Best Practices for Creating High Performance Healing Environments™

Version 2.1 Pilot Report

August 2007

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RELEASE FOR PUBLIC USE

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FOREWORD

From November 2004 to January 2007, 119 pioneering health care facilities joined with the *Green Guide for Health Care* as pilot projects to navigate what have been uncharted waters. These projects, representing more than 30 million square feet, tested those waters and provided invaluable feedback to the *Green Guide* steering committee and staff—what credits worked and what didn't; what thresholds needed to be adjusted to make them viable; what strategies needed to be better understood to be adopted. Additionally, Pilot projects had a unique opportunity to share information with their peers through the confidential, peer-to-peer on-line *Green Guide* Forum. This searchable learning community for the health care sector—focused on high performance healing environments—prompted a robust exchange of ideas, working through knowledge and institutional barriers, and creating the beginnings of a database of best practices that the *Green Guide* foresees continuing as one of our service offerings.

We applaud the *Green Guide* Pilot projects as forging a path that helped create *GGHC* v2.2, released in January 2007, now serving as the foundational document for LEED® for Health Care. The values-based underpinning of the Pilot experience—discovery, sharing information, and working under a common goal of high performance healing environments—establishes an identifiable benchmark towards a remarkable transformation; one that is well-positioned to guide health care facility design, construction, and operations in the years and decades ahead.

Robin Guenther, FAIA, Gail Vittori, and Walt Vernon, PE, Co-Coordinators, *Green Guide for Health Care*

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ACKNOWLEDGEMENTS

The unprecedented success of the *Green Guide* Pilot can be attributed in large part to a small group of dedicated individuals who have given freely of their time and expertise by serving on the *Green Guide for Health Care* Steering Committee:

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Convened by the Center for Maximum Potential Building Systems in 2002, the *Green Guide for Health Care* is a project of Health Care Without Harm and Center for Maximum Potential Building Systems. Initial funding for the *Green Guide* was provided by the Merck Family Fund. Additional sponsor-level support has been provided by Hospitals for a Healthy Environment (H2E), New York State Energy Research and Development Authority (NYSERDA), Pacific Gas and Electric Company (PG&E), and Southern California Edison.

By agreement, the U.S. Green Building Council allowed the LEED® rating system to be used as a foundational document for the *Green Guide's* development. Collaboration between the two organizations continues with the *Green Guide for Health Care* Version 2.2 being used as a foundational document of the LEED for Health Care rating system.

Adele Houghton, AIA, LEED® AP, Pilot Project Coordinator and Project Manager of the *Green Guide for Health Care*, managed the Pilot program and coordinated the development of *Green Guide* Version 2.2. Adele acted as Principal Author of the *Green Guide for Health Care Version 2.1 Pilot Report*.

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EXECUTIVE SUMMARY[1]

Between November 2004 and January 2007, the *Green Guide for Health Care's* Pilot program grew to include 119 projects representing more than 30 million square feet of health care facility construction– with a 45% increase from 2005 to 2006. As the first green building best practices toolkit tailored to the U.S. health care industry, the *Green Guide* relies heavily on public input and comment to ensure that the tool reflects industry priorities and current best practices. In December 2003, *Green Guide* Version 1.0 Draft was released for public comment, generating about 1,200 comments. The *Green Guide* Steering Committee followed with the release of Version 2.0 Pilot in November 2004, with substantial modifications responding to the comments.

The Pilot has provided the opportunity for the *Green Guide* to collaborate with a cross-section of leading health care institutions in an active development process. The Pilot's internal list-serve Forum, online project management tools, and personal contact with the Pilot Coordinator generated sustained communications between the Pilot projects and the *Green Guide*, resulting in several revised credits in *Green Guide for Health Care* Version 2.1, released in September 2005. For more information about data collection during the Pilot, see the "Interpreting *Green Guide for Health Care* Pilot Data" section below.

A two year project, the *Green Guide* Pilot generated a wide-ranging set of comments and suggestions to improve and enhance the next version of the *Green Guide* toolkit, *Green Guide* Version 2.2. The Pilot touched an estimated 2.7% of all U.S. health care construction completed in 2006 and 4.8% of health care construction completed in 2007. Pilot projects range in size, building type, building phase (including facility operations), and region, demonstrating the *Green Guide*'s versatility to be an effective tool for many building types and project phases. The *Green Guide's* emphasis on integrating green design and construction strategies with operational priorities led to an increasing number of Pilots' pursuing the *Construction* and *Operations* sections of the *Green Guide* in parallel.

The launch of *Green Guide* Version 2.2 in January 2007 marked the end of the Pilot and the *Green Guide*'s transition into a full-fledged registration and self-certification program. In its new role, the *Green Guide* will continue to work closely with project teams to gather case studies and to promote research into innovative design strategies and technologies.

Interpreting *Green Guide for Health Care* Data

Role of a Self-Certifying Toolkit

The *Green Guide for Health Care* is a self-certifying metric toolkit of best practices that designers, owners, and operators can use to guide and evaluate their progress towards the creation of high performance healing environments. While the *Green Guide* is structured around a point system and specific, verifiable design and technology strategies, its goal is market transformation through education in best practices. It is neither intended to establish regulatory requirements, nor to be viewed as a minimum standard for design, construction or operations. Rather, it is designed to serve as a voluntary educational guide for early adopters of sustainable design, construction, and operations practices, to encourage continuous improvement in the health care sector, and to provide market signals to catalyze a richer palette of strategies for those who follow the early adopters.

Data Collection

The *Green Guide* Pilot's data collection process was tailored to take advantage of the tool's emphasis on self-certification. *Green Guide* Pilots engaged with the program in several ways. Some tracked performance data in a manner appropriate for third party certification (such as for the LEED® rating system), verifying compliance with every *Green Guide* Prerequisite and Credit on their checklists. In many cases, these project teams presented a documentation binder to the owner at the project's completion, demonstrating completion of all *Green Guide* Prerequisites and applicable voluntary Credits.

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[1] All credits referenced in this document correspond to *Green Guide for Health Care* Version 2.1 Pilot.

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The majority of Pilots, however, approached *Green Guide* project registration as an opportunity to engage in best practices and join a learning community of their peers through the online Forum. The self-certifying nature of the toolkit and the absence of credit thresholds provided sufficient flexibility to add value to both seasoned trendsetters and novices. As a result, rather than representing the top 5% of green health care construction in the U.S., their project profiles and checklists more accurately correspond to a broad cross-section of the industry, spanning the top 80%.

Many Pilots used the *Green Guide* as a mechanism to implement a continuous improvement program across the entire organization. Several health care campuses registered more than one *Green Guide* Pilot project, building on each in turn as a learning experience and an opportunity to increase their commitment to enhancing their overall environmental health profile, both through design and construction practices and through facility operations. Many architecture, engineering, and construction firms have likewise registered multiple projects with the *Green Guide* Pilot as part of a program to add depth to their green building knowledge and continuously improve their ability to provide quality high performance, healing environments to their clients.

The Green Guide *collected Pilot Data in several ways:*

- All *Green Guide* Pilots were required to fill out a form on the website with basic project statistics: e.g., location, size, and construction type.
- Pilots were requested to update an online checklist on a regular basis. About 18% of the pilots (21 out of 119) did not complete a checklist. These projects have been excluded from the credit evaluation findings in this report.
- Pilot project teams posted questions and comments associated with specific *Green Guide* credits to the Forum, an online list-serve open only to Pilot project teams.
- The Pilot Project Coordinator interviewed roughly one-half of the project teams to gather more detailed information about the project and the team's experience using *Green Guide for Health Care Version 2.0 Pilot* and *Version 2.1 Pilot*.
- The *Green Guide* convened periodic conference calls with the Pilots to discuss specific sections of the *Green Guide*, answer questions from project teams, and allow conversation and knowledge sharing among Pilot participants.
- Several project teams forwarded additional project information to the *Green Guide* in the form of expanded credit checklists, reports, and PowerPoint presentations.

Data Precision

All *Green Guide* Pilot checklists should be assumed to represent preliminary goals. The flexible nature of the *Green Guide's* self-certification system resulted in a degree of imprecision in data collection, mainly arising from the lack of back-up documentation. Another contributing factor was the long lead-time between project inception and occupancy for most health care construction projects (some as long as 10 years). For most projects, the two-year Pilot program covered only a small slice of the total project schedule for a typical acute care construction project. Most *Green Guide* projects that anticipated completing construction by the end of the Pilot had already reached the Construction Document stage (or even started Construction) before beginning to implement *Green Guide* strategies. These projects were necessarily limited in their ability to implement many green building strategies that would have been possible at an earlier project phase. As the Pilot progressed, however, the opposite circumstance came to dominate the project pool. By the end of the Pilot, over 80% of registered projects (97 Pilots), began to incorporate *Green Guide* principles early enough in the project schedule that they had not yet progressed to the Construction phase of the project by the Pilot's conclusion. As a result, their checklists, included in this report's aggregate data, represent preliminary, not final, credit goals.

The margin of error built into the *Green Guide* data collection process outlined above requires a comparison methodology to interpret aggregate data. As a result, the credit achievement tables in Appendix A and included in other areas of this report in aggregate form should not be interpreted as definite proof of achievement. Instead, the *Green Guide* evaluates Pilot checklists to establish trends across credit groupings, construction types, and building types.

PROFILE OF THE GREEN GUIDE FOR HEALTH CARE PILOT PROGRAM

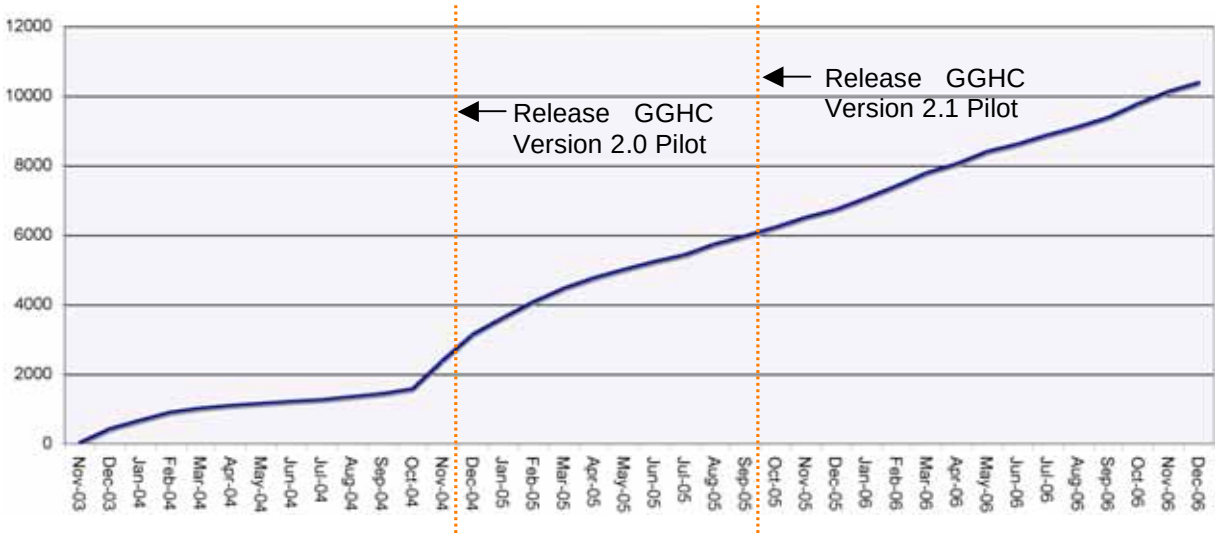
Website

The *Green Guide* website often acted as the portal for health delivery institutions and project teams to learn about green building in health care – a first step towards eventually joining the *Green Guide* Pilot. *Green Guide* website registrants have access to a free, downloadable copy of the *Green Guide*, an archive of the *Green Guide*'s monthly newsletter, an Events calendar that advertises *Green Guide* educational events around the country, and the ability to register projects. Occasionally, *Green Guide* website registrants participate in polls that measure current priorities in the green health care market. The continuous and rapid growth of the *Green Guide's* online community demonstrates the health care sector's desire for education and green building tools tailored to the unique challenges of health care construction, emphasizing a healing environment for patients and staff as well as regional and global environmental health considerations.

The *Green Guide* built a global online community over 10,000 strong during the Pilot program (Figure 1). Over the final three months of 2006, the pace of website registration quickened from 220 per month to close to 400. The *Green Guide's* international reach also expanded to 86 countries and included every state in the U.S. and every province in Canada.

A few examples of the *Green Guide's* international reach include: Australia, Bahrain, Canada, China, Colombia, Egypt, France, Germany, India, Indonesia, Iraq, Japan, Kenya, Mexico, Nigeria, Saudi Arabia, Singapore, South Africa, South Korea, Turkey, and the United Kingdom.

Figure 1: GGHC Website Registrant Growth



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The strength of this community is its diversity (Figure 3). While design professions dominate the pool of *Green Guide* website registrants, health care providers represent almost 20% of the total. The *Green Guide*'s recognition of emerging innovative technologies has also prompted the educational and product manufacturing sectors to take notice and share their knowledge and experience through public comments and email correspondence.

Figure 2: GGHC Website Registrants in the US

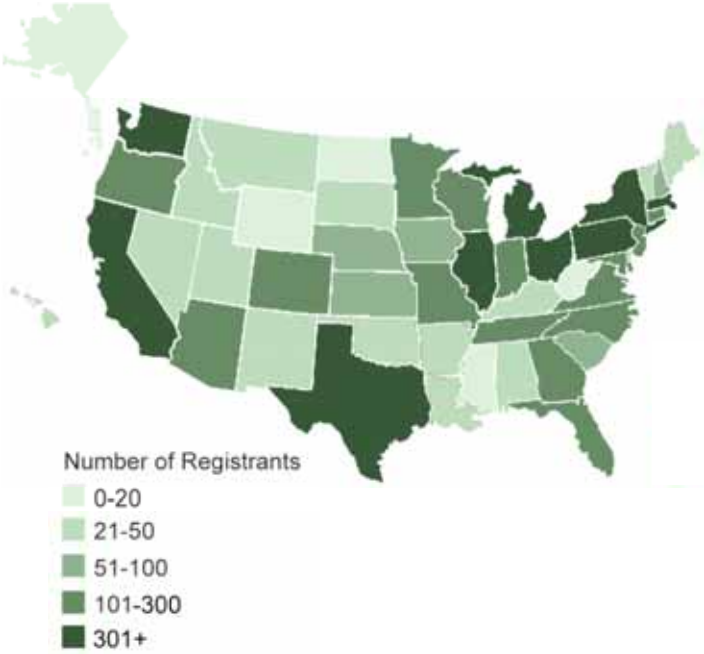
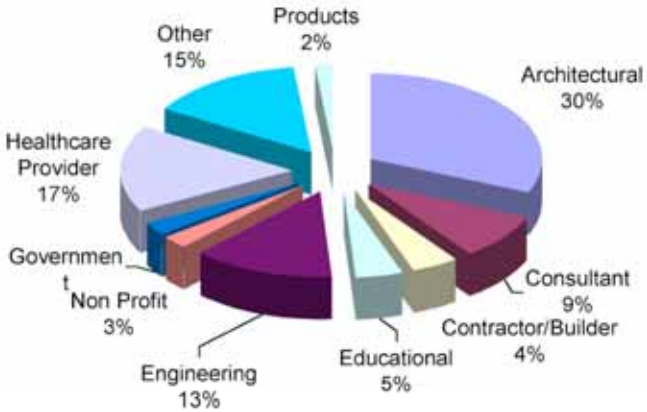


Figure 3: GGHC Website Registrants' Affiliations



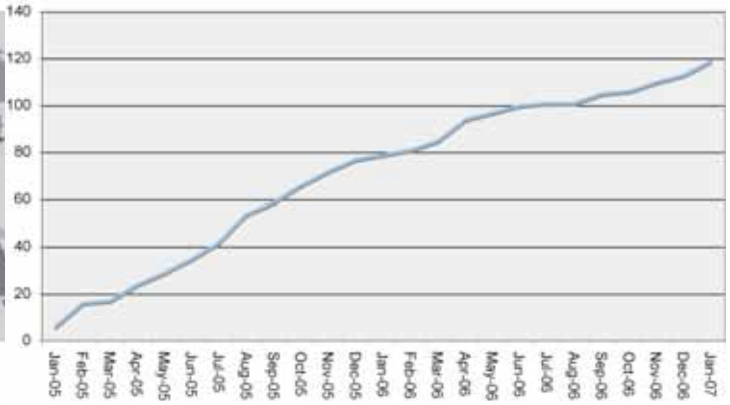
Market Penetration

119 projects registered as *Green Guide* Pilots in 2005 and 2006 (Figure 5), representing more than 30 million square feet of construction. The majority of *Green Guide* Pilot projects (110 total) are located in the U.S. (Figure 4). Five projects are located in Canada, and four more outside of North America. U.S. regions hosting a critical mass of Pilot projects are creating a context for innovation and exemplary performance in the health care community. Boston is particularly notable for the eight institutions that have pledged to achieve at least 50 credits in the *Green Guide*'s *Construction* section.

Figure 4: GGHC Pilot: Geographic Dist\ribution

Image Source: Mission to Planet Earth Education Series, NASA ESIP funded project

Figure 5: GGHC Pilot Growth



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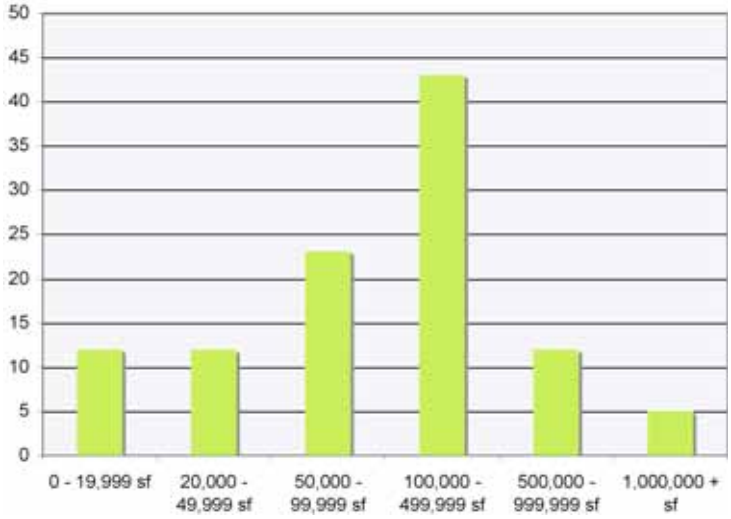
Pilot Project Profile

The *Green Guide*'s flexible structure has also accommodated all sizes of Pilot projects (Figure 6), from small renovations to major replacement facilities and operations. The scope of the smallest *Green Guide* Pilot project is 1,900 square feet; the largest, 3 million, with a concentration (43 out of 119 total) falling between 100,000 and 500,000 square feet.

Figure 6: GGHC Pilot Project Size



The *Green Guide* Pilot program is dominated by new construction (50% based on project type) and Acute Care facilities (60% based on facility type) (Figures 7 & 8). The interest among facilities engaged in addition and renovation projects, as well as long-term care, suggests the continued development of credit language that specifically addresses the unique challenges of these important market segments.

Figure 7: GGHC Pilot Project Type

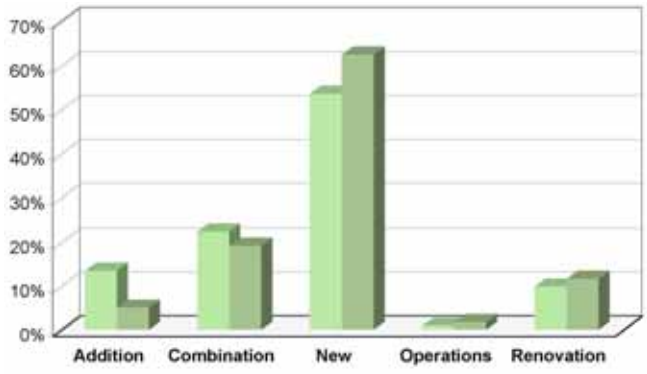


Figure 8: GGHC Pilot Facility Type

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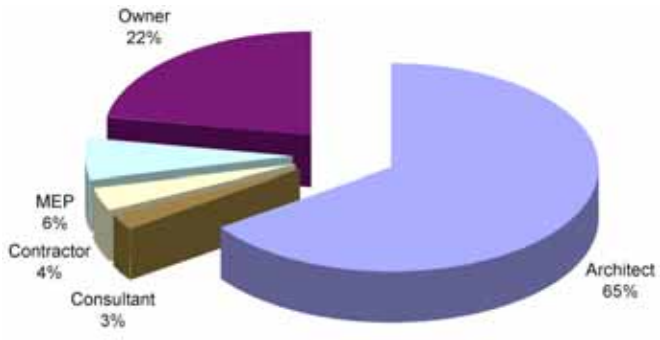
Architects managed the majority of *Green Guide* Pilot projects (66%), with owners representing the second-largest group (22%) (Figure 9). In fact, the only construction type that does not follow this model is Renovation – where owners act as the *Green Guide*'s primary contact for 45% of the Pilot projects. This breakdown of responsibilities reflects a trend in other building sectors for the Architect to coordinate the green building aspect of the project. The architecture profession has also demonstrated swift uptake of the rating system that acts as the *Green Guide's* foundational organizational structure, the U.S. Green Building Council's Leadership in Energy & Environmental Design (LEED®). Uptake by health care organizations (facility managers, nurses, etc.) increased over the duration of the Pilot program as the *Green Guide's* organizational format gained in familiarity and as more and more project teams began to pursue the *Construction* and *Operations* sections of the *Green Guide* in parallel.

Figure 9: GGHC Pilot Green Project Managers



Project Achievement

Over one-half of *Green Guide* Pilots (57 of total 98 credit checklists submitted) pursued the *Construction* and *Operations* section in parallel (Figure 10). In fact, the most successful projects were the most aggressive in integrating operational priorities into the design. See the "Green Guide for Health Care – Section by Section" chapter for more information.

A comparison of average point achievement by *Green Guide* Pilots with total available points in each area of the *Green Guide Version 2.1 Pilot Construction* section (Figure 11) shows highest achievement levels in the Sustainable Sites, Materials & Resources, and Environmental Quality sections. Average achievement in the Environmental Quality section rose to almost 50% of total available points.

The Integrated Design section is not included in Figure 11 because all Pilots were required to comply with the two Prerequisites in that section governing an organized integrated design process and the inclusion of a health issues statement in the project's design intent document.

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The interest generated by the health based credits in the Sustainable Sites (e.g., GGHC v2.1 Sustainable Sites Credit 9: Connection to the Natural World: Places of Respite), Materials & Resources (e.g., GGHC v2.1 Materials & Resources Prerequisite 2: Mercury Elimination and Credit 8: PBT Elimination), and Environmental Quality (e.g., GGHC v2.1 Environmental Quality Credit 4: Low-Emitting Materials and Credit 8: Daylight & Views) sections may have contributed to the high achievement in these sections.

Figure 10: Total GGHC Pilots Pursuing *Construction* v. *Operations* Section

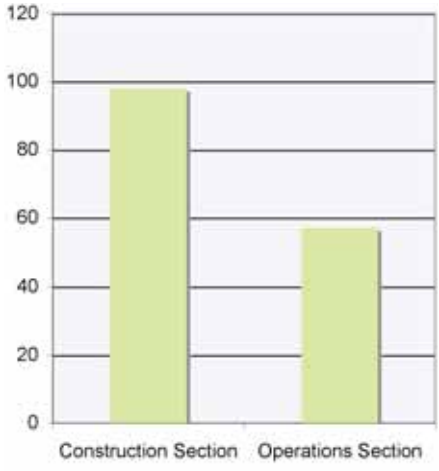
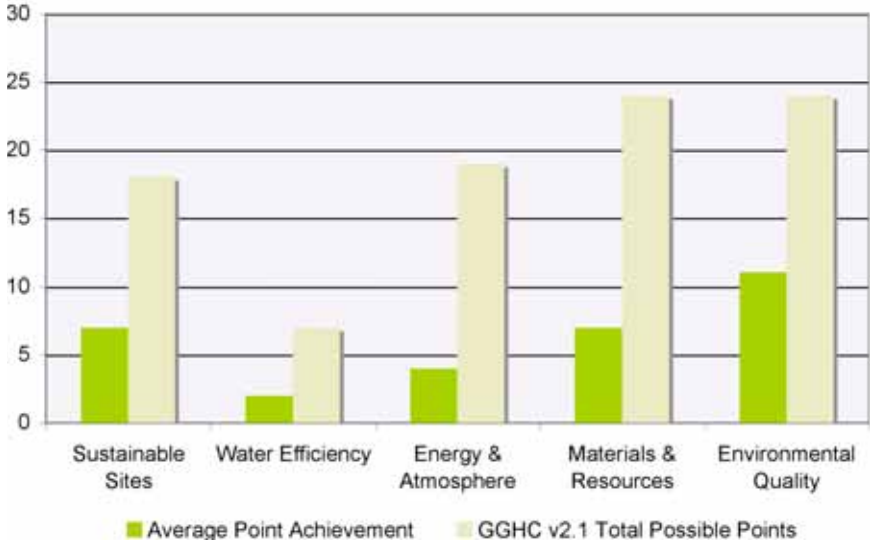


Figure 11: Average Point Achievement: All *Green Guide* Pilots



Overall the *Green Guide* Pilot program demonstrated that the U.S. health care industry is ready to incorporate green building principles and strategies on a large scale into both new construction projects and operational facilities at a critical moment in history – the largest health care construction boom in over half a century.

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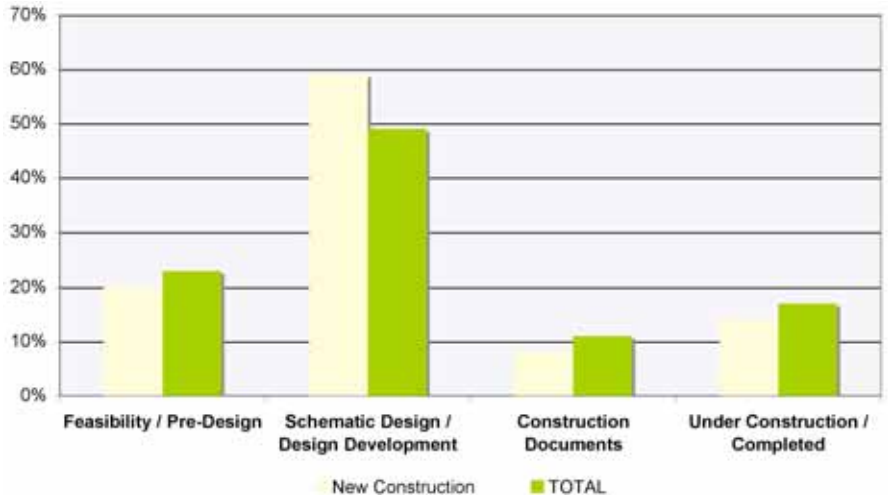
GREEN GUIDE FOR HEALTH CARE PILOTS – AT A GLANCE

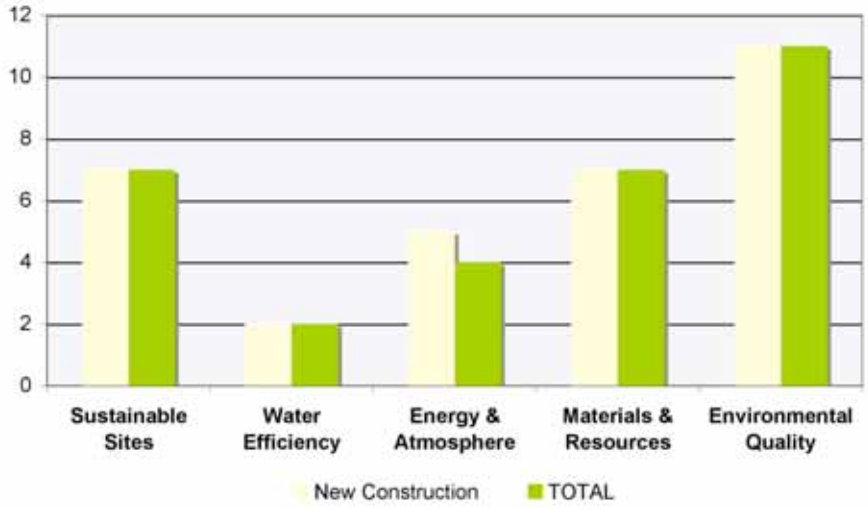
Project Type: **New Construction**

Number of Pilots:	**66 TOTAL**	57 Construction	33 Operations	9 No Checklist
Size:	Smallest 3,300 sf	Average 306,000 sf	Largest 2,100,000 sf	
Joint Registration, GGHC/LEED®:	13	*(out of 27 Pilots registered with both GGHC and LEED)*		

GGHC Pilot Project Phase: New Construction v. Total



Average Point Achievement: New Construction v. Total



Public GGHC Pilots:

Note: The Green Guide *only releases the name of projects that have expressed interest in being publicly recognized.*

Amery Regional Medical Center, Amery, WI
Bon Aqua Health Care, Bon Aqua, TN
Brigham and Women's Hospital, Boston, MA
Children's Hospital, Boston, MA
Dana-Farber Center for Cancer Care, Boston, MA
Dell Children's Medical Center of Central Texas, Austin, TX
Denver Health Medical Center, Denver, CO

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Hackensack University Medical Center, Hackensack, NJ	Rush University Medical Campus, Chicago, IL
Jefferson County Hospital, Fairfield, IA	Saint John Owasso Hospital, Owasso, OK
Kaiser Permanente Modesto Medical Center, Modesto, CA	Saint Joseph's Regional Medical Center, South Bend, IN
La Maestra Community Health Center, San Diego, CA	Salem Hospital, Salem, OR
McGill University, Montréal, Quebec, Canada	US Department of Health and Human Services Critical Access Hospital Prototype (200 nationwide)
Oregon Health & Science University Patient Care Facility, Portland, OR	Veterans Homes of California, West Los Angeles, CA
Palomar Pomerado Health, San Diego, CA	Veterans Homes of California, Ventura, CA
	Washington Hospital, Fremont, CA

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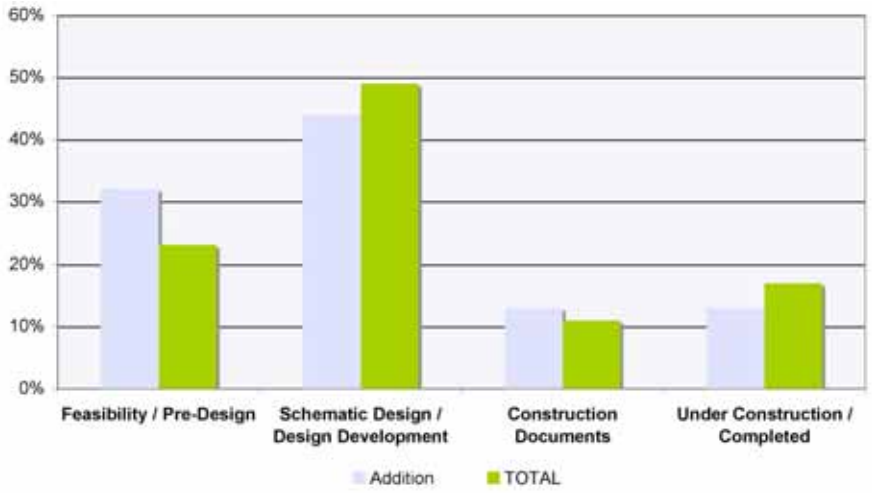
GREEN GUIDE FOR HEALTH CARE PILOTS – AT A GLANCE

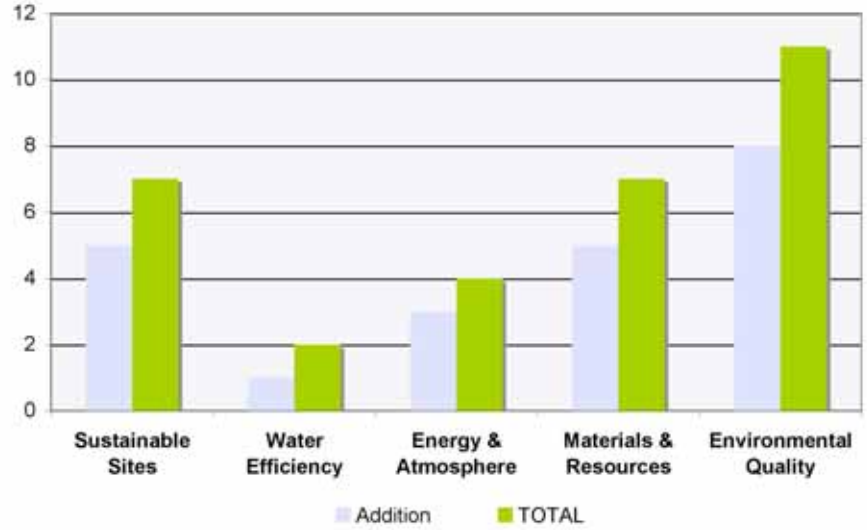
Project Type: **Addition**

Number of Pilots:	**16 Total**	13 Construction	5 Operations	3 No Checklist
Size:	Smallest 5,000 sf	Average 111,700 sf	Largest 350,000 sf	
Joint Registration, GGHC/LEED®:	2	*(out of 27 Pilots registered with both GGHC and LEED)*		

GGHC Pilot Project Phase: Addition v. Total



Average Point Achievement: Addition v. Total



Public GGHC Pilots:

Note: The Green Guide *only releases the name of projects that have expressed interest in being publicly recognized.*

Longmont United Hospital, Longmont, CO

New York Presbyterian Hospital, New York, NY

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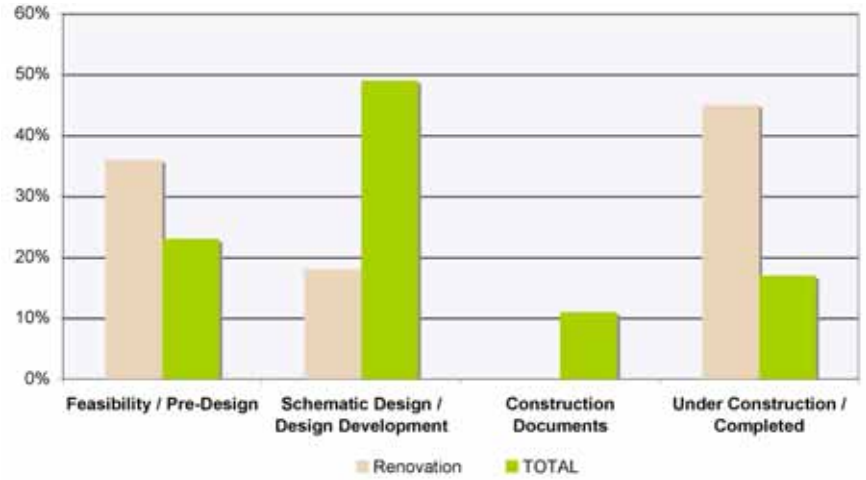
GREEN GUIDE FOR HEALTH CARE PILOTS – AT A GLANCE

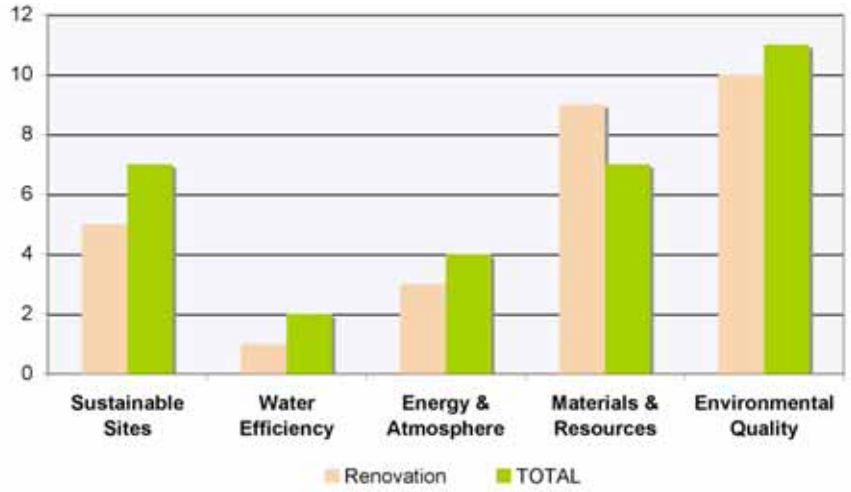
Project Type: **Renovation**

Number of Pilots:	**11 Total**	8 Construction	4 Operations	3 No Checklist
Size:	Smallest 1,900 sf	Average 375,000 sf	Largest 3,000,000 sf	
Joint Registration, GGHC/LEED®:	2	*(out of 27 Pilots registered with both GGHC and LEED)*		

GGHC Pilot Project Phase: Renovation v. Total



Average Point Achievement: Renovation v. Total



Public GGHC Pilots:

Note: The Green Guide *only releases the name of projects that have expressed interest in being publicly recognized.*

The Christ Hospital, Cincinnati, OH
CSSS de la Montagne, Montréal, Quebec, Canada
Donald Dexter Dental Clinic, Eugene, OR
New York Presbyterian Hospital Weill Cornell Medical Center, New York, NY
Wellspring Medical Center, Woodburn, OR

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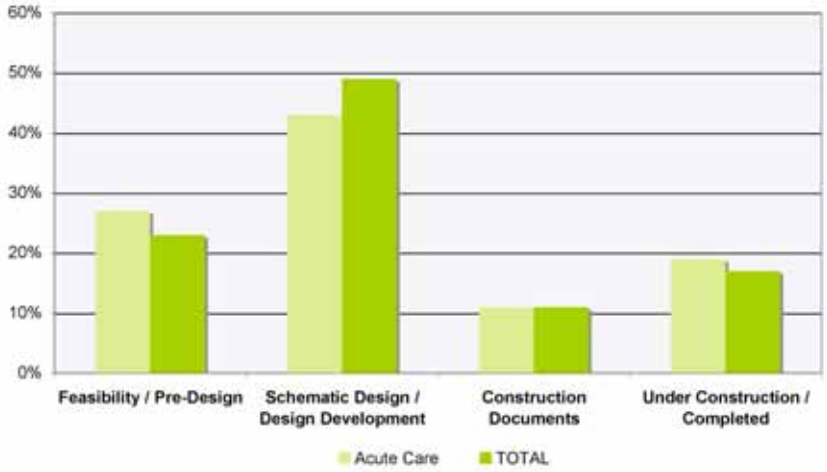
GREEN GUIDE FOR HEALTH CARE PILOTS – AT A GLANCE

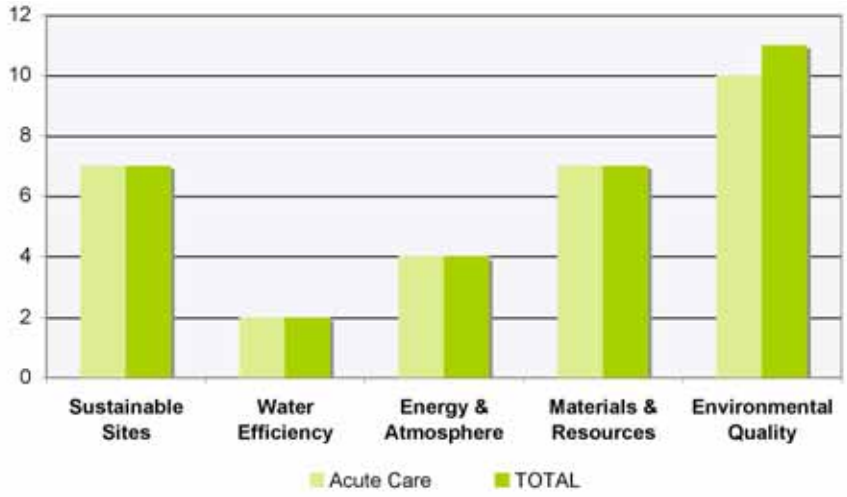
Facility Type: **Acute Care**

Number of Pilots:	**70 Total**	57 Construction	33 Operations	13 No Checklist
Size:	Smallest 4,000 sf	Average 380,500 sf	Largest 3,000,000 sf	
Joint Registration, GGHC/LEED®:	16	*(out of 27 Pilots registered with both GGHC and LEED)*		

GGHC Pilot Project Phase: Acute Care v. Total



Average Point Achievement: Acute Care v. Total



Public GGHC Pilots:

Note: The Green Guide *only releases the name of projects that have expressed interest in being publicly recognized.*

Amery Regional Medical Center, Amery, WI
Beverly Hospital, Beverly, MA
Brigham and Women's, Boston, MA
The Christ Hospital, Cincinnati, OH
Christus St. Catherine, Katy, TX
Denver Health Medical Center, Denver, CO
Jefferson County Hospital, Fairfield, IA
Kaiser Permanente Modesto Medical Center, Modesto, CA
Longmont United Hospital, Longmont, CO

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McGill University, Montréal, Quebec, Canada	Saint Joseph's Regional Medical Center, South Bend, IN
Metropolitan Hospital, Grand Rapids, MI	Salem Community Hospital, Salem, OH
New York Presbyterian Hospital, New York, NY	Salem Hospital, Salem, OR
Oregon Health & Science University Patient Care Facility, Portland, OR	Santa Barbara Cottage Hospital, Santa Barbara, CA
Palomar Pomerado Health, San Diego, CA	US Department of Health and Human Services Critical Access Hospital Prototype (200 nationwide)
Saint John Owasso Hospital, Owasso, OK	Washington Hospital, Fremont, CA

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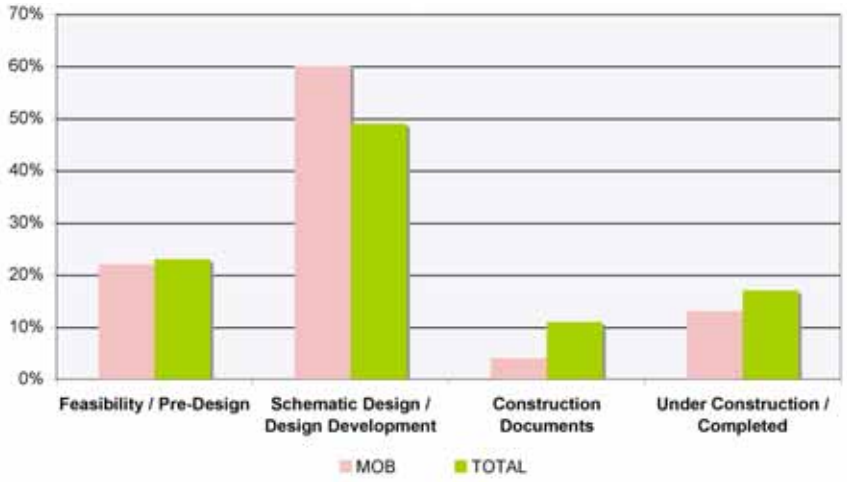
GREEN GUIDE FOR HEALTH CARE PILOTS – AT A GLANCE

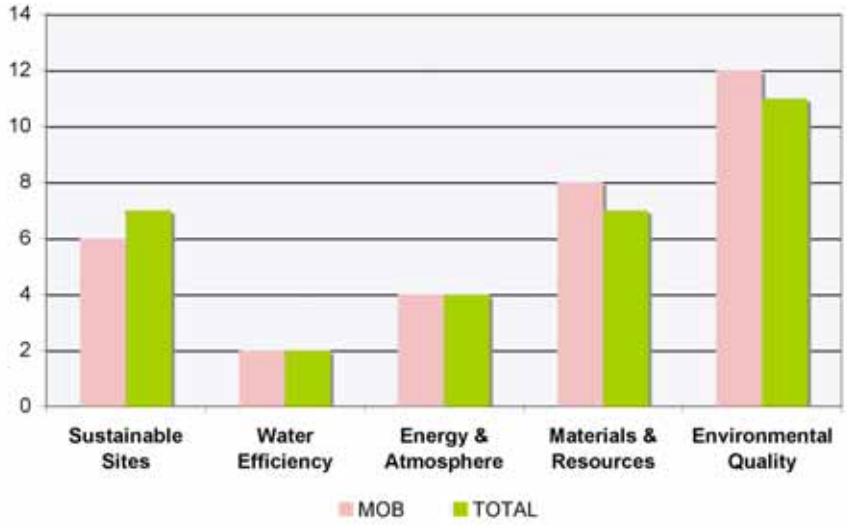
Facility Type: **Medical Office Building**

Number of Pilots:	**22 Total**	18 Construction	10 Operations	4 No Checklist
Size:	Smallest 1,900 sf	Average 94,000 sf	Largest 407,000 sf	
Joint Registration, GGHC/LEED®:	4	*(out of 27 Pilots registered with both GGHC and LEED)*		

GGHC Pilot Project Phase: MOB v. Total



Average Point Achievement: MOB v. Total GGHC Pilots



Public GGHC Pilots:

Note: The Green Guide *only releases the name of projects that have expressed interest in being publicly recognized.*

CSSS de la Montagne, Montréal, Quebec, Canada
Dana-Farber Cancer Center, Boston, MA
Donald Dexter Dental Clinic, Eugene, OR
La Maestra Community Hospital, San Diego, CA
Rush University Medical Center, Chicago, IL
Wellspring Medical Center, Woodburn, OR

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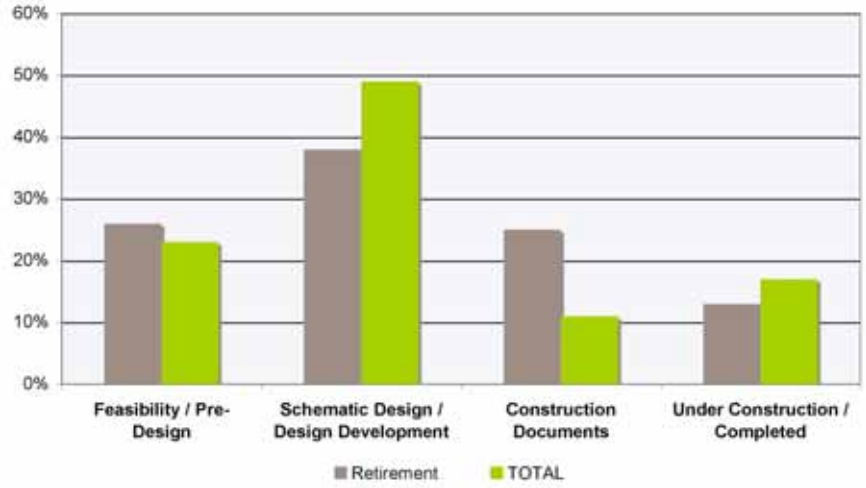
GREEN GUIDE FOR HEALTH CARE PILOTS – AT A GLANCE

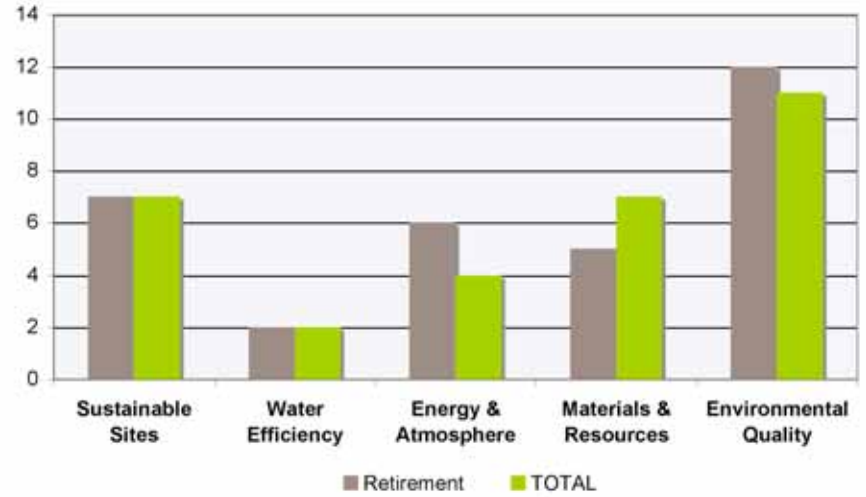
Facility Type: **Retirement**

Number of Pilots:	**8 Total**	7 Construction	5 Operations	1 No Checklist
Size:	Smallest 5,000 sf	Average 162,500 sf	Largest 483,000 sf	
Joint Registration, GGHC/LEED®:	1	*(out of 27 Pilots registered with both GGHC and LEED)*		

GGHC Pilot Project Phase: Retirement v. Total



Average Point Achievement: Retirement v. Total GGHC Pilots



Public GGHC Pilots:

Note: The Green Guide *only releases the name of projects that have expressed interest in being publicly recognized.*

Bon Aqua Health Care, Bon Aqua, TN

Veterans Homes of California, Ventura, CA

Veterans Homes of California, West Los Angeles, CA

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GREEN GUIDE FOR HEALTH CARE PILOTS – SECTION BY SECTION

The *Green Guide for Health Care* Pilot program spanned the initial phase of education and market uptake of green building principles and practices in the U.S. health care industry. In January 2005, green building was just emerging as a topic of discussion for most health care capital projects. By November 2006, the climate had changed so dramatically that *Facility Care* magazine was able to report findings from a poll of 250 hospitals around the country indicating that 81% of the polled facilities were actively addressing sustainable design in some way.

The *Green Guide* Pilots represent a broad cross-section of the health care industry: building type, construction type, project size, region, and level of commitment to green practices. The flexibility and confidentiality provided by the *Green Guide's* self-certifying Pilot program results in a group of Pilots that resemble a cross-section of the top 80% of green building performers. Several prominent green building health care projects (representing the top 5% of leadership institutions), such as the Dell Children's Medical Center of Central Texas in Austin, TX, and Hackensack University Medical Center in Hackensack, NJ, participated in the *Green Guide* Pilot program. However, rather than interpreting the lessons learned from the Pilot as a reflection of the experience of early adopters attempting to break through barriers in an incipient marketplace, the *Green Guide* Pilot provides a snapshot of the health care industry as a whole as it transitions towards incorporating high performance, healing environments into standard construction practice.

The industry as a whole has clearly embraced the *Green Guide's* proposal that, in the health care market, the definition of green building must be fundamentally tied to health care's mission to "first, do no harm." This principle underlies every credit in the *Green Guide for Health Care*. And, while some credits derived from LEED for New Construction were more readily achieved by project teams familiar with the LEED process, the new health-based credits generated the most interest – even among project teams unable to achieve them. In particular, the Places of Respite credit (GGHC v2.1 Sustainable Sites Credit 9), the toxics credits (GGHC v2.1 Materials & Resources Prerequisite 2: Mercury Elimination, Materials & Resources Credit 8: PBT Elimination, Materials & Resources Credit 9: Furniture & Medical Furnishings, and Environmental Quality Credit 4: Low-Emitting Materials), the Circadian Rhythm credit (GGHC v2.1 Environmental Quality Credit 8.4), and the Acoustic Environment Credit (GGHC v2.1 Environmental Quality Credit 9) have developed a loyal following who are actively exploring strategies to overcome technical and financial challenges, given these topics' primacy to the health care mission.

The *Green Guide* Pilot program also uncovered artificial "glass ceilings" to achieving water and energy efficiency credits – sparking research into methods to overcome regulatory, safety, and financial barriers. For example, energy efficiency programs are commonplace in operating health care facilities, but the cost of energy modeling during design has not been a standard budgeted item due to most health care facilities' exemption from complying with energy codes. In response, the *Green Guide*, in coordination with the USGBC, oversaw research to develop a "prescriptive path" for energy efficiency that would remove the need for an energy model for facilities wishing to earn 2 out of 10 possible Energy Optimization credits (GGHC v2.1 Energy & Atmosphere Credit 1). GGHC v2.2 will be updated in Fall 2007 to incorporate the new prescriptive path option. Another research project is currently testing the ventilation and infection control effectiveness of displacement natural ventilation (GGHC v2.1 Environmental Quality Credit 2: Increase Ventilation Effectiveness) in certain areas of a health care facility, such as exam rooms, with the eventual goal of inserting a natural ventilation path into health care ventilation regulations.

The *Green Guide* Pilot introduced a compilation of best practices for the health care industry that has been widely adopted over the past two years. This trend follows the example of LEED for New Construction, with many credits incorporated into standard specifications for commercial construction around the country. The lessons learned and key strategies listed below reflect a similar broad foundation of knowledge acquired during the Pilot. They provide a solid starting place for teams working on their first *Green Guide* design project. Likewise, they outline the underlying foundation for green building projects aspiring to reach the pinnacle of their industry.

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INTEGRATED DESIGN

Lessons Learned

1. **A robust Integrated Design process (GGHC v2.1 ID Prerequisite 1) is critical to successfully implement a green health care project.** While integrated design is an important element of any green building project, it is particularly crucial for health care facilities because of the complexity of building and mechanical systems, high dollar/square foot costs, and the benefit of stakeholder input involved in their design, construction, and operations.
2. **A successful integrated design process requires active support and commitment from every member of the integrated design team.** Including community leaders and the head of facilities management and medical personnel in all Integrated Design meetings is essential to the success of the integrated design process. In many cases, community leaders can help the team prioritize community stewardship initiatives such as reducing the hospital's impact on site stormwater infrastructure (GGHC v2.1 SS Credit 6) or introducing community-based program elements to the design. Facility managers and environmental services personnel are particularly important voices on the Integrated Design team, because they share maintenance experience and historical data on the systems and materials under consideration for the project. Medical personnel have an intimate knowledge of creating environments to optimize patient care. In many cases, the Pilot project's Integrated Design team coordinates with the hospital's in-house "green" or "high performance" committee (GGHC v2.1 IO Prerequisite 2) to enhance natural synergies and reap maximum operational benefits from design decisions.
3. **While most Pilot project teams are familiar with the term "Integrated Design," few reorganized their project schedule and roles & responsibilities to take best advantage of its benefits.** Integrated design often requires redistributing the fee schedule to allow additional time for collaborative design development early in the project, streamlining the process later on.
4. **The most successful *Green Guide* Pilots tied their vision of creating a high performance, healing environment to the health care provider's mission to promote health and community stewardship.** A health mission statement acts as a guiding document for design team selection, design criteria development, and construction documents. It also establishes a direct connection to the health care facility's overall mission statement.
5. **Incorporating a short list of clear, measurable objectives in the project documents helps to ensure that integrated design priorities are revisited at major project milestones.** The most challenging part of the integrated design process is ensuring that the project goals established at eco-charrettes during the visioning and schematic design stage drive all major decisions throughout the course of the project.

Key Strategies

The central importance of developing clear, concise guiding principles in a health mission statement (GGHC v2.1 ID Prerequisite 2) at the project's outset was demonstrated repeatedly throughout the Pilot. Developing the health mission statement at an eco-charrette early in the project (during visioning and/or schematic design) with broad participation from stakeholders will ensure support for the project's strategic direction. The project's guiding principles should combine aspirational goals with measurable criteria that can be tracked both during design and construction and post-occupancy.

GGHC Pilot Case Study: Howard Memorial Hospital, Willits, CA

Community involvement in facility planning (GGHC v2.1 Integrated Design Prerequisite 1) pushed the project team to incorporate innovative program and sustainable strategies that emphasize the community's health and well-being as well as issues important to patients. Strategies include: on-site renewable energy (GGHC v2.1 EA Credit 2), local materials (GGHC v2.1 MR Credit 5), an organic garden that will service the cafeteria (GGHC v2.1 EP Credit 1), operable windows (GGHC v2.1 EQ Credit 6), and room service food preparation (GGHC v2.1 EP Credit 1).

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GGHC Pilot Case Study: Dell Children's Medical Center of Central Texas, Austin, TX

The project team for this $200 million, 169 bed replacement facility constructed on the site of the old airport in Austin, TX, convened an integrated design committee (GGHC v2.1 Integrated Design Prerequisite 1) composed of all the major stakeholders for the project and established a regular meeting schedule throughout the design and construction process. The guiding principles for the project set standards for cost (maximum 8.33 year payback based on life cycle costing), equipment maintenance, specification criteria, and motivation (only pursue credits that make sense). At every major milestone in project development, the integrated design team compared their progress to the guiding principles to ensure that they remained on track. The integrated design process was particularly important to this project, whose goal is to become the first LEED Platinum certified hospital in the world.

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SUSTAINABLE SITES

Lessons Learned

1. **In general, the relationship between a health care facility and its surrounding site is similar to commercial construction.** The set of sustainable site design strategies implemented on health care projects is roughly the same as commercial construction. However, the emphasis in health care on improving public health and community stewardship focuses its approach to site design on strategies that enhance the healing process and reduce the site's environmental impact on the surrounding community.
2. **In many cases, *Green Guide* Sustainable Sites credits can be incorporated into a design by folding them into the larger goal of creating a patient-centered healing environment.** Perhaps the best example of this approach is the Places of Respite credit (GGHC v2.1 SS Credit 9). As health care providers work to improve the environment of care with a focus on creating a healing environment for patients and staff, direct connection to nature or natural elements is encouraged, because it has been shown to speed the healing process and improve staff productivity in the health care environment. Establishing outdoor places of respite can also help projects achieve other *Green Guide* credits. For example, a therapeutic roof garden will help mitigate the building's contribution to urban heat island effect (GGHC v2.1 SS Credit 7.2). Similarly, strategically placed interior courtyards could help improve access to daylight and views for patients and staff (GGHC v2.1 EQ Credit 8.1).
3. **The most effective site strategies seek to impact the entire medical campus and surrounding neighborhood, rather than targeting a single construction project.** The site provides an opportunity for the health care institution to demonstrate its commitment to public health and community stewardship in a tangible way. Many Sustainable Sites strategies, such as constructing structured parking facilities (GGHC v2.1 SS Credit 5), ensuring light pollution reduction (GGHC v2.1 SS Credit 8), and increasing building density on the site (GGHC v2.1 SS Credit 2), are only tangentially effective unless they are implemented on a large scale – at a minimum, across the entire medical campus.
4. **Large health care institutions have the ability to spur smart growth in their communities by acting as an anchor site for new amenities, such as public transit (GGHC v2.1 SS Credit 4.1), and basic services supporting near-by housing.** Health care institutions can set the example for their neighborhood by encouraging green site and development strategies that improve the health and well being of the community as a whole. As personnel-intensive workplaces, many health care providers increase regional density sufficiently to warrant increased investment in diversified modes of transit, cultural institutions such as libraries, and retail services such as grocery stores and banks.
5. **Many health care providers have begun to position themselves as leaders in community stewardship by reducing or eliminating site pollution that could negatively impact public health.** In the 1980's the U.S. health care sector gained a reputation as a major contributor to the release of toxic chemicals into the environment. Many of these chemicals can contribute to serious health concerns such as cancer and birth defects when they come into contact with humans through contaminated air, land or water. In 1998, the U.S. health care industry solidified its commitment to reducing its impact on the environment through a Memorandum of Understanding between the American Hospital Association and the U.S. Environmental Protection Agency. Over the past ten years, formidable progress has been made in reducing the volume of hazardous and medical waste in health care facilities across the country. Several credits in the *Green Guide's* Sustainable Sites section carry that work into the construction phase of a facility's lifecycle: Brownfield Remediation (GGHC v2.1 SS Credit 3), Stormwater Management (GGHC v2.1 SS Credit 6), Heat Island Effect (GGHC v2.1 SS Credit 7), and Community Contaminant Prevention (GGHC v2.1 SS Credit 10).

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Key Strategies

The *Green Guide* Pilots demonstrated that the key to successful sustainable site design in health care was listening to the surrounding community's expressed needs and desires. Replacement facilities regularly select a new location based on their patients' georgraphic growth pattern; however, these same institutions have only recently begun to respond to community requests that health care developments enhance the general health and well being of the surrounding community. For example, *Green Guide* Pilot Kaiser Modesto reduced its environmental impact on the surrounding community by filtering and retaining all stormwater on-site through the use of porous pavement (GGHC v2.1 SS Credit 6). In a similar move, St. John Owasso in Owasso, OK, purchased additional land off-site to build a second retaining pond (GGHC v2.1 SS Credit 6) after learning from the residential neighborhood bordering the site that previous big box developments on the other side of the medical campus had caused flooding in the neighborhood. St. John also installed cut-off fixtures on all exterior-installed lamps (GGHC v2.1 SS Credit 8), converting the medical campus into a nocturnal buffer for the neighborhood, which had previously suffered from light pollution emissions from the neighboring big box retail development. Another Pilot, Howard Memorial Hospital in Willits, CA, has set aside land on its new site for a community garden (GGHC v2.1 EP Credit 1) at the request of its neighbors. Brigham & Women's Hospital in Boston, MA, relocated existing houses from the site of its expansion to empty lots in the same neighborhood (GGHC v2.1 MR Credit 2) and added a public courtyard park to its existing campus (GGHC v2.1 SS Credit 9) in response to neighborhood concerns that the new building would dramatically reduce the amount of green space in that part of the city. While all of these examples demonstrate community stewardship, they also resulted in tangible economic benefits through methods such as: expediting building permit review, reducing or eliminating the need to connect to municipal storm sewer infrastructure, and reducing operating costs.

GGHC Pilot Case Study: St. John Owasso Hospital, Owasso, OK

The new St. John Owasso medical campus restored natural habitat (GGHC v2.1 SS Credit 5) and improved the stormwater management (GGHC v2.1 SS Credit 6) of its surrounding neighborhood. The greenfield site had been bare, abandoned farmland with a utilitarian pond. The project restored natural vegetation, reducing erosion, and re-designed the pond into an attractive retention pond. The next phase of the project will develop a hike and bike trail with picnic tables for use by patients, staff, visitors, and local residents (GGHC v2.1 SS Credit 9). Water from the pond will be used to satisfy 100% of the medical campus's irrigation needs (GGHC v2.1 WE Credit 1). An irrigation meter to add city water to the pond in times of extreme drought ensures that this system will function even in adverse conditions. The project developer also constructed an off-site retention pond adjacent to the site to mitigate the flooding effects of surrounding developments that have entirely paved over their sites without considering the impact that reduced pervious land would have on the neighborhood. The overall retention and water treatment accomplished by the series of ponds will improve overall stormwater quality and will reduce the site's contribution to the stormwater infrastructure. In an additional effort to improve the surrounding community's quality of life, the hospital uses cut-off fixtures to illuminate its property at night (GGHC v2.1 SS Credit 8), acting as a buffer to the light pollution created by the big box retail west of the site.

GGHC Pilot Case Study: Saint Joseph's Regional Medical Center, South Bend, IN

St. Joseph's Regional Medical Center is an example of a facility that has integrated both outdoor and indoor places of respite (GGHC v2.1 SS Credit 9) into the fundamental design vision. A café and dining terrace form one link in a series of combined indoor/outdoor places of respite spread across the site. The places of respite serve, in part, as wayfinding landmarks, integrating exterior spaces with the interior. For example, the planter in the lobby extends from the chapel garden into the interior, providing a direct connection between the exterior and interior. The series of places of respite are designed as programmed anchors at the edges of the building, with the lakes to the south and gardens to the north. Orientation to the major wayfinding landmarks is reinforced through signage and finish selection. In contrast to the programmed areas of respite on the edges of the building, the interior of the building is flexible (GGHC v2.1 MR Credit 11.1) and can be remodeled to accommodate programmatic needs as departments expand and contract over time.

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WATER EFFICIENCY and ENERGY & ATMOSPHERE

Lessons Learned

1. **Water and Energy conservation strategies are more achievable when operational priorities are incorporated into the design phase.** One of the major differences between health care and other building types is the interconnected nature of construction and operations, particularly on large medical campuses. Complex building systems are often shared campus-wide, and facility engineers can offer valuable advice about how to maximize efficiencies and minimize awkward connections across systems. Water and energy efficiencies are also often interconnected in mechanical systems and medical equipment. In some cases, a technology that improves water efficiency may have a negative impact on energy efficiency goals. The key to pinpointing the most effective strategy for both water and energy efficiency is to approach them as a unit, to avoid technologies that are expensive to maintain, and to work closely with facility engineers and infection control personnel.
2. **Major breakthroughs in process water conservation strategies will be required before health care facilities are able to dramatically reduce their overall water consumption.** Process water (ie. water used in building systems and medical equipment) can account for up to 70% of total water usage in a typical U.S. health care facility. The *Green Guide* Pilot program demonstrated both the high level of interest in improving process water efficiency and the difficulty involved in implementing major efficiency strategies. Additional research will be required to develop new strategies that do not compromise energy efficiency or infection control priorities and fit within a reasonable project budget.
3. **Upgrading the central plant can act as a catalyst for green building on a campus.** In many *Green Guide* Pilot projects, the central plant played a central role in their overall success using the *Green Guide for Health Care*. In some cases, aging mechanical systems acted as the major stumbling block for making substantial progress in the Water, Energy, and Environmental Quality sections. More common were Pilots that used a renovation or replacement of the central plant on a medical campus as a steppingstone to embracing a wide array of green building strategies outside of fundamental water and energy efficiency.
4. **Pilot experience has shown that the energy efficiency strategies with the largest payback are: effective envelope design, efficient lighting design, efficient mechanical equipment, and combined heat and power.** The energy intensive nature of health care facilities (particularly acute care hospitals) privileges strategies that reduce peak load. In addition, many health care institutions were not required to meet energy code until recently and have therefore not upgraded basic fixtures such as energy intensive lighting and mechanical equipment. The result is that many facilities have the opportunity to reduce their annual energy usage dramatically through retrofits that upgrade their lamps and equipment to current best practice (approximately 20-25% better than ASHRAE 90.1-2004). However, upon reaching that plateau, a conceptual leap is often required to reach the next level of achievement (30-40% improvement over ASHRAE 90.1-2004).
5. **Water and Energy conservation can be difficult for minor renovations and additions.** Many smaller renovation and addition projects do not impact the mechanical or electrical infrastructure directly enough to warrant system upgrades. As a result, these projects tend to focus on materials and environmental quality strategies instead of water and energy efficiency.

Key Strategies

Green Guide Pilots found the Water Efficiency section in *Green Guide* Version 2.1 the most difficult to achieve, in part because it did not reflect the reality of water usage in typical health care facilities. In response to Pilot comments, the *Green Guide* Steering Committee restructured the section in Version 2.2 to place more emphasis on all forms of potable water use reduction, including measurement & verification (GGHC v2.1 WE Credit 4.1/GGHC v2.2 WE Credit 2.1), domestic fixtures (GGHC v2.1 WE Credit 3.1 & 3.2/GGHC v2.2 WE Credit 2.2 & 2.3), and process water uses (GGHC v2.1 WE Credit 4.2/GGHC v2.2 WE Credit 2.4 & 2.5). Non-potable water use for irrigation (GGHC v2.1 WE Credit 1) was reduced from two points in *Green Guide* Version 2.1 to one point in Version 2.2 because irrigation represents a small percentage of total water use on a typical health care campus.

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The most effective water efficiency strategies in health care facilities often involve replacing water-intensive equipment with water-free alternatives (GGHC v2.1 WE Credit 4.2). For example, water-free alternatives for radiology equipment, vacuum pumps, and icemakers can dramatically reduce overall building water use. Many process water sources (such as reject water from sterilizers, reverse osmosis, and air handling unit coil condensate) can be reused as cooling tower makeup. Properly balancing the chemicals in the cooling tower can also reduce overall water use. Many facilities lose water in unexpected places – such as water closets that consume three times their posted rate. Successful long-term water conservation requires regular water use measurement and verification audits and/or continuous commissioning (GGHC v2.1 WC Credit 4) to ensure that all equipment continues to perform at optimum capacity after installation.

Most *Green Guide* Pilots implemented at least modest energy efficiency measures on their projects, both for new construction projects and ongoing facility operations, in part because the rising cost of energy provides a financial incentive and growing consciousness about global climate change. Pilots found that most clients will accept system upgrades with a proven payback schedule of three years or less. And, many hospitals have begun to specify high efficiency mechanical equipment as a matter of course. As more information becomes available, purchasing departments are beginning to review energy efficiency as one of several criteria for medical equipment purchasing standards (GGHC v2.1 EA Credit 7). Many Pilots also took advantage of local, state, and federal incentives to help fund energy efficiency strategies. As an added design savings, a prescriptive path has been developed that offers two out of ten possible energy optimization points (GGHC v2.1 EA Credit 1) without requiring an energy model. GGHC v2.2 will be updated in Fall 2007 to incorporate the new prescriptive path option.

Few Pilots achieved more than two or three points in GGHC v2.1 EA Credit 1: Energy Optimization due to the complexity of building systems and the energy intensive nature of the building type. Many projects still find the lighting efficiency thresholds in ASHRAE 90.1-2004 difficult to attain. In addition, projects constructed on existing medical campuses often lack control over choice of building orientation, skin, or massing. Similar to new water efficiency technologies, some energy efficiency technologies (such as economizers) can raise concerns about infection control. However, more and more project teams are initiating early discussions about systems integration with the goal of achieving higher energy performance.

Many Pilots also explored on-site renewable energy sources (GGHC v2.1 EA Credit 2), in spite of the difficulty of achieving a significant percentage of the facility's overall energy production. Several projects such as Kaiser Permanente's Modesto campus, Salinas Valley hospital, and Oregon Health & Science University installed on-site photovoltaic cells as a first step towards energy independence. *Green Guide* Version 2.2 encourages health care providers to claim a leadership position in countering global warming through investment in renewable energy by simplifying the calculation for on-site renewables and offering four new points to projects that purchase off-site energy from renewable sources.

GGHC Pilot Case Study: The Christ Hospital, Cincinnati, OH

By combining green construction and operations into a single continuous improvement program with clear, measurable goals, The Christ Hospital successfully implemented projects reaping multiple benefits, such as reducing both energy (GGHC v2.1 EE Credit 1) and water (GGHC v2.1 WC Credit 3) consumption by installing a dynamic control for the chilled water plant. The hospital also upgraded to closed-loop process water systems throughout the facility (GGHC v2.1 WE Prerequisite 1). Used process water is diverted to the central plant and re-used as cooling tower makeup. The facility also pursued new technologies, such as waterless urinals (GGHC v2.1 WC Credit 2), which have proved to be very popular and were promoted by educational posters in the restrooms explaining how they work. The hospital also plans to convert to a 100% rainwater irrigation system in 2007 following an in-house feasibility research project (GGHC v2.1 WC Credit 1). The hospital's programs to date have reduced annual water consumption by 1 million gallons (data compiled for 9/05 – 9/06).

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GGHC Pilot Case Study: Denver Health Medical Center, Denver, CO

Denver Health's new Pavilion for Women and Children is a 212,200 square foot addition to Colorado's safety net hospital. Denver Health received a $20,000 grant from the Governor's Office of Energy Management and Conservation's Rebuild Colorado program to engage a high-performance design specialist to facilitate an integrated design process (GGHC v2.1 ID Prerequisite 1 & 2) and oversee the LEED approach. The resulting building exceeds ASHRAE 90.1-1999 by 19%. Energy efficiency design attributes include: efficient lighting, chiller, and boiler burners; a reflective roof (GGHC v2.1 SS Credit 7.2), shading devices; and high performance glazing optimized for orientation. In addition, 90% of eligible appliances and equipment purchased for the project are Energy Star® rated (GGHC v2.1 EA Credit 7), further reducing the facility's overall energy use.

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MATERIALS & RESOURCES and ENVIRONMENTAL QUALITY

Lessons Learned

1. **The most effective materials selection and construction practices criteria on a green project address both building material content and on-site emissions.** Health care projects must comply with strict regulatory requirements, infection control criteria, and durability and cleanability protocols in addition to normal commercial construction best practices. In such complex circumstances, many Pilots drafted protocols to bridge the traditional material content/emissions divide, and the division between construction and operations. Materials specification and construction practices particularly benefit from this approach. A purchasing protocol or specification (GGHC v2.1 MR Credit 3-9) that weighs the relative merits of several material attributes ensures that one sustainable attribute (such as recycled content) is not incorporated into the project at the expense of potentially exposing future occupants to toxic emissions (GGHC v2.1 EQ Credit 4). Comprehensive construction practice protocols benefit in a similar way. Construction waste management programs (GGHC v2.1 MR Credit 2.1 & 2.2) should be coordinated with other strategies such as site and materials management (GGHC v2.1 MR Credit 2.3), utility and emissions control (GGHC v2.1 MR Credit 2.4), and environmental quality management (GGHC v2.1 EQ Credit 3). Comprehensive protocols and programs stress the importance of avoiding potential health consequences associated with building materials and construction practices with a goal to protect the health of the construction workers, the building's occupants, and occupants of adjacent properties.
2. **Daylighting design (GGHC v2.1 EQ Credit 8) for staff in Diagnostic & Treatment (D&T) areas and Inpatient Units (IPUs) should be incorporated into the earliest stages of the project: during programming and massing.** Most health care projects in the U.S. plan D&T areas as large blocks, due to the need to accommodate multiple critical adjacencies. Additionally, even though code requires a window in all patient rooms, most hospitals do not provide daylighting or direct access to exterior views from nursing stations or D&T areas. While *Green Guide* Pilot feedback overwhelmingly placed daylighting as a priority in the public and inpatient areas, designs that provide D&T areas and nursing stations with access to daylighting are rare. Projects should work closely with medical space planners from the earliest phases of design to penetrate the D&T block with interior courtyards and to ensure that nursing stations, D&T areas and patient rooms have access to the healing influence of daylight and views of nature.
3. **Pollution Prevention (P2) programs can be expanded to cover building materials in addition to eliminating Persistent Bioaccumulative Toxic Chemicals (PBTs) in facility operations.** While PBT avoidance is a relatively new topic for the green building industry, the health care industry has demonstrated leadership over the past ten years in reducing and eliminating PBTs such as mercury from health care operations and purchasing (GGHC v2.1 WM Credits 1 & 2 and EP Credit 4). Many *Green Guide* Pilots found that internal expertise gained through P2 programs provided background and guidance for the design team as they sought to implement toxic chemical avoidance strategies for building materials, furniture and furnishings on substances such as mercury (GGHC v2.1 MR Prerequisite 2 and Credit 8.2), dioxin (GGHC v2.1 MR Credit 8.1), lead & cadmium (GGHC v2.1 MR Credit 8.3), and copper (GGHC v2.1 MR Credit 10).
4. **Indoor air quality best practices should focus on two major themes: 1) introducing natural ventilation to appropriate areas of the health care facility; and, 2) removing sources of pollution resulting from delivery of care.** Many Pilots expressed concern that the *Green Guide* Version 2.1 Environmental Quality credits (GGHC v2.1 EQ Prerequisite 1 and Credit 2) associated with mechanical indoor air quality were adapted from LEED for New Construction (a rating system tailored to commercial office buildings) rather than reflecting best practices in regulated health care facilities. Research also found that strategies to approximate health care best practices by requiring increased ventilation rates produced diminishing returns and increased cost. In response, *Green Guide* Version 2.2 acknowledges current regulations in the Prerequisite and focuses the voluntary credit on the emerging topics of natural and displacement ventilation. Natural ventilation and natural cooling have been implemented on several projects in the Pacific Northwest over the past few years. A research project is currently underway with the goal of changing regulations to allow for appropriate uses of displacement natural ventilation in regulated health care facilities in the U.S. Another area of

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research concerns the sources of pollution (both indoor and outdoor) that result from delivery of care (GGHC v2.1 EQ Credit 5 and CM Credit 2). Facilities can eliminate some sources – such as switching from the toxic sterilant EtO to a non-toxic alternative. Alternatively, they can move the source away from building occupants – such as moving a hospital's helipad or ambulance idling queues away from building entrances and air intakes. Facilities can also protect points of entry from sources of contamination using MERV 13 filters on air intakes and pressurized entryway vestibules.

5. **A high level of interest among Pilots to improve the environment of care is coupled with limited experience and rapidly evolving research into topics such as circadian rhythm (GGHC v2.1 EQ Credit 8.4) and acoustic environments (GGHC v2.1 EQ Credit 9).** Mounting evidence suggests that the physical environment can accelerate the healing process for patients and improve alertness and productivity among staff. For example, nighttime electric lighting for patient rooms in the red color spectrum is less likely to disturb patient sleep. Installing a "light shower" in staff break rooms can improve alertness in nighttime staff by resetting their circadian clocks (the natural sleep/wake cycle). Noise is also a well-documented source of stress in health care settings. In many cases, noise-related concerns in patient areas can be addressed through simple design accommodations such as providing visual access to patient rooms through closed doors. *Green Guide* Pilot experience indicates that many health care facilities are exploring design solutions for environmental quality topics such as circadian rhythm and acoustics; however, in many cases, a successful solution will benefit from the integrated design process, combining design issues with operational realities that fall outside the purview of the design team.

Key Strategies

The *Green Guide* Materials & Resources and Environmental Quality sections emphasize market transformation. For example, the success of a construction waste management program (GGHC v2.1 MR Credit 2) hinges more on the availability of nearby recycling infrastructure than on the details of the construction waste management plan itself. Likewise, some green building materials (such as porous pavement and FSC certified wood) can be difficult to obtain in certain areas of the country (GGHC v2.1 MR Credit 3-9). While this challenge is not unique to health care projects, the significant purchasing power associated with large hospitals and health systems can be leveraged to speed development of products that meet their environmental and human health standards. Kaiser Permanente, the largest non-profit health system in the U.S., and several Group Purchasing Organizations (GPOs) have successfully collaborated with manufacturers to develop building materials and medical supply products that meet Environmentally Preferable Purchasing standards (GGHC v2.1 EP Credit 1-6).

Health care facilities are often in use for fifty to seventy-five years. During this time, they undergo substantial renovation and remodeling to accommodate changing clinical requirements, technologies and regulatory requirements. A design that reinforces both the long term durability of the facility (GGHC v2.1 MR Credit 11.2) and its adaptability (GGHC v2.2 MR Credit 11.1) must provide a healing environment throughout the entire facility, because areas designated Diagnostic & Treatment (D&T) today might be renovated for Outpatient functions at a later date. The key to successfully integrating adaptability, flexibility, and daylight (GGHC v2.1 EQ Credit 8) into health care design is to break through assumptions regarding critical adjacencies, building massing, and programming at the project's inception, concentrating instead on designing durable, flexible, adaptive, generic spaces with narrow floor plates or other mechanisms to introduce daylight into the heart of the building.

Revisiting fundamental design assumptions can present a challenge; however, several recent projects show that it is not impossible. Providence Newberg Medical Center (LEED® NC Gold Certified) in Newberg, OR, successfully introduced daylight into their surgical suite. *Green Guide* Pilot Dell Children's Medical Center of Central Texas in Austin, TX, (also registered with LEED) introduced daylight into their D&T block by strategically inserting enclosed courtyards throughout the facility. The courtyards double as a wayfinding tool and places of respite (GGHC v2.1 SS Credit 9). High performance glass ensures that the energy efficiency (GGHC v2.1 EA Credit 1) of the building is not compromised. Interior shading devices and light shelves reduce glare in addition to throwing the light farther into the interior of the facility (GGHC v2.1 EQ Credit 8). The design for a *Green Guide* Pilot prototype for Critical Access rural hospitals combined a two story 32' x 20' infrastructure spine with universal spaces laid out on a 32' x 32' structural grid. The flexibility (GGHC v2.1 MR Credit 11.1) associated with this modular design will accommodate

renovations, technology upgrades, and incremental growth with minimal disruption to the rest of the facility, lengthening its useful life. It also ensures that daylight (GGHC v2.1 EQ Credit 8) penetrates every occupied space of the facility.

GGHC Pilot Case Study: Hackensack University Medical Center Gabrellian Women's and Children's Pavilion, Hackensack, NJ

The Gabrellian Women's & Children's Pavilion project team focused on reducing toxic chemicals in building materials, furniture and furnishings (GGHC v2.1 MR Credit 8 & 9 and EQ Credit 4) as a pathway to creating a patient-centered healing environment. Like many other *Green Guide* Pilot projects, the inspiration for green building grew out of work on toxic chemical reduction in facility operations and clinical care. Hackensack is a Hospitals for a Healthy Environment (H2E) Partner and received an H2E Partner for Change Award in 2002, recognizing facilities that continuously improve and expand on their mercury elimination (GGHC v2.1 EP Credit 4.1), waste reduction (GGHC v2.1 WM Credit 1 & 2), and pollution prevention programs. The Deirdre Imus Environmental Center for Pediatric Oncology, opened in 2001 and, located at Hackensack, has been central to reducing exposure to chemical toxicants. For instance, they have developed and implemented their own non-toxic cleaning solutions and policy campus-wide (GGHC v2.1 ES Credits 3 & 4). The hospital also offers patient room service with an organic food option (GGHC v2.1 EP Credit 1), reducing food waste and potential exposure to toxic chemicals.

The materials targeted for reduction/elimination in the new facility's building materials, furnishings, medical equipment, and operations include: asbestos (GGHC v2.1 EQ Prerequisite 2), dioxin (through PVC avoidance) (GGHC v2.1 MR Credit 8.1), fiberglass, formaldehyde (GGHC v2.1 EQ Credit 4.4), mercury (GGHC v2.1 MR Prerequisite 2 & Credit 8.2), and flooring finishes with high VOC emissions (GGHC v2.1 EQ Credit 4.3).

Adopting a precautionary approach to achieve a healthy environment, non-toxic building materials were selected using criteria evaluating both emissions and content. Where possible, natural products sourced from rapidly renewable materials (GGHC v2.1 MR Credit 6) replaced conventional materials, such as wheatboard in place of plywood in casework and natural cotton insulation in place of a conventional fiberglass product. The attention to health-focused strategies also extended to construction of a vegetated roof (GGHC v2.1 SS Credit 7.2) that reduces the facility's stormwater run-off (GGHC v2.1 SS Credit 6), and an alternative transportation program (GGHC v2.1 SS Credit 4) for visitors and staff.

GGHC Pilot Case Study: HHS/HUD/USDA Critical Access Hospital Prototype (will be used as the basis for up to 900 rural hospitals throughout the US)

Providing daylighting without glare to all patient rooms was a major priority for the Critical Access Hospital Prototype. By designing a two-story facility with patient rooms on the second floor, the project team was able to reduce the facility's footprint by half (GGHC v2.1 SS Credit 5), narrowing the floorplate, and raising the patient windows to a level where they could visually access an on-site protected natural preserve incorporated into the prototype site design. The two design prototypes offer a bar shape and an L-shape option with a daylit interior spine to maximize sunlight penetration into all areas of the facility (GGHC v2.1 EQ Credit 8). Furthermore, patient rooms offer direct views from patient beds to treetops, including those nearby shading the parking area and further away in the nature preserve. All patient rooms are daylit through clerestories. In north-facing rooms, the clerestory is in the room. In south-facing rooms, the clerestory is in the two-story circulation spine adjacent to the patient room. This placement diffuses the daylight before it enters the room, preventing glare and direct heat gain through the window. South facing patient rooms look out across the interior spine and through a parallel window on the far wall across the roof to the designated on-site nature preserve in the distance.

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OPERATIONS SECTION

Lessons Learned

1. **The strength of the *Green Guide's Operations* section is its combination of generic green building strategies with topics specific to health care facilities, such as chemical management.** Green building practitioners will recognize credits borrowed from LEED for Existing Buildings, such as GGHC v2.1 TO Credit 1: Alternative Transportation and GGHC v2.1 ES Credit 3: Environmentally Preferable Cleaning Policy. Health-based credits such as GGHC v2.1 WM Credit 2: Regulated Medical Waste, on the other hand, will resonate with health care providers. Many credits in the *Operations* section can be traced to environmental non-profits active in the health care sector, such as Health Care Without Harm and Hospitals for a Healthy Environment.
2. **The single-most effective strategy to improve the Environmental Health performance of a green health care project is integrating green *Operations* programs and protocols into the construction Integrated Design process.** 60% of *Green Guide* Pilots are pursing both the *Green Guide Construction* and *Operations* sections. The percentage of projects implementing both sections grew significantly during the Pilot's second year, recognizing that significant synergies can surface between a new facility and existing operational strategies, such as pollution prevention and waste management programs. Incorporating a liaison from the facility's "Green Team" into the construction project's Integrated Design team also helps refine the project's overall philosophy and design goals. The GGHC/H2E Green Building teleconference series launched in 2006 raised awareness among Pilots about the most accessible areas of overlap for green construction and operations.
3. **The first step towards effective green operations is establishing and implementing a robust Integrated Operations program.** Over one half of all *Green Guide* Pilots pursuing the *Operations* section indicated pursuit of all Prerequisites and Credits in the Integrated Operations section, including: ongoing self-certification, establishing an integrated operations & maintenance process, environmental tobacco smoke control, maintaining outside air introduction & exhaust systems, staff education, building systems maintenance, building systems monitoring, maintaining indoor air quality, and reducing particulates in air distribution. The first step in this process, of course, is establishing a "Green Team" with a mandate from upper management and representation from all the departments impacted by the program.
4. **Pollution Prevention (P2) and Chemical Management programs required by U.S. EPA and other regulatory bodies can spur creation of a larger program of ecological practices in facility operations, as well as future construction projects.** Many health care facilities already meet the Credit Goals for selected credits, such as GGHC v2.1 WM Credit 1.1: Total Waste Reduction, 15%, due to economic or regulatory priorities. The advantage of the *Green Guide* toolkit is the credit framework, which crosses departments and disciplines, allowing the facility's internal "Green Team" to develop a set of comprehensive goals that can be implemented facility-wide and may require multiple departments to coordinate in novel ways.
5. **Approach *Green Guide Operations* credits with parallels in the *Construction* section as the second phase in the lifecycle of a green building strategy.** Many credits in the *Operations* section measure the result of strategies employed in the *Construction* section. For example, GGHC v2.1 EE Credit 1: Optimize Energy Performance offers points for facilities that achieve a specific U.S. EPA Energy Star score. Facilities that achieve the parallel credit in the *Construction* section (GGHC v2.1 EA Credit 1: Optimize Energy Performance) are more likely to achieve higher scores in the *Operations* section. Water credits work in a similar manner: the *Operations* section provides an opportunity for facilities to measure the success of the strategies they employed on the *Construction* side. Other parallel credits are not as obvious. For example, several *Green Guide* Pilots have integrated their Construction Waste Management program (GGHC v2.1 MR Credit 2) into the facility's larger Solid and Regulated Medical Waste reduction program (GGHC v2.1 WM Credit 1 and GGHC v2.1 WM Credit 2, respectively), which in many facilities includes an extensive recycling program.

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Key Strategies

The *Green Guide's Operations* section should be approached as a long-term, continuous improvement tool. Using the *Green Guide*, new and replacement facilities have the opportunity to develop a comprehensive green operations program during the design process that aligns with the goals and priorities of the green construction project. Existing facilities and facilities constructed on a campus with existing infrastructure, on the other hand, are more likely to work towards incremental improvement, setting a handful of measurable goals each year, rather than attempting to overhaul the entire facility operations at once. The most effective green operations programs track measurable goals from within the facility's existing recordkeeping system. *Green Guide* Credit Goals and Suggested Documentation have been designed to facilitate this kind of integration, rather than requiring additional forms and paperwork to verify credit achievement.

Many community stewardship and benefit programs undertaken by health care facilities are reinforced through the *Green Guide's Operations* credits. The 1998 Memorandum of Understanding between the U.S. EPA and the American Hospital Association committed the health care industry to minimize (and eliminate, where possible) the use of Persistent Bioaccumulative Toxicants (PBTs) and other chemicals of concern, as well as solid waste. A group of *Green Guide Operations* credits provide guidance to develop and implement a comprehensive plan to minimize toxic chemicals in health care facilities. For example, the Chemical Management section covers airborne releases of pollutants, leaks & spills, occupational exposure to chemicals used in clinical and sanitation processes, and disposal of chemical and pharmaceutical waste at the end of their useful life. Likewise, GGHC v2.1 WM Credit 2 targets regulated medical waste reduction. Toxic chemicals are often used unnecessarily by the environmental services department for cleaning and pest control. GGHC v2.1 ES Credits 2 & 3 outline low-impact alternatives to conventional practices in these areas. Community stewardship also encompasses outreach programs to the surrounding community. The *Green Guide* encourages health care facilities to leverage their size and economic impact in the community to advocate for alternative transportation programs, such as bus and metro lines and accommodations for cyclists (GGHC v2.1 TO Credit 1). Many health care facilities have also assumed a leadership role promoting locally grown, organic food (GGHC v2.1 EP Credit 1). These policies improve the patient's experience while also supporting the local economy. Recognizing the significant health benefits, some health care facilities have hosted a community garden or farmer's market on their site, improving access to fresh, organic food to their patients, staff and the surrounding community.

GGHC Pilot Case Study: Metropolitan Health, Grand Rapids, MI

Metropolitan Health, a 238-bed, full service hospital in Grand Rapids, MI, joined the *Green Guide for Health Care* Pilot program with the goal of developing a robust green operations program while its replacement facility, a project registered with the U.S. Green Building Council's LEED for New Construction program, was under development. Metro Health's work in operations was designed to continue and expand upon the green principles and strategies incorporated into its new green replacement facility (GGHC v2.1 IO Prerequisite 1). It has also actively worked to improve the existing facility's environmental health performance over the past few years through engagement with Hospitals for a Healthy Environment (H2E). The guiding principles for the new hospital, established and supported by senior leadership, included implementation of green development strategies in both construction and operations.

The first step towards greening operations at Metro Health involved the establishment of a new department, Environmental Management Services (GGHC v2.1 IO Prerequisite 2), charged with coordinating the new program, working closely with managers in other departments, and encouraging active participation amongst interested parties throughout the hospital. A key strategy for the program's overall success has been an ongoing staff education program that describes the new green operations strategies as a value-add for staff and encourages staff to participate in the program through implementation and suggestions for improvement.

Starting small, the Environmental Management Services department identified one or two measurable and clearly identifiable goals each year and folded their implementation into the JCAHO process. For example, the first year's goal was paper recycling. The second year's goal was total waste reduction

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(GGHC v2.1 WM Credit 1). From 2004 to 2005, Metro reduced total solid waste by 4% (23 tons). In 2006, they saved $35,000 in waste disposal costs. Establishing a continuous quality improvement process within the framework of the Joint Commission's Environment of Care category has facilitated transparency and established the program's overall success.

Each new project is tested through a pilot process before implementing it facility-wide. Metro Health's green operations program has slowly grown to include electronic waste recycling (GGHC v2.1 EP Credit 3), green cleaning (GGHC v2.1 ES Credit 3 & 4), and mercury and glutaraldehyde elimination (GGHC v2.1 EP Credit 4.1 and GGHC v2.1 CM Credit 2, respectively).

In 2007, Metro plans to recycle 33% of total solid waste and develop a recycling program for food services (GGHC v2.1 WM Credit 3). They also plan to implement compostable kitchenware (GGHC v2.1 EP Credit 2) and develop an employee carpooling program (GGHC v2.1 TO Credit 1.3).

Metro Health found that improving its environmental health performance leads to both financial incentives and public recognition. It achieved H2E's Making Medicine Mercury Free award in 2006 and the Partners for Change award in both 2006 and 2007. It also received grants to help offset the cost of establishing a carpooling database and a bioware project. The Clean Michigan Initiative awarded funding for a comprehensive stormwater management project. And, Metro Health was the first health care system in Michigan to be designated as a Clean Corporate Citizen by the Michigan Department of Environmental Quality.

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EMERGING OPPORTUNITIES

With the release of *Green Guide for Health Care* Version 2.2 in January 2007, the *Green Guide* began to lay a foundation for the next steps in the evolution of the health care industry, emphasizing a comprehensive ecological approach. Six groundbreaking white papers released in September 2006, commissioned by the Center for Health Design and Health Care Without Harm and sponsored by the Robert Wood Johnson Foundation, provide a glimpse into the future of the green health care movement. Entitled "Designing the 21st Century Hospital: Environmental Leadership for Healthier Patients and Facilities," the papers correlate the environmental impact of health care construction and public health concerns. New findings suggest that very low levels of exposure to chemicals routinely incorporated into building materials can result in chronic health disorders such as cancer and asthma. Several of the papers outline the proactive steps that leading health care institutions have taken to address the concerns raised by environmental health and evidence-based design findings in the realm of building materials, food service, and pollution prevention programs.

"Values-Driven Design and Construction: Enriching Community Benefits through Green Hospitals", written by *Green Guide* co-coordinators Robin Guenther and Gail Vittori, with Cynthia Atwood, presents interviews with CEOs of early adopter health care facilities that have embraced green building practices and operations. These executives identify sustainability as a mechanism to transform the health care system's current image as a polluter and major contributor to the release of toxic chemicals into the environment into an industry that promotes health. Creating health care facilities that are high-performance, healthy, and healing environments can help spur the necessary market and organizational transformations that will be required to fuel a paradigm shift towards ecological health care.

In the months following the release of *Green Guide for Health Care* Version 2.2 and the end of the Pilot, the *Green Guide* has continued to advance the health care community's knowledge of green building principles and practices. The *Green Guide's* online project management tools were enhanced and expanded. Technical briefs covering an array of *Green Guide* topics were released. And, the *Green Guide* continues to collaborate with Hospitals for a Healthy Environment on the GGHC/H2E Green Building Teleconference Series, a monthly program that focuses on green building topics of particular interest to the health care industry. In the midst of its second year of offerings and with a monthly audience exceeding 200 since its inception, the GGHC/H2E Green Building teleconference series has created a framework for sharing knowledge across design & construction teams and facilities management.

The *Green Guide Operations* section was minimally updated during the Version 2.2 document revision. However, many lessons learned from Pilot projects and the evolution of the market point to the need to review and update the *Operations* section as comprehensively as the recent *Construction* section revision.

The anticipated release of LEED® for Health Care in first quarter 2008, as recently announced by the U.S. Green Building Council (USGBC), will also mark a moment of transition for the *Green Guide Construction* section, a foundational document for the LEED for Health Care Rating System. The release of LEED for Health Care will bolster the momentum towards market transformation initiated by the launch of the *Green Guide* Pilot in December 2004. Additionally, the *Green Guide* and the USGBC have committed to formalize a partnership to support the organizations' continued provision of complementary services to the health care market, including a broad-based education program. Building on the body of work pioneered by the *Green Guide*, LEED for Health Care will represent the first third-party certification green building tool tailored to health care construction in the U.S.

In addition to its ongoing collaboration with the USGBC, the *Green Guide* will continue to work closely with Hospitals for a Healthy Environment (H2E) to encourage integration of green construction practices with programs within health care facilities that promote pollution prevention and green facility operations. Already, 60% of *Green Guide* Pilot projects are pursuing both the *Construction* and *Operations* sections of the *Green Guide* simultaneously.

The *Green Guide* Pilot program served a dual market transformational purpose. Pilot experience helped to dispel the initial real and perceived obstacles to implementing green design: for example, establishing

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a robust integrated design process, the perception that green buildings cost too much, alternatives to building materials containing toxic chemicals, energy and water efficiency strategies, and coordinating the priorities of project teams and "Green Teams" within the facility to maximize the success of green building strategies. Through aggregated Pilot data and case studies of *Green Guide* and other green health care projects, organizations such as the *Green Guide for Health Care*, Hospitals for a Healthy Environment, and the U.S. Green Building Council have shared strategies and largely overcome obstacles associated with this first generation of implementation.

The Pilots also uncovered the next set of hurdles to implementing breakthrough strategies. The challenge before the *Green Guide for Health Care* is now to work with the industry to develop simple, cost effective solutions to the next generation of challenges and support the health care industry as it evolves to a leadership position in green building.

Examples of the second generation of real and perceived obstacles to green building and operations include:

- Working with regulatory agencies to allow green building strategies as alternative paths in code.
- Integrating infection control criteria into relevant green building methodologies.
- Establishing stronger links between material content criteria and environmental quality.
- Assessing energy and water efficiency strategies as an integrated whole.
- Continuing to develop green building strategies that improve the environment of care.

Opportunities such as those listed above will define the future of green building in health care over the next five years. The power of the *Green Guide* as a learning community is its interdisciplinary and international flavor. *Green Guide* website registrants and registered projects are ideally positioned to lead the way on this new project through collaboration on research and implementation programs. The *Green Guide* looks forward to continuing to facilitate this work and educate the larger health care and construction community as new information becomes available. The Pilot was only the first step in a movement that has already begun to transform not only the health care industry but the construction industry as a whole.

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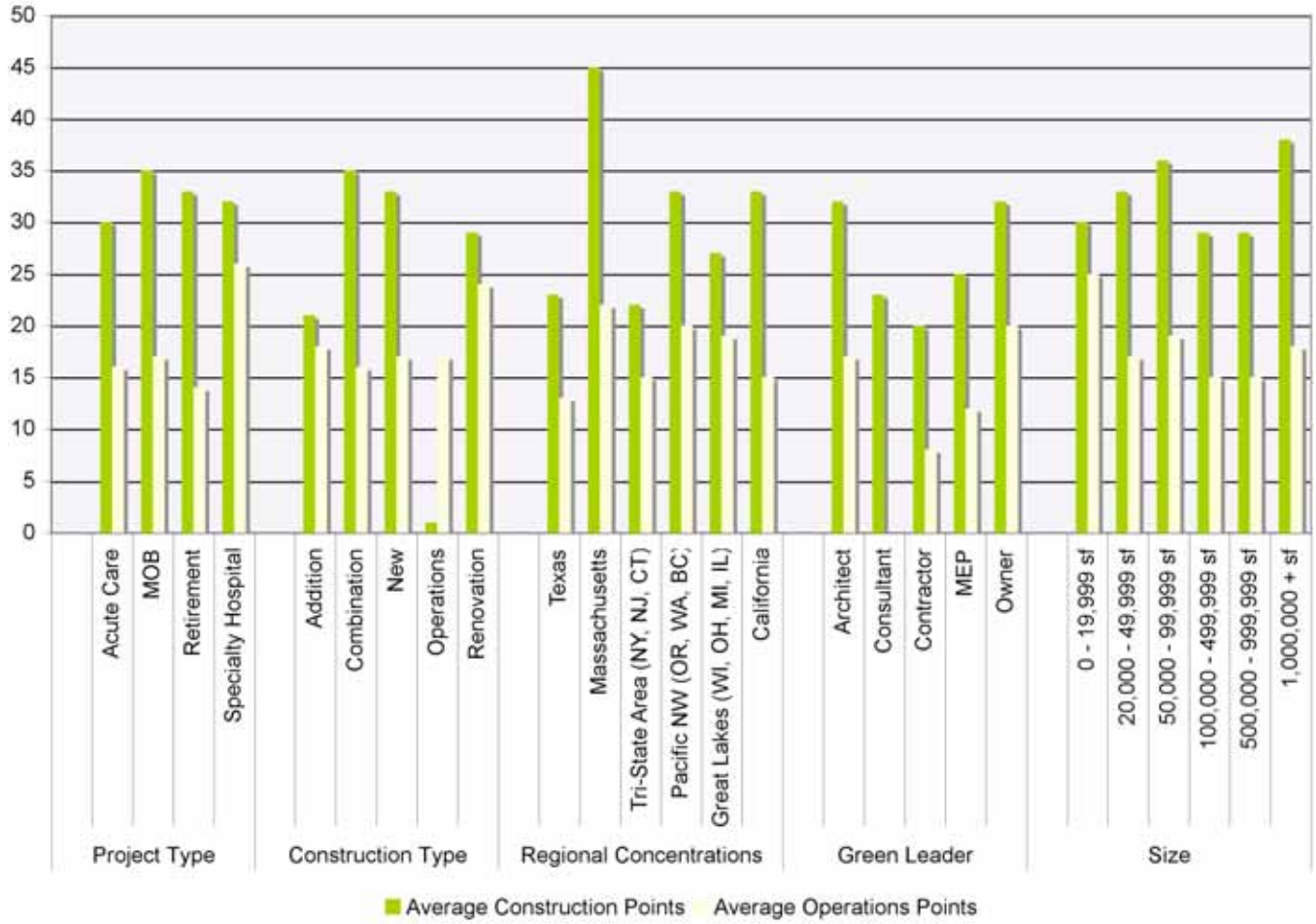
APPENDIX A: GGHC Version 2.1 Pilot Projects – Average Point Achievement



	Number of Pilots	Smallest Project Size	Largest Project Size	Average Project Size	Average Construction Points	Average Operations Points
Project Type						
Acute Care	70	4,000	3,000,000	380,500	30	16
MOB	23	1,900	407,000	94,000	35	17
Retirement	8	5,000	350,000	125,500	33	14
Specialty Hospital	18	5,000	483,000	162,500	32	26
Construction Type						
Addition	16	5,000	350,000	111,700	21	18
Combination	25	21,500	1,050,000	252,000	35	16
New	66	3,300	2,100,000	306,000	33	17
Operations	1	507,000	507,000	507,000	1	17
Renovation	11	1,900	3,000,000	375,000	29	24

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	Number of Pilots	Smallest Project Size	Largest Project Size	Average Project Size	Average Construction Points	Average Operations Points
Regional Concentrations						
Texas	7	21,500	471,000	205,300	23	13
Massachusetts	9	54,000	500,000	231,600	45	22
Tri-State Area (NY, NJ, CT)	12	20,000	3,000,000	423,000	22	15
Pacific NW (OR, WA, BC)	12	1,900	600,000	196,000	33	20
Great Lakes (WI, OH, MI, IL)	16	5,000	1,100,000	209,000	27	19
California	19	33,000	1,500,000	415,500	33	15
Green Leader						
Architect	76	3,300	1,050,000	191,500	32	17
Consultant	3	290,000	347,000	318,500	23	0
Contractor	4	150,000	1,500,000	594,300	20	8
MEP	7	106,300	3,000,000	792,400	25	12
Owner	29	1,900	2,100,000	323,800	32	20
Size						
0 - 19,999 sf	12				30	25
20,000 - 49,999 sf	12				33	17
50,000 - 99,999 sf	22				36	19
100,000 - 499,999 sf	43				29	15
500,000 - 999,999 sf	12				29	15
1,000,000 + sf	5				38	18

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APPENDIX B: Public GGHC Pilot Projects

Note: The Green Guide *only releases the name of projects that have expressed interest in being publicly recognized.*

Amery Regional Medical Center, Amery, WI

Beverly Hospital, Beverly, MA

Bon Aqua Health Care, Bon Aqua, TN

Brigham and Women's Hospital, Boston, MA

CSSS de la Montagne, Montréal, Quebec, Canada

Children's Hospital, Boston, MA

The Christ Hospital, Cincinnati, OH

Christus St. Catherine Hospital, Katy, TX

Dana-Farber Center for Cancer Care, Boston, MA

Dell Children's Medical Center of Central Texas, Austin, TX

Denver Health Medical Center, Denver, CO

Donald Dexter Dental Clinic, Eugene, OR

Hackensack University Medical Center Gabrellian Women's and Children's Pavilion, Hackensack, NJ

Jefferson County Hospital, Fairfield, IA

Kaiser Permanente Modesto Medical Center, Modesto, CA

Indianapolis Community Hospital South, Indianapolis, IN

La Maestra Community Health Center, San Diego, CA

Longmont United Hospital, Longmont, CO

McGill University Health Centre, Montréal, Quebec, Canada

Metropolitan Hospital, Grand Rapids, MI

New York Presbyterian Hospital, New York, NY

Oregon Health & Science University Patient Care Facility, Portland, OR

Palomar Pomerado Health, San Diego, CA

Rush University Medical Campus, Chicago, IL

Saint John Owasso Hospital, Owasso, OK

Saint Joseph's Regional Medical Center, South Bend, IN

Salem Community Hospital, Salem, OH

Salem Hospital, Salem, OR

Santa Barbara Cottage Hospital, Santa Barbara, CA

Spaulding Rehabilitation Hospital, Boston, MA

US Department of Health and Human Services Critical Access Hospital Prototype (200 nationwide)

Veterans Homes of California, West Los Angeles, CA

Veterans Homes of California, Ventura, CA

Washington Hospital, Fremont, CA

Wellspring Medical Center, Woodburn, OR

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