III. Analysis 1: Implementing Gold LEED® Certification

Green buildings and sustainable methods of construction are emerging topics and will only continue to grow. City Hospital is seeking LEED® Silver Certification for New Construction which requires the project to earn between 33- 38 points. Some of the credits the hospital are applying for are construction activity pollution control, complying to minimum energy performance standard as set forth by ASHRAE90.1-2004, storage and collection of recyclables on site, and complying with minimum indoor air quality act.

Problem Statement

The basis of my research is to identify four LEED® points that are not currently being explored. I would explore different design and construction methods to encourage a Gold LEED® rating (39-51 points). For example, the goal of controlling stormwater run-off lessens contamination of receiving waters by implement a stormwater management plan can be aligned with *SS Credit 6.2: Stormwater Design: Quality Control*. The second analysis on this topic would be a more detailed research on the LEED® credit *SS Credit 6.2: Stormwater Design: Quality Control* from the credits established initially for LEED® Gold rating. This analysis will require a large amount of research that will impact the schedule and the cost. The credits I will pursue will implement value engineering and schedule reduction.

Methodology

1. Literature review to become familiar with the different LEED® points
2. Review the LEED® points that are intended to be achieved on the project
3. Review potential LEED® points with LEED® consultant, Gabriella Edwards on the City Hospital project
4. Identify four LEED® additional points for Gold Certification (includes *SS Credit 6.2*)
5. Investigate the implementation of *SS Credit 6.2: Stormwater Design: Quality Control* which includes research options such as limiting the disturbance of natural water hydrology by managing stormwater runoff.

Solution

Leadership in Energy and Environmental Design (LEED®) is becoming the standard in sustainable design. There are six major categories under the LEED® rating system; they are sustainable sites, water efficiency, energy & atmosphere, materials & resources, indoor environment quality, and innovation & design process. Under these categories there are prerequisites and credits outlined in the scoring system. Executing the credits under these

categories in terms of cost may range in savings to incredibly costly during construction and operation. Although there is a high cost to constructing a sustainable building, the advantages are very rewarding. For hospitals and healthcare facilities, the benefits to people are equally impressive. Studies show that green buildings dramatically increase health and productivity. "Anecdotal studies demonstrate that people in green buildings have 40-60 percent fewer incidents of colds, flu, and asthma; patients in green hospitals are discharged as much as two and a half days earlier..." (Holowka, 1) The first LEED® hospital, Boulder Community Foothills Hospital was awarded LEED® v2.0 Silver Certification. "Since the LEED® program started in 2000, only four health care facilities have achieved certification, although there are 71 healthcare projects that have been registered and are expecting LEED® certification once complete." (Weller, 1) There are very few LEED® hospitals because of the high cost involved. As a result, the Green Guide for Health Care was developed and is modeled after the LEED® rating system to the needs of hospitals. Now the US Green Building Council developed the LEED® for Healthcare Rating System and has adopted Green Guide for Health Care which addresses the challenges of health care buildings, considering health issues as a factor in each credit, and integrates the healing process into the design of the facility.

A few examples of some of the credits that can be gained, according to the guide, are using innovative technologies that address health care's significant energy and water consumption, eliminating and containing toxic chemicals, provide occupants with connections between indoor and outdoor spaces, implementing green housekeeping and incorporating staff break rooms with views. LEED® hospitals recognize that there is a link between the value of the environment and the value of health.

The four LEED® points that I have identified that would explore different design and construction methods on the City Hospital project are:

***EA Credit 5*: Measurement & Verification (1 Point)**

The intent of this credit is ensuring that water and energy cost savings are maintained overtime after building occupancy. This allows for ongoing documentation and improvement of building energy and water consumption over the life of the facility.

LEED® requires a Measurement and Verification Plan with reference to the "*International Performance Measurement & Verification Protocol (IPMVP)*" which provides the support and management for the measurement and verification of building energy performance. Metering equipment is to be installed to measure energy use which will be compared to predicted performance. Systems can be monitored by Sophisticated Electrical Management Systems, Building Automation Systems or Direct Digital Control systems. The Measurement &

Verification and information collected from post-occupancy is essentially providing feedback from the building such as the buildings energy efficiency.

City Hospital is currently using a building automation system called direct digital control (DDC) to monitor and control various function of the mechanical equipment. To earn the measurement and verification credit, City Hospital can expand this system and incorporate the use of data loggers (Figure 5.10) on the project site. Onset Computer Corporation offers the technology "HOBO data loggers" to independently measure and monitor the buildings temperature, humidity, light intensity, CO_2 levels, air pressure and quality, and voltage which can assist with building commissioning, the monitoring of occupant comfort settings, and energy use and efficiency. For example, energy use from lighting and equipment can be monitored to determine whether they are cutting electricity costs. Outdoor and indoor units are available that can measure up to 24 hrs a day, 7 days a week. They can be battery powered or hardwired through USB connections to be connected to an existing network or to the internet for easy data access.

www.onsetcomp.com

Figure 5.10: Data Loggers

The factors that should be considered with this system are function, initial cost, operating cost, and schedule. The system is expandable allowing up to hundred data loggers to use multiple monitoring stations and that can be easily relocated. Not only is data collected and stored, it is also backed up across the network allowing data to be continuously recorded in an event of a power failure.

The following table in Figure 5.11 recognizes the requirements City Hospital would need to meet this credit.

Requirements
1. Develop a Measurement & Verification Plan
2. Include a schedule of the instrumentation and controls for the following monitoring categories.
• Lighting controls and systems
• Energy efficiency systems and equipment
• Boiler efficiency
• Chiller efficiency
• Cooling load
• Air and water economizer and heat recovery cycles
• Air distribution pressures and ventilation air volumes
• Variable frequency drive operation
• Constant and variable motor loads
• Water risers
3. Include cut sheets of sensors and the data collection system used to provide metering.

Figure 5.11: Requirements for Measurement &Verification

This LEED® point requires early planning into the design and construction effort so that mechanical and electrical engineer are able to design systems that can be monitored easily for comparisons. For example, electrical equipment can be connected onto one panel board for ease of monitoring. One of the benefits of this system is most of these design requirements are zero or negligible cost items if included as part of the original design.

The Measurement and Verification scope of work will interface with other LEED® credits to be obtained or proposed for by the City Hospital such as *WE Credit 2*: Innovative Wastewater Technologies, *EA Credit 3*: Additional Commissioning, *IEQ Prerequisite 1*: Minimum IAQ Performance, *IEQ Credit 1*: Carbon Dioxide (CO_2) Monitoring, and *IEQ Credit 6:* Controllability of Systems. For example, the measurement and verification credit will coordinate with the CO_2 monitoring system to make certain it functions properly over time and innovative wastewater technologies to include water treatment and reuse in the plan.

***EQ Credit 1*: Outdoor Air Delivery Monitoring (1 Point)**

The focus of this credit is to monitor outdoor air ventilation rates to ensure that they supply the required amount of fresh air to the building that will maintain the minimum indoor air quality requirements. This credit interfaces with *EA Credit 5*: Measurement & Verification as proposed

which uses data loggers to measure air flow and CO_2 levels. The data loggers would feed the information to the Direct Digital Control which would trigger an alarm if conditions fluctuate by 10% from the normal.

LEED® requires:

For mechanically ventilated spaces:

Install carbon dioxide monitors between 3 feet and 6 feet above the floor within all spaces occupied by 25 or more people per 1000 sq. ft.

Install outdoor airflow measurement devices (+/- 15% accuracy of design minimum outdoor air rate) for each HVAC system serving non-densely occupied spaces.

For naturally ventilated spaces:

Install carbon dioxide monitors between 3 feet and 6 feet above the floor. One carbon dioxide sensor may be used to represent multiple spaces if the design meets requirements.

For City Hospital the data loggers would essentially be operating as a carbon dioxide monitor to maintain low levels of CO_2. The advantages of using this system are to improve indoor air quality which in turn would improve the occupants' health, comfort and productivity. Also especially in a hospital setting this would eliminates the risk of allergies, asthma and other health effects. The system provides significant energy cost savings by limiting the amount of unnecessary outside air for ventilation purposes.

***WE Credit 2*: Innovative Wastewater Technologies (1 Point)**

The intent of this credit is to decrease the use of waste water and potable water usage on site by 50%. The most common way to achieve this LEED® point is to specify high efficiency fixtures. Usually, efficient fixtures alone are not enough to get to the 50% standard.

In the case of the City Hospital, *SS Credit 6.2*: Stormwater Design: Quality Control implements a rainwater capturing system to further reduce potable water consumption. The steps below are the requirements proposed for the City Hospital Project.

1. Use high efficiency fixtures, such as toilets and waterless urinals.

Kohler provides a variety of efficient fixtures. High efficiency toilets use 1.2 gallons of water or less per flush, averaging about $300 per unit, compared to 1.6 gpf typically used today. Waterless urinals conserve thousands of gallons of water per fixture per year. The Wellworth® Pressure Lite™ 1.1 gpf toilet and the Steward™ S waterless urinal provides value to the customer by reducing water, sewage and maintenance costs. Each unit cost $451.20 and $489.25, respectively

www.us.kohler.com

Figure 5.12: Kohler water fixtures

2. Reuse of stormwater and non-potable applications such as mechanical systems and irrigation.

   Proposed in credit ***SS Credit 6.2*: Stormwater Design: Quality Control**

***SS Credit 6.2*: Stormwater Design: Quality Control (1 Point)**

This credit is used to reduce water pollution by capturing and treating stormwater runoff.

A plan must be put in place to:

1. treat and capture 90% storm water runoff
2. remove 80% TSS (total suspended solids)
3. use acceptable Best Management Practices such as sustainable design strategies and alternative surfaces

According to EPA, "A unique rooftop rainwater recovery system captures and filters rainwater for use in wastewater fixtures; it cuts treated domestic water use by approximately 50 percent and reduces site runoff by 40 percent…LEED® documentation estimates an annual water savings of 735,000 gallons from this unique system." This system can be used to earn this credit on City Hospital; a Stormwater Catchment System. Captured rainwater runoff must be treated then stored in tanks or pipes for reuse. On a crammed site like City Hospital, the water would be reused for irrigation and cooling towers. The components of this system include the rainwater catchment area (roof), transportation system (gutter and piping), filtration system,

storage system (cistern), and a pump to distribute the captured rainfall to the landscape or building as shown in Figure 5.13. A leaf screen can be used along the gutter or downspout to collect debris and other objects to preventing clogging.

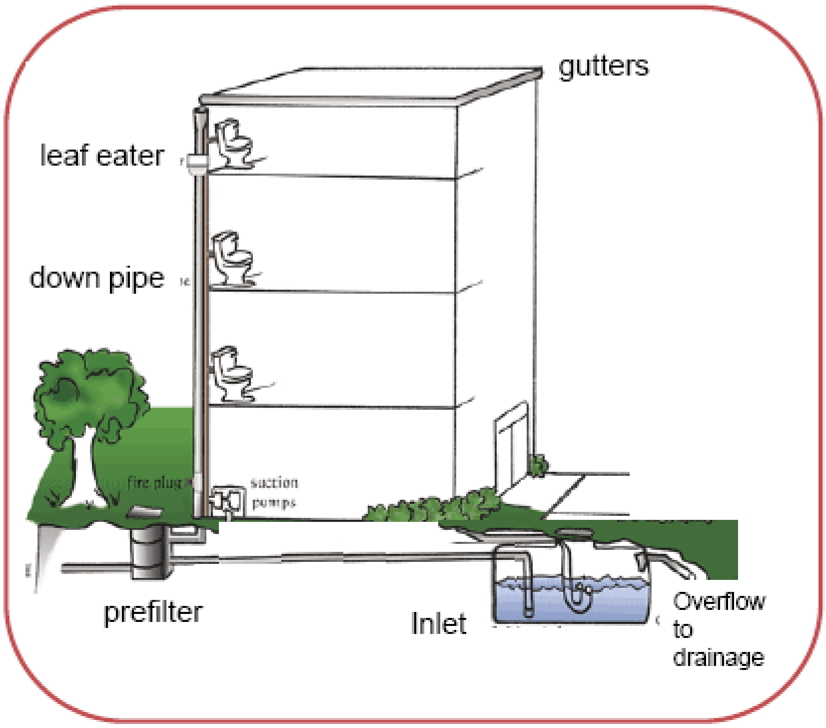

Figure 5.13: Stormwater Catchment System

A few factors that must be considered upon using this method for stormwater catchment are the budget, aesthetic features, planning, site layout and conditions, and local weather patterns. This cistern is costly but "the payback period for cistern systems is less than 10 years" (Hunt, 6). "The entire system cost for installation ranges from $0.75 per gallon for larger cisterns to nearly $2 per gallon for smaller cisterns." (Hunt, 6) Before installing the cistern, local utilities company must be contacted to locate buried pipes and cables. Also a support system for the cistern is needed and shown not be located immediately next to the building in order to avoid damage to the building's foundation. Rainfall in the Philadelphia area should be calculated to size the cistern. This system will include a pump (submersible pump or jet pump) to pump the treated water to be reused for the cooling towers and irrigation. The Lane Counter Flow Technology Water Quality Unit (Lane CFT) can be used to intercept the stormwater flow, remove pollutants, and discharge treated flow in a manner suitable for today's stormwater

regulator. It helps with pollutants removal in the first flush. The first flush occurs at the beginning of each rain event as sediments deposited from the previous event, as well as floatable debris is collected and carried away with the initial rainwater flow. When evaluating and comparing to determine the critical concerns when implementing this system, there will be advantages and disadvantages.

Some of the advantages that will be gained in using this system are;

- Below ground cisterns are not visible to the viewer
- Reduces water bills and system pays for itself over time
- Reduces erosion and pollution caused by runoff
- Tax credits and rebate program available
- Reduces the harm done to the environment

Some of the disadvantages in implementing this system are;

- Due to the large size and weight of cisterns, delivery charges are often substantial
- Underground cisterns limit access after installation for repairs

Calculations for sizing cistern:

The size of the cistern depends on the rainfall supply and demand. According to LEED®, the stormwater system must be designed to handle 90% of the average annual rainfall. In Philadelphia, 1 inch of rainfall is 90% of the average annual rainfall. Figure 5.14 provides the cistern capacity; the calculations below are used to size the cistern for the project.

1” of rain over the area × Catchment Area (Roof) = water (gal.) stored in cistern

$$\left[1'' \times \frac{1'}{12''}\right] \times 87{,}432\, sq.\ ft. = 7{,}286\, cu.\, ft. = 54{,}503\, gal.$$

Philadelphia average annual rainfall = 42.05”

Annual rain fall × Catchment area (Roof) = water (gal.) collected per year

$$\left[42.05'' \times \frac{1'}{12''}\right] \times 87{,}432\, sq.\ ft. = 306{,}376\, cu.\, ft. = 2{,}291{,}852\, gal.$$

Height (feet)	6-foot Diameter	12-foot Diameter	18-foot Diameter
6	1,269	5,076	11,421
8	1,692	6,768	15,227
10	2,115	8,460	19,034
12	2,538	10,152	22,841
14	2,961	11,844	26,648
16	3,384	13,535	30,455
18	3,807	15,227	34,262
20	4,230	16,919	38,069

http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf

Figure 5.14: Cistern Capacity (Galloons)

Cistern Structural Support:

The soil that the cistern will be supported by must be known to determine whether the soil can support the structure. Structural support will be needed if the load "is greater than 2,000 lb/ ft^2 load bearing capacity of the soil." (Jones, 6) The calculation below can be used to determine the need for support. Concrete or a layer of gravel can be used as a support system.

$$\text{Cistern Load} = \frac{\text{Capacity} \times 8.35 \text{ lbs/gal} + \text{Cistern Weight}}{\text{Footprint Area}}$$

The proposed Stormwater Catchment System in section and plan view for City Hospital can be found in Appendix C.

MEP Coordination:

The coordination of mechanical, electrical, and plumbing (MEP) systems with the stormwater system will be required. Plumbing designers and contractors will need to configure piping from roof to the cooling towers and irrigation system. Electrical connections will be needed to power the pump, cisterns and controls. Overall this system will affect the schedule; therefore coordination before construction will need to take place.