather Point, and their visual impact. This action would reduce manmade intrusions. The cost would be \$150,000. Lack of funds is a barrier. A strategy would be to incorporate this action into the plan.

The following two actions would improve the park’s service for international visitors and arouse interest in the resource.

- Provide international interns to assist in interpretation and transfer of values to international tour groups. Tour group operators should underwrite the costs for this service. A barrier would be an increased demand for employee housing. A strategy for implementation would be to work with international tour groups.

- Provide multilingual interactive media opportunities. The cost of this action is included in the estimates of the *General Management Plan*. A strategy would be to adopt the plan.

GRAND CANYON VILLAGE: "MAN TO CULTURE"

The goal of the "man to culture" experience is to provide numerous opportunities for education about Grand Canyon culture. Grand Canyon Village and its cultural centers present ideal situations for visitor cultural experiences.

At present there is no clear physical identity for the Grand Canyon Village and its five visitor experience zones: the village rim zone, the historic depot area, the Bright Angel zone, the powerhouse zone, and the Maswik transportation center. Along with this lack of physical identity is a lack of appropriate interpretive themes. The visitor experience workgroup developed three principles for integrating a sense of place, historic values, and sustainability into facility design and the interpretive experience. The three principles are as follows:

- Clarify the best of the physical qualities. Link the cultural landscape to an exploration of how cultural attitudes shaped specific places.
- Consider the entire cultural landscape an exhibit in which human intervention should be part of the learning process and the interpretive message.
- As the cultural story to be told is continually evolving, it should begin with prehistory and extend into a vision of the "sustainable" future. Sustainable building retrofits, adaptive reuse, and landscape restoration should be integral parts of the visitor experience from planning through project implementation, maintenance, and monitoring.

Design guidelines relating to circulation and lighting for Grand Canyon Village are discussed below.

Circulation

Support the recommendations (from the *General Management Plan*) to designate the entire village area for pedestrian use only, and link all possible areas with pedestrian circulation.

"Down-tech" all minor paths by making their surfaces of stabilized earth and lining them with native vegetation.

Lighting

Lighting should reflect the park image. Develop a park master plan that outlines park lighting standards. Create lighting guidelines that establish quality low-glare lighting throughout the park. The standards should address light pollution and trespass, lighting levels, brightness ratios, and equipment standards. The following standards should be enforced over the entire village area.

- Relate lighting to decision-making areas and possible conflict zones. Examples of this would be to light walkway intersections with roads, roadway intersections, entries to building drives and/or parking lots, and pedestrian hazards such as steep ramps and stairs.
- Lower the lighting level throughout Grand Canyon Village.
- Balance brightnesses between adjacent areas. Transitions between lighted and unlighted areas should be gradual.
- Give buildings a welcoming glow through interior lighting. Light building entries in a soft manner that welcomes visitors.
- Reduce the daytime and nighttime clutter of the lighting by locating equipment where it is appropriate. An example of this would be to place pedestrian light poles or bollards at the beginning of a path or at a resting/destination point.
- Integrate lighting into the architecture and other constructed features like pedestrian furniture (for example, place lighting under benches on paths to signal seating).
- Eliminate unwanted glare from the existing lighting.
- Light select building surfaces softly to establish a nighttime scene in the park.
- Eliminate light pollution with correct equipment selection, aiming, and location.

The following are some equipment standards that should be followed.

- Reestablish historic lights on buildings and pedestrian pathways.
- Replace bright sources with more appropriate low-glare luminaires.
- Incorporate indigenous materials in the lighting equipment. An example would be to use stone light bollards along the pathways.

- Use white light sources such as metal halide and compact fluorescent lamps.
- Use low wattage and low brightness light sources.
- Use the 300-foot power source rule as developed by the resource efficiency group.
- Use motion-sensitive lights so that each area is lighted only when occupied.

VILLAGE RIM

The workgroup recommends that interpretation in areas along the village rim be focused on two different themes, as follows:

- our sustainable relationship with the landscape
- Native Americans' harmony with nature

In addition, the area's character needs to be redefined. Visitors' experience should be one of a relaxed social promenade along the canyon edge.

Recommendations for achieving these interpretation focuses and physical character redefinition are as follows:

Short-term Actions

Replace turf and ornamental trees with native vegetation and find alternate uses for recycled water. Barriers to this action are the availability of staff and plant materials.

Medium-term Action

Support the recommendations of the *General Management Plan* by removing gift shops and rehabilitating the interiors of structures for historic uses or appropriate adaptive uses.

Long-term Actions

Create a park from open land resulting from the removal of the Kachina and Thunderbird Lodges. Relate the newly created park to the promenade and frame the park with low, open vegetation in the foreground and high, dense vegetation in the background. Barriers to this action are the pending

approval of the *General Management Plan* and negotiations with Grand Canyon National Park Lodges to eliminate the lodging.

HISTORIC DEPOT AREA

The new interpretive themes for the historic depot area are as follows:

- Conquering the West: “the machine in the garden.”³
- The evolution of the present visitor-to-park relationship (pampering the visitor in the wilderness, Native Americans as exhibits).

The redefined area character is that of a turn-of-the-century grand lodge/railroad packaged vacation.

Short-term actions recommended to achieve these themes and this site character are as follows:

- Remove turf from around all buildings and replace it with native vegetation. Barriers to this action could be the availability of staff and plant materials.
- Create small exhibits in El Tovar Hotel and the depot dealing with turn-of-the-century attitudes toward the environment and private versus public land use. Funding is the only barrier.

BRIGHT ANGEL AREA

The new interpretive focus of the Bright Angel area is the ways that the automobile influenced vacation styles and affected the landscape of the 1930s.

The redefined area character reflects early car-oriented individual cabin vacations.

Recommendations for achieving this interpretive focus and this site character are detailed below.

3. A reference to Leo Marx, *The Machine in the Garden: Technology and the Potential in America* (1919; reprint, New York: Oxford University Press, 1964).

Short-term Actions

Focus visitor attention on buildings that fit sensitively into the landscape with exhibits on Mary Jane Colter. A barrier to this action would be funding for the exhibits.

Interpret the history of the Fred Harvey Company and other concessioners in the park, including their associated cultural, landscape, and economic impacts. A strategy for implementation would be to partner with concessioners.

Medium- and Long-term Actions

Demonstrate the impact of the automobile on Grand Canyon National Park from its introduction to the present.

Show a sustainable future with the removal of parking lots and roads and the introduction of alternate transit systems.

A barrier to these actions would be the cost and effort involved in removing parking and reconfiguring roads; however, a strategy would be to include this work in partnerships created for the development of alternate transit modes.

POWERHOUSE AREA

The new interpretive focus for the powerhouse area is an expression of sustainable living and learning. Grand Canyon National Park is the park of the future, with demonstrations of landscape and building rehabilitation, including sustainable use of energy and water.

The area's present character would be retained in some areas; in others it would be redefined.

Retain the functional character of the utility buildings.

Create public spaces and buildings that have the character of a marketplace — lively, fun, active day and night.

Recommendations for achieving this interpretive focus and redefining area character are as follows:

Short-term Actions

Establish a variety of active uses for buildings and outdoor areas (educational meeting rooms should not be included in the powerhouse area).

Work with Native Americans to create a Native American center. The barrier is achieving consensus with so many diverse groups. A strategy would be to continue the current dialogue after completion of the *General Management Plan*.

Restore eroded areas on slopes and use them to demonstrate the restoration of degraded areas. Because time and staff are limited, a strategy would be to solicit help from volunteers or special donors.

Medium-term Action

Establish the first “ecolodge” at Victor Hall (see resource group proposals) with greenhouses, following the historic tradition at El Tovar. An impediment would be relocating dormitories. See the recommendations on this subject from the resource efficiency group (“Topic 1” chapter) for strategy.

Medium- to Long-Term Actions

Adaptively reuse historic buildings. Use sustainable technology while preserving the historic character. Focus on individual technologies and find commercial partners as a strategy for implementation. Interpret these technologies while the project is in process. Acceptance of the *General Management Plan* and funding are the barriers.

Preserve the outdoor industrial character by stabilizing bare soil surfaces in areas of human activity. This should be done after the building retrofits are completed, with part of the overall renovation funding being used for this action.

Restore natural drainage patterns and use them as a display of riparian corridor habitat. This also should be done after building renovation is completed, with part of the overall renovation funding being used for this action.

Allow small entrepreneurs to sell foods indigenous to the region (lemonade, Navajo tacos, health food, ice cream, etc.). A strategy would be to develop an entrepreneurial consortium under one umbrella contract.

Provide outdoor alcoves within the marketplace for children’s education activities such as water erosion experiments. Indoors, provide a space for

free-form exploratory activities for all ages. A barrier is that concessioner support functions would have to be relocated. A strategy would be to use part of the overall area funding, as well as raising funds specifically for children's educational activities.

Establish a "consumption exhibit" in the powerhouse in connection with the historic generators used to power the park. Concessioner functions also would have to be relocated for this exhibit. A strategy would be to focus on funding from big manufacturers and corporations such as DuPont and federal entities such as the Department of Energy.

MASWIK TRANSPORTATION CENTER AND MASWIK LODGE AREA

The new interpretive focus for the Maswik transportation center and the Maswik Lodge area is the integration of modern development into the surrounding natural and cultural environment.

To redefine the area's character, a "green" town feeling must be achieved by retrofitting the existing suburban area; that is, interweave buildings into a restored natural landscape.

Short-term Actions

Reorganize the entry and exit experience as follows:

- Reduce the proposed number of trains from Tusayan.
- Tusayan trains and day use buses should pick up passengers at Maswik transportation center.
- Have all trains drop off passengers at the historic depot.
- Have daytime buses drop off passengers at Mather.

A barrier to these actions would be determining the direction of the light rail proposed in the *General Management Plan*. A strategy would be to work with the Grand Canyon Railroad.

Retrofit all parking lots to minimize paved surfaces and incorporate extensive areas of native vegetation. Use paved surfaces to collect water through drainage channels and systems as recommended in the water section of the "Topic 1: Resource Efficiency" chapter. A barrier to this action would be funding and staff availability. This should be made a priority project, and partnership funding should be sought with organizations such as the Grand Canyon Trust or the Sierra Club.

Eliminate as much paved surface as possible around the Maswik transportation center to return the area to its native landscape setting. Seek partnership funding as above.

Reestablish natural drainage channels and the native landscape in and throughout the entire area by seeking partnership funding as above.

Make the Maswik transportation center an exhibit area for the integration of modern development in the surrounding environment. Barriers would be funding and staff availability.

Provide displays for visitors upon their departures to teach them how they can take home the lessons learned at the park. Barriers would be funding and staff availability.

Medium-term Action

Provide a path or trail through natural woodlands to the powerhouse with demonstrations of a degraded landscape restored to its original condition. A barrier to this action is that at present there is no visitor staging area in the powerhouse area.





TOPIC 3: INFORMATION MANAGEMENT

GUIDING PRINCIPLES AND INFORMATION MANAGEMENT ISSUES

One of the guiding principles of the National Park Service is that resource protection and enjoyment of the resources must be balanced. Information is an essential tool in crafting this delicate balance at Grand Canyon National Park and in continuing that balance into the surrounding region. The recommendations of the workshop for methods of information management will be helpful in organizing sustainability efforts and ideas and disseminating the resulting information.

At present there is no information management system at Grand Canyon National Park. Without such a system there is no way to communicate the benefits of sustainable development or tell visitors how to experience the park in the most responsible manner possible.

The following five information management issues must be addressed at Grand Canyon National Park to promote sustainability.

- A great deal of information about the Grand Canyon exists; however, this information is fragmented, inefficiently distributed, confusing, and buried by a proliferation of unrelated information.
- Little information related to sustainable development is available at Grand Canyon National Park. That which is available is insufficient, unorganized, and difficult to comprehend.
- Not only is current information related to sustainable development unavailable, but sustainability issues specific to Grand Canyon National Park have yet to be discovered, studied, or disseminated.
- No one “point person” is responsible for managing the flow of information at Grand Canyon National Park.
- The expectations of prospective visitors to Grand Canyon National Park need to include concepts of sustainability. Visitors must understand that they are planning a visit to a fragile area with minimal resources and that their visit must not impair the integrity of resources for the region or for future generations.

Three major groups use information related to Grand Canyon National Park: the National Park Service, visitors, and the Grand Canyon National Park community. The community is made up of Native American tribes, concessioners, travel service organizations, the entire ecoregion, hub cities, regional host communities, park

host (gateway) communities, and academic institutions. Each of the major groups requires recommendations specific to its individual situation, and there are overall information needs regarding general information, resources, trips and activities, and education. Probable needs for information on sustainable development are listed in table 2.

The following principles should guide the development of this information:

- Keep it simple so that it will be easily used.
- Visitors must be made aware that their actions have a direct impact on the environment of the park and the region.
- Understanding the origins and life cycles of resources is critical to understanding sustainability.

ACTIONS

The actions needed to improve the flow of information to and from each major information user group range from immediate to long term. The necessary actions are listed below by major user group. Because of its leadership role, the National Park Service must be responsible for the implementation of most of the short-term recommendations, which center on organizational changes, the documentation of baseline conditions and sustainable design opportunities, and the creation and promotion of an information management strategy. These short-term steps are vital for establishing consensus on expectations and documenting conditions against which progress will be measured.

National Park Service

Immediate Action. Establish an integrated information management “champion” for sustainable design and development: an advocate who is empowered to develop and present information to managers at Grand Canyon National Park, enabling them to make wise decisions regarding resource management (see detailed description in appendix C).

Short-term Actions. The National Park Service should take the following information management actions in the short term.

TABLE 2: PROBABLE INFORMATION NEEDS

User Group/Subgroup	Purpose/Type of Information
National Park Service	
Park facility managers and operators	<i>For planning, implementing, and monitoring</i> — Internal and external information on existing resources — Feedback on performance (quality loop) — Information on alternatives (infrastructure, superstructure, contracts) - Benchmarks - by system (for example, heating) - by park or other defined "facility"
Rangers	<i>For visitor interface and implementation</i> — Current information on operations for sustainable development - Education and interpretation - Orientation
Denver Service Center, System Support Offices, Park Clusters	<i>For advising, supporting, and promoting</i> — Reliable information on success (economics, visitor experience, resource management and preservation) — Baseline and benchmarks <i>For resource managers</i> — Monitoring condition/health of resources, impacts of visitation or external threats — Monitoring restoration programs and establishing carrying capacity
Visitors	
Long-term and short-term planners	<i>For ensuring a satisfactory and sustainable experience</i> — Education and interpretation — Visit optimization and scheduling — Cultural adaptation — Trip planning and level of commitment needed
Potential and "virtual" visitors	<i>For people who need information to decide whether to visit Grand Canyon, and for people who cannot have a personal Grand Canyon experience</i> — Education — Trip planning information — Multimedia simulation
Grand Canyon National Park Community	
Concessioners	<i>For choosing to employ sustainable design alternatives</i> — Economic benefits of sustainable development options (mandates, incentives, procedures)
Native Americans	<i>For deciding how to participate in sustainable design alternatives</i> — Updated information on sustainable design — Visitors' interest in Native American culture (services and products)
Regional groups (gateway communities; travel organizations)	<i>For helping visitors decide on appropriate visit options; for other basic education</i> — Trip planning (logistics of when, where, cost) — How to be connected to larger information base — Financial benefits of sustainability — Demographic information — Updated sustainable information on technologies, systems, and materials, which is then conveyed to communities — Case studies (e.g., Tucson's solar, water, and tree planting programs)
Forest Service	<i>For deciding between various planning, implementing, and funding options</i> — Benchmark for forestry practices and sustainable forestry practices — Planning employee housing communities in public/private land exchange currently in progress
Grand Canyon Trust	<i>For deciding how to participate in sustainable design and benefit Grand Canyon National Park</i> — Useful information that connects the organization to Grand Canyon National Park
Academia	<i>For understanding how to research and teach sustainable design issues as related to Grand Canyon National Park</i> — Opportunities for research, training, oral history, and incubation centers for businesses — Dialogue fostering partnerships

General — Recommended general actions are as follows:

- Establish an ad hoc information team. Invite potential concerned parties to participate.
- Begin an inventory and a library of Grand Canyon National Park information sources.
- Complete a study on information for the requirements for sustainability development and use it as a guide for medium-term and long-term initiatives.

Resource Information — Obtain baseline and procurement information on current use of historic, natural, and cultural resources and establish provisions for ongoing monitoring and feedback in the future. The following are examples of subjects on which usage information should be gathered.

- the use of local building material
- wastewater and “gray water” systems
- energy use and historic energy systems
- gardening and agricultural patterns
- sensitivity to local culture and cultural patterns

Research and gather information on alternative methods of energy generation, land and water use, and culture appreciation to serve as benchmarks against which current methods can be measured.

Trip and Activity Information — Set quality criteria for lodging information and determine park activity information requirements.

Education and Information — Develop information on park interpretation.

Grand Canyon Community and Partners

Short-term resource information actions for various groups and areas in the Grand Canyon community are listed below by group or area.

Concessioners — Establish economic benefits of sustainable development options and actions.

- Identify incentives and procedures.

Resource Providers — Obtain baseline and procurement information on historic and current regional resource use, and provide for continual monitoring and feedback for the future.

- For benchmarking purposes, research and gather information on alternatives to the current use of resources.

Native Americans — Share updated information on sustainable development, and encourage the Native American community to participate in this development.

- Encourage and manage visitors' interest in Native American culture.

Regional Interests — Organize and empower gateway communities.

- Involve travel organizations in information dissemination.
- Serve as an interface for lodging and activity information.

Forest Service — Gather information on sustainable forestry practices.

- Gather information on planning sustainable communities.

Colorado Plateau — Establish one source for visitor information.

- Gather and condense information on other parks.

Actions for Visitor Experience

The following short-term actions are recommended to improve the visitor experience. These could be carried out either by the National Park Service or by partners or community organizations.

Resource Information — Develop simple feedback systems for startup projects to demonstrate sustainable resource use to visitors. Make visitors "stewards of the park." Focus on nonconsumption or low consumption. The following are examples of subjects for the systems.

- Monitoring of energy use for transportation, lodging, and support structures.
- Monitoring of traditional water use and water collection by cistern.
- Monitoring of waste collection and recycling.
- Monitoring of food production, transportation, and consumption.

Trip and Activity Information — The following actions could be taken to give information to actual and potential visitors.

- Establish an “800” or “900” phone number for lodging information in park and gateway regions. Add activity information as available.
- Improve information kiosks and place them in park gateway locations.
- Communicate planning information to arriving visitors through strategically located regional gateways.
- Extend radio information outside of the park.
- Prepare a CD-ROM that prospective visitors can buy for assistance in planning a visit to Grand Canyon National Park.

Educational Information — The following actions are recommended to educate visitors about park resources.

- Use a CD-ROM or other interpretive media to communicate information on fragile resources that cannot withstand heavy visitor use. Make this information available to prospective visitors before their arrival.
- Layer information by complexity, so that simple information is presented first, with more detailed information accessible upon request.
- Explain to visitors how to enjoy park resources without impairing them, and why this is necessary. (Experience at Carlsbad Caverns has shown that information such as this can reduce visitor impacts on resources by 80%.)
- Educate visitors about Native Americans’ concept of hospitality and home. Visitors to Grand Canyon National Park are entering Native Americans’ ancestral home and should behave accordingly.
- Provide information on alternative regional recreational areas to minimize impacts on Grand Canyon National Park and to help visitors tailor their trip to suit their desires.

SUGGESTIONS FOR MANAGING SUSTAINABLE DESIGN AND DEVELOPMENT

After information on the sustainable use of cultural and natural resources has been collected and analyzed, communication of this information is essential. This information will be invaluable in helping visitors understand the concept of responsible resource use and in building support with the regional community and potential partners. Topics that need to be researched, analyzed, and interpreted are listed below. This covers the gamut of topics discussed during the workshop.

Use of Resources (No Negative Use)

- land use (landfills, erosion issues, roadways)
- material use (preservation efforts, recycling, reduction of solid waste stream)

Use of Energy (Least is Best)

- appliances, lighting, and plug loads
- heating, ventilation, and air conditioning (HVAC — heating/cooling)
- material production
- maintenance
- operations
- transportation

Environmental Impacts (No Negative Impacts)

- air quality
- noise quality
- water quality
- visual quality

Economic Inputs and Outputs (Manage to Carrying Capacity)

- quality and satisfaction indexes (complaints and incidents)
- number of visitors
- types and lengths of visits

Visitor Experience (Manage to Carrying Capacity)

- quality and satisfaction indexes (complaints and incidents)
- number of visitors
- types and lengths of visits



EXAMPLES OF INFORMATION MANAGEMENT

"CANYON COMPANION — VIRTUAL RANGER" PROPOSAL

The "Canyon Companion" is a concept for a personal, easily portable multimedia electronic display and communication device. It would be self-recharging (solar), weatherproof, wireless, and interactive. The device would provide information in the language and of the kind and depth required by each user. It would have enough artificial intelligence to adapt its responses to that user's ability and interest. Its purpose would be to displace fixed interpretive and logistical facilities with virtual ones. This device would not be suitable for all visitors (some older and less educated visitors in particular might not choose to use the Companion, and should not have to), but it would suit enough visitors to decongest and displace some costly fixed facilities.

The Companion's ability to tailor information and opportunities to each user's needs and tastes could prevent congestion at visitor centers and other gateways where visitors normally have a homogeneous entry and briefing. Instead, users could disperse under customized guidance to places and activities matched to their diversity. Of course, personal contact and conventional forms of assistance would remain available to those who might prefer them, but from first gateway (for example, Flagstaff) to last exit, visitors wanting a Canyon Companion could borrow one, like a car renter borrowing a cellular phone.

A rental fee or credit-card deposit could be charged, but the device probably would save the park more than enough money in facility staffing to cover the cost of loaning it free, as part of the normal entry fee. It would have appropriate theft-resistant features (for example, it could be made useless outside of the park, or it might send a wireless alert if taken out of bounds). The Canyon Companion would be highly rugged, reliable, and self-diagnostic. It would output color graphics and text, and it would have soft-"key" touchscreen options and a digital headphone audio, with wireless communications, possibly including an inexpensive information retrieval (IR) port. It would have capabilities in several languages and would offer options such as enlarged type for sight-impaired or hearing-impaired visitors. All its functions would be in software or mass storage (such as miniature CD-ROM and flash ROM) so that its programming and data could be updated readily at little or no cost. The Canyon Companion would have three main functions: logistics, interpretation, and market research and feedback.

Logistics: The Companion could ask questions, register responses, and interactively handle all ordinary logistical needs. It would provide real-time waiting times in response to congestion queries about destinations and activities in the park; report on current weather and forecasts; and suggest destinations, routes, details, and navigational aids to fit each visitor's wishes. Being conscious of where and when it was being used, it could, for example, remind the user on the West Rim that the last Cyber-Tran shuttle leaves in twenty minutes, or help plan the day's activities subject to constraints and preferences provided by the user.

The Canyon Companion also would permit preordering of food, drink, and souvenirs for quick pickup at designated points, analogous to the pickup of duty-free items by departing international air travelers. It could summon emergency medical or law-enforcement help, locate/transpond, or alert rangers to nonemergency demands, and broadcast or singlecast emergency paging messages for visitors.

Interpretation: The Companion would provide both introductory material (text, graphics, and audio) and material specific to its time and place, sensed via micropower local beacons in the park (since full global positioning system [GPS] functionality probably is not required); that is, if a visitor was at Mather Point, the Canyon Companion would provide a diagram and an oral description of the view so that the visitor would know what he was seeing. Options would be available for calling up more levels of information on geology, natural history, air quality, or whatever else might interest the user. Both general and site-specific information would be hypertexted to provide cross-references and various depths of information. Virtually any inquiry could be accommodated by the multilevel hypertext structure. If inquiries were too detailed to handle, the user would be referred to external resources such as books and videos, with information on where to get them ("Check here if you want to buy this product; it will be waiting at station x on your departure.").

Market Research and Feedback: When getting acquainted with each new user's language preferences and interests, the Canyon Companion would gather (and could anonymously store and report back on) information vital to continuous improvement of interpretive and logistical services such as demographics, origin, travel mode, places visited, routes and means, lodging and meals. It also could solicit and record feedback from visitors.

The Companion would be 5–6" x 7–9", weigh less than one kg. (probably ~600 g.), and would consume less than one watt. It would have a $\pm$ 20h battery life with no solar input, but normally it would pick up enough power from its photovoltaic skin to maintain a good state of charge.

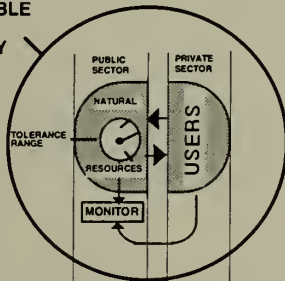
Today the Canyon Companion would cost on the order of \$1,800 if made in modest quantities, but in million+ unit markets, it could realistically be expected to cost no more than \$500 in 2000 and perhaps \$200 in 2010 (1994 dollars), including all display, mass-storage, and wireless features. Possibly such vendors as Apple, Hewlett-Packard, and Sony would be interested in responding to a request for proposal (RFP — the government's advertisement to solicit printed proposals to satisfy the stated need), given the market for Companions for urban as well as national park uses. Meanwhile, some very simple innovations could enormously improve the park's information systems; for example, a single central reservation number, an audiocassette to play on the drive into the park, and less than 5W radio repeaters on the access roads.

INFORMATION ELECTRONIC RANGER

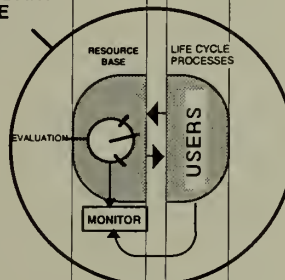
DESCRIPTION

INFORMATION MANAGEMENT MODEL

SUSTAINABLE SYSTEM BOUNDARY

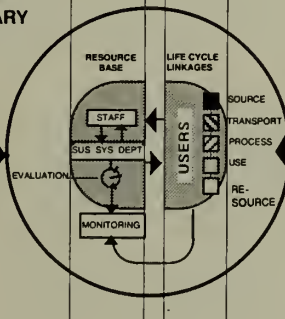


BOUNDARY SCALE



SUSTAINABLE SYSTEM BOUNDARY

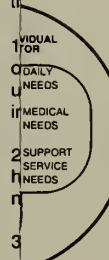
PARK SYSTEM



USER LINKAGE POINTS

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Scale: Individual Person
User: Person
Flow: Information Metabolism
Implementation: Medium Term
Info delivery Mechanism: PCMCIA
Linkage Point: Park Gate/Lodging Services



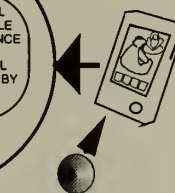
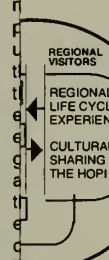
BOUNDARY

Scale: Park
User: Park Visitor/Concessions
Flow: Information/Solid Waste
Implementation: Medium Term
Info delivery Mechanism: PCMCIA
Linkage Point: Concessions



BOUNDARY -

Scale: Cultural Region
User: Regional Visitor/Public
Flow: Information/Information
Implementation: Medium Term
Info delivery Mechanism: CD-ROM
Linkage Point: Community/Gateway Towns



INFORMATION ORGANIZING MODEL FOR SUSTAINABLE SYSTEMS

GRAND CANYON NATIONAL PARK

INFORMATION SERVICES

DESCRIPTION

Any sustainable system depends on a balance of resource use compared to the amount of resources existing. Key to this balance is an information system that keeps the user in touch with key aspects of this balance system. An organizational approach that enables the right type and the right quantity of information to be transferred is essential. The main ingredients for the establishment of such a system are

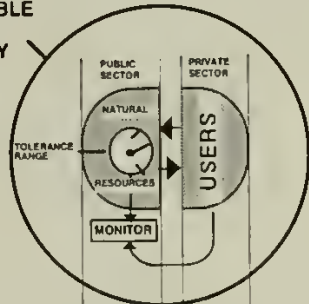
1. The identification of the physical boundaries of natural resources and the number of people using them, so that one can identify the kind of information that must be managed.
2. A monitoring technique that keeps a record of how people use resources and where management actions are required.
3. An agreed upon range of tolerance within which resource use must function so that the system can continue to operate effectively.

A sustainable park system also depends on several hierarchical scales that must in themselves be sustainable, since one builds upon the other. The identity of these scales and the different boundaries they represent are proposed as the following: the life zone of plants, the visitor himself or herself as possessing metabolic needs, each building or complex and their surroundings, the village and surroundings, the national park heritage zone, the National Park Service and the Forest Service, the cultural region, the Colorado Plateau, the four-state area, the southwestern United States, the world heritage zone.

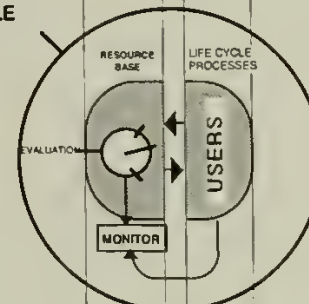
In order for users to properly connect into what the particulars are in the Grand Canyon National Park and surrounding areas, their experience must be linked into the resource cycles of the park. Our method for accomplishing this is to understand these cycles through what is called the life cycle. The life cycle consists of 5 steps that represent any flow, whether it be material or energy based. The examples for the use of the electronic park ranger that acts as a personal guide in our information system is organized around this life cycle and the steps within it so that one or more of these steps occurs during everyday activities. Visitors to this special place called the Grand Canyon are considered users. The community of people presently residing there and businesses are also considered users. The stewards of the national park are the park staff, while the "sustainable systems department" of the National Park Service at Grand Canyon National Park is made up of the people who develop the criteria for what is sustainable and what is not.

INFORMATION MANAGEMENT MODEL

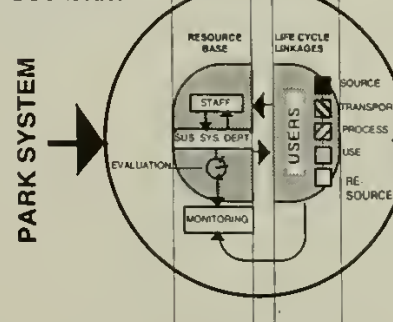
SUSTAINABLE SYSTEM BOUNDARY



BOUNDARY SCALE



SUSTAINABLE SYSTEM BOUNDARY

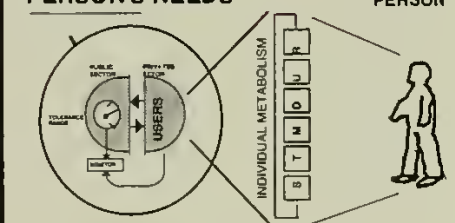


USER LINKAGE POINTS

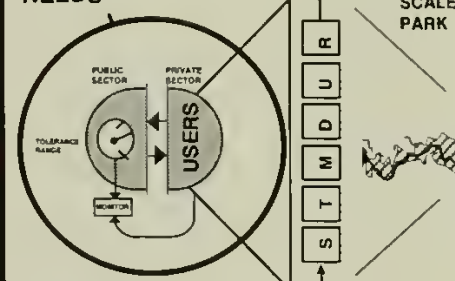
SCALES OF EXPERIENCE

DESCRIPTION

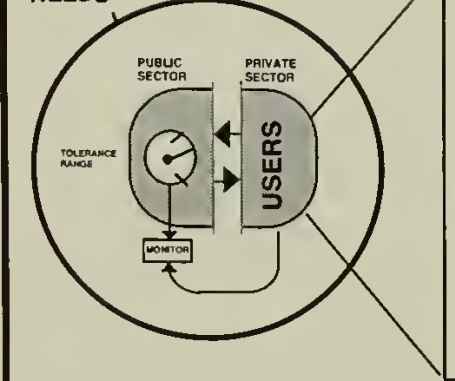
BOUNDARY OF IMPACT RELATIVE TO A PERSON'S NEEDS



BOUNDARY OF IMPACT RELATIVE TO THE PARK'S NEEDS



BOUNDARY OF IMPACT RELATIVE TO THE REGION'S NEEDS



The most obvious small scale is that of a person. They require certain things such as food, water, sanitation facilities, and living requirements such as shelter with a certain temperature range. If we were to carefully take into account the individual's metabolic needs—but also consider those needs in the context of the park—requirements might be not to use as much water for showering or toilets or to use less—if any—imported energy for temperature requirements. At the same time, one must be able to give the individual choice, as long as the outcome of such choice stays within the boundary of what all people need while within the park's capacity to set requirements.

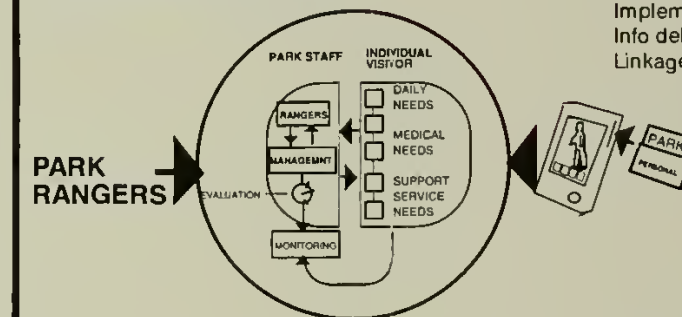
The scale of impact that the park has according to its needs and that of the individual person should be accounted for equally. In total, the park visitation requirements should stay within the bounds of what the park can supply and not infringe on other areas. If one brings in too much to support too many people, the delicate balance within the park itself is at jeopardy. Information should relate the ability of everyone to respect the cycles of resources within the park. The park system has an internal metabolism of its own, and how this metabolism or combinations of internal life cycles work relative to adjacent areas is of utmost importance.

The cultural region also contains a careful balance in its metabolism relative to the scale above and below it. The traditional cultures of the region, for example, have exemplified that balance as much as possible, so deep respect for this must also be built into our information system.

EXAMPLES - ELECTRONIC RANGER

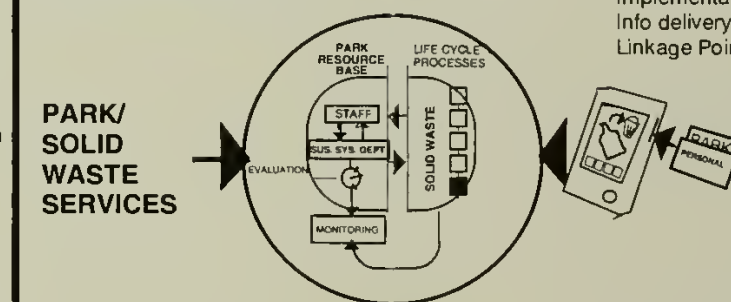
DESCRIPTION

SUSTAINABLE SYSTEM BOUNDARY - PERSON



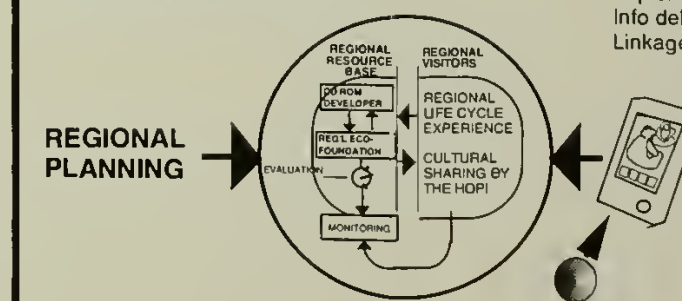
Scale: Individual Person
User: Person
Flow: Information Metabolism
Implementation: Medium Term
Info delivery Mechanism: PCMCIA
Linkage Point: Park Gate/Lodging Services

SUSTAINABLE SYSTEM BOUNDARY PARK GROUNDS



Scale: Park
User: Park Visitor/Concessions
Flow: Information/Solid Waste
Implementation: Medium Term
Info delivery Mechanism: PCMCIA
Linkage Point: Concessions

SUSTAINABLE SYSTEM BOUNDARY - REGION & ITS CULTURE



Scale: Cultural Region
User: Regional Visitor/Public
Flow: Information/Information
Implementation: Medium Term
Info delivery Mechanism: CD-ROM
Linkage Point: Community/Gateway Towns





TOPIC 4: IMPLEMENTATION AND PARTNERING PLAN

ACTIONS AND GOALS

The fourth workgroup focused on how to implement the recommendations for action proposed by the previous three workgroups and the actions included in the *General Management Plan*. The National Park Service will have to engage in extensive and innovative partnering to achieve environmentally and economically sustainable parks. This workgroup developed short-term, medium-term, and long-term implementation plans where the National Park Service could form partnerships for each of the areas discussed below.

Information and Reservations

Short-term Action. Form a Grand Canyon gateway marketing group with a toll-free “800” telephone number — possibly 1-800-GCANYON.

The National Park Service and the Grand Canyon Association would initiate a Grand Canyon gateway community marketing association to coordinate all park and gateway community hospitality business, recreational activities, and educational services. The association would be funded by membership fees from all service providers. It would partner with a professional reservation provider to establish a regionally based information and reservation center. The center would receive a percentage from each ticket or room reservation. Providers of the reservation system would finance installation of toll-free messaging, switchboards, operator assistance stations, computer systems, and other equipment for the regionally based information and reservation center. They would receive a percentage of the park’s admission and activity fees and a percentage of regional services. Through the reservation system, each business owner would have access to all visitors arriving at Grand Canyon.

Medium-term Action. Expand the reservation system to the Colorado Plateau.

Long-term Action. Continue to develop a state-of-the-art reservation system at Grand Canyon National Park that would serve as a model for all national parks, and link all national parks to the system.

Accommodations

The goal for accommodations is to create a positive interpretive experience of living in a sustainably built and furnished environment that can be applied to the Colorado Plateau region as a whole.

Short-term Action. Define sustainability as it relates to hotel room accommodations, set a standard, and implement a review and rating program.

The National Park Service would begin to convert its accommodations to this standard of sustainability and develop economic benefits for converting to sustainable facilities, furniture, fixtures, and equipment. The park's purchasing leverage would be used to begin establishing regionally based businesses for these products and services. A strategy would be to obtain the concessioner's concurrence and support to partner in this effort.

Medium- to Long-term Action. Complete the conversion of all park accommodations to the standard of sustainability. Expand the program to the gateway communities by documenting the economic and quality of life advantages for existing and new accommodations.

The *General Management Plan* contains a proposal to convert the old dormitories in the village area into "bed-and-breakfast" operations. The workgroup proposes to use these new lodges for in-depth experiences for visitors, starting with the Mary Jane Colter dormitory, Victor Hall. The park would undertake a thorough "green" renovation of the building, including using photovoltaic energy to take the building off the electric grid. Guests would have a minimum stay of four to six days, and they would be involved in the operation of the lodge (monitoring their own energy and water consumption, for example). The guests/participants would have selection of daily activities such as lectures, classes on local ecology and native cultures, hikes, tours of park operations, removal of exotic plants, and building maintenance and restoration (some of these programs already exist).

The building grounds and operations would become a laboratory for "green" design and sustainable development for the rest of the park. Food service would come from a network of regional organic producers. Grounds would be landscaped with native vegetation and vegetable gardens with plants from local tribes. Partnerships could be formed with the Sonora Desert Museum of Tucson, which has a botanical garden, and the Native Seed Search Program of Santa Fe, which does research in traditional food crops, especially those of the Hopi. The alternative energy systems could be partnered with Sandia National Laboratories/National Research Energy Laboratories.

This would be the first conversion; other dormitories would be converted this way as well. The eco-adventure laboratories would be laboratories for all lodge operations.

Working with the Grand Canyon Association and Arizona Public Service, the National Park Service would try to obtain funds and in-kind resources to implement this project. This unique experience would be paid for through a tuition fee structure, and all guests in this program would be easily identified by clothing type. Participants in the program would be encouraged to become teachers, relating their experience to other guests during their stay.

Regionally Produced Goods and Services

The goal is to establish a viable economy for regionally produced sustainable goods and services.

Short-term Action. Concessioners and the National Park Service should evaluate all products sold to determine what can be produced or purchased cost-effectively within the region.

The National Park Service and concessioners should implement a phasing strategy for converting to this purchasing preference, and effective monitoring procedures and selection guidelines should be established. Assistance in this task is available from the Central States Education Center in Champaign, Illinois.

Medium-term Action. Develop a database of all goods and services and determine what can be produced profitably in the region.

Develop partnerships with the Center for Maximum Potential Building Systems, Inc., of Austin, Texas, and the Grand Canyon Trust. Also partner with regional schools of forestry, mining, landscape architecture, and regional planning to fund and implement the regional inventory system of the Center for Maximum Potential Building Systems, Inc. Include natural resources, human resource assessment, and associated technologies for implementation of these partnerships. Implement a phasing strategy for regionally based sustainable goods and services.

Agriculture

The goal for agriculture is to establish a viable economy for regionally produced foods.

Short-term Action. Establish a network of organic food producers and agree that all park grocery and restaurant providers are to buy only from these sources.

Partners in this network would include Native Americans, agricultural universities, the Sustainable Agriculture Alliance, and extension agents from the U.S. Department of Agriculture. Excess food would be provided to regional family crisis and homeless shelters. Other food scrap by-products would go to a park compost center. The park, with the concessioner, would initiate a study of all packaging of food products to determine strategies for reducing sources of waste.

Medium-term Action. Extend the one-year program into the gateway communities to expand economic opportunities for sustainable farming in cooperation with regional grocery and restaurant providers. Establish a regionally based cooperative for direct marketing with the Grand Canyon gateway community marketing association.

Long-term Action. Extend the program to the Colorado Plateau. Partner with national conservation foundations, the Land Institute, and the Grand Canyon Trust.

Education

The goal for education is to have Grand Canyon National Park become an international center for experiencing and teaching sustainable living.

Short-term Action. Establish documentation for reporting results and impacts.

Convert knowledge into educational programs with the support of the Grand Canyon Association. The programs should serve kindergarten through grade 12, adult continuing education, and industry training. Funding support could be obtained through foundations, government agencies, corporations, and professional and trade associations. Develop a mechanism for real-time feedback that will educate Grand Canyon National Park employees, suppliers, and visitors.

Medium- to Long-term Action. With the Grand Canyon Association, develop and establish a docent program for regional and indigenous communities to provide interpretive and other service to support the park staff. Develop a participation program of volunteer community/ecosystem services open to all visitors as part of their visit.

Cultural Education and Regional Arts

The goal for cultural education and regional arts is to respect indigenous cultures, communicate the importance of these cultures to the value of Grand Canyon National Park and the region, and support the regional arts community.

Short-term Action. Continue a dialogue with the Council for Native American Interpretation to develop indigenous cultural, education, and arts programs. Immediately eliminate all elements of NPS and concessioner operations that are not respectful and truly representative of regional cultures.

Medium-term Action. Become a place for regional artists to sell and exhibit their work under a specialized concessioner cooperative.

Develop a Grand Canyon Art Institute in the performing and visual arts, and integrate this institute with the newly planned Canyon Forest Village in Tusayan. The institute would be developed in partnership with the gateway marketing association, the Grand Canyon Association, the Grand Canyon Trust, the local artistic community, and Native American communities.

Housing

The goal for housing is to have all employee and visitor housing developed and financed by a regionally based professional housing provider.

Short-term Actions. Identify locations outside Grand Canyon National Park where employee housing could be placed on either Forest Service land or private land. Evaluate the cost and benefits of the present system under which Grand Canyon National Park is providing low-cost employee housing, and determine whether this benefit is transferable to an out-of-park location.

Identify and implement all energy and resource efficiency recommendations that have a one-year payback.

Medium- to Long-term Action. Develop a partnership with Integrated Building Construction Solutions (IBACOS) (a Department of Energy consortium that conducts research on residential construction) for the purpose of selecting a regional builder to construct and finance sustainable housing in or outside of the park for NPS and concessioner employees.

Transportation

The goal for transportation is to eliminate the intrusion of the automobile on the park experience and have visitors rely on a concessioner-operated transportation system within the park. The recommendation differs from the provisions in the *General Management Plan* in that the goal would be to allow into the park only cars of residents and visitors with lodge reservations.

Short-term Action. Introduce a per-person entry fee that would support public transportation, and charge an additional per-car fee. Initiate a

concessioner contract for any energy-efficient, low-impact public transit that is adequate to support the visitor and employee population.

Medium-term Action. Establish a regional transit and parking authority with the gateway communities to build and manage parking structures and adjacent transportation hubs. Facilities and systems would be financed through municipal or state bonds. The transportation system, which would be the most cost-effective and environmentally benign means of transporting the visitors from the hubs to Grand Canyon National Park, would integrate with internal public transit.

Long-term Action. Initiate a study of the hub cities from which visitors arrive and their means of transportation. The study should include analysis of the most cost-effective and environmentally benign means of transporting the visitors from the hubs to the gateway communities. The study should be funded by transportation and research laboratories.

Energy

The goal for energy would be to retrofit Grand Canyon National Park facilities and gateway communities with the most resource-efficient and sustainable energy technologies.

Short-term Actions. Undertake energy studies to determine what strategies have a payback of less than one year. Everything with a one-year payback would be financed by the National Park Service (or accessible federal money), as determined by energy studies performed by national laboratories. To create a revolving pool of research funds for future projects, savings generated in NPS and concessioner facilities would be partially shared with research laboratories conducting the energy studies.

If concessioners resist implementing retrofits with paybacks of less than one year, the National Park Service should establish a shared savings program with Arizona Public Service to fund the completion of the retrofits. The National Park Service should work with regional utilities to identify conservation and renewable opportunities through integrated resource planning.

Resource efficiency strategies should be implemented for concessioner laundry operations.

Medium-term Action. Set up a solar utility with municipalities or as a subsidiary of utilities to fund installation of domestic hot water and commercial hot water systems. The utility also could fund other conservation projects that exceed a one-year payback. These projects would normally create a lease obligation whose cost would be less than present utility bills. Expand this renewables funding program to the gateway communities.

Waste Management

The goal for waste management is to establish a practice that moves toward nature's model of no waste.

Grand Canyon National Park should be used as a catalyst to develop a regional waste management industry that implements source reduction and reuse and recycling strategies. The park's high-profile position should be used to interest national industry, governmental agencies, and research laboratories in developing the park as an international model for waste management.

Short-term Actions. In view of the imminent closing of the landfill in the park, identify a new or existing partner to deal cost-effectively with the solid waste problem.

Evaluate concessioner packaging, shipment of goods, and present waste stream to implement a source reduction and reuse program immediately. The concessioner should fund the study and reap the benefits of the savings. The National Park Service should evaluate its internal purchasing practices and waste stream for all operations and implement a source reduction and reuse plan. The National Park Service also should determine the effectiveness of the existing recycling program for landscape and household waste.

Medium-term Action. Implement a comprehensive source reduction, reuse, and recycling plan, including interpretive programs to communicate the benefits to employees, visitors, and the gateway community.

Long-term Action. Implement the medium-term action on a regional scale.

Building Materials and Construction Processes

The goal for building materials and construction processes is to catalyze a regionally based sustainable building practice.

Short-term Actions. Select two current building programs to become models of sustainable practices, and establish a monitoring program to document the results.

Enlist government national laboratories as cooperating partners.

Establish *Guiding Principles of Sustainable Design* (NPS 1993) as the operating building code for all new construction and renovation.

With the Forest Service, identify opportunities for locally produced building and landscape materials. Use the Grand Canyon Association as a vehicle to acquire products and services from sustainable sources.

Evaluate the feasibility of building an experimental rammed-earth house.

Obtain a commitment to the use of *Guiding Principles of Sustainable Design* as the code for land development and building from the developer of the employee housing communities in the public/private land exchange now in progress.

Medium-term Actions. Use the model projects as a regional education resource for the building and design professions.

Develop reuse strategies for household, construction, and natural materials as construction products.

Develop partnerships with professional design, engineering, and construction schools and with professional and trade organizations for the purpose of designing, building, and monitoring sustainable projects in the park. Develop a strategy to transfer the sustainable development and building principles and methodologies to the gateway communities, in partnership with the newly formed Gateway Marketing Association.

Long-term Actions. In partnership with the Grand Canyon National Trust, develop a strategy to transfer the sustainable development and building principles and methodologies to the Colorado Plateau.

PARTNERSHIP MODELS

There are a number of successful models for developing a consortium for partners to work together. A good model is the process used to develop a sustainable community partnership in Aspen, Colorado. The partnership includes two electric utilities, two ski resorts, a natural gas utility, the county, and a citizens' group. The office is called the Community Office for Resource Efficiency. A professional facilitator worked with the potential partners and the community to develop the vision and create the best organizational structure.

The Consortium for Energy Efficiency is a partnership of investor-owned utilities, environmentalists, and government. These competitors are working toward a common goal of lowering the cost of energy efficiency.

A good model for transferring the partnership process to other parks and communities is the "neighborhood housing services" model, which has been used successfully for many years. This is a local partnership of a neighborhood, a city, and local businesses. Successful neighborhood housing services are mentors for new communities across the country: each successful partnership helps set up new partnerships.



CONCLUSION

The Sustainable Grand Canyon workshop, in conjunction with the *General Management Plan*, has set forth a bold and innovative vision for the future of the Grand Canyon. The time is now for the National Park Service to be a leader in sustainable development in all its environmental, economic, and cultural manifestations. The ideas and technologies outlined in this workshop report will serve as the foundation for actions to occur over the next ten years.

The National Park Service, as an agency in the Department of the Interior, has a responsibility to preserve and manage the natural and cultural resources within Grand Canyon National Park for generations to come. In this age of overpopulation and reliance on technology, it is imperative that the National Park Service set the best possible example of resource stewardship and serve as a flagship for lifestyle and philosophical change. Through cooperation with regional and local jurisdictions and organizations and with other federal agencies, Grand Canyon National Park can become a shining example of responsible human interaction with nature.



APPENDIXES

APPENDIX A: GREATER GRAND CANYON PARTNERSHIP

The proposal presented in this appendix was dated December 21, 1994.

PROPOSAL: GREATER GRAND CANYON PARTNERSHIP

Contents

- I. Introduction
- II. Background
- III. The Solution: Developing a Regional Vision
- IV. Potential Partners
- V. Greater Grand Canyon Partnership Principles
- VI. Next Steps: Create the Partnership
- VII. Conclusion
- VIII. Proposal Steering Committee

Appendix I

Ideas from the Sustainable Grand Canyon Workshop

Appendix II

Partnership Models

Greater Grand Canyon Partnership

A Vision Across Boundaries

If you don't know how things are interconnected, then a solution can cause more problems than it solves. On the other hand, if you understand the hidden connections between energy, water, agriculture, transportation, security, and economic and social development, you can often devise a solution to one problem (such as energy) that will create solutions to many more problems at no extra cost.

— Amory Lovins

I. INTRODUCTION

Grand Canyon National Park has traditionally been managed as an island, but that is changing. The park has a mandate to serve two purposes: first, to protect the canyon's natural and cultural resources and second, to provide opportunities for visitors to experience and understand the Canyon's environmental interrelationships and resources. A balance or a contradiction? How can the park system win? An increasing interdependence is developing between the park, its gateway communities, neighboring agencies, tribes, and beyond. Without strengthening the relationship between the park and these other entities, there will be many difficult choice between protecting resources, and providing access for park visitors.

As visitation to Grand Canyon National Park and the surrounding region skyrockets, the demand for new roads, lodging, commercial and retail services, and infrastructure continues to increase. Five million visitors see the park each year, and this number is expected to reach seven million people in fifteen years. Too many cars compete for too few parking spaces; air quality is deteriorating; information is difficult to find; long waiting lines are common. This is creating pressure to provide necessary services and amenities outside and adjacent to park boundaries. The quality of the visitor experience has diminished and the resources of the park are threatened.

The Secretary of the Interior recently stated that the building of new infrastructure inside national parks should be restricted, but visitation should not be limited. Continued development of fragile lands throughout the region is inevitable with increased visitation. Unplanned, incremental and piecemeal development threatens to overwhelm the region's existing infrastructure and threatens to compromise fundamental park values and the uniqueness of the Northern Arizona region.

In this changing environment, the park needs to focus on what it does best: manage and interpret its incredible natural resources. However, the park and other stakeholders must work together to create a vision for the Greater Grand Canyon Region. In partnership, interconnected issues will be resolved and these most important natural, cultural, and economic resources will be protected.

II. BACKGROUND

This year is the park's 75th anniversary. The Grand Canyon spans 1.2 million acres and includes at least 1,000 buildings. Six Native American tribes have sacred cultural ties to the canyon. Grand Canyon National Park is recognized internationally as a place of superlative natural and cultural value. As a World Heritage site, with a significant number of international visitors each year, the park provides the world with cultural, historic, and spiritual wonders. The great biological diversity of the park contains five of the seven life zones, including three of the four desert habitats in North America. The park serves as an ecological refuge for protected plant and animal species and contains relatively undisturbed remnants of otherwise dwindling ecosystems. It is a living science laboratory, and host to world-class research and scientists.

An important opportunity exists to create and implement a vision of sustainability for the park and the surrounding region which depends on the park. The park's educational value, and value of its preservation as a living laboratory, have global implications. The Grand Canyon region can be a powerful model of sustainable development which would be transferable to many other national parks and communities. It is imperative that we embrace this opportunity to protect one of our country's most important natural resources.

III. THE SOLUTION: DEVELOPING A REGIONAL VISION

Over the past decade, diverse public and private interests have indicated their desire to cooperate in finding ecologically and economically sustainable solutions to meet the demand of rapidly increasing tourism and other development pressures in the Grand Canyon region. A preliminary draft of the park's new General Management Plan indicates that the park should "work cooperatively with surrounding entities to encourage planning and management actions outside the park's boundaries that are compatible with those inside the park."

There is an immediate and pressing need for an integrated planning process in the south and east rim regions of Grand Canyon National Park. While many have recognized this need for some time, no one has yet been able to respond at the level needed. Separate jurisdictions and independent interests outside the park's boundary continue to pursue their own agendas for resource management and development.

A regionally based partnership must be created to define a bold vision for the region and coordinate an integrated plan to meet that vision. The strength of a regional partnership is the power and ability to carry out a commonly developed vision that will give equal standing to economic, environmental, and community values.

Who is the Partnership?

The "Greater Grand Canyon Partnership" will be a working partnership of community leaders, business leaders, and government officials, and the national support team, who have joined together to revitalize the Grand Canyon region.

The partnership will offer an opportunity to connect expertise and regional interests to develop integrated strategies for the region. It will be a partnership of people and organizations who want to invest time, energy, labor and money to create and implement a common vision.

Why the Partnership Should Be Created

The Grand Canyon is the economic engine that drives the region. The relationship between the park and the region is important: they can complement each other or be at odds. The partnership will be a catalyst for creating a community that is both economically and environmentally viable.

The greater Grand Canyon is a biogeographic region which depends upon interconnections and sustainable management to achieve long term environmental, cultural, and economic success. The partnership will respond to the need for an integrated approach to resource management and economic development.

How to Make a Difference

The partners believe that given encouragement, commitment, skill, and resources, people will work to make a difference. The people who live in the region know its needs and capabilities better than anyone else.

A representative steering committee of regional entities and a national support team will be formed to identify all potential partners and to raise initial funds. A regional coordinator and a national coordinator will work with the steering committee to develop the partnership. See section IX for more information. All regional stakeholders will be invited and welcome to participate. This will allow the partnership to comprehensively identify and address critical problems from an integrated perspective.

The partnership will identify and secure public and private investment. It will be funded and professionally staffed for the start-up period of three to five years, after which the partnership will be financially independent and decide how best to continue. The park's General Management Plan addresses many critical issues and ideas that will be a basis for deliberation by the partnership.

IV. POTENTIAL PARTNERS

Although the spirit of community and regional partnerships exists, it needs to be strengthened through a more formal effort. This effort needs to develop such that all regional partners work together as equals and their diverse interests are all fairly represented. Integral to the partnership is the leadership and investments to build these partnerships.

Here is a preliminary list of partners and a role each might play:

Regional Partners

Regional partners will include tribes, developers, business groups, environmental groups, history associations, landowners, government, and other public interests. These partners will be identified and brought in through the partnership development process.

Investment Partners

Investment partners include developers, foundations, government, and corporations. The partnership will aggregate federal and private money.

National Support Partners

The national support partners consist of national experts such as architects, engineers, environmental scientists, and developers to address areas including buildings, air quality, energy and resource efficiency, land use, transportation, water resources, economic development, community development, education, and interpretation. The Sustainable Grand Canyon Workshop brought national leaders in these fields to the Grand Canyon. Participants in the workshop are potential partners to the Greater Grand Canyon Partnership. See appendix I for a more detailed discussion.

V. GREATER GRAND CANYON PARTNERSHIP PRINCIPLES

- **The Grand Canyon Park Should Do What It Does Best.** The park should manage and interpret its incredible natural resources. Public and private partnerships should be considered for the following: housing, transportation, waste management, reservations, and other non-resource services.
- **Regional Community Leadership.** This effort will enable the Greater Grand Canyon community to assume leadership in the long term sustainability of the park and the region. The park and the region's future are interdependent. The partnership will empower the region to face its problems, create its solutions and own its future.
- **Environmental Quality.** The Grand Canyon region's natural resources are unique and need to be protected and enhanced for future generations. The partnership will find opportunities for environmental protection that enhance cultural and economic values in the region.
- **Partnerships.** Through enhanced partnerships, the Grand Canyon will become a catalyst for a sustainable, diverse economy. Trust, respect, and understanding gained through the partnering process will change each of the

partners in a positive way. Each partner will be strengthened through this process.

- **A Vision is Needed Before Money.** The Greater Grand Canyon Partnership should be developed in the spirit of a true partnership, with no single partner dominating the vision, the agenda, or the funding. Once the vision is in place, the funding should begin and the organization should be formalized. Enough funding to create the partnership will be raised in advance.
- **Leverage Private Capital.** Private investment should be leveraged with public investment to implement the plan developed by the partnership. There is no longer adequate federal funding. However, private capital is available for much of what needs to be done. This additional capital will enable the community to create a sustainable base and will bring economic benefits and employment to the region.

VI. NEXT STEPS: CREATE THE PARTNERSHIP

Phase I

Locate seed money and identify potential partners. Potential partners will be invited to the Grand Canyon for three days of workshops to develop a shared vision and to create a working partnership.

- Identify and contact key leaders and investors. Raise \$40,000 to implement Phase I of the partnership.
- Identify regional partners and advisors.
- Conduct 2–3 day workshop with potential partners.
- Develop a communication network through a regional newsletter and a computer bulletin board.

Phase II

Conduct ongoing, facilitated organizational meetings with the regional partners, investment partners, and advisory partners.

- Partnership operational; implementation begins.

VII. CONCLUSION

Doing nothing is filled with risk. Today's problems will be easier to solve with the bold vision outlined here. The opportunities, expertise, and commitment exist to make this vision a reality. The park, its culture, history, and fragile ecosystems have many lessons to teach us about our past and about our future. If we pay attention, these lessons will influence the decisions we make today and the course we set for the future. The time is right to create a partnership for the Greater Grand Canyon region.

VIII. PROPOSAL STEERING COMMITTEE

This draft proposal was originated at the Sustainable Grand Canyon Workshop and was subsequently developed and written by:

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Margaret Howard, Global Environmental Options (GEO)

with

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Bob Berkebille, BNIM Architects
Nancy Clanton, Clanton Engineering
Harry Gordon AIA, Burt Hill Kosar Rittelmann Associates
John Knott, Jr., Dewees Island
Amory Lovins, Rocky Mountain Institute
Ann Moss, Shapins Associates, Inc.
Anne Sprunt Crawley, DOE, Federal Energy Management Program
Brad Traver, Grand Canyon National Park

APPENDIX I: IDEAS FROM THE SUSTAINABLE GRAND CANYON WORKSHOP

The following ideas were initiated at the Sustainable Grand Canyon Workshop, which took place September 27 through October 1, 1994, at Grand Canyon National Park. The workshop included regional experts and 34 national leaders in sustainable design and development. These experts are available as national support partners to the Greater Grand Canyon Partnership. The following are some recommendations developed at the workshop:

Create a Bold Vision for the Park

- Primarily manage natural resources.
- “Natural resource” leadership role inside and outside the park.
- Non-resource services managed by others.
- Stake in outside services creates an active regional role for the park.

Create a Bold Vision for the Region

- More local jobs.
- Regionally based partnership.
- Selected services relocated outside of the park.
- Improved transportation and reservation systems.

Create a Bold Vision for the Visitor

- Better information.
- Higher quality experience.
- More time for park visit; less time spent on parking and logistics.

A: Selected Workshop Findings: Ten Critical Areas for Consideration

Information and Reservations

This initiative is already in the beginning stages and should be supported by the partnership. The goal is to cut the clutter and confusion through a central reservation system. This can be accomplished in the short term through a regional partnership. Gateway businesses can come together with the park through a private sector reservation system. In the longer term, the park offers exciting demonstration opportunities for certain types of information technologies with far larger and broader market prospects ripe for private capital.

Resource Efficiency

Promote resource efficiency, particularly in the profitable areas of energy and water. Water is scarce and a controversial issue which should be resolved through partnership. Pumping costs to get water to the rim is about \$225,000 per year. Major, very costly water infrastructure improvements could be avoided through water efficiency. Improving energy efficiency and transportation will improve air quality slightly, but more importantly, will set a good example for all visitors coming from the areas that cause the air pollution. Comfort and service should not be compromised. Determine one-year paybacks and implement these immediately. Federal money, municipal bonds, and private partnerships are all available. Longer-term, cost-effective solutions may include developing demand-side resource partnerships with local utilities, developing a solar utility, and installing solar domestic hot water systems.

Education and Regional Arts

Communicate past and present cultures in the region. Improve support for indigenous crafts. Create an honest experience for visitors by removing culturally offensive gifts from park gift shops. Develop a partnership with the Native American Interpretive Association, Grand Canyon Trust, Natural History Association and others. Increase support for a regional center for the arts, Native American cultural centers, and an education center. Establish a strong docent program. Create a Native American and international intern program with the park. Develop a volunteer eco-education system where people have an opportunity to help plant, reforest, and build in a sustainable way. Involvement is the key to learning. Public/private partnerships are good funding mechanisms for education and the regional arts. Encouraging examples such as the Tri-Cultural Inn of the Anasazi in Santa Fe have been an outstanding commercial success.

Housing

All new housing should be outside of the park. It should be built and financed regionally through outside developers. Various housing options have already been tried, but with limited success. Private developers have not been able to make housing profitable outside the park. This is a very difficult issue that needs a fresh look and new ideas. Housing should be a high priority for the partnership. Strong partnerships will ensure integrated planning, financing, and high quality development.

Transportation

The transportation initiative is already underway. The partnership should support and assist in this ongoing effort. Transportation goals include eliminating the intrusion of the automobile on the park experience and establishing a regional transportation and parking authority. The system can be financed and developed through the private sector. Create a transportation hub system with the gateway communities. There are many funding opportunities using public/private bond financing, municipal bonds, and grants.

Waste Management

Return what we don't use to some other use. The park should be a catalyst for developing a regional waste management system. Implement source reduction. Use the park's high visibility as an example.

Agriculture

Help foster and create a sustainable economy for regionally grown food. There are numerous opportunities for organic farming using low water practices and integrated pest management. To encourage this development, the concessionaires could agree to buy high quality products from these farms for the first year.

Regional Products and Services

Review all products and services for what can be economically produced and sold locally. A regional ecosystem should support a sustainable economy, community, and environment. Currently, most money leaves the community, but with this system, more money stays in the region. Money which recirculates in the community ultimately multiplies several fold and strengthens the local economy.

Building Materials and Construction Processes

Produce markets and businesses that encourage integrated, sustainable design and building practices. Develop the use of indigenous building materials. Ensure the highest level of indoor air quality through the use of appropriate building materials and systems. The first projects should be models. Establish monitoring program and document results. The National Labs can be partners and develop the model for the rest of the park and all parks. After being developed, these practices can be transferred to the rest of the community. This approach creates local jobs and keeps more money in the community.

Transferable Sustainable Experience

Positive sustainable experiences in the park are transferable to other national parks and the rest of the Colorado Plateau. Promising ideas include converting dormitories into wholly sustainable lodging with electricity, heat, and water created at the building. Locally grown food would also be served. This would be a complete interpretive experience.

B: Newsletter from Sustainable Grand Canyon Workshop

The newsletter that was published by the workshop in October 1994 is reproduced on the following pages.



News from the Grand Canyon Sustainable Design Workshop

THE SUSTAINABLE GRAND CANYON WORKSHOP

The Grand Canyon National Park (GCNP), a world heritage site, is celebrating its 75th anniversary this year. As part of the celebration, the park hosted a four-day workshop to identify integrated design and planning solutions for implementation. The recommendations that were developed seek to create a vision that is environmentally and economically sustainable.

The workshop was a collaborative process that brought together national and regional environmental leaders; government, utility, commercial, and community interests; private developers; Native American representatives; and other local citizens. Four U.S. federal agencies: the National Park Service (NPS), Western Area Power Administration, the Army Corps of Engineers, and the U.S. Department of Energy, also worked in partnership.

The goal of the workshop was to encourage access to the park while building a sustainable vision for future generations. The project addressed integrated environmental solutions and their implementation in areas including: energy efficiency; land use; transportation; wastewater; buildings and indoor air quality; population; economic/community development; cultural change and human factors; education and interpretation. The team broke into three groups to address: resource efficiency, visitor experience, and information. In addition, another

group developed economic partnership concepts. The groups delivered recommendations, based on the park's Draft In-house General Management Plan (GMP), to help to build a globally recognized model that could be translated to parks and communities world-wide.

National Park Service, "Organic Act", of August 25, 1916.

"...which purpose is to conserve the scenery and natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

EXECUTIVE SUMMARIES

Resource Efficiency

The resource efficiency group focused on tangible ways to conserve resources and reduce impacts on the Grand Canyon and the regional community. The group divided into four subgroups in order to address the different scales of actions that need to take place. These subgroups are:

1. Building use/land use/transportation patterns
2. Sustainable buildings criteria
3. Transportation
4. Economic resources and partnerships
5. Water supply

The Building use/land use/transportation patterns subgroup

focused on preventing future impacts, and mitigating past impacts. A long-term alternative would be to study the feasibility of relocating some housing and services outside the park, enhancing the sense of community in Tusayan, restoring open space at the Rim, and reconfiguring the legal and economic restrictions on water use.

Sustainable buildings criteria addresses primarily energy conservation/solar energy, building materials/indoor air quality, waste, and water. Applying new energy-efficient technologies to existing buildings can reduce energy consumed and its resultant pollution. Currently, over \$4 million of electricity, propane, and fuel oil are used per year. A \$1.5 million investment in lighting and residential water and space heating technologies could save over 30 percent of the energy used with a three-year payback.

Transportation solutions focused on developing regional and local hubs, generating economic and interpretive disincentives for the private automobile, alternative energy sources, information dissemination, and funding options. An example of a short- to long-term solution would be to have a hybrid fuel system for buses: the fuel would initially be gasoline or propane, but could eventually be converted into a bio-fuel.

By forming partnerships with public and private entities, and leveraging capital, NPS can move towards implementation of the Draft In-house GMP. An example of a partnership would be to

convert several dormitories into Bed & Breakfasts, using them as model sustainable renovations. Power would be supplied by the sun, and a multi-day stay would be required, of which one day would be spent performing community service in the park.

Those studying the water supply for the park found that there is a lot of untapped potential for immediate savings through conservation. In fact, application of low-flow plumbing fixtures would save approximately 60 percent of the water consumed on the South Rim. Annual savings are about \$1.5 million with a simple payback of eight months.

Visitor Experience

The GCNP visitor experience has traditionally been one of awe. Experiencing the Rim for the first time is breathtaking, with a noticeable hush. Too often, this is the only experience the majority of visitors have. The park's goal is to extend this to a ring of experiences similar to the rings of life of a ponderosa. Visitors should feel compelled to leave the Park in better shape than when they arrived.

Currently, many visitors treat the park with disrespect, expecting the park to fill all of the amenities of urban life. This attitude is one of *taking* which leads to destruction. Changing the visitor's experience to one of *giving*, will lead to preservation and reconstruction. This attitude change needs to begin at home or at the conception of the trip. The continuation of its development occurs during travel, arrival, education and experience. Leaving the park, the spirit will continue and change lives forever.

Authentic experiences will emphasize special relationships between spirit and matter. It also means that culture, history and science are truthfully presented in a manner meaningful to the visitor.

Meaningful experiences will help the visitor to connect with the history and culture of the Grand Canyon and its natural environment.

One goal is to eliminate or minimize frustrating travel, arrival and in-park conflicts. Another goal is to provide immediate man-to-nature exposures and continue educating man-to-culture experiences. A third goal would be to encourage man-to-spirit connections to the person and to the moment. The theme of connecting man to his environment should be carried away with each visitor.

The group's recommendations provide numerous opportunities for fulfilling, personal experiences. It should be noted that the scope of this workshop focused primarily on the South Rim populated area. All of the park areas should be evaluated in terms of the visitor experience similar to our process.

Information Group

There is no integrated information management system. Without this system there is no way to understand the benefits of sustainable development.

To create this system, specific recommendations are made for each of the three information user groups: 1) NPS; 2) visitors; and 3) the GCNP community of Native American tribes, concessionaires, and other stakeholders. Because of

its leadership role, the NPS will be responsible for implementing most of the short-term recommendations. These center on organizational change, documenting baseline conditions and sustainable design opportunities, and also on the preparation of an information management study. These short-term steps are vital for establishing consensus on expectations and documenting conditions against which progress will be measured.

Within five years, recommendations will rely upon the NPS continuing its leadership role but with substantial participation of selected stakeholders as partners. For example, recommendations for improving visitor user information center on several categories such as, trip planning; visit optimization; and education and interpretation; where each involve travel organizations. Trip planning is essential to managing expectations of potential visitors and is a key benefit of the system.

Ultimately, as individual sustainable development projects are implemented, the park is expected to emerge as a widely recognized sustainable development program success. As such, it will serve as a benchmark for others.

Consequently, information on its successful implementation experiences will be sought by interested parties worldwide and its knowledge will be exported. Information management recommendations are made for the transfer of this information and continuing the process with community-wide participation.

An integrated information management system will document the benefits of sustainable

development and facilitate sharing of its success.

Recommended actions for the following timeframes include:

Short-term (within one year)

1. Establish a sustainable information champion.
2. Attain baseline and procurement information on historic and current resource usage, and ensure continual monitoring and feedback for the future. Gather information on alternatives for benchmarking purposes.

Mid-term (within 1 to 5 years)

3. Create, document and report park and regional case studies. Use information technology to share sustainable visions. For example: partner with Native Americans to develop a CD-ROM for sharing their culture; sharing their sustainable vision; sharing their experience of this World Heritage site, with its majestic landscape and rich history; and building local economic development.
4. Make information useful. "Canyon Companion" technology to convey trip planning information (lodging, meals, and activities currently available), resource use, ecological information, etc.

Long-term (by the year 2010)

5. The information system is developed and transparent so visitors can get immediate feedback to understand their resource use here, and can take the experience of sustainability home.

Regional Economic Development Partnering Group

The park is an integral part of the economic future of the Colorado Plateau region. As such, the park should play an active role in regional, sustainable economic development.

Although community and regional partnerships exist, they need to be strengthened to ensure a sustainable economy and environment. We are recommending the creation of a consortium of regional partners. This consortium would hire a full-time community development executive to realize this expounded vision. In order to reach this vision, the following should be considered:

1. Leverage private capital resources to implement the plan.
2. Enable the regional community to take ownership in the long term sustainability of the park.
3. The park should develop partnerships to create a diverse, sustainable economy in the Gateway region.
4. Park development should foster systemic change in all partners; the economic and health benefits learned through involvement in the Draft In-house GMP are extended beyond the GCNP.

5. The park should concentrate on resource management and leave community development to partnerships with the private sector. "Let the park do what it does best."

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PRINCIPLES OF SUSTAINABILITY

(From "Guiding Principles for Sustainable Design", NPS, 1993; and the "Hannover Principles", William McDonough Architects.)

1. Insist on the right of humanity and nature to co-exist in a healthy, supportive, diverse, and sustainable condition.
2. Recognize Interdependence. The elements of human design interact with and depend on the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.
3. Respect relationships between spirit and matter. Consider all aspects of human settlement including community, dwelling, industry, and trade in terms of existing and evolving connections between spiritual and material consciousness.
4. Accept responsibility for the consequences of design decisions upon human well being, the viability of natural systems, and their right to co-exist.
5. Create safe objects of long-term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creations of products, processes, or standards.
6. Eliminate the concept of waste. Evaluate and optimize the full life cycle of products and processes, to approach the state of natural systems in which there is no waste.
7. Rely on natural energy flows. Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.
8. Understand the limitations of design. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not an inconvenience to be evaded or controlled.
9. Seek constant improvements by sharing knowledge. Encourage direct and open communication between colleagues, patrons, manufacturers, and users to link long-term sustainable considerations with ethical responsibility, and reestablish the integral relationship between natural processes and human activity.

APPENDIX II: PARTNERSHIP MODELS**A. Community Office for Resource Efficiency**

There are a number of successful models for developing a consortium. A good model is the process used to develop a sustainable community partnership in Aspen, Colorado. The partnership includes two electric utilities, two ski resorts, a natural gas utility, the county, and a citizens' group. The office is called the Community Office for Resource Efficiency. A professional facilitator worked with the potential partners and the community to develop the vision and create the best organizational structure. Great care was taken to bring all interests to the table and craft a vision for the office.

B. Consortium for Energy Efficiency

Other excellent models exist as well. The Consortium for Energy Efficiency is a partnership of investor-owned utilities, environmentalists, and government. These competitors are working toward a common goal of lowering the cost of energy efficiency.

C. Neighborhood Housing Services

A good model for transferring the partnership process to other parks and communities is the "neighborhood housing services" (NHS) model which has been used successfully for many years. NHS is a local partnership between a neighborhood, the city, and local businesses. Successful NHS communities are mentors for new NHS communities across the country: each successful partnership helps set up new partnerships. The mentors are neighbors helping neighbors, cities helping cities, and businesses helping businesses.

APPENDIX B: GRAND CANYON BUILDING DATA

Tables B-1, B-2, and B-3 present statistics of Grand Canyon buildings by owner, by location, and by function.

Table B-1: Buildings by Owner				
Owner	Number of Buildings	Area (square feet)	Percentage (by number)	Percentage (by area)
Amfac/Fred Harvey Company	254	625,144	26.6	45.6
National Park Service	462	444,118	48.3	32.4
National Park Service (leased to TW Recreation Services)	155	107,498	16.2	7.8
Grand Canyon Schools	266	7,422	2.7	4.9
Babbitt's General Store	145	7,892	1.5	4.2
TW Recreation Services	4	17,200	0.4	1.3
Verkamp's, Incorporated	101	3,930	1.0	1.0
Grand Canyon Association	5	7,820	0.5	0.6
U.S. Postal Service	2	6,109	0.2	0.4
Grand Canyon Health Clinic	3	3,900	0.3	0.3
Arizona Public Service	3	3,801	0.3	0.3
US West	2	2,879	0.2	0.2
Bank One	1	2,774	0.1	0.2
Baptist Church	1	2,300	0.1	0.2
National Park Service/ Grand Canyon Association	1	2,126	0.1	0.2
Catholic Church	1	1,804	0.1	0.1
Community Church	2	1,346	0.2	0.1
National Park Service/ Fred Harvey Company	1	916	0.1	0.1
U.S. Geological Survey	1	312	0.1	0.0
Owner unknown	3	76	0.3	0.0
Total	951	1,369,367	100.0	100.0

Table B-2: Buildings by Location

Location	Number of Buildings	Area (square feet)	Percentage (by number)	Percentage (by area)
South Rim	569	1,118,661	60.0	81.7
North Rim	237	176,202	24.8	12.9
Desert View	312	7,008	3.2	2.0
Phantom Ranch	402	6,893	4.2	2.0
Indian Garden	37	7,121	3.9	0.5
East Rim	5	3,139	0.5	0.2
West Rim	10	3,043	1.0	0.2
Unspecified	3	2,281	0.3	0.2
Tuweep	4	1,939	0.4	0.1
Inner Canyon	9	1,094	0.9	0.1
Roaring Springs	4	828	0.4	0.1
Lees Ferry	1	720	0.1	0.1
Cottonwood	1	438	0.1	0.0
Total	951	1,369,367	100.0	100.0

Table B-3: Buildings by Function

Location	Number of Buildings	Area (square feet)	Percentage (by number)	Percentage (by area)
Administration	336	4,054	3.5	4.7
Community Services	16	107,665	2.1	7.9
Housing	297	482,558	31.1	35.2
Lodging	272	305,590	28.5	22.3
Unheated shelters	142	39,971	14.9	2.9
Retail/Dining	231	66,720	2.5	12.3
Utility	527	2,714	5.4	5.3
Warehouse	103	130,086	10.8	9.5
Demolished	8	0	0.8	0.0
Unspecified	5	0	0.5	0.0
Total	956	1,370,923	100.0	100.0

APPENDIX C: DESIRED QUALIFICATIONS — ADVOCATE FOR SUSTAINABLE DESIGN

Overall, the integrated information management champion for sustainable design and development is expected to develop and present information to the managers at Grand Canyon National Park, enabling them to make wise decisions regarding resource management. As part of a larger sustainable design and development team, the champion must make major contributions to the promotion of sustainable design and development broadly throughout the National Park Service and specifically in Grand Canyon National Park. Finally, the champion must design and implement steps that will enable other interested parties to understand, transfer, and build on the results of actions taken at the park.

Required Knowledge and Learning Ability

The champion must understand or be able to learn quickly the following items:

- the information flow and dependencies at Grand Canyon National Park
- existing and planned automated information systems
- resource management decisions at Grand Canyon National Park, and the information needed to justify these decisions
- general operations at Grand Canyon National Park
- sustainable design and development principles and NPS policy
- current and anticipated information management technology

Required Skills

Analytical. Must have the ability to analyze large masses of data and dissect them into discrete segments, relate them to other data sets in traditional and nontraditional methods, and efficiently reach logical endpoints.

Organizational. Must be able to assemble large groups of information in systems that facilitate rapid retrieval and analysis.

Communication. Written and oral communication skills should be outstanding in both formal and informal settings.

Diplomatic. Diplomatic skills are critical. Being persuasive and positive in promoting sustainable development and design at Grand Canyon National Park and elsewhere is paramount. Diplomacy may be vital in gaining access to all necessary data.

Attributes. The following attributes are essential.

- ability to give attention to detail but retain “big picture” orientation
- personal interest in natural resource management
- ability to travel
- team member outlook with coaching and leadership potential



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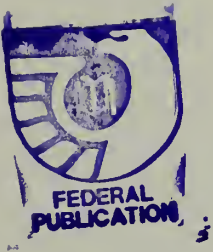
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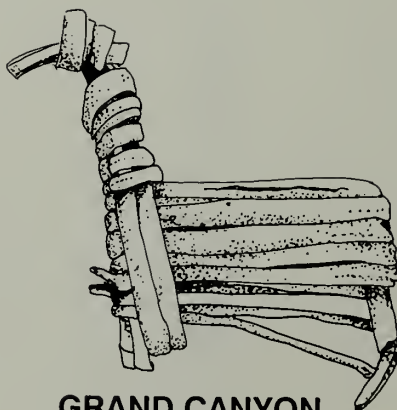
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GRAND CANYON

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