A Design Tool for the Building Life Cycle: The Hennepin County Sustainable Design Guide and Rating System

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INTRODUCTION

An interdisciplinary team comprised of architectural consultants, researchers, and advisors from the design professions is creating a Sustainable Design Guide and Rating System (SDGR) to assist in the design of medical, institutional, and office buildings constructed by Hennepin County Property Services in Hennepin County, Minnesota. The purpose of this system is to encourage environmentally responsible design practices in Hennepin County by providing design guidelines (fundamental concepts, principles, and design strategies) as well as specific rating criteria (performance indicators and a process for design evaluation).

The county currently owns 69 buildings and leases 40 more, for a combined 7.2 million square feet of space. Hennepin County is an urban county in Minnesota with a population of about 1.2 million people in 46 municipalities, including the city of Minneapolis. The county will pilot the system during the next five years on all building projects with a construction value of at least $100,000—which includes virtually all its projects. Hennepin County officials hopes the system will be adapted and utilized by other public and government agencies.

The Hennepin County system builds on other rating systems, including LEED, GBC '98, and BREEAM. These rating systems were studied and used to evaluate a new Hennepin County Public Safety Facility in downtown Minneapolis, currently in design development. By testing LEED, GBC '98, and BREEAM, the team was able to evaluate the advantages and disadvantages of existing systems and to clarify the intentions, concepts, priorities, and needs of the Hennepin County System. The Hennepin County System has expanded on existing systems in several ways: 1) environmental issues are organized around the building life cycle (and related design and operational phases), 2) the system can be used as both a guide to inform design thinking and as a rating method to evaluate building performance, 3) scoring can be tailored to reflect the opportunities and constraints of a specific project, and 4) the system is located on an Internet website for ease of access and updating. The primary audience for the system includes local design firms that consult with the County and facility managers who will use the system during operations. The system will be available on an Internet website accessible to county staff and architectural consultants. If local architectural firms do not have access to the Internet, the necessary software will be made available from the county.

The first phase of the project, which was completed in December 1998, involved development of the structure and content for the guide and rating system. The second phase of the project, which began in January 1999 and will extend through April 2000, involves the development of resouse materials to assist designers in the implementation and realization of the system. An interdisciplinary team including building researchers, architects, interior designers, and landscape architects are working together to integrate resource materials, references, design tools, and case studies into the existing system. This phase also includes the development of curriculum for workshops that will be conducted for representatives of at least 100 design firms that work with Hennepin County. In addition, instructors from related professions will be trained to conduct future workshops for other audiences within the design community. An advisory board of local design representatives, researchers, and educators has been formed to explore future development and care of the system.

PROJECT DESCRIPTION

The system focuses on sustainable design considerations at the scale of the site, building, and components. Unlike other rating systems, the Sustainable Design Guide and Rating System (SDGR), as its name suggests, is both a design guide and an assessment tool. As a design tool, it is intended to assist decision-making during the design, construction, and operation phases for new and renovated facilities. It provides guidelines such as fundamental concepts, principles, and resources to inform design thinking. As a rating system it provides minimum performance indicators and a scoring system to evaluate the design. Since the system is located on a website, information is organized in layers. On entering the website a visitor first encounters an introductory page, which provides access to the Overview, Process, and Resource Sections (see Figure 1). The Overview Section provides general background information on sustainable design and the objectives of Hennepin County. The Process Section includes the actual design guide and rating system.

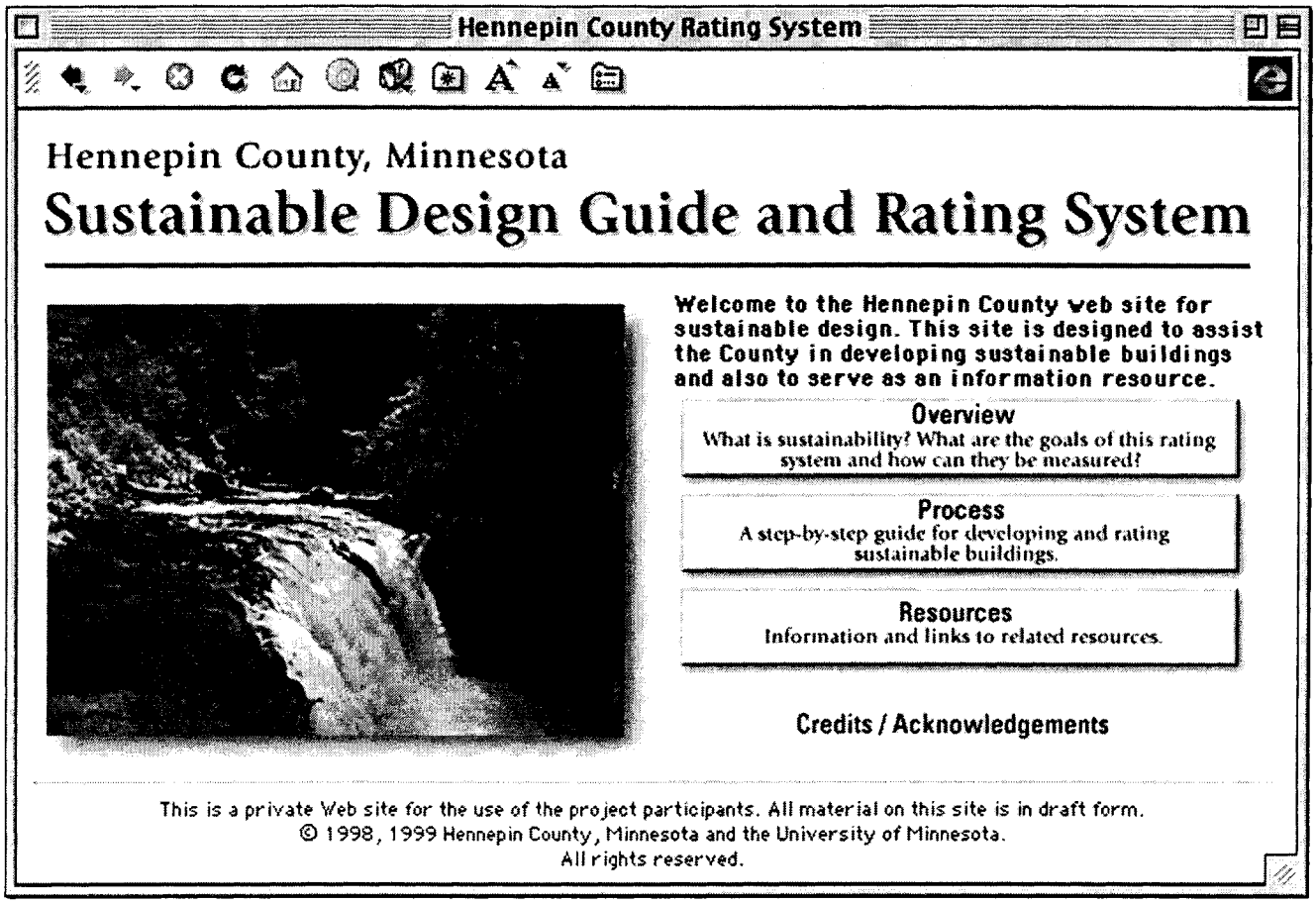

Fig. 1. Introductory page to the Sustainable Design Guide and Rating System

The Resource Section contains all supporting material needed to implement the system (including specifications, standards, codes, fundamental concepts and principles, etc.).

Sustainable design issues are organized by seven environmental topics that include site, water, energy, indoor air quality (IAQ), human factors, materials, and waste. Each topic is organized by phases of the building life cycle—planning, design, construction, occupancy, and next use—and subsequently by strategies. As one moves further into the system strategies include 'action items' which guide the design team through the decision-making process and 'performance indicators' which provide criteria for evaluation. This system is unique in providing guidelines and performance indicators that relate to the entire building life cycle (planning, design, construction, occupancy, and next use). Scoring occurs after building commissioning, start-up, and one year of operations (a timeline has not yet been defined for on-going evaluations during operations). Upon completion of the second phase of the project the system will include support materials such as specifications, codes, standards, design tools, references, and case studies. Each of these layers of the system will be briefly considered in the following discussion (environmental topics, design phases, strategies and actions, performance indicators, scoring, and supporting materials).

Environmental Topics

Seven topics (site, water, energy, IAQ, human factors, materials, and waste) were chosen as a means of organizing environmental concerns (see Figure 2). Each environmental topic includes a set of related design strategies that are used to assess and implement the broader goals of the topic (strategies will be discussed in a following section). The general goals of the seven environmental topics include the following issues:

Site: The site-related goals of the system are to encourage development near to mass transit, existing infrastructure, and currently developed areas. An underlying objective is to avoid and/or minimize the development of agricultural, wetland, and forested areas. Other goals are to maintain and/or enhance the ecology of the site, response to climate and microclimate for energy efficiency and comfort, use native plant materials, minimize erosion, and protect water quality.

Water: The water-related goals at the site scale address water management, erosion control, stormwater, irrigation, and reduction of water consumption through native and naturalized plants and vegetation. Building strategies include water management, conservation, consumption patterns, efficient fixtures and appliances, graywater systems, and/or cooling tower design.

Energy: The primary energy goal is to reduce the consumption of natural resources for heating, cooling, lighting, and related equipment and systems. Strategies include both passive and active systems. A related goal is to use energy sources that are renewable and that have low environmental impacts.

Indoor Air Quality (IAQ): The IAQ strategies are address air quality issues at the scale of the site, building envelope, materials, and HVAC systems. The first priority is to eliminate pollutant-generating activities and secondly to control those that can not be eliminated either from the site or building. The goals of the IAQ strategies are to create environments that foster health and well being in the built environment.

Human Factors: The human factors strategies address issues related to thermal, luminous, and acoustic comfort. The goal of this

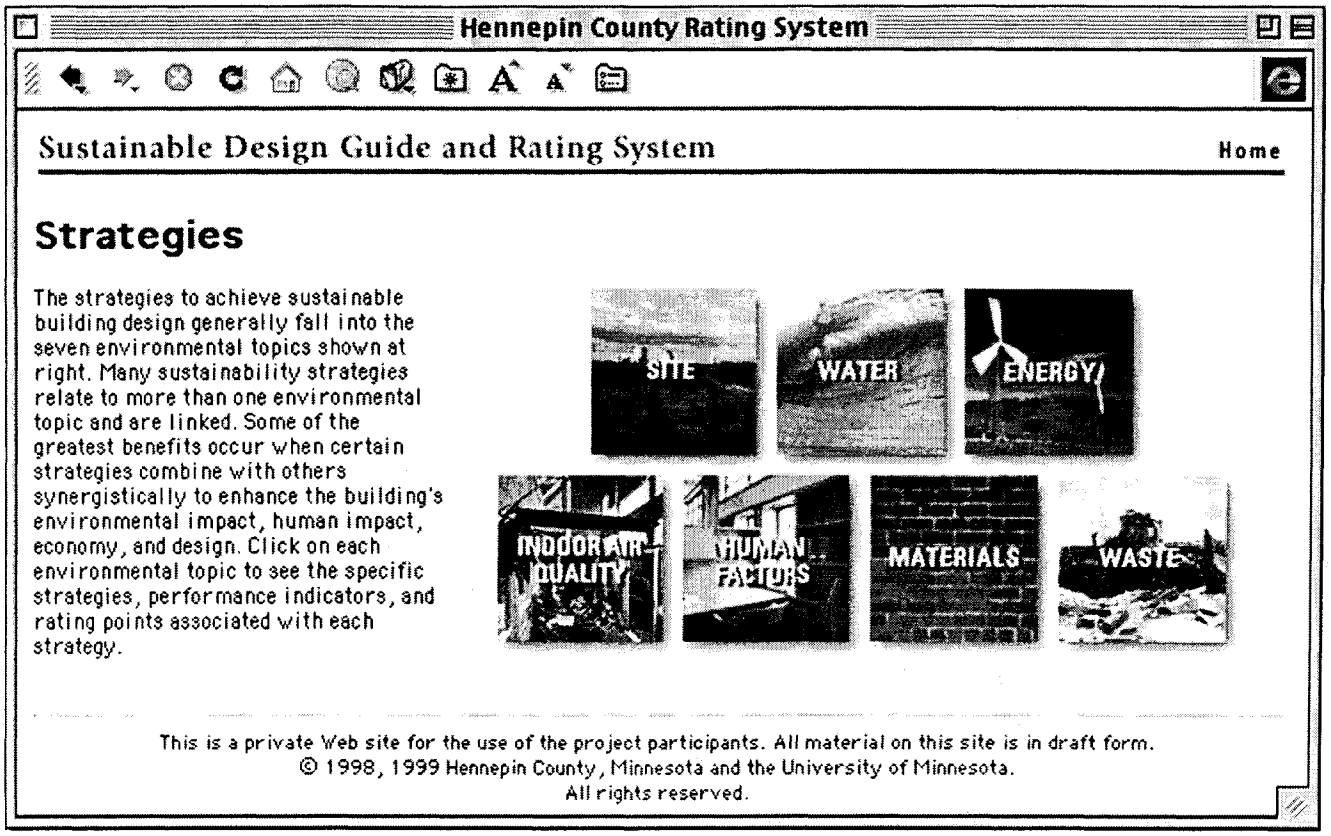

Fig. 2. Introductory page for environmental topics and strategies

topic is to ensure that occupants have a physical environment that maximizes human comfort, health, and well being.

Materials: The goals for materials are to reduce the consumption of natural resources—especially those that are nonrenewable—and to select materials that are durable, manufactured locally, have low environmental impacts in their manufacturing process, and contribute to a healthy indoor environment.

Waste: Waste-related goals include the elimination, reduction, and recycling of waste during construction as well as during the operating life of the building (including hazardous waste). A strategic design goal of the system is to reduce demolition waste by designing buildings to facilitate building disassembly and adaptability.

The Building Life Cycle

Each environmental topic (site, water, energy, IAQ, human factors, materials, and waste) considers related issues throughout the building life cycle — including different phases of planning, design, construction, occupancy, and next use (see Figure 3). To integrate environmentally responsible design easily and effectively into Hennepin County's design and building process, it became important not just to identify the end goal, but to identify what particular actions to take during each phase of the design process or operating phase to realize the goal. Since the environmental impacts of operating and maintaining the building over its life are significant, the building life cycle includes design and the entire occupancy period of the facility, as well as its next use. As a result, the system provides guidelines and rating for both the design and operational phases.

The term "building life cycle" includes decisions during design, occupancy, and ultimately next use. Subsequently, the system is organized according to the building life cycle. Each environmental topic includes a matrix for each that organizes the topic strategies by the building life cycle (see Figure 4). For example, the matrix in Figure 4 illustrates a list of strategies in the water category. Across the top of the matrix are the phases representing the life cycle of the building (planning, design, construction, occupancy, and next use). The vertical column at the left illustrates the strategies included under the water topic (strategies 2.1 to 2.5). For each strategy a "box" is located in the phases of the building life cycle that include "actions" (or design guidelines) to consider by the design team during planning, design, and construction or by the operations and maintenance staff during occupancy (additional discussion of strategies and actions will be considered in a following section). The Hennepin County system includes guidelines for decision-making during the following phases and subphases of the building life cycle:

1. Planning
   - A. Project Initiation
   - B. Programming
   - C. Site Selection
2. Design
   - A. Schematic Design
   - B. Design Development
   - C. Construction Documents and Specs
3. Construction
   - A. Bidding and Award
   - B. Construction
   - C. Commissioning
4. Occupancy
   - A. Start Up
   - B. Operations and Maintenance
5. Next Use
   - A. Asses/Reuse
   - B. Salvage/Recycle

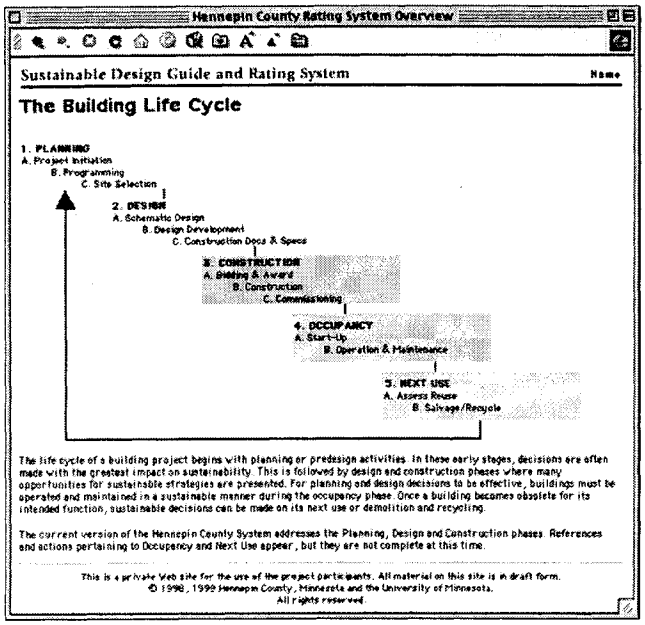

Fig. 3. Building life cycle summary

Design Strategies and Actions

The system includes approximately 45 strategies that are organized according to seven environmental topics (site, water, energy, IAQ, human factors, materials, and waste). Each topic includes a Strategy Summary which identifies the strategies for the particular topic as well as related material in other topics. For example, within the second topic which is Water, there are five strategies which include *Strategy 2.1: Conserve Building Water Consumption, 2.2: Conserve Cooling Tower Water, 2.3: Use Gray Water Systems, 2.4: Manage Site Water, and 2.5: Use Biological Waste Treatement Systems* (see Figure 5). Water-related issues are also identified in the site and energy topics. Connections, interrelations, and links between topics are identified so that the designer can more easily understand the impact of the part within the whole.

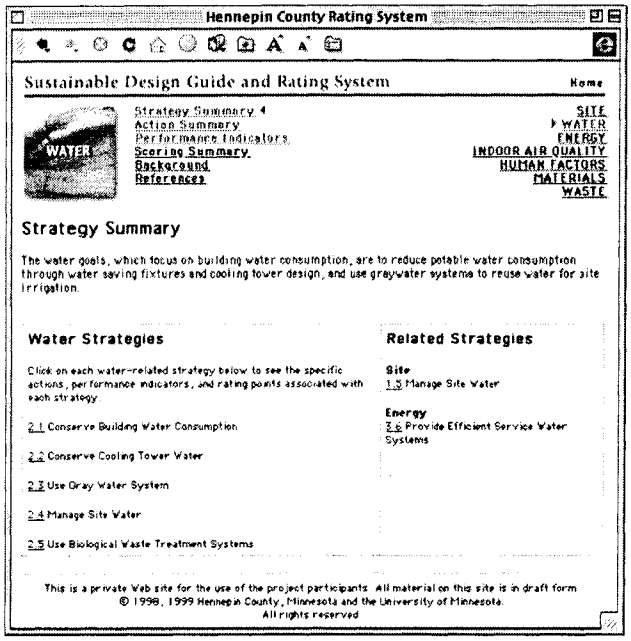

Fig 5. Strategy summary for water

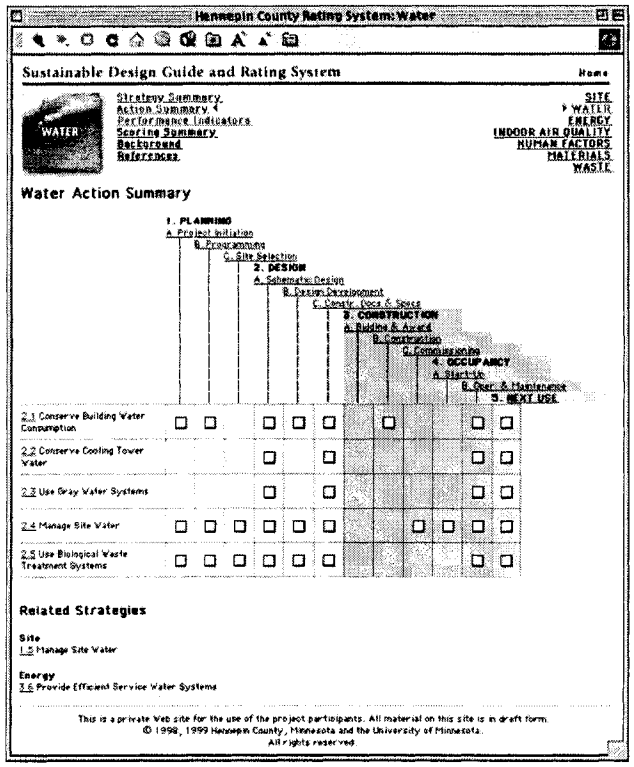

Fig. 4. Water matrix organized by building life cycle and strategies

As we move into the layer of the system that includes the strategies we find issues organized according to distinct "actions" or guidelines for relevant phases of the building life cycle (not all strategies include actions for each phase). For example, *Strategy 2.3: Use Gray Water Systems* includes "actions" within project initiation, programming, design, operations and maintenance, and next use (see Figure 6). The actions are tailored to the type of issues the design team or operations and maintenance staff would consider during a particular phase of design or building operations. For example, in the planning phase of project initiation an "action" for *Strategy 2.3* might determining whether it is feasible to use a gray water system based on the program, site, or budget. In contrast, if a gray water system was used in the building, the ìactionsîduring the operations phase of *Strategy 2.3* might involve educating building occupants and maintenance staff about how the system operates or is maintained. The actions are tailored to the different phases of design and operations (or the building lifecycle) in order to help designers and maintenance staff incrementally move toward the realization of the strategy and its related environmental goals. The actions provide a step-by-step guide for decision making. Action items are also summarized for all topics according to each phase of the building lifecycle. For example, a design team can also access a summary that lists actions for all environmental topics during project initiation (or any other phase).

Measuring Performance

It was determined that in order to measure performance and apply rating numbers to each strategy, the total life cycle of the building had to be divided into two parts— the building delivery process and the occupancy period. The first part consists of the planning, design, and construction phases. This set of activities has a finite timeline and is generally under the control of the county architects and administrators involved in the building delivery process. The second part of the building life cycle includes the entire building occupancy period and eventual demolition or conversion to next use.

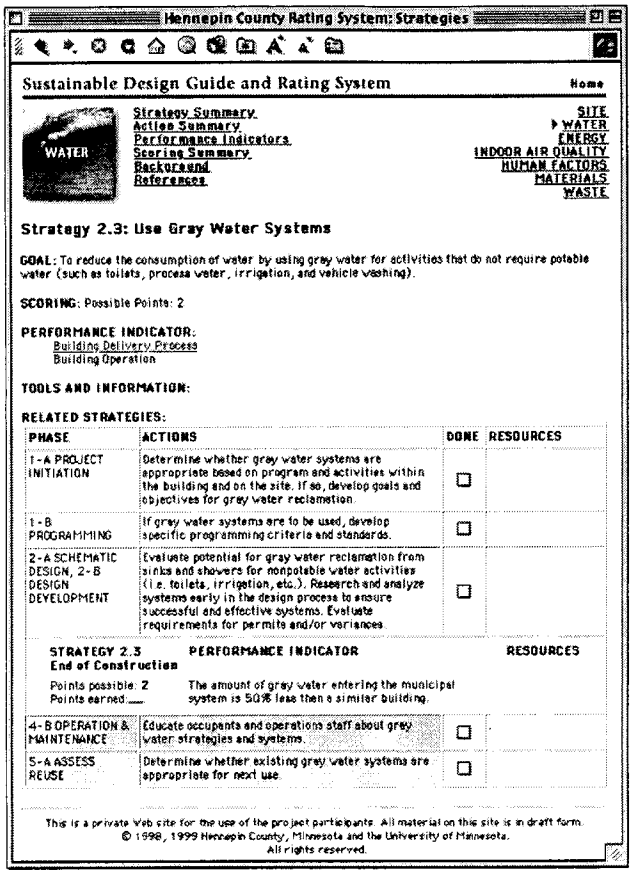

Figure 6: Strategy 2.3 including actions and perfomance indicator

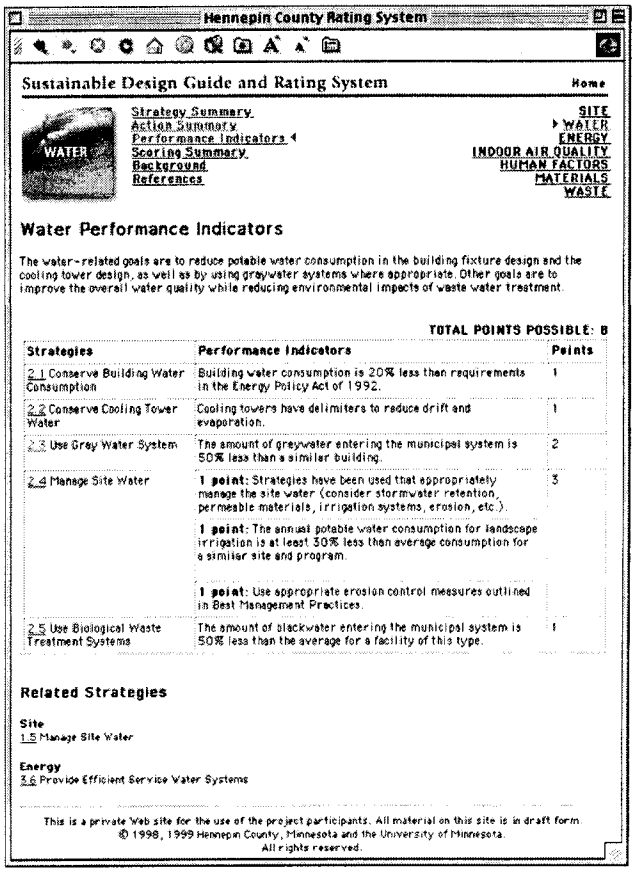

Fig. 7. Summary of performance indicators for water

Occupancy begins with the start-up phase after completion of construction and includes the training of building operators and education of building occupants. This is followed by the operation and maintenance phases, and finally, any transition to the next use of the facility. The goal of the rating system is to rate the building following construction, start-up, and during operations. However the current rating system is focused on the building delivery process (planning, design, and construction) and only includes performance indicators for each strategy that will be used to rate the building after construction (see Figure 6). Eventually performance indictors to be developed for the start-up and operations phases so that the building performance can be monitored through different times in the building life cycle (i.e. after 1, 5, 10 years, etc.). The system includes summaries of performance indicators for each topic (see Figure 7).

Depending on the nature of the strategy the performance indicators may be quantitative (i.e. exceeding a particular code or standard) or qualitative (i.e. considering various design, experiential, physiological, and/or psychological factors). Given the current state of sustainable design research and practice some strategies lend themselves to quantification while others must be stated more broadly and openly. For example, the performance indicator for *Energy Strategy 3.5: Maximize Efficiency of HVAC System* is to exceed the minimum Minnesota State Energy Code by 20%, 30%, or 40% (with higher scores for increased performance). In contrast, the performance indicator for *Strategy 6.3: Design for Disassembly* simply states that points will be given if a significant effort has been made to facilitate building disassembly. Since building disassembly is an emerging area of practice the performance indicator is broadly stated. Quantifiable performance indicators are used whenever possible; however, less tangible, immeasurable, and even developing areas of sustainable design are also rewarded. As the knowledge base of the profession grows the performance indicators will be modified and updated.

Scoring

The scoring method and performance measures for the rating system are still under refinement. However, it has been agreed that the scoring will be flexible and designed in a way to reward efforts rather than penalize deficiencies. To encourage flexibility the design team will determine a "target score" based on the characteristics of the project, building type, and site. The target score represents a feasible, yet ambitious, design goal. Since some strategies apply only to certain projects (i.e. renovations versus new construction, urban versus rural sites, etc.) it is important that the target score can be tailored to reflect the opportunities and constraints of the project. Strategies and related points that are irrelevant to a given project will be subtracted from the overall target. For example, although 100 points total could be achieved in the system, a team may determine that only 83 points are feasible (for example, some strategies may be inappropriate or impossible to achieve given the nature of the project). The final score following construction would be a percentage of the actual points earned. For example, a project might receive a post-construction score of 78% based on earning 65 points from the projected target score of 83 points (see Figure 8). In contrast to some rating systems, the design team and Hennepin County are not penalized for neglecting strategies that are impossible to achieve. Currently the rating of a project only occurs following construction, however, eventually evaluation and rating will also occur following start-up and during operation and maintenance. This ensures that the building design will be assessed, upgraded, and reconsidered through its life. The performance criteria and rating system is currently being pilot tested on several

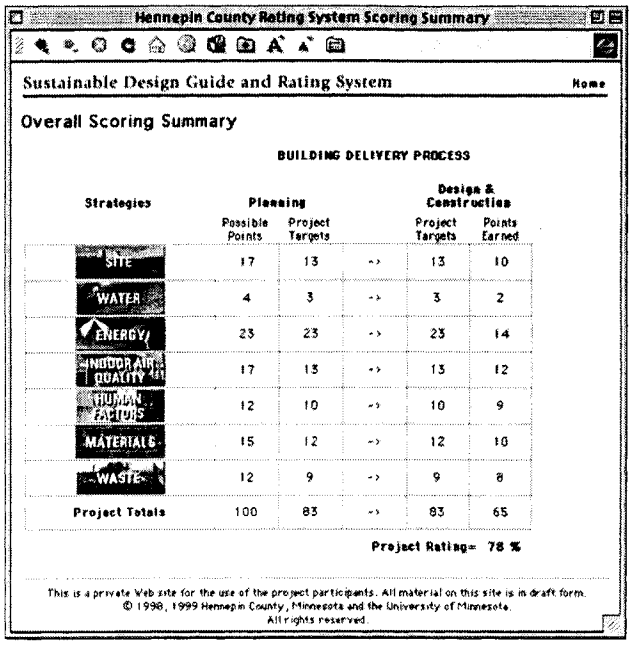

Fig. 8. Scoring summary

Hennepin County projects. Finally, the distribution of the 100 points within the seven topics is based on weighting of the priorities, relative environmental impacts, and the health implications of each performance indicator by Hennepin County.

Supporting Materials and Future Developments

The next phase of the project involves the addition of resource materials such as codes, standards, specifications, design tools, principles, references, and case studies to the website. During the coming year a team of architectural educators, researchers, and designers will be working together to develop the resource materials for each design strategy. Corresponding curriculum materials will be developed for workshops scheduled in spring 2000. An integral aspect of this phase also involves several pilot tests that will use current Hennepin County design projects to evaluate the content and clarity of the resource materials. Pilot workshops will also be conducted to evaluate workshop curriculum. Training of workshop instructors (from the professional community) will ensure that the education process continues in the future. The project is envisioned as a dynamic and evolving system of which these first two phases are only the beginning. It is hoped that the system will continue to grow, change, and be adapted to inform design thinking within the broader design community.

ACKNOWLEDGMENTS

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