Final Report

Voorhees Replacement Facility | Voorhees, NJ

Steven Farrah | Construction Option

4/7/2010

Chris Magent

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VOORHEES REPLACEMENT HOSPITAL

VOORHEES, NJ

STEVEN FARRAH

CONSTRUCTION OPTION

General Data

Owner: Virtua Health
CM: Turner Construction Company
Architect: HGA Architects & Engineers
MEP/Structural Engineer: HGA Architects & Engineers
Delivery Method: CM@ Risk, GMP Contract
Construction Costs: $323 Million
Dates of Construction: March 2008 - March 2011

Electrical/Lighting

1 Electrical service at 12,470 volts distributed to 6 substations where power is brought down to 480/277V 3 phase 4 wire.

Substations are paired to create redundancy if a substation should fail.

3 1,500KW diesel generators sized to provide 96 hours of backup. 900 KW rotary UPS to provide uninterrupted backup power.

Lighting primarily on 277V. Minimal use of incandescent lighting.

Mechanical

Building heating, domestic water heating and auxiliary steam is being provided by saturated steam boilers and condensing hot water boilers.

Chilled water will be generated by electric drive, water-cooled, centrifugal chillers. Cooling heat will be rejected through 4 induced cooling tower cells.

3 sets of AHUs
AHU Sets 1&2 - 2 50,000 CFM VAV units each
AHU Set 3 - 6 75,000 CFM VAV units

Architecture

675,000 square foot, replacement hospital providing inpatient and outpatient care.

Made up of an 8-story bed tower (370 beds), 9-story spine, 4 stories of ancillary spaces, a central utility plant and a loading dock.

Designed to promote healing and human interaction through the use of space.

Exterior facades include a massive aluminum and glass curtainwall system on the bed tower, stone veneer, insulated and composite metal panels and solid phenolic panels.

Structural

Almost 4,000 stone columns, about 45 feet deep were installed under the building footprint to allow the building to be supported by typical spread footings. (over 100 million lbs of stone)

Structure composed of composite steel framing for floors and non-composite for the roofs. Typical floor construction consists of 3 1/2" lightweight concrete on 3" x 18 gauge metal deck.

Typical bay sizes are 30'x32' in the bed tower and 31'-4"x29'-4" in the ancillary spaces. Lateral system consists of steel braced frames.

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Executive Summary

The following document is a collection of different analysis's that focuses on various industry issues and construction management techniques within the Voorhees Replacement Hospital. The Voorhees Replacement Hospital is a project being constructed for Virtua Health and is located in Voorhees, New Jersey. The hospital is 8 stories tall and 675,000 square feet including a 300 bed patient wing and supporting ancillary spaces. The analysis's performed for this document include a sustainability and LEED study, a LED lighting analysis, and an analysis of the fit-out schedule for the bed tower.

The first analysis attempts to analyze the hospital for LEED points it is already achieving and then determines the cost to reach each LEED certification through a point-by-point analysis. This analysis was chosen because the Voorhees Replacement Hospital is not currently attempting to achieve a LEED rating and sustainability is a big issue within the construction industry at the moment. After performing the point-by-point analysis it was determined that the Voorhees Replacement Hospital with its current design and specified systems would be obtaining 30 points out of 110 LEED points. To become LEED certified the minimum amount of points required is 40, to get a silver rating 50 points are needed, to get a gold rating 60 points are needed, and 80 to 110 points is a platinum rating. Through the point-by-point analysis costs were determined to achieve each point and then points were mixed and matched to find the cheapest path to each rating. The summary of the cost to obtain each rating can be seen in the table below.

TOTALS				
LEED Rating	**Total Additional Cost**	**% Construction Cost Increse**	**Point Range**	**Point Total**
Base Building	$ -	-	-	30
Certified	$ 99,888.00	0.031%	40-49	42
Silver	$ 817,345.00	0.252%	50-59	51
Gold	$ 8,736,182.00	2.633%	60-79	60
Platinum	-	-	80-110	-

The second analysis attempts to redesign the lighting in a typical patient room to utilize LED down lighting, determine the effect the lighting change has on the mechanical system, and then evaluate the life cycle of the newly designed room. The room could be designed to the required light levels using LED lighting and at a lower total room lighting wattage then the designed fluorescent room. After determining the new lighting wattage in a typical patient room the HVAC system was analyzed to determine if there were any cost savings due to the change in lighting. It was determined that the change in lighting would produce a energy savings of about $1,427.00 a year and the mechanical equipment could not be resized due to the change in lighting. Through performing a life cycle and cash flow analysis it was determined that even though LED lights last longer, use less energy and produce a mechanical savings the initial cost of the LED lighting was to great to overcome throughout its lifetime and therefore should not be considered in the hospital.

The final analysis attempts to investigate and revise the current schedule for the rough-in and finish stages of the bed tower. The revision will break down the schedule of each floor into the processes for each patient room and develop a short interval schedule for the entire bed tower. After completing the short interval schedule for the bed tower it was determined that there would be a 35-day reduction in schedule. Because the bed tower fit-out is along the critical path of the project this schedule reduction would result in a general conditions savings that was calculated to be the amount of $528,412.00.

Introduction

The Voorhees Replacement Facility is a 675,000 square foot hospital located in Voorhees, New Jersey. It is an 8-story replacement hospital that provides both inpatient and outpatient care such as but not limited to pediatrics, oncology, cardiology, cancer treatment, sleep center and emergency services. The hospital is being constructed for Virtua Health who upon building completion will transfer all of their current patients to the replacement hospital from the existing hospital in Voorhees.

Virtua is constructing the replacement hospital because the current Voorhees hospital has reached its capacity and does not have enough space to accommodate the growing needs of the community it serves. Additionally the current Voorhees hospital was designed around old technology and would not be able to utilize future technologies that could dramatically increase the effectiveness of healthcare.

The building itself is made up of 5 parts, an 8-story bed tower, a 9-story spine running perpendicular to the middle of the bed tower, 4 stories of ancillary spaces, a central utility plant, and a loading dock. The bed tower will house 370 beds each with its own private room. The lower floors of the spine will be part of the ancillary spaces and the upper floors above the ancillary spaces will house any mechanical equipment not found in the central utility plant. The ancillary spaces will include the supporting components of the hospital such as emergency rooms, surgeries, and baby delivery rooms. The central utility plant will be home to extremely large system equipment such as the main switchgears, chillers and generators.

The Voorhees Replacement Hospital is designed to create a warm, welcoming and comfortable environment that will promote healing and human interaction through the use of space. The replacement hospital is truly a ‘form follows function’ in this sense. Virtua Health participated in a healthcare environment study called the “Pebble Project” which examined how a healthcare environment can affect the outcome of patients. From this study each patient room was designed with large windows with a scenic overlook and a distinct family zone welcoming the family into the healing process with the patient.

Client Information

Virtua Health is a non-profit organization employing about 7,900 clinical and administrative personnel and over 1,800 physicians as medical staff members. Virtua consists of four hospitals: Virtua Memorial, Berlin, Marlton and Voorhees. Virtua delivers nearly 7,600 babies a year, more then any other healthcare organization in its region and also provides the latest technology and treatments for all forms of cancer.

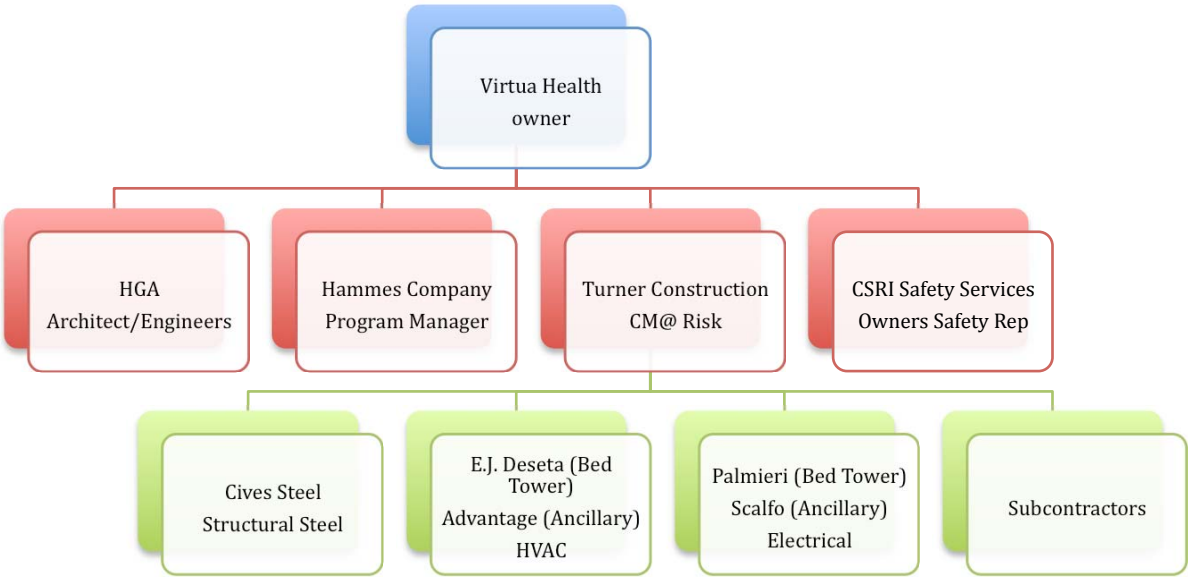
Currently Virtua occupies a hospital located in the same town, Voorhees, NJ that has reached its capacity and does not have space to accommodate the growing needs of the community. The current hospital was also designed on outdated technology and is not able to implement future technology along with Virtua's new and improved workflow plan.

Virtua's vision for the new Voorhees Replacement Facility is to create a warm and comfortable environment that promotes positive human interaction through personalized service and enhances healing through the use of light, space and the application of the advanced technology being showcased in the new hospital.

Upon the opening of the replacement facility all patients of the existing hospital will be transported to the new hospital. This creates an emphasis on completing construction on time. Virtua wanted a fast-tracked schedule and in order to get the 3-year construction schedule started as soon as possible steel and foundation packages were issued long before the rest of the design was complete.

The key to completing the Voorhees Replacement Facility on time is to manage the subcontractors efficiently. With such a large volume project it is easy to have setbacks due to subcontractors getting in the way of one another due to the excessive number of workers on site at any time. This with a combination of proper engineering and project management will ensure that Turner can deliver the hospital on time to Virtua.

Project Delivery System



The Voorhees Replacement Facility is being delivered using the traditional design-bid-build approach. Virtua Health hired each company using the "best value" approach meaning they took into account both price and experience when selecting each company they hold contracts with. As seen above in the organizational chart Virtua holds contracts with the A/E, Program Manager, Construction Manager, and their Safety Rep. Virtua also holds other contracts such as their medical equipment planner, commissioning agent and food service consultant however the 4 companies shown in the chart are the main players during construction. The contract that Virtua holds with Turner Construction is a guaranteed maximum price contract which means that Turner has guaranteed that they will construct the hospital per the construction documents for no more then their bid price.

Since Turner Construction is acting as a CM@ Risk, they hold all the subcontractor contracts. Turner, like Virtua did not just select their subcontractors by low bid but used their prequalification system to select the right subcontractor for each bid package. The contract type between Turner and all of the subcontractors is a guaranteed maximum price contract. Since the project is utilizing building information modeling to perform MEP coordination one of the most important contract terms to note is that all the subcontractors involved in the coordination process are required to submit and update a 3D model so that Turner can utilize 3D coordination.

Lastly it is important to note that Virtua holds an OCIP on this particular project. An OCIP is an Owner Controlled Insurance Program and provides insurance to all participants on the project. An advantage to having an OCIP is it allows for both the owner and the construction manager to hire the best subcontractors for the project without having to worry about the availability of insurance coverage for any subcontractor. Having an OCIP also reduces the cost of the project for the owner as well as reduces the number of claims.

Site Plan of Existing Conditions

Please see Appendix N for the site plan of existing conditions.

The site for the Voorhees Replacement Facility is located in Voorhees, New Jersey located between Dutchtown Road and Route 73. There are no buildings immediately surrounding the site that would constrain any construction operations. In Figure 1 one can see the location of the new hospital. The dotted red line indicates the property boundary.

Kresson Golf Course
Dutchtown Rd
Berlin Kresson Rd
Berlin Kresson Rd
Kresson Gibbsboro Rd
Cedar Lake
Lost Lake
Kresson Crossing Center
Coventry Dr
Battery Rd
Bluebird Ln
Bluebird Ln
Bluebird Ln

Local Conditions

Since the Voorhees Replacement Facility is a private project, the preferred method of construction is defined by an owner's needs and wants. In the case of Virtua Health (owner) they knew that they didn't want just low bid. They wanted to select each company involved with the management and design of the project that would provide the best value, a combination of both cost and healthcare experience.

Since the site as shown earlier is very large and does not have any restrictions due to proximity to other buildings, site parking was able to be provided for all trades. After the site was prepared the base build of the main hospital parking lot was put down so that subcontractors could set up their trailers and have space to park.

Over the course of June 2006, Virtua hired a geo-technical engineer to perform tests to determine the soil conditions of the site. From the geo-technical report it was found that in depths up to 35 feet the soil was only made up of sand and silts. Due to this discovery it was the recommendation of the geo-technical engineer to provide ground improvements under the entire building pad to mitigate potential for excessive settlements during a seismic event. The ground solution that was recommended was the installation of stone columns, which will be described in the building systems section.

From the geo-technical report it was also reported that groundwater showed up an average of about 8 feet below the surface. This discovery required dewatering during the stone column installation.

Site Layout Planning

Please see Appendix O for a copy of the Finish Phase Site Utilization Plan.

By looking at the site utilization plan in Appendix O one can see that the site for the Voorhees Replacement Hospital is wide open and does not contain many hazards that might affect construction. Even with the abundance of open space on site it is still important to make the site as efficient as possible so that trades do not interfere with each other and the schedule can stay on track.

The first example of utilizing the space appropriately is the site access roads as well as the subcontractor parking and trailer lots. The space for the subcontractor parking and trailers as seen on the utilization plan is the location of the hospital parking lot to be. In order to use this space effectively, just before the major subcontractors mobilize to the site the base layer of the parking lot is placed so that not only will the base layer already be in place later on down the road but it also allows for a hardtop surface for trailers and parking. This is true for the majority of the access roads seen on the plan as well.

Next, one can see that there are 2 construction gates located off of dutchtown road and route 73, which allows for separate delivery and car entrances. The entrance off of dutchtown road is used primarily for personnel and small deliveries such as FedEx. The entrance off of route 73 is a doublewide gate that allows for 2-way access to the site. The loop around the courtyard outside of the bed tower allows for larger delivery trucks to not have to reverse once on the site creating a safety hazard. It is also important to note that the location of certain spaces such as material storage, dumpster and porta potty's are placed alongside the access roads to provide easy access for waste removal and deliveries.

Each of the two locations of the material and personnel hoists shown on the site utilization plan contains both a material and personnel hoist totaling 4 mechanical hoists. These are located only at the bed tower because the bed tower is 8 stories above ground as opposed to the ancillary spaces that are only 4 stories above ground and have a loading dock with stairs.

Lastly the orange directional lines shown on the footprint of the building show the direction of workflow on each floor for the finish phase of the project. The vertical workflow of the building is from the garden level to the top floor of each space.

Building Systems

Demo

Since there are no buildings that occupied the location of the Replacement Hospital, the only demolition that was required to allow for construction to start was the clearing of trees and prepping the site for breaking ground.

Structural Steel Frame

The main structural system of the Replacement Hospital is composite steel framing for the floors and non-composite steel framing for the roofs. Typical bay sizes are approximately 30'x32' in the bed tower and 31'-4"x29'-4" in the ancillary portion of the building. Elevated floors use a 3" thick by 18 gauge galvanized composite steel deck while the roofs consist of a 3" thick by 20 gauge galvanized roof deck. Beam to beam and beam to column connections are typical bolt shear connections except in areas where lateral forces are being resisted. At these locations where lateral forces are being resisted welded connections were used.

Lateral loads on the building are resisted by steel braced frames and steel moment frames. It was a particular design challenge to design the lateral systems of the building without compromising the buildings appearance. Some basement walls also act as shear walls to transfer lateral loads to the building foundation.

To erect the steel, 3 300-ton crawler cranes were used.

Cast in Place Concrete

All cast in place concrete used on the job was placed using a pump truck and plywood formwork. Typical elevated floors have 3 ½" of 3500 psi lightweight concrete on top of the metal decking. Elevated slabs are reinforced with fiber reinforcing. Typical slab on grade concrete is 5" and has a strength of 4000 psi reinforced with welded wire fabric.

Precast Concrete

No precast concrete is included on this project.

Mechanical System

The main mechanical equipment is located in 2 different locations throughout the building. The main chiller equipment is located in the central utility plant with the main electrical and emergency electrical equipment. The remainder of the mechanical equipment is located in the spine portion of the building between floors 5 and 8.

Building heating, HVAC humidification, domestic water heating, and auxiliary steam is being provided primarily from the 5th floor utility plant in the spine. The system consists of saturated steam boilers, condensing hot water boilers, a chiller heat recovery system, and space for future domestic hot water heaters.

Facility cooling will be provided by a centralized chilled water system. The chilled water generation will take place in the Central Utility Plant area. The chilled water will be generated by electric drive, water-cooled, centrifugal water chillers. Cooling heat will be rejected through 4 induced cooling tower cells.

There are a total of 3 sets of AHUs that service all of the hospital and are located on the 7th floor of the spine. AHU-1 consists of 2 50,000 CFM VAV units stacked on each other. This AHU will serve non-patient care areas such as dietary, environmental services, receiving, and lab and maintenance. AHU-2 consists of 2 50,000 CFM VAV units stacked on each other. This AHU will service the emergency department, pediatric emergency, surgery, c-section operating rooms, the pharmacy and the NICU. AHU-3 consists of 6 75,000 CFM VAV units stacked on each other. AHU-3 will service all of the patient care areas in the ancillary and bed tower.

Electrical

The electrical service to the building is being provided at 12,470 volts where it is distributed to 6 main substations of the building located in the main electrical room in the central utility plant. Already put in place is an extra set of concrete encased PVC conduit for a second service to the building when the hospital expands in the future.

At the substations a transformer brings down the power to 480/277 3 phase 4 wire. The substations are broken down into 3 sets of 2 to create redundancy in the system. If one of the substations fails, the paired substation is sized large enough to take on the full load of both substations until the substation is repaired.

From the substations, power is carried to each floor via cables and either kept at the 480/277 voltage or dropped down even further to 120/208 for certain building functions. Most lighting will be 277V because this allows for more lights per circuit and lower voltage drops across long lengths of wire.

For emergency standby power, there are 3 1,500 KW diesel generators that will service all life safety and building functions that cannot afford to lose power. There is space to provide a 4th generator when the hospital expands in the future. The fuel tank for the generators is sized to provide 96 hours of backup.

To provide uninterrupted backup power before the generators kick in if power failure occurs there is a 900 KW rotary UPS installed. The rotary UPS is sized to provide about 36 seconds of run time, long enough to provide power to the building during the 10-second lag time until the generators kick in.

Masonry

A majority of the masonry on the project is veneer masonry. The only load bearing masonry is located at the loading dock and has a concrete masonry unit veneer. Veneer masonry is located mainly on the bed tower and is made up of both calcium silicate building stone and limestone. Typical veneer masonry connection can be seen in figure 1. The masonry is being installed by using both hex scaffolding and swing stages.

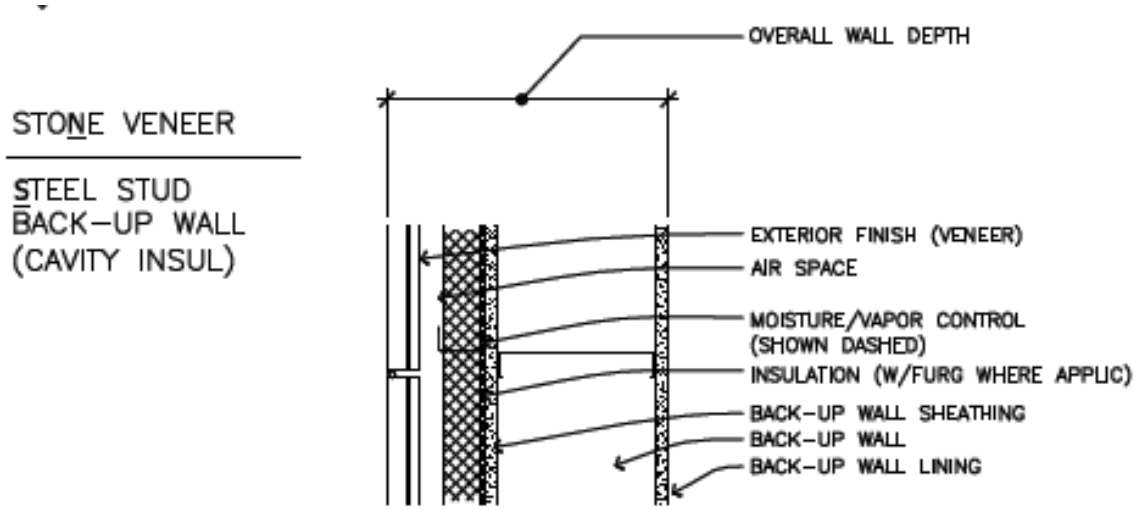


Figure 2 – Stone Veneer

Curtain Wall

Along the bed tower portion of the replacement hospital is a curtain wall system. The system is made up of exposed aluminum finishes and concealed steel reinforcement. The glass in the curtain wall system includes vision and

spandrel glass, fritted in some locations to provide natural sunshade to the patient rooms. The curtain wall is stick built and is put in place using hex scaffolding. A typical curtain wall connection detail can be seen in figure 2.

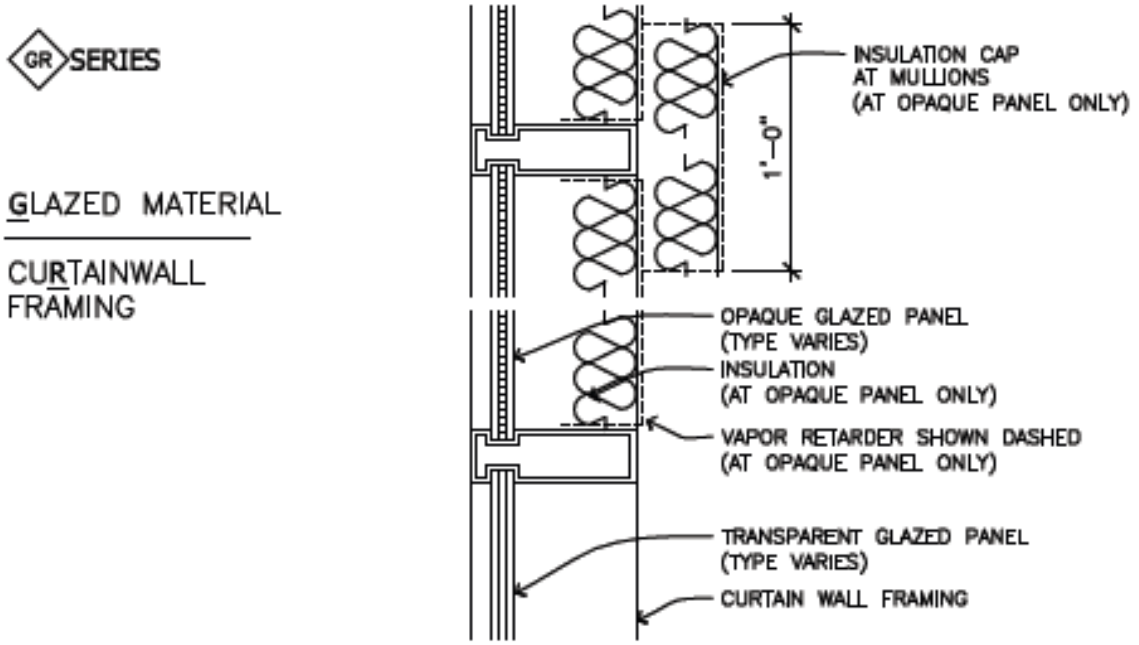


Figure 3 - Curtain Wall

Support of Excavation

There was no major excavation on this project so no major temporary or permanent support systems were necessary. However the geotechnical engineer determined that the site consisted of mostly loose sands, which do not perform well under seismic conditions. In order to stabilize the ground to allow for typical spread footings to be installed a process of installing stone columns was recommended. Almost 4,000 stone columns, each about 45 feet deep were installed under the building footprint to get the soil to an allowable pressure of 6000 psf. Over 100 million pounds of stone was used in this soil stabilization.

Since the water table in the location of the building was determined to be 8 feet below the surface dewatering was necessary to allow for the stone column installation. Since the footprint of the building is so large dewatering was done in multiple phases, this allowed for the stone columns to be installed more quickly and reduce the cost of providing a dewatering system over the entire footprint.

Schedule Summary

Please see Appendix P for project schedule summary.

As seen from the project schedule summary the total duration from schematic design to building turnover of the project spans from November 2006 to March 2011. It is important to note however that the owner Virtua Health had owned the site before bringing in the Architect to conceptualize a design. During this time Virtua did site evaluations including bringing in the geo-technical engineer to assess the site conditions.

The schematic design process unlike most design-bid-build projects was used to create bid documents for the construction manager bidding process because of such a fast tracked schedule. Turner Construction was awarded the project and then authorized to commence their duties on March 26, 2007. Again due to the fast tracked schedule, design packages were scheduled to release in different phases starting with the structural package so that Turner could buyout a subcontractor and start the long procurement time of structural steel. Throughout a good portion more of the design development stage the remainder of the design packages were released from the architecturals all the way to electrical and telecommunications. The end date of the design development phase shown on the schedule summary is when the last major design change was released.

As shown on the schedule summary contractor buyouts and engineering/ procurement are very long duration tasks. This is because contractors that do not commence work until the final stages of construction are not bought out immediately.

The key element of the foundation and site work are the geo-piles. As described in a later section almost 4,000 stone piles were installed around the site. This was the critical path at this point in construction because without the geo-piles installed in the ground foundation work could not start. It was important to get the site cleared and start installing the geo-piles as early as possible.

During the structural steel erection the key element is simply to keep on schedule. There were no space limitations due to such a large site so keeping on schedule and to the erection plan was key to completing the steel erection on time.

During the finishing stages the fit-out of the bed tower become the critical path. The fit-out of the bed tower does not complete until nearly the end of the project, any delays in the schedule will push back the completion date. As the construction manager it is important to manage our resources during this fit-out. With the numerous trades coming and going from the space it is extremely important to make sure that trades do not overlap and get in the way of each other. By making sure each trade has enough space to complete their work as well as making sure each trade knows the project schedule the fit-out can go smoothly and to schedule.

Project Cost Summary

Project Costs

Cost Type	Total Cost	Cost / SF
Construction Cost	$294,561,141.00	$436.39/SF
Total Project Cost	$450,000,000.00	$666.66/SF
Structural Steel	$25,466,126.00	$37.73/SF
Rough Carpentry & Drywall	$21,677,690.00	$32.11/SF
Windows, Storefronts and Curtain Wall Systems	$10,376,859.00	$15.37/SF
Plumbing, HVAC Piping/Sheet Metal/Equipment and Medical Gas	$64,952,583.00	$96.22/SF
Electrical Core/Shell and Fit-Out	$35,765,769.00	$52.98/SF

Table 1 – Actual Project Costs

Please see the above table 1 for all costs regarding the Voorhees Replacement Facility.

Construction cost as shown in table 1 is defined as all of the direct costs to the project. This does not include any general conditions, insurance, contingency or construction management or architect fees. Sitework was left in the construction cost price due to the large majority of the sitework bid package including the geo-piles to create a more stable ground.

Total project cost as shown in table 1 is defined as the total of every cost incurred by both construction and indirect fees.

General Conditions Summary

Please see Appendix Q for the breakdown of the General Conditions Estimate

Table 2: General Conditions Estimate Summary	
Description	**Estimate**
Personnel	$3,076,280.00
Temporary Facilities	$1,235322.00
General Expenses	$988,524.00
Hoisting	$1,330,360.00
Temporary Utilities	$204,750.00
Cleaning	$2,857,990.00
Protection & Safety	$1,177,000.00
GC Total	**$10,870,226.00**

Table 2 – General Conditions Summary

The general conditions estimate above and in Appendix Q was prepared through the use of both 2009 RS Means cost data and current industry costs provided by Turner Construction Company. The personnel make up a large portion of the estimate and were calculated using RS Means cost data and includes both the preconstruction and construction phase of the project. The project-staffing plan was utilized to determine the proper staffing for the project.

Analysis 1 – LEED/Sustainability

Scope of Work

According to the February issue of the Medical Construction & Design magazine "just 3% of current of current LEED-certified projects are healthcare-related"(15). Although the Voorhees Replacement Hospital does incorporate some green design it is not attempting to achieve a LEED rating of any level. In a continuously growing green market is there a way to push the hospitals design to incorporate more sustainable ideas and possibly achieve a LEED rating? The following analysis will attempt to analyze the Voorhees Replacement Hospital for LEED points it is currently achieving and then determine the cost to reach different LEED certifications.

Introduction

When owners are first considering whether or not to pursue a LEED rated building more often then not their first question is "what does it cost to build a LEED certified building"? If a LEED rated building is pursued what benefits will I get from my building? While the LEED rating to some may just be a glorified way to attract attention to a building, the LEED certification process establishes accountability of the certified building and verifies that the building is in fact sustainable. LEED certification requires that a project incorporate design and construction practices that emphasize the sustainable use of sites, water, energy, materials and indoor air quality.

Before we dive into discussing the LEED points it is important to have a basic understanding of where LEED came from. LEED stands for the Leadership in Energy and Environmental Design. The LEED rating system was developed in the late 1990s by the United States Green Building Council, which is non-profit organization made up of many recognized industry professionals. The LEED system is a point-based system in which buildings earn points based on the different credits they pursue. Obtaining a certain amount of points will reward the building with one of four certification levels, Certified, Silver, Gold and Platinum. Of course each certification level requires a different amount of points with the higher levels requiring more points respectively.

LEED Point Analysis

Soft Costs

Before we examine each LEED point to determine where the Voorhees Replacement Facility is achieving points already and the cost to reach different LEED certifications we must first look at the "soft costs" associated with attempting to build a LEED building. Soft costs are defined as any costs that are not involved with the physical construction of the project such as increased architectural design efforts including all engineering services, documentation of all LEED points and LEED related paperwork, LEED application feeds, and energy modeling. Soft costs are an additional cost to the project because the Voorhees Replacement Hospital is not attempting to achieve a LEED rating.

Soft Cost Estimates			
Cost Description	**% of Construction Cost**	**Total Construction Cost**	**Cost to Project**
Design Costs	0.50%	$323,000,000	$1,615,000
Documentation & Application Fees	0.50%	$323,000,000	$1,615,000
Energy Modeling	0.10%	$323,000,000	$323,000

Total	**$3,553,000**

Table 1 – Soft Cost Estimates

Table 1 above shows the estimated soft costs associated with attempting to build a LEED rated building. The percentages of total construction cost used in table 1 were obtained from the paper titled Analyzing the Cost of Obtaining LEED Certification and are not exact costs.

Hard Costs

The following portion of this analysis is the point by point analysis of the LEED rating system as it applies to the Voorhees Replacement Hospital. The setup of each point analysis will be as follows…

LEED Section – Credit Description (# of Obtainable Points)

Intent

This section of the analysis includes the intent of the credit as defined from the LEED 2009 Manual for New Construction and Major renovations.

Requirements

This section of the analysis includes the requirements that the building must meet in order to obtain the points for the credit. The requirements are taken directly from the LEED 2009 Manual for New Construction and Major Renovations.

Potential Strategies

This section will include different design and construction that any building could utilize to obtain the points for the credit. These strategies were developed from reviewing the LEED 2009 Manual for New Construction and Major Renovations as well as other publications, which can be found on the references page.

Analysis Within the Voorhees Replacement Facility

This section will decide whether or not the Voorhees Replacement Hospital is already achieving the credit requirements and if not what design or construction strategies will be analyzed to obtain the credit points.

Cost Summary

This section will include the cost analysis of the chosen design or construction strategies to obtain the credit points as defined in the analysis section.

Additional Thoughts

This section will include direction to applicable appendix's as well as a reference to any other credits that may be obtained from obtaining the credit being analyzed.

Sustainable Sites Prerequisite 1: Construction Activity Pollution Prevention (Prerequisite)

Intent

To reduce pollution from construction activities by controlling soil erosion, waterway sedimentation and airborne dust generation.

Requirements

Create and implement an erosion and sedimentation control plan for all construction activities associated with the project. The plan must conform to the erosion and sedimentation requirements of the 2003 EPA Construction General Permit OR local standards and codes, whichever is more stringent. The plan must describe the measures implemented to accomplish the following objectives:

- To prevent loss of soil during construction by storm water runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- To prevent sedimentation of storm sewers or receiving streams.
- To prevent pollution of the air with dust and particulate matter.

Potential Strategies

Develop an erosion and sedimentation control plan early in project planning. Develop of the plan to address all potential problems including loss of soil by erosion, sedimentation of sewers and streams, and air pollution. Consider using strategies such as:

- Seeding
- Mulching
- Silt Fencing
- Sediment Traps
- Sediment Basins
- Construction vehicle clean-off area

Analysis Within the Voorhees Replacement Facility

No cost analysis was performed for this prerequisite because the erosion and sedimentation plan is already included in the Voorhees Replacement Facility project.

Cost Summary

No additional cost to the project

Additional Thoughts

See Appendix A for a copy of the erosion and sedimentation plan.

Sustainable Sites Credit 1: Site Selection (1 Point)

Intent
To avoid the development of inappropriate sites and reduce the environmental impact from the location of a building on a site.

Requirements
Do not develop buildings, hardscape, roads or parking areas on portions of sites that meet any of the following criteria:

- Prime farmland as defined by the U.S. Department of Agriculture in the United States Code of Federal Regulations, Title 7, Volume 6, Parts 400 to 699, Section 657.5 (citation 7CFR657.5)
- Previously undeveloped land whose elevation is lower than 5 feet above the elevation of the 100-year flood as defined by the Federal Emergency Management Agency (FEMA)
- Land specifically identified as habitat for any species on federal or state threatened or endangered lists
- Land within 100 feet of any wetlands as defined by the U.S. Code of Federal Regulations 40 CFR, Parts 230-233 and Part 22, and isolated wetlands or areas of special concern identified by state or local rule, OR within setback distances from wetlands prescribed in state or local regulations, as defined by local or state rule or law, whichever is more stringent
- Previously undeveloped land that is within 50 feet of a water body, defined as seas, lakes, rivers, streams and tributaries that support or could support fish, recreation or industrial use, consistent with the terminology of the Clean Water Act
- Land that prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner (park authority projects are exempt).

Potential Strategies

When choosing the site location of the project, avoid locations that are included in the list of requirements shown above.

Analysis Within the Voorhees Replacement Facility

Sustainable sites credit 1 is not an obtainable credit for the Voorhees Replacement Facility since land is being developed within 100 feet of wetlands.

Cost Summary

No additional cost to project because credit is not obtainable.

Additional Thoughts

See Appendix B for details regarding wetland setbacks.

Sustainable Sites Credit 2: Development Density and Community Connectivity (5 Points)

Intent

To channel development to urban areas with existing infrastructure, protect greenfields, and preserve habitat and natural resources.

Requirements

Construct or renovate a building on a previously developed site AND in a community with a minimum density of 60,000 square feet per acre net. The density calculation is based on a typical two-story downtown development and must include the area of the project being built.

Potential Strategies

During the site selection process select a site location that meets the requirements for either option of the credit.

Analysis Within the Voorhees Replacement Facility

Since the Voorhees Replacement Hospital is not located on a previously developed site this credit is not obtainable.

Cost Summary

No additional cost to project because credit is not obtainable.

Additional Thoughts

None

Sustainable Sites Credit 3: Brownfield Redevelopment (1 Point)

Intent

To rehabilitate damaged sites where development is complicated by environmental contamination and to reduce pressure on undeveloped land.

Requirements

OPTION 1

- Develop on a site documented as contaminated (by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local voluntary cleanup program).

OR

OPTION 2

- Develop on a site defined as a brownfield by a local, state, or federal government agency.

Potential Strategies

During the site selection process, select a site defined as brownfield by a local, state or federal agency. Make sure to coordinate the contamination cleanup as appropriate for the site.

Analysis Within the Voorhees Replacement Facility

Since the Voorhees Replacement Facility is not located on a contaminated or brownfield site sustainable sites credit 3 is not obtainable.

Cost Summary

No additional cost to the project because the credit is not obtainable.

Additional Thoughts

None

Sustainable Sites Credit 4.1: Alternative Transportation – Public Transportation Access (6 Points)

Intent
To reduce pollution and land development impacts from automobile use.

Requirements
OPTION 1. Rail Station Proximity

- Locate the project within 1/2-mile walking distance (measured from a main building entrance) of an existing or planned and funded commuter rail, light rail or subway station.

OR

OPTION 2. Bus Stop Proximity

- Locate the project within 1/4-mile walking distance (measured from a main building entrance) of 1 or more stops for 2 or more public, campus, or private bus lines usable by building occupants.

Potential Strategies

Perform an analysis on the usage of the proposed building and determine what the primary occupants will be and how they will be traveling to the building. Locate the building near railways, public transit lines or provide new bus stops on site.

Analysis Within the Voorhees Replacement Facility

Credit 4.1 is achieved by the planned addition of bus stops on site. The Voorhees Replacement Facility will provide new bus stops on site for public transportation.

Cost Summary

No additional cost to the project is incurred because bus stops were planned from project start.

Additional Thoughts

None

Sustainable Sites Credit 4.2: Alternative Transportation – Bicycle Storage and Changing Rooms (1 Point)

Intent
To reduce pollution and land development impacts from automobile use.

Requirements
CASE 1. Commercial or Institutional Projects

- Provide secure bicycle racks and/or storage within 200 yards of a building entrance for 5% or more of all building users (measured at peak periods)
- Provide shower and changing facilities in the building, or within 200 yards of a building entrance, for 0.5% of fulltime equivalent (FTE) occupants.

Potential Strategies

Design the building to include showers/changing rooms to accommodate employees who choose to bike to work. Also provide bike racks within 200 yards of the building entrance.

Analysis Within the Voorhees Replacement Facility

Bike racks and changing rooms/showers are being provided in the Voorhees Replacement Facility in accordance to the credits requirements. Sustainable sites credit 4.2 is achieved through this.

Cost Summary

No additional cost to the project because requirements were met in original design of the Voorhees Replacement Facility.

Additional Thoughts

None

Sustainable Sites Credit 4.3: Alternative Transportation – Low-Emitting and Fuel-Efficient Vehicles (3 Points)

Intent

To reduce pollution and land development impacts from automobile use.

Requirements

OPTION 1

- Provide preferred parking[1] for low-emitting and fuel-efficient vehicles[2] for 5% of the total vehicle parking capacity of the site. Providing a discounted parking rate is an acceptable substitute for preferred parking for low-emitting/fuel-efficient vehicles. To establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20%. The discounted rate must be available to all customers (i.e., not limited to the number of customers equal to 5% of the vehicle parking capacity), publicly posted at the entrance of the parking area and available for a minimum of 2 years.

OR

OPTION 2

- Install alternative-fuel fueling stations for 3% of the total vehicle parking capacity of the site. Liquid or gaseous fueling facilities must be separately ventilated or located outdoors.

OR

OPTION 3

- Provide low-emitting and fuel-efficient vehicles[1] for 3% of full-time equivalent (FTE) occupants. Provide preferred parking[2] for these vehicles.

OR

OPTION 4

- Provide building occupants access to a low-emitting or fuel-efficient vehicle-sharing program. The following requirements must be met:
    - One low-emitting or fuel-efficient vehicle must be provided per 3% of FTE occupants, assuming that 1shared vehicle can carry 8 persons (i.e., 1 vehicle per 267 FTE occupants). For buildings with fewer than 267 FTE occupants, at least 1 low emitting or fuel-efficient vehicle must be provided.
    - A vehicle-sharing contract must be provided that has an agreement of at least 2 years.
    - The estimated number of customers served per vehicle must be supported by documentation.

Potential Strategies

Providing preferred parking, alternative-fuel fueling stations or providing fuel-efficient vehicles for full time building occupants could achieve this credit. Depending on the use of the building different options may be more feasible then others.

For a 24-hour facility such as the Voorhees Replacement Facility options 3 and 4 are very cost intensive due to the large number of full time employees associated with the hospital. Option 2 would also come at a high cost because 41 alternative-fuel fueling stations would have to be provided. Option 1 therefore, is the best choice for the hospital.

Analysis Within the Voorhees Replacement Facility

The option that I have chosen to pursue for the sustainable sites credit 4.3 is providing preferred parking for low-emitting and fuel-efficient vehicles. Providing 5% of the total parking capacity for preferred parking requires a total of 68 spaces. There are 3 lots outlined in Appendix D that the 68 spaces could be spread out over to achieve this credit.

Cost Summary

No additional costs would be associated with obtaining this credit because parking spaces that would be designated for preferred parking would already be included in the base building.

Additional Thoughts

See Appendix C for alternative parking plan.

Sustainable Sites Credit 4.4: Alternative Transportation – Parking Capacity (2 Points)

Intent
To reduce pollution and land development impacts from automobile use.

Requirements
CASE 1. Non-Residential Projects
OPTION 1

- Size parking capacity to meet but not exceed minimum local zoning requirements. Provide preferred parking for carpools or vanpools for 5% of the total parking spaces.

OR
OPTION 2

- For projects that provide parking for less than 5% of full-time equivalent (FTE) building occupants: Provide preferred parking[1] for carpools or vanpools, marked as such, for 5% of total parking spaces. Providing a discounted parking rate is an acceptable substitute for preferred parking for carpool or vanpool vehicles. To establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20%. The discounted rate must be available to all customers (i.e., not limited to the number of customers equal to 5% of the vehicle parking capacity).

Potential Strategies

This credit can be achieved by making a conscious effort to reduce the amount of parking on site. This can be done by considering sharing of parking facilities with nearby buildings or providing alternatives that limit the use of single occupancy vehicles or promote the use of carpools.

Analysis Within the Voorhees Replacement Facility

The total number of spaces designed for the Voorhees Replacement Facility is 1,357. These are all new parking spaces and is greater then 5% of the full time building occupants. From this information option 2 and 3 can no longer achieve the credit.

The local zoning requirements are 2 parking spaces for every bed in a hospital. Since the Voorhees Replacement Facility has 370 beds the local zoning requires at least 740 parking spaces. Since the number of spaces being provided is greater then this requirement option 1 is not met either.

It would be possible to reduce the number of parking spaces which in turn would reduce the cost of paving however a study was done by Professional Engineering Services stating that 1,225 spaces are needed to meet demand. Because of this study we will say that this credit cannot be achieved.

Cost Summary

No additional or reduced cost is incurred for this credit because the credit is not obtainable.

Additional Thoughts

None

Sustainable Sites Credit 5.1: Site Development – Protect or Restore Habitat (1 Point)

Intent
To conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

Requirements
CASE 1. Greenfield Sites[1]
Limit all site disturbance to the following parameters:

- 40 feet beyond the building perimeter;
- 10 feet beyond surface walkways, patios, surface parking and utilities less than 12 inches in diameter;
- 15 feet beyond primary roadway curbs and main utility branch trenches;
- 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities and playing fields) that require additional staging areas to limit compaction in the constructed area.

Potential Strategies

- Develop a site utilization plan early in the construction process to comply with the requirements stated above.
- Provide clearly marked boundaries of the site so that disturbance is controlled.
- Focus on vertical transportation throughout the building instead of horizontal around the footprint.
- Schedule all material deliveries for delivery when materials are needed so large material storage areas are not needed.

Analysis Within the Voorhees Replacement Facility

When buildings are being built in crowded urban areas this credit is relatively easy to obtain because the buildings are usually being built very close to the property line. In the case of the Voorhees Replacement Facility the property is very large and the building footprint, walkways and parking take up only a small portion of the total site area. Because of this is it extremely important to implement a site utilization plan incorporating the requirements of the sustainable sites credit 5.1. In the case of the Voorhees Replacement Facility I would recommend this plan being put in place and disturbance boundaries clearly defined with markers before breaking ground.

Cost Summary

Since this credit only requires the development of a site utilization plan before breaking ground there are no major hard costs to the project. Since it is important to layout the disturbance boundaries to limit the site disruption small costs would be incurred through the surveying and layout of the perimeter lines. There may also be soft costs associated with the extra time spent by the construction manager to develop the site utilization plan. This however is not major and all costs associated with this are included in the soft cost section of this analysis.

We will assume a 3 man surveying crew over a weeks work at $50/hour to complete the boundary lines.

Total Additional Cost to Project – $6,000

Additional Thoughts - None

Sustainable Sites Credit 5.2: Site Development – Maximize Open Space (1 Point)

Intent

To promote biodiversity by providing a high ratio of open space to development footprint.

Requirements

CASE 1. Sites with Local Zoning Open Space Requirements

- Reduce the development footprint[1] and/or provide vegetated open space within the project boundary such that the amount of open space exceeds local zoning requirements by 25%.

ALL CASES

- For projects in urban areas that earn SS Credit 2: Development Density and Community Connectivity, vegetated roof areas can contribute to credit compliance.
- For projects in urban areas that earn SS Credit 2: Development Density and Community Connectivity, pedestrian-oriented hardscape areas can contribute to credit compliance. For such projects, a minimum of 25% of the open space counted must be vegetated.
- Wetlands or naturally designed ponds may count as open space and the side slope gradients average 1:4 (vertical: horizontal) or less and are vegetated.

Potential Strategies

- Select a site with open space potential during the site selection process.
- Stack the building instead of creating larger floor areas.
- Provide leveled parking or underground parking.

Analysis Within the Voorhees Replacement Facility

The local zoning open space requirements state that there must be a minimum of 10% open space on the site. To meet the requirements for sustainable sites credit 5.2 the Voorhees Replacement Facility must achieve 35% open space. Since the project site is so large one can determine from looking at the site plan that the amount of developed area is much less then the maximum 65% to meet the credit requirements.

Cost Summary

The Voorhees Replacement Facility already meets the requirements for this credit so there is no additional cost to the project for obtaining this credit.

Additional Thoughts

Please see appendix D for a copy of the site plan showing the building footprint vs. open space.

Sustainable Sites Credit 6.1: Stormwater Design – Quantity Control (1 Point)

Intent

To limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff and eliminating contaminants.

Requirements

CASE 1. Sites with Existing Imperviousness 50% or Less

OPTION 1

- Implement a stormwater management plan that prevents the post development peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the 1- and 2-year 24-hour design storms.

OR

OPTION 2

- Implement a stormwater management plan that protects receiving stream channels from excessive erosion. The stormwater management plan must include stream channel protection and quantity control strategies.

CASE 2. Sites with Existing Imperviousness Greater Than 50%

- Implement a stormwater management plan that results in a 25% decrease in the volume of stormwater runoff from the 2-year 24-hour design storm.

Potential Strategies

- Design the project site to maintain a natural flow of water equal to or less then the undeveloped site conditions.
- Specify pervious pavements that reduce water runoff.
- Include green roofs in the design.
- Collect and reuse stormwater for uses such as irrigation or toilet flushing.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Facility was designed with a comprehensive grading and drainage plan for stormwater management. We will assume that the grading and drainage plan was designed to either reduce or keep the discharge rate the same as the pre developed land. Because of this sustainable sites credit 6.1 is achieved.

Cost Summary

No additional cost to the project because the grading and drainage plan is part of the building baseline.

Additional Thoughts

See Appendix E for a copy of the overall grading and drainage plan.

Sustainable Sites Credit 6.2: Stormwater Design – Quality Control (1 Point)

Intent
To limit disruption and pollution of natural water flows by managing stormwater runoff.

Requirements
Implement a stormwater management plan that reduces impervious cover, promotes infiltration and captures and treats the stormwater runoff from 90% of the average annual rainfall[1] using acceptable best management practices (BMPs).

BMPs used to treat runoff must be capable of removing 80% of the average annual postdevelopment total suspended solids (TSS) load based on existing monitoring reports. BMPs are considered to meet these criteria if:

- They are designed in accordance with standards and specifications from a state or local program that has adopted these performance standards,

OR

- There exists infield performance monitoring data demonstrating compliance with the criteria. Data must conform to accepted protocol (e.g., Technology Acceptance Reciprocity Partnership [TARP], Washington State Department of Ecology) for BMP monitoring.

Potential Strategies

This credit can be achieved in a number of ways including…

- Green roofs
- Pervious pavements
- Rainwater collection and recycling
- Integrate natural treatment systems such as constructed wetlands or vegetated filters.

Analysis Within the Voorhees Replacement Facility

The current design of the Voorhees Replacement Facility directs a majority of the stormwater runoff from the building and pavement to the city storm piping. In order to capture and treat 90% of the average annual rainfall the best practices for the building would be to either provide a vegetative roof or a rainwater collection and treatment plant. However in order to achieve the 90% for the entire site we would have to include the treatment of stormwater from all pavement runoffs. To do this the best possible option is to replace the designed pavement with a porous pavement.

Cost Summary

The cost to add a vegetative roof over all areas and the cost difference in providing porous pavement are shown below. This additional cost would enable the Voorhees Replacement Facility to achieve this LEED credit. Cost per square foot was determined through contacting suppliers and subcontractors and includes all materials and installation.

Vegetative Roofing Estimate			
Roof Type	**Square Feet**	**Cost / SF**	**Total Cost**

LiveRoof	10755	Included in Base Building	
LiveRoof	56850	$30.00	$1,705,500.00
Pervious Asphalt Cost Difference			
Pavement Type	**Square Feet**	**Cost / SF**	**Total Cost**
Existing	390000	$3.12	$1,216,800.00
Pervious	390000	$2.55	$994,500.00
Cost Difference			($222,300.00)

As seen above there is an added cost to install the vegetative roof over 50% of the roof area but there is a savings when changing the paving type to pervious. It is important to note that the cost savings from switching to pervious pavement is due to the decreased thickness of the parking lot paving. The pervious pavement itself is more expensive per ton but due to the decreased thickness of the section there is a cost savings. It is also important to note that if it is decided to include pervious paving in the project that there is a required pavement cleaning every 6 months to make sure the pervious pavement is not clogged and functioning properly.

Total Additional Cost to Project - $1,483,200.00

Additional Thoughts

By achieving this credit through the use of a fully vegetative roof system and complete pervious pavement system there is a possibility to achieve other sustainable sites credits as well. The vegetative roof system may help achieve sustainable sites credit 7.2 Heat Island effect as well as providing a considerable reduction in energy use related to the energy and atmosphere LEED category.

The pervious pavement system may help achieve sustainable sites credit 7.1 heat island effect if the pervious pavement is designed to cover at least 50% of all hardscapes on the project.

Sustainable Sites Credit 7.1 Heat Island Effect – Nonroof (1 Point)

Intent

To reduce heat islands[1] to minimize impacts on microclimates and human and wildlife habitats.

Requirements

OPTION 1

Use any combination of the following strategies for 50% of the site hardscape (including roads, sidewalks, courtyards and parking lots):

- Provide shade from the existing tree canopy or within 5 years of landscape installation. Landscaping (trees) must be in place at the time of occupancy.
- Provide shade from structures covered by solar panels that produce energy used to offset some nonrenewable resource use.
- Provide shade from architectural devices or structures that have a solar reflectance index[2] (SRI) of at least 29.
- Use hardscape materials with an SRI of at least 29.
- Use an open-grid pavement system (at least 50% pervious).

OR

OPTION 2

Place a minimum of 50% of parking spaces under cover[3]. Any roof used to shade or cover parking must have an SRI of at least 29, be a vegetated green roof or be covered by solar panels that produce energy used to offset some nonrenewable resource use.

Potential Strategies

Design all hardscaped areas to be shaded by use of any of the strategies shown above. Other strategies include providing hardscaped surfaces of lighter color with a SRI higher then 29 other then typical black asphalt or providing 50% parking below ground.

Analysis Within the Voorhees Replacement Facility

There is approximately 390,000 square feet of hardscaped areas on the Voorhees Replacement Hospital site. It would be extremely expensive to accommodate the same amount of parking underground or place 50% of the parking spaces under cover. Having a parking deck above or below grade would require expensive structural work as well as expensive excavation for the below grade parking.

If the owner chooses to acquire sustainable sites credit 6.2 then this credit will only cost the amount that was determined in S.S. credit 6.2.

If the owner chooses to only attempt at this credit then to achieve the credit the owner would have to provide pervious pavement/asphalt to 50% of the hardscape area or provide a SRI of 29 or higher to 50% of the hardscape. The cost for each solution is shown below.

Cost Summary

Cost per square foot was determined from contacting suppliers and subcontractors and includes all materials and installation.

Pervious Asphalt Cost Difference			
Pavement Type	**Square Feet**	**Cost/SF**	**Total Cost**
Existing	195000	$3.12	$608,400.00
Pervious	195000	$2.55	$497,250.00
Cost Difference			($111,150.00)
StreetBond Slate (SRI=33)			
Type	Square Feet	Cost/SF	Total Cost
StreetBond Slate (SRI=33)	195000	$2.00	$390,000.00

Total Additional Cost to Project if S.S. Credit 6.2 is Achieved - $0.00

Total Additional Cost to Project if StreetBond is Applied to 50% of Designed Ashphalt - $390,000.00

Total Additional Cost to Project if Pervious Pavement is Substituted for the Designed Asphalt – ($111,150.00)

It is important to note that the cost savings from switching to pervious pavement is due to the decreased thickness of the parking lot paving. The pervious pavement itself is more expensive per ton but due to the decreased thickness of the section there is a cost savings. It is also important to note that if it is decided to include pervious paving in the project that there is a required pavement cleaning every 6 months to make sure the pervious pavement is not clogged and functioning properly.

Additional Thoughts

See appendix F for a description of the StreetBond product.

Sustainable Sites Credit 7.2: Heat Island Effect – Roof (1 Point)

Intent

To reduce heat islands[1] to minimize impacts on microclimates and human and wildlife habitats.

Requirements

OPTION 1

Use roofing materials with a solar reflectance index[2] (SRI) equal to or greater than the values in the table below for a minimum of 75% of the roof surface.

Roofing materials having a lower SRI value than those listed below may be used if the weighted rooftop SRI average meets the following criteria:

$$\frac{\text{Area Roof Meeting Minimum SRI}}{\text{Total Roof Area}} \times \frac{\text{SRI of Installed Roof}}{\text{Required SRI}} \geq 75\%$$

Roof Type	Slope	SRI
Low-sloped roof	≤ 2:12	78
Steep-sloped roof	> 2:12	29

OR

OPTION 2

Install a vegetated roof that covers at least 50% of the roof area.

OR

OPTION 3

Install high-albedo and vegetated roof surfaces that, in combination, meet the following criteria:

$$\frac{\text{Area Roof Meeting Minimum SRI}}{0.75} + \frac{\text{Area of Vegetated Roof}}{0.5} \geq \text{Total Roof Area}$$

Roof Type	Slope	SRI
Low-sloped roof	≤ 2:12	78
Steep-sloped roof	> 2:12	29

Potential Strategies

- Install a white or light colored roofing membrane.
- Install a vegetative roof system

Analysis Within the Voorhees Replacement Facility

If the owner decides to achieve sustainable sites credit 6.2 then this credit, S.S. 7.2 will be achieved because the roof will be at least 50% vegetated and no new costs will be incurred.

If the owner decides to only attempt to achieve S.S. credit 7.2 and not S.S. credit 6.2 then in order to achieve this credit the owner will need to provide a reflective roofing membrane for 75% of the roof or a vegetated roof for 50% of the roof area.

Cost Summary

There is no additional cost to the project if S.S. credit 6.2 was achieved.

The cost to implement both the vegetated roof and reflective roof membrane are shown below. Cost per Square foot was determined through contacting suppliers and subcontractors and includes installation.

Vegetative Roofing Estimate			
Roof Type	**Square Feet**	**Cost / SF**	**Total Cost**
LiveRoof	10755	Included in Base Building	
LiveRoof	42495	$30.00	$1,274,850.00
Reflective Roofing Membrane			
Roof Type	**Square Feet**	**Cost / SF**	**Total Cost**
RubberGard EcoWhite EPDM Roofing System (SRI = .8)	79875	$1.50*	$119,813.00

*Please note that this cost/sf is the difference in price between the installed roofing and the EcoWhite roofing system.

Total Additional Cost to Project if S.S. Credit 6.2 is Achieved - $0.00

Total Additional Cost to Project if Vegetative Roof is Installed Over 50% of the Roof Area - $1,274,850.00

Total Additional Cost to Project if Roof is Designed to Include a EcoWhite Roofing System - $119,813.00

Additional Thoughts

None

Sustainable Sites Credit 8: Light Pollution Reduction (1 Point)

Intent

To minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction and reduce development impact from lighting on nocturnal environments.

Requirements

Project teams must comply with 1 of the 2 options for interior lighting AND the requirement for exterior lighting.
For Interior Lighting
OPTION 1

- Reduce the input power (by automatic device) of all nonemergency interior luminaires with a direct line of sight to any openings in the envelope (translucent or transparent) by at least 50% between 11 p.m. and 5 a.m. After-hours override may be provided by a manual or occupant-sensing device provided the override lasts no more than 30 minutes.

OR
OPTION 2

- All openings in the envelope (translucent or transparent) with a direct line of sight to any nonemergency luminaires must have shielding (controlled/closed by automatic device for a resultant transmittance of less than 10% between 11 p.m. and 5 a.m.)

For Exterior Lighting Light areas only as required for safety and comfort. Lighting power densities must not exceed ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda[1]) for the classified zone. Meet exterior lighting control requirements from ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda[1]) Exterior Lighting Section, without amendments. Classify the project under 1 of the following zones, as defined in IESNA RP-33, and follow all the requirements for that zone:
LZ3: Medium (all other areas not included in LZ1, LZ2 or LZ4, such as commercial/ industrial, and high-density residential)
Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than 0.20 horizontal and vertical footcandles at the site boundary and no greater than 0.01 horizontal footcandles 15 feet beyond the site. Document that no more than 5% of the total initial designed fixture lumens (sum total of all fixtures on site) are emitted at an angle of 90 degrees or higher from nadir (straight down).
LZ2, LZ3 and LZ4 - For site boundaries that abut public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.
For All Zones
Illuminance generated from a single luminaire placed at the intersection of a private vehicular driveway and public roadway accessing the site is allowed to use the centerline of the public roadway as the site boundary for a length of 2 times the driveway width centered at the centerline of the driveway.

Potential Strategies

- Design indoor lighting with automatic controls that reduce the input power by 50% between 11 p.m. and 5 a.m.
- Design all exterior lighting including plazas, sidewalks, parking lots, and roadways to the minimum illuminance level specified in the IESNA handbook.
- Provide exterior light fixtures that do not produce uplight.

- Use low reflective materials on surfaces illuminated by exterior lighting.

Analysis Within the Voorhees Replacement Facility

This credit is not obtainable for the Voorhees Replacement Facility because of the interior lighting requirements. Due to differing needs of patients, patient rooms cannot be designed with automatic controls that reduce the input power during certain times of night. For the same reason there cannot be automatic shielding devices preventing the patient from having views to the outside anytime.

Cost Summary

There is no additional cost because the credit is unobtainable.

Additional Thoughts

None

Water Efficiency Prerequisite 1: Water Use Reduction (Prerequisite)

Intent

To increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements

Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation).
Calculate the baseline according to the commercial and/or residential baselines outlined below.[1] Calculations are based on estimated occupant usage and must include only the following fixtures and fixture fittings (as applicable to the project scope): water closets, urinals, lavatory faucets, showers, kitchen sink faucets and prerinse spray valves.

The following fixtures, fittings and appliances are outside the scope of the water use reduction calculation:

- Commercial Steam Cookers
- Commercial Dishwashers
- Automatic Commercial Ice Makers

Potential Strategies

In order to complete this prerequisite the internal plumbing fixtures of the building should be evaluated and compared against the baseline set forth by the LEED credit. Water efficient fixtures should be considered including, water closets, sinks, urinals, and showers.

If further water use reduction is needed consider implementing a water treatment system that can utilize stormwater, greywater or even blackwater. Consider using composting toilets.

Analysis Within the Voorhees Replacement Facility

Quantities of all plumbing fixtures were taken off and the baseline was compared to the installed fixtures of the Voorhees Replacement Facility. Although the current fixtures are relatively water friendly there was only a 2 percent water savings between the installed fixtures and the baseline. More water efficient fixtures were researched and then compared against the baseline to determine if a water reduction of 20% was possible. One important thing to note is that there are very few urinals because almost all of the bathrooms in the hospital are same sex single bathrooms or changing rooms for full time employees to use, which contain only a water closet. Also there is a single bathroom in every patient room containing no urinals as well. Due to the majority of bathrooms containing water closets the assumption was made that the uses for all water closets would be the same per day no matter if the occupant was a male or female. The analysis is as follows…

Scenario 1

Fixture Type	Quantity	Average Uses/Unit a day	Unit	Baseline Water Used/Unit	Installed Water Used/Unit	Proposed Water Used/Unit
Water Closet	480	3	Flushes	1.6	1.6	1.28
Urinal	37	3	Flushes	1	0	0

Lavatory	1121	0.75	Minutes	2.2	2.2	1.5
Shower	332	1.5	Minutes	2.5	2.5	2.5

			Baseline Water Used/Year (Gallons)	**Installed Water Used/Year (Gallons)**	**Proposed Water Used/Year (Gallons)**
			840960	840960	672768
			40515	0	0
			675122	675122	460311
			454425	454425	454425
Total Water Used/Year (Gallons)			**2011022**	**1970507**	**1587504**
	% Water Savings per Year			**2.01%**	**21.06%**

Scenario 2

Fixture Type	Quantity	Average Uses/Unit a day	Unit	Baseline Water Used/Unit	Installed Water Used/Unit	Proposed Water Used/Unit
Water Closet	480	3	Flushes	1.6	1.6	1.6
Urinal	37	3	Flushes	1	0	0
Lavatory	1121	0.75	Minutes	2.2	2.2	1.5
Shower	332	1.5	Minutes	2.5	2.5	1.5

			Baseline Water Used/Year (Gallons)	**Installed Water Used/Year (Gallons)**	**Proposed Water Used/Year (Gallons)**
			840960	840960	840960
			40515	0	0
			675122	675122	460311
			454425	454425	272655
Total Water Used/Year (Gallons)			**2011022**	**1970507**	**1573926**
	% Water Savings per Year			**2.01%**	**21.74%**

From the above situations one can see that by using lavatories that dispense water at a rate of 1.5 gallons per minute and then either water closets that flush at 1.28 gallons per flush or showers that dispense water at a rate of 1.5 gallons per minute. Either of the 2 situations meets the 20% water reduction requirement.

Cost Summary

Scenario 1

Fixture Type	Quantity	Base Building Cost/Fixture	Proposed Cost/Fixture	Base Building Total Cost	Proposed Total Cost
Water Closet	480	$150.00	$150.00	$72,000.00	$72,000.00
Urinal	37	$380.00	$380.00	$14,060.00	$14,060.00
Lavatory	1121	$125.00	$150.00	$140,125.00	$168,150.00
Shower	332	$400.00	$500.00	$132,800.00	$166,000.00
			Total Cost	**$358,985.00**	**$420,210.00**
				Difference in Cost	**$61,225.00**

Scenario 2

Fixture Type	Quantity	Base Building Cost/Fixture	Proposed Cost/Fixture	Base Building Total Cost	Proposed Total Cost
Water Closet	480	$150.00	$200.00	$72,000.00	$96,000.00
Urinal	37	$380.00	$380.00	$14,060.00	$14,060.00
Lavatory	1121	$125.00	$150.00	$140,125.00	$168,150.00
Shower	332	$400.00	$400.00	$132,800.00	$132,800.00
			Total Cost	**$358,985.00**	**$411,010.00**
				Difference in Cost	**$52,025.00**

The cost estimates above were determined through contact with distributors and subcontractors and include material only. This is based on the assumption that there is the same number of fixtures and should take the same amount of time to install.

It is also important to note that the reduction in water usage would result in a cost savings throughout the building however that analysis is note included in the scope of this analysis.

From the different scenarios above we can see that the most cost effective way to achieve the prerequisite is by implementing the water saving water closets and urinals.

Total Additional Cost to Project - $52,025

Additional Thoughts

Please see appendix G for product data sheets of the water efficient lavatories, water closets, and showers used in the calculations above.

Water Efficiency Credit 1: Water Efficient Landscaping (2-4 Points)

Intent

To limit or eliminate the use of potable water or other natural surface or subsurface water resources available on or near the project site for landscape irrigation.

Requirements

OPTION 1. Reduce by 50% (2 points)
Reduce potable water consumption for irrigation by 50% from a calculated midsummer baseline case.
Reductions must be attributed to any combination of the following items:

- Plant species, density and microclimate factor
- Irrigation efficiency
- Use of captured rainwater
- Use of recycled wastewater
- Use of water treated and conveyed by a public agency specifically for nonpotable uses

Groundwater seepage that is pumped away from the immediate vicinity of building slabs and foundations may be used for landscape irrigation to meet the intent of this credit. However, the project team must demonstrate that doing so does not affect site stormwater management systems.
OR
OPTION 2. No Potable Water Use or Irrigation1 (4 points)
Meet the requirements for Option 1.
AND
PAT H 1
Use only captured rainwater, recycled wastewater, recycled graywater or water treated and conveyed by a public agency specifically for nonpotable uses for irrigation.
OR
PAT H 2
Install landscaping that does not require permanent irrigation systems. Temporary irrigation systems used for plant establishment are allowed only if removed within 1 year of installation.

Potential Strategies

To earn the water efficient landscaping credit some of the following strategies can be utilized…

- When designing the buildings landscaping select native plant species that will require minimal to no irrigation after installation.
- Avoiding the use of turf grass
- Use water efficient irrigation systems that run on timers or sensors.
- Systems that capture stormwater, greywater or blackwater can be utilized for irrigation. (Blackwater must be treated before use)

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital is already earning the first 2 points of this credit because almost all of the planting that is being done on site is native to the region. There is only a small amount of turf grass being placed around the footprint of the building which requires irrigation. Because there is irrigation taking place, the remaining 2 points of this credit are not already in the cost of the base building.

In order for the Voorhees Replacement Facility to gain the last 2 points of this credit planning would have had to be done to call for the planting of all indigenous species on site. Another method would be to install a rainwater or greywater collection system which would provide irrigation for the non-indigenous plantings.

Cost Summary

First 2 points are included in the base building budget and therefore do not present an additional cost to the Voorhees Replacement Hospital.

Installing a rainwater or greywater collection system to irrigate would present a considerable cost to the project however this cost evaluation is not included in this analysis.

Additional Thoughts

None

Water Efficiency Credit 2: Innovative Wastewater Technologies (2 Points)

Intent

To reduce wastewater generation and potable water demand while increasing the local aquifer recharge.

Requirements

OPTION 1

Reduce potable water use for building sewage conveyance by 50% through the use of water-conserving fixtures (e.g., water closets, urinals) or nonpotable water (e.g., captured rainwater, recycled graywater, on-site or municipally treated wastewater).

OR

OPTION 2

Treat 50% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site.

Potential Strategies

To obtain this credit buildings must reduce the water used for sewage conveyance by at least 50%. Some strategies to do this include…

- Waterless urinals
- Dual flush toilets or ultra low flush toilets

If the credit cannot be achieved with just providing water efficient urinals and toilets then a greywater or stormwater collection system would have to be used.

Analysis Within the Voorhees Replacement Facility

Fixture Type	Quantity	Average Uses/Unit a day	Unit	Baseline Water Used/Unit	Installed Water Used/Unit	Proposed Water Used/Unit
Water Closet	480	3	Flushes	1.6	1.6	1.28
Urinal	37	3	Flushes	1	0	0

	Baseline Water Used/Year (Gallons)	Installed Water Used/Year (Gallons)	Proposed Water Used/Year (Gallons)
	840960	840960	672768
	40515	0	0
Total Water Used/Year (Gallons)	**881475**	**840960**	**672768**

% Water Savings per Year	**4.60%**	**23.68%**

The above spreadsheet shows the percent of water reduction of just the urinals and water closets as specified in the water reduction credit sections. It is evident that in order to reach the 50% water reduction mark a water collection and treatment system will have to be installed. Because the Voorhees Replacement Facility is a hospital no collected water would be used to flush toilets or urinals because of the risk of infection or disease. Because of this we will say that this credit is not obtainable.

Cost Summary

No additional cost to the project because credit is not obtainable.

Additional Thoughts

None

Water Efficiency Credit 3: Water Use Reduction (2-4 Points)

Intent

To further increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements

Employ strategies that in aggregate use less water than the water use baseline calculated for the building (not including irrigation). The minimum water savings percentage for each point threshold is as follows:

Percentage Reduction	Points
30%	2
35%	3
40%	4

Calculate the baseline according to the commercial and/or residential baselines outlined below.[1] Calculations are based on estimated occupant usage and must include only the following fixtures and fixture fittings (as applicable to the project scope): water closets, urinals, lavatory faucets, showers, kitchen sink faucets and pre-rinse spray valves.

Potential Strategies

In order to complete this prerequisite the internal plumbing fixtures of the building should be evaluated and compared against the baseline set forth by the LEED credit. Water efficient fixtures should be considered including, water closets, sinks, urinals, and showers.

If further water use reduction is needed consider implementing a water treatment system that can utilize stormwater, greywater or even blackwater. Consider using composting toilets.

Analysis Within the Voorhees Replacement Facility

Water efficient water closets, lavatories, and showers were evaluated against the baseline water usage to determine the total water use reduction when all water efficient plumbing fixtures are used in tandem. One important thing to note is that there are very few urinals because almost all of the bathrooms in the hospital are same sex single bathrooms or changing rooms for full time employees to use, which contain only a water closet. Also there is a single bathroom in every patient room containing no urinals as well. Due to the majority of bathrooms containing water closets the assumption was made that the uses for all water closets would be the same per day no matter if the occupant was a male or female. The results are below.

Fixture Type	Quantity	Average Uses/Unit a day	Unit	Baseline Water Used/Unit	Installed Water Used/Unit	Proposed Water Used/Unit
Water Closet	480	3	Flushes	1.6	1.6	1.28
Urinal	37	3	Flushes	1	0	0
Lavatory	1121	0.75	Minutes	2.2	2.2	1.5

Shower	332	1.5	Minutes	2.5	2.5	1.5

		Baseline Water Used/Year (Gallons)	Installed Water Used/Year (Gallons)	Proposed Water Used/Year (Gallons)
		840960	840960	672768
		40515	0	0
		675122	675122	460311
		454425	454425	272655
Total Water Used/Year (Gallons)		**2011022**	**1970507**	**1405734**
	% Water Savings per Year		**2.01%**	**30.10%**

As seen in the spreadsheet above when all 4 water saving plumbing fixtures are used together there is a total water use reduction of 30.10%. This is good enough to achieve the first 2 points out of the possible 4 for this credit.

In order to get to 35% or 40% water use reduction throughout the building a greywater or stormwater collection system would have to be put in place to allow for toilets to be flushed with this collected water. However due to the Voorhees Replacement Facility being a hospital it is only acceptable to flush toilets with potable water to reduce the risk of infection or disease. Therefore we will say that only the first 2 points of this credit are obtainable.

Cost Summary

The added cost to obtain the 30% water use reduction is shown below.

Fixture Type	Quantity	Base Building Cost/Fixture	Proposed Cost/Fixture	Base Building Total Cost	Proposed Total Cost
Water Closet	480	$150.00	$200.00	$72,000.00	$96,000.00
Urinal	37	$380.00	$380.00	$14,060.00	$14,060.00
Lavatory	1121	$125.00	$150.00	$140,125.00	$168,150.00
Shower	332	$400.00	$500.00	$132,800.00	$166,000.00
			Total Cost	**$358,985.00**	**$444,210.00**
				Difference in Cost	**$85,225.00**

It is important to note that the reduction in water usage would result in a cost savings throughout the building however that analysis is note included in the scope of this analysis.

Total Additional Cost to Project - $85,225 - $52,025(prerequisite cost) = $33,200

Additional Thoughts

Please see appendix G for product data sheets of the water efficient lavatories, water closets, and showers used in the calculations above.

Energy & Atmosphere Prerequisite 1: Fundamental Commissioning of Building Energy Systems (Prerequisite)

Intent

To verify that the project's energy-related systems are installed, and calibrated to perform according to the owner's project requirements, basis of design and construction documents.

Benefits of commissioning include reduced energy use, lower operating costs, fewer contractor callbacks, better building documentation, improved occupant productivity and verification that the systems perform in accordance with the owner's project requirements.

Requirements

The following commissioning process activities must be completed by the project team:

- Designate an individual as the commissioning authority (CxA) to lead, review and oversee the completion of the commissioning process activities.
    - The CxA must have documented commissioning authority experience in at least 2 building projects.
    - The individual serving as the CxA must be independent of the project design and construction management, though the CxA may be an employee of any firm providing those services. The CxA may be a qualified employee or consultant of the owner.
    - The CxA must report results, findings and recommendations directly to the owner.
    - For projects smaller than 50,000 gross square feet, the CxA may be a qualified person on the design or construction team who has the required experience.
- The owner must document the owner's project requirements. The design team must develop the basis of design. The CxA must review these documents for clarity and completeness. The owner and design team must be responsible for updates to their respective documents.
- Develop and incorporate commissioning requirements into the construction documents.
- Develop and implement a commissioning plan.
- Verify the installation and performance of the systems to be commissioned.
- Complete a summary commissioning report.

Commissioned Systems

Commissioning process activities must be completed for the following energy-related systems, at a minimum:

- Heating, ventilating, air conditioning and refrigeration (HVAC&R) systems (mechanical and passive) and associated controls
- Lighting and daylighting controls
- Domestic hot water systems
- Renewable energy systems (e.g., wind, solar)

Potential Strategies

- During the design process of the building incorporate a commissioning agent for input in the design.
- Develop a commissioning plan for the project and determine what the project requirements are.
- Document all commissioning, testing, and balancing for use later on in the LEED process.
- Provide an end of project detailed commissioning report for LEED uses.

Analysis Within the Voorhees Replacement Facility

Commissioning has been a part of the project plan for the Voorhees Replacement Facility since early in the project. All major systems are being commissioned and documented. Because of this, prerequisite #1 is already being achieved in the baseline Building.

Cost Summary

There is no additional cost to the project.

Additional Thoughts

None

Energy & Atmosphere Prerequisite 2: Minimum Energy Performance (Prerequisite)

Intent

To establish the minimum level of energy efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.

Requirements

Demonstrate a 10% improvement in the proposed building performance rating for new buildings, or a 5% improvement in the proposed building performance rating for major renovations to existing buildings, compared with the baseline building performance rating.

Calculate the baseline building performance rating according to the building performance rating method in Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda[1]) using a computer simulation model for the whole building project.

Potential Strategies

This prerequisite and E.A. credit 1 are often the most difficult to assess complience with LEED requirements. However once the basis for assessment of the buildings energy consumption has been determined it is fairly simple to achieve this prerequisite and the first few points of E.A. credit 1. Some strategies that can be utilized in minimizing the buildings energy performance are…

- Reduce heating and cooling loads through the building design and orientation.
- Specify energy efficient lighting.
- Specify energy efficient HVAC systems.
- Use renewable energy sources such as solar panels, wind turbines, geothermal heating, or even daylighting.
- Use energy modeling software to determine the baseline energy consumption to compare against proposed building and system designs.

Analysis Within the Voorhees Replacement Facility

To determine the energy performance of the designed Voorhees Replacement Facility the Carrier Hourly Analysis Program was used. In order to determine the energy savings in the Voorhees Replacement Facility a baseline energy usage had to be determined to compare the designed building against. For the purposes of this energy evaluation only the hospitals bed tower (areas 1,2,3) was evaluated. The assumption is made that the systems employed in the bed tower are the same systems used in the ancillary building and the energy reduction would remain constant throughout.

The assumptions that were made when designing and selecting systems for the baseline that conform to the ANSI/ASHRAE/IESNA standard are the following.

- Wall Type – Face Brick/Air Space/Flashing/Vapor Barrier/Gypsum Board/Metal Wall Studs w/ Insulation/Gypsum Board.
- Roof Type – Decking/Felt/Membrane/Slag or Stone
- Standard Glass (25% of wall area) - .57 BTU/hr/ft^2/F
- 25 CFM/Person

- 2.1 w/ft^2 Interior Lighting
- 2.2 w/ft^2 Electrical Equipment
- Chilled Water AHU's with a VAV reheat system
- Heating Via Hot Water
- 2 Chillers w/Cooling Towers

The assumptions that were made when inputting the data for the designed Voorhees Replacement Facility are the following.

- Wall Type – Face Brick/Air Space/Flashing/Vapor Barrier/Gypsum Board/Metal Wall Studs w/ Insulation/Gypsum Board.
- Roof Type – Steel Deck/R14 Insulation/Built Up Roofing Membrane
- High Performance Glass (60% of wall area) - .35 BTU/hr/ft^2/F
- 25 CFM/Person
- .9 w/ft^2 Interior Lighting
- 2.2 w/ft^2 Electrical Equipment
- Chilled Water AHU's with a VAV reheat and heat recovery system
- Heating Via Steam
- 2 Chillers w/Cooling Towers

After performing the energy analysis using the Carrier Hourly Analysis Program there was a calculated 17.5% energy savings. The detailed analysis can be seen in appendix I.

Cost Summary

There is no additional cost t the project to achieve this prerequisite because the energy analysis determined there is already at least a 10% improvement in energy from the baseline.

It is however important to note that there may be soft costs to this credit because a professionally executed energy analysis would have to be completed. This can be seen in the soft costs portion of the analysis.

Additional Thoughts

Please see appendix H for a copy of the energy analysis report.

Energy & Atmosphere Prerequisite 3: Fundamental Refrigerant Management (Prerequisite)

Intent
To reduce stratospheric ozone depletion.

Requirements
Zero use of chlorofluorocarbon (CFC)-based refrigerants in new base building heating, ventilating, air conditioning and refrigeration (HVAC&R) systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phase-out conversion prior to project completion. Phase-out plans extending beyond the project completion date will be considered on their merits.

Potential Strategies

When designing the building specify HVAC equipment with the use of no CFC based refrigerants.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital has zero use of CFC based refrigerants in the HVAC system and therefore this prerequisite is met.

Cost Summary

No additional cost to project.

Additional Thoughts

None

Energy & Atmosphere Credit 1: Optimize Energy Performance (1-19 Points)

Intent

To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

Requirements

Demonstrate a percentage improvement in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda1) using a computer simulation model for the whole building project. The minimum energy cost savings percentage for each point threshold is as follows:

New Buildings	Existing Building Renovations	Points
12%	8%	1
14%	10%	2
16%	12%	3
18%	14%	4
20%	16%	5
22%	18%	6
24%	20%	7
26%	22%	8
28%	24%	9
30%	26%	10
32%	28%	11
34%	30%	12
36%	32%	13
38%	34%	14
40%	36%	15
42%	38%	16
44%	40%	17
46%	42%	18
48%	44%	19

Potential Strategies

This credit and prerequisite 1 are often the most difficult to assess complience with LEED requirements. However once the basis for assessment of the buildings energy consumption has been determined it is fairly simple to achieve this prerequisite and the first few points of this credit. Some strategies that can be utilized in minimizing the buildings energy performance are…

- Reduce heating and cooling loads through the building design and orientation.
- Specify energy efficient lighting.
- Specify energy efficient HVAC systems.
- Use renewable energy sources such as solar panels, wind turbines, geothermal heating, or even daylighting.
- Use energy modeling software to determine the baseline energy consumption to compare against proposed building and system designs.

Analysis Within the Voorhees Replacement Facility

To determine the energy performance of the designed Voorhees Replacement Facility the Carrier Hourly Analysis Program was used. In order to determine the energy savings in the Voorhees Replacement Facility a baseline energy usage had to be determined to compare the designed building against. For the purposes of this energy evaluation only the hospitals bed tower (areas 1,2,3) was evaluated. The assumption is made that the systems employed in the bed tower are the same systems used in the ancillary building and the energy reduction would remain constant throughout.

The assumptions that were made when designing and selecting systems for the baseline that conform to the ANSI/ASHRAE/IESNA standard are the following.

- Wall Type – Face Brick/Air Space/Flashing/Vapor Barrier/Gypsum Board/Metal Wall Studs w/ Insulation/Gypsum Board.
- Roof Type – Decking/Felt/Membrane/Slag or Stone
- Standard Glass (25% of wall area) - .57 BTU/hr/ft^2/F
- 25 CFM/Person
- 2.1 w/ft^2 Interior Lighting
- 2.2 w/ft^2 Electrical Equipment
- Chilled Water AHU's with a VAV reheat system
- Heating Via Hot Water
- 2 Chillers w/Cooling Towers

The assumptions that were made when inputting the data for the designed Voorhees Replacement Facility are the following.

- Wall Type – Face Brick/Air Space/Flashing/Vapor Barrier/Gypsum Board/Metal Wall Studs w/ Insulation/Gypsum Board.
- Roof Type – Steel Deck/R14 Insulation/Built Up Roofing Membrane
- High Performance Glass (60% of wall area) - .35 BTU/hr/ft^2/F
- 25 CFM/Person
- .9 w/ft^2 Interior Lighting
- 2.2 w/ft^2 Electrical Equipment
- Chilled Water AHU's with a VAV reheat and heat recovery system
- Heating Via Steam
- 2 Chillers w/Cooling Towers

After performing the energy analysis using the Carrier Hourly Analysis Program there was a calculated 17.5% energy savings. The detailed analysis can be seen in appendix I.

Cost Summary

The 17.5% energy savings calculated is the current proposed building and no additional solutions to reduce the energy consumption of the building were explored. This is not part of the scope of this analysis.

It is however important to note that there may be soft costs to this credit because a professionally executed energy analysis would have to be completed. This can be seen in the soft costs portion of the analysis.

Additional Thoughts - Please see appendix H for a copy of the energy analysis report.

Energy & Atmosphere Credit 2: On-site Renewable Energy (1-7 Points)

Intent

To encourage and recognize increasing levels of on-site renewable energy self-supply to reduce environmental and economic impacts associated with fossil fuel energy use.

Requirements

Use on-site renewable energy systems to offset building energy costs. Calculate project performance by expressing the energy produced by the renewable systems as a percentage of the building's annual energy cost and use the table below to determine the number of points achieved.

Use the building annual energy cost calculated in EA Credit 1: Optimize Energy Performance or the U.S. Department of Energy's Commercial Buildings Energy Consumption Survey database to determine the estimated electricity use.

The minimum renewable energy percentage for each point threshold is as follows:

Percentage Renewable Energy	Points
1%	1
3%	2
5%	3
7%	4
9%	5
11%	6
13%	7

Potential Strategies

Include renewable energy systems in the building to produce renewable energy including…

- Solar
- Wind
- Geothermal
- Hydro

Incorporate the design of the systems early in the project and project energy savings early on.

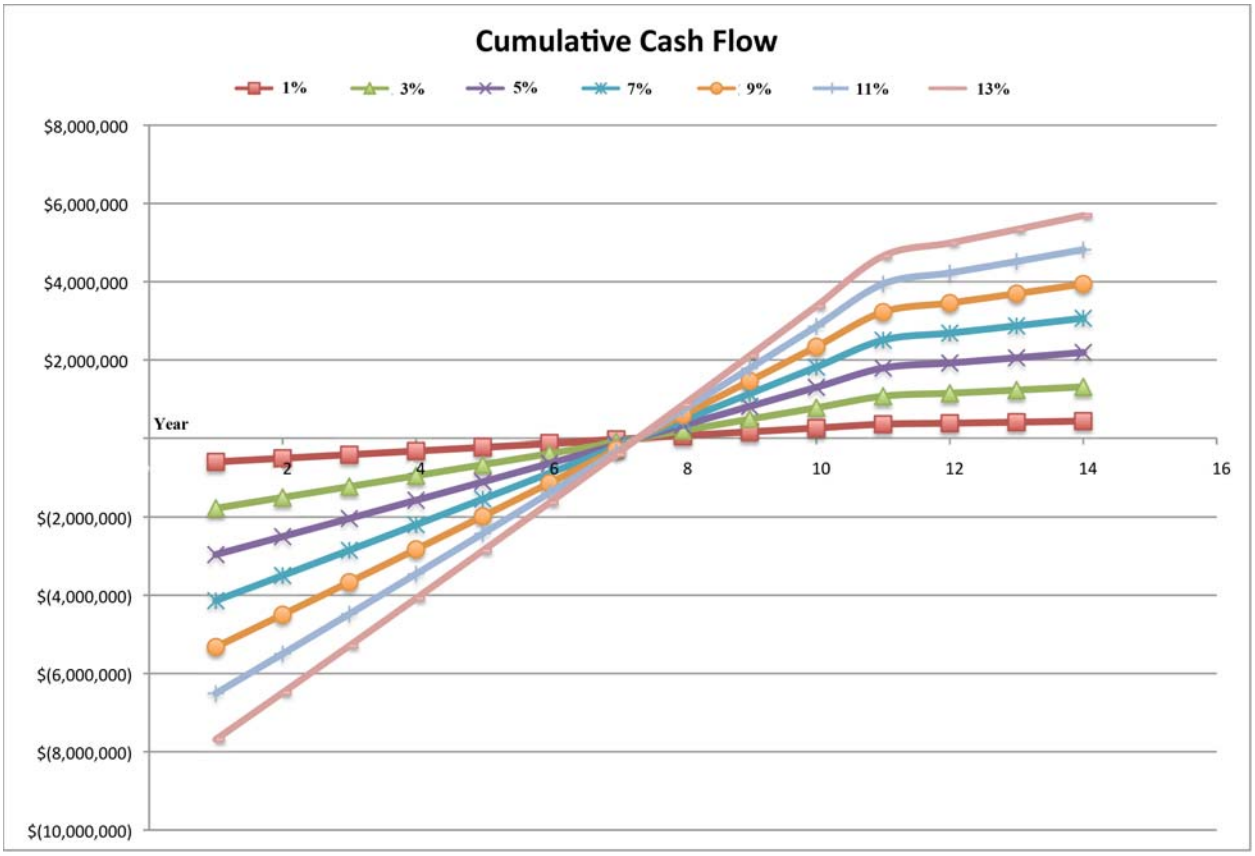
Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital does not currently include any renewable energy systems. The system that this analysis will look at is installing a solar panel system on the roof to produce renewable energy.

Cost Summary

Photovoltaic Energy Production Cost Analysis			
		Sun Exposure (hrs/day)	4.5

		Electricity Usage (kW hrs/month)		886000
% of Building to Use Renewable Energy	Total Watage of System Needed (kW) (Takes Into Account For System Inefficiencies)	Total Materials Cost of System ($3,900/kW)	Total Installation Cost of System ($6,000/kW)	Total System Initial Cost
1%	85	$331,500.00	$510,000.00	$841,500.00
3%	256	$998,400.00	$1,536,000.00	$2,534,400.00
5%	427	$1,665,300.00	$2,562,000.00	$4,227,300.00
7%	597	$2,328,300.00	$3,582,000.00	$5,910,300.00
9%	768	$2,995,200.00	$4,608,000.00	$7,603,200.00
11%	939	$3,662,100.00	$5,634,000.00	$9,296,100.00
13%	1109	$4,325,100.00	$6,654,000.00	$10,979,100.00



One can see that the payback period for all of the solar panel scenarios is a little over 7 years.

Additional Thoughts

Please see appendix I for a detailed life cycle analysis of each solar panel situation.

Energy & Atmosphere Credit 3: Enhanced Commissioning (2 Points)

Intent

To begin the commissioning process early in the design process and execute additional activities after systems performance verification is completed.

Requirements

Implement, or have a contract in place to implement, the following additional commissioning process activities in addition to the requirements of EA Prerequisite 1: Fundamental Commissioning of Building Energy Systems and in accordance with the LEED Reference Guide for Green Building Design and Construction, 2009 Edition:

- Prior to the start of the construction documents phase, designate an independent commissioning authority (CxA) to lead, review and oversee the completion of all commissioning process activities.
    - The CxA must have documented commissioning authority experience in at least 2 building projects.
    - The individual serving as the CxA:
        i. Must be independent of the work of design and construction.
        ii. Must not be an employee of the design firm, though he or she may be contracted through them.
        iii. Must not be an employee of, or contracted through, a contractor or construction manager holding construction contracts.
        iv. May be a qualified employee or consultant of the owner.
    - The CxA must report results, findings and recommendations directly to the owner.
- The CxA must conduct, at a minimum, 1 commissioning design review of the owner's project requirements basis of design, and design documents prior to the mid-construction documents phase and back-check the review comments in the subsequent design submission.
- The CxA must review contractor submittals applicable to systems being commissioned for compliance with the owner's project requirements and basis of design. This review must be concurrent with the review of the architect or engineer of record and submitted to the design team and the owner.

Potential Strategies

In order to achieve this credit owners must hire on commissioning agents early on in the project to provide system design reviews. The commissioning agent must perform at least 1 design review, review all submittals related to the commissioned systems, and provide a manual that gives future operating staff the information to safely and efficiently operate the commissioned systems.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Facility already has an owner hired commissioning agent to oversee and review all the systems that are being commissioned on the project. Because of this the energy and atmosphere credit 3 is achieved.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Energy & Atmosphere Credit 4: Enhanced Refrigerant Management (2 Points)

Intent

To reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to climate change.

Requirements

OPTION 1

Do not use refrigerants.

OPTION 2

Select refrigerants and heating, ventilation, air conditioning and refrigeration (HVAC&R) equipment that minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change. The base building HVAC&R equipment must comply with the following formula, which sets a maximum threshold for the combined contributions to ozone depletion and global warming potential:

$$LCGWP + LCODP \times 10^5 \leq 100$$

Calculation definitions for $LCGWP + LCODP \times 10^5 \leq 100$
LCODP = [ODPr x (Lr x Life +Mr) x Rc]/Life
LCGWP = [GWPr x (Lr x Life +Mr) x Rc]/Life
LCODP: Lifecycle Ozone Depletion Potential (lb CFC 11/Ton-Year)
LCGWP: Lifecycle Direct Global Warming Potential (lb CO_2/Ton-Year)
GWPr: Global Warming Potential of Refrigerant (0 to 12,000 lb CO_2/lbr)
ODPr: Ozone Depletion Potential of Refrigerant (0 to 0.2 lb CFC 11/lbr)
Lr: Refrigerant Leakage Rate (0.5% to 2.0%; default of 2% unless otherwise demonstrated)
Mr: End-of-life Refrigerant Loss (2% to 10%; default of 10% unless otherwise demonstrated)
Rc: Refrigerant Charge (0.5 to 5.0 lbs of refrigerant per ton of gross ARI rated cooling capacity)
Life: Equipment Life (10 years; default based on equipment type, unless otherwise demonstrated)

Potential Strategies

When designing the building either use no refrigerants or utilize a HVAC system that meets the requirements shown above.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Facility was evaluated based on the formula in option 2 shown above because the HVAC system includes refrigerants. The mechanical engineers conclusions was that the building meets the requirements.

Cost Summary

No additional cost to project.

Additional Thoughts

None

Energy & Atmosphere Credit 5: Measurement and Verification (3 Points)

Intent

To provide for the ongoing accountability of building energy consumption over time.

Requirements

OPTION 1

Develop and implement a measurement and verification (M&V) plan consistent with Option D: Calibrated Simulation (Savings Estimation Method 2) as specified in the International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003.

The M&V period must cover at least 1 year of post-construction occupancy.

Provide a process for corrective action if the results of the M&V plan indicate that energy savings are not being achieved.

OR

OPTION 2

Develop and implement a measurement and verification (M&V) plan consistent with Option B: Energy Conservation Measure Isolation, as specified in the International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003.

The M&V period must cover at least 1 year of post-construction occupancy..

Potential Strategies

To achieve this credit a measurement and verification plan must be established that clearly states how the building will measure its energy consumption. The plan must also state how it will compare the actual building usage to the estimated building usage and lay out a plan for corrective action if the building is not achieving the energy savings predicted.

In most situations the best way to determine the energy consumption of the building is by providing metering at locations throughout the building. Metering should include all electrical panels, gas flow supply lines and main water lines.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital does not currently have metering systems include in the budget. For the purposes of this analysis we will assume that there will be meters set up at all electrical panels to determine total electricity usage as well as gas flow and water flow meters at all gas and water feeders.

Cost Summary

There was no detailed analysis performed on this credit and the cost to install meters averages to $0.40/sf. This cost per square foot was obtained from the GSA LEED Cost Study.

Total Additional Cost to Project - $0.40/sf x 675,000sf = $270,000.00

Additional Thoughts

None

Energy & Atmosphere Credit 6: Green Power (2 Points)

Intent

To encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

Requirements

Engage in at least a 2-year renewable energy contract to provide at least 35% of the building's electricity from renewable sources, as defined by the Center for Resource Solutions' Green-e Energy product certification requirements.
All purchases of green power shall be based on the quantity of energy consumed, not the cost.
OPTION 1. Determine Baseline Electricity Use
Use the annual electricity consumption from the results of EA Credit 1: Optimize Energy Performance.
OR
OPTION 2. Estimate Baseline Electricity Use
Use the U.S. Department of Energy's Commercial Buildings Energy Consumption Survey database to determine the estimated electricity use.

Potential Strategies

To achieve this credit the building must participate in purchasing green energy for 35% of the buildings electricity usage. The buildings electricity usage is determined through using an energy analysis program. The green power must be derived from either solar, wind, geothermal, biomass or low-impact hydro sources.

Analysis Within the Voorhees Replacement Facility

In New Jersey the state offers residential or commercial buildings to participate in the New Jersey Clean Power Choice Program. The program allows owners to choose to pay an additional price per kWhr to receive energy from the renewable source of the owners choice. The cost analysis is shown below.

Cost Summary

Green Power				
Type of Energy	**Additional Price per kWhr**	**kWhrs/Year (35% of Total)**	**# of Years**	**Total Additional Cost**
67% Wind 33% Small Hydro	$0.035	3,692,238	2	**$258,457.00**

Total Additional Cost to Project - $258,457.00

Additional Thoughts

None

Materials & Resources Prerequisite 1: Storage and Collection of Recyclables (Prerequisite)

Intent
To facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.

Requirements
Provide an easily-accessible dedicated area or areas for the collection and storage of materials for recycling for the entire building. Materials must include, at a minimum: paper, corrugated cardboard, glass, plastics and metals.

Potential Strategies

To achieve this credit the design team and owner must create sufficient space for sorting and storage of materials to be recycled. Make sure a plan is in place that all employees comply with to ensure the correct sorting and recycling of all materials designated to be recycled.

Analysis Within the Voorhees Replacement Facility

Through speaking with the project architect he stated that the owner, Virtua Health would be collecting, sorting and recycling many different materials in an effort to help the environment. This recycling effort achieves the materials and resources prerequisite.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Materials & Resources Credit 1.1: Building Reuse – Maintain Existing Walls, Floors and Roof (1-3 Points)

Intent

To extend the lifecycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Maintain the existing building structure (including structural floor and roof decking) and envelope (the exterior skin and framing, excluding window assemblies and non-structural roofing material). The minimum percentage building reuse for each point threshold is as follows:

Building Reuse	Points
55%	1
75%	2
95%	3

Hazardous materials that are remediated as a part of the project must be excluded from the calculation of the percentage maintained. If the project includes an addition that is more than 2 times the square footage of the existing building, this credit is not applicable.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital is a new building and therefore this credit is not obtainable.

Cost Summary

No additional cost to project.

Additional Thoughts

None

Materials & Resources Credit 1.2: Building Reuse – Maintain Interior Nonstructural Elements (1 Point)

Intent

To extend the lifecycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Use existing interior nonstructural elements (e.g., interior walls, doors, floor coverings and ceiling systems) in at least 50% (by area) of the completed building, including additions. If the project includes an addition with square footage more than 2 times the square footage of the existing building, this credit is not applicable.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital is a new building and therefore this credit is not obtainable.

Cost Summary

No additional cost to project.

Additional Thoughts

None

Materials & Resources Credit 2: Construction Waste Management (1-2 Points)

Intent

To divert construction and demolition debris from disposal in landfills and incineration facilities. Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites.

Requirements

Recycle and/or salvage nonhazardous construction and demolition debris. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or comingled. Excavated soil and land-clearing debris do not contribute to this credit. Calculations can be done by weight or volume, but must be consistent throughout. The minimum percentage debris to be recycled or salvaged for each point threshold is as follows:

Recycled or Salvaged	Points
50%	1
75%	2

Potential Strategies

Develop a construction waste management plan that specifies the collection and sorting of waste as well as the disposal of the waste.

Analysis Within the Voorhees Replacement Facility

The original contract did not include a construction waste management plan that required the sorting and recycling of materials. The cost associated with sorting and recycling materials is an additional cost to the project and can be seen below.

Cost Summary

Due to the lack of information there is not a detailed estimate evaluating the cost increase to obtain this credit. The GSA LEED Cost Study determined that there was an estimated $0.12/sf cost associated with achieving 50% recycling and a $0.20/sf cost associated with achieving 75% recycling.

Total Additional Cost to Achieve 50% Recycling – $0.12/sf x 675,000sf = $81,000.00

Total Additional Cost to Achieve 75% Recycling – $0.20/sf x 675,000sf = $135,000.00

Additional Thoughts

None

Materials & Resources Credit 3: Materials Reuse (1-2 Points)

Intent

To reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, the sum of which constitutes at least 5% or 10%, based on cost, of the total value of materials on the project. The minimum percentage materials reused for each point threshold is as follows:

Reused Materials	Points
5%	1
10%	2

Mechanical, electrical and plumbing components and specialty items such as elevators and equipment cannot be included in this calculation. Include only materials permanently installed in the project. Furniture may be included if it is included consistently in MR Credit 3: Materials Reuse through MR Credit 7: Certified Wood.

Potential Strategies

When designing the building attempt to identify places in which salvaged or refurbished materials can be incorporated. The most common items that can be incorporated into the project include wood flooring or paneling, doors and frames, and or furniture items.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital is not currently incorporating salvaged, refurbished or reused materials in the design of the building. However because of the required cleanliness of a hospital it is not readily acceptable to install salvaged materials into the design without proper cleaning first. For this reason we will say that this credit is unobtainable.

Cost Summary

No additional cost to project because credit is unobtainable.

Additional Thoughts

None

Materials & Resources Credit 4: Recycled Content (1-2 Points)

Intent

To increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.

Requirements

Use materials with recycled content[1] such that the sum of postconsumer[2] recycled content plus 1/2 of the preconsumer[3] content constitutes at least 10% or 20%, based on cost, of the total value of the materials in the project. The minimum percentage materials recycled for each point threshold is as follows:

Recycled Content	Points
10%	1
20%	2

The recycled content value of a material assembly is determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
Mechanical, electrical and plumbing components and specialty items such as elevators cannot be included in this calculation. Include only materials permanently installed in the project. Furniture may be included if it is included consistently in MR Credit 3: Materials Reuse through MR Credit 7: Certified Wood.

Potential Strategies

Make sure to establish what recycled content the building is trying to accomplish early in the project. Ensure through submittals and superintendent verification that the correct materials are being installed. Typical materials that contain recycled content include…

- Steel
- Carpet
- Floor Tiles
- Insulation
- Steel Framing
- Gypsum Wallboard
- Acoustical Ceiling Tiles

Analysis Within the Voorhees Replacement Facility

Through speaking with the architect he stated that the Voorhees Replacement Hospital is including products that contain recycled content. Some of these products include structural steel, gypsum wallboard, acoustical ceiling tiles, carpeting, and ceramic tiles. Through the use of these materials with recycled content the 10% level should be reached and therefore is no additional cost to the project.

To obtain the 2 points for 20% recycled content is however a much higher threshold and will most likely incur an additional cost to the project. The GSA LEED Cost Study estimates the cost to obtain this additional point to be $0.30/sf.

Cost Summary

Total Additional Cost to Achieve 10% Recycled Content - $0.00

Total Additional Cost to Achieve 20% Recycled Content - $0.30/sf x 675,000sf = $202,500.00

Additional Thoughts: None

Materials & Resources Credit 5: Regional Materials (1-2 Points)

Intent

To increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation.

Requirements

Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10% or 20%, based on cost, of the total materials value. If only a fraction of a product or material is extracted, harvested, or recovered and manufactured locally, then only that percentage (by weight) can contribute to the regional value. The minimum percentage regional materials for each point threshold is as follows:

Regional Materials	Points
10%	1
20%	2

Mechanical, electrical and plumbing components and specialty items such as elevators and equipment must not be included in this calculation. Include only materials permanently installed in the project. Furniture may be included if it is included consistently in MR Credit 3: Materials Reuse through MR Credit 7: Certified Wood.

Potential Strategies

Due to the change in this credit in the LEED 2009 version it is now required that materials be extracted and manufactured within 500 miles of the project location. Because of the extraction requirement to achieve this credit it is best to use simple materials to obtain this credit. Some of the best examples include…

- Concrete
- Structural Steel
- Stone
- Brick
- Concrete Masonry Units
- Gypsum Wallboard
- Acoustical Ceiling Tiles

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Facility is such as a large project that obtaining the 10% and 20% limits to achieve this credit are going to be at an extra cost to the project. The 500 mile region surrounding the project in Voorhees, New Jersey covers a large area of the mid Atlantic region and most of the materials listed above should be available at an extra cost. The additional costs per square foot numbers were obtained through the GSA LEED Cost Study.

Cost Summary

Additional cost to achieve 10% regional materials – $0.30/sf x 675,000sf = $202,500.00

Additional cost to achieve 20% regional materials - $0.44/sf x 675,000sf = $297,000.00

Additional Thoughts - None

Materials & Resources Credit 6: Rapidly Renewable Materials (1 Point)

Intent

To reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials.

Requirements

Use rapidly renewable building materials and products for 2.5% of the total value of all building materials and products used in the project, based on cost. Rapidly renewable building materials and products are made from plants that are typically harvested within a 10-year or shorter cycle.

Potential Strategies

In order to achieve this credit it must be looked at very early on in the project design to see where these types of materials could be incorporated into the project. Materials that would help meet this credits requirements include…

- Bamboo
- Wool
- Cotton
- Agrifiber
- Linoleum
- Wheatboard
- Strawboard
- Cork

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Facility does not have any space in the project to incorporate any rapidly renewable materials discussed above. Because of this we will say that this credit is unobtainable.

Cost Summary

No additional cost to the project because credit is unobtainable.

Additional Thoughts

None

Materials & Resources Credit 7: Certified Wood (1 Point)

Intent
To encourage environmentally responsible forest management.

Requirements
Use a minimum of 50% (based on cost) of wood-based materials and products that are certified in accordance with the Forest Stewardship Council's principles and criteria, for wood building components. These components include at a minimum, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes.

Include only materials permanently installed in the project. Wood products purchased for temporary use on the project (e.g., formwork, bracing, scaffolding, sidewalk protection, and guard rails) may be included in the calculation at the project team's discretion. If any such materials are included, all such materials must be included in the calculation. If such materials are purchased for use on multiple projects, the applicant may include these materials for only one project, at its discretion. Furniture may be included if it is included consistently in MR Credits 3, Materials Reuse, through MR Credit 7, Certified Wood.

Potential Strategies

Define in the project scope to include 50% of wood based materials to be certified by the Forest Stewardship Council. Typical and most available sources of certified wood include…

- Millwork
- Hardwood Flooring
- Wood Doors
- Plywood

Analysis Within the Voorhees Replacement Facility

Because the Voorhees Replacement Facilities millwork package is about 7.5 million, assuming that this is the extent of major wood products in the building about 3.75 million dollars worth of millwork would need to be certified wood products. The GSA LEED Cost Study defined the additional cost on new construction for this credit to be $2.28/sf. However the project was a courthouse and there was a considerable amount of wood installed. According to a study done by Davis Langdon, he found that if the buildings majority of wood is finish carpentry like the Voorhees Replacement Hospital, and there is more then one supplier the cost premium is minimal to achieve this credit. Because of this we will assume the additional cost for the Voorhees Replacement Hospital to be $0.50/sf.

Cost Summary

Additional cost to the project - $0.50/sf x 675,000sf = $337,500.00

Additional Thoughts

None

Indoor Environmental Quality Prerequisite 1: Minimum Indoor Air Quality Performance (Prerequisite)

Intent

To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants.

Requirements

Meet the minimum requirements of Sections 4 through 7 of ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality (with errata but without addenda1).
AND
CASE 1. Mechanically Ventilated Spaces
Mechanical ventilation systems must be designed using the ventilation rate procedure or the applicable local code, whichever is more stringent.
CASE 2. Naturally Ventilated Spaces
Naturally ventilated buildings must comply with ASHRAE Standard 62.1-2007, Paragraph 5.1 (with errata but without addenda1).

Potential Strategies

Design the building HVAC systems to meet or exceed the minimum indoor air quality requirements based on the ASHRAE code.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Facility is achieving the minimum indoor air quality requirements according to ASHRAE. This was determined based on a conversation with the mechanical engineer.

Cost Summary

No Additional Cost to the Project.

Additional Thoughts

None

Indoor Environmental Quality Prerequisite 2: Environmental Tobacco Smoke (ETS) Control (Prerequisite)

Intent

To prevent or minimize exposure of building occupants, indoor surfaces and ventilation air distribution systems to environmental tobacco smoke (ETS).

Requirements

CASE 1. All Projects
OPTION 1

- Prohibit smoking in the building.
- Prohibit on-property smoking within 25 feet of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.

OR
OPTION 2

- Prohibit smoking in the building except in designated smoking areas.
- Prohibit on-property smoking within 25 feet of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.
- Provide designated smoking rooms designed to contain, capture and remove ETS from the building. At a minimum, the smoking room must be directly exhausted to the outdoors, away from air intakes and building entry paths, with no recirculation of ETS-containing air to nonsmoking areas and enclosed with impermeable deck-to-deck partitions. Operate exhaust sufficient to create a negative pressure differential with the surrounding spaces of at least an average of 5 Pascals (Pa) (0.02 inches of water gauge) and a minimum of 1 Pa (0.004 inches of water gauge) when the doors to the smoking rooms are closed.

Potential Strategies

Prohibit smoking in the building and or a minimum distance away from the building to ensure no smoke enters the building.

Analysis Within the Voorhees Replacement Facility

Since the Voorhees Replacement Facility is a hospital there is absolutely no smoking allowed in or around the building and therefore this prerequisite is met.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Indoor Environmental Quality Credit 1: Outdoor Air Delivery Monitoring (1 Point)

Intent

To provide capacity for ventilation system monitoring to help promote occupant comfort and well-being.

Requirements

Install permanent monitoring systems to ensure that ventilation systems maintain design minimum requirements. Configure all monitoring equipment to generate an alarm when airflow values or carbon dioxide (CO2) levels vary by 10% or more from the design values via either a building automation system alarm to the building operator or a visual or audible alert to the building occupants

AND

CASE 1. Mechanically Ventilated Spaces

- Monitor CO2 concentrations within all densely occupied spaces (those with a design occupant density of 25 people or more per 1,000 square feet). CO2 monitors must be between 3 and 6 feet above the floor.
- Provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow with an accuracy of plus or minus 15% of the design minimum outdoor air rate, as defined by ASHRAE Standard 62.1-2007 (with errata but without addenda1) for mechanical ventilation systems where 20% or more of the design supply airflow serves nondensely occupied spaces.

CASE 2. Naturally Ventilated Spaces

- Monitor CO2 concentrations within all naturally ventilated spaces. CO2 monitors must be between 3 and 6 feet above the floor. One CO2 sensor may be used to monitor multiple nondensely occupied spaces if the natural ventilation design uses passive stack(s) or other means to induce airflow through those spaces equally and simultaneously without intervention by building occupants.

Potential Strategies

Design the building to include both CO2 monitoring in spaces that are densely populated as defined by the credit requirements. Design the building to include monitors that read the amount of outdoor air supplied to the building.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital has included both CO2 monitoring and outdoor air intake monitors in the design of the building. Because of this the indoor environmental quality credit 1 is achieved.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Indoor Environmental Credit 2: Increased Ventilation (1 Point)

Intent

To provide additional outdoor air ventilation to improve indoor air quality (IAQ) and promote occupant comfort, well-being and productivity.

Requirements

CASE 1. Mechanically Ventilated Spaces

Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by ASHRAE Standard 62.1-2007 (with errata but without addenda1) as determined by IEQ Prerequisite 1: Minimum Indoor Air Quality Performance.

CASE 2. Naturally Ventilated Spaces

Design natural ventilation systems for occupied spaces to meet the recommendations set forth in the Chartered Institution of Building Services Engineers (CIBSE) Applications Manual 10: 2005, Natural Ventilation in Nondomestic Buildings. Determine that natural ventilation is an effective strategy for the project by following the flow diagram process shown in Figure 2.8 of the CIBSE Applications Manual 10.

AND

OPTION 1

- Use diagrams and calculations to show that the design of the natural ventilation systems meets the recommendations set forth in the CIBSE Applications Manual 10: 2005, Natural Ventilation in Non-domestic Buildings, CIBSE AM 13 (Mixed Mode Ventilation), or natural ventilation/mixed mode ventilation related sections of the CIBSE Guide B2 (Ventilation and Air Conditioning).

OR

OPTION 2

- Use a macroscopic, multizone, analytic model to predict that room-by-room airflows will effectively naturally ventilate, defined as providing the minimum ventilation rates required by ASHRAE 62.1-2007 Chapter 6 (with errata but without addenda1), for at least 90% of occupied spaces.

Potential Strategies

Design the HVAC system to provide the building with outside air 30% greater then as defined by ASHRAE. Think about utilizing heat recovery systems to offset the cost to provide the extra outside air.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital meets the requirements for this credit because it provides about 60% outdoor air. This is fairly standard for hospitals because so much air is required to be exhausted for infection control.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Indoor Environmental Credit 3.1: Construction Indoor Air Quality Management Plan – During Construction (1 Point)

Intent

To reduce indoor air quality (IAQ) problems resulting from construction or renovation and promote the comfort and well-being of construction workers and building occupants.

Requirements

Develop and implement an IAQ management plan for the construction and preoccupancy phases of the building as follows:

- During construction, meet or exceed the recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines For Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).
- Protect stored on-site and installed absorptive materials from moisture damage.
- If permanently installed air handlers are used during construction, filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2- 1999 (with errata but without addenda1). Replace all filtration media immediately prior to occupancy.

Potential Strategies

The construction manager must develop and submit an indoor air quality management plan that addresses maintaining an acceptable air quality throughout construction. The 5 areas that the IAQ management plan should address are...

- HVAC Protection – Filters, Close-off Open Ends
- Source Control – Sealing off construction areas from occupied areas
- Pathway Interruptions – Walkoff Mats
- Housekeeping – Cleaning Up After Spills, Use of Cleaning Compounds
- Scheduling – Schedule Low VOC Emitting Materials to be Installed After High VOC Emitting Materials

Analysis Within the Voorhees Replacement Facility

Turner Construction has developed an IAQ management plan that is being implemented throughout construction. Because of this plan credit 3.1 is obtained.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Indoor Environmental Quality Credit 3.2: Construction Indoor Air Quality Management Plan – Before Occupancy (1 Point)

Intent

To reduce indoor air quality (IAQ) problems resulting from construction or renovation to promote the comfort and well-being of construction workers and building occupants.

Requirements

Develop an IAQ management plan and implement it after all finishes have been installed and the building has been completely cleaned before occupancy.

OPTION 1. Flush-Out[1]

- After construction ends, prior to occupancy and with all interior finishes installed, install new filtration media and , perform a building flush-out by supplying a total air volume of 14,000 cubic feet of outdoor air per square foot of floor area while maintaining an internal temperature of at least 60° F and relative humidity no higher than 60%.

OR

OPTION 2. Air Testing

- Conduct baseline IAQ testing after construction ends and prior to occupancy using testing protocols consistent with
  the EPA Compendium of Methods for the Determination of Air Pollutants in Indoor Air and as additionally detailed
  in the LEED Reference Guide for Green Building Design and Construction, 2009 Edition.

Potential Strategies

Before occupancy, perform a building "flush-out" which runs all HVAC systems and flushes out all airborne VOCs and infectious construction wastes left behind.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital will achieve this credit because for hospital projects it is typical to flush the building out prior to occupancy to reduce risk of diseases when transferring patients into the new building. Because the flush out of the building was originally included in the base cost, this credit is achieved at no additional cost to to he project.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Indoor Environmental Quality Credit 4.1: Low-Emitting Materials – Adhesives and Sealants (1 Point)

Intent

To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

All adhesives and sealants used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following requirements as applicable to the project scope[1]:

- Adhesives, Sealants and Sealant Primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168. Volatile organic compound (VOC) limits listed in the table below correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.
- Aerosol Adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

Potential Strategies

For all low-emitting materials credits it is most vital that these low-emitting materials are clearly outlined in the specifications when soliciting bids. It is also extremely important to both document all low-emitting materials being used on the project as well as ensuring that the correct products are being used.

Analysis Within the Voorhees Replacement Facility

Per an email from the project architect the Voorhees Replacement Hospital will be utilizing low-emitting adhesives, sealants, paint, carpet and composite wood products. If the specified low-emitting materials used in the project are not enough to meet the requirements for the credit then the results of this analysis would still find that there would be no extra cost to the project. This conclusion was drawn from analyzing the GSA LEED Cost Study and Davis Langdons Cost of Green Revisited. Low-emitting materials are readily available now and usually at no extra cost as long as they are specified early in the project.

Cost Summary

No additional cost to the project because they are included in the base building and low-emitting materials are readily available on the market.

Additional Thoughts

None

Indoor Environmental Quality Credit 4.2: Low-Emitting Materials – Paints and Coatings (1 Point)

Intent

To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

Paints and coatings used on the interior of the building (i.e., inside of the weatherproofing system and applied onsite) must comply with the following criteria as applicable to the project scope[1]:

- Architectural paints and coatings applied to interior walls and ceilings must not exceed the volatile organic compound (VOC) content limits established in Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.
- Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250 g/L established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.
- Clear wood finishes, floor coatings, stains, primers, and shellacs applied to interior elements mustl not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

Potential Strategies

For all low-emitting materials credits it is most vital that these low-emitting materials are clearly outlined in the specifications when soliciting bids. It is also extremely important to both document all low-emitting materials being used on the project as well as ensuring that the correct products are being used.

Analysis Within the Voorhees Replacement Facility

Per an email from the project architect the Voorhees Replacement Hospital will be utilizing low-emitting adhesives, sealants, paint, carpet and composite wood products. If the specified low-emitting materials used in the project are not enough to meet the requirements for the credit then the results of this analysis would still find that there would be no extra cost to the project. This conclusion was drawn from analyzing the GSA LEED Cost Study and Davis Langdons Cost of Green Revisited. Low-emitting materials are readily available now and usually at no extra cost as long as they are specified early in the project.

Cost Summary

No additional cost to the project because they are included in the base building and low-emitting materials are readily available on the market.

Additional Thoughts

None

Indoor Environmental Quality Credit 4.3: Low-Emitting Materials – Flooring Systems (1 Point)

Intent

To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

OPTION 1

All flooring must comply with the following as applicable to the project scope:

- All carpet installed in the building interior must meet the testing and product requirements of the Carpet and Rug Institute Green Label Plus[1] program.
- All carpet cushion installed in the building interior must meet the requirements of the Carpet and Rug Institute Green Label program.
- All carpet adhesive must meet the requirements of IEQ Credit 4.1: Adhesives and Sealants, which includes a volatile organic compound (VOC) limit of 50 g/L.
- All hard surface flooring must be certified as compliant with the FloorScore[2] standard (current as of the date of this rating system, or more stringent version) by an independent third-party. Flooring products covered by FloorScore include vinyl, linoleum, laminate flooring, wood flooring, ceramic flooring, rubber flooring and wall base.
- An alternative compliance path using FloorScore is acceptable for credit achievement: 100% of the non-carpet finished flooring must be FloorScore-certified and must constitute at least 25% of the finished floor area. Examples of unfinished flooring include floors in mechanical rooms, electrical rooms and elevator service rooms.
- Concrete, wood, bamboo and cork floor finishes such as sealer, stain and finish must meet the requirements of South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.
- Tile setting adhesives and grout must meet South Coast Air Quality Management District (SCAQMD) Rule 1168. VOC limits correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.

OR

OPTION 2

- All flooring elements installed in the building interior must meet the testing and product requirements of the
  California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from
  Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

Potential Strategies

For all low-emitting materials credits it is most vital that these low-emitting materials are clearly outlined in the specifications when soliciting bids. It is also extremely important to both document all low-emitting materials being used on the project as well as ensuring that the correct products are being used.

Analysis Within the Voorhees Replacement Facility

Per an email from the project architect the Voorhees Replacement Hospital will be utilizing low-emitting adhesives, sealants, paint, carpet and composite wood products. If the specified low-emitting materials used in the project are not enough to meet the requirements for the credit then the results of this analysis would still find that there would be no extra cost to the project. This conclusion was drawn from analyzing the GSA LEED Cost Study and Davis Langdons Cost of Green Revisited. Low-emitting materials are readily available now and usually at no extra cost as long as they are specified early in the project.

Cost Summary

No additional cost to the project because they are included in the base building and low-emitting materials are readily available on the market.

Additional Thoughts

None

Indoor Environmental Quality Credit 4.4: Low-Emitting Materials – Composite Wood and Agrifiber Products (1 Point)

Intent

To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

Composite wood and agrifiber products used on the interior of the building (i.e., inside the weatherproofing system) must contain no added urea-formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies must not contain added urea-formaldehyde resins.

Composite wood and agrifiber products are defined as particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates and door cores. Materials considered fixtures, furniture and equipment (FF&E) are not considered base building elements and are not included.

Potential Strategies

For all low-emitting materials credits it is most vital that these low-emitting materials are clearly outlined in the specifications when soliciting bids. It is also extremely important to both document all low-emitting materials being used on the project as well as ensuring that the correct products are being used.

Analysis Within the Voorhees Replacement Facility

Per an email from the project architect the Voorhees Replacement Hospital will be utilizing low-emitting adhesives, sealants, paint, carpet and composite wood products. If the specified low-emitting materials used in the project are not enough to meet the requirements for the credit then the results of this analysis would still find that there would be no extra cost to the project. This conclusion was drawn from analyzing the GSA LEED Cost Study and Davis Langdons Cost of Green Revisited. Low-emitting materials are readily available now and usually at no extra cost as long as they are specified early in the project.

Cost Summary

No additional cost to the project because they are included in the base building and low-emitting materials are readily available on the market.

Additional Thoughts

None

Indoor Environmental Quality Credit 5: Indoor Chemical and Pollutant Source Control (1 Point)

Intent

To minimize building occupant exposure to potentially hazardous particulates and chemical pollutants.

Requirements

Design to minimize and control the entry of pollutants into buildings and later cross-contamination of regularly occupied areas through the following strategies:

- Employ permanent entryway systems at least 10 feet long in the primary direction of travel to capture dirt and particulates entering the building at regularly used exterior entrances. Acceptable entryway systems include permanently installed grates, grill s and slotted systems that allow for cleaning underneath. Roll-out mats are acceptable only when maintained on a weekly basis by a contracted service organization.
- Sufficiently exhaust each space where hazardous gases or chemicals may be present or used (e.g., garages, housekeeping and laundry areas, copying and printing rooms) to create negative pressure with respect to adjacent spaces when the doors to the room are closed. For each of these spaces, provide self-closing doors and deck-to-deck partitions or a hard-lid ceiling. The exhaust rate must be at least 0.50 cubic feet per minute (cfm) per square foot with no air recirculation.
- In mechanically ventilated buildings, install new air filtration media in regularly occupied areas prior to occupancy; these filters must provide a minimum efficiency reporting value (MERV) of 13 or higher. Filtration should be applied to process both return and outside air that is delivered as supply air.
- Provide containment (i.e. a closed container for storage for off-site disposal in a regulatory compliant storage area, preferably outside the building) for appropriate disposal of hazardous liquid wastes in places where water and chemical concentrate mixing occurs (e.g., housekeeping, janitorial and science laboratories).

Potential Strategies

Design the building to include spaces that isolate contaminants for exhausting their chemical fumes. Maintain these areas and make sure they are isolated from the rest of the building. Make sure there are high quality filters preventing outdoor contaminants from entering the building.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Facility achieves this credit because they have designated areas for collecting, storing and properly disposing of hazardous materials. These rooms also have a separate exhaust system to prevent potential contamination in the rest of the hospital. This was determined through speaking with the mechanical engineer and reviewing drawings.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Indoor Environmental Quality Credit 6.1: Controllability of Systems – Lighting (1 Point)

Intent

To provide a high level of lighting system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms and conference areas) and promote their productivity, comfort and well-being.

Requirements

Provide individual lighting controls for 90% (minimum) of the building occupants to enable adjustments to suit individual task needs and preferences

Provide lighting system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences.

Potential Strategies

Design the building with lighting controls that provide controllability for occupants. Potential ideas include occupancy sensors, daylight sensors and dimming systems.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital is providing controllable and sensor-controlled lighting to a large portion of the hospital. However a majority of the bed tower patient rooms do not have occupant dimming controls and therefore the building is not reaching the 90% mark for lighting controls over the building.

Because of insufficient information there is no cost analysis performed on this credit. We can only say that the credit is not included in the base building and there would be an additional cost to obtain it.

Cost Summary

No cost analysis performed.

Additional Thoughts

None

Indoor Environmental Quality Credit 6.2: Controllability of Systems – Thermal Comfort (1 Point)

Intent

To provide a high level of thermal comfort system control[1] by individual occupants or groups in multi-occupant spaces (e.g., classrooms or conference areas) and promote their productivity, comfort and well-being.

Requirements

Provide individual comfort controls for 50% (minimum) of the building occupants to enable adjustments to meet individual needs and preferences. Operable windows may be used in lieu of controls for occupants located 20 feet inside and 10 feet to either side of the operable part of a window. The areas of operable window must meet the requirements of ASHRAE Standard 62.1-2007 paragraph 5.1 Natural Ventilation (with errata but without addenda[2]).

Provide comfort system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences.

Conditions for thermal comfort are described in ASHRAE Standard 55-2004 (with errata but without addenda[2]) and include the primary factors of air temperature, radiant temperature, air speed and humidity.

Potential Strategies

Design the building and HVAC system to provide occupant control of their thermal comfort.

Analysis Within the Voorhees Replacement Facility

The Voorhes Replacement Facility achieves this credit because there are automatic temperature controls in all the rooms that adjust based on usage and occupant preferences. This automatic temperature control system was included in the base building and therefore is at no additional cost to the project.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Indoor Environmental Quality Credit 7.1: Thermal Comfort – Design (1 Point)

Intent
To provide a comfortable thermal environment that promotes occupant productivity and well-being.

Requirements
Design heating, ventilating and air conditioning (HVAC) systems and the building envelope to meet the requirements of ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy (with errata but without addenda1). Demonstrate design compliance in accordance with the Section 6.1.1 documentation.

Potential Strategies

Use the ASHRAE standard for thermal comfort of building occupants to establish criteria for thermal comfort in the building. Design the system to match the criteria established.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Hospital is providing automatic temperature controls that meet the ASHRAE standard for thermal comfort for human occupancy. This was determined through a conversation with the mechanical engineer.

Cost Summary

No additional cost to the project.

Additional Thoughts

None

Indoor Environmental Quality Credit 7.2: Thermal Comfort – Verification (1 Point)

Intent
To provide for the assessment of building occupant thermal comfort over time.

Requirements
Achieve IEQ Credit 7.1: Thermal Comfort—Design

Provide a permanent monitoring system to ensure that building performance meets the desired comfort criteria as determined by IEQ Credit 7.1: Thermal Comfort—Design.

Agree to conduct a thermal comfort survey of building occupants within 6 to 18 months after occupancy. This survey should collect anonymous responses about thermal comfort in the building, including an assessment of overall satisfaction with thermal performance and identification of thermal comfort-related problems. Agree to develop a plan for corrective action if the survey results indicate that more than 20% of occupants are dissatisfied with thermal comfort in the building. This plan should include measurement of relevant environmental variables in problem areas in accordance with ASHRAE Standard 55-2004 (with errata but without addenda[1]).

Potential Strategies

Design the HVAC system to monitor that the installed system is working per the designed system. Develop a thermal comfort plan that addresses how the building will verify the thermal comfort of occupants and define steps to be taken if the thermal comfort is not met.

Analysis Within the Voorhees Replacement Facility

Per a conversation with the mechanical engineer, there is a monitoring system and plan in place to verify and maintain the thermal comfort of the occupants. Because of this credit 7.2 is achieved.

Cost Summary

No additional cost to project.

Additional Thoughts

None

Indoor Environmental Quality Credit 8.1: Daylight and Views – Daylight (1 Point)

Intent

To provide building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

Requirements

Through 1 of the 4 options, achieve daylighting in at least the following spaces:

Regularly Occupied Spaces	Points
75%	1

Potential Strategies

The best and only way to achieve this credit is through the design process. Owners and Architects must decide they wish to achieve this credit early in the project and design the building to achieve the required amount of daylight. Strategies include orientation of the building, using highly reflective finishes, and increasing the building perimeter.

Analysis Within the Voorhees Replacement Facility

Because of the complexity of this credit no analysis was performed.

Cost Summary

No cost analysis performed.

Additional Thoughts

None

Indoor Environmental Quality Credit 8.2: Daylight and Views – Views (1 Point)

Intent

To provide building occupants a connection to the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

Requirements

Achieve a direct line of sight to the outdoor environment via vision glazing between 30 inches and 90 inches above the finish floor for building occupants in 90% of all regularly occupied areas. Determine the area with a direct line of sight by totaling the regularly occupied square footage that meets the following criteria:

- In plan view, the area is within sight lines drawn from perimeter vision glazing.
- In section view, a direct sight line can be drawn from the area to perimeter vision glazing.

The line of sight may be drawn through interior glazing. For private offices, the entire square footage of the office may be counted if 75% or more of the area has a direct line of sight to perimeter vision glazing. For multi-occupant spaces, the actual square footage with a direct line of sight to perimeter vision glazing is counted.

Potential Strategies

The best and only way to achieve this credit is to decide early on in the project that this is a credit the owner wants to achieve. During the design process the Architect should design the building to maximize daylight and views. Some strategies to achieve this include the use of interior glazing or utilization of low partitions.

Analysis Within the Voorhees Replacement Facility

The Voorhees Replacement Facility provides a large number of occupied areas with views of outdoor environments. However due to the first few floors of the ancillary space, the minimum 90% of occupied spaces with views of outdoor environments is not achieved. Because of this, credit 8.2 is not obtainable.

Cost Summary

No additional cost because credit is not obtainable.

Additional Thoughts

None

Innovation In Design Credit 1: Innovation in Design (1-5 Points)

Intent

To provide design teams and projects the opportunity to achieve exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.

Requirements

Credit can be achieved through any combination of the Innovation in Design and Exemplary Performance paths as described below:

PAT H 1. Innovation in Design (1-5 points)

Achieve significant, measurable environmental performance using a strategy not addressed in the LEED 2009 for New Construction and Major Renovations Rating System.

One point is awarded for each innovation achieved. No more than 5 points under IDc1 may be earned through PATH 1—Innovation in Design.

Identify the following in writing:

- The intent of the proposed innovation credit.
- The proposed requirement for compliance.
- The proposed submittals to demonstrate compliance.
- The design approach (strategies) used to meet the requirements.

PAT H 2. Exemplary Performance (1-3 points)

Achieve exemplary performance in an existing LEED 2009 for New Construction and Major Renovations prerequisite or credit that allows exemplary performance as specified in the LEED Reference Guide for Green Building Design & Construction, 2009 Edition. An exemplary performance point may be earned for achieving double the credit requirements and/or achieving the next incremental percentage threshold of an existing credit in LEED.

One point is awarded for each exemplary performance achieved. No more than 3 points under IDc1 may be earned through PATH 2— Exemplary Performance.

Potential Strategies

Show either a distinct innovation in design that provides excellent measurable environmental quality or show that the building greatly exceeds energy use requirements set by LEED.

Analysis Within the Voorhees Replacement Facility

Because this credit is not generally defined an analysis will not be done.

Cost Summary

No analysis performed.

Additional Thoughts

None

Innovation In Design Credit 2: LEED Accredited Professional (1 Point)

Intent
To support and encourage the design integration required by LEED to streamline the application and certification process.

Requirements
At least 1 principal participant of the project team shall be a LEED Accredited Professional (AP).

Potential Strategies

Assign a project manager or senior superintendent who is a LEED Accredited Professional to the project.

Analysis Within the Voorhees Replacement Facility

This credit is obtained because there is a LEED Accredited Professional assigned to the Voorhees Replacement Facility.

Cost Summary

No additional cost to project.

Additional Thoughts

None

Regional Priority Credit 1: Regional Priority (1-4 Points)

Intent

To provide an incentive for the achievement of credits that address geographically-specific environmental priorities.

Requirements

Earn 1-4 of the 6 Regional Priority credits identified by the USGBC regional councils and chapters as having environmental importance for a project's region. A database of Regional Priority credits and their geographic applicability is available on the USGBC website, http://www.usgbc.org.

One point is awarded for each Regional Priority credit achieved; no more than 4 credits identified as Regional Priority credits may be earned. Projects outside of the U.S. are not eligible for Regional Priority credits.

Potential Strategies

To receive 1-4 points for this credit the Voorhees Replacement Facility must have achieved 1-4 of the following 6 credits.

- Sustainable Sites Credit 4.1
- Sustainable Sites Credit 5.1
- Sustainable Sites Credit 6.2
- Energy & Atmosphere Credit 1 – 36%
- Energy & Atmosphere Credit 1 – 40%
- Energy & Atmosphere Credit 2 – 1%

Analysis Within the Voorhees Replacement Facility

Sustainable Sites Credit 4.1 – Included in project

Sustainable Sites Credit 5.1 – Can obtain at a cost to the project

Sustainable Sites Credit 6.2 – Can obtain at a cost to the project

Energy & Atmosphere Credit 1 – 36% Improvement – Not in scope of analysis

Energy & Atmosphere Credit 1 – 40% Improvement – Not in scope of analysis

Energy & Atmosphere Credit 2 – 1% Produced – Can obtain at a cost to the project

Cost Summary

There is no cost to obtain the first point because sustainable sites credit 4.1 is at no cost to the project. The remaining 3 possible points are obtainable but would cost what the corresponding required credit would cost to obtain. Please see the corresponding credits for the cost analysis.

Additional Thoughts

None

Analysis & Conclusions

The summary table showing the breakdown of credits that are in the base building, credits that are not obtainable, credits that can be obtained at no extra cost, credits that can be obtained at an extra cost and credits that were not evaluated within this analysis can be seen below in table 1.

	Credit Obtained From Base Building			
	Credit Not Obtainable			
	Credit Can Be Obtained at No Extra Cost			
	Credit Can Be Obtained at Extra Cost			
	Credit Was Not Evaluted			
Sustainable Sites			**Possible Points:**	**26**
Prereq 1	Construction Activity Pollution Prevention		Prerequisite	
Credit 1	Site Selection		1	
Credit 2	Development Density and Community Connectivity		5	
Credit 3	Brownfield Redevelopment		1	
Credit 4.1	Alternative Transportation—Public Transportation Access		6	
Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Roon		1	
Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Ve		3	
Credit 4.4	Alternative Transportation—Parking Capacity		2	
Credit 5.1	Site Development—Protect or Restore Habitat		1	
Credit 5.2	Site Development—Maximize Open Space		1	
Credit 6.1	Stormwater Design—Quantity Control		1	
Credit 6.2	Stormwater Design—Quality Control		1	
Credit 7.1	Heat Island Effect—Non-roof		1	
Credit 7.2	Heat Island Effect—Roof		1	
Credit 8	Light Pollution Reduction		1	
Water Efficiency			**Possible Points:**	**10**
Prereq 1	Water Use Reduction—20% Reduction		Prerequisite	
Credit 1	Water Efficient Landscaping		2 to 4	
		Reduce by 50%	2	
		No Potable Water Use or Irrigation	4	
Credit 2	Innovative Wastewater Technologies		2	
Credit 3	Water Use Reduction		2 to 4	
		Reduce by 30%	2	
		Reduce by 35%	3	
		Reduce by 40%	4	

Table 1.1 – Summary of Point-by-Point Analysis

Energy and Atmosphere			Possible Points:	35	
Prereq 1	Fundamental Commissioning of Building Energy Systems			Prerequisite	
Prereq 2	Minimum Energy Performance			Prerequisite	
Prereq 3	Fundamental Refrigerant Management			Prerequisite	
Credit 1	Optimize Energy Performance			1 to 19	
		Improve by 12% for New Buildings or 8% f		1	
		Improve by 14% for New Buildings or 10%		2	
		Improve by 16% for New Buildings or 12%		3	
		Improve by 18% for New Buildings or 14%		4	
		Improve by 20% for New Buildings or 16%		5	
		Improve by 22% for New Buildings or 18%		6	
		Improve by 24% for New Buildings or 20%		7	
		Improve by 26% for New Buildings or 22%		8	
		Improve by 28% for New Buildings or 24%		9	
		Improve by 30% for New Buildings or 26%		10	
		Improve by 32% for New Buildings or 28%		11	
		Improve by 34% for New Buildings or 30%		12	
		Improve by 36% for New Buildings or 32%		13	
		Improve by 38% for New Buildings or 34%		14	
		Improve by 40% for New Buildings or 36%		15	
		Improve by 42% for New Buildings or 38%		16	
		Improve by 44% for New Buildings or 40%		17	
		Improve by 46% for New Buildings or 42%		18	
		Improve by 48%+ for New Buildings or 44%		19	
Credit 2	On-Site Renewable Energy			1 to 7	
		1% Renewable Energy		1	
		3% Renewable Energy		2	
		5% Renewable Energy		3	
		7% Renewable Energy		4	
		9% Renewable Energy		5	
		11% Renewable Energy		6	
		13% Renewable Energy		7	
Credit 3	Enhanced Commissioning			2	
Credit 4	Enhanced Refrigerant Management			2	
Credit 5	Measurement and Verification			3	
Credit 6	Green Power			2	

Table 1.2 – Summary of Point-by-Point Analysis

Materials and Resources			**Possible Points:**	**14**
Prereq 1	Storage and Collection of Recyclables			Prerequisite
Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof			1 to 3
		Reuse 55%		1
		Reuse 75%		2
		Reuse 95%		3
Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elemer			1
Credit 2	Construction Waste Management			1 to 2
		50% Recycled or Salvaged		1
		75% Recycled or Salvaged		2
Credit 3	Materials Reuse			1 to 2
		Reuse 5%		1
		Reuse 10%		2
Credit 4	Recycled Content			1 to 2
		10% of Content		1
		20% of Content		2
Credit 5	Regional Materials			1 to 2
		10% of Materials		1
		20% of Materials		2
Credit 6	Rapidly Renewable Materials			1
Credit 7	Certified Wood			1
Indoor Environmental Quality			**Possible Points:**	**15**
Prereq 1	Minimum Indoor Air Quality Performance			Prerequisite
Prereq 2	Environmental Tobacco Smoke (ETS) Control			Prerequisite
Credit 1	Outdoor Air Delivery Monitoring			1
Credit 2	Increased Ventilation			1
Credit 3.1	Construction IAQ Management Plan—During Construction			1
Credit 3.2	Construction IAQ Management Plan—Before Occupancy			1
Credit 4.1	Low-Emitting Materials—Adhesives and Sealants			1
Credit 4.2	Low-Emitting Materials—Paints and Coatings			1
Credit 4.3	Low-Emitting Materials—Flooring Systems			1
Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Produc			1

Table 1.3 – Summary of Point-by-Point Analysis

Credit 5	Indoor Chemical and Pollutant Source Control		1	
Credit 6.1	Controllability of Systems—Lighting		1	
Credit 6.2	Controllability of Systems—Thermal Comfort		1	
Credit 7.1	Thermal Comfort—Design		1	
Credit 7.2	Thermal Comfort—Verification		1	
Credit 8.1	Daylight and Views—Daylight		1	
Credit 8.2	Daylight and Views—Views		1	
Innovation and Design Process		**Possible Points:**	**6**	
Credit 1.1	Innovation in Design: Specific Title		1	
Credit 1.2	Innovation in Design: Specific Title		1	
Credit 1.3	Innovation in Design: Specific Title		1	
Credit 1.4	Innovation in Design: Specific Title		1	
Credit 1.5	Innovation in Design: Specific Title		1	
Credit 2	LEED Accredited Professional		1	
Regional Priority Credits		**Possible Points:**	**4**	
Credit 1.1	Regional Priority: Specific Credit		1	
Credit 1.2	Regional Priority: Specific Credit		1	
Credit 1.3	Regional Priority: Specific Credit		1	
Credit 1.4	Regional Priority: Specific Credit		1	
Total		**Possible Points:**	**110**	

Table 1.4 – Summary of Point-by-Point Analysis

The above table is a general summary of the results found from the point-by-point analysis.

After the completion of the point-by-point analysis the points were added together to determine the number of points the Voorhees Replacement Facility is achieving in its current design. This Voorhees Replacement Hospital was determined to be achieving 30 LEED points in its current design. The next step is to determine the cost to reach each consecutive LEED rating based on the point-by-point analysis completed in the previous section of analysis 1. It is important to note that the scope of the analysis does not cover any additional energy optimization credits other then the modeling base credits the building is already achieving. Because of this the total number of possible points the building can achieve is limited to less then required for a platinum rating. Therefore there is no analysis completed for the platinum rating. Table 2 below shows the summary by credit section of points used in each certification level and the additional cost to reach each level.

Sustainable Sites				
LEED Rating	**Points Included In Base Building**	**Points Obtained at a Cost**	**Additional Cost of Points**	**Section Total Points**
Base Building	9	-	$ -	9
Certified	9	6	$ 14,663.00	15
Silver	9	6	$ 14,663.00	15
Gold	9	7	$ 1,483,200.00	16
Platinum	-	-	-	-

Water Efficiency				
LEED Rating	**Points Included In Base Building**	**Points Obtained at a Cost**	**Additional Cost of Points**	**Section Total Points**
Base Building	0	-	$ -	0
Certified	0	4	$ 85,225.00	4
Silver	0	4	$ 85,225.00	4
Gold	0	4	$ 85,225.00	4
Platinum	-	-	-	-

Energy & Atmosphere				
LEED Rating	**Points Included In Base Building**	**Points Obtained at a Cost**	**Additional Cost of Points**	**Section Total Points**
Base Building	7	-	$ -	7
Certified	7	0	$ -	7
Silver	7	5	$ 285,457.00	12
Gold	7	9	$ 6,195,757.00	16
Platinum	-	-	-	-

Materials & Resources				
LEED Rating	**Points Included In Base Building**	**Points Obtained at a Cost**	**Additional Cost of Points**	**Section Total Points**
Base Building	1	-	$ -	1
Certified	1	0	$ -	1
Silver	1	4	$ 432,000.00	5
Gold	1	6	$ 972,000.00	7
Platinum	-	-	-	-

Indoor Air Quality				
LEED Rating	**Points Included In Base Building**	**Points Obtained at a Cost**	**Additional Cost of Points**	**Section Total Points**
Base Building	12	-	$ -	12
Certified	12	0	$ -	12
Silver	12	0	$ -	12
Gold	12	0	$ -	12
Platinum	-	-	-	-

Table 2.1 – Summary of Points Per Credit Section to Achieve Each LEED Rating

Innovation & Design Process (Not In Analysis)				
LEED Rating	**Points Included In Base Building**	**Points Obtained at a Cost**	**Additional Cost of Points**	**Section Total Points**
Base Building	1	-	$ -	0
Certified	1	0	$ -	1
Silver	1	0	$ -	1
Gold	1	0	$ -	1
Platinum	-	-	-	-

Reginal Priority				
LEED Rating	**Points Included In Base Building**	**Points Obtained at a Cost**	**Additional Cost of Points**	**Section Total Points**
Base Building	1	-	$ -	1
Certified	1	1	$ -	2
Silver	1	1	$ -	2
Gold	1	3	$ -	4
Platinum	-	-	-	-

TOTALS				
LEED Rating	**Total Additional Cost**	**% Construction Cost Increse**	**Point Range**	**Point Total**
Base Building	$ -	-	-	30
Certified	$ 99,888.00	0.031%	40-49	42
Silver	$ 817,345.00	0.252%	50-59	51
Gold	$ 8,736,182.00	2.633%	60-79	60
Platinum	-	-	80-110	-

Table 2.2 – Summary of Points Per Credit Section to Achieve Each LEED Rating

Table 2 above shows the breakdown of each LEED section and the number of credits used from each section to achieve certified, silver and gold ratings. From the above table one can see that the hard cost to reach a certified or silver level is very minimal compared to the total cost of the hospital. To get the total cost to reach each level we must add in the hard cost shown in table 2 to the soft costs calculated in the beginning of the analysis. A more detailed breakdown of what points were utilized in achieving each LEED rating can be seen below in table 3.

Points Used in Each LEED Rating				Base Building	Certified	Silver	Gold
Sustainable Sites		Possible Points:	**26**				
Prereq 1	Construction Activity Pollution Prevention		Prerequisite				
Credit 1	Site Selection		1				
Credit 2	Development Density and Community Connectivity		5				
Credit 3	Brownfield Redevelopment		1				
Credit 4.1	Alternative Transportation—Public Transportation Access		6				
Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Roon		1				
Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Ve		3				
Credit 4.4	Alternative Transportation—Parking Capacity		2				
Credit 5.1	Site Development—Protect or Restore Habitat		1				
Credit 5.2	Site Development—Maximize Open Space		1				
Credit 6.1	Stormwater Design—Quantity Control		1				
Credit 6.2	Stormwater Design—Quality Control		1				
Credit 7.1	Heat Island Effect—Non-roof		1				
Credit 7.2	Heat Island Effect—Roof		1				
Credit 8	Light Pollution Reduction		1				
Water Efficiency		Possible Points:	**10**				
Prereq 1	Water Use Reduction—20% Reduction		Prerequisite				
Credit 1	Water Efficient Landscaping		2 to 4				
	Reduce by 50%		2				
	No Potable Water Use or Irrigation		4				
Credit 2	Innovative Wastewater Technologies		2				
Credit 3	Water Use Reduction		2 to 4				
	Reduce by 30%		2				
	Reduce by 35%		3				
	Reduce by 40%		4				

Table 3.1 – Point Used in Each LEED Rating

Energy and Atmosphere			Possible Points: 35				
Prereq 1	Fundamental Commissioning of Building Energy Systems			Prerequisite			
Prereq 2	Minimum Energy Performance			Prerequisite			
Prereq 3	Fundamental Refrigerant Management			Prerequisite			
Credit 1	Optimize Energy Performance			1 to 19			
		Improve by 12% for New Buildings or 8% f		1			
		Improve by 14% for New Buildings or 10%		2			
		Improve by 16% for New Buildings or 12%		3			
		Improve by 18% for New Buildings or 14%		4			
		Improve by 20% for New Buildings or 16%		5			
		Improve by 22% for New Buildings or 18%		6			
		Improve by 24% for New Buildings or 20%		7			
		Improve by 26% for New Buildings or 22%		8			
		Improve by 28% for New Buildings or 24%		9			
		Improve by 30% for New Buildings or 26%		10			
		Improve by 32% for New Buildings or 28%		11			
		Improve by 34% for New Buildings or 30%		12			
		Improve by 36% for New Buildings or 32%		13			
		Improve by 38% for New Buildings or 34%		14			
		Improve by 40% for New Buildings or 36%		15			
		Improve by 42% for New Buildings or 38%		16			
		Improve by 44% for New Buildings or 40%		17			
		Improve by 46% for New Buildings or 42%		18			
		Improve by 48%+ for New Buildings or 44%		19			
Credit 2	On-Site Renewable Energy			1 to 7			
		1% Renewable Energy		1			
		3% Renewable Energy		2			
		5% Renewable Energy		3			
		7% Renewable Energy		4			
		9% Renewable Energy		5			
		11% Renewable Energy		6			
		13% Renewable Energy		7			
Credit 3	Enhanced Commissioning			2			
Credit 4	Enhanced Refrigerant Management			2			
Credit 5	Measurement and Verification			3			
Credit 6	Green Power			2			

Table 3.2 – Point Used in Each LEED Rating

Materials and Resources			**Possible Points:**	**14**			
Prereq 1	Storage and Collection of Recyclables			Prerequisite			
Credit 1.1	Building Reuse--Maintain Existing Walls, Floors, and Roof			1 to 3			
		Reuse 55%		1			
		Reuse 75%		2			
		Reuse 95%		3			
Credit 1.2	Building Reuse--Maintain 50% of Interior Non-Structural Elemer			1			
Credit 2	Construction Waste Management			1 to 2			
		50% Recycled or Salvaged		1			
		75% Recycled or Salvaged		2			
Credit 3	Materials Reuse			1 to 2			
		Reuse 5%		1			
		Reuse 10%		2			
Credit 4	Recycled Content			1 to 2			
		10% of Content		1			
		20% of Content		2			
Credit 5	Regional Materials			1 to 2			
		10% of Materials		1			
		20% of Materials		2			
Credit 6	Rapidly Renewable Materials			1			
Credit 7	Certified Wood			1			
Indoor Environmental Quality			**Possible Points:**	**15**			
Prereq 1	Minimum Indoor Air Quality Performance			Prerequisite			
Prereq 2	Environmental Tobacco Smoke (ETS) Control			Prerequisite			
Credit 1	Outdoor Air Delivery Monitoring			1			
Credit 2	Increased Ventilation			1			
Credit 3.1	Construction IAQ Management Plan--During Construction			1			
Credit 3.2	Construction IAQ Management Plan--Before Occupancy			1			
Credit 4.1	Low-Emitting Materials--Adhesives and Sealants			1			
Credit 4.2	Low-Emitting Materials--Paints and Coatings			1			
Credit 4.3	Low-Emitting Materials--Flooring Systems			1			

Table 3.3 – Point Used in Each LEED Rating

Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Produc		1			
Credit 5	Indoor Chemical and Pollutant Source Control		1			
Credit 6.1	Controllability of Systems—Lighting		1			
Credit 6.2	Controllability of Systems—Thermal Comfort		1			
Credit 7.1	Thermal Comfort—Design		1			
Credit 7.2	Thermal Comfort—Verification		1			
Credit 8.1	Daylight and Views—Daylight		1			
Credit 8.2	Daylight and Views—Views		1			
Innovation and Design Process		Possible Points:	6			
Credit 1.1	Innovation in Design: Specific Title		1			
Credit 1.2	Innovation in Design: Specific Title		1			
Credit 1.3	Innovation in Design: Specific Title		1			
Credit 1.4	Innovation in Design: Specific Title		1			
Credit 1.5	Innovation in Design: Specific Title		1			
Credit 2	LEED Accredited Professional		1			
Regional Priority Credits		Possible Points:	4			
Credit 1.1	Regional Priority: S.S. Credit 4.1		1			
Credit 1.2	Regional Priority: S.S. Credit 5.1		1			
Credit 1.3	Regional Priority: S.S. Credit 6.2		1			
Credit 1.4	Regional Priority: E.A. Credit 2 (1%)		1			
Total		Possible Points:	110			
			Points Obtained	30	42	51	60
				-	Point Range (40-49)	Point Range (50-59)	Point Range (60-79)

Table 3.4 – Point Used in Each LEED Rating

From completing the point-by-point analysis and then determining the soft and hard costs required to achieve each LEED rating we can see that the cost to achieve certified and silver ratings is very small compared to the total construction costs. From this we can draw that conclusion that it would not have been difficult for the Voorhees Replacement Hospital to obtain a LEED rating. We can also say that the most important contributor to obtaining a LEED rating is proper planning. Because there was no goal to achieve a LEED rating from the beginning of the design process certain LEED points that are relatively easy and cheap to achieve were not considered and therefore not included in the project. For any healthcare or non-healthcare building I would recommend that LEED be considered early in the design process and implemented from the start so that all credits that can be obtained are achieved.

Analysis 2 – LED Lighting

Scope of Work

The patient rooms are currently designed around the use of fluorescent lighting. As energy issues grow and owners continuously look for energy savings in their buildings I will investigate the use of LED lighting in the patient rooms. This analysis will attempt to redesign the lighting in a typical patient room to utilize LED down lighting, determine the effect the lighting change has on the mechanical system, and then finally evaluate the life cycle of the newly designed room. Furthermore this analysis will attempt to determine if the switch to LED lighting would positively affect patients.

Introduction

Lighting in commercial buildings can account for as much as 30% of the total electricity usage. Because of this it is important for owners to explore the different lighting options that they can utilize in their buildings to attempt to reduce both their energy consumption and carbon footprint.

Typical commercial buildings now utilize fluorescent lighting which provide considerable energy savings over the now phased out incandescent light. Fluorescent lighting in most commercial applications can last up to 20,000 hours, almost 20 times as long as typical incandescent lights and can produce the same amount of light with a lot less energy. With the constant threat of skyrocketing electricity prices and the continuously increasing standards of green technology what can a owner do to reduce his electricity load and annual costs?

Light-emitting diodes or LED's have been around for a long time however scientists are just starting to discover the technology to produce the white light required for space lighting. LED's in the past and present are typically used in electronics such as TV's, radios, telephones, calculators, and even watches as a way to produce light with little energy. A typical LED can be seen in figure 1 below.

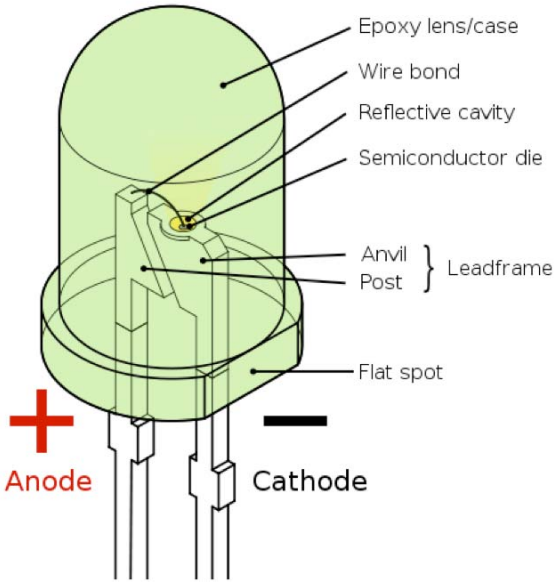


Figure 1 - Typical LED
(http://en.wikipedia.org/wiki/File:LED,_5mm,_green_(en).svg)

In the LED as shown above in figure 1 an electrical current passes through the semiconductor diode, which in turn gives off a photon of light. In the past LED's could only be designed to give off a certain color depending on what wavelength of light they were manufactured to give off. So in order to produce the white light required to light spaces in commercial buildings the RGB or phosphor method must be used. The RGB method is simply using three individual LED's that produce red, green and blue light, which creates the white light. The phosphor method is using a single LED in combination with a phosphor to absorb a portion of the short wavelength light to create white light. The phosphor method is the widely used approach in typical white light applications.

To utilize LED's in a commercial lighting application the individual LED's must be arranged in close proximity to each other to produce the high intensity light. An example of a LED lamp that shows an arrangement of LED's can be seen below in figure 2.

Figure 2 – Example of LED Lamp
(http://www.supplierlist.com/photo_images/107803/High_Power_LED_Lamp.jpg)

The LED lamp shown in figure 2 is the typical LED lamp setup which include the individual LED's, the housing, the LED driver to control the LED's and a heat sink to direct the heat away from the cluster of LED's. LED's exposed to large amounts of heat can be at risk to dim the lamp and reduce the lifetime of the LED's. The current expected lifetime of LED lamps range from 35,000 to as high as 100,000 hours. LED lamps right now can reach as high as 100 lumens per watt and are expected to reach efficiencies as high as 150 lumens per watt. Seemingly the LED light should be the next jump in lighting technology in commercial applications, however the initial prices of LED lighting is higher then fluorescent and incandescent and can deter owners from specifying it in their buildings. The following analysis will determine if LED lighting in the patient rooms is worth the initial payment.

Lighting Breadth – Typical Patient Room LED Design

The Voorhees Replacement Hospital typical patient room is designed with three major light fixtures illuminating the space. There are two 8" compact fluorescent down lights, each that house two 26-watt compact fluorescent lamps located in the family space and entrance space. There is a 2'x4' luminaire directly above the patient bed that houses 4 54-watt T5 high output fluorescent lamps. This fixture uses 2 of the lamps for ambient lighting and all 4 lamps for exam level lighting. A lighting analysis showing the footcandle levels of the typical fluorescent lit patient room during ambient lighting can be seen in figure 3 below. The program AGI was used to develop this figure.

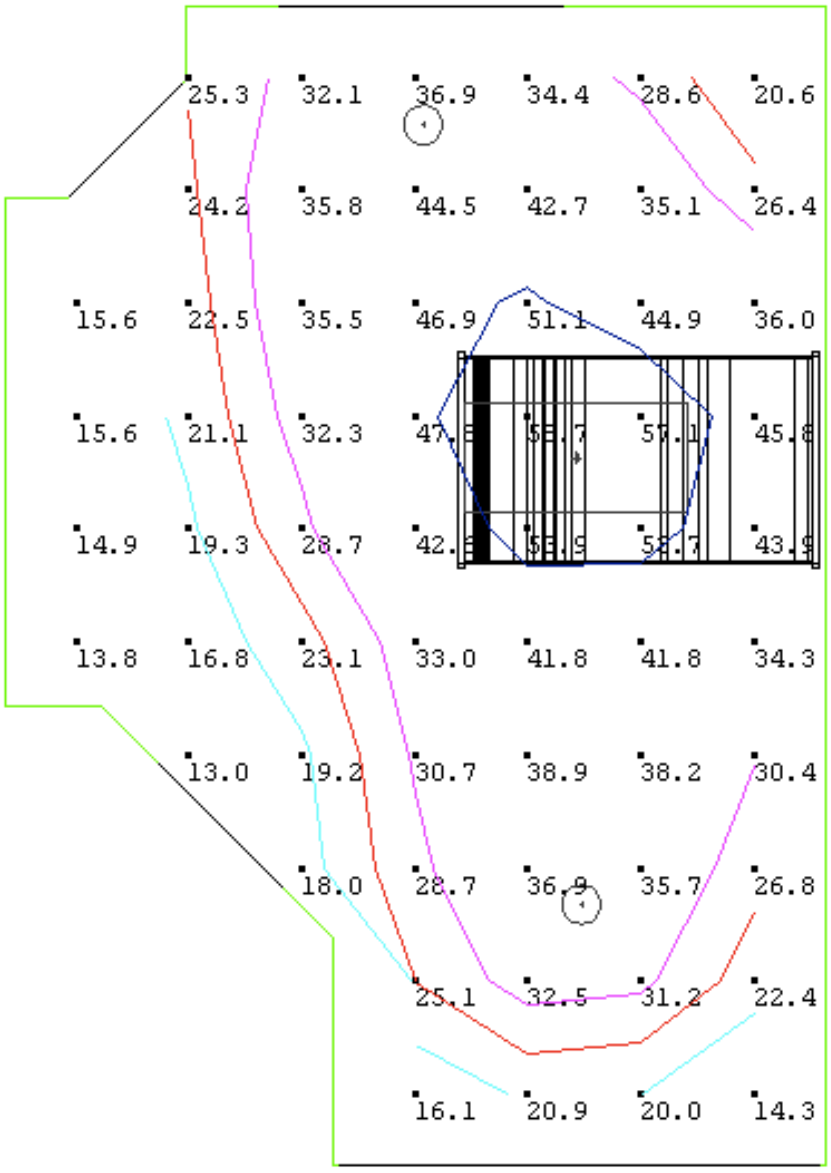


Figure 3 – Typical Fluorescent Lit Patient Room

To redesign the typical patient room using LED lighting one must first find the required light levels in a hospital patient room. From referencing the IESNA Handbook the lighting levels required for inpatient hospital patient rooms are as follows…

- Reading – 30 footcandles
- Exam Level – 50 footcandles
- General – 5 footcandles
- Observation 5 footcandles

Next using the AGI software program the patient room was modeled using wall lengths from the construction documents and a ceiling height of 9 feet from the reflected ceiling plan. The walls, ceiling and floor material was found using the finish schedule and reflectance's were chosen from AGI as best possible. The reflectance's used are as follows…

- Walls – Painted Sherwin Williams 7555 Patience – Reflectivity of .85
- Ceiling – Acoustical Ceiling Tile Armstrong Tegular 2'x2' White – Reflectivity of .92
- Floor – Sheet Vinyl Flooring – Reflectivity of .42

Next research was conducted to determine the best luminaires to use in the new design of the patient room. The luminaires that were chosen to be included in the new patient room lighting design were the Cree LR24 and the Halo 900 series LED module. The manufacturer's specifications can be found in appendix J. The Cree LR24 LED down light is a 2'x2' luminaire that provides 3800 lumens at 58 input watts. The Halo 900 series LED module is a 6" down light similar to a fluorescent down light that provides 950 lumens at 14 input watts. Again the manufacturer's specifications can be found in appendix J. Pictures of the two different luminaires can be found below in figures 4 and 5.

Figure 4 – Cree LR24
(http://www.ssldes.com/images/081219_cree_LR24.jpg)

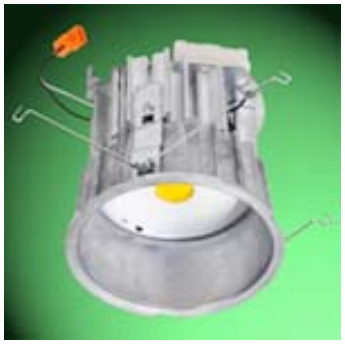


Figure 5 – Halo 900 series
(http://www.cooperlighting.com/images/obgdatabase/Halo/HR_900-Module_150.jpg)

The computer files for the two LED luminaires were then uploaded into the program AGI. Light loss factors were then determined and plugged into each luminaire before the room could be designed. Light loss factors are factors that need to be included in lighting calculations because they reduce the projected light output of a particular luminaire. The light loss factors and assumptions for the two LED luminaires are as follows…

- Ballast Factor – 1.0 because LED's do not have ballasts
- Lamp Lumen Depreciation – The LED lamp does not catastrophically fail. Instead the LED lamp is considered at its end life when the lumen output is less then 70% of its original output. Because of this a LLD of 0.9 is used.
- Luminaire Dirt Depreciation – LED lights do not rely on reflected light so a LDD of 1.0 is used.
- Lamp Burnout Factor – Since LED lights do not "burn out" the factor must be 1.0

After the light loss factors had been inputted the room was then designed with trial and error. After achieving the required light levels the following layout was the new design. A CD with the AGI files is included in appendix K.

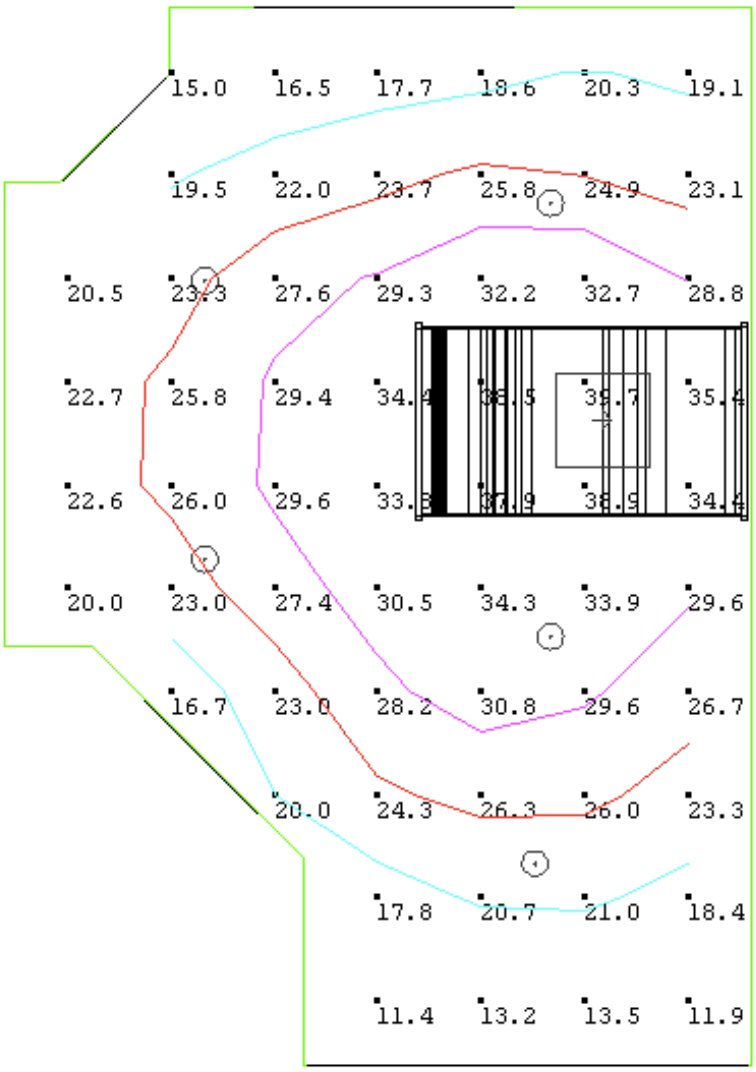


Figure 6 – Patient Room Reading Level LED Design

Figure 6 above is the LED light design for a typical patient room when reading level light is required. The required level of 30 footcandles is met by dimming the luminaire over the patient bed by 50%. The exam level requirement of 50 footcandles is then met by the luminaire over the bed on at 100% lumen output. This situation can be seen in figure 7 below.

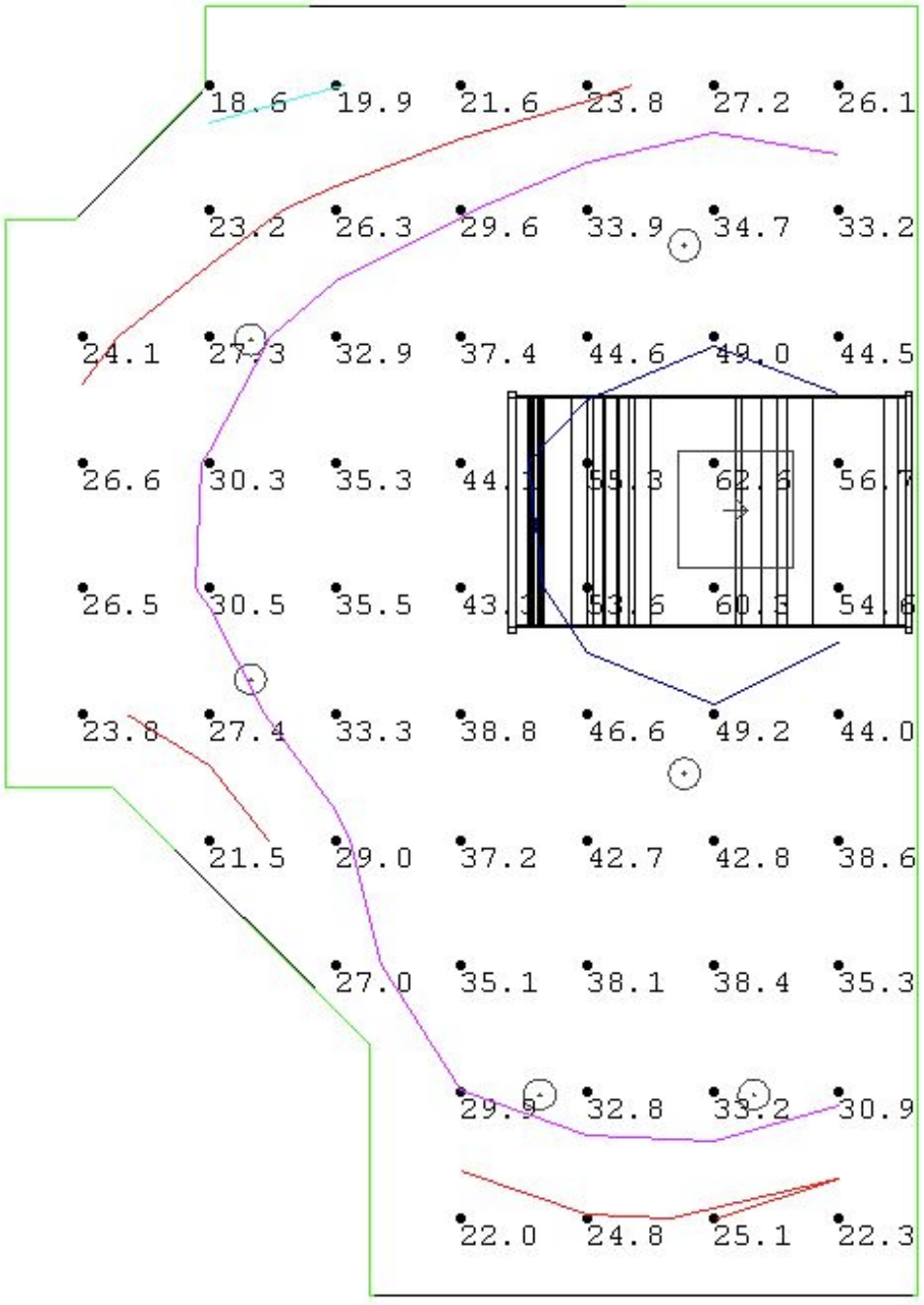


Figure 7 – Patient Room Exam level LED Design

As seen in figure 7 above when the luminaire above the patient bed is on at 100% the exam level requirement of 50 footcandles is met. Renderings of the patient room can be seen below in figures 8-10.

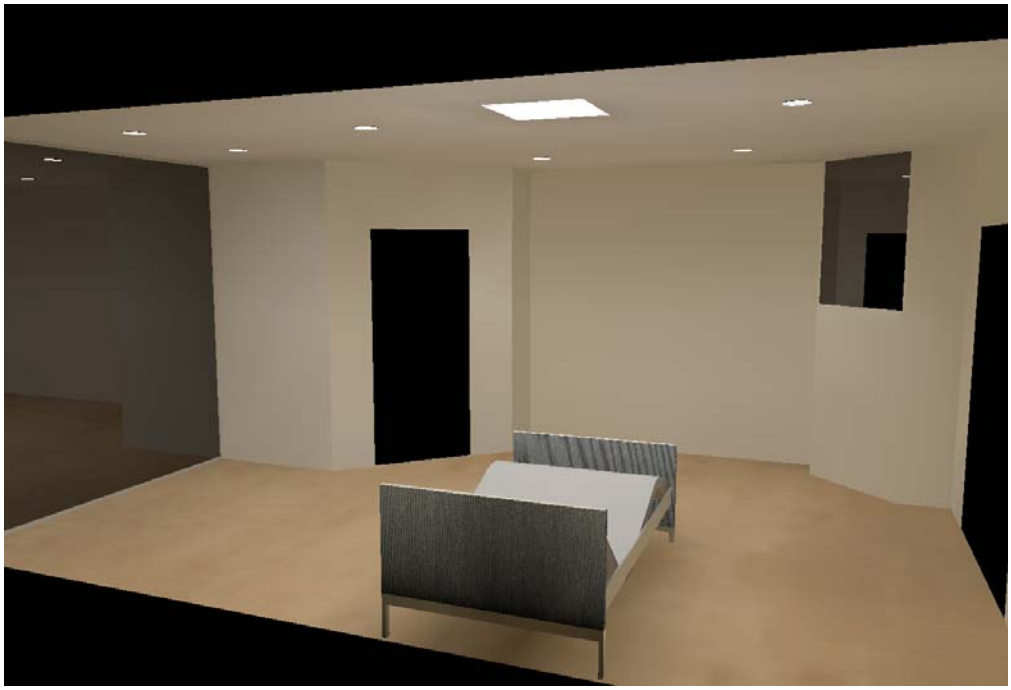


Figure 8 – Patient Room LED Design Rendering 1

Figure 9 – Patient Room LED Design Rendering 2

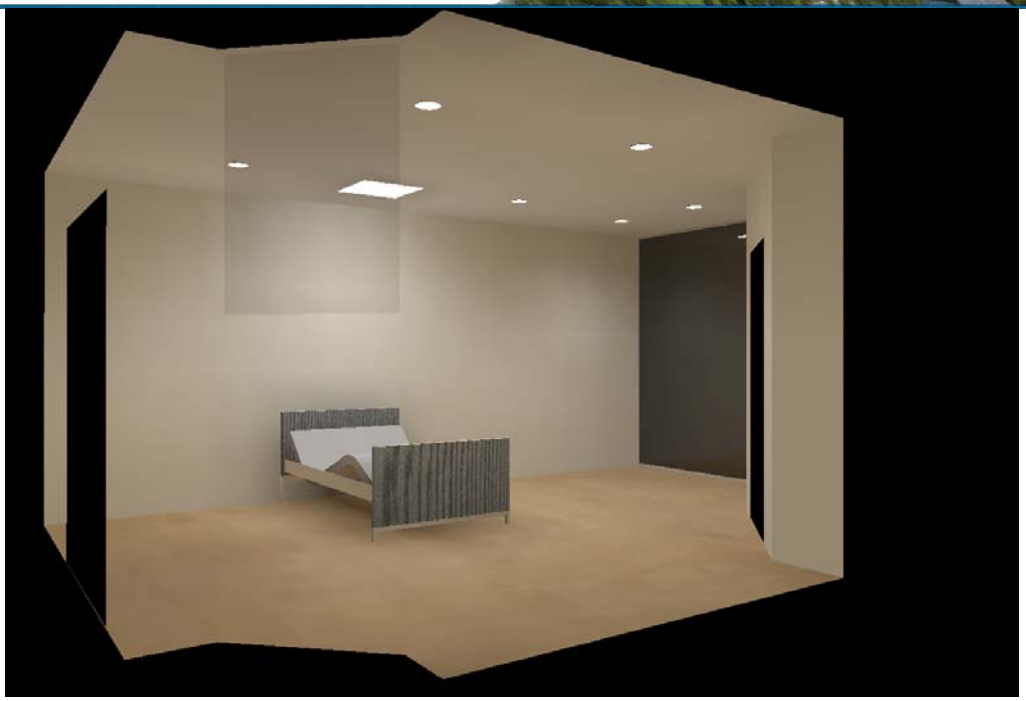


Figure 10 – Patient Room LED Design Rendering 3

As described above the luminaire above the patient bed will have dimming capabilities. The four Halo 900 series modules surrounding the bed will also be dimmable so that energy can be saved during the day when the patient rooms are letting in light from the large windows on the south side of the rooms. The luminaires will be dimmed using a wireless system from Lutron. Product data for the dimming system can be found in appendix L.

The total wattage of the new LED designed patient room is 142 watts compared to the fluorescent designed patient room, which is 212 watts.

Mechanical Breadth – Mechanical Savings

Because the LED lighting patient room design shows a reduction in total wattage one must look at the energy savings in the mechanical systems due to the reduction of room wattage. The equation to determine the heat given off due to lighting is as follows (from the AE310 textbook)…

$q = 3.41(W)(f_u)(f_s)$ Where…

q – Heat given off in BTU/hr
W – Total room wattage (watts)
f_u – Use factor (ratio of wattage in use to total wattage installed)
f_s – Special allowance factor (ballast factor)

The calculation for the fluorescent room in BTU/hr is as follows…

$q = 3.41(W)(f_u)(f_s) = 3.41(212)(1.0)(1.2) = 867.5$ BTUs/hrΩ

W = 212(wattage of fluorescent room)
$f_u = 1.0$
$f_s = 1.2$ for fluorescent fixtures

The calculation for the LED room in BTU/hr is as follows…

$q = 3.41(W)(f_u)(f_s) = 3.41(142)(1.0)(1.04) = 503.5$ BTUs/hr

W = 142(wattage of LED room)
$f_u = 1.0$
$f_s = 1.04$ for LED fixtures

The reduction in BTUs/hr from the fluorescent-lit room to the LED-lit room is as follows…

$\Delta q = 867.5$ BTUs/hr – 503.5 BTUs/hr = 364 BTUs/hr

By changing from fluorescent lighting to LED lighting there is a reduction in heat produced by 364 BTUs/hr.

Total BTUs/hr reduction for the 300 patient rooms is then…

Total Reduction in BTUs/hr = (364 BTUs/hr-room)(300 patient rooms) = 109,200 BTUs/hr

From this total reduction in BTUs/hr we can then determine the total reduction CFM for the patient rooms and the energy savings from the cooling system, mainly from the chillers.

To determine the reduction CFM required due to the reduction in BTUs/hr the generalized equation is as follows…

CFM reduction = ΔBTUs/hr / ΔT / 1.1 where…

ΔT – Difference in outside temperature and design temperature
1.1 – Included to account for variable factors

So the reduction in CFM for all of our patient rooms is then…

CFM reduction = 109,200 BTUs/hr / 20° / 1.1 = 4964 CFM

ΔT = 20° per the mechanical engineer

The designed air handling unit supplying air to all of the patient rooms consists of 6 separate air handling units at 75,000 CFM each. The CFM reduction of 4964 due to the switch to LED lighting does not provide a large enough change to consider resizing the air handling units.

There is no mechanical equipment cost savings from the switch to LED lighting.

To determine the energy savings from the reduction in BTUs/hr the equation is as follows. It is important to note that the following equation is based on the assumption that the savings are from a reduced load on the chillers.

Cost Savings/Year = (0.6kW/Ton)(ΔTons)(2000hrs)($/kWhr) where…

0.6kW/Ton – Chiller Efficiency
ΔTons – Change in BTUs/hr converted to change in Tons. (12,000 BTUs = 1 Ton)
2000 hours – The average number of hours the chiller runs per year
$/kWhr – Electricity price per kilowatt-hour

So the energy savings for all of our patient rooms is then…

Cost Savings/Year = (0.6kW/Ton)(9.1Tons)(2000hrs)($0.1307/kWhr) = $1,427.00/Year

ΔTons = 109,200/12000 = 9.1Tons
$/kWhr = $0.1307/kWhr

Total cost savings from the reduced chiller load = $1,427.00/Year

Life Cycle Cost Analysis

LED vs Fluorescent Life Cycle Analysis				
Voorhees Replacement Facility				
Average Number of Hours of Use Per Day				12
Price of Electricity (Dollars/per kWH)				0.1307
	Existing Fluorescent Lighting		LED Replacement Lighting	
Luminaire Description	DF 11	MF 13	HALO	CREE
Input Watts Per Luminaire (W)	44	122	14.8	58
# of Patient Rooms	300	300	300	300
Luminaires/room	2	1	6	1
Total # of Luminaires	600	300	1800	300
Cost/Luminaire	$ 130	$ 435	$ 168	$ 439
Total Luminaire Cost	$ 78,000	$ 130,500	$ 302,400	$ 131,700
Cost of Controls/Patient Room	N/A	N/A	$	300
Total Controls Cost	N/A	N/A	$	90,000
Total Initial Cost	**$**	**208,500**	**$**	**524,100**
Total Input Watts Before Controls (W)	26400	36600	26640	17400
Quantity of Lights w/ Controls (per patient room)	0	0	6	1
Operating Hours Controlled Per Day	N/A	N/A	6	10
% Light Output When Controlled	N/A	N/A	50%	50%
Annual Energy Consumptin w/Controls (kWh)	115632	160308	97236	44457
Annual Energy Costs	**$ 15,113**	**$ 20,952**	**$ 12,709**	**$ 5,811**
Per Fixture Replacement Cost	$ 14	$ 20	$ 142	$ 330
Per Fixture Replacement Labor Cost	$ 12	$ 12	$ 24	$ 24
Rated Lamp Life (hours)	20000	20000	50000	50000
years/lamp	4.57	4.57	11.42	11.42
Average Annual Lamp Maintenance Cost	**$ 3,416**	**$ 2,102**	**$ 26,175**	**$ 9,303**
Total Patient Room Energy Costs	**$**	**36,065**	**$**	**18,519**
Energy Savings from LED per year			**$ 17,546**	
Total Average Annual Maintenance Cost	**$**	**5,519**	**$**	**35,478**
Extra Average Maintenance Cost for LED			**$ (29,959)**	
Savings per year			**$ (12,413)**	

Table 1 – LED vs Fluorescent Savings

In table 1 above, one can see the analysis completed comparing the energy usage of the specified fluorescent patient room to the redesigned LED patient room. The analysis in table 1 above takes into account the newly designed lighting controls in the room that will provide a reduced light output when the patient room is being illuminated by the sun during the day. This analysis does not include periods of time when exam level lighting is being used. It is assumed that the amount of time the exam level lighting is being utilized is negligible compared the amount of time the lighting is being used at reading levels. Other assumptions made include…

- Labor cost to replace the LED lighting is twice that to replace fluorescent lighting due to the complexity of LED lighting modules.
- Fluorescent lamps assumed to be 20,000 hour rated.
- LED lamps assumed to be 50,000 hour rated.
- Average annual lamp maintenance cost does not include routine cleanings because it is assumed that the cost is roughly equal for both lamp types.
- Average annual lamp maintenance is a average cost based on the cost of replacement divided by the number of years until replacement. This average number does not mean that the specified cost will be incurred each year.
- It is assumed that to replace the LED lamp the entire LED module must be replaced which is equal to roughly about 75% of the initial luminaire cost.
- Costs of each light fixture and control system were found through contacting lighting distributors.

From the initial analysis we see that there is annual cost savings due to the reduction of energy of about $17,500. We also see that the LED lighting, although needs to be replaced less frequently still costs on average about $30,000 more a year because of the replacement costs. Overall the conclusion of this initial analysis is that it costs about $12,500 more a year to install the LED lighting. This analysis does not include inflation or the energy savings due to the reduced mechanical load. Table 2 below is a yearly cost analysis that includes both inflation and the savings from the reduced mechanical load.

Voorhees Replacement Facility
Voorhees, NJ

LED vs Fluorescent Cashflow Analysis							
Year	Construction	1	2	3	4	5	6
$/kW Electricity (Assume 3.5% Inflation)	$ 0.1307	$ 0.1353	$ 0.1400	$ 0.1449	$ 0.1500	$ 0.1552	$ 0.1607
Additional LED Cost	$ 315,600	$ -	$ -	$ -	$ -	$ -	$ -
Electricity Savings	$ -	$ 18,160	$ 18,796	$ 19,454	$ 20,135	$ 20,839	$ 21,569
Mechanical Energy Savings	$ 1,427	$ 1,477	$ 1,529	$ 1,582	$ 1,638	$ 1,695	$ 1,754
Maintenance Savings*	$ -	$ -	$ -	$ -	$ 25,200	$ -	$ -
Yearly Cash Flow	$ (314,173)	$ 19,637	$ 20,325	$ 21,036	$ 46,972	$ 22,534	$ 23,323
Cumulative Cash Flow	**$ (314,173)**	**$ (294,535)**	**$(274,211)**	**$(253,175)**	**$ (206,202)**	**$(183,668)**	**$(160,345)**

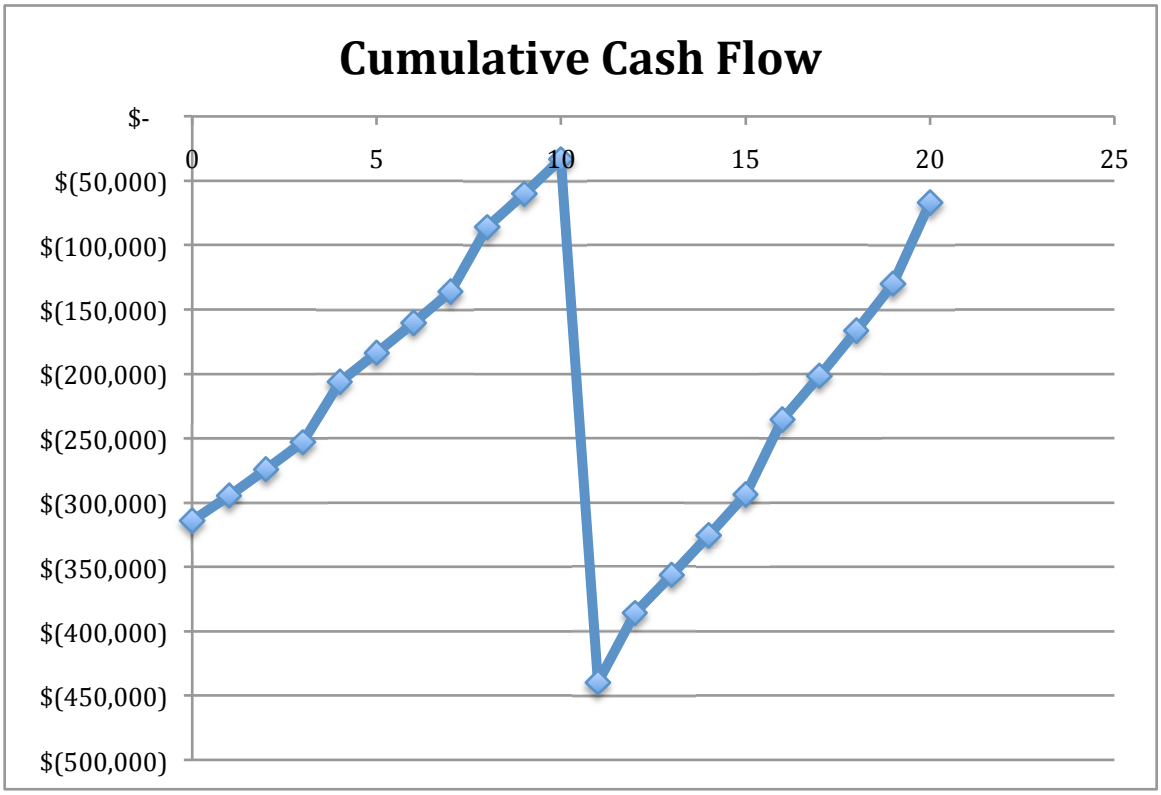
Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 3.5% Inflation)	$ 0.1663	$ 0.1721	$ 0.1781	$ 0.1844	$ 0.1908	$ 0.1975	$ 0.2044
Additional LED Cost	$ -	$ -	$ -	$ -	$ 434,100	$ -	
Electricity Savings	$ 22,324	$ 23,105	$ 23,914	$ 24,750	$ 25,617	$ 26,513	$ 27,441
Mechanical Energy Savings	$ 1,816	$ 1,879	$ 1,945	$ 2,013	$ 2,084	$ 2,157	$ 2,232
Maintenance Savings*	$ -	$ 25,200	$ -	$ -	$ -	$ 25,200	$ -
Yearly Cash Flow	$ 24,139	$ 50,184	$ 25,859	$ 26,764	$ (406,400)	$ 53,870	$ 29,673
Cumulative Cash Flow	**$ (136,205)**	**$ (86,021)**	**$ (60,163)**	**$ (33,399)**	**$ (439,798)**	**$(385,928)**	**$(356,255)**

Year	14	15	16	17	18	19	20
$/kW Electricity (Assume 3.5% Inflation)	$ 0.2116	$ 0.2190	$ 0.2266	$ 0.2346	$ 0.2428	$ 0.2513	$ 0.2601
Additional LED Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Electricity Savings	$ 28,402	$ 29,396	$ 30,425	$ 31,490	$ 32,592	$ 33,732	$ 34,913
Mechanical Energy Savings	$ 2,310	$ 2,391	$ 2,475	$ 2,561	$ 2,651	$ 2,744	$ 2,840
Maintenance Savings*	$ -	$ -	$ 25,200	$ -	$ -	$ -	$ 25,200
Yearly Cash Flow	$ 30,712	$ 31,787	$ 58,099	$ 34,051	$ 35,243	$ 36,476	$ 62,953
Cumulative Cash Flow	**$ (325,543)**	**$ (293,756)**	**$(235,656)**	**$(201,605)**	**$ (166,363)**	**$(129,886)**	**$ (66,934)**

Table 2 – LED vs Fluorescent Cash Flow Analysis

Table 2 above is a cash flow analysis of the LED designed patient room versus the original fluorescent designed patient room. In this analysis one can see that the price for electricity is assumed to increase at an inflation rate of 3.5% a year. This inflation over each year is not guaranteed however it has been shown that over the past 100 years the average inflation is around 3.5% a year. This analysis does not take into account any jumps in electricity prices due to deregulation of electricity. The additional LED cost is the initial cost at construction and then the price to replace the LED modules when they require replacement. Electricity savings are calculated using the annual kilowatt-hours determined in table 1 and the inflated electricity prices in table 2. Mechanical energy savings are calculated using the kilowatt-hours determined in the mechanical breadth and the inflated electricity prices in table 2. Maintenance savings as shown in table 2 is defined as the maintenance cost of the fluorescent system on years that lamps need to be replaced. From all of the above costs and savings the yearly and cumulative cash flow were calculated.

The graph of the cumulative cash flow versus time is shown below in graph 1.



Graph 1 – Cumulative Cash Flow vs. Time

From the cumulative cash flow graph above one can see that the LED system never breaks into the positive side throughout the lifespan. Although it is shown that the LED fixtures do provide a significant energy savings the initial and replacement cost of the system is to much to overcome.

Effects of Lighting on Patients

The effect of light sources on patient health is a much looked at topic in health care as of recent. Studies have been conducted to determine what the best type of light is in regards to patient health as well as employee health. The type of fixture (i.e. LED or fluorescent), does not have an a noticeable effect on the health of patients because it is the type of light (i.e. color bands, wavelengths) that determine how the eye perceives light. LED's and fluorescent lighting are both readily available with high color rendering index's and ranges from warm to cool light.

Because of this, this section will focus mainly on the impact that light has on humans and compare the best practices to the Voorhees Replacement Hospital.

According to Anjali Joseph, Director of Research for The Center for Health Design there are 4 main ways in which light impacts our health and performance of tasks. The four main ways include performing visual tasks, controlling the body's circadian system, affecting mood and perception, and providing direct absorption for critical chemical reactions within the body (Joseph 3).

The first of the four, performing visual tasks may seem obvious and trivial but in a healthcare setting the level of light provided can either hinder or help the employees in their everyday tasks. The most important reason to provide adequate light levels in all spaces for healthcare employees is to reduce the number of medical errors. Employees everyday perform important tasks such as charting, filling prescriptions and administering drugs to patients. If lighting levels are not adequate then doctors are more likely to make an error, which could take a patients life. Studies showed that higher lighting levels reduced the number of medication-dispensing errors in the pharmacy. In general when it comes to performing any visual tasks the best solution is to provide high light levels. The use of light colored finishes can also help with achieving high light levels at less light wattage.

The next way light impacts both employee and patient health is through controlling the body's circadian system. The circadian system is our body's internal clock. For many patients and workers this internal clock can become independent of the workday or sleeping patterns, which may cause drowsiness or even depression. The best way to ensure the internal clock matches each patient is to offer daylighting to all patient rooms. By providing daylight to patient rooms the patient will be exposed to natural light which is the key factor in determining the phase of the circadian rhythm. According to Anjali Joseph patient exposure to daylight can reduce depression among patients, decrease a patients length of stay, improve sleep cycles, and even ease the pain of patients (Joseph 4).

The third way light affects our bodies, affecting mood and perception, is a reiteration that providing daylight will reduce depression and improve the mood of patients. The last way light affects our bodies is by providing direct absorption for critical chemical reactions within the body. When the body is exposed to high levels of light through the eyes and skin chemical reactions occur which create vitamin D in the body as well as preventing jaundice from occurring.

Because the owner of the Voorhees Replacement Hospital, Virtua is a member of the "Pebble Project" which is an initiative to create a better healthcare environment for both patients and employees most of the strategies and techniques described above are included in the Voorhees Replacement Facility. The typical patient room in the hospital has access to large windows facing either north or south depending on where the patient is located which provide daylighting. The patient has control of mechanically controlled curtains to decide whether or not to let light into the room. This option of daylight mixed with the electric light provided enables the patient to have full control over their environment to ensure they are happy.

In conclusion the switch from fluorescent lighting to LED lighting will not provide a significant advantage or disadvantage for the patients health. It was also determined that the Voorhees Replacement Hospital's typical patient room is designed to enhance the wellbeing of the patient by providing the controllability of daylighting as well as electric lighting.

Conclusions

In conclusion, from the analysis above it was shown that it was possible to effectively meet the illumination requirements using LED down lighting in a typical patient room in the Voorhees Replacement Hospital. It was also shown that the LED designed patient room would provide a reduction in heat generation due to lighting which in turn produced a reduction in both the required airflow to each patient room and cooling costs. It was also said that even though there was a reduction in the amount of airflow required to each patient room that the change was not large enough to consider resizing the mechanical equipment for a savings.

Through the life cycle analysis of the LED lighting system it was determined that the LED system provides an electricity savings of about $17,500 a year. It was also shown that because the replacement cost of LED modules is about 75% of the initial cost there was an average extra maintenance cost of about $30,000. Through the cash flow analysis and the graph of cumulative cash flow it was shown that it is not cost effective to install LED down lighting in the typical patient room. This was determined because even though the LED lighting does provide a energy savings the initial and replacement cost of the system was to great to overcome. In general it can be said that if and when the cost of LED luminaires are reduced it will be very cost effective to install LED lighting for most, if not all lighting applications.

Lastly the switch from fluorescent lighting to LED lighting will not provide a significant advantage or disadvantage for the patient's health. It was also determined that the Voorhees Replacement Hospital's typical patient room is designed to enhance the wellbeing of the patient by providing the controllability of daylighting as well as electric lighting.

Analysis 3 – Bed Tower Patient Room Schedule (Short Interval Schedule)

Scope of Work

The rough-in and fit-out of the bed tower is along the critical path of the project and is the last major portion of construction before substantial completion. Is there a way to manage the rough-in and fit-out of the bed tower to reduce the schedule time without causing a reduction in productivity due to overlapping trades? The following analysis will attempt to investigate and revise the current schedule for the rough-in and finish stages of the bed tower. The revision will break down the schedule of each floor into the processes for each patient room and develop a short interval schedule for the entire bed tower. If a schedule savings is found from developing the short interval production schedule this would in turn create a cost savings from a general conditions standpoint. These savings could be used to offset costs of obtaining a LEED rating shown in analysis 1.

Introduction

A short interval schedule is a schedule which breaks down a schedule into more detailed weekly or daily activities. On a normal project schedule tasks are broken up in large areas such as by floor or wing. In the case of the Voorhees Replacement Facility the construction schedule for the bed tower is broken down into each of the floors. Although this method of presenting a schedule is extremely helpful when providing the owner with schedule updates, it may not be detailed enough to manage a job the most effective way possible. Although a short interval schedule is not a replacement for the main schedule it can help the construction management team effectively allocate resources to reduce the time subcontractors spend waiting around to know their next task.

Short interval schedules are most effectively used in cases where there is repetition in the way a certain portion of the project is constructed. Typical examples of this include office buildings, schools and hotels. Hospitals can also be a good example of a repetitive process. In the Voorhees Replacement Hospital being analyzed there are almost 300 patient rooms spanning over 6 floors of the bed tower which are almost all identical in design. Because of this repetition the bed tower of the Voohees Replacement Facility is a perfect candidate to utilize a short interval schedule. In order for a short interval schedule to be developed there needs to be communication between the construction manager and subcontractors to determine the duration of activities being included in the short interval schedule. After the schedule has been created it is imperative for the construction management team to ensure that the schedule is being met and that each subcontractor knows exactly what is expected of them each workday. If a short interval schedule is properly used it can reduce the schedule of the project and create less conflict between construction manager and subcontractor.

Short Interval Schedule

To develop the short interval schedule for the bed tower of the Voorhees Replacement Hospital the following process was used.

1. Break down the main schedule into smaller areas to be scheduled individually.
2. Break down the defined area into the construction activities being included in the short interval schedule.
3. Develop durations for each activity through speaking with subcontractors.
4. Develop a short interval schedule.

Step 1

The first step in the process to develop the short interval schedule is to break down the main schedule into smaller components. The main schedule for the Voorhees Replacement Facility breaks down the bed tower by floor therefore for the short interval schedule we will break down each floor further. For the short interval schedule we will break down each floor by the 2 different wings and then even further by groups of 2 patient rooms. The example of a typical area broken down into groups of 2 patient rooms can be seen in figure 1 below.

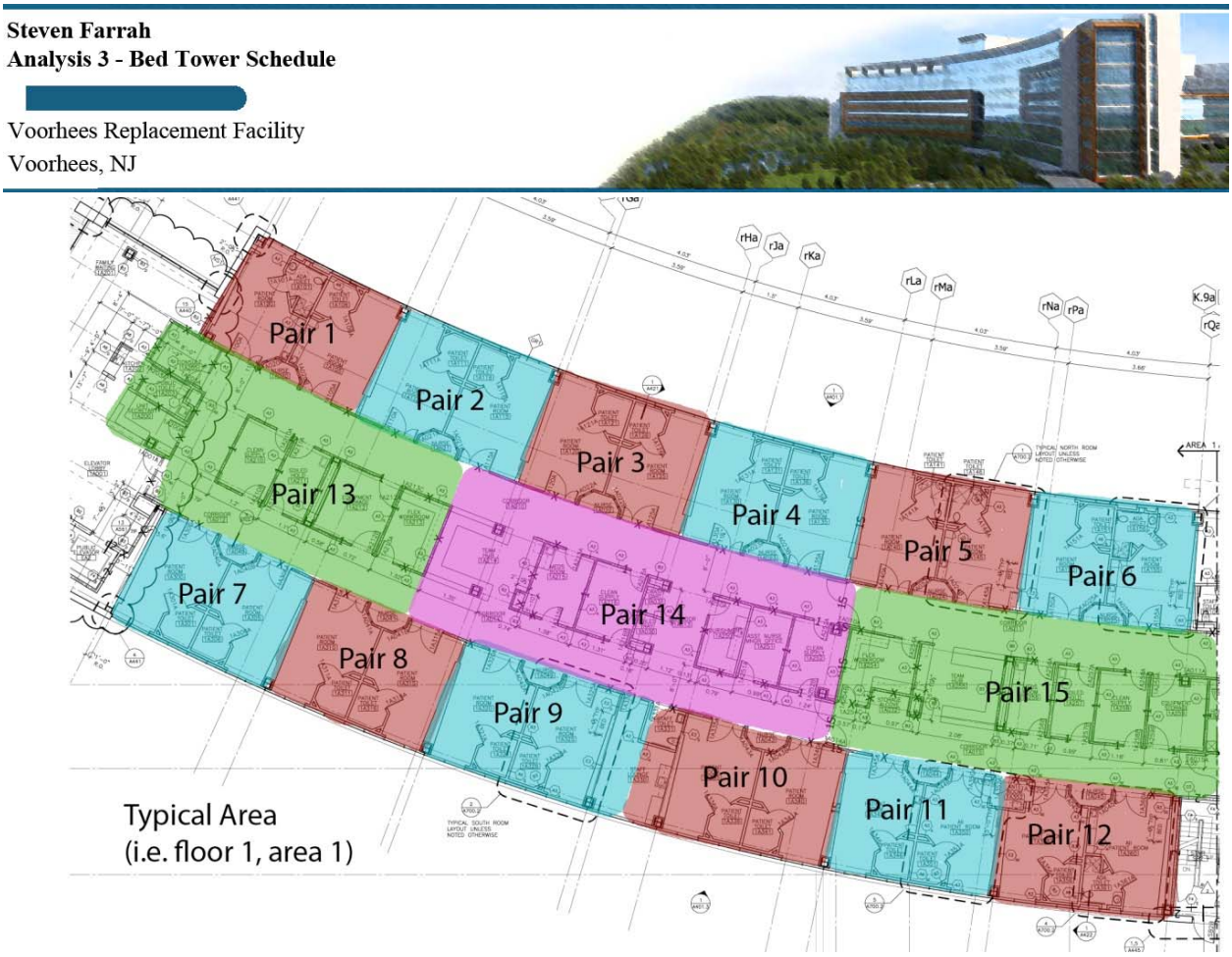


Figure 1 – Typical Area Pairings

Figure 1 above shows the pairing of patient rooms that will be used to create the short interval schedule. As shown above the typical wing/area as shown above also includes medical support spaces in the middle of the 2 rows of patient rooms. These medical support spaces are typical throughout each of the 6 floors of the bed tower. Since the medical support spaces are not in fact patient rooms the assumption is made that the support spaces will be split up and counted as 3 pairs of patient rooms. Even though each of the 3 support spaces is made up of a greater floor area then a typical pairing of patient rooms the amount of work is about equal. This was determined by analyzing the construction documents. It was determined that there was less plumbing, mechanical and electrical work in the support spaces so a larger floor area was required to match a pairing of patient rooms. From the 15 pairs of patient rooms per area, and 2 areas per floor this leaves us with a total of 180 pairs.

Step 2

Step 2 in the process of developing the short interval schedule is to define the activities that are required to construct the defined spaces in step 1 and also determine the order in which each activity will occur. For the short interval schedule we will be creating the schedule will assume that all overhead mechanical, plumbing and electrical work has been completed as well as all firewall construction and metal stud installation. From this step in the construction process the activities and order they will be constructed in is as follow…

1. Rough-in in wall plumbing
2. Rough-in in wall duct drops
3. Rough-in in wall medical gas
4. Rough-in in wall electrical
5. Rough-in in wall low-voltage wiring

6. Insulate, drywall and tape partitions
7. Frame drywall ceilings
8. Electrical work in drywall ceilings
9. Ductwork in drywall ceilings
10. Drywall and tape drywall ceilings
11. Prime and paint 1 coat walls and drywall ceilings
12. Install acoustical ceiling tile grid
13. Drop in and install light fixtures
14. Install all ceramic tile floors and partial walls
15. Install millwork
16. Install plumbing/bathroom fixtures
17. Install carpet, VCT flooring and base
18. Install grilles and diffusers
19. 2nd and final coat of paint
20. Install doors, hardware and interior glazing
21. Drop in acoustical ceiling tile into grid
22. Cut in sprinkler heads (ACT and drywall)
23. Finish and install low voltage devices
24. Finish and install medical gas trim plates and labels
25. Finish and install electrical devices and trim plates

Step 3

Step 3 in short interval process is to develop durations for each activity defined in step 2. This step can be either accomplished by use of an estimating department within the construction management company or through speaking directly with the subcontractors. Speaking directly with the subcontractors is the best course of action because it allows for them to be included in the short interval process early so that they understand what is expected of them and they can give their input on realistic durations for particular activities. To determine the duration of each activity per pair of patient rooms for the short interval schedule the subcontractors involved in the Voorhees Replacement Hospital were contacted. It is important to note that although all the durations are integers the durations received from the subcontractors were not all exact numbers. Conversations were held with the subcontractors to ensure that each activity listed could be performed in the amount of days included in the schedule. The duration of 1 day for many of the activities was the most common duration. Some activities, for example placing VCT flooring, did not require a full workday to complete the work however due to the scheduling and constraints of a short interval schedule the duration of 1 day was used. This method of scheduling a full workday for activities that did not require the full day is typical throughout the analysis.

Construction Activity Durations	
All Durations Assume An 8 Hour Workday	
	Workdays/ Patient Room Pair
Rough-In In Wall Plumbing	2
Rough-In In Wall Duct Drops	1
Rough-In In Wall Medical Gas	1
Rough-In In Wall Electrical	2
Rough-In In Wall Low-Voltage Wiring	1
Insulate & Drywall Partitions (tape)	2
Frame Drywall Ceilings	1
Electrical Work In Drywall Ceilings	1
Ductwork In Drywall Ceilings	1
Drywall Ceilings (tape)	1
Prime & Paint 1 Coat Walls & Drywall Ceilings	1
Install Acoustical Ceiling Tile Grid	1
Drop In and Install Light Fixtures	1
Install All Ceramic Tile Floors and Partial Walls	1
Install Millwork	1
Install Plumbing/Bathroom Fixtures	1

Figure 2.1 – Construction Activity Durations

Install Carpet, VCT Flooring & Base	1
Install Grilles & Diffusers	1
2nd Coat of Paint	1
Install Doors, Hardware & Interior Glazing	1
Drop In Acoustical Ceiling Tile into Grid	1
Cut In Sprinkler Heads (ACT & Drywall)	1
Finish & Install Low Voltage Devices	1
Finish & Install Medical Gas Trim Plates & Labels	1
Finish & Install Electrical Devices & Trim Plates	2

Figure 2.2 – Construction Activity Durations

Step 4

The final step in the process is to create the short interval schedule. There are many ways to present a short interval process. It can be done in a typical bar chart schedule, by a date list which lists the start and finish dates for each activity based on location, or by a matrix schedule where columns represent dates and rows represent locations and activities. These are just 3 of the different types of ways to establish a short interval schedule, and for this analysis a matrix schedule was developed. The schedule will start on May 11th, 2009. This start date was determined from evaluating the main project schedule and determining when the original start date for each patient room was. The short interval schedules start and finish can be seen in figures 3 and 4 below. The full short interval schedule can be seen in appendix M.

Steven Farrah
Analysis 3 - Bed Tower Schedule

Voorhees Replacement Facility
Voorhees, NJ

| Floor | Area | Pair # | May-09 | | | | | | | | | | | | | | | Jun-09 | | | | | | | | | | | | | | |

Steven Farrah
Analysis 3 - Bed Tower Schedule

Voorhees Replacement Facility
Voorhees, NJ

Floor	Area	Pair #	Oct-10																													Nov-10						
			358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391
5	3	12																																		
5	3	13																																		
5	3	14																																		
5	3	15																																		
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6	1	15																																		
6	3	1	25																																	
6	3	2	23	24	25																															
6	3	3	21	22	23	24	25																													
6	3	4	19	20	21	22	23	24	25																											
6	3	5	17	18	19	20	21	22	23	24	25																									
6	3	6	15	16	17	18	19	20	21	22	23	24	25																							
6	3	7	13	14	15	16	17	18	19	20	21	22	23	24	25																					
6	3	8	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25																			
6	3	9	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25																	
6	3	10	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25															
6	3	11	6		7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25													
6	3	12		5	6		7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25										
6	3	13	3	4		5	6		7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25								
6	3	14		2	3	4		5	6		7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25						
6	3	15		1		2	3	4		5	6		7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25				

1	Rough-In In Wall Plumbing
2	Rough-In In Wall Duct Drops
3	Rough-In In Wall Medical Gas
4	Rough-In In Wall Electrical
5	Rough-In In Wall Low-Voltage Wiring
6	Insulate & Drywall Partitions (tape)
7	Frame Drywall Ceilings
8	Electrical Work In Drywall Ceilings
9	Ductwork In Drywall Ceilings
10	Drywall Ceilings (tape)
11	Prime & Paint 1 Coat Walls & Drywall Ceilings
12	Install Acoustical Ceiling Tile Grid
13	Drop In and Install light Fixtures
14	Install Ceramic Tile Floors & Partial Walls
15	Install Millwork
16	Install Plumbing/Bathroom Fixtures
17	Install Carpet, VCT Flooring & Base
18	Install Grilles & Diffusers
19	Paint 2nd Coat
20	Install Doors, Hardware & Interior Glazing
21	Drop In Acoustical Ceiling Tile In Grid
22	Cut In Sprinkler Heads (ACT & Drywall)
23	Finish & Install Low Voltage Devices
24	Finish & Install Medical Gas Trim Plates & Labels
25	Finish & Install Electrical Devices & Trim Plates

Figure 2 - Short Interval Schedule Finish

Conclusions

According to the main schedule of the Voorhees Replacement Facility the last activity of installing the electrical devices and trim plates is to finish on December 23rd, 2010. From our short interval schedule the last activity of installing the electrical devices and trim plates is scheduled to finish on November 2nd, 2010. The difference in workdays between the main schedule and short interval schedule is 35 days, Or about 1.75 calendar months. Since the bed tower fit-out is along the critical path of the schedule this 1.75 calendar months or 35 workdays directly affects the substantial completion date and will create a savings in general conditions.

From technical analysis 2 which can be found on the CPEP site the general conditions of the project total $10,870,226.00. For the 36-month schedule, general conditions are at a cost of $301,950.00/calendar month to the project. So the 1.75 calendar month schedule reduction saves the project the following…

General Conditions Savings = ($301,950.00/calendar month)x(1.75 calendar months) = $528,412.00

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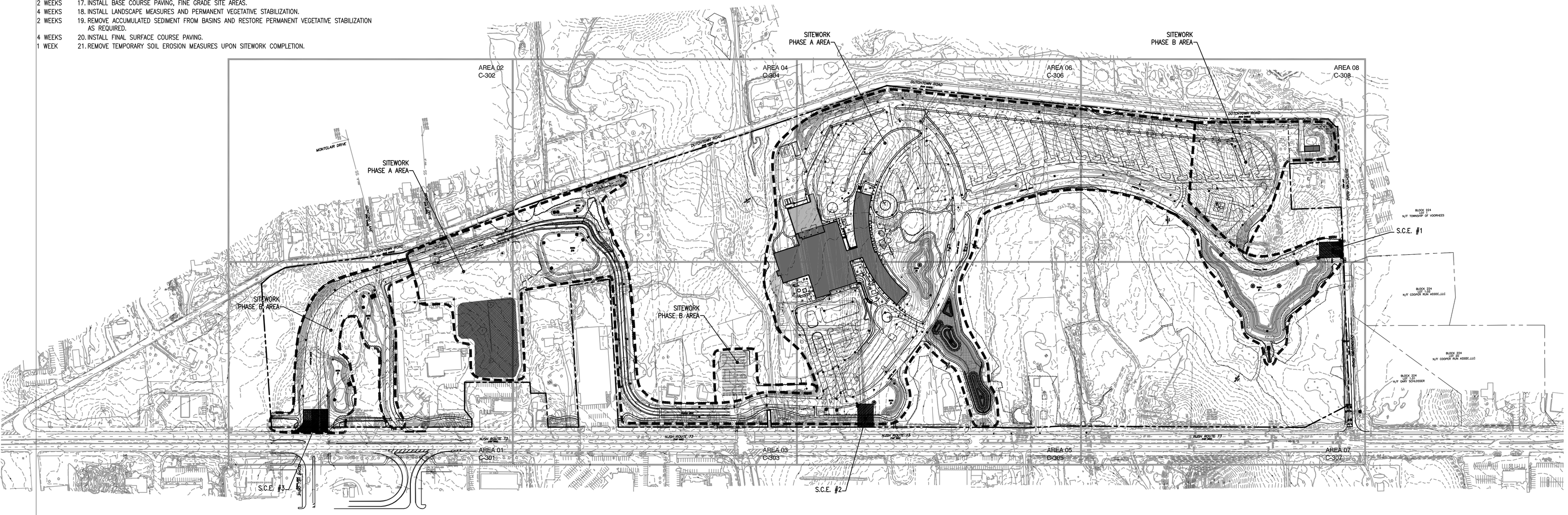
Appendix A – Erosion & Sedimentation Plan

Construction Sequence

1 WEEK	1. INSTALL PERIMETER SOIL EROSION MEASURES IN PHASE A AREA AND CONSTRUCTION ENTRANCE #1.
2 WEEKS	2. CLEAR AND GRUB BUILDING PAD SITE. STOCKPILE TOPSOIL FOR RE-USE AND STABILIZE WITH TEMPORARY SEEDING.
6 WEEKS	3. PERFORM ROUGH GRADING OF BUILDING SITE AND CONSTRUCT TEMPORARY SEDIMENT BASINS.
36 MONTHS	4. COMMENCE BUILDING FOUNDATIONS AND BUILDING CONSTRUCTION.
8 WEEKS	5. PERFORM ROUGH GRADING OF REMAINING PHASE A PORTION OF SITE.
2 DAYS	6. INSTALL CONSTRUCTION ENTRANCE #2.
8 WEEKS	7. INSTALL UNDERGROUND UTILITIES, STORMWATER DRAINAGE SYSTEM AND ADDITIONAL SOIL EROSION CONTROLS AS REQUIRED.
4 WEEKS	8. INSTALL CURBING AND FINE GRADE PAVEMENT SUBGRADE. STABILIZE AREAS TO BE PAVED BY INSTALLING DENSE GRADED AGGREGATE BASE COURSE.
4 WEEKS	9. INSTALL BASE COURSE PAVING, FINE GRADE SITE AREAS.
6 WEEKS	10. INSTALL LANDSCAPE MEASURES AND PERMANENT VEGETATIVE STABILIZATION.
2 WEEKS	11. REMOVE ACCUMULATED SEDIMENT FROM BASINS AND RESTORE PERMANENT VEGETATIVE STABILIZATION AS REQUIRED.
1 WEEK	12. INSTALL PERIMETER SOIL EROSION MEASURES IN PHASE B AREA AND CONSTRUCTION ENTRANCE #3.
2 WEEKS	13. CLEAR AND GRUB PHASE B SITE AREA. STOCKPILE TOPSOIL FOR RE-USE AND STABILIZE WITH SEEDING.
4 WEEKS	14. PERFORM ROUGH GRADING OF PARKING AND ROADWAYS AND CONSTRUCT INFILTRATION BASINS.
6 WEEKS	15. INSTALL UNDERGROUND UTILITIES, STORMWATER DRAINAGE SYSTEM AND ADDITIONAL SOIL EROSION CONTROLS AS REQUIRED.
2 WEEKS	16. INSTALL CURBING AND FINE GRADE PAVEMENT SUBGRADE. STABILIZE AREAS TO BE PAVED BY INSTALLING DENSE GRADED AGGREGATE BASE COURSE.
2 WEEKS	17. INSTALL BASE COURSE PAVING, FINE GRADE SITE AREAS.
4 WEEKS	18. INSTALL LANDSCAPE MEASURES AND PERMANENT VEGETATIVE STABILIZATION.
2 WEEKS	19. REMOVE ACCUMULATED SEDIMENT FROM BASINS AND RESTORE PERMANENT VEGETATIVE STABILIZATION AS REQUIRED.
4 WEEKS	20. INSTALL FINAL SURFACE COURSE PAVING.
1 WEEK	21. REMOVE TEMPORARY SOIL EROSION MEASURES UPON SITEWORK COMPLETION.



Notes

1. THE CAMDEN COUNTY SOIL CONSERVATION DISTRICT SHALL BE NOTIFIED SEVENTY-TWO (72) HOURS PRIOR TO PROPOSED ACTIVITY.

2. A SEPARATE SOIL EROSION AND SEDIMENT CONTROL PLAN WILL BE PREPARED AND SUBMITTED FOR APPROVAL PER OFFSET UTILITY AND ROADWAY IMPROVEMENTS. THIS PLAN IS FOR ON SITE WORK ONLY.

3. AREAS LOCATED WITHIN INFILTRATION BASINS SHALL BE PROTECTED FROM COMPACTION BY CONSTRUCTION EQUIPMENT AND SEDIMENT CONTAMINATION. ALL EXCAVATION MUST BE PERFORMED BY EQUIPMENT PLACED OUTSIDE THE BASIN AREA TO THE MAXIMUM EXTENT POSSIBLE.

4. INFILTRATION BASIN BOTTOMS SHALL BE PLACED A MINIMUM OF 2 FEET ABOVE THE SEASON HIGH WATER TABLE.

Legend

- INLET PROTECTION
- STABILIZED CONSTRUCTION ENTRANCE
- STOCKPILE WITH PERIMETER SEDIMENT BARRIER
- TREE CLEARING LIMIT
- SILT FENCE

Stabilization Specifications

A. TEMPORARY SEEDING AND MULCHING:

LIME – 90 LBS/1,000 SF GROUND LIMESTONE;

FERTILIZER – 11 LBS/1,000 SF;10-20-10 OR EQUIVALENT
WITH 50% WATER INSOLUBLE NITROGEN. WORK INTO SOIL A MINIMUM OF 4".

SEED – PERENNIAL RYEGRASS 100 LBS/ACRE OR
OTHER APPROVED SEEDS; PLANT BETWEEN FEB 15 AND
MAY 1 OR BETWEEN AUGUST 15 AND OCTOBER 15.

MULCH – SALT HAY OR SMALL GRAIN STRAW AT A RATE
OF 70 TO 90 LBS/1,000 SF, TO BE APPLIED ACCORDING TO
THE NJ STANDARDS. MULCH SHALL BE SECURED BY
APPROVED METHODS (I.E. PEG AND TWINE, MULCH NETTING,
CRIMPER, OR LIQUID MULCH BINDER).

B. PERMANENT VEGETATIVE COVER FOR SOIL STABILIZATION:

REFER TO LANDSCAPE PLANS.

C. STABILIZATION WITH MULCH DURING NON-GROWING SEASON

1. PROTECTIVE MATERIALS
A. UNROTTED SMALL-GRAIN STRAW, OR SALT HAY AT 2.0 TO 2.5 TONS PER ACRES IS SPREAD UNIFORMLY AT 90 TO 115 POUNDS PER 1,000 SQUARE FEET AND ANCHORED WITH A MULCH ANCHORING TOOL, LIQUID MULCH BINDERS, OR NETTING TIE DOWN.
B. WOOD-FIBER OR PAPER-FIBER MULCH AT THE RATE OF 1,500 POUNDS PER ACRES (OR ACCORDING TO MANUFACTURER'S REQUIREMENTS) MAY BE APPLIED BY A HYDROSEEFER.
C. MULCH NETTING, SUCH AS PAPER JUTE, EXCELSIOR, COTTON, OR PLASTIC, MAY BE USED.

2. MULCH ANCHORING
A. PEG AND TWINE- DRIVE 8 TO 10 INCH WOODEN PEGS TO WITHIN 2 TO 3 INCHES OF THE SOIL SURFACE EVERY 4 FEET IN ALL DIRECTIONS. STAKES MAY BE DRIVEN BEFORE OR AFTER APPLYING MULCH. SECURE MULCH TO SOIL SURFACE BY STRETCHING TWINE BETWEEN PEGS IN A CRIS-CROSS AND SQUARE PATTERN. SECURE TWINE AROUND EACH PEG WITH TWO OR MORE ROUND TURNS.
B. MULCH NETTINGS- STAPLE PAPER, COTTON, OR PLASTIC NETTINGS OVER MULCH. USE A DEGRADABLE NETTING IN AREAS TO BE MOWED. NETTING IS USUALLY AVAILABLE IN ROLLS 4 FEET WDE AND UP TO 300 FEET LONG.
C. CRIMPER MULCH ANCHORING COULTER TOOL- A TRACTOR-DRAWN IMPLEMENT ESPECIALLY DESIGNED TO PUNCH AND ANCHOR MULCH INTO THE SOIL SURFACE. THIS PRACTICE AFFORDS MAXIMUM EROSION CONTROL, BUT ITS USE IS LIMITED TO THOSE SLOPES UPON WHICH THE TRACTOR CAN OPERATE SAFELY. SOIL PENETRATION SHOULD BE ABOUT 3 TO 4 INCHES. ON SLOPING LAND, THE OPERATION SHOULD BE ON THE CONTOUR.

Camden County Soil Erosion And Sediment Control Notes

1. ALL APPLICABLE EROSION AND SEDIMENT CONTROL PRACTICES SHALL BE IN PLACE PRIOR TO ANY GRADING OPERATION AND/OR INSTALLATION OF PROPOSED STRUCTURES OR UTILITIES.

2. SOIL EROSION AND SEDIMENT CONTROL PRACTICES ON THIS PLAN SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY.

3. APPLICABLE EROSION AND SEDIMENT CONTROL PRACTICES SHALL BE LEFT IN PLACE UNTIL CONSTRUCTION IS COMPLETED AND/OR THE AREA IS STABILIZED.

4. THE CONTRACTOR SHALL PERFORM ALL WORK, FURNISH ALL MATERIALS AND INSTALL ALL MEASURES REQUIRED TO REASONABLY CONTROL SOIL EROSION RESULTING FROM CONSTRUCTION OPERATIONS AND PREVENT EXCESSIVE FLOW OF SEDIMENT FROM THE CONSTRUCTION SITE.

5. ANY DISTURBED AREA THAT IS TO BE LEFT EXPOSED FOR MORE THAN THIRTY (30) DAYS AND NOT SUBJECT TO CONSTRUCTION TRAFFIC SHALL IMMEDIATELY RECEIVE A TEMPORARY SEEDING AND FERTILIZATION IN ACCORDANCE WITH THE NEW JERSEY STANDARDS AND THEIR RATES SHOULD BE INCLUDED IN THE NARRATIVE. IF THE SEASON PROHIBITS TEMPORARY SEEDING, THE DISTURBED AREAS WILL BE MULCHED WITH SALT HAY OR EQUIVALENT AND ANCHORED IN ACCORDANCE WITH THE NEW JERSEY STANDARDS (I.E. PEG AND TWINE, MULCH NETTING OR LIQUID MULCH BINDER).

6. IT SHALL BE THE RESPONSIBILITY OF THE DEVELOPER TO PROVIDE CONFIRMATION OF LIME, FERTILIZER AND SEED APPLICATION AND RATES OF APPLICATION AT THE REQUEST OF THE CAMDEN COUNTY SOIL CONSERVATION DISTRICT.

7. ALL CRITICAL AREAS SUBJECT TO EROSION WILL RECEIVE A TEMPORARY SEEDING IN COMBINATION WITH STRAW MULCH AT A RATE OF 2 TONS PER ACRE, ACCORDING TO THE NEW JERSEY STANDARDS IMMEDIATELY FOLLOWING ROUGH GRADING.

8. THE SITE SHALL AT ALL TIMES BE GRADED AND MAINTAINED SUCH THAT ALL STORMWATER RUNOFF IS DIVERTED TO SOIL EROSION AND SEDIMENT CONTROL FACILITIES.

9. ALL SEDIMENTATION STRUCTURES WILL BE INSPECTED AND MAINTAINED ON A REGULAR BASIS AND AFTER EVERY STORM EVENT.

10. A CRUSHED STONE, TIRE CLEANING PAD WILL BE INSTALLED WHEREVER A CONSTRUCTION ACCESS EXISTS. THE STABILIZED PAD WILL BE INSTALLED ACCORDING TO THE STANDARD FOR STABILIZED CONSTRUCTION ACCESS

11. ALL DRIVEWAYS MUST BE STABILIZED WITH 2 ½" CRUSHED STONE OR SUBBASE PRIOR TO INDIVIDUAL LOT CONSTRUCTION.

12. PAVED ROADWAYS MUST BE KEPT CLEAN AT ALL TIMES.

13. ALL CATCH BASIN INLETS WILL BE PROTECTED ACCORDING TO THE CERTIFIED PLAN.

14. ALL STORM DRAINAGE OUTLETS WILL BE STABILIZED, AS REQUIRED, BEFORE THE DISCHARGE POINTS BECOME OPERATIONAL.

15. ALL DEWATERING OPERATIONS MUST DISCHARGE DIRECTLY INTO A SEDIMENT FILTER AREA. THE SEDIMENT FILTER SHOULD BE COMPOSED OF A SUITABLE SEDIMENT FILTER FABRIC. (SEE DETAIL) THE BASIN MUST BE DEWATERED TO NORMAL POOL WITHIN 10 DAYS OF THE DESIGN STORM.

17. MULCHING IS REQUIRED ON ALL SEEDED AREAS TO INSURE AGAINST EROSION BEFORE GRASS IS ESTABLISHED TO PROMOTE EARLIER VEGETATION COVER.

18. OFFSITE SEDIMENT DISTURBANCE MAY REQUIRE ADDITIONAL CONTROL MEASURES TO BE DETERMINED BY THE EROSION CONTROL INSPECTOR.

19. A COPY OF THE CERTIFIED SOIL EROSION AND SEDIMENT CONTROL PLAN MUST BE MAINTAINED ON THE PROJECT SITE DURING CONSTRUCTION.

20. THE CAMDEN COUNTY SOIL CONSERVATION DISTRICT SHALL BE NOTIFIED 48 HOURS PRIOR TO ANY LAND DISTURBANCE.

21. ANY CONVEYANCE OF THIS PROJECT PRIOR TO ITS COMPLETION WILL TRANSFER FULL RESPONSIBILITY FOR COMPLIANCE WITH THE CERTIFIED PLAN TO ANY SUBSEQUENT OWNERS.

22. IMMEDIATELY AFTER THE COMPLETION OF STRIPPING AND STOCKPILING OF TOPSOIL, THE STOCKPILE MUST BE STABILIZED ACCORDING TO THE STANDARD FOR TEMPORARY VEGETATIVE COVER. STABILIZE TOPSOIL PILE WITH STRAW MULCH FOR PROTECTION IF THE SEASON DOES NOT PERMIT THE APPLICATION AND ESTABLISHMENT OF TEMPORARY SEEDING. ALL SOIL STOCKPILES ARE NOT TO BE LOCATED WITHIN FIFTY (50) FEET OF A FLOODPLAIN, SLOPE, ROADWAY OR DRAINAGE FACILITY AND THE BASE MUST BE PROTECTED WITH A SEDIMENT BARRIER.

23. ANY CHANGES TO THE SITE PLAN WILL REQUIRE THE SUBMISSION OF A REVISED SOIL EROSION AND SEDIMENT CONTROL PLAN TO THE CAMDEN COUNTY SOIL CONSERVATION DISTRICT. THE REVISED PLAN MUST BE IN ACCORDANCE WITH THE CURRENT NEW JERSEY STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL.

24. METHODS FOR THE MANAGEMENT OF HIGH ACID PRODUCING SOILS SHALL BE IN ACCORDANCE WITH THE STANDARDS. HIGH ACID PRODUCING SOILS ARE THOSE FOUND TO CONTAIN IRON SULFIDES OR HAVE A PH OF 4 OR LESS.

25. TEMPORARY AND PERMANENT SEEDING MEASURES MUST BE APPLIED ACCORDING TO THE NEW JERSEY STANDARDS, AND MULCHED WITH SALT HAY OR EQUIVALENT AND ANCHORED IN ACCORDANCE WITH THE NEW JERSEY STANDARDS (I.E. PEG AND TWINE, MULCH NETTING OR LIQUID MULCH BINDER).

26. MAXIMUM SIDE SLOPES OF ALL EXPOSED SURFACES SHALL NOT BE CONSTRUCTED STEEPER THAN 3:1 UNLESS OTHERWISE APPROVED BY THE DISTRICT.

27. DUST IS TO BE CONTROLLED BY AN APPROVED METHOD ACCORDING TO THE NEW JERSEY STANDARDS AND MAY INCLUDE WATERING WITH A SOLUTION OF CALCIUM CHLORIDE AND WATER.

28. ADJOINING PROPERTIES SHALL BE PROTECTED FROM EXCAVATION AND FILLING OPERATIONS ON THE PROPOSED SITE.

29. USE STAGED CONSTRUCTION METHODS TO MINIMIZE EXPOSED SURFACES, WHERE APPLICABLE.

30. ALL VEGETATIVE MATERIAL SHALL BE SELECTED IN ACCORDANCE WITH AMERICAN STANDARDS FOR NURSERY STOCK OF THE AMERICAN ASSOCIATION OF THE NURSERYMEN AND IN ACCORDANCE WITH THE NEW JERSEY STANDARDS.

31. NATURAL VEGETATION AND SPECIES SHALL BE RETAINED WHERE SPECIFIED ON THE LANDSCAPE PLAN.

32. THE SOIL EROSION INSPECTOR MAY REQUIRE ADDITIONAL SOIL EROSION MEASURES TO BE INSTALLED, AS DIRECTED BY THE DISTRICT INSPECTOR.

Virtua HEALTH

VOORHEES REPLACEMENT FACILITY
CAMDEN COUNTY, NEW JERSEY

CERTIFICATE OF NEED # FR050201-04-01

DCA REFERENCE NO. 5183-07

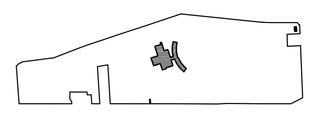
BLOCK 223
LOTS 1, 2, 2.01, 3, 4, 5, 6, 6.01, 7, 8, 9, 10, 11, 12

BLOCK 228
LOTS 7, 8, 8.01, 9, 11, 11.01, 13, 14, 15, 16, 17, 18

NJ State Highway Route 73
Tax Map Sheets 28 & 30

Township of Voorhees
Camden County, New Jersey

KEY MAP



SCALE
200 0 100 200
(IN FEET)
1 inch = 200 ft.

1	AUGUST 10, 2007
2	NOVEMBER 1, 2007
3	MARCH 28, 2008
4	MAY 30, 2008

REVISION HISTORY - THIS SHEET

Dewberry
Dewberry-Goodkind, Inc.
600 PARSIPPANY ROAD
3RD FLOOR
PARSIPPANY, NJ 07054
PHONE: 973.739.9400
FAX: 973.739.9710

(CIVIL) CERTIFICATE OF AUTHORIZATION # 24GA28047600 EXP. DATE 8/31/08

DATE: MAY 30, 2008

Christopher M. Cirrotti
PROFESSIONAL ENGINEER,
N.J. LICENSE No. 24GE03853800

OVERALL SOIL EROSION AND SEDIMENT CONTROL PLAN

COMM. NO.	2727-001-00
SCALE	AS SHOWN
DATE	JUNE 4, 2007
CONTACT/DRAWN	CMC

CONSTRUCTION DOCUMENTS

C-300

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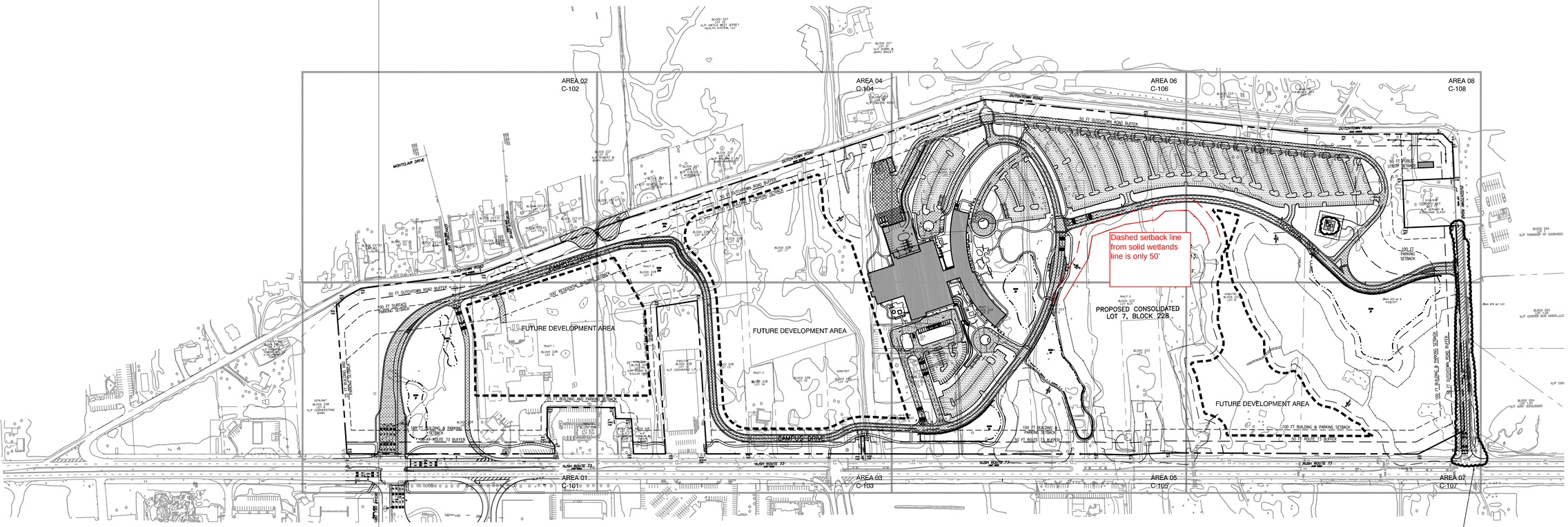
Appendix B – Wetlands Setback



Parking Space Summary

SPACES PER PARKING DEMAND STUDY, BY PROFESSIONAL ENGINEERING SERVICES, DATED MARCH 2007; 1,225 SPACES

SPACES CURRENTLY PROVIDED: 1,357 SPACES

ACCESSIBLE SPACES: 20 FOR THE FIRST 1,000, THEN 1 PER HUNDRED ABOVE 1,000: 24 SPACES

Paving Type Legend

- PARKING AREAS*
- LOADING DOCK*
- DUTCHTOWN ROAD*
- ENTRY, LOOP AND SERVICE ROADS*
- CONCRETE PAVING*

* SEE DETAIL SHEET

NOTES

THERE ARE NO EASEMENTS ARE SHOWN ON THE SITE AT THIS TIME. IT IS ANTICIPATED THAT AN EASEMENT WILL BE REQUIRED FOR WATER MAINS SUBJECT TO NEW JERSEY AMERICAN WATER COMPANY REQUIREMENTS.

Virtua HEALTH

VOORHEES REPLACEMENT FACILITY
CAMDEN COUNTY, NEW JERSEY

CERTIFICATE OF NEED # FR050201-04-01

DCA REFERENCE NO. 5183-07

BLOCK 223
LOTS 1, 2, 2.01, 3, 4, 5, 6, 6.01, 7, 8, 9, 10, 11, 12

BLOCK 228
LOTS 7, 8, 8.01, 9, 11, 11.01, 13, 14, 15, 16, 17, 18

NJ State Highway Route 73
Tax Map Sheets 28 & 30

Township of Voorhees
Camden County, New Jersey

KEY MAP

SCALE
200 0 100 200
(IN FEET)
1 inch = 200 ft.

8/10	AUGUST 10, 2007
11/1	NOVEMBER 1, 2007
3/28	MARCH 28, 2008
5/12	MAY 30, 2008
10/28	OCTOBER 31, 2008

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(CIVIL) CERTIFICATE OF AUTHORIZATION # 24GA28047600

DATE: OCTOBER 31, 2008

Christopher M. Cirrotti
PROFESSIONAL ENGINEER,
N.J. LICENSE No. 24GE03853800

OVERALL SITE LAYOUT PLAN

COMM. NO.	2727-001-00
SCALE	AS SHOWN
DATE	JUNE 4, 2007
CONTACT/DRAWN	CMC

CONSTRUCTION DOCUMENTS

C-100

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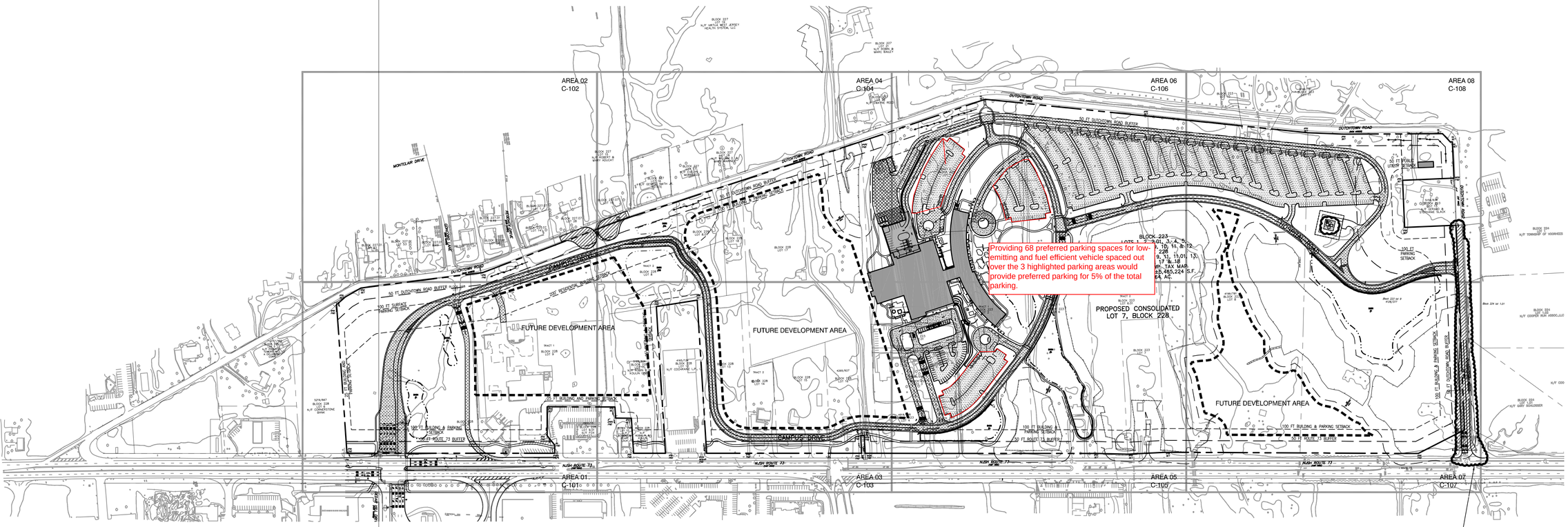
Appendix C – Alternative Transportation - Parking



ALL IMPROVEMENTS ON DUTCHTOWN ROAD ARE ON HOLD PENDING NJDOT APPROVAL

Parking Space Summary

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Paving Type Legend

- PARKING AREAS*
- LOADING DOCK*
- DUTCHTOWN ROAD*
- ENTRY, LOOP AND SERVICE ROADS*
- CONCRETE PAVING*

* SEE DETAIL SHEET

NOTES

THERE ARE NO EASEMENTS ARE SHOWN ON THE SITE AT THIS TIME. IT IS ANTICIPATED THAT AN EASEMENT WILL BE REQUIRED FOR WATER MAINS SUBJECT TO NEW JERSEY AMERICAN WATER COMPANY REQUIREMENTS.

Virtua HEALTH

VOORHEES REPLACEMENT FACILITY
CAMDEN COUNTY, NEW JERSEY

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DATE: OCTOBER 31, 2008

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N.J. LICENSE No. 24GE03853800

OVERALL SITE LAYOUT PLAN

COMM. NO.	2727-001-00
SCALE	AS SHOWN
DATE	JUNE 4, 2007
CONTACT/DRAWN	CMC

CONSTRUCTION DOCUMENTS

C-100

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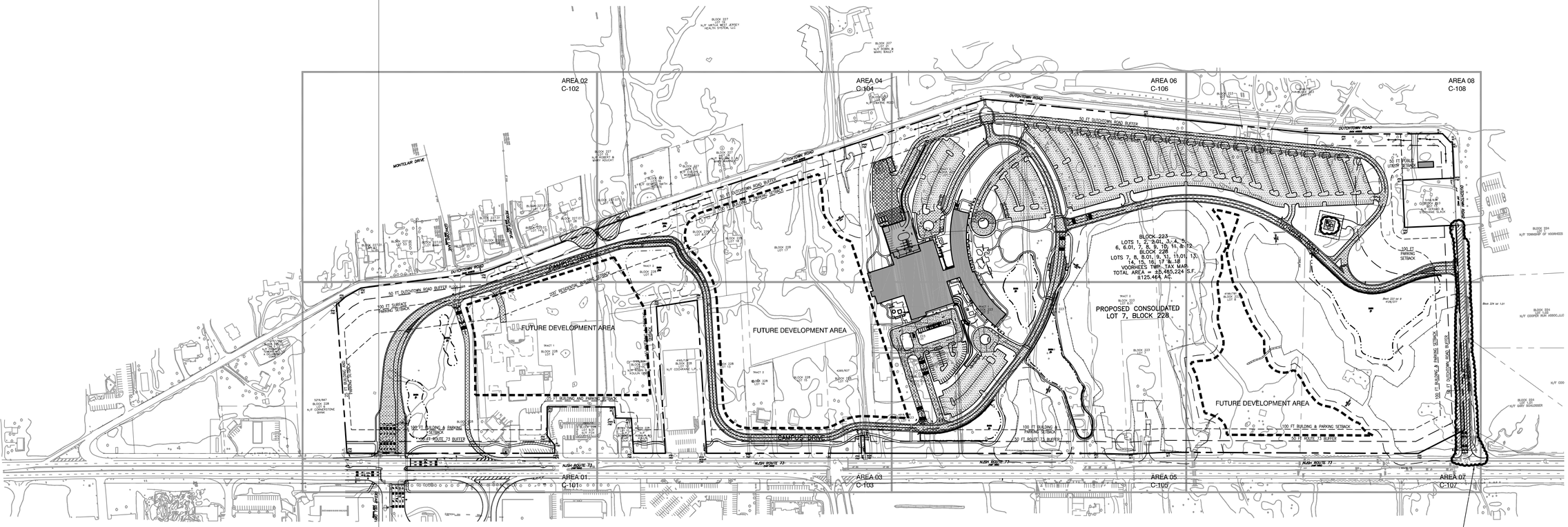
Appendix D – Open Space Document



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Paving Type Legend

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- LOADING DOCK*
- DUTCHTOWN ROAD*
- ENTRY, LOOP AND SERVICE ROADS*
- CONCRETE PAVING*

* SEE DETAIL SHEET

NOTES

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Virtua HEALTH

VOORHEES REPLACEMENT FACILITY
CAMDEN COUNTY, NEW JERSEY

CERTIFICATE OF NEED # FR050201-04-01

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Camden County, New Jersey

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(IN FEET)
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5	AUGUST 10, 2007
4 (1)	NOVEMBER 1, 2007
3	MARCH 28, 2008
2 (12)	MAY 30, 2008
1 (28)	OCTOBER 31, 2008

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DATE	JUNE 4, 2007
CONTACT/DRAWN	CMC

CONSTRUCTION DOCUMENTS

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Appendix E – Stormwater Plan

Infiltration & Test Pit Data

TEST #	SEASONAL HIGH GW ELEVATION	INFILTRATION RATE (IN/HR)
1	± 121.20	3.31
2	103.92	20.92
3	± 102.50	3.05
4	± 102.05	60.58
5	± 113.77	15.38
6	± 113.20	3.17
7	± 114.47	1.52
8	113.28	3.35
9	107.18	
10	104.00	
11	100.88	11.38
12	100.37	5.71
13	97.25	33.00
14	± 93.3	1.77
15	105.10	0.04
16	105.00	1.57
17	98.77	2.35
18	100.90	5.75
19	98.80	2.35
20	98.70	6.02
21	103.70	3.12
22	± 102.50	3.45
TP 12	102.37	NON =
TP 13	100.12	NON =
TP 19	99.52	NON =
TP 20	99.62	NON =
TP 21	99.2	NON =

Legend

- SANITARY SEWER LINE
- GAS LINE
- WATER LINE
- ELECTRIC, TELEPHONE, CABLE LINES
- STORM
- ROOF LEADERS
- MANHOLE
- INLET
- CLEANOUT
- EXISTING MANHOLE TO BE RECONSTRUCTED
- EXISTING INLET TO BE RECONSTRUCTED
- INFILTRATION AND TEST PIT LOCATION
- TEST PIT LOCATION
- AERATION SPRAY PUMP
- OUTLET STRUCTURE WITH WING WALL
- FLARED END SECTION
- HEADWALL

General Grading And Drainage Notes:

1. ALL AREAS TO RECEIVE FILL SHALL BE STRIPPED OF ALL ORGANIC MATERIAL AND PROOF-ROLLED WITH A MINIMUM 10 TON STATIC WEIGHT VIBRATORY COMPACTOR.

2. FILL MATERIAL SHALL BE PLACED IN NOT MORE THAN 8 INCH LOOSE LAYERS AND COMPACTED TO A MINIMUM OF 95% OF MAXIMUM DENSITY AS DETERMINED BY ASTM D-698. FROZEN MATERIAL SHALL NOT BE USED AND FILL SHALL NOT BE PLACED ON FROZEN SUBGRADE.

3. FILL MATERIAL SHALL CONSIST OF WELL GRADED SOIL AGGREGATE, FREE OF ORGANIC MATTER OR OTHER UNSUITABLE MATERIALS, HAVING A MAXIMUM SIZE OF 3 INCHES AND LESS THAN 15% PASSING THE NO. 200 SIEVE.

4. SUBGRADE OF EXCAVATED AREAS SHALL BE COMPACTED WITH A MINIMUM OF 4 PASSES OF A 10 TON STATIC WEIGHT VIBRATORY COMPACTOR. ANY SOFT AREAS SHALL BE EXCAVATED, FILLED WITH SUITABLE MATERIAL, AND COMPACTED AS PER NOTE 2.

5. CONTRACTOR SHALL CONSTRUCT SUBGRADES TO THE LINES, GRADES AND ELEVATIONS INFERRED BY THIS PLAN. CONTRACTOR SHALL MAINTAIN POSITIVE DRAINAGE ONSITE AT ALL TIMES.

6. CONTRACTOR SHALL MAINTAIN ALL EROSION CONTROL MEASURES AT ALL TIMES, AND INSPECT AFTER EACH RAINFALL.

7. CONTRACTOR SHALL ARRANGE FOR A MARKOUT OF ALL UTILITIES AT THE SITE PRIOR TO START OF WORK.

8. SPOT ELEVATIONS SHOWN IN PAVED AREAS INDICATE PAVEMENT ELEVATION UNLESS OTHERWISE NOTED.

9. RESET/RAISE AND MODIFY RIM ELEVATION OF ALL EXISTING MANHOLES, VALVE COVERS/COLLARS IN AREAS TO BE PAVED.

10. ALL REINFORCED CONCRETE PIPE SHALL BE CLASS III UNLESS OTHERWISE NOTED.

11. AREAS LOCATED WITHIN INFILTRATION BASINS SHALL BE PROTECTED FROM COMPACTION BY CONSTRUCTION EQUIPMENT AND SEDIMENT CONTAMINATION. ALL EXCAVATION MUST BE PERFORMED BY EQUIPMENT PLACED OUTSIDE THE BASIN AREA TO THE MAXIMUM EXTENT POSSIBLE.

12. INFILTRATION BASIN BOTTOMS SHALL BE PLACED A MINIMUM OF 2 FEET ABOVE THE SEASON HIGH WATER TABLE.

13. THE WETLANDS BUFFER LINES SHALL BE STAKED OUT PRIOR TO CONSTRUCTION.

14. DETAILS OF OFFSITE DRAINAGE IMPROVEMENTS ALONG ROUTE 73 WILL BE PART OF PLANS PREPARED FOR OFFSITE IMPROVEMENTS SUBMITTED TO NJDOT FOR APPROVAL.

Virtua HEALTH

VOORHEES REPLACEMENT FACILITY
CAMDEN COUNTY, NEW JERSEY

CERTIFICATE OF NEED # FR050201-04-01

DCA REFERENCE NO. 5183-07

BLOCK 223
LOTS 1, 2, 2.01, 3, 4, 5, 6, 6.01, 7, 8, 9, 10, 11, 12

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NJ State Highway Route 73
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Township of Voorhees
Camden County, New Jersey

KEY MAP

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200 0 100 200
(IN FEET)
1 inch = 200 ft.

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3	NOVEMBER 1, 2007
4	MARCH 28, 2008
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REVISION HISTORY - THIS SHEET

Dewberry
Dewberry-Goodkind, Inc.
600 PARSIPPANY ROAD
3RD FLOOR
PARSIPPANY, NJ 07054
PHONE: 973.739.9400
FAX: 973.739.9710

(CIVIL) CERTIFICATE OF AUTHORIZATION # 24GA28047600 EXP. DATE 8/31/08

DATE: MAY 30, 2008

Christopher M. Cirrotti
PROFESSIONAL ENGINEER,
N.J. LICENSE No. 24GE03853800

OVERALL GRADING AND DRAINAGE PLAN

COMM. NO.	2727-001-00
SCALE	AS SHOWN
DATE	JUNE 4, 2007
CONTACT/DRAWN	CMC

CONSTRUCTION DOCUMENTS

C-200

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Appendix F – StreetBond Product Data

Introducing NEW StreetBondSR™ – LEED® Parking Lot Series

LEED Project at Annenberg Community Beach Club in Santa Monica, CA

All the Features and Benefits of StreetBond150™ with Specialized Characteristics

StreetBond150™ LEED® parking lot series contributes to sustainable parking lot design and helps keep them looking new and clean.

Pavement surfaces are a leading cause of **Urban Heat Island Effect** contributing roughly 30-40% of the urban footprint. **Reducing Heat Island Effect** lowers energy consumption and can potentially cut air conditioning bills up to 33%[i]. Not to mention, cooler pavements mean safer more comfortable pavements as well.

Parking lots comprise a large portion of this urban footprint. **StreetBondSR™ – LEED® parking lot series** has specialized solar reflective characteristics that help keep parking lot surfaces cooler and can contribute to **LEED® credits.**

Durable and value priced, StreetBondSR™ – LEED® parking lot series was developed to help reduce parking lot maintenance and cleaning costs. It is available exclusively in specific colors designed to help hide the inevitable soiling and wear & tear parking lots experience, keeping them looking new and clean.

Not Only Sustainable Parking Lots – Safer, More Attractive Ones as Well

Create a positive brand experience for your customer from the time they arrive in your **parking lot** to the time they leave.

A wide range of decorative, **textured imprint asphalt** are available that match beautification with performance expectations. Stamped asphalt and asphalt color coating systems that are pedestrian safe, resistant to cracking, peeling and delaminating. They are designed to work in a wide range of wear and weather conditions. Carefully developed, tested and field proven, our systems have ideal application in safe and attractive pedestrian channelization as well as entranceways, courtyards and feature areas.

StreetBondSR™ – LEED® parking lot series can contribute LEED® credits under the following categories:

1. **New Construction (NC)** – Sustainable Sites (SSc7.1) – Heat Island Effect – Non-Roof
2. **Existing Building Operations (EBOM)** – Sustainable Sites (SSc7.1) – Heat Island Effect – Non-Roof
3. **Schools – Sustainable Sites (SSc7.1)** – Heat Island Effect – Non-Roof
4. **Green Neighborhood Development** – Green Infrastructure and Buildings – Heat Island Reduction (GIB Credit 9)

One credit can be realized through the use of surface materials which have a Solar Reflectance Index (SRI) of 29 or higher applied to at least 50% of the sites total hardscape including parking lots, roads, sidewalks and courtyards.

Appendix G – Plumbing Fixtures

American Standard
Style That Works Better

MADERA™ FloWise® 16-1/2" HEIGHT 1.28 GPF FLUSHOMETER TOILET

BARRIER FREE

MADERA™ FloWise® 16-1/2" HEIGHT

- Floor mount flushometer valve toilet
- Vitreous china
- Meets definition for HET (High Efficiency Toilet)
- High Efficiency (4.8 Lpf/1.28 gpf)
- EverClean® surface inhibits the growth of stain- and odor-causing bacteria, mold, and mildew on the surface
- 10" or 12" roughing-in
- 16-1/2" rim height for accessible application
- Condensation channel
- Elongated bowl
- Powerful direct-fed siphon jet action
- Fully glazed 2-1/8" trapway
- 10" x 12" water surface area
- 1-1/2" top spud
- 2 bolt caps
- 100% factory flush tested

SEE REVERSE FOR ROUGHING-IN DIMENSIONS

❏ **3461.128** Elongated bowl only, top spud
❏ **3462.128** Elongated bowl only, top spud with slotted rim for bedpan holding (White only)
❏ **3465.128** Elongated bowl only, top spud with 4 bolts
❏ **3466.128** Elongated bowl only, top spud with slotted rim for bedpan holding with 4 bolts (White only)
❏ **3463.128** Elongated bowl only, back spud
❏ **3464.128** Elongated bowl only, back spud with slotted rim for bedpan holding (White only)

Component Parts:
❏ **047007-0070A** Inlet spud (furnished with bowl)
❏ **481310-100** Bolt caps with retainers (furnished with bowl)

Nominal Dimensions:
718 x 356 x 419mm
(28-1/4" x 14" x 16-1/2")

Recommended working pressure–between 25 psi at valve when flushing and 80 psi static

Fixture only, less seat and flushometer valve

Compliance Certifications -
Meets or Exceeds the Following Specifications:
- ASME A112.19.2 for Vitreous China Fixtures
- CAN/CSA International B45

To Be Specified:
❏ Color: ❏ White ❏ Bone ❏ Silver ❏ Linen ❏ Black
❏ Seat:
  ❏ American Standard #5901.100 Heavy duty open front less cover
  ❏ American Standard #5905.100 Extra heavy duty open front less cover
❏ Flushometer Valve:
  ❏ American Standard Selectronic™ #6065.121.002 DC Power (Top Spud)
  ❏ American Standard Selectronic™ #6065.221.007 DC Power (Back Spud)
  ❏ American Standard Selectronic™ #6067.221.007 AC Power (Back Spud)
  ❏ American Standard Selectronic™ #6068.221.007 Multi AC Power (Back Spud)

MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 REQUIREMENTS FOR ACCESSIBLE AND USABLE BUILDING FACILITIES - CHECK LOCAL CODES.

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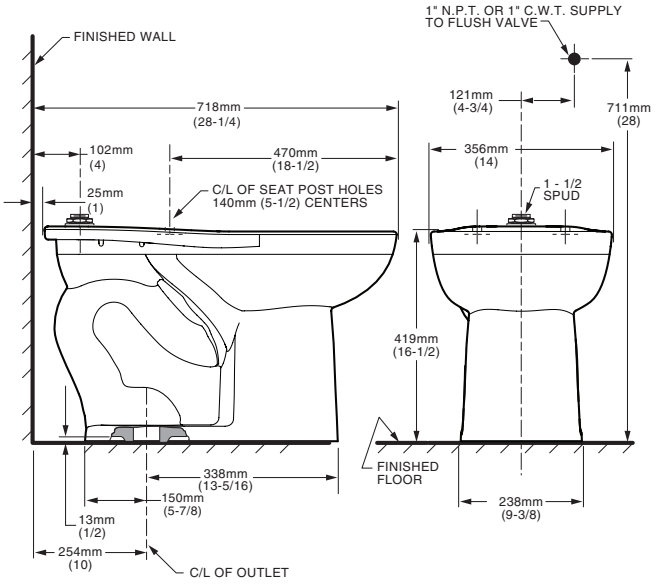
American Standard
Style That Works Better

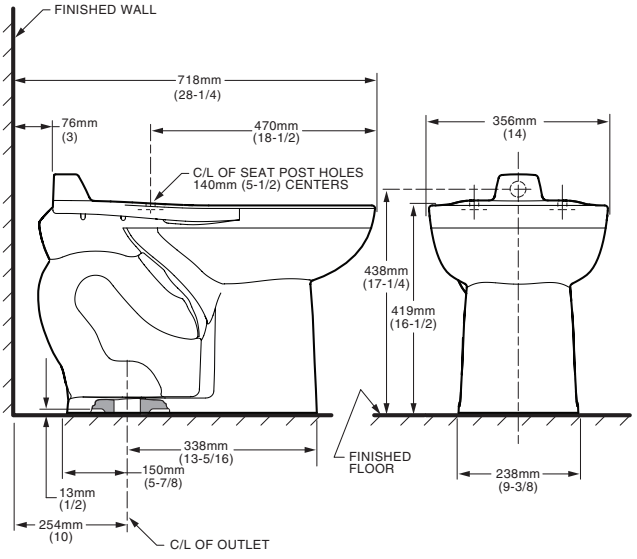
BARRIER FREE

MADERA™ FloWise® 16-1/2" HEIGHT 1.28 GPF FLUSHOMETER TOILET

3461.128/3462.128/3465.128/3466.128



3463.128/3464.128



NOTES:
PRODUCT 3451.160 AND 3453.160 SHOWN, 3452.160 AND 3455.160 SAME AS EXCEPT WITH SLOTTED RIM FOR BED PAN HOLDING.
TO COMPLY WITH AREA CODE GOVERNING THE HEIGHT OF VACUUM BREAKER ON THE FLUSHOMETER VALVE, THE PLUMBER MUST VERIFY DIMENSIONS SHOWN FOR SUPPLY ROUGHING.
THIS TOILET DESIGNED TO ROUGH-IN AT A MINIMUM DIMENSION OF 254MM (10") AND A MAXIMUM DIMENSION OF 305MM (12") FROM FINISHED WALL TO C/L OF OUTLET.
FLUSHOMETER VALVE NOT INCLUDED WITH FIXTURE AND MUST BE ORDERED SEPARATELY. FLUSHOMETER VALVE REQUIREMENTS FOR 12" (305MM) ROUGH-IN: SWEAT EXTENSION NIPPLE IS REQUIRED. REFER TO VALVE MANUFACTURER AND LOCAL CODES.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

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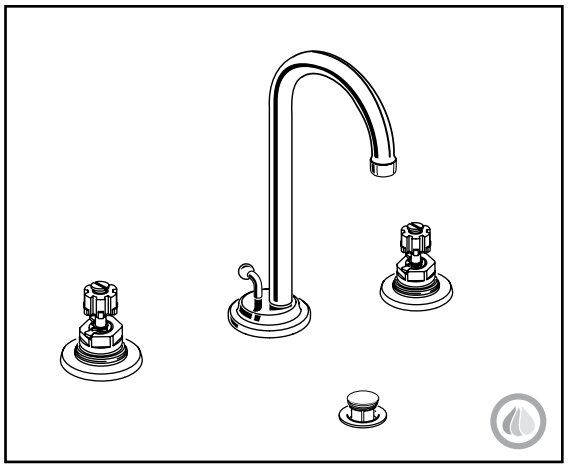
American Standard
Style That Works Better

HERITAGE

TWO-HANDLE 8" WIDESPREAD LAVATORY FAUCET

WITH GOOSENECK SPOUT

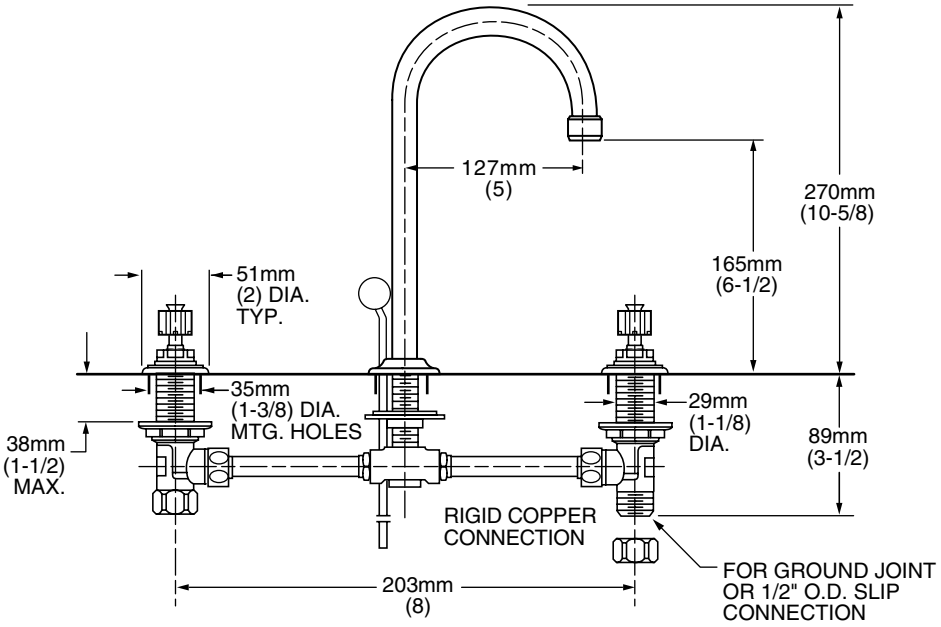


6831.000 Shown

MODEL NUMBER:

- **6830.000 8" Widespread Lavatory**
  Rigid gooseneck spout. 1.5 gpm pressure compensating aerator. Less drain. Less handles. Rigid copper connection.
- **6831.000 8" Widespread Lavatory**
  Rigid gooseneck spout. 1.5 gpm pressure compensating aerator. Pop-up drain. Less handles. Rigid copper connection.
- **6832.000 8" Widespread Lavatory**
  Rigid gooseneck spout. 1.5 gpm pressure compensating aerator. Grid strainer drain. Less handles. Rigid copper connection.

Handles must be ordered separately.



GENERAL DESCRIPTION:

Cast brass valve bodies with rigid copper 8" (203mm) connections. Amarilis 1/4 turn washerless ceramic disc valve cartridges. Fixed brass spout. One-half inch male inlet shanks with brass coupling nuts and shank nuts. All brass drain body (on applicable models) with 1-1/4" (32mm) tailpiece. 1.5gpm/5.7L/min. maximum flow rate.

PRODUCT FEATURES:

Pressure Compensating Aerator: Provides a constant water flow of 1.5 gpm throughout the pressure range.

Brass Construction: Durable - Excellent in high use applications. Ideal for prolonged contact with water.

Ceramic Disc Valve Cartridges: Assures a lifetime of drip-free performance.

Low Lead: Meets NSF Standard 61/Section 9 & Prop 65 lead requirements.

SUGGESTED SPECIFICATION:

Two handle widespread lavatory faucet shall feature cast brass valve bodies with 8" rigid copper connections. All brass shank nuts and coupling nuts. Shall feature water-conserving 1.5 gpm/5.7L/min. pressure compensating aerator. Shall also feature 1/4 turn washerless ceramic disc valve cartridges. Fitting shall be American Standard Model #680_.000.___ and handle kit # 0000.___.___.

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HERITAGE

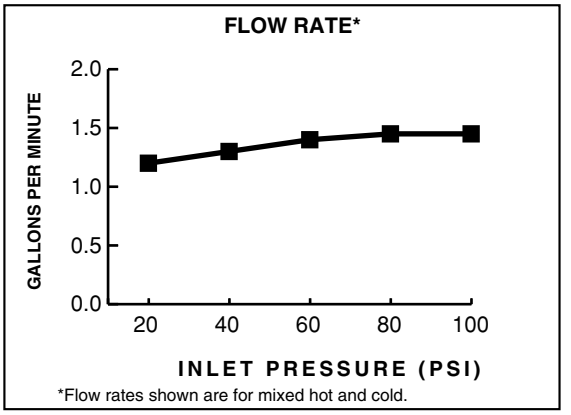
TWO-HANDLE 8" WIDESPREAD LAVATORY FAUCET

WITH GOOSENECK SPOUT

CODES AND STANDARDS

These products meet or exceed the following codes and standards:

ASME A112.18.1
CSA B 125
NSF 61/Section 9



*Flow rates shown are for mixed hot and cold.

Product Number	Description	Finish: Polished Chrome 002
6830.000	Lavatory Faucet. 1.5 gpm/5.7L/min pressure compensating aerator. Less drain. Less handles.	
6831.000	Lavatory Faucet. 1.5 gpm/5.7L/min pressure compensating aerator. Pop-up drain. Less handles.	
6832.000	Lavatory Faucet. 1.5 gpm/5.7L/min pressure compensating aerator. Grid strainer drain. Less handles.	

Handles must be ordered separately.

The above fittings will accept the following Amarilis-Series handles.

Wrist Blade	Lever
372H 372V	342H 342V

Meets the American Disabilities Act Guidelines and **ANSI A117.1** Requirements for the physically challenged.

Other Aerators Available:

Part Suffix	Description
V15	1.5 gpm Pressure Compensating Vandal-Resistant Aerator
L15	1.5 gpm Pressure Compensating Laminar Flow
LV15	1.5 gpm Pressure Compensating Vandal-Resistant Laminar Flow Outlet
V05	0.5 gpm Pressure Compensating Vandal-Resistant Spray

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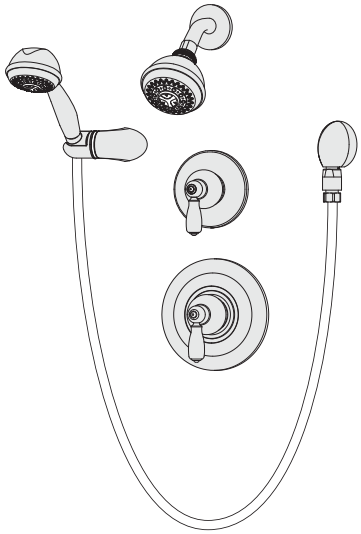
Location:

SYMMONS® Allura™

Shower System with Hand Shower 4705

Specification Submittal



Feature Highlights

- Symmons shower system with lever handles.
- Symmons Temptrol® pressure balancing mixing valve with adjustable stop screw to limit handle turn.
- Separate dual outlet lever diverter valve
- Wall/hand shower with 5 foot flexible metal hose, in-line vacuum breaker, wall connection and cradle for hand shower mounting
- Shower head with mounting bracket
- Flow rate 2.5 gpm (9.5 L/min) for both shower head and hand shower
- Polished chrome finish

Model Numbers

- ☐ 4705 ..... Shower System with Symmons Temptrol® pressure balancing mixing valve p/n 4000-BODY and dual outlet diverter p/n 4-458E-BODY
- ☐ 4705-TRM ..... Trim only, valve and diverter must be ordered separately
- ☐ 4000-BODY..... Symmons Temptrol® pressure balancing mixing valve without trim
- ☐ 4000-X-BODY.... Symmons Temptrol® pressure balancing mixing valve without trim. Valve includes integral service stops to allow water shut-off for service.
- ☐ 4-458E-BODY.... Symmons dual outlet diverter valve without trim

Finish Options / Modifications

Append appropriate -suffix to model number.

- ☐ -STN Satin nickel
- \- Polished chrome (standard finish)

Options / Modifications

Append appropriate -suffix to model number.

- ☐ -IPS 1/2 inch female IPS connections on Symmons Temptrol® mixing valve
- ☐ -X Symmons Temptrol® pressure balancing mixing valve includes integral service stops to allow water shut-off for service, p/n 4000-X-BODY. (Option only applies when ordering model 4705.)
- ☐ -2.0 2.0 (7.6 L/min) Flow rate restrictor
- ☐ -1.5 1.5 (5.7 L/min) Flow rate restrictor

Standards / Certifications

ASME A112.18.1-2005/CSA B125.1-05

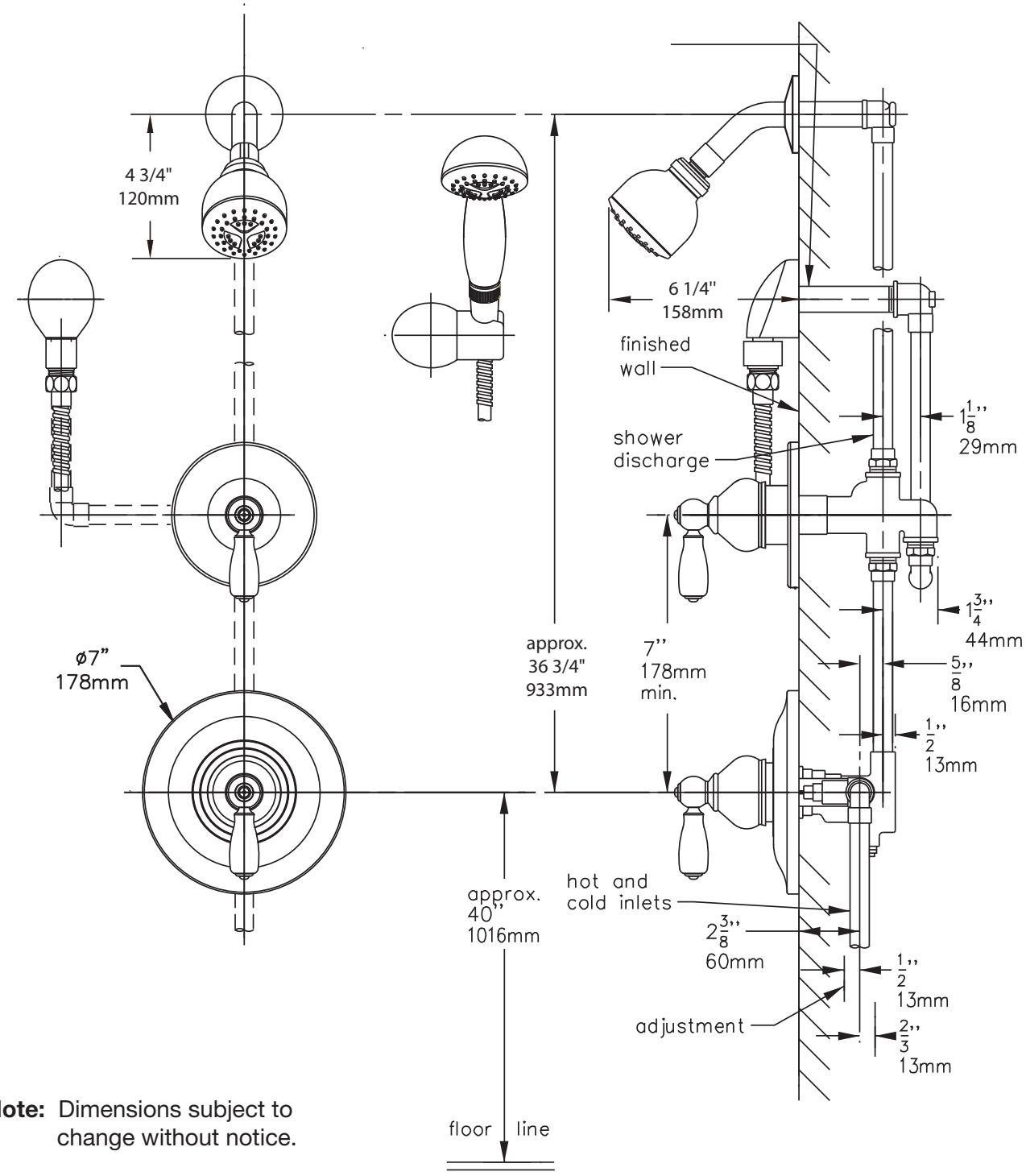
Warranty

- Limited Lifetime - to the original end purchaser in consumer installations.
- 5 years - for commercial installations

Print Email Reset Form

Dimensions *Allura Shower and Hand Shower System, 4705*

Male 1/2" I.P.S. thread must be recessed 1/4" (6mm) from finished wall for proper installation of street ell.



Note: Dimensions subject to change without notice.

Symmons Industries, Inc. ▪ 31 Brooks Drive ▪ Braintree, MA 02184
(800) 796-6667, (781) 848-2250 ▪ Fax (800) 961-9621, (781) 664-1300
Website: www.symmons.com ▪ Email: customerservice@symmons.com

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SYMMONS®
the smart choice™

Appendix H – Energy Analysis

LEED NC 2.2 EA Credit 1 Summary Report

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General Information

Simulation Program Name and Version	**Hourly Analysis Program v4.41**	
Simulation Weather File Name	**Newark, New Jersey (TM2)**	
Total Conditioned Floor Area	**307,200**	ft²
Total Floor Area	**307,200**	ft²

Building Designations

Proposed Building	**ALT2 - Sample**
Baseline - 0 degrees	**ALT1 - Base**
Baseline - 90 degrees	**n/a**
Baseline - 180 degrees	**n/a**
Baseline - 270 degrees	**n/a**

Window-to-Wall Ratios

	Proposed Design	Baseline
Window to Wall Ratio	60 %	25 %
Gross Wall Area (ft²)	134,400	134,400
Vertical Window Area (ft²)	80,640	33,600

Advisory Messages

	Proposed Building	Baseline Building (0 deg. rotation)	Difference
Number of hours heating loads not met	0	0	0
Number of hours cooling loads not met	1	0	+1

Table 1.5. Energy Type Summary

Energy Type	Utility Rate Description	Units of Energy	Units of Demand
Electric	Sample Electric Rate	kWh	kW

Energy Units:
1 kBTU = 1,000 BTU
1 kWh = 3.412 kBTU

Demand Units:
1 MBH = 1,000 BTU/h
1 kW = 3.412 MBH

Table 1.8.1. Baseline Performance - Performance Rating Method Compliance

End Use	Process	Baseline Design Energy Type	Units of Annual Energy & Peak Demand	Baseline (0 deg rotation)	Baseline (90 deg rotation)	Baseline (180 deg rotation)	Baseline (270 deg rotation)	Baseline Design
Interior Lighting	No	Electric	Energy kWh	2,022,967	0	0	0	2,022,967
			Demand kW	580.6	0.0	0.0	0.0	580.6
Space Heating	No	Natural Gas	Energy	2,559,668	0	0	0	2,559,668
			Demand	4,280.8	0.0	0.0	0.0	4,280.8
Space Cooling	No	Electric	Energy kWh	640,954	0	0	0	640,954
			Demand kW	452.2	0.0	0.0	0.0	452.2
Pumps	No	Electric	Energy kWh	255,569	0	0	0	255,569
			Demand kW	84.1	0.0	0.0	0.0	84.1
Heat Rejection	No	Electric	Energy kWh	86,282	0	0	0	86,282
			Demand kW	47.6	0.0	0.0	0.0	47.6
Fans - Interior	No	Electric	Energy kWh	555,856	0	0	0	555,856
			Demand kW	101.7	0.0	0.0	0.0	101.7
Receptacle Equipment	Yes	Electric	Energy kWh	2,119,299	0	0	0	2,119,299
			Demand kW	608.3	0.0	0.0	0.0	608.3

LEED NC 2.2 EA Credit 1 Summary Report

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Baseline Energy Totals	Total Annual Energy Use kBTU	21,942,990	0	0	0	19,383,322
	Annual Process Energy kBTU					7,231,047

Process Cost accounts for 37% of Baseline Performance. Process cost must equal at least 25% of Baseline Performance or the narrative at the end of this form must document why this building's process costs are less than 25%.

Table 1.8.1(b). Baseline Energy Costs

Energy Type	Baseline Cost (0 deg rotation) ($)	Baseline Cost (90 deg rotation) ($)	Baseline Cost (180 deg rotation) ($)	Baseline Cost (270 deg rotation) ($)	Baseline Building Performance ($)
Electric	742,497	0	0	0	742,497
Total Baseline Costs	**742,497**	**0**	**0**	**0**	**742,497**

Table 1.8.2. Performance Rating Table - Performance Rating Method Compliance

End Use	Process	Proposed Design Energy Type	Proposed Design Units	Proposed Building Results	Baseline Building Units	Baseline Building Results	Percent Savings
Interior Lighting	No	Electric	Energy kWh	866,986	Energy kWh	2,022,967	57 %
			Demand kW	248.8	Demand kW	580.6	57 %
Space Heating	No	Natural Gas	Energy	1,582,851	Energy	2,559,668	38 %
			Demand	3,175.3	Demand	4,280.8	26 %
Space Cooling	No	Electric	Energy kWh	673,934	Energy kWh	640,954	-5 %
			Demand kW	495.3	Demand kW	452.2	-10 %
Pumps	No	Electric	Energy kWh	270,701	Energy kWh	255,569	-6 %
			Demand kW	94.9	Demand kW	84.1	-13 %
Heat Rejection	No	Electric	Energy kWh	98,633	Energy kWh	86,282	-14 %
			Demand kW	50.4	Demand kW	47.6	-6 %
Fans - Interior	No	Electric	Energy kWh	659,003	Energy kWh	555,856	-19 %
			Demand kW	141.1	Demand kW	101.7	-39 %
Receptacle Equipment	Yes	Electric	Energy kWh	2,119,299	Energy kWh	2,119,299	0 %
			Demand kW	608.3	Demand kW	608.3	0 %
Energy Totals		Total Annual Energy Use kBTU		17,580,204		19,383,322	9 %
		Annual Process Energy kBTU		7,231,047		7,231,047	0 %

Table 1.8.2(b). Energy Cost and Consumption by Energy Type - Performance Rating Method Compliance

	Proposed Design		Baseline Design		Percent Savings	
Energy Type	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost**
Electric	4,688,556 kWh	612,794	5,680,927 kWh	742,497	17.5 %	17.5 %
Subtotal (Model Outputs)	**17,580,204 kBTU**	**612,794**	**19,383,322 kBTU**	**742,497**	**9.3 %**	**17.5 %**
On Site Renewable Energy	**Energy Generated**	**Renewable Energy Cost**				
Exceptional Calculations	**Energy Savings**	**Cost Savings**				
	Proposed Design	**Proposed Design**	**Baseline Design**	**Baseline Design**	**Percent Savings**	**Percent Savings**
	Energy Use	**Cost ($)**	**Energy Use**	**Cost ($)**	**Energy**	**Cost**
Total:	kBTU		kBTU		%	%

Note: In Table 1.8.2(b), On-Site Renewable, Exceptional Calculation and amended total results at bottom of table are to be filled in manually if these separate calculations were performed.

LEED NC 2.2 EA Credit 1 Summary Report

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LEED NC 2.2 EA Credit 1 Points Reference Table

New Construction % Cost Savings	Existing Building Renovations % Cost Savings	LEED NC 2.2 Points Awarded
10.5 %	3.5 %	1 pt
14.0 %	7.0 %	2 pts
17.5 %	10.5 %	**3 pts**
21.0 %	14.0 %	4 pts
24.5 %	17.5 %	5 pts
28.0 %	21.0 %	6 pts
31.5 %	24.5 %	7 pts
35.0 %	28.0 %	8 pts
38.5 %	31.5 %	9 pts
42.0 %	35.0 %	10 pts

Appendix I – Solar Panel Life Cycle

1% of Electricity Provided by Solar Panels							
Year	Construction	1	2	3	4	5	6
$/kW Electricity (Assume 3.5% Inflation)		$ 0.1300	$ 0.1346	$ 0.1393	$ 0.1441	$ 0.1492	$ 0.1544
Cost	$ 841,500	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Installed Cost)	$ 252,450	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ -	$ 73,290	$ 73,290	$ 73,290	$ 73,290	$ 73,290	$ 73,290
Utility Savings	$ -	$ 18,150	$ 18,785	$ 19,442	$ 20,123	$ 20,827	$ 21,556
Yearly Cash Flow	$ (589,050)	$ 91,440	$ 92,075	$ 92,732	$ 93,413	$ 94,117	$ 94,846
Cumulative Cash Flor	$ (589,050)	$ (497,610)	$ (405,536)	$ (312,803)	$ (219,390)	$ (125,273)	$ (30,427)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 3.5% Inflation)	$ 0.1598	$ 0.1654	$ 0.1712	$ 0.1772	$ 0.1834	$ 0.1898	$ 0.1964
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ 73,290	$ 73,290	$ 73,290	$ 73,290	$ -	$ -	$ -
Utility Savings	$ 22,311	$ 23,091	$ 23,900	$ 24,736	$ 25,602	$ 26,498	$ 27,425
Yearly Cash Flow	$ 95,601	$ 96,381	$ 97,190	$ 98,026	$ 25,602	$ 26,498	$ 27,425
Cumulative Cash Flor	$ 65,173	$ 161,555	$ 258,744	$ 356,770	$ 382,372	$ 408,870	$ 436,295

3% of Electricity Provided by Solar Panels

Year	Construction	1	2	3	4	5	6
$/kW Electricity (Assume 3.5% Inflation)		$ 0.1300	$ 0.1346	$ 0.1393	$ 0.1441	$ 0.1492	$ 0.1544
Cost	$ 2,534,400	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Installed Cost)	$ 760,320	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ -	$ 220,500	$ 220,500	$ 220,500	$ 220,500	$ 220,500	$ 220,500
Utility Savings	$ -	$ 54,662	$ 56,576	$ 58,556	$ 60,605	$ 62,726	$ 64,922
Yearly Cash Flow	$ (1,774,080)	$ 275,162	$ 277,076	$ 279,056	$ 281,105	$ 283,226	$ 285,422
Cumulative Cash Flor	$ (1,774,080)	$ (1,498,918)	$ (1,221,842)	$ (942,786)	$ (661,681)	$ (378,455)	$ (93,033)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 3.5% Inflation)	$ 0.1598	$ 0.1654	$ 0.1712	$ 0.1772	$ 0.1834	$ 0.1898	$ 0.1964
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ 220,500	$ 220,500	$ 220,500	$ 220,500	$ -	$ -	$ -
Utility Savings	$ 67,194	$ 69,546	$ 71,980	$ 74,499	$ 77,107	$ 79,805	$ 82,599
Yearly Cash Flow	$ 287,694	$ 290,046	$ 292,480	$ 294,999	$ 77,107	$ 79,805	$ 82,599
Cumulative Cash Flor	$ 194,661	$ 484,707	$ 777,187	$ 1,072,186	$ 1,149,293	$ 1,229,098	$ 1,311,697

5% of Electricity Provided by Solar Panels

Year	Construction	1	2	3	4	5	6
$/kW Electricity (Assume 3.5% Inflation)		$ 0.1300	$ 0.1346	$ 0.1393	$ 0.1441	$ 0.1492	$ 0.1544
Cost	$ 4,227,300	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Installed Cost)	$ 1,268,190	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ -	$ 368,207	$ 368,207	$ 368,207	$ 368,207	$ 368,207	$ 368,207
Utility Savings	$ -	$ 91,175	$ 94,366	$ 97,669	$ 101,088	$ 104,626	$ 108,288
Yearly Cash Flow	$ (2,959,110)	$ 459,382	$ 462,573	$ 465,876	$ 469,295	$ 472,833	$ 476,495
Cumulative Cash Flor	$ (2,959,110)	$ (2,499,728)	$ (2,037,155)	$ (1,571,278)	$ (1,101,984)	$ (629,151)	$ (152,657)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 3.5% Inflation)	$ 0.1598	$ 0.1654	$ 0.1712	$ 0.1772	$ 0.1834	$ 0.1898	$ 0.1964
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ 368,207	$ 368,207	$ 368,207	$ 368,207	$ -	$ -	$ -
Utility Savings	$ 112,078	$ 116,000	$ 120,060	$ 124,262	$ 128,612	$ 133,113	$ 137,772
Yearly Cash Flow	$ 480,285	$ 484,207	$ 488,267	$ 492,469	$ 128,612	$ 133,113	$ 137,772
Cumulative Cash Flor	$ 327,628	$ 811,835	$ 1,300,102	$ 1,792,572	$ 1,921,183	$ 2,054,296	$ 2,192,068

7% of Electricity Provided by Solar Panels

Year	Construction	1	2	3	4	5	6
$/kW Electricity (Assume 3.5% Inflation)		$ 0.1300	$ 0.1346	$ 0.1393	$ 0.1441	$ 0.1492	$ 0.1544
Cost	$ 5,910,300	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Installed Cost)	$ 1,773,090	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ -	$ 514,800	$ 514,800	$ 514,800	$ 514,800	$ 514,800	$ 514,800
Utility Savings	$ -	$ 127,474	$ 131,936	$ 136,554	$ 141,333	$ 146,280	$ 151,400
Yearly Cash Flow	$ (4,137,210)	$ 642,274	$ 646,736	$ 651,354	$ 656,133	$ 661,080	$ 666,200
Cumulative Cash Flor	$ (4,137,210)	$ (3,494,936)	$ (2,848,200)	$ (2,196,846)	$ (1,540,713)	$ (879,633)	$ (213,433)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 3.5% Inflation)	$ 0.1598	$ 0.1654	$ 0.1712	$ 0.1772	$ 0.1834	$ 0.1898	$ 0.1964
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ 514,800	$ 514,800	$ 514,800	$ 514,800	$ -	$ -	$ -
Utility Savings	$ 156,699	$ 162,183	$ 167,859	$ 173,735	$ 179,815	$ 186,109	$ 192,623
Yearly Cash Flow	$ 671,499	$ 676,983	$ 682,659	$ 688,535	$ 179,815	$ 186,109	$ 192,623
Cumulative Cash Flor	$ 458,065	$ 1,135,049	$ 1,817,708	$ 2,506,243	$ 2,686,058	$ 2,872,167	$ 3,064,789

9% of Electricity Provided by Solar Panels

Year	Construction	1	2	3	4	5	6
$/kW Electricity (Assume 3.5% Inflation)		$ 0.1300	$ 0.1346	$ 0.1393	$ 0.1441	$ 0.1492	$ 0.1544
Cost	$ 7,603,200	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Installed Cost)	$ 2,280,960	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ -	$ 662,256	$ 662,256	$ 662,256	$ 662,256	$ 662,256	$ 662,256
Utility Savings	$ -	$ 163,987	$ 169,727	$ 175,667	$ 181,816	$ 188,179	$ 194,765
Yearly Cash Flow	$ (5,322,240)	$ 826,243	$ 831,983	$ 837,923	$ 844,072	$ 850,435	$ 857,021
Cumulative Cash Flor	$ (5,322,240)	$ (4,495,997)	$ (3,664,014)	$ (2,826,091)	$ (1,982,019)	$ (1,131,584)	$ (274,563)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 3.5% Inflation)	$ 0.1598	$ 0.1654	$ 0.1712	$ 0.1772	$ 0.1834	$ 0.1898	$ 0.1964
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ 662,256	$ 662,256	$ 662,256	$ 662,256	$ -	$ -	$ -
Utility Savings	$ 201,582	$ 208,638	$ 215,940	$ 223,498	$ 231,320	$ 239,416	$ 247,796
Yearly Cash Flow	$ 863,838	$ 870,894	$ 878,196	$ 885,754	$ 231,320	$ 239,416	$ 247,796
Cumulative Cash Flor	$ 589,275	$ 1,460,169	$ 2,338,365	$ 3,224,118	$ 3,455,438	$ 3,694,855	$ 3,942,651

11% of Electricity Provided by Solar Panels

Year	Construction	1	2	3	4	5	6
$/kW Electricity (Assume 3.5% Inflation)		$ 0.1300	$ 0.1346	$ 0.1393	$ 0.1441	$ 0.1492	$ 0.1544
Cost	$ 9,296,100	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Installed Cost)	$ 2,788,830	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ -	$ 809,711	$ 809,711	$ 809,711	$ 809,711	$ 809,711	$ 809,711
Utility Savings	$ -	$ 200,500	$ 207,517	$ 214,781	$ 222,298	$ 230,078	$ 238,131
Yearly Cash Flow	$ (6,507,270)	$ 1,010,211	$ 1,017,228	$ 1,024,492	$ 1,032,009	$ 1,039,789	$ 1,047,842
Cumulative Cash Flor	$ (6,507,270)	$ (5,497,059)	$ (4,479,831)	$ (3,455,339)	$ (2,423,330)	$ (1,383,541)	$ (335,699)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 3.5% Inflation)	$ 0.1598	$ 0.1654	$ 0.1712	$ 0.1772	$ 0.1834	$ 0.1898	$ 0.1964
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ 809,711	$ 809,711	$ 809,711	$ 809,711	$ -	$ -	$ -
Utility Savings	$ 246,466	$ 255,092	$ 264,020	$ 273,261	$ 282,825	$ 292,724	$ 302,969
Yearly Cash Flow	$ 1,056,177	$ 1,064,803	$ 1,073,731	$ 1,082,972	$ 282,825	$ 292,724	$ 302,969
Cumulative Cash Flor	$ 720,478	$ 1,785,281	$ 2,859,012	$ 3,941,984	$ 4,224,809	$ 4,517,533	$ 4,820,502

13% of Electricity Provided by Solar Panels							
Year	Construction	1	2	3	4	5	6
$/kW Electricity (Assume 3.5% Inflation)		$ 0.1300	$ 0.1346	$ 0.1393	$ 0.1441	$ 0.1492	$ 0.1544
Cost	$ 10,979,100	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit (30% of Installed Cost)	$ 3,293,730	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ -	$ 956,304	$ 956,304	$ 956,304	$ 956,304	$ 956,304	$ 956,304
Utility Savings	$ -	$ 236,799	$ 245,087	$ 253,665	$ 262,544	$ 271,733	$ 281,243
Yearly Cash Flow	$ (7,685,370)	$ 1,193,103	$ 1,201,391	$ 1,209,969	$ 1,218,848	$ 1,228,037	$ 1,237,547
Cumulative Cash Flor	$ (7,685,370)	$ (6,492,267)	$ (5,290,876)	$ (4,080,906)	$ (2,862,059)	$ (1,634,022)	$ (396,475)

Year	7	8	9	10	11	12	13
$/kW Electricity (Assume 3.5% Inflation)	$ 0.1598	$ 0.1654	$ 0.1712	$ 0.1772	$ 0.1834	$ 0.1898	$ 0.1964
Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New Jersey Solar Renewable Energy Certificates ($525/MWh)	$ 956,304	$ 956,304	$ 956,304	$ 956,304	$ -	$ -	$ -
Utility Savings	$ 291,087	$ 301,275	$ 311,819	$ 322,733	$ 334,029	$ 345,720	$ 357,820
Yearly Cash Flow	$ 1,247,391	$ 1,257,579	$ 1,268,123	$ 1,279,037	$ 334,029	$ 345,720	$ 357,820
Cumulative Cash Flor	$ 850,916	$ 2,108,494	$ 3,376,618	$ 4,655,655	$ 4,989,684	$ 5,335,403	$ 5,693,223

Appendix J – LED Light Fixtures

Architectural Lay-In

LR24

Product Description

The LR24 is a revolutionary architectural lay-in designed for applications that require high ambient light levels, including offices, schools, and hospitals. It utilizes Cree LED Lighting technology that generates white light with LEDs in a new way and is the first to combine high efficacy, beautiful color and affordability.

The use of this technology releases the design constraints of traditional lay-ins and enables a fresh approach to the architectural appearance of the light. It also allows an optimal distribution of light that delivers high illuminance levels to horizontal surfaces balanced with an ideal amount of light to vertical surfaces resulting in an effective, attractive, and comfortable environment.

Delivered light output is set to provide the ideal amount of light with the lowest possible energy consumption for standard ceiling heights.

Performance Summary

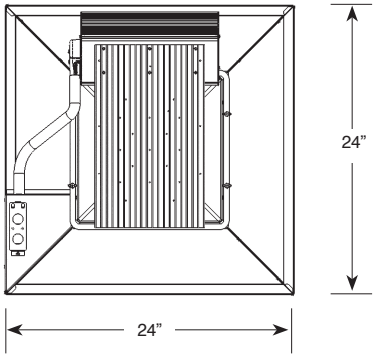
The LR24 is designed to deliver an optimal amount of light with typical luminaire spacing.

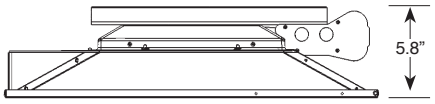
- Utilizes Cree TrueWhite™ technology
- CRI = 90
- 3500K
- Dimmable to 5% with 0-10V DC control
- 3200 lumens – 40FC maintained with typical 8'x8' spacing and ceiling*
- Nominal input power = 44 Watts
- Three Year Warranty

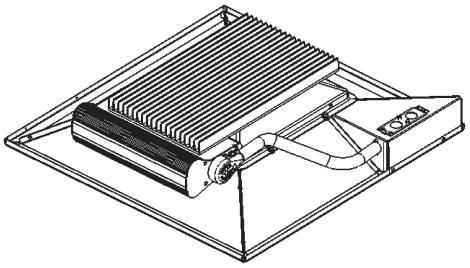
*Note: Light levels based on common room configurations will vary based upon actual conditions

Ordering Information

LR24-32SKA35 - 120V-277V, 3200 lumens, 3500K







CREE TRUE WHITE TECHNOLOGY

CREE LED Lighting

LR24

Architectural Lay-In

Product Information

Cree TrueWhite™ Technology

- A better way to generate white light that utilizes a patented mixture of unsaturated yellow and saturated red LEDs.
- Tuned to optimal color point before shipment.
- Color management system maintains color consistency over time and temperature.
- Designed to last 50,000 hours and maintain at least 70% of initial lumen output.

Construction

- Cold rolled steel lower reflector for installation in nominal 2' x 2' ceiling openings.
- Field replaceable light engine integrates LEDs, driver, power supply, thermal management, and optical mixing components. Access to light engine from adjoining ceiling tiles.
- Integrated thermal management system conducts heat away from LEDs and transfers it to the surrounding environment. Designed to keep LEDs below specified maximum temperatures in typical commercial installations.
- Height = 5.8"

Optical System

- Proprietary optical system utilizes a unique combination of reflective and refractive optical components to achieve a uniform, comfortable appearance. Pixelation and direct view of uncomfort able LEDs is eliminated.
- Lower reflector finished with a textured high reflectance white polyester powder coating to create a comfortable visual transition from the diffuser to the ceiling plane.
- Mechanical shielding of diffuser delivers a subtle glowing appearance at high angles for visual integration with the ceiling plane.
- Distribution of light balances the delivery of high light levels to horizontal surfaces with an ideal amount of light to vertical surfaces.

Electrical System

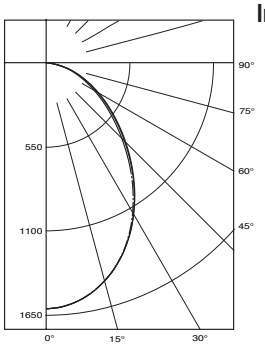
- Integral, high efficiency driver and power supply.
- Nominal Power Factor = 0.9
- Input voltage = 120V - 277V, 50/60Hz
- Dimmable to 5% with 0 to 10V DC control protocol

Regulatory and Voluntary Programs

- Tested and certified to UL standards

Photometry

LR24-32SKA35 – Based on ITL Test 61450



Intensity (Candlepower) Summary

ANGLE	CP°	CP45°
0°	1600	1600
5°	1582	1584
15°	1467	1469
25°	1258	1263
35°	981	996
45°	695	721
55°	459	482
65°	276	294
75°	131	142
85°	2	5
90°	0	0

Zonal Lumen Summary

ZONE	LUMENS	%LAMP	%FIX
0°- 30°	1145	53.5	53.5
0°- 40°	1767	76.9	76.9
0°- 60°	2750	98.8	98.8
0°- 90°	3200	100.00	100.00

CREE® LED Lighting

Cree LED Lighting
Morrisville • NC • 27560 • USA
1-919-287-7700 Fax 1-919-991-0730
www.CreeLEDLighting.com

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HALO®

HALO LED Module 900 Series
For New and Existing Installations

Catalog #		Type	
Project			
Comments		Date	
Prepared by			

The Halo LED ML7098xxICAT120D modules are designed for retro-fit applications with an Edison screw base adapter (included with the module) for use in existing housings OR may also be used in new construction with the LED dedicated housing Series H750x. Halo LED 900 Series modules deliver in the range of 520-1000 lumens (depending upon the trim and selected color temperature); and the 900 Series offers a selection of four color temperatures: 2700K, 3000K, 3500K and 4000K. Halo LED offers a superior optical design that yields productive beam lumens, good cutoff and low glare. The Halo LED recessed luminaire exceeds high efficacy requirements (with designated trims) for Title 24-2008 and IECC-2009.

DESIGN FEATURES

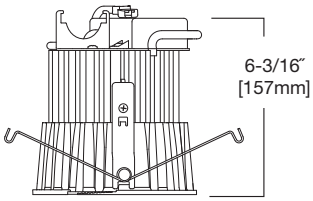
Exceeds the light output and distribution of a 75W PAR30 or PAR38 halogen lamp or a 26W compact fluorescent luminaire, while consuming less than 15 watts.

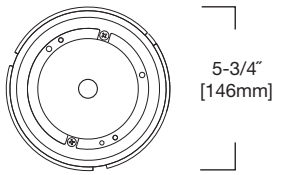
Dimming

The HALO LED luminaire is dimmable to 15% with standard 120V incandescent, magnetic low voltage, and electronic low voltage dimmers (or to 5% using dimmers with low end trim adjustment.) Standard incandescent dimmers require a minimum load of typically >40 watts on the circuit for full range dimming performance (four LED modules). For dimming with digital (smart) multi-location dimmers or when dimming fewer than four LED modules, electronic low voltage dimmers are required (ELV dimmers need a neutral connection in the wallbox).

Quality of Light

Halo 900 Series provides excellent color rendering (80 CRI), and a selection of four color temperatures (2700K, 3000K, 3500K and 4000K). CRI and color temperature performance conform to parameters established by ENERGY STAR® SSL standards (refer to ANSI-C78.377 - 2008 for CCT specifications). LED's have virtually no ultraviolet and minimal infrared wavelengths, and they do not emit heat like conventional lamps.





Optical Design

Optical design yields productive beam lumens, 50° cutoff, and low glare.

Life

Rated for 50,000 hours at 70% lumen maintenance.

Compatibility

The Halo ML7098xxICAT120D LED module is designed for use in the dedicated H750x series housings OR for retrofit applications in existing Halo or ALL-PRO™ H7/ET7/EI7 housings. The Halo LED module is designed for use in either IC (insulated ceiling) or non-IC construction.
Compatible HALO and ALL-PRO housings include model numbers:

- Dedicated LED Housing: H750x Series
- Halo Housings: H7x Series
- ALL-PRO Housings: ET7x and EI7x Series

Screw Base Adapter

Edison screw-base adapter supplied with module allows simple wiring connection to existing housing.

Module Construction

Durable die-cast and extruded aluminum construction conducts heat away from the LED keeping the junction temperatures below specified maximums even when installed in insulated ceiling environments.

Air-Tite™ Rating

The Halo LED module has passed restricted air flow testing, and now qualifies any housing to meet air-tight building codes. Certified under ASTM-E283 standards.

LED Driver

The LED module is controlled by a high efficiency driver with a power factor of >.90 at an input power of 120V, 50/60Hz. Driver has integral thermal protection in the event of over temperature or internal failure.

Warranty

Cooper Lighting provides a three year limited warranty on the Halo LED Luminaire which includes the LED Module, LED Recessed Housing and LED trims.

LED Module in New or Existing Construction – Housings other than Halo or All-Pro

If used in recessed housings other than Halo or All-Pro the Cooper Lighting 3-year warranty applies to the LED Module and Trim only. As with any electrical installation, a qualified electrician must ensure compatibility of use with a particular housing; this includes all applicable national and local electrical and building codes.
Installer is responsible to securely retain the LED Module and Trim in a housing at time of installation.

Labels

- UL/cUL Listed

Meets following requirements:

- State of California Title 24-2008 High Efficacy Compliant (with designated trims)
- International Energy Conservation Code (IECC) 2009 High Efficacy Compliant (with designated trims)
- Washington State Energy Code - AIR-TITE™
- New York State Energy Conservation Construction Code AIR-TITE™

Accessories

- Oversize Trim Rings (Goof Rings) - OT400P and OT403P oversize trim rings are installed behind the Halo LED trim ring to aid in masking ceiling irregularities and cut-out errors.
- H277 –The H277 Step-down transformer for use with non-IC housings (H7T, H7TNB, H750T, H750TCP, H750TD010) and LED Module.
- H347 –The H347 Step-down transformer for use with non-IC housings (H7T, H7TNB, H750T, H750TCP, H750TD010) and LED Module.

ML709840ICAT120D 900 Series LED Dimmable Module

4000°K Correlated Color Temperature

49X_Series Trims

6″ LED Module and Trim For New Construction OR Retrofit Applications

900 Series Energy Data:	
(Values at non-dimming line voltage)	
Minimum Starting Temp: -30°C (-22°F)	
EMI/RFI: FCC Title 47 CFR, Part 18, Class B (Consumer)	
Sound Rating:	Class A standards
Input Voltage:	120V
Power Factor:	>0.90
Input Frequency:	50/60Hz
THD:	<20%
Rated Wattage:	14.3W
Input Power:	14.3W
Input Current:	700mA
Maximum IC (Insulated Ceiling) Ambient Continuous Operating Temperature: 25°C (77°F)	
Maximum Non-IC Ambient Continuous Operating Temperature 40°C (104°F)	

900 Series Summary Lighting Data:

Lumen range: 520-1000
Lumens per watt: . . . . . .68 max.
Watts at 120VAC: 14.3

Color

Correlated Color Temperature (CCT): 2700-4000K
Color Rendering Index (CRI, R_a): 80

ENERGY STAR | T24 2008 California Title 24 High Efficacy Compliant | International Energy Conservation Code IECC Code Compliant

Qualified & Compliant with designated LED modules and trims.

ALU

airtight™

ADV091855
rev 11/16/09

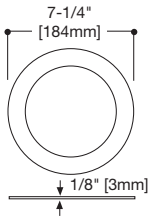
COOPER Lighting
www.cooperlighting.com

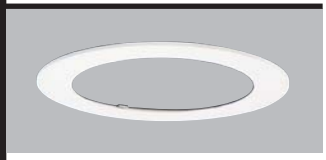
Correlated Color Temperature

ENERGY STAR® SSL Nominal CCT	LED Module	Also Available		
4000°K nominal (3985; 2700K 3000K 3500K 4100K 5000K 6500K)	ML709840ICAT120D	2700°K nominal	3000°K nominal	3500°K nominal
		ML709827ICAT120D	ML709830ICAT120D	ML709835ICAT120D

TRM490 Thin Profile Trim Ring (Optional Accessory)

- Die-cast trim ring
- Thin trim ring provides a more subtle ceiling appearance
- Purchase as accessory and discard ring supplied with trim
- Trim ring height of .120" at OD and .180" at ID
  - TRM490BK = Black
  - TRM490PC = Polished Chrome
  - TRM490SN = Satin Nickel
  - TRM490TBZ = Tuscan Bronze
  - TRM490WH = White



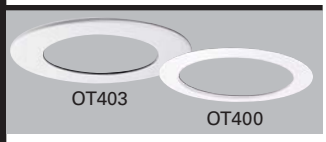


TRM490
Optional Accessory
Thin Profile Trim Ring

Oversize Trim Rings

For use when ceiling opening is irregular or cut too large. The oversized trim ring is installed behind the Halo LED trim ring to mask irregularities or cutout errors of the ceiling opening.

- OT400P = Oversize White Metal Trim Ring 6" ID x 9-1/4" OD
- OT403P = Oversize White Plastic Trim Ring 6" ID x 8" OD



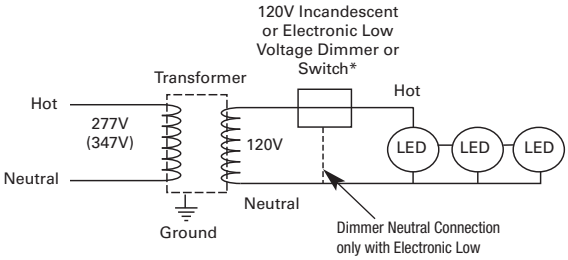
OT400, OT403
Oversize Trim Rings

Step Down Transformer

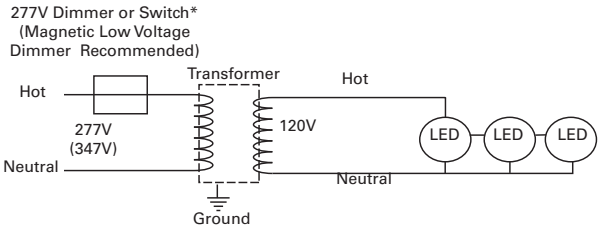
H277= Transformer - Steps 277 line voltage down to 120 volts. Attaches to knockout on junction box and is 300VA (18 modules max.) rated. H277 is a UL Recognized Component that is listed for use under the luminaire UL/cUL listing for use with with non-IC housings (H750T, H750TCP, H7T, H7TNB, H7RT, H750TD010, H750RTD010 and LED Module)

H347= Transformer - Steps 347 line voltage down to 120 volts. Attaches to knockout on junction box and is 75VA (4 modules max.) rated. H347 is a CSA/UL Listed Component that is listed for use under the luminaire UL/cUL listing for use with non-IC housings (H750T, H750TCP, H7T, H7TNB, H7RT, H750TD010, H750RTD010 and LED Module) (Note: No 347V dimmers currently available)

Transformer with Dimmer /Switch on Secondary

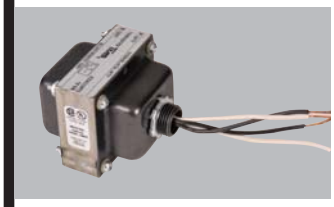


Transformer with Dimmer /Switch on Primary



* Dimmer or Switch may be on the Primary (277V) OR Secondary (120V) side of the transformer.

H277
277V Step Down Transformer



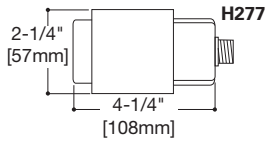
H347
347V Step Down Transformer

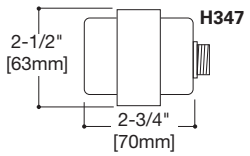
Transformer Load - H277 (300VA)

1. H277Transformer at full loading consumes a maximum of 16W of power
2. When dimmer or switch is on the secondary (120V) side of the transformer, power is consumed by the transformer when the dimmer or switch is in "OFF" mode at 6.5W and in "ON" mode at 16W maximum with full loading.
3. When a dimmer or switch is on the primary (277V) side of the transformer, power is consumed only in "ON" mode to a maximum of 16W under full loading.

Transformer Load - H347 (75VA)

1. H347Transformer at full loading consumes a maximum of 15W of power
2. When dimmer or switch is on the secondary (120V) side of the transformer, power is consumed by the transformer when the dimmer or switch is in "OFF" mode at 2.5W and in "ON" mode at 15W maximum with full loading.
3. When a dimmer or switch is on the primary (347V) side of the transformer, power is consumed only in "ON" mode to a maximum of 15W under full loading.





Protected / Non-insulated Soffits, Porches, and Canopies

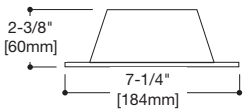
Halo LED modules when used with Non-IC recessed housings in protected soffits, porches or canopies offers a solution for outdoor accent lighting without concern for typical outdoor temperatures found in both cold and warm climates. Halo LED is rated for continuous operation from -30°C to 40°C when used with H7T, H7TNB, H7RT, ET700, ET700R, H750T, H750TCP, H750TD010, H750RTD010 Series non-IC housings.

DESCRIPTION: LED Trims

Multiple reflector and baffle options allow the Halo LED recessed luminaire to be used in many interior spaces. Choose the best reflector finish and trim for the interior space. Aesthetically pleasing regressed shower trims are available for applications requiring wet location listings.

494P06 White Reflector with White Trim Ring

- Halo matte white finish die-cast trim ring
- Halo matte white aluminum reflector
- Trim ring height of .160" at OD and .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal

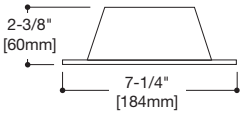


ENERGY STAR® Qualified: ML709840ICAT120D with 494P06

494P06
White Reflector
with White Trim Ring

494SC06 Specular Reflector with White Trim Ring

- Halo matte white finish die-cast trim ring
- Specular Clear aluminum reflector
- Trim ring height of .160" at OD and .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal

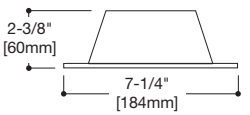


ENERGY STAR® Qualified: ML709840ICAT120D with 494SC06

494SC06
Specular Reflector
with White Trim Ring

494H06 Haze Reflector with White Trim Ring

- Halo matte white finish die-cast trim ring
- Haze aluminum reflector
- Trim ring height of .160" at OD and .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal

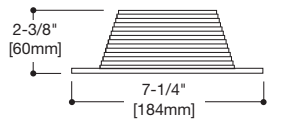


ENERGY STAR® Qualified: ML709840ICAT120D with 494H06

494H06
Haze Reflector
with White Trim Ring

494WB06 White Baffle with White Trim Ring

- Halo matte white finish die-cast trim ring
- Halo Matte White baffle
- Trim ring height of .160" at OD and .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal

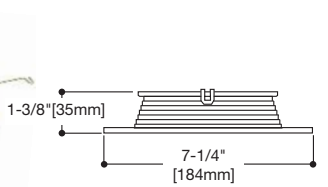


ENERGY STAR® Qualified: ML709840ICAT120D with 494WB06

494WB06
White Baffle
with White Trim Ring

492PS06 Lensed Trim with White Baffle and Trim Ring

- Halo Matte White trim ring and baffle, regressed lens
- Wet location listed for use in showers and protected canopy applications
- Aluminum baffle and die-cast trim ring
- Frosted glass lens
- Trim height of .160" at OD & .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal



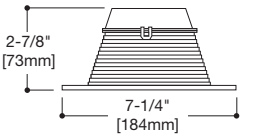
ENERGY STAR® Qualified: ML709840ICAT120D with 492PS06

492PS06
Lensed White Baffle with
White Trim Ring

Shimmerlight

493WBS06 Solite® Regressed Lens with White Baffle and White Trim Ring

- Halo matte white trim ring and baffle with Anti-Microbial finish standard
- Upper specular aluminum reflector for optical control and enhanced lumen delivery
- Wet location listed for use in showers and protected canopy applications
- Aluminum baffle and trim ring
- Trim height of .160" at OD & .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal



ENERGY STAR® Qualified: ML709840ICAT120D with 493WBS06

493WBS06
Regressed Solite® Lensed
White Baffle with
White Trim Ring

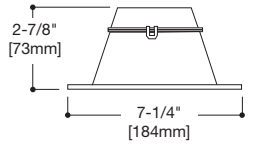
Shimmerlight

ANTI-MICROBIAL finish

493SCS06 Solite® Regressed Lens with Specular Clear Reflector and White Trim Ring

- Halo matte white trim ring with specular clear reflector
- Upper specular aluminum reflector for optical control and enhanced lumen delivery
- Wet location listed for use in showers and protected canopy applications
- Aluminum reflector and trim ring
- Trim ring height of .160" at OD and .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal

ENERGY STAR® Qualified: ML709840ICAT120D with 493SCS06



ENERGY STAR | T24 2008 California Title 24 High Efficacy Compliant | International Energy Conservation Code IECC Code Compliant

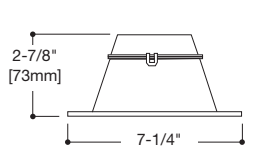
493SCS06
Regressed Solite® Lensed Specular Reflector with White Trim Ring

Skylight

493HS06 Solite® Regressed Lens with Haze Reflector and White Trim Ring

- Halo matte white trim ring with Haze reflector
- Upper specular aluminum reflector for optical control and enhanced lumen delivery
- Wet location listed for use in showers and protected canopy applications
- Aluminum reflector and trim ring
- Trim ring height of .160" at OD and .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal

ENERGY STAR® Qualified: ML709840ICAT120D with 493HS06



ENERGY STAR | T24 2008 California Title 24 High Efficacy Compliant | International Energy Conservation Code IECC Code Compliant

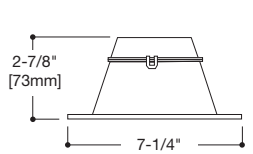
493HS06
Regressed Solite® Lensed Haze Reflector with White Trim Ring

Skylight

493SNS06 Solite® Regressed Lens with Satin Nickel Reflector and Satin Nickel Trim Ring

- Halo Statin Nickel trim ring with Satin Nickel reflector
- Upper specular aluminum reflector for optical control and enhanced lumen delivery
- Wet location listed for use in showers and protected canopy applications
- Aluminum reflector and trim ring
- Trim ring height of .160" at OD and .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal

ENERGY STAR® Qualified: ML709840ICAT120D with 493SNS06



ENERGY STAR | T24 2008 California Title 24 High Efficacy Compliant | International Energy Conservation Code IECC Code Compliant

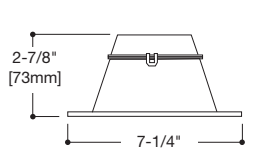
493SNS06
Regressed Solite® Lensed Satin Nickel Reflector with Satin Nickel Trim Ring

Skylight

493TBZS06 Solite® Regressed Lens with Tuscan Bronze Reflector and Tuscan Bronze Trim Ring

- Halo Tuscan Bronze trim ring with Tuscan Bronze reflector
- Upper specular aluminum reflector for optical control and enhanced lumen delivery
- Wet location listed for use in showers and protected canopy applications
- Aluminum reflector and trim ring
- Trim ring height of .160" at OD and .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal

ENERGY STAR® Qualified: ML709840ICAT120D with 493TBZS06



ENERGY STAR | T24 2008 California Title 24 High Efficacy Compliant | International Energy Conservation Code IECC Code Compliant

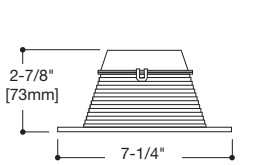
493TBZS06
Regressed Solite® Lensed Tuscan Bronze Reflector with Tuscan Bronze Trim Ring

Skylight

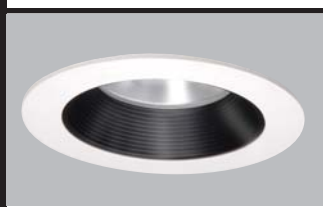
493BBS06 Solite® Regressed Lens with Black Baffle and White trim Ring

- Halo matte white trim ring with Black Baffle
- Upper specular aluminum reflector for optical control and enhanced lumen delivery
- Wet location listed for use in showers and protected canopy applications
- Aluminum baffle and trim ring
- Trim ring height of .160" at OD and .180" at ID
- Provides clearance for remodeler flange and gasket for AIR-TITE™ seal

ENERGY STAR® Qualified: ML709840ICAT120D with 493BBS06



ENERGY STAR | T24 2008 California Title 24 High Efficacy Compliant | International Energy Conservation Code IECC Code Compliant



493BBS06
Regressed Solite® Lensed Black Baffle with White Trim Ring

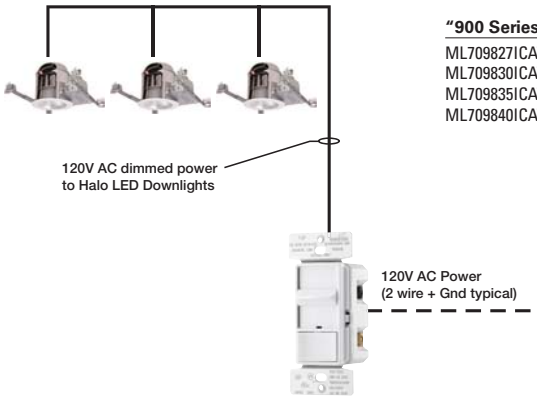
Skylight

Standard Dimming Control

Standard "incandescent type" 120V line voltage dimming is offered for the 900 Series LED. This is the most common type of dimming for residential and light commercial applications.

120VAC Standard Dimming - Incandescent and Magnetic Low Voltage Dimmers
Standard 120VAC line voltage dimmers for incandescent and magnetic low voltage loads control the light source with "forward phase control". With forward phase control the dimmer "chops" the forward part of the AC wave to deliver less or more power to the light source. Halo LED is generally compatible with this type of dimmer, but minimum load requirements of the dimmer may require four or more LEDs on the circuit. In addition, digital or smart versions of incandescent and magnetic low voltage dimmers are not compatible for circuits with LEDs only (digital versions of incandescent dimmers require an incandescent load on the circuit). The recommended dimmer for less than four LEDs and digital incandescent dimmer types is the electronic low voltage dimmer.

120VAC Standard Dimming - Electronic Low Voltage
Standard 120VAC line voltage dimmers for electronic low voltage loads control the light source with "reverse phase control". With reverse phase control the dimmer "chops" the back part of the AC wave to deliver less or more power to the light source. Halo LED is compatible with this type of dimmer providing there is a neutral connection on the dimmer (connected to neutral in the wallbox). An ELV dimmer can typically control a minimum of one LED on the circuit.
In addition, digital or smart versions of electronic low voltage dimmers (with a neutral connection) are compatible for circuits with LEDs only. Therefore, an electronic low voltage is the recommended dimmer for less than four LEDs and when a digital type dimmer is desired.



"900 Series" Modules
ML709827ICAT120D
ML709830ICAT120D
ML709835ICAT120D
ML709840ICAT120D

Electronic Low Voltage Digital and Analog Dimmers, Minimum Circuit Load of One LED Module, Dimming to 15%
Requires a neutral in the wall box

Lutron*

Diva	DVELV Series	Nova T	NTELV & NTLV Series
Maestro	MAELV Series	Skylark	SELV Series
Nova	NLV Series	Vierti	VTELV Series

Leviton

Acenti	ACE. Series (Electronic low voltage dimmer with low end programmable trim from control panel for dimming to less than 5%)
Illumitech	IPE.Series (Electronic low voltage dimmer with low end manual trim behind face plate for dimming to less than 5%)
Vizia +	VPE.Series (Electronic low voltage dimmer with low end programmable trim from control panel for dimming to less than 5%)

***** *Refer to Lutron "LED Product Report Card" for additional information.*

Incandescent / Magnetic Low Voltage Analog Standard Dimmers with Circuit Load of 4 LED Modules or More, Dimming to 15%

Cooper Wiring Devices

ASPIRE RF	N/A
ASPIRE	9530, 9532, 9538, 9540
Decorator Slide	DI06P, DI10P
Decorator Full-Slide	SI061, SI06P, SI10P
Toggle	6441, 6443, 6453
Rotary	6001, 6013, 6000, 6003, 6020, 6023
Architectural Rotary	RAI10, RAI15, RAI20

Lutron

Ariadni	AY/TG Series	Lyneo	LX Series
Ceana	CN Series	Nova	N Series
Centurion	C Series	Nova T	NT/NTB/NTA Series
Dalia	DL Series	Qoto	Q Series
Diva	DV Series	Skylark	S Series
Glyder	GL Series		
Lumea	LG Series		

***** *Refer to Lutron "LED Product Report Card" for additional information.*

Leviton

Illumitech	IPI/RPI.Series	Trimatron	6681/6683/6602
Sureslide	663.Series		

SPECIAL NOTE: Incandescent Digital Dimmers (also called Smart or Multi-Location) require an incandescent load for circuit loads with LED modules only - use electronic low voltage dimmers, (Refer to Electronic Low Voltage dimmer matrix)

Cooper Wiring Devices

ASPIRE RF	RF9534-N, RF9534 (no neutral), RF9536-N, RF9536 (no neutral)
ASPIRE	9534, 9536
Smart	SM600, SM1000

Lutron

Abella	AB Series	Vareo	V Series
Faedra	FA Series	Vierti	VT Series
Maestro	MA Series		
Spacer	SPS Series		

Leviton

Acenti	ACI. Series	TrueTouch	6606/TTI.Series
Mural	MDI/MSI.Series	Vizia +	VPI.Series
ToggleTouch	TGI.Series		

Incandescent Dimmers with Minimum Brightness Adjustment (Low End Trim), Circuit Load of 4 LED Modules or More, Dimming to 5%

Leviton

Illumitech	IP10/IP40/IPM406/IPM10 Series dimmers
Acenti	ACI/ACE/ACX/ATI Series (Programmable trim)
Vizia +	VPI/VPE/VPX.Series (Programmable trim)

Whole House Integrated Control Systems

Lutron*

Homworks	HW-RPM-4A-120 Remote Power Module-Adaptive Dimming
	HW-RPM-4V-120 Remote Power Module-Dimming
	HWD-5NE, HRD-5NE Wired Maestro and RF Maestro Local Controls

***** *Refer to Lutron "LED Product Report Card" for additional information.*

Commerical Integrated Control Systems

Lutron*

Commercial Panel Systems	LP-RPM-4A120 Remote Power Module - Adaptive Dimming

***** *Refer to Lutron "LED Product Report Card" for additional information.*

Universal Wireless Dimmers (Incandescent, Magnetic Low Voltage, Electronic Low Voltage), Minimum Circuit Load of Two LED Modules, Dimming to 15%

Watt Stopper

Miro Universal	DRD4 Series Dimmers
	DCD267 Series Dimmers
	DCD68 (series multilocation - When used with DRD4 or DCD267 series master dimmers

Incandescent Wireless Dimmers, Minimum Circuit Load of Five LED Modules, Dimming to 15%
A 15W minimum incandescent load or a neutral in the wall box are recommended to reliably dim

Watt Stopper

Miro Incandescent	DRD2 Series Dimmers
	DCD26 Series Dimmers
	DCD68 (series multilocation - When used with DRD2 or DCD26 series master dimmers

Application Notes

1. LED Dimming performance may vary from incandescent dimming. Performance results may vary based upon dimmer model, manufacturer, circuit wiring and circuit loading.
2. Dimmer maximum load rating with LED may differ from published Incandescent and Electronic Low Voltage dimmer ratings. Consult dimmer manufacturer for maximum dimmer load with Halo LED.
3. There are no warranties of performance or compatibilty implied.

ORDERING INFORMATION

SAMPLE NUMBER: ML709840ICAT120D 494P06

Order LED Module and trim separately

900 Series LED Module

ML709	8	40	ICAT120D
ML709= 6" LED Module 900 Series LED	**8**=80 CRI	**27**=2725°K **30**=3045°K **35**=3465°K **40**=3985°K	**ICAT120D**= ICAT, 120V Module with standard 120V dimming

Trim Options

494P06=Matte White Reflector/ white die cast trim ring.
494WB06=White Baffle/ white die cast trim ring.
494H06=Haze Reflector/ white die cast trim ring.
494SC06=Specular Reflector/ white die cast trim ring.
492PS06=Regressed Lens, white die-cast baffle and trim ring. Shower rated.
493WBS06=Solite® Regressed Lens, upper reflector, White die-cast baffle and White die-cast trim ring with anti-microbial paint (standard). Shower Rated.
493SCS06=Solite® Regressed Lens, upper reflector, Specular Clear die-cast reflector and die-cast white trim ring. Shower Rated.
493HS06=Solite® Regressed Lens, upper reflector, Haze die-cast reflector, and white die-cast trim ring. Shower Rated.
493SNS06=Solite® regressed Lens, upper reflector, Satin Nickel die cast reflector and Satin Nickel die-cast trim ring. Shower Rated.
493TBZS06=Solite® Regressed Lens, upper reflector, Tuscan Bronze die-cast reflector and Tuscan Bronze die-cast trim ring. Shower Rated.
493BBS06=Solite® Regressed Lens, Black die-cast baffle with die-cast white trim ring. Shower Rated.

Accessories
(see product details for application information)

OT400P=Oversize White Metal Trim Ring 6" ID x 9-1/4" OD
OT403P=Oversize White Plastic Trim Ring 6" ID x 8" OD
H277=Transformer - Steps 277 line voltage down to 120V
H347=Transformer - Steps 347 line voltage down to 120V

Thin Profile Trim Rings:
TRM490WH=Thin Profile matte white die-cast trim ring
TRM490SN=Thin Profile Satin Nickel die-cast trim ring
TRM490TBZ=Thin Profile Tuscan Bronze die-cast trim ring
TRM490BK=Thin Profile Black die-cast trim ring
TRM490PC=Thin Profile Polished Chrome die-cast trim ring

3 YEAR PRODUCT LIMITED WARRANTY

Cooper Lighting (The Company) warrants the HALO ML7098xxICAT120D LED Modules, HALO H750x Series housings and HALO LED trims against defects in material or workmanship for a period of three years from date of original purchase, and agrees to repair or, at the company's option, replace a defective product without charge for either replacement parts or labor during such time. This does not include labor to remove or install fixtures. If used in recessed housings other than Halo or ALL-Pro, the Cooper Lighting 3-year warranty applies to the LED Module and trim only.

This warranty is extended only to the original purchaser of the product. A purchasers receipt or other proof of date of original purchase acceptable to the Company is required before warranty performance shall be rendered.

This warranty only covers product failure due to defects in materials or workmanship which occurs in normal use. It does not cover the failure of product caused by accident, misuse, abuse, lack of reasonable care, alteration, or faulty installation, subjecting the product to any but the specified electrical service or any other failure not resulting from defects in materials or workmanship. Damage to the product caused by separately purchased, non-Company supplied components and corrosion or discoloration of components are not covered by this warranty. There are no express warranties except as described above.

THE COMPANY SHALL NOT BE LIABLE FOR INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF THE PRODUCT OR ARISING OUT OF ANY BREACH OF THIS WARRANTY. ALL IMPLIED WARRANTIES, IF ANY, INCLUDING IMPLIED WARRANTS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE DURATION OF THIS EXPRESS WARRANTY. Some states do not allow the exclusion or limitation of incidental or consequential damages, or limitations on how long an implied warranty lasts, so the above exclusions or limitations may not apply to you.

No other warranty, written or verbal, is authorized by the Company. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

To obtain warranty service, please write to Cooper Lighting, 1121 Highway 74 South, Peachtree City, Georgia 30269. Enclose product model number and problems you are experiencing, along with address and telephone number. You will then be contacted with a solution or a Return Goods Authorization number and full instructions for returning the product. All returned products must be accompanied by a Return Goods Authorization Number issued by the Company and must be returned freight prepaid. Any product received without a Return Goods Authorization Number from the Company will be refused.

Cooper Lighting is not responsible for merchandise damaged in transit. Repaired or replaced products shall be subject to the terms of this warranty and are inspected when packed. Evident or concealed damage that is made in transit should be reported at once to the carrier making the delivery and a claim filed with them.

Solite® is a registered trademark of AGC Flat Glass North America

Appendix K – AGI Files (CD)

See Hard Copy of Final Report for a Copy of the AGI Files On CD

Appendix L – Lighting Dimming Controls

Maestro Wireless®

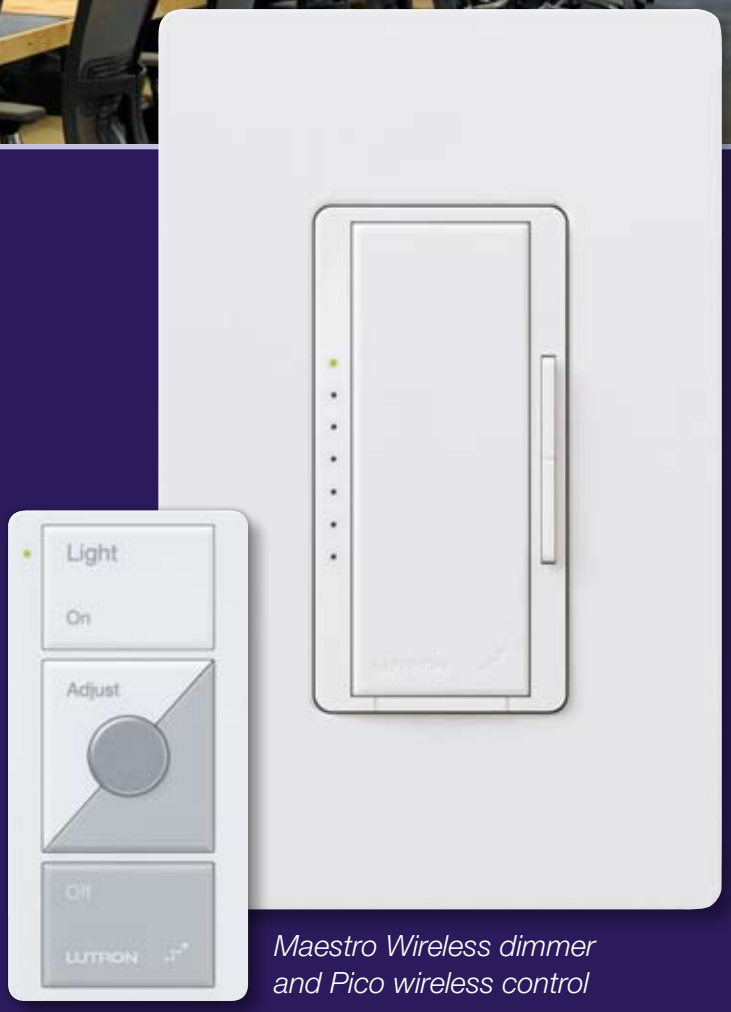
simplicity. convenience. control.

commercial product offering

NEW

Use the Maestro Wireless family of products to build custom solutions for commercial spaces without spending a lot of time on the job.

- Lutron's reliable Clear Connect™ RF Technology is ideal for renovation as well as new construction.
- Easily install a **3-way dimmer or an occupancy sensor without pulling new wire**.
- Hassle-free set up of dimmer, switch, Pico™ wireless control, and occupancy sensor.
- Build custom solutions for any commercial space, including conference rooms, restrooms, hotel rooms, storage areas, corridors, and more.



Maestro Wireless dimmer and Pico wireless control

switch

lamp dimmer

mounted controller

car visor clip

table stand

Radio Powr Savr™ wireless occupancy/vacancy sensor

LUTRON®

save energy with Lutron™

Maestro Wireless® | ordering information

commercial product offering

Dimmers and switches		
Model number	**Control Type**	**Maximum Capacity**
MRF2-10D-120-	single-pole/multi-location **spec grade dimmer**	120 V, 1000 W incandescent/ halogen, magnetic low voltage
MRF2-6ND-120-	single-pole/multi-location **spec grade neutral wire dimmer**	120 V, 600 W incandescent/ halogen, magnetic low voltage
MA-R-	multi-location companion dimmer	120 V, provides multi-location dimming for additional locations
MRF2-8S-DV-	single-pole/multi-location **spec grade non-neutral switch**	120V/277V, 8 A light, incandescent, halogen, MLV, ELV, non-dim fluorescent ballasts, does not require a neutral wire connection
MRF2-8ANS-120-	single-pole/multi-location **spec grade switch**	120 V, 8 A light or 5.8 A fan, incandescent, halogen, MLV, ELV, non-dim fluorescent ballasts, and general purpose fans
MA-AS-	multi-location companion switch	120 V, provides multi-location switching for up to nine additional locations
MRF2-6ANS-277-	single-pole/multi-location **spec grade switch**	277 V, 6 A light, MLV, ELV, non-dim fluorescent ballasts
MA-AS-277-	multi-location companion switch	277 V, provides multi-location switching for up to nine additional locations
MRF2-3LD-	plug-in lamp dimmer	300 W, inc./halogen for table or floor lamps
Pico™ wireless control and accessories		
MRF2-3BRL-L-	Pico wireless control – communicates wirelessly with up to 10 Maestro Wireless dimmers, lamp dimmers, and switches	
QSA-PED1-	table stand for Pico wireless control	
CW-__-	Claro® wallplate in 1-4 openings	
Radio Powr Savr™ wireless occupancy and vacancy sensor		
LRF2-OCRB-P-WH	occupancy and vacancy sensor – auto-on/auto-off or manual on/auto-off	
LRF2-VCRB-P-WH	vacancy sensor – manual on/auto-off only (complies with CA Title 24 requirements)	

Products available in the following colors:

sensors – white (WH) only

lamp dimmers & table stands (for Pico wireless control) – white (WH), black (BL)

Pico wireless controls:

gloss finish – white and gray (WG), white (WH), ivory (IV), almond (AL), light almond (LA), gray (GR), brown (BR), black (BL)

dimmers, switches and Claro wallplates:

gloss finish – white (WH), ivory (IV), almond (AL), light almond (LA), gray (GR), brown (BR), black (BL)

satin finish – hot (HT), merlot (MR), plum (PL), turquoise (TQ), sea glass (SG), taupe (TP), eggshell (ES), biscuit (BI), snow (SW), palladium (PD), midnight (MN), sienna (SI), terracotta (TC), greenbriar (GB), bluestone (BG), mocha stone (MS), goldstone (GS), desert stone (DS), stone (ST), limestone (LS)

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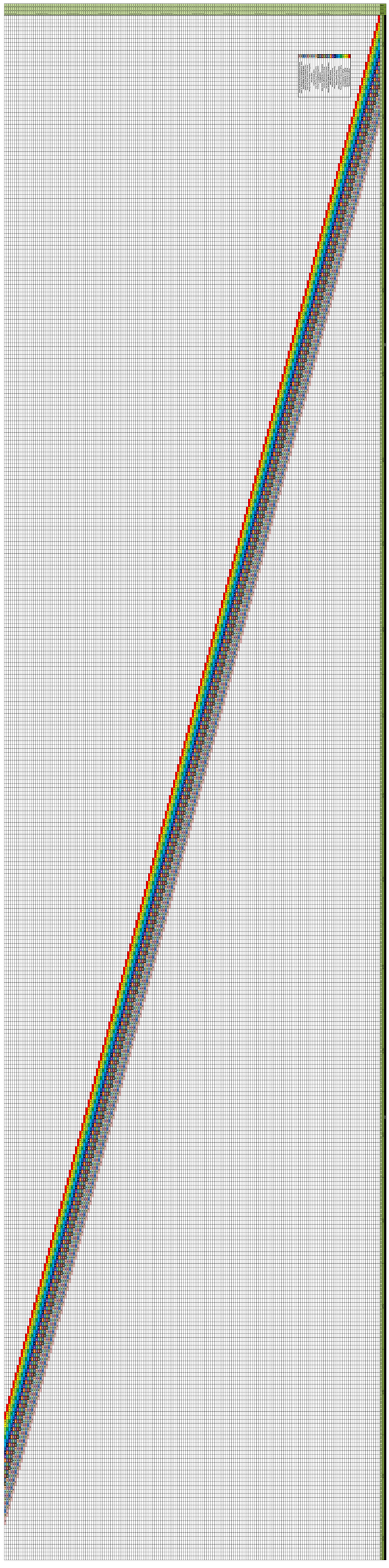
Appendix M – Complete Short Interval Schedule



Appendix N – Site Plan of Existing Conditions

AREA 02
C-402

AREA 04
C-404

AREA 06
C-406

AREA 08
C-408

MONTCLAIR DRIVE

8 Stories

North

← Existing Structures →

Existing
House
(Site Office)

AREA 01
C-401

AREA 03
C-403

AREA 05
C-405

AREA 07
C-407

Site Plan of Existing Conditions

Scale: NTS

LEGEND

- Water Lines
- Electrical, Telephone, Cable Lines
- Sanitary Sewer Lines
- Gas Lines
- Fire Lines
- Traffic Flow
- Property Line
- Fire Hydrants

Steven Farrah

Technical Assignment #1

Voorhees Replacement Hospital

Voorhees, NJ

Appendix O – Finish Phase Site Utilization Plan

Site Utilization Plan for Finish Phase

AREA 01 C-101

AREA 02 C-102

AREA 03 C-103

AREA 04 C-104

AREA 05 C-105

AREA 06 C-106

AREA 07 C-107

AREA 08 C-108

Dutchtown Road

Campus Drive

Montclair Drive

Rosedale Lane

Dutchtown Road

50 FT DUTCHTOWN ROAD BUFFER

100 FT BUILDING & PARKING SETBACK

50 FT BUILDING & PARKING SETBACK

100 FT SURFACE PARKING SETBACK

200' RESIDENTIAL BUILDING SETBACK

25 FT BUILDING AND PARKING SETBACK

100 FT BUILDING & PARKING SETBACK

50 FT ROUTE 73 BUFFER

100 FT BUILDING & PARKING SETBACK

50 FT ROUTE 73 BUFFER

100 FT PUBLIC UTILITY SETBACK

100 FT PARKING SETBACK

100 FT BUILDING & PARKING SETBACK

50 FT DUTCHTOWN ROAD BUFFER

50 FT ROUTE 73 BUFFER

100 FT BUILDING & PARKING SETBACK

50 FT ROUTE 73 BUFFER

ROUTE 73

ROUTE 73

200 0 100 200

(IN FEET)

N

ALL IMPROVEMENTS ON DUTCHTOWN ROAD ARE ON HOLD PENDING NJDOT APPROVAL

LEGEND

- Property Line
- Site Access
- Construction Fence/Gates
- Work Flow
- CM Offices
- Subcontractor Trailers
- Subcontractor Parking
- Material Storage
- Loading Areas
- Dumpsters
- Porta-Pottys
- Material/Personnel Hoists
- Loading Dock w/ Stairs
- Route 73

Steven Farrah

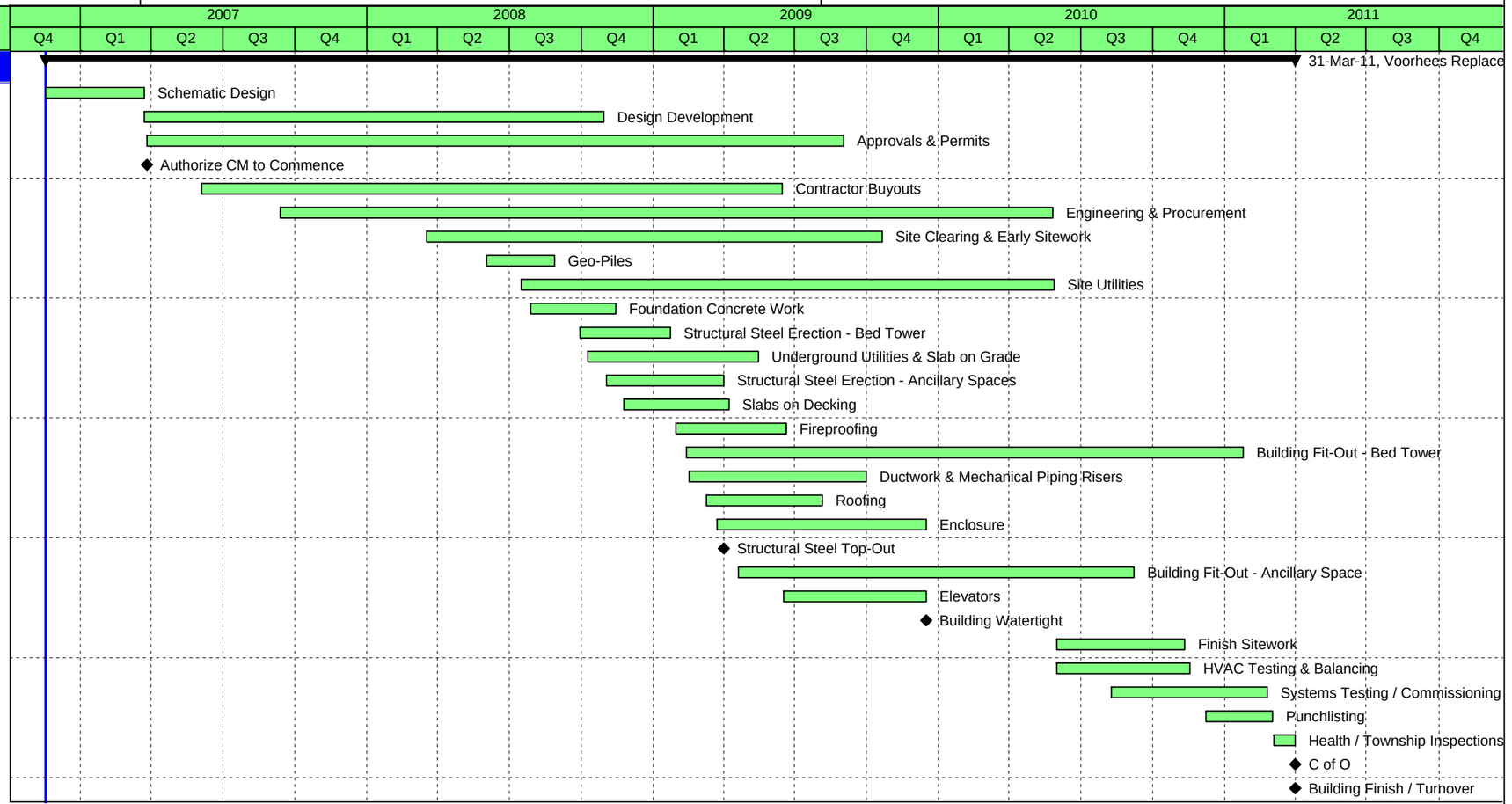
Technical Assignment #2

Voorhees Replacement Hospital

Voorhees, NJ

Appendix P – Project Schedule Summary

Activity Name	Original Duration	Start	Finish
Voorhees Replacement F	1136	17-Nov-06	31-Mar-11
Schematic Design	87	17-Nov-06	23-Mar-07
Design Development	420	23-Mar-07	30-Oct-08
Approvals & Permits	636	26-Mar-07	31-Aug-09
Authorize CM to Commence	0	26-Mar-07	
Contractor Buyouts	531	04-Jun-07	15-Jun-09
Engineering & Procurement	706	12-Sep-07	26-May-10
Site Clearing & Early Sitework	417	17-Mar-08	20-Oct-09
Geo-Piles	63	03-Jun-08	28-Aug-08
Site Utilities	487	17-Jul-08	28-May-10
Foundation Concrete Work	79	29-Jul-08	14-Nov-08
Structural Steel Erection - Bed Tower	85	29-Sep-08	23-Jan-09
Underground Utilities & Slab on Gra	156	10-Oct-08	15-May-09
Structural Steel Erection - Ancillary S	108	03-Nov-08	01-Apr-09
Slabs on Decking	97	24-Nov-08	07-Apr-09
Fireproofing	102	29-Jan-09	19-Jun-09
Building Fit-Out - Bed Tower	508	12-Feb-09	24-Jan-11
Ductwork & Mechanical Piping Risers	163	16-Feb-09	30-Sep-09
Roofing	107	10-Mar-09	05-Aug-09
Enclosure	191	24-Mar-09	15-Dec-09
Structural Steel Top-Out	0		01-Apr-09
Building Fit-Out - Ancillary Space	362	20-Apr-09	07-Sep-10
Elevators	131	17-Jun-09	16-Dec-09
Building Watertight	0		15-Dec-09
Finish Sitework	117	01-Jun-10*	10-Nov-10
HVAC Testing & Balancing	122	01-Jun-10*	17-Nov-10
Systems Testing / Commissioning	144	09-Aug-10*	24-Feb-11
Punchlisting	62	08-Dec-10*	03-Mar-11
Health / Township Inspections	20	04-Mar-11*	31-Mar-11
C of O	0		31-Mar-11
Building Finish / Turnover	0		31-Mar-11



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

TASK filter: All Activities

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Appendix Q – General Conditions Estimate

General Conditions & Requirements					
Voorhees Replacement Hospital Voorhees, NJ					
Construction Dates : March 2008 - March 2011 (36 months) Preconstruction : (8 months)					
PERSONNEL		QTY	Unit	Price/Unit	Total
	Sr. Project Executive	6	month	$ 10,000.00	$ 60,000.00
	Sr. Project Manager	44	month	$ 8,400.00	$ 369,600.00
	Safety Engineer	31	month	$ 3,000.00	$ 93,000.00
	Administrative Assistant	37	month	$ 1,520.00	$ 56,240.00
	Documents Clerk	37	month	$ 1,520.00	$ 56,240.00
	Project Engineer	42	month	$ 4,800.00	$ 201,600.00
	Assistant Engineer	13	month	$ 3,600.00	$ 46,800.00
	Assistant Engineer (MEP)	30	month	$ 4,000.00	$ 120,000.00
	Engineer (Arch./Int)	30	month	$ 4,000.00	$ 120,000.00
	Assistant Engineer (Elevators /Equip. /Specialities)	33	month	$ 3,600.00	$ 118,800.00
	Engineer's Assistant (Interior Glass/ Millwork/Doors, Frames & Hardware	24	month	$ 3,400.00	$ 81,600.00
	Assistant Engineer/Superintendent	16	month	$ 3,400.00	$ 54,400.00
	Project Superintendent (Ancillary)	38	month	$ 8,000.00	$ 304,000.00
	Assistant Superintendent (Ancillary)	27	month	$ 5,000.00	$ 135,000.00
	Assistant Superintendent (Site/ Structure)	22	month	$ 5,000.00	$ 110,000.00
	Field Engineer	24	month	$ 4,000.00	$ 96,000.00
	Project Superintendent (Bed Tower)	30	month	$ 8,000.00	$ 240,000.00
	Assistant Superintendent (Bed Tower)	26	month	$ 5,000.00	$ 130,000.00
	Field Engineer	24	month	$ 4,000.00	$ 96,000.00
	Superintendent (MEP)	35	month	$ 8,000.00	$ 280,000.00
	Assistant Super. (Electrical/Telecom)	29	month	$ 5,000.00	$ 145,000.00
	Assistant Superintendent (MEP)	27	month	$ 6,000.00	$ 162,000.00
Subtotal Personnel					$ 3,076,280.00

TEMPORARY FACILITIES		QTY	Unit	Price/ Unit	Total
	Job Office	36	month	$ 8,413	$ 302,868
	Vehicle Rental	36	month	$ 139	$ 5,004
	Tools & Supplies	1	LS	$ 134,250	$ 134,250
	Temporary Roads	1	LS	$ 336,500	$ 336,500
	Winter Weather/Temporary Protection	1	LS	$ 65,000	$ 65,000
	Temporary Building/Installations	1	LS	$ 391,700	$ 391,700
Subtotal Temporary Facilities					$ 1,235,322

General Conditions & Requirements

Voorhees Replacement Hospital
Voorhees, NJ

Construction Dates : March 2008 - March 2011 (36 months)
Preconstruction : (8 months)

GENERAL EXPENSES		QTY	Unit	Price/ Unit	Total
	Office Equipment & Supplies	36	month	$ 3,472	$ 124,992
	Telephone & Shipping	36	month	$ 4,228	$ 152,208
	Construction Documents & Printer	36	month	$ 4,111	$ 147,996
	Computer Expenses	36	month	$ 5,738	$ 206,568
	Accounting Expense	36	month	$ 5,306	$ 191,016
	Living/Travel Expenses	36	month	$ 1,383	$ 49,788
	Photographs	36	month	$ 827	$ 29,772
	Miscellaneous Expenses	36	month	$ 2,394	$ 86,184
Subtotal General Expenses					$ 988,524

HOISTING		QTY	Unit	Price/Unit	Total
	Material Hoists	1	LS	$ 189,600.00	$ 189,600.00
	Operation of Material Hoists	1	ALLOW	$ 442,880.00	$ 442,880.00
	Personnel Hoists	1	LS	$ 188,000.00	$ 188,000.00
	Operation of Personnel Hoists	1	ALLOW	$ 442,880.00	$ 442,880.00
	Temporary Elevators	1	LS	$ 67,000.00	$ 67,000.00
Subtotal Hoisting					$ 1,330,360.00

TEMPORARY UTILITIES		QTY	Unit	Price/Unit	Total
	Temporary Light & Power	36	month	$ 2,000.00	$ 72,000.00
	Temporary Plumbing	36	month	$ 1,250.00	$ 45,000.00
	Porta-Pottys	36	month	$ 2,437.50	$ 87,750.00
	Temporary Heat (owner provided)	0	month	$ -	$ -
Subtotal Temporary Utilities					$ 204,750.00

General Conditions & Requirements					
Voorhees Replacement Hospital					
Voorhees, NJ					
Construction Dates : March 2008 - March 2011 (36 months)					
Preconstruction : (8 months)					
CLEANING		QTY	Unit	Price/Unit	Total
	General Cleaning	1	ALLOW	$ 1,380,190.00	$ 1,380,190.00
	Chutes	1	LS	$ 36,000.00	$ 36,000.00
	Rubbish Removal	1	ALLOW	$ 316,800.00	$ 316,800.00
	Site/Street Cleaning	1	ALLOW	$ 72,000.00	$ 72,000.00
	Glass Cleaning	1	LS	$ 3,000.00	$ 3,000.00
	Final Cleaning	1	LS	$ 1,050,000.00	$ 1,050,000.00
Subtotal Cleaning					$ 2,857,990.00

PROTECTION & SAFETY		QTY	Unit	Price/Unit	Total
	General Protection & Safety	1	ALLOW	$ 462,000.00	$ 462,000.00
	Protection of Finish Work	1	ALLOW	$ 490,000.00	$ 490,000.00
	Fencing/Gates	1	LS	$ 152,000.00	$ 152,000.00
	Watchman	1	LS	$ 25,000.00	$ 25,000.00
	First Aid Facility	1	LS	$ 48,000.00	$ 48,000.00
Subtotal Protection & Safety					$ 1,177,000.00

General Conditions & Requirements Total	**$ 10,870,226.00**