FINAL THESIS REPORT

4/8/2015

THE BARNES FOUNDATION

2025 BENJAMIN FRANKLIN PARKWAY
PHILADELPHIA, PA 19130

JOSEPH BRENNER
LIGHTING|ELECTRICAL
RICHARD MISTRICK

Joseph
Brenner

Fig. 1 | Exterior at Night

THE BARNES FOUNDATION

PROJECT TEAM

OWNER | The Barnes Foundation
ARCHITECT | Todd Williams Billie Tsien Architects
LIGHTING | Fisher Marantz Stone
MEP | Altieri Sebor Wieber
STRUCTURAL | Severud Associates
CONTRACTOR | Aegis Property Group

BUILDING STATISTICS

LOCATION | Philadelphia, PA
OCCUPANCY | Art Education Facility
SIZE | 91,748 GSF
LEVELS | 2 Above Ground, 3 Total
CONSTRUCTION | November 2009 - February 2012
COST | $75,890,374
DELIVERY | Guaranteed Maximum Price (GMP)

ARCHITECTURE

The Barnes accomplishes the goal of "a gallery in a garden and a garden in a gallery" with the use of a large exterior public garden and multiple interior courtyards. Covered in gray-gold limestone with an illuminated Light Box (Fig. 1), at night The Barnes glows like a lantern. The interior Light Court is made up of the same limestone as the exterior; this entrance space extends out of the west end of the facility to create an exterior courtyard covered by the cantilevered Light Box. The galleries within the building were designed to the exact dimensions of Dr. Barnes' old house in Merion, PA, where the art was first displayed.

STRUCTURAL

A steel beam system is used in the majority of the building; however the East end of the building uses 24" concrete void slabs on the first and second floors. The cantilevered end of the Light Box uses steel cross bracing as support.

LIGHTING/ELECTRICAL

Primarily fluorescent, halogen, and metal halide fixtures make up the lighting design of the facility. Cove lighting was included in the gallery spaces to allow for less direct light on the paintings; the same style of cove lighting is repeated through the building.

The primary utility transformer is a 13.2 kV 3 PH, 3 wire primary and a 277Y/480 3 PH, 4 wire secondary. Photovoltaic panels supply some of the power to the building. There is also a 400 kW diesel generator to provide emergency power.

MECHANICAL

There is one dedicated outdoor air AHU's supplying a total of 48,120 CFMs and nine more AHU's supplying a total of 92,500 CFMs. A Variable Air Volume control system is in place throughout the facility. Three chillers are used to cool the building, two are centrifugal and one is scroll. The DOAS uses steam for heating and also has a heat recovery system. The remaining AHUs use converter to heat hot water using steam.

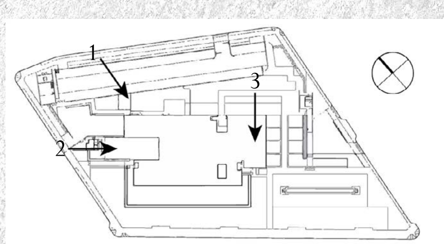

Fig. 2 | West Exterior Courtyard

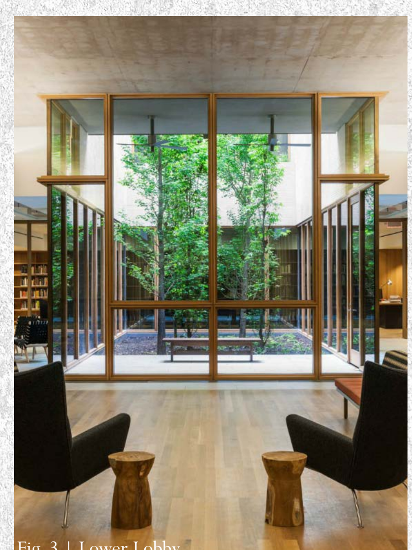

Fig. 3 | Lower Lobby

All photos courtesy of ©Tom Crane

Executive Summary

The following report discusses a lighting redesign, electrical analysis, structural redesign, daylighting study, and mechanical redesign for The Barnes Foundation in Philadelphia, PA, that was conducted for the Architectural Engineering senior thesis. Five spaces will be focused on for this report; the Site, Light Box, Light Court, Lower Lobby, and Office.

The Barnes Foundation is an art education facility that's goal is to inspire and educate visitors. The building houses galleries, an auditorium, reception areas, office areas, and more. The new lighting designs is based around the concept of "The Barnes in Philly and Philly in The Barnes"; expressing the connection of the facility to the city that it calls home and creating its own identity that will become part of Philadelphia's vibrant history.

The site lighting of The Barnes was designed to create a more open and safe area for visitors and passer-bys. Site walls were then highlighted to aid in way-finding when searching for the entrance of the building. The Light Box, located on the roof, contains linear RGB LEDs that create a subtle, yet dynamic, color-changing display to symbolize the energy and excitement of the city. The Light Court uses the limestone paneling of the walls to emphasize circulation while bollards along the center of the space create gathering areas. The Lower Lobby was primarily lit with recessed linear fixtures that resemble the pattern of the limestone paneling of the Light Court. Public and private scenes were also created in this space. The Office consisted of newly designed skylight wells to increase the amount of natural light in the space and direct/indirect lighting is then used to create the remaining ambient light of the space.

The electrical analysis of the building consisted of three portions: a branch circuit redesign, a short circuit analysis, and photovoltaic array study. The branch circuits were redesigned to ensure the facility can handle the new lighting loads. Short circuit calculations were conducted on one path of the one-line diagram to ensure proper protection of from overcurrents and power outages. A photovoltaic array study found that an additional array above the Office roof could create 31,000 kWh of energy for the facility.

The skylight wells in the Office required a redesign of the roof structural system of that area. The roof was converted from a concreted cambered structure to a steel one and the pre-existing green roof was removed to reduce the total dead load. After testing various beams and girders, a working structure was created that allowed for the desired skylight well design.

The skylight wells were designed to resemble the large roof monitors located in many of the gallery spaces within the facility. The final design was then analyzed with the use of Daysim; the results showed that the skylight design achieved the LEED requirement of 55% spatial daylight autonomy.

Because of these new skylights, a mechanical redesign was required to assess if the current mechanical system was capable of handling the loads caused by the skylight and reduction of the green roof. Using Trane TRACE it was found that the new load was roughly 4 tons while the current system was designed for 6 tons. This resulted in only having to redesign the layout of the mechanical system to avoid the skylight wells and lighting.

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Building Overview

Building Name
The Barnes Foundation
Philadelphia Campus

Location
2025 Benjamin Franklin Parkway, Philadelphia, PA 19130

Building Occupant Name
The Barnes Foundation

Occupancy or Function Types
Assembly (A-3), Business (B)
Conference Rooms, Auditorium, Lounges, Library

Size (Total square feet)
91,748 sq ft

Number of Stories Above Grade / Total Levels
2 Stories above ground | 61' above ground
3 Stories total

Dates of Construction
11/10/2009 – 2/23/2012

Cost Information
Total Cost - $75,890,374

Project Delivery Method
Guaranteed Maximum Price (GMP)

Primary Project Team

Owner
The Barnes Foundation | http://www.barnesfoundation.org/

Architect
Tod Williams Billie Tsien Architects | http://www.twbta.com/

Associate Architect/LEED
Ballinger Architects | http://www.ballinger-ae.com/

Landscape Architect
Olin Partnership | http://www.theolinstudio.com/

MEP Engineer
Altieri Sebor Wieber | http://www.altieriseborwieber.com/

Lighting Designer
Fisher Marantz Stone | http://www.fmsp.com/

Architecture

When designing this building, the driving idea was to create "a gallery in a garden and a garden in a gallery". This is accomplished first by utilizing the site as a public garden that guests must walk through between the gate house (where tickets are purchased) to the main building, seen in figures 1. Within the museum is a grand interior public space that can be used for a variety of events and extends out into the public garden, shown in figure 2.

Doctor Albert Coombs Barnes established The Barnes Foundation in 1922 in Merion, PA, with the help of his wife, Laura Barnes. His goal was to "promote the advancement of education and the appreciation of the fine arts and horticulture." It is here, in Merion, where Barnes accumulated artwork while his wife developed a 12-acre arboretum surrounding the house. After the construction of The Barnes Foundation's Philadelphia campus, the artwork from the Merion campus was moved to the 12,000 square feet of art galleries in the new facility. Classrooms were then included on every floor to encourage the education of the art in honor of Dr. Barnes.

Used as both the beacon for The Barnes Foundation and a key daylighting feature, a light box runs the length of the building and cantilevers over the terrace. While the box itself is square, the forms inside are quite unique, allowing a vast amount of daylight to enter in the interior courtyard. At night, the light box glows to create a symbol for The Barnes Foundation.

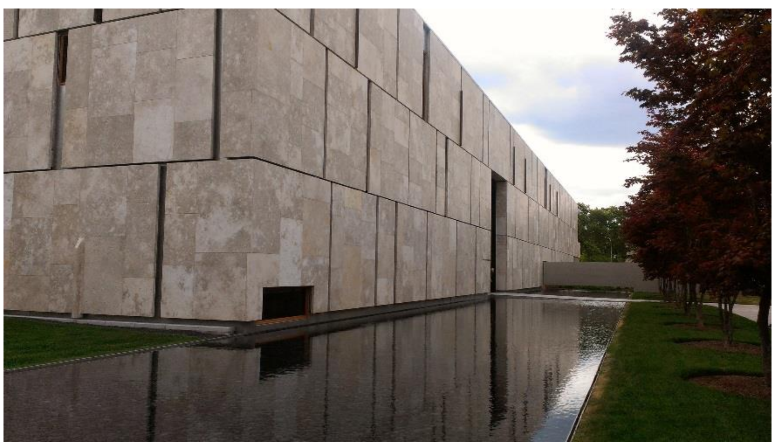


Figure 1 | Exterior Walkway | Courtesy of FMS


Figure 2 | Lower Lobby | Courtesy of FMS


Figure 3 | Exterior Light Box Canopy | Courtesy of FMS

Major National Model Codes

IBC 2006
IFC 2006
IMC 2006
ANSI A117.1: 2003 edition
ADA 1994

Zoning

Philadelphia Zoning District | Active Parks and Open Space (Special Purpose) [SP-PO-A]

> "All lighting must prevent glare onto surrounding Residentially-zoned properties"
> - Philadelphia Zoning Code

Construction Type IIA
Allowable height – 85 ft
Allowable stories – 4 ft
Allowable building area per floor with 200% increase for automatic sprinkler protection throughout – 46,500 sq ft
Allowable total building area – 139,500 sq ft

Historical Requirements

After Albert Barnes passed away in 1951, in his will was the requirement for this new facility to have the galleries constructed to perfectly match the same shape and size as the galleries in Merion, PA. Furthermore, his will required that all the artwork be displayed in the same locations and manner.

Building Enclosure

Windows

The windows along The Barnes are fixed, wood framed windows. There are both contemporary and traditional styles for the windows. The traditional styles match the windows found on the original Merion Building. Low transmission glazing was applied to the windows to protect artwork inside.

Façade/Exterior Wall Materials

The museum is cladded in fossilized limestone panels of various sizes secured by a steel sub-frame. A portion of the museum consists of a long interior courtyard space that is identified on the exterior by a "light box". The box is made up of a laminated translucent glazing system.

Roofing

There are three different parts of the roof: Reinforced Polyvinyl-Chloride (PVC) flexible membrane sheet roofing over the gallery, a green roof with grounding screen over the pavilion, and a photovoltaic roof over the light box. The PVC is found on all types of roofing and acts as a thermoplastic waterproofing membrane.

Shading Devices

The clerestories within the building are accompanied by blackout shades and fixed aluminum sunshades extruded across the clerestory. The museum windows have electrically operated shades that are controlled by a calendar timer for control during low sun angle months.

Sustainability Features

The Barnes Foundation has a daylight control system throughout the building. This system is able to analyze daylight levels using photosensors, be programmed to remember specific calendar events, and use an astronomic time clock. The time clock is also used to control the shading system to limit the amount of direct sunlight penetrating the space. The daylighting system uses an open loop solar adaptive algorithm. Low transmission glazing on the windows prevents UV-radiation from entering the building while also reducing the electrical usage of lighting.

Furthermore, the green roof covering the majority of the roof allows for the collection of rain and grey water to be reused in irrigating the building site. Materials used in the building come from renewable, local, and recycled content. The Barnes Foundation is the first art educational facility in the country to receive a LEED Platinum Certification.

Primary Engineering Systems

Construction

Aegis Property Group was the general contractor for the construction of The Barnes Foundation. The Guaranteed Maximum Price delivery projected had an approximate cost of $76,000,000 with construction beginning in November of 2009 and ending in February of 2012. The museum portion of the art education facility was constructed first and the artwork put in place before the rest of the facility was built.

Electrical

An exterior transformer, owned by the facility, converts the 13.2 kV medium voltage primary service that is supplied to The Barnes into 480Y/277V secondary. Power is then fed to a 2500A main switchboard that sends power to four distribution panels; two of which are emergency panels. These emergency distribution panels are fed by a 400 kW/500 kVA diesel generator located outside of the building. Mechanical equipment is primarily running at 480V and lighting and receptacles are running at 120V.

Lighting

The Barnes Foundation is illuminated mainly by fluorescent, halogen, and metal halide sources. A great deal of indirect lighting was included in the building with the use of cove lighting and clerestories due to the fragile artwork. In the gallery spaces, lighting was also integrated with daylight controls to prevent direct sunlight from hitting the artwork. A CRI of 80 was maintained between all fixtures with the majority of those fixtures being set at 3500K.

Lighting throughout the building is controlled by an ETC dimming system which uses Paradigm and Light Designer in unison to adjust light levels. These programs allow for there to be a base lighting schedule associated with the different spaces on the building; although, this base schedule can be overridden if there is a special event occurring in one of the spaces. Depending on the room, some spaces may have fully addressable fixtures, while other spaces may only have zones to control.

Mechanical
There is one dedicated outdoor air Air Handling Unit supplying a total of 48,120 CFMs and nine more AHU's supplying a total of 92,500 CFMs throughout the facility. A Variable Air Volume control system is in place throughout the facility to supply specified amounts of CFM to the various galleries, classrooms, lobbies, etc. One 150 ton water cooled centrifugal chiller and one 76 ton water cooled scroll chiller are used in the building, with an additional 150 ton standby chiller. The DOAS uses steam for heating and also has a heat recovery system. The remaining air handling units use a converter to heat hot water using steam.

Structural
The Barnes Foundation uses a combination of composite steel, non-composite steel, and concrete structural systems with a 10" framed slab on grade base. A composite steel system is used in the museum areas and Light Box roof; while the rest of the facility uses concrete structures. The upper floors on the east end of the building, which are comprised of special exhibits, offices, and a green roof, use 24" concrete void slabs; the lower level uses 14" and 18" concrete slabs. The remainder of the building uses concrete slabs in a range from 6" to 22".The cantilevered end of the Light Box on the west end of the building uses a non-composite steel system for its structure. W12x26 beams along the exterior and W12x40 along the interior of the void are used with steel cross bracing between the interior and exterior beams for support.

Engineering Support Systems

Fire Protection
There are sprinklers throughout the entire facility in case of a fire. Smoke detectors and beam detectors are both used to sense smoke in the various spaces. Speaker/Strobes and some strobe lights are used to alert occupants to any fire related danger in the building. The Fire Alarm Control Panel is located on the first floor in the security office.

Transportation
There are three elevators in the facility; the first is able to transport visitors and employees from the first floor to the lower level where the auditorium, gift shop, and back-of-house areas are. This same elevator is also able to bring employees to the second floor where the offices are located with the use of card access. The next elevator is located in the museum area of the building to transport visitors between the two levels of the galleries. The last elevator is primarily used for freight. There are also six sets of stairs scattered throughout the facility.

Telecommunication
The main Telecom room is located in the lower level while there is a secondary IT/Comm room located on the second floor. These rooms control the data necessary for the offices on the lower level and second floor, as well as the classrooms located in the museum portion of The Barnes. The Telecom room on the lower level contains six racks that each have individual UPS's to provide emergency power. There are also six empty racks in place for future expansion.

Lighting Depth

The Lighting Depth will focus on five spaces within The Barnes Foundation:

| The Site
| Light Box
| Light Court
| Lower Lobby
| Office

All AGi32 files are located in Y:\Brenner\Senior Thesis\Lighting.

Concept

Being located along the Benjamin Franklin Parkway, The Barnes Foundations is surrounded by important landmarks; Logan Square, The Rodin Museum, the Free Library of Philadelphia, and The Philadelphia Museum of Art. Needless to say, this is the heart of Philadelphia and it is important to connect the building to the city in which it resides and to express its importance among so much of Philadelphia's history. As stated previously, the concept of Tod Williams and Billie Tsien for the design of the building was "a gallery in a garden and a garden in a gallery"; it was from this concept and the city of Philadelphia that the overall lighting design concept was found.

The Barnes in Philly and Philly in The Barnes is an expression of the city of brotherly love throughout the facility and the site of The Barnes Foundation. This concept was chosen to connect The Barnes with Philadelphia and to give each space a more lively and enjoyable appearance for Philadelphians and visitors alike.

Figure 4 | Concept Images

Site

The surrounding public area of The Barnes Foundation consists of three sections: the Entry Park, the Entry Court, and the Auto Court. For this lighting design the Entry Park and Entry Court will be looked at specifically.

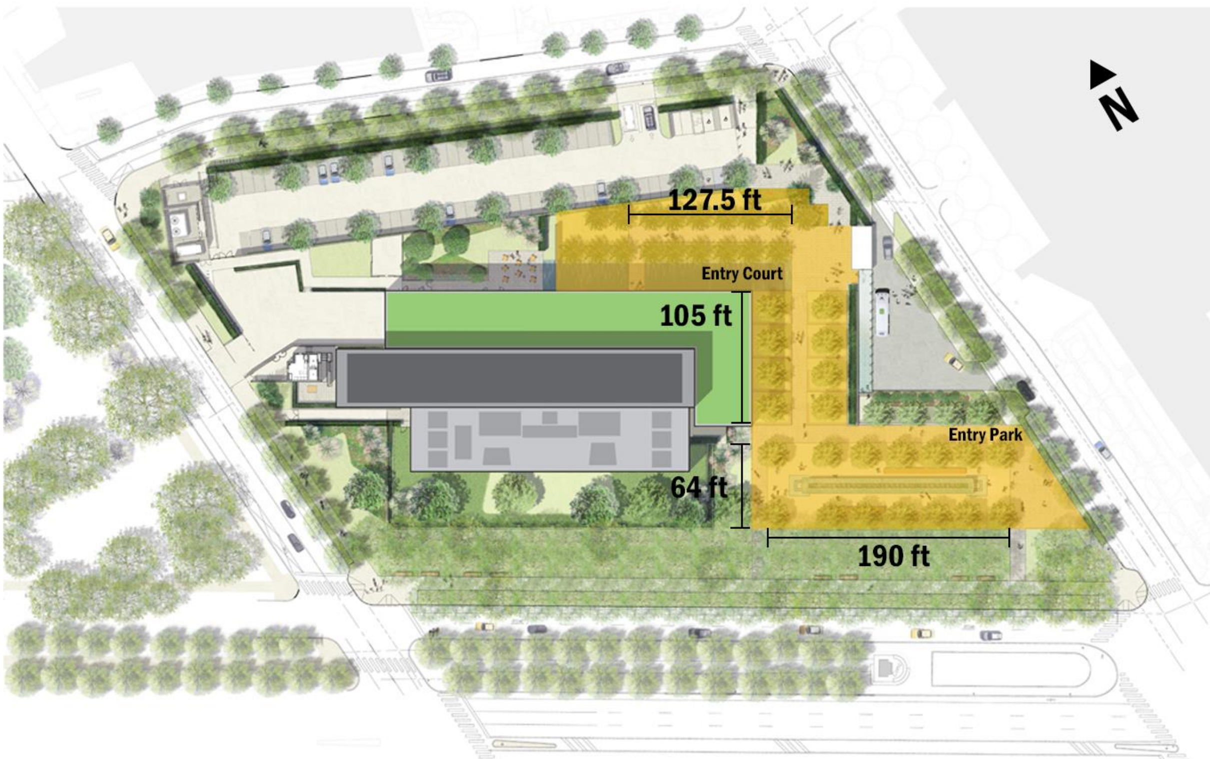


Figure 5 | Site Dimensions

The entry park, located adjacent to the Parkway, consists of a central fountain surrounded by two wooden benches and gravel. Trees line the length of the park while a stone walkway follows the perimeter of the area. The stone walkway leads to a tree-lined ramp that brings visitors from the park elevation up to the Entry Court elevation. The Entry Court begins with a large plaza area that includes a large metallic statue and a stone wall to distinguish the Entry Court and Auto Court from one another. The walkway continues from the plaza and leads visitors to a tree-lined path bringing them to the entrance of the facility. Two shallow pools of water line both sides of the entrance façade.

Figure 6 | Site Photos | ©Michael Moran

Table 1 | Site Materials

Surface	Material	LRV
Gound	Decomposed Stone Paving	0.33
	Planting Area	0.2
	Renaissance Gray Limestone	0.4
	San Sebastian Granite - Granite Pavers Stone	0.3
Wall	San Sebastian Granite - Granite Pavers Stone	0.3
Fountain	San Sebastian Granite - Granite Setts Stone	0.15

Design Goals

After speaking with the facility manager, it was discovered that many people were having trouble locating the entrance of The Barnes Foundation when visiting. This lead to the main goal of the redesigned site light to be way-finding. The second goal was to create a friendlier Entry Park that would bring more people to the building at night; this will increase the overall appeal of the building and attract more visitors to visit during operating hours.

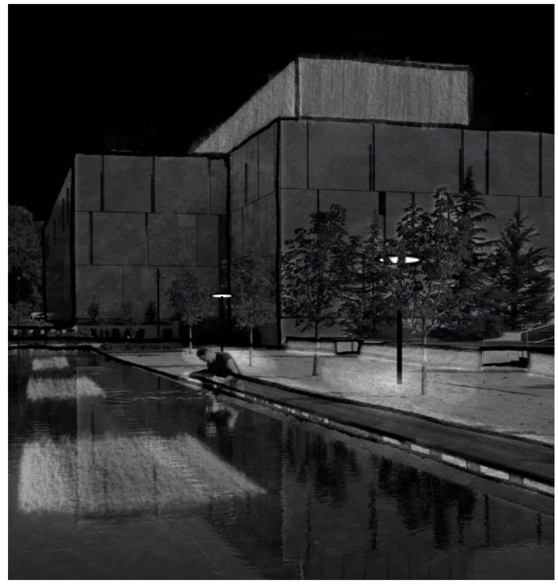


Figure 7 | Concept sketches of Site Lighting

Design Criteria

The Site will be designed to the following criteria.

Table 2 | Site Illuminance Criteria

Space	Ev (fc)
Entry Park	0.4
Entry Court	0.4
Ramps	0.6

Table 3 | Site LPD Criteria

Space	ASHRAE 90.1 LPD (W/ft^2)
Site	0.16

Psychological Impression

The Entry Park will be designed to feel open and friendly; it should become an inviting location for all passer-bys. Fountain lighting will be implemented to create a central focus to the area while under-bench lighting will be used to create accents on specific parts of the park.

Way-Finding

The Entry Court will be focused on way-finding. It is important to ensure that all visitors have a clear and easy time finding the entrance to the facility. Asked by the facility manager, path lights will be used that properly illuminate the walkway but are nearly invisible to visitors. Site walls will be lit to help guide visitors towards the entrance.

Fixture Housing

All fixtures will be rated for outdoor conditions of IP67 or greater. The specific fountain lighting will be rated for IP68, or fully-submerged lighting.

Color Temperature

The color temperature of the fixtures used throughout the Site will be either 3000K or 3500K. This will help to bring out the warmth of the exterior materials.

Design Development

The Entry Park lighting design used pole mounted fixtures, spread through the area to emphasize the boundaries of the park and to create the majority of the ambient light. Linear LED strip lighting was then placed under each bench to accent the seating area of the park. Lastly, lights placed in the fountain's filtration areas created a central focus to the area.

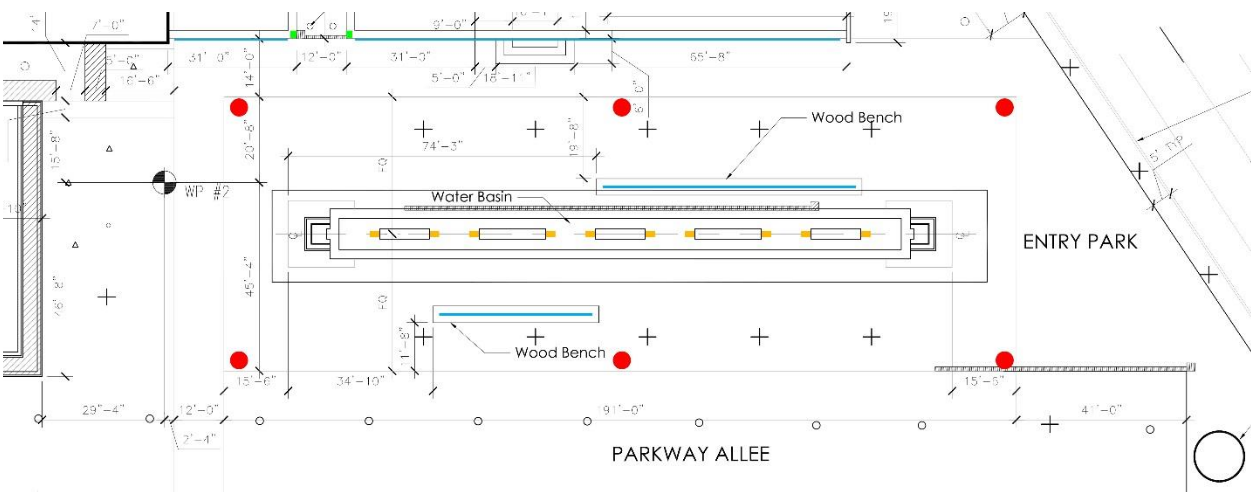


Figure 8 | Entry Park Lighting Plan

To draw visitors from the park to Entry Court, a cove is added to the retaining walls along the border of the park and along the ramp leading to the entrance elevation. This cove houses a linear LED strip that illuminates the retaining walls, drawing visitors' eyes closer to the entrance. Once the plaza is reached, in-grade lighting against the site walls creates the boundary of the Entry Court and aids in drawing a person's focus towards the entry walkway. From here, path lights illuminate the walkway to bring visitors to the entrance of the building. The path lights chosen are very shallow to make them nearly invisible at night.

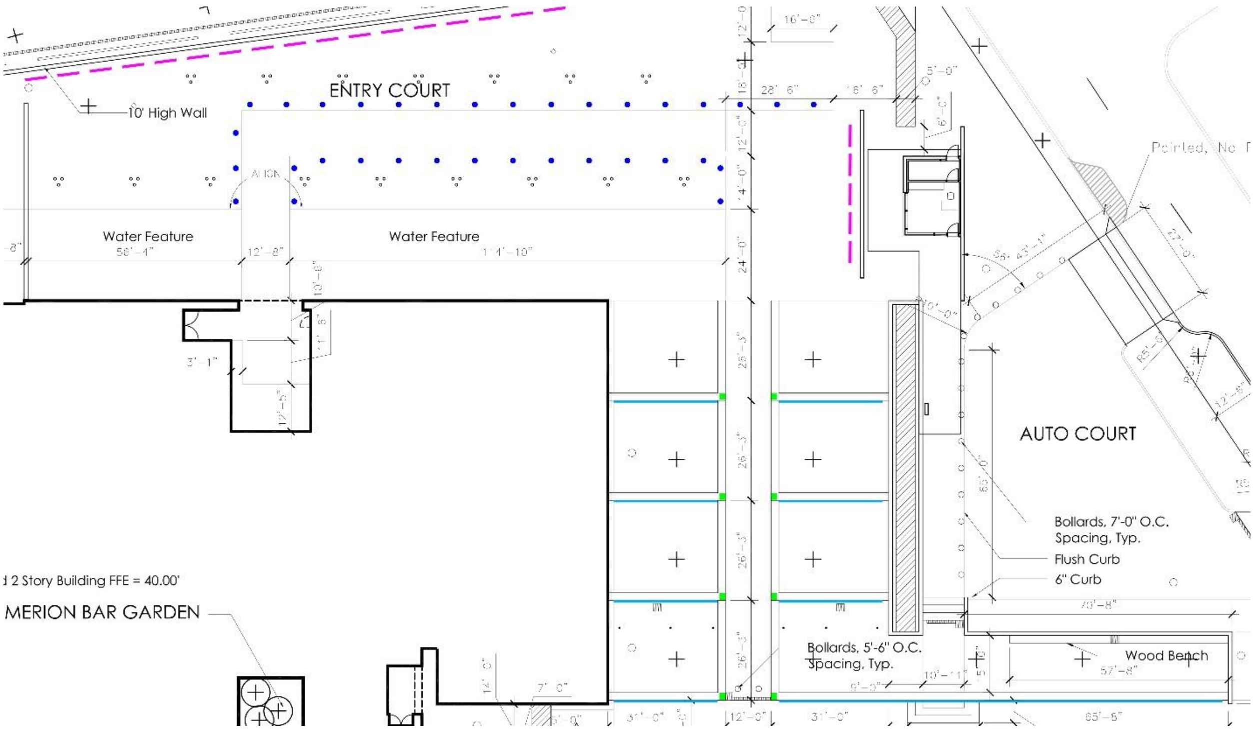


Figure 9 | Entry Court Lighting Plan

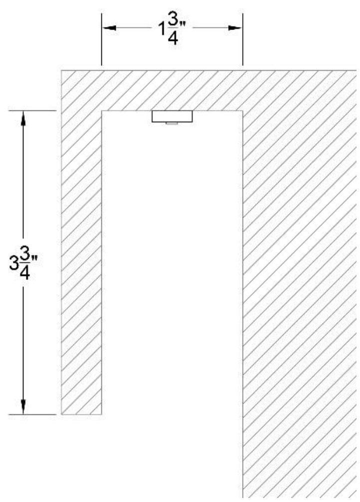


Figure 10 | Site Wall Cove Detail

Table 4 | Site Fixture Schedule

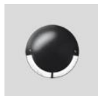
Type			Description	MFR.
XFC			Exterior LED pole light with integral electronic driver and 13' pole height.	Bega
XFD			Surface mounted LED light with half-sided light sector at 3000K.	Bega
XFE			Recessed LED wall light at 3000K with clear safety glass.	Bega
XFF			In-grade LED flood light with assymetrical distribution at 3000K. Clear safety glass included.	Bega
XFG			Recessed LED underwater wall light at 3000K with aluminum reflector.	Bega
XFH			Linear LED strip light at 3500K.	LED Linear

Table 5 | Site Fixture Light Loss Factors

Type	LLF				LDD Breakdown			
	LLD	LDD	BF	Total	Environ.	Lum.	Dist.	Letter
XFC	0.7	0.8	-	0.56	Dirty	Other	Direct	Y
XFD	0.7	0.74	-	0.52	Dirty	Open	Direct	Z
XFE	0.7	0.74	-	0.52	Dirty	Open	Direct	Z
XFF	0.7	0.74	-	0.52	Dirty	Other	Indirect	Z
XFG	0.7	0.9	-	0.63	Moderate	Other	Direct	X
XFH	0.7	0.8	-	0.56	Dirty	Other	Direct	Y
XFI	0.7	0.8	-	0.56	Dirty	Other	Direct	Y

Detailed lighting/electrical plans of the Entry Park and Entry Court can be found in Appendix C.

Controls

The site lighting will be controlled by a time clock. Based on the time of year, the site lighting will turn on slightly before sunset and remain on until 2AM.

Evaluation

Table 6 | Site Illuminance

Space	Eh (fc)	
	Criteria	Calculated
Entry Park	0.4	0.38
Entry Court	0.4	0.3
Ramps	0.6	0.74

Table 7 | Site LPD

Type	Watt	Quantity	Total Watts
XFC	26 W	6	156 W
XFD	6.7 W	34	227.8 W
XFE	7.5 W	8	60 W
XFF	13.2 W	24	316.8 W
XFG	5 W	10	50 W
XFH	1.46 W/ft	407	594.22 W
Total Watts (W)			1404.82
Area (ft^2)			42233
Measured LPD (W/ft^2)			0.033
ASHRAE 90.1 LPD (W/ft^2)			0.16
Complient			YES

Figure 11 | Entry Park Rendering | 3D Studio, Photoshop

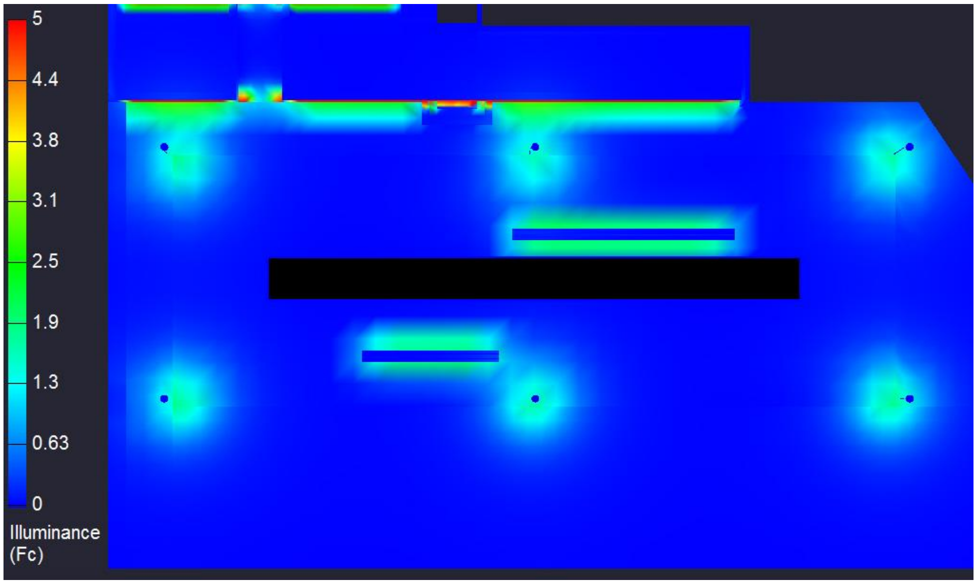


Figure 12 | Entry Park Pseudocolor | AGi32

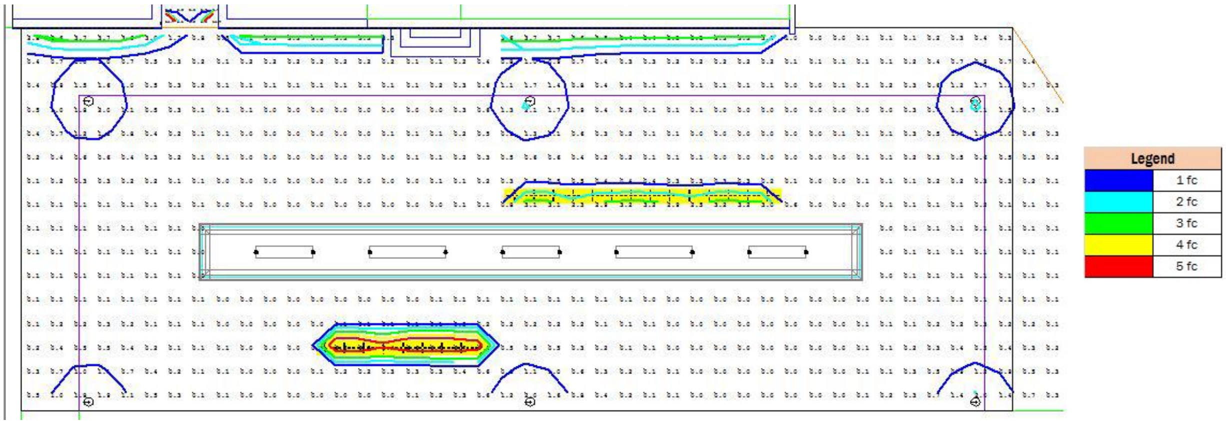


Figure 13 | Entry Park Contour Plot | AGi32

Figure 14 | Ramp Rendering | 3D Studio, Photoshop

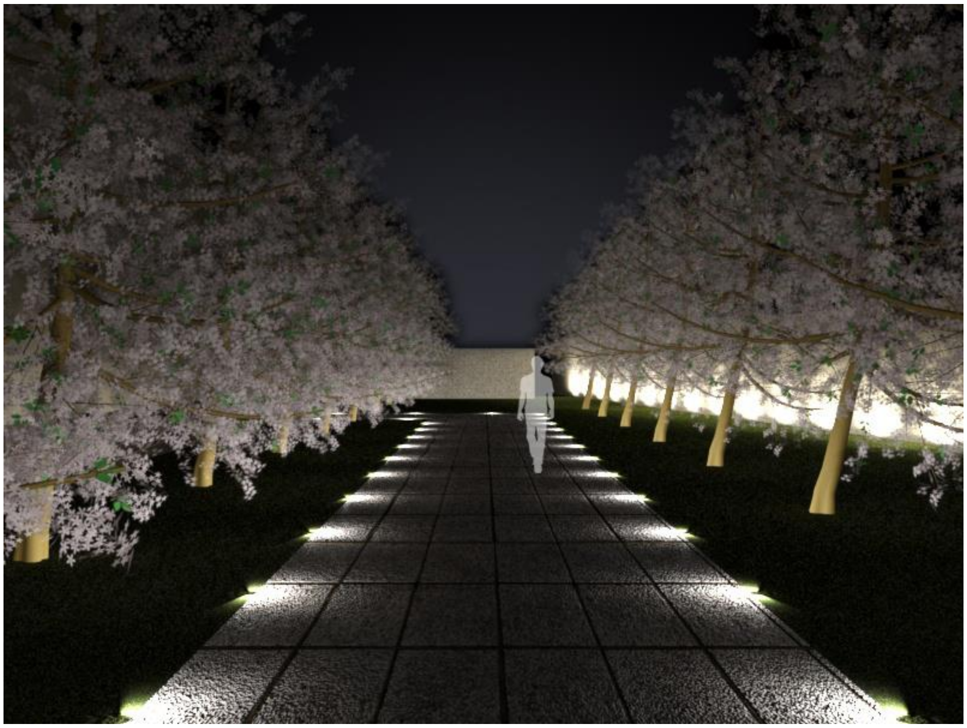


Figure 15 | Entry Court Rendering | 3D Studio, Photoshop

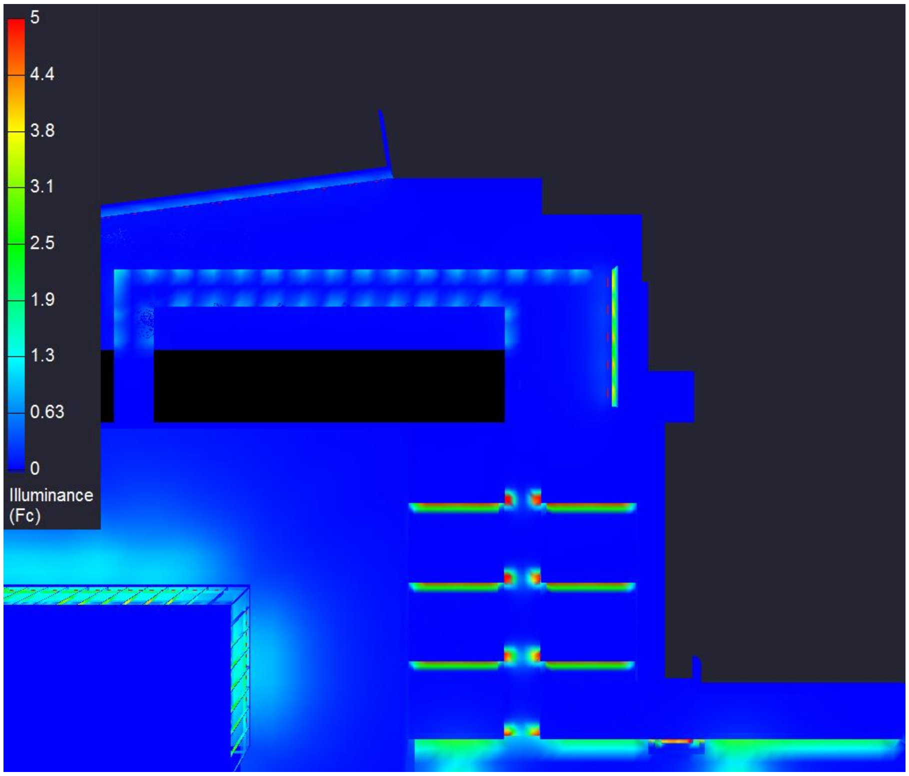


Figure 16 | Entry Park Pseudocolor | AGi32

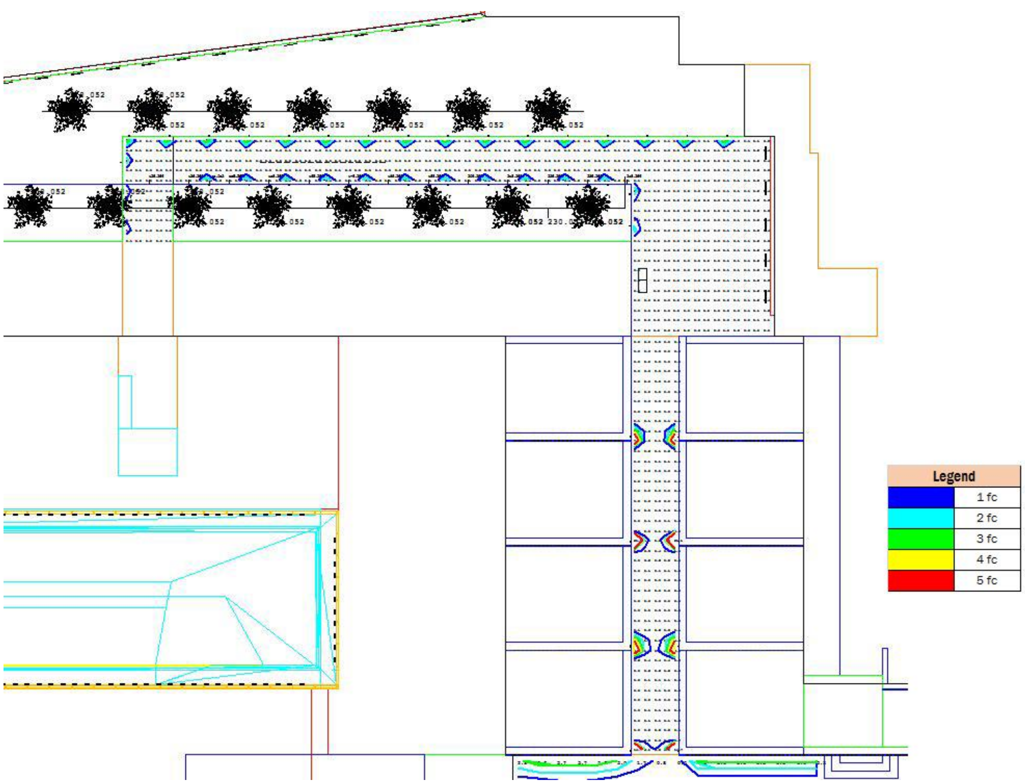


Figure 17 | Entry Park Contour Plot | AGi32

The site lighting effectively creates a more inviting park that will be usable by all pedestrians throughout the night. By creating a sufficient amount of ambient light while not detracting from the accented areas, the park attains a friendlier atmosphere while maintaining the drama associated with the building. Way-finding is accomplished by highlighting the site walls to draw a visitor's focus along the desired path and bringing them to the entrance.

Light Box

Resembling a lantern at night, The Light Box becomes a beacon for The Barnes Foundation to the surrounding city. The glass box surrounds the ceilings of the Light Court, as discussed in the following section, and the outdoor patio. The interior of the Light Box consists of the glass façade and an acoustical plaster wall, a 3 foot wide rubber walkway allows access to the entirety of the Light Box.

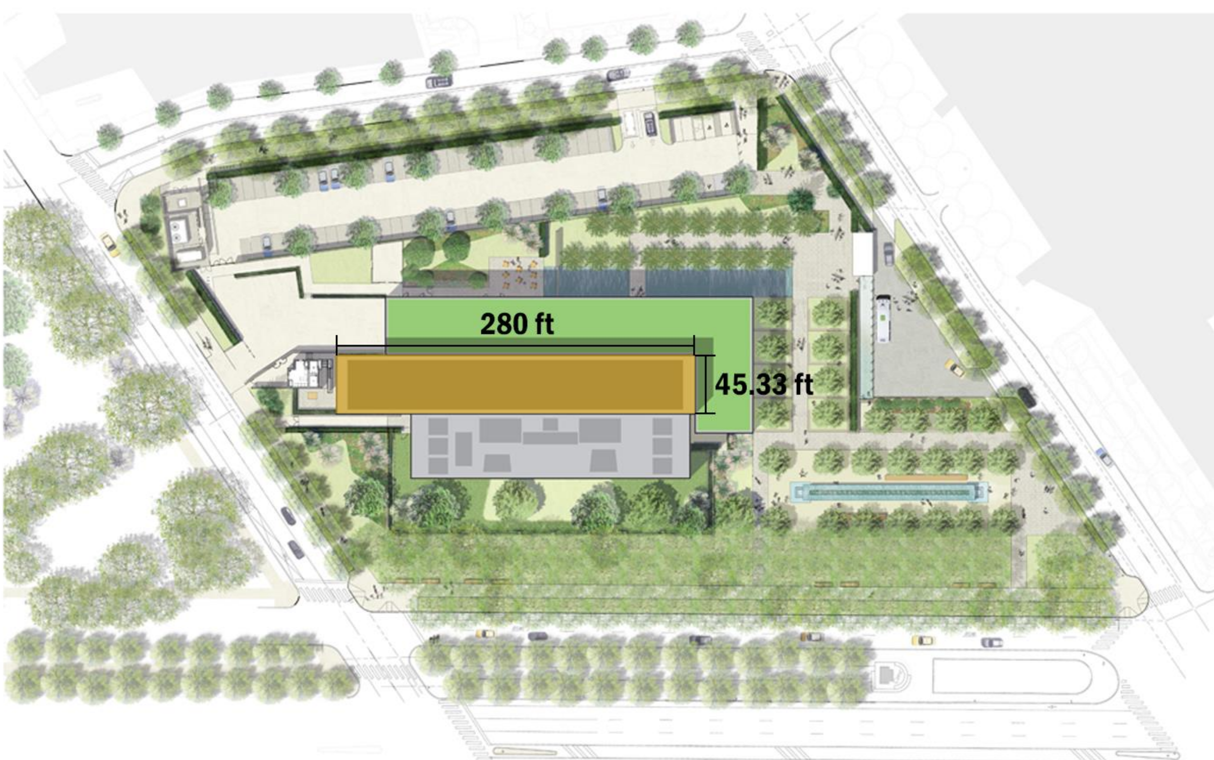


Figure 18 | Light Box Dimensions

Figure 19 | Light Box Photo | ©Michael Moran

Table 8 | Light Box Materials

Surface	Material	LRV
Wall	Acoustic Plaster	0.79
Floor	Rubber Walkway Surface	0.6

Surface	Material	VLT
Glass	PPG Starphire Tempered Lite Translucnet Glass with Acid Etch	0.7

Design Goals

The goal for the design of the Light Box was to create not just a symbol for the facility, but to create a display that was dynamic and would reflect the moving and lively nature of Philadelphia. This kinetic show would help to draw in new visitors to The Barnes and connect with the surrounding city.

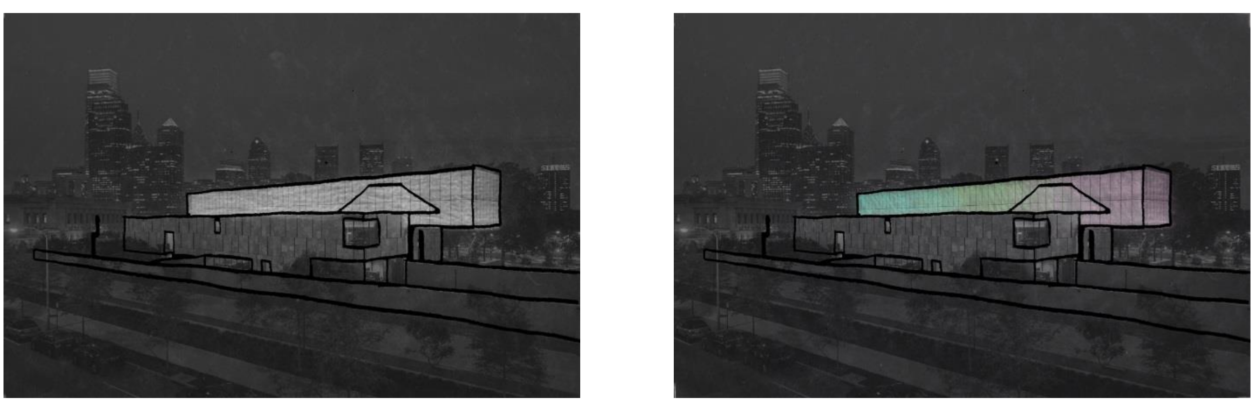


Figure 20 | Concept sketches of Light Box

Design Criteria

The Light Box will be designed to the following criteria.

Table 9 | Light Box Illuminance Criteria

Space	Ev (fc)
Light Box	5

Table 10 | Light Box LPD Criteria

Space	ASHRAE 90.1 LPD (W/ft)
Site	3.75

Psychological Impression

The Light Box will be designed to create not only a focal point for the entire exterior of the facility but to create a dynamic lighting experience that will attract pedestrians to The Barnes and bring more attention to the facility and what's inside. The lighting should represent the energy of Philadelphia and the elegance of The Barnes Foundation.

Vertical Illuminance

The two floor levels of the Light Box and shallow spacing distance requires the need for different wattage fixtures with similar photometric outputs to create an even distribution across the height difference.

Design Development

The desired fixture for this space was an RGB LED asymmetrical linear fixture; however, after a great deal of search one could not be found. This resulted in the use of two Philips Color Kinetics wall grazing fixtures; although, all fixtures will be required to have custom mounting to create the same vertical illuminance distribution on the walls. Furthermore, fixture XFA, located on the lower height portion of the Light Box, will be a 20W fixture and have a 15°x30° distribution; while fixture XFB, located on the higher height portion of the Light Box, will be a 15W fixture with a 30°x60° distribution. This will allow for a similar vertical output along the length of the entire Light Box.

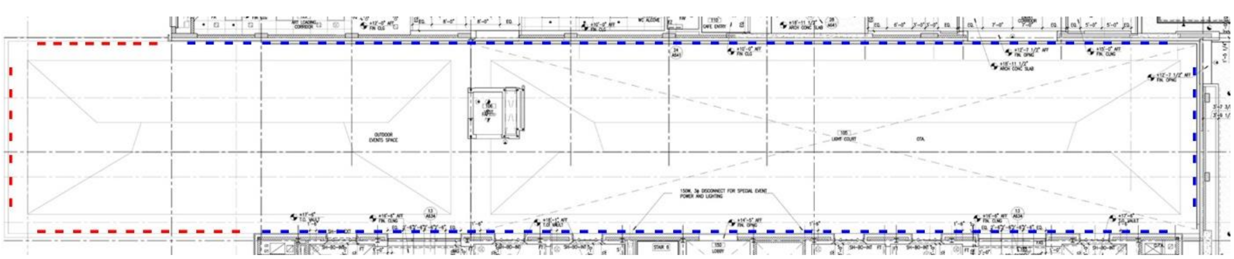


Figure 21 | Light Box Lighting Plan

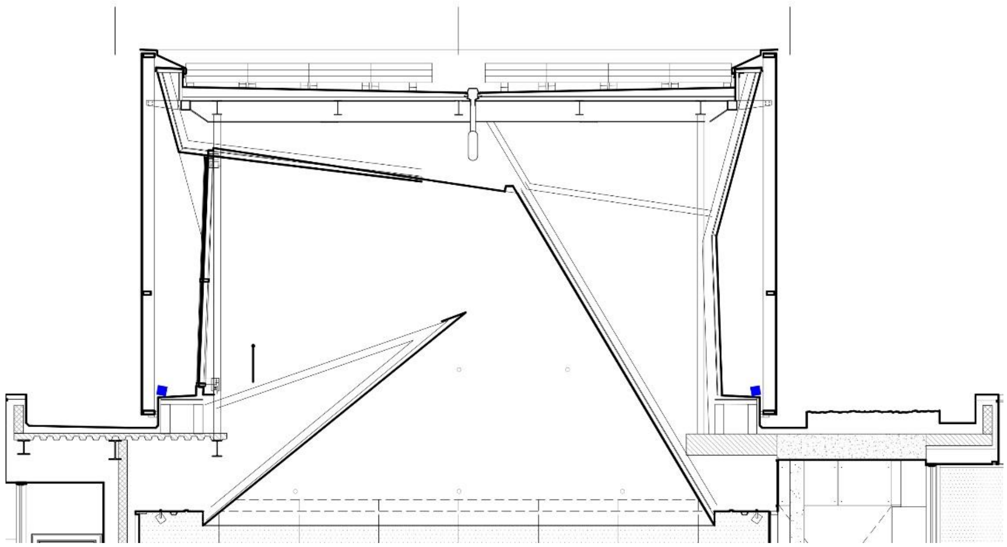


Figure 22 | Light Box Section

Table 11 | Light Box Fixture Schedule

Type			Description	MFR.
XFA			RGB LED wall graze light with 15° x 30° beam angle and clear polycarbonate lens. Angled at 10° from vertical.	Philips Color Kinetics
XFB			RGB LED wall graze light with 15° x 30° beam angle and clear polycarbonate lens. Angled at 15° from vertical.	Philips Color Kinetics

Table 12 | Light Box Fixture Light Loss Factors

Type	LLF				LDD Breakdown			
	LLD	LDD	BF	Total	Environ.	Lum.	Dist.	Letter
XFA	0.7	0.9	-	0.63	Moderate	Other	Direct	X
XFB	0.7	0.9	-	0.63	Moderate	Other	Direct	X

A subtle color-changing effect is desired for the kinetic lighting design of the Light Box. While remaining white light for the majority of the night, the Light Box will change colors gradually ever so often. This effect will create awe in those walking by the Light Box.

A detailed lighting/electrical plan of the Light Box can be found in Appendix C.

Controls

The Light Box will be controlled by the Lutron DMX Quantum System to create the color changing displays as shown above. Each fixture will consist of a red, green, and blue channel that will have a specific address with the Quantum system. This will result in the need for 12 DMX control interfaces each handling 32 of the 378 total channels controlling the Light Box, the module specified can be found in Appendix D.

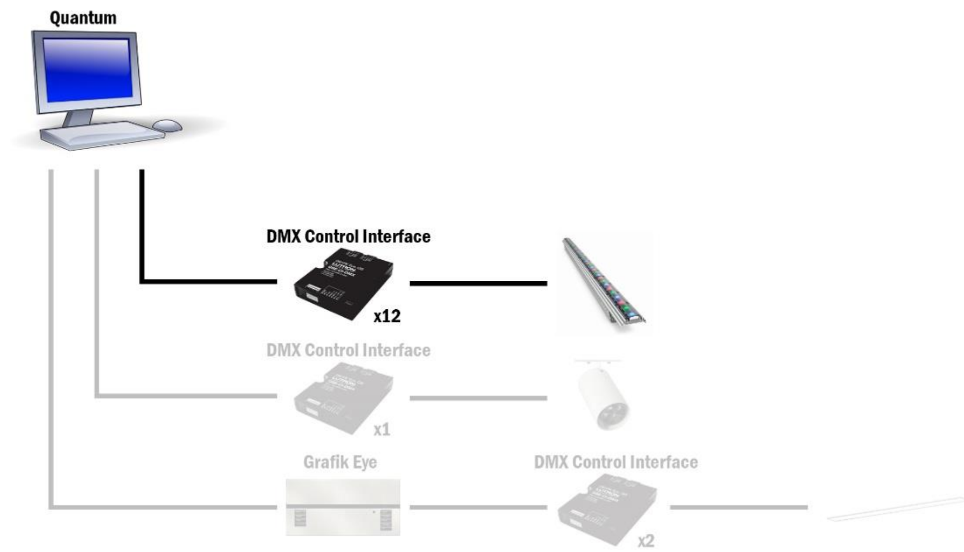


Figure 23 | Light Box Control Diagram

Evaluation

Table 13 | Light Box Illuminance

Space	Ev (fc)	
	Criteria	Calculated
Light Box	5	2.47

Table 14 | Light Box LPD

Type	Watt	Quantity	Total Watts
XFA	20 W/ft	27 ft	540 W
XFB	15 W/ft	95 ft	1425 W
Total Watts (W)			1965
Perimeter (ft)			628
Measured LPD (W/ft)			3.13
ASHRAE 90.1 LPD (W/ft)			3.75
Complient			YES

Figure 24 | Light Box Rendering | 3D Studio

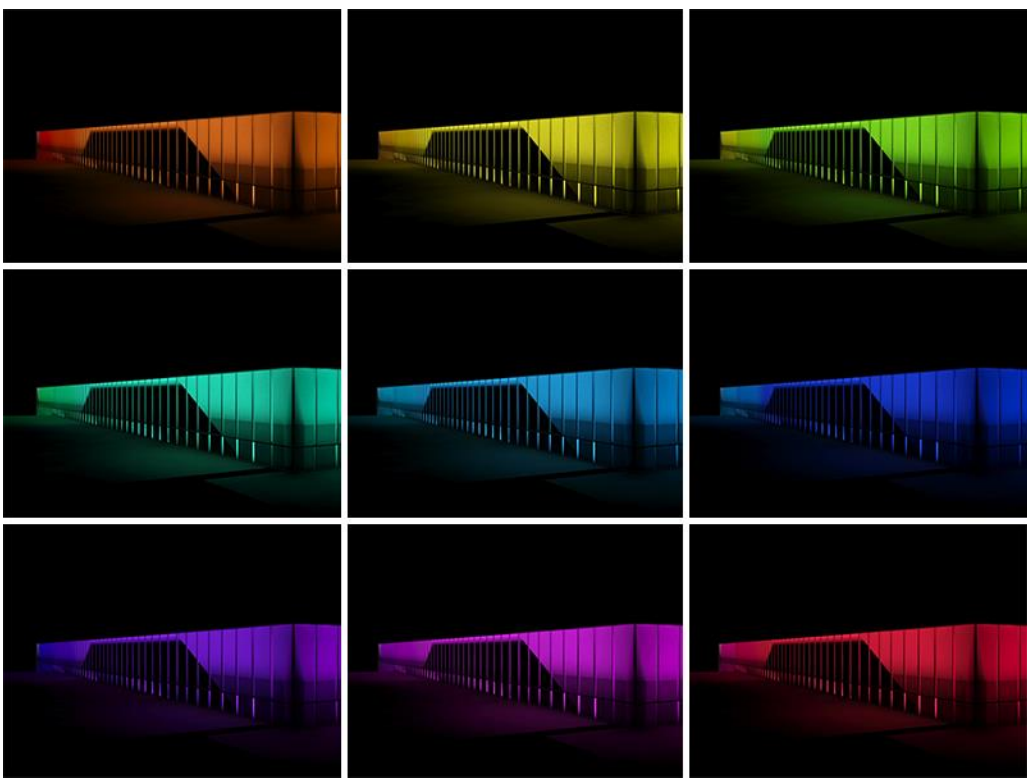


Figure 25 | Light Box Color Changing Aspect | 3D Studio

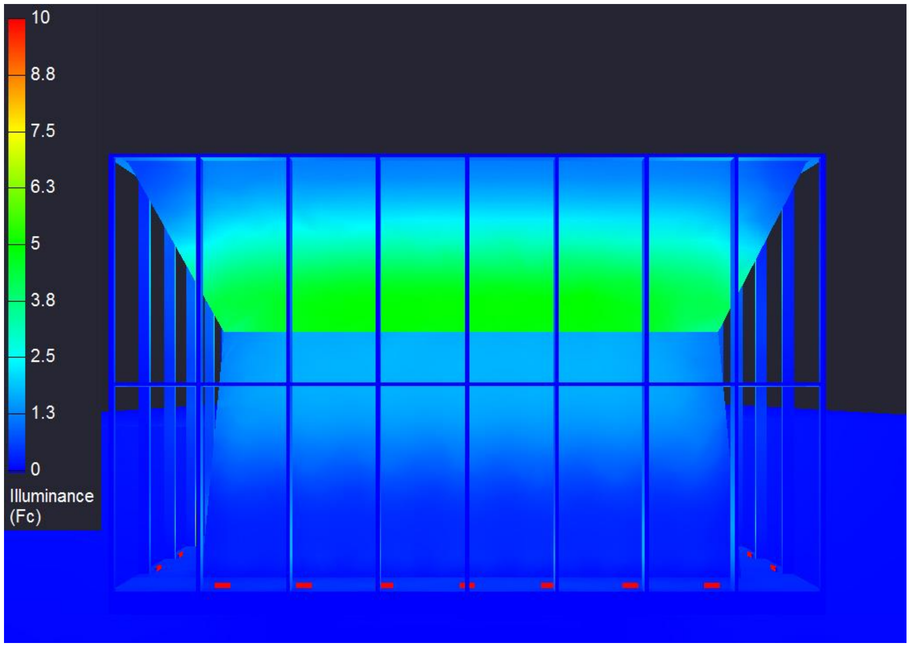


Figure 26 | Light Box Pseudocolor | AGi32

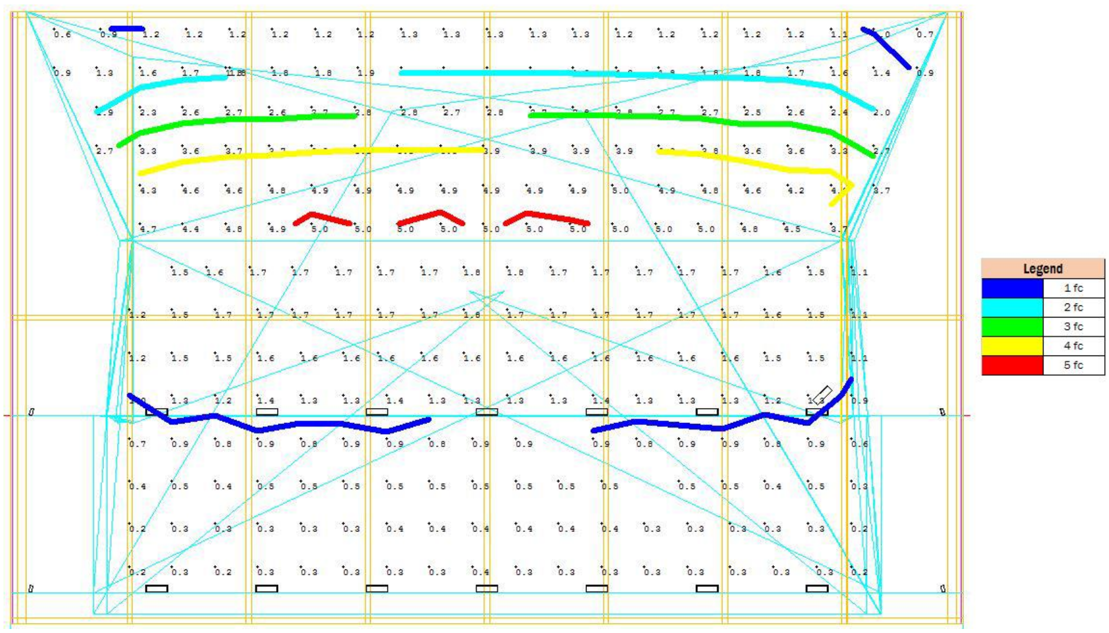


Figure 27 | Light Box Contour Plot | AGi32

The color-changing LED fixtures used throughout the Light Box created the desired effect and created a fun-loving environment similar to that of the City of Philadelphia surrounding the building. Although it will be difficult to create the custom mounting for the fixtures, it will be necessary to receive this effect until a more suitable light fixture is created. While the illuminance criteria was not met, it is believed that the desired affect is still achieved.

Light Court

The Light Court is the main atrium of The Barnes Foundation and acts as reception hall for a variety of events throughout the year. The space consists of movable furniture, a fountain, and a vestibule area made from wood. This vestibule acts as the gateway between the Light Court and the exterior patio; the two spaces are separated by a glass wall. Limestone panels that match the exterior façade material are used for the remaining walls of the Light Court. Fabric panels are located in various position on the walls, and translucent glass along the second level faculty corridors allows for a similar lantern affect in the Light Court at night as does the Light Box to the city. The floor has a stone section that runs along the perimeter of the space while the interior section is made up of parquet wood flooring. The ceiling was designed to allow a large amount of daylight into the space and is made of acoustical plaster. The shape of the ceiling is referred to as the "knife edge" due to the sharp edge created by the daylight aperture.

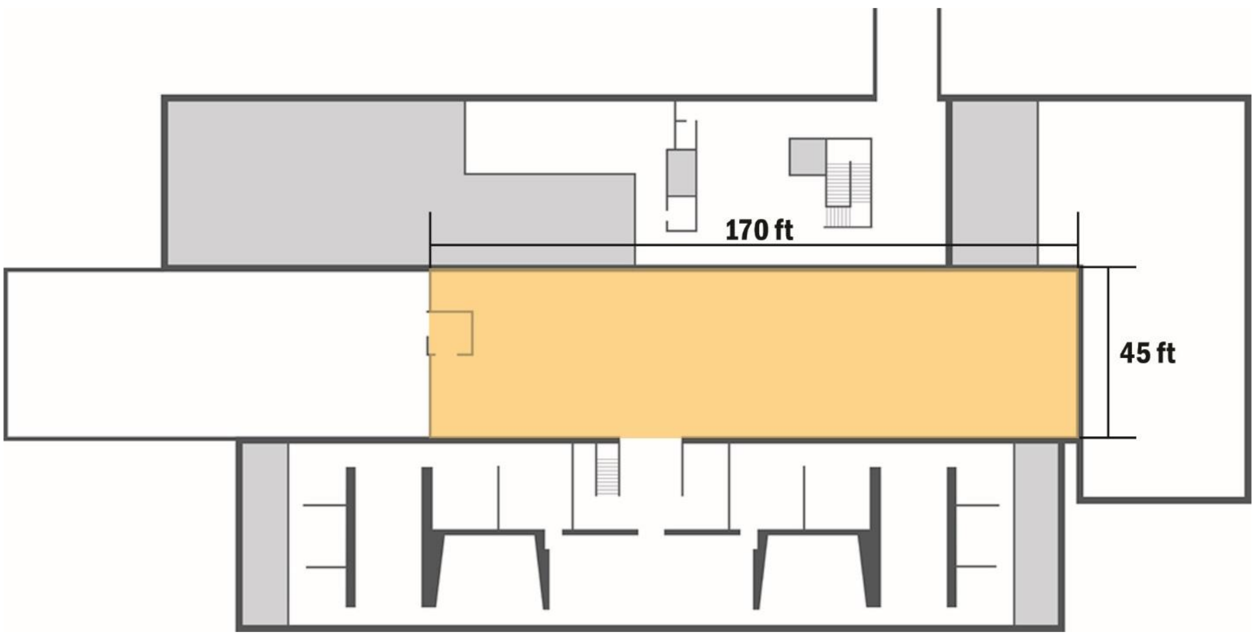


Figure 28 | Light Court Dimensions

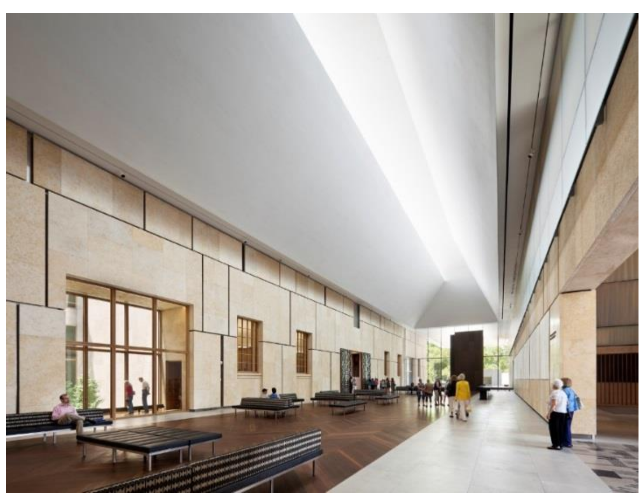


Figure 29 | Light Court Photo | œMichael Moran

Table 15 | Light Court Materials

Surface	Material	LRV
Ceiling	Acoustic Plaster	0.79
Wall	Ramon Gold Limestone	0.55
	Ramon Gray-Gold Stone	0.5
	Bronze Plated Statue	0.62
	Gypsum Wall Board	0.9
Floor	Renaissance Gray Limestone	0.4
	Tongue-and-Groove IPE Parquet Flooring	0.32
Surface	**Material**	**VLT**
Glass	Acid-Etched Tempered Glass	0.7
	Laminated Multi-Layered PPG Glass	0.5

Design Goals

Because of the large amount of events the Light Court will cater to throughout the year there needs to be an ability to create different scenes and focus light on different areas based on the event. The knife edge lighting should effectively simulate how light normally enters during the day while properly illuminate the ceiling to create diffuse light in the space.

Extending the public park aspect into the Light Court is also a goal. In this way, the external park previously mentioned will be brought into the building, and in this way, the liveliness of the city will be brought into The Barnes too. This will result in a mixture of perimeter lighting and, normally considered, exterior fixtures. The images below were the initial concept drawings for the space.

Figure 30 | Concept sketches of Light Court

Design Criteria

The Light Court will be designed to the following criteria.

Table 16 | Light Court Illuminance Criteria

Space	Eh (fc)	Ev (fc)	Avg/Min
Light Court	5	2	4

Table 17 | Light Court LPD Criteria

Space	ASHRAE 90.1 LPD (W/ft^2)
Site	1.65

Reinforcement of Architecture

Placing light behind the limestone panels will bring attention to this small cove at night, enhancing the grid pattern created by the panels. Furthermore, this will help to bring more visual focus to the fabric pieces located along the wall. The lighting of the space will also be used to distinguish the separation of the stone and wood flooring sections.

Circulation

Using light to distinguish the different floor materials will also create two types of space. The lighting along the stone flooring should emphasize movement along the perimeter; while the lighting along the wood flooring should emphasize congregation areas.

Color Temperature

The color temperature of the fixtures used in the Light Court will be 3500K. This is due to a mixture of both warm and cool materials throughout the entire space. A mid-temperature light will be able to accentuate color tones on both ends of the color spectrum.

Design Development

The limestone panel lighting was designed first for the Light Court. As seen in figure 31, there is enough space to place a linear LED strip to illuminate the coves of the panels. It was decided that focusing on the horizontal grid lines of the panels would create a more continuous effect for the Light Court that emphasized the circulation of the space, rather than focusing on the vertical grid lines. This also created an accent on the perimeter stone flooring. In the locations of the limestone paneling that are above the fabric displays an aimed linear LED fixture is used to graze the fabric. The fabric displays will also be set back slightly from their initial position flush with the wall to allow for a better wall graze.

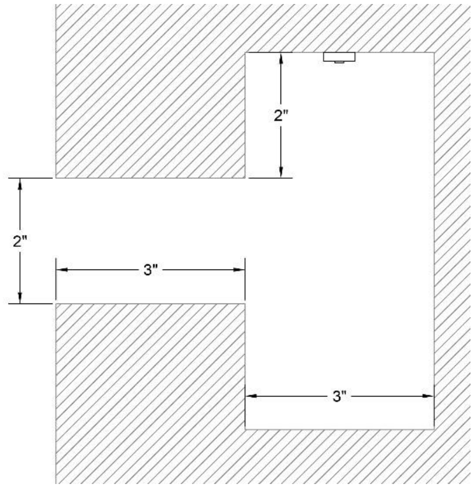


Figure 31 | Light Court Cove Detail

Bollards were then placed along the center of the wood portion of the floor. This creates a different lighting effect on the wood to distinguish the different floor materials. The linearly lit stone flooring emphasizes movement and circulation, while the central bollards emphasize focal points that, during events, will create gathering spaces along the floor.

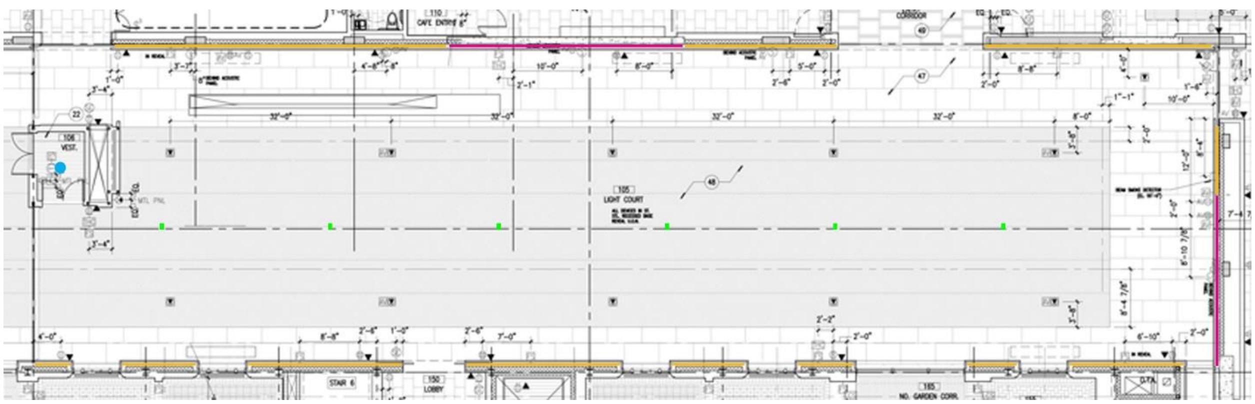


Figure 32 | Light Court Lighting Plan

The general ambient lighting will be supplied by a recessed track lighting system. It was found that 24, 2800 lumen, spotlights would be necessary to achieve the recommended illuminance levels for the Light Court. These fixtures were spread 12' apart from one another, resulting in a total of 144' of track on each side of the Light Court. However, the track system is designed for 20W per foot of track, and if higher light levels are needed for an event, it is possible to place 151 of the track fixtures specified on the system.

To illuminate the ceiling of the Light court, 11 flood lights were placed behind the knife edge, as seen in figure 34, and angled at 45° from vertical to illuminate the ceiling of the Light Court and the portion of the knife edge that can be seen from the exterior of the building. A design goal for the knife edge lighting was to have it resemble daylight entering the space through the aperture, this resulted in mounting the fixtures to the ceiling of the aperture. After some analysis, it was deemed ultimately too expensive in maintenance costs and resulted in the location as shown in figure 34.

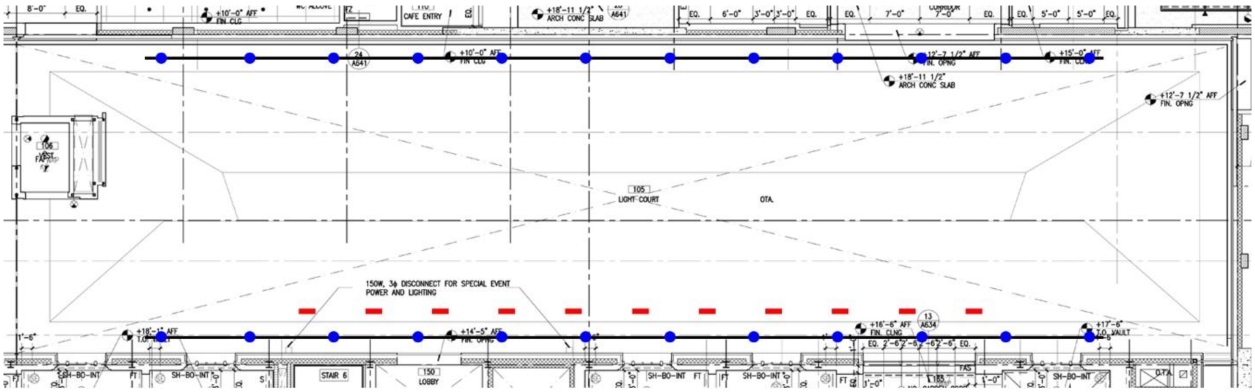


Figure 33 | Light Court Knife Edge Lighting Plan

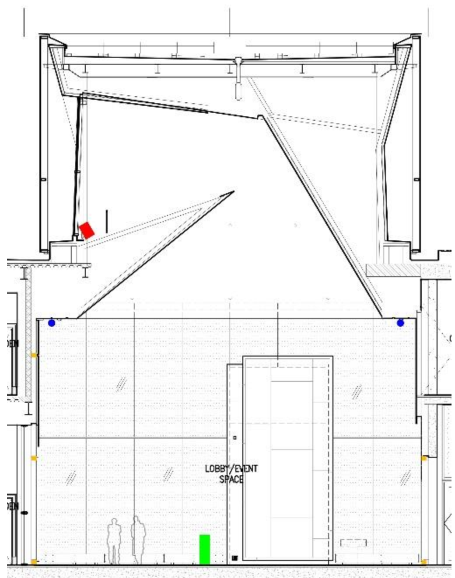


Figure 34 | Light Court Section along Width

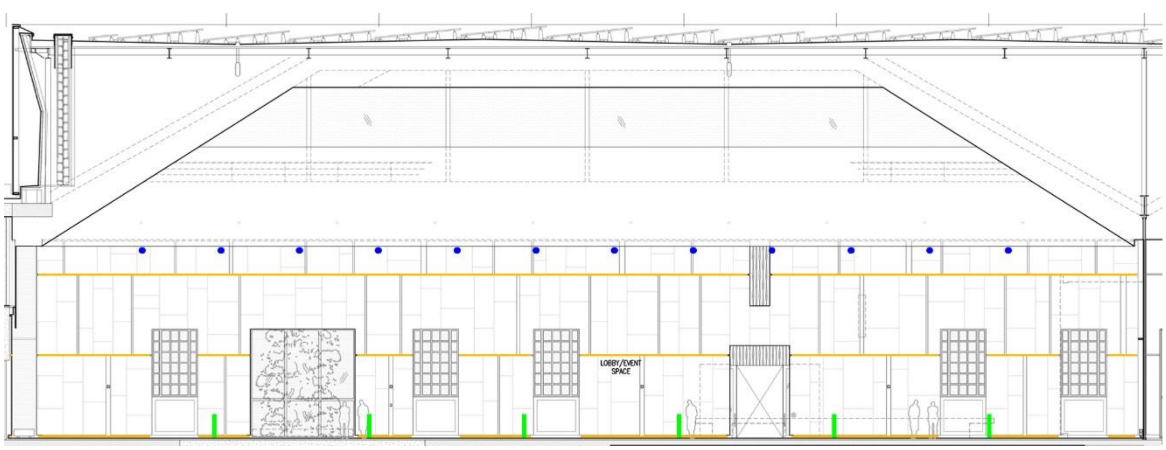


Figure 35 | Light Court Section along Length

Table 18 | Light Court Fixture Schedule

Type			Description	MFR.
FA			Base mounted LED flood light with 36° frosted lens at 4000K. Angled at 45° from vertical.	Phillips
FB			Shielded LED bollard at 3000K.	Bega
FC			Fully recessed two-circuit lighting track with flush trim.	Edison Price
FD			Track mounted adjustable LED accent light at 3500K. Nominally 5.75" diameter with matte black cross-baffle.	Edison Price
FE			Linear LED strip light at 3500K.	LED Linear
FF			Linear LED wallwasher at 3500K. Aimed at a 45° angle with clear cover.	LED Linear
FJ			Recessed LED downlight with nominally 4" aperture at 3500K, 20° spread reflector.	Edison Price

Table 19 | Light Court Fixture Light Loss Factors

Type	LLF				LDD Breakdown			
	LLD	LDD	BF	Total	Environ.	Lum.	Dist.	Letter
FA	0.7	0.9	-	0.63	Moderate	Other	Direct	X
FB	0.7	0.94	-	0.66	Clean	Other	Direct	W
FC	Track							
FD	0.7	0.94	-	0.66	Clean	Open	Direct	W
FE	0.7	0.85	-	0.60	Moderate	Open	Direct	XY
FF	0.7	0.9	-	0.63	Moderate	Other	Direct	X
FJ	0.7	0.94	-	0.66	Clean	Open	Direct	W

A detailed lighting/electrical plan of the Light Court can be found in Appendix C.

Controls

The track system along the ceiling perimeter will be set up with the Lutron Quantum System to allow for specific sections on the track to be dimmed. As mentioned earlier, the Light Court is used for a variety of events, especially at night. This will require the need for users to be able to adjust the light levels easily to obtain the desired ambiance for the event.

The fixtures illuminating the ceiling of the Light Court will be controlled by a photosensor. Although not analyzed thoroughly in this report, the photosensor will turn on the fixtures if it is an overcast day; otherwise, the daylight entering through the Light Box will give the same effect as the lighting. All fixtures will also be controlled by a time clock to ensure the proper light levels when necessary.

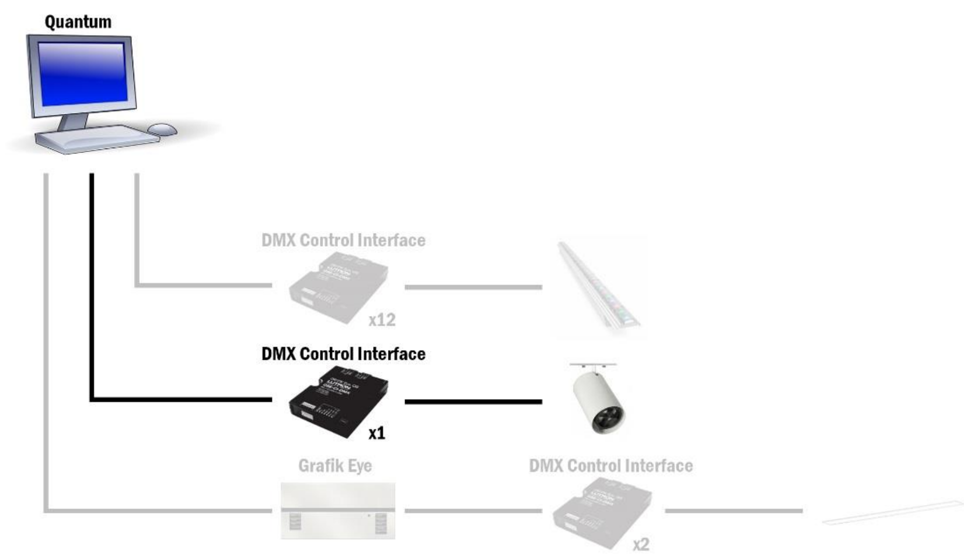


Figure 36 | Light Court Control Diagram

Evaluation

Table 20 | Light Court Illuminance

Space	Eh (fc)		Ev (fc)		Avg/Min	
	Criteria	Calculated	Criteria	Calculated	Criteria	Calculated
Daytime (Clear Sky)	10	43.2	3	30.95	4	5.4
Daytime (Overcast)*	10	19.23	3	15.61	4	5.24
Nighttime	5	4.84	2	2.2	4	5.36

Table 21 | Light Court LPD

Type	Watt	Quantity	Total Watts
FA	50 W	11	550 W
FB	29.5 W	6	177 W
FC	20 W/ft	288	5760 W
FE	1.46 W/ft	732	1068.72 W
FF	1.83 W/ft	51	93.33 W
FJ	23 W	1	23 W
Total Watts (W)			7672.05 W
Area (ft^2)			7707
Measured LPD (W/ft^2)			1.00
ASHRAE 90.1 LPD (W/ft^2)			1.65
Complient			YES

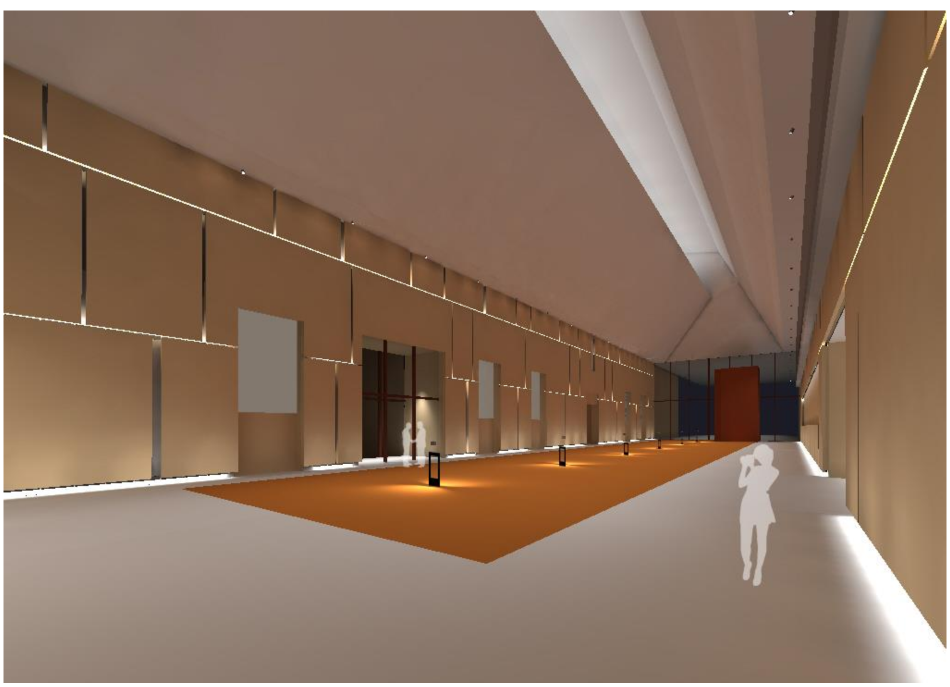


Figure 37 | Light Court Rendering | 3D Studio, Photoshop

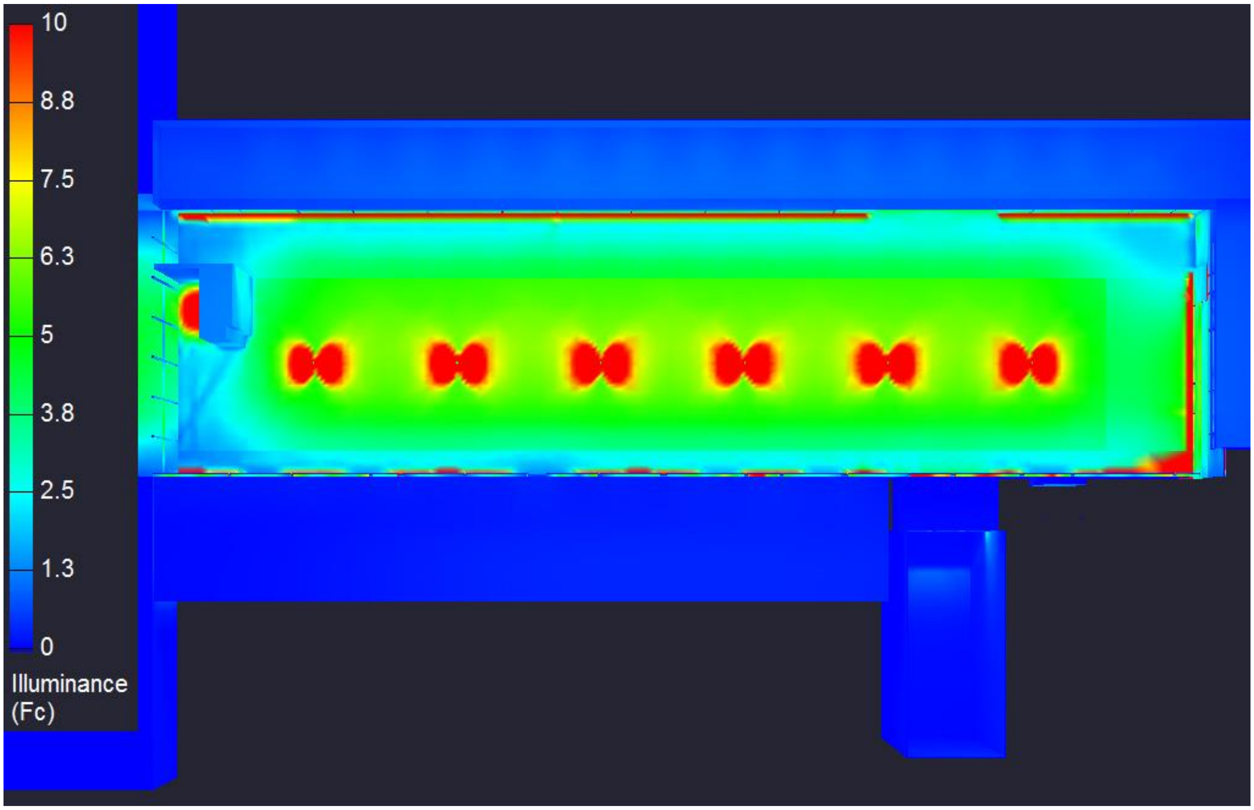


Figure 38 | Light Court Pseudocolor | AGi32

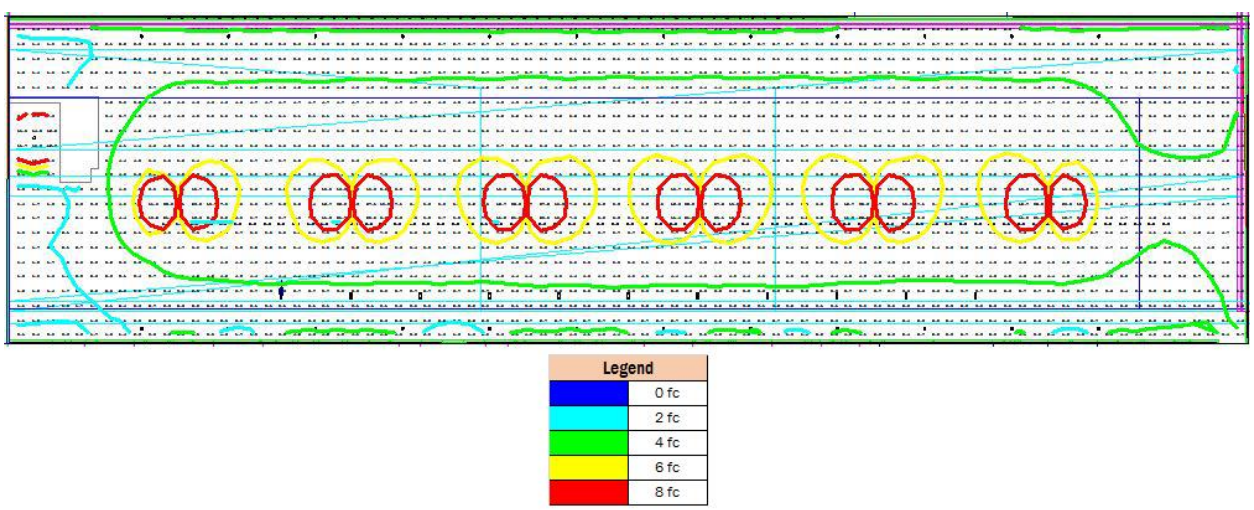


Figure 39 | Light Court Contour Plot | AGi32

The Light Court effectively draws in the liveliness of the city through its decorative lighting and continued exterior park lighting design elements. The linear LED cove lighting promotes the circulation of the space while the bollards create gathering locations. This is very much how the Entry Park was designed in having light accentuating the perimeter of the space while lighting accents were created to promote gathering. While the knife edge lighting was not able to optimally resemble daylighting, it is believed that, overall, the final lighting design will create the most efficient effect.

Lower Lobby

Acting as a lobby to the auditorium, café, library, and gift shop of The Barnes Foundation, the Lower Lobby doubles as a reception space for guest speakers and various events. The space consists of a large open area with moveable furniture, display shelves along both walls, and an interior garden area. Stone flooring is located along the perimeter of the space while wood flooring makes up the central floor area. The walls are concrete along the main portion of the lobby with it changing to wood paneling closer to the garden area. The ceiling is in two section, the lower section made of plaster and the upper section made of concrete. The interior garden is surrounded by glass and is comprised of both a dirt and concrete patio floor.

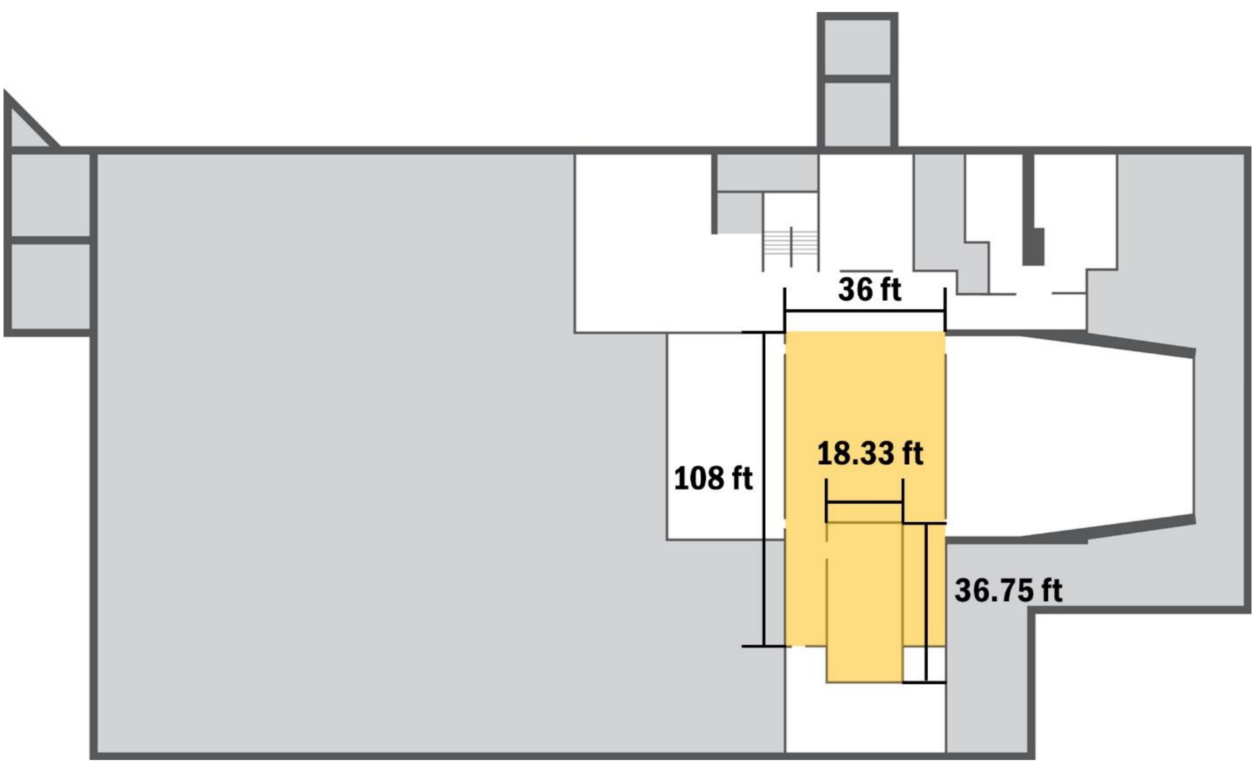


Figure 40 | Lower Lobby Dimesnions

Figure 41 | Lower Lobby Photo | ©Michael Moran

Table 22 | Lower Lobby Materials

Surface	Material	LRV
Ceiling	Exposed Lightly Sandblasted Concrete	0.25
	Gypsum Wall Board	0.9
Wall	Exposed Bush-Hammered Concrete	0.15
	Exposed Form Finish Concrete	0.62
Floor	Renaissance Gray Limestone	0.4
	Tongue-and-Groove Oak Strip Flooring	0.22
Surface	**Material**	**VLT**
Glass	Clear Tempered Glass	0.76

Design Goals

The goal of the Lower Lobby was to focus on its various uses. Acting as a lobby during normal business hours, the space should feel open and public. To do this, uniform lighting would be utilized to promote spaciousness and circulation of the area. However, since the Lower Lobby is also used for reception events there must be the option of scene controls to allow for more private settings. These private settings would have non uniform light and create accents on specific areas of the room. The walls will also be highlighted to create a focus on the perimeter of the space.

Figure 42 | Concept sketches of Lower Lobby

Design Criteria

The Lower Lobby will be designed to the following criteria.

Table 23 | Lower Lobby Illuminance Criteria

Space	Eh (fc)	Ev (fc)	Avg/Min
Lobby	30	15	2

Table 24 | Lower Lobby LPD Criteria

Space	ASHRAE 90.1 LPD (W/ft^2)
Site	0.9

Psychological Impression

Using scenes and addressable fixtures, the Lower Lobby will be able to create both public and private settings based upon the event occurring in the space. Furthermore, accent on the walls will be added during the private settings to provide light to the display shelving and draw focus to the perimeter of the space.

Reinforcement of Architecture

To connect the architecture of The Barnes Foundation throughout the building, the ambient lighting will resemble the grid pattern created by the limestone paneling of the exterior façade and Light Court walls.

Fixture Housing

The lighting located in the interior garden will be outdoor rated of IP65 or greater.

Color Temperature

As with the Light Court, the color temperature of the fixtures used in the Lower Lobby will be 3500K. This is due to the mixture of both warm and cool materials throughout the entire space. A mid-temperature light will be able to accentuate color tones on both ends of the color spectrum.

Design Development

To create the grid pattern of the limestone panels, fixtures that had the capability of connecting at 90° angles were looked at until a Selux fixture was specified that produced the desired amount of footcandles and was a reasonable wattage. The ceiling was then changed from concrete to plaster to allow for these lights to be placed flush in the ceiling. Using this fixture, a grid was created with four main lines running the length of the lobby while various 8' lengths of the Selux fixture were placed in a seemingly random pattern to connect the grid lines and to form the limestone panel pattern.

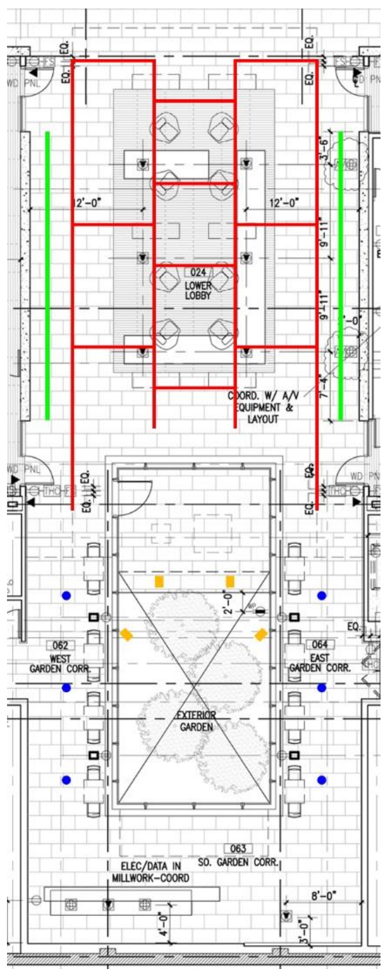


Figure 43 | Lower Lobby Lighting Plan

LED downlight were used in the back hallways of the Lower Lobby to create contrast between the lobby area and the transition spaces to the café and library areas. Floodlighting was used in the interior garden for accent lighting of the trees within. The ambient lighting of the garden is produced by the surrounding grid fixtures and downlights, while the floodlights will shine through the trees to create a more dramatic effect in the space.

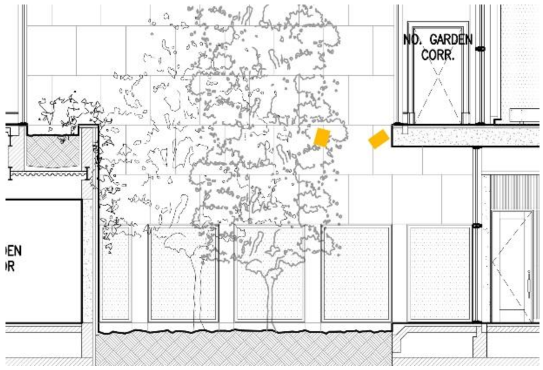


Figure 44 | Lower Lobby Garden Section

Coves along the perimeter lengths of the space were then created to provide accent lighting on the walls during private events.

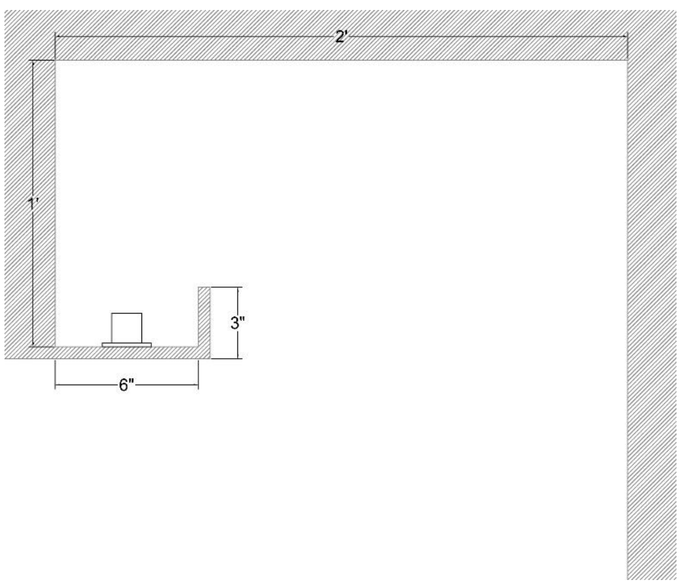


Figure 45 | Lower Lobby Cove Detail

Table 25 | Lower Lobby Fixture Schedule

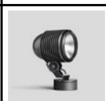
Type			Description	MFR.
FG			Recessed linear LED light with acryclic lens at 3500K, nominal 2 3/8" wide extrusion.	Selux
FH			Cove LED light with 120° optical lens at 3500K.	Ecosense
FJ			Recessed LED downlight with nominally 4" aperture at 3500K, 20° spread reflector.	Edison Price
FK			Wall mounted LED light at 3500K, 350° swivel mounting and 90° tilt.	Bega

Table 26 | Lower Lobby Fixture Light Loss Factors

Type	LLF				LDD Breakdown			
	LLD	LDD	BF	Total	Environ.	Lum.	Dist.	Letter
FG	0.7	0.94	-	0.66	Clean	Other	Direct	W
FH	0.7	0.9	-	0.63	Clean	Other	Indirect	X
FJ	0.7	0.94	-	0.66	Clean	Open	Direct	W
FK	0.86	0.94	-	0.81	Clean	Other	Direct	W

A detailed lighting/electrical plan of the Lower Lobby can be found in Appendix C.

Controls

The grid and cove fixtures will be set up with the Lutron Quantum System, this will allow for private scenes to be created for various events while also allowing specific scenes to be created if necessary. Two DMX control interfaces will be required to control the space.

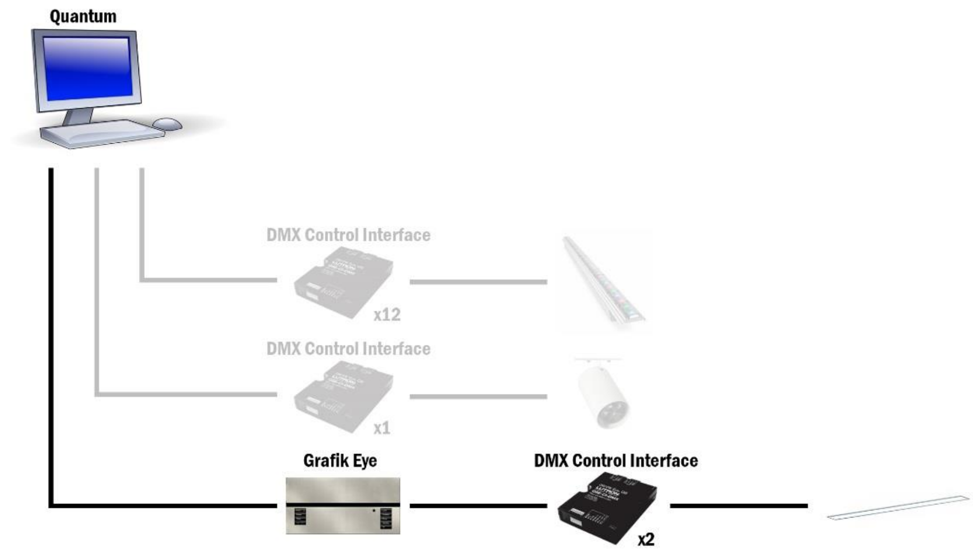


Figure 46 | Lower Lobby Control Diagram

Evaluation

Table 27 | Lower Lobby Illuminance

Space	Eh (fc)		Ev (fc)		Avg/Min	
	Criteria	Calculated	Criteria	Calculated	Criteria	Calculated
Lobby	30	32.12	15	21.74	2	1.98

Table 28 | Lower Lobby LPD

Type	Watt	Quantity	Total Watts
FG	24 W	60	1440 W
FH	4.5 W/ft	60	270 W
FJ	23 W	6	138 W
FK	17 W	4	68 W
Total Watts (W)			1916
Area (ft^2)			3030
Measured LPD (W/ft^2)			0.63
ASHRAE 90.1 LPD (W/ft^2)			0.9
Complient			YES

Figure 47 | Lower Lobby Public Scene Rendering | 3D Studio, Photoshop

Figure 48 | Lower Lobby Private Scene Rendering | 3D Studio, Photoshop

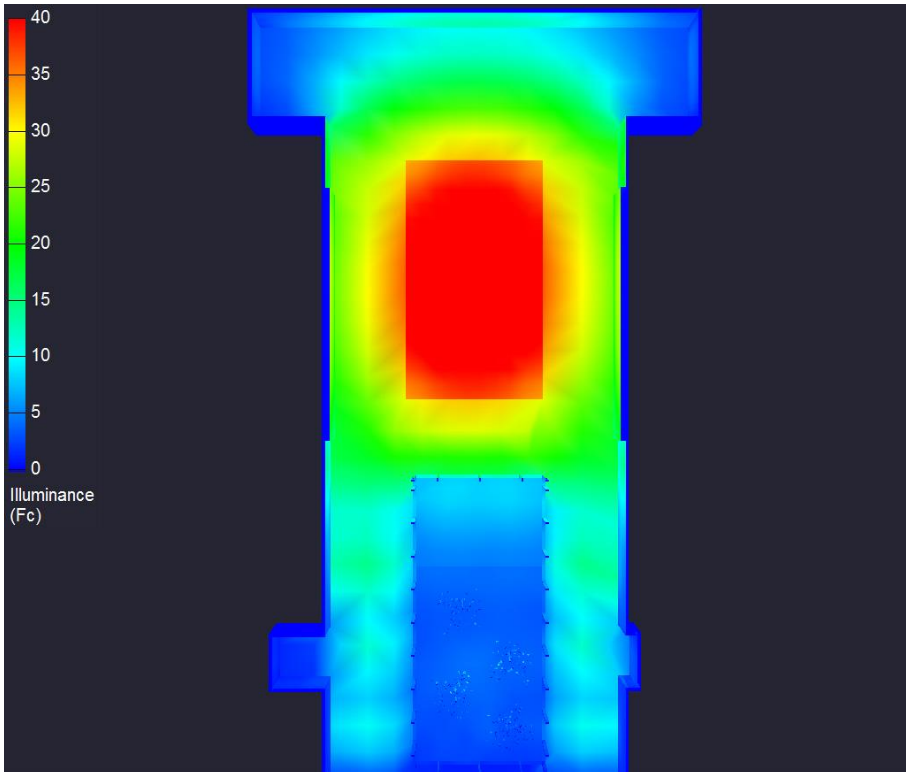


Figure 49 | Lower Lobby Pseudocolor | AGi32

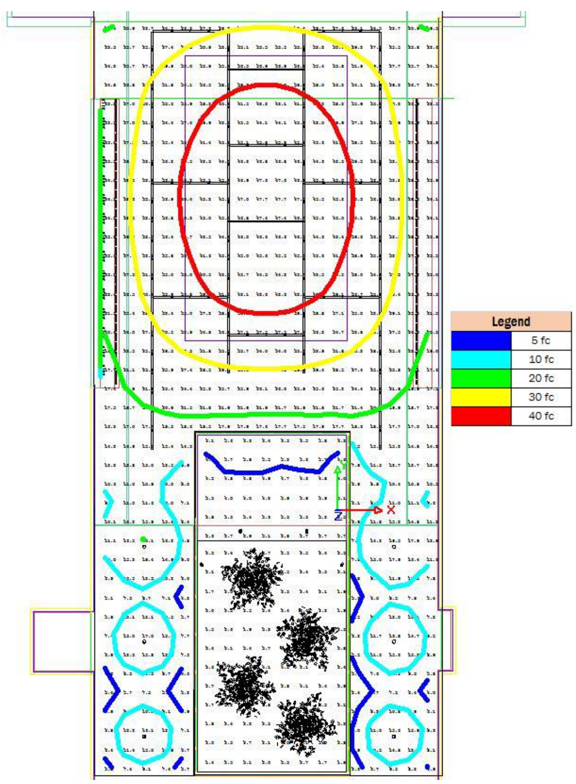


Figure 50 | Lower Lobby Contour Plot | AGi32

With the use of addressable ceiling grid lighting, the Lower Lobby can optimally create public scenes and private scenes to any desired layout of space. While not being obvious, the grid pattern creates a connection to the Light Court in its own way. The usage of downlights properly create the definition of spaces in the area while the garden lighting creates a slight accent for visitors.

Office

The Open Office area located at the East end of the building houses 28 of The Barnes' employees, with six of them located in private offices. The ceiling is partially plaster with a central portion of 2x4 acoustical ceiling tiles at a 10' height. The exterior wall is gypsum wall board while the private offices have dark translucent glass to allow some light from the open office area to enter into the private spaces. The remaining wall is a translucent glass material that overlooks the Light Court. Along the exterior wall and the translucent glass the ceiling raises up 3' to create a cove. Wood flooring is found along the perimeter of the office space while the cubicle area has carpeted flooring. One large window provides the majority of the daylighting in the office while two smaller windows provide a miniscule amount.

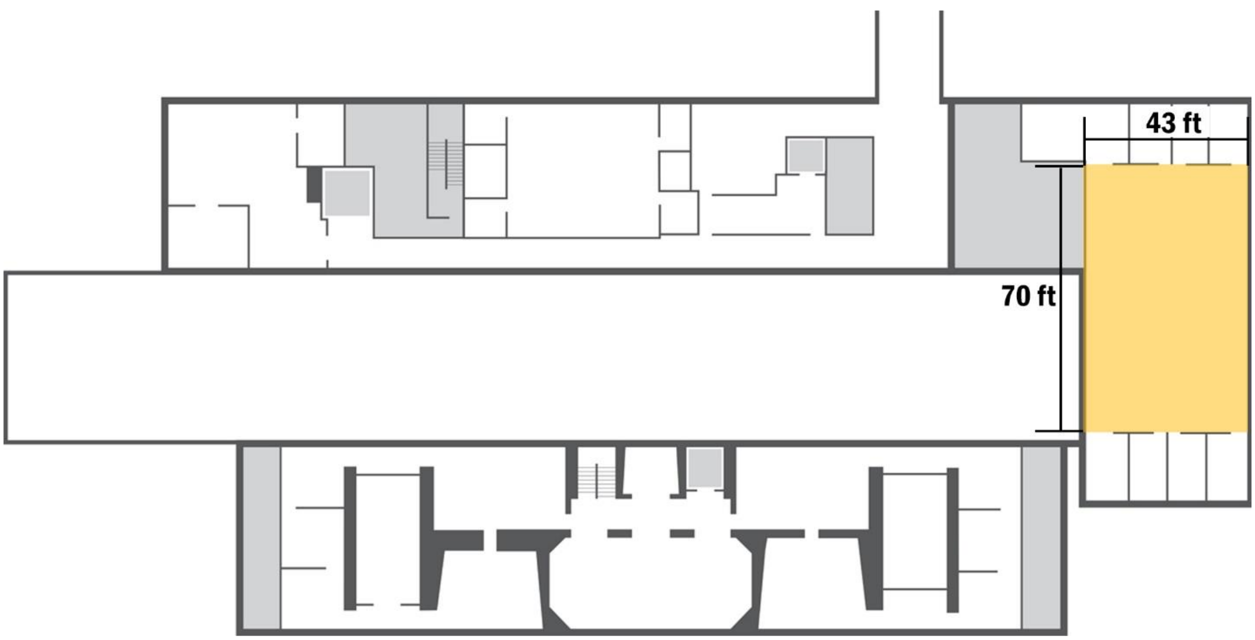


Figure 51 | Office Dimensions

Figure 52 | Office Photo | Courtesy of FMS

Design Goals

The main goal in the redesign of the Open Office will be to increase the amount of natural light in the space. This will help liven up the office for the employees and reduce the necessity for electric light. Furthermore, the office must be uniformly light with the inclusion of the increased amount of natural light in the space. Light must also illuminate the translucent glass facing the Light court to continue the lantern effect.

Figure 53 | Concept sketch of Office

Design Criteria

The Office will be designed to the following criteria.

Table 29 | Office Illuminance Criteria

Space	Eh (fc)	Avg/Min
Lobby	30	2

Table 30 | Office LPD Criteria

Space	ASHRAE 90.1 LPD (W/ft^2)
Site	0.98

Psychological Impression

The increased amount of daylight will increase the happiness of the occupants of the office area and promote more efficient work. Furthermore, having an even distribution of light across the space will create a spacious and open feeling to the office and encourage interaction between employees.

Reinforcement of Architecture

To connect the Office to the rest of The Barnes, the daylight apertures of the gallery spaces will be observed. If possible, similar apertures will be created in the open office to associate the employees' work space with the galleries that they are working to preserve.

Color Temperature

As with the Light Court and Lower Lobby, the color temperature of the fixtures used in the Lower Lobby will be 3500K. This is due to the mixture of both warm and cool materials throughout the entire space. A mid-temperature light will be able to accentuate color tones on both ends of the color spectrum.

Design Development

Before the lighting design of the Office could begin, the daylight apertures had to first be created. A thorough explanation of this can be found in both the Structural Breadth and MAE Daylighting Breadth sections of this report. With the skylight well set, cove lighting was then created to uplight the wells. Because of the size of the wells, bordering pendant fixtures could not properly illuminate the area below the well. This resulted in cove fixtures being created in each well to provide uplight in the well and create indirect diffuse lighting on the area below.

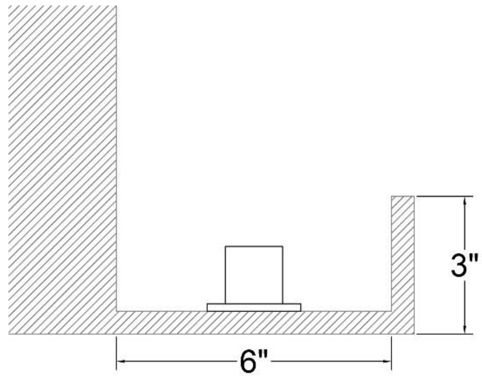


Figure 54 | Skylight Well Cove Detail

Direct/Indirect pendants with a 40% down and 60% up distribution were then chosen to provide an even distribution on light at 30fc across the room; however, due to the cove along the exterior wall of the Office, the cubicles adjacent to the walls were not receiving enough light. Direct/Indirect fixtures with a distribution of 40% down and 60% up were then placed along the cove to provide direct lighting for the occupants of those cubicles while creating cove lighting and accenting the exterior wall.

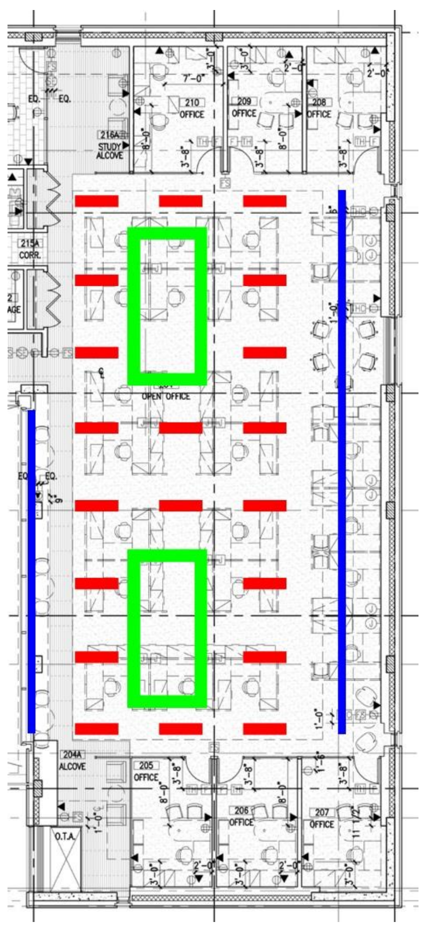


Figure 55 | Office Lighting Plan

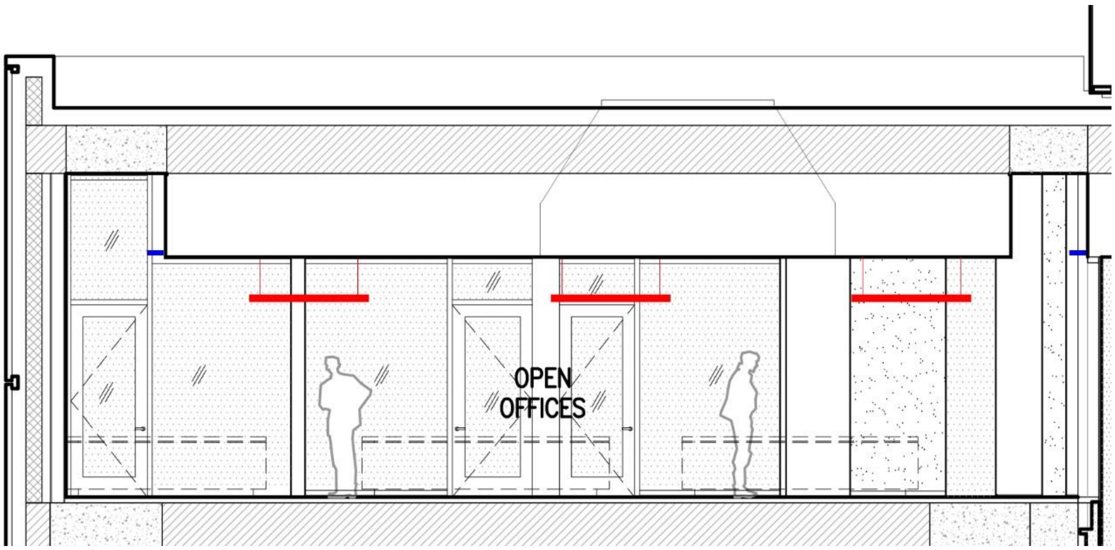


Figure 56 | Office Section

The same direct/indirect fixtures were then used in the cove along the translucent glass to provide light along the perimeter of the Office and create a glow on the glass facing the Light Court.

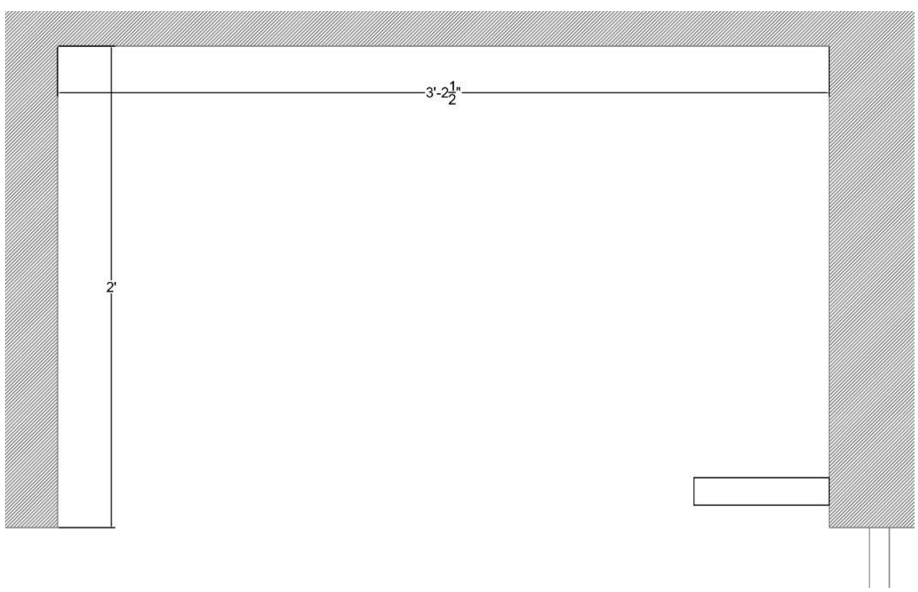


Figure 57 | Office Cove Detail

Table 31 | Office Fixture Schedule

Type			Description	MFR.
FH			Cove LED light with 120° optical lens at 3500K.	Ecosense
FL			Fluorsecent direct/indirect pendant at 3500K with integral dimming ballast. 40% down / 60% up.	Axis
FM			Wall mounted fluorescent direct/indirect light at 3500K with integral dimming ballast. 40% down / 60% up.	Axis

Table 32 | Office Fixture Light Loss Factors

Type	LLF				LDD Breakdown			
	LLD	LDD	BF	Total	Environ.	Lum.	Dist.	Letter
FH	0.7	0.9	-	0.63	Clean	Other	Indirect	X
FL	0.93	0.94	1	0.87	Clean	Other	Dir/Ind	W
FM	0.93	0.94	1	0.87	Clean	Other	Dir/Ind	W

A detailed lighting/electrical plan of the Office can be found in Appendix C.

Controls

All fixtures will be set to a time clock that will turn off the lighting at 10PM. Furthermore, the majority of the lighting will be controlled by photosensors that will regulate the total amount of light in the space, further information can be found in the MAE Daylighting Breadth section. All Axis fixtures will be controlled by an occupancy sensor to ensure the main ambient lighting is only being used when necessary.

Evaluation

Table 33 | Office Illuminance

Space	Eh (fc)		Avg/Min	
	Criteria	Calculated	Criteria	Calculated
Daytime (Clear Sky)	30	143.65	2	11.31
Daytime (Overcast)	30	46.71	2	15.07
Nighttime	30	25.76	2	2

Table 34 | Office LPD

Type	Watt	Quantity	Total Watts
FH	4.5 W/ft	108 ft	486 W
FL	32 W	21	672 W
FM	32 W	25	800 W
Total Watts (W)			1958
Area (ft^2)			2919
Measured LPD (W/ft^2)			0.67
ASHRAE 90.1 LPD (W/ft^2)			0.98
Complient			YES

Figure 58 | Office Rendering | 3D Studio

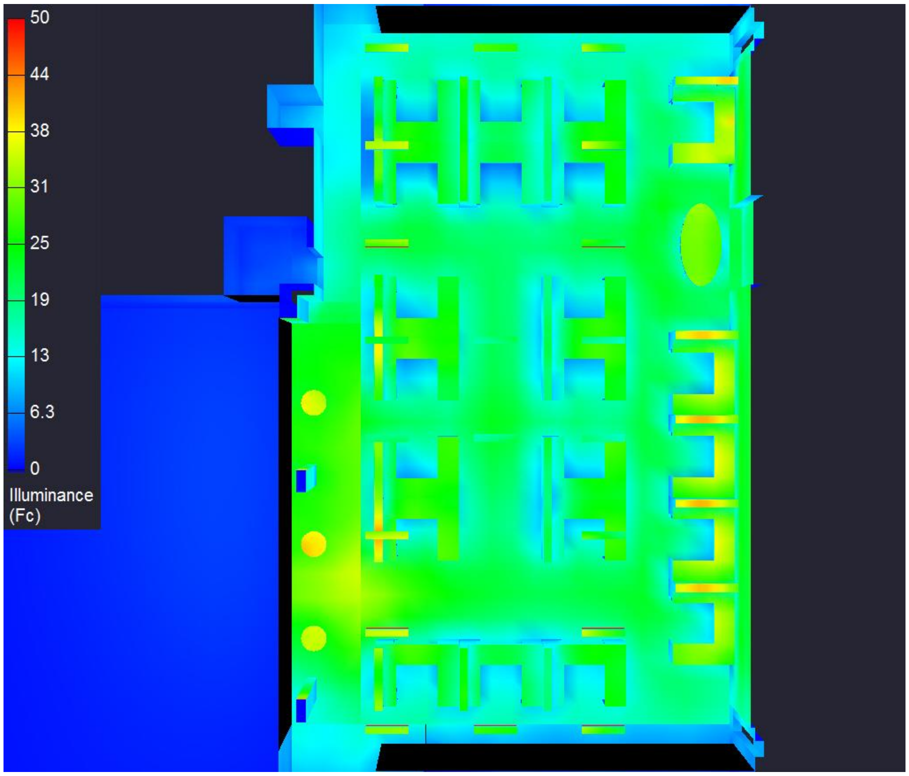


Figure 59 | Office Pseudocolor | AGi32

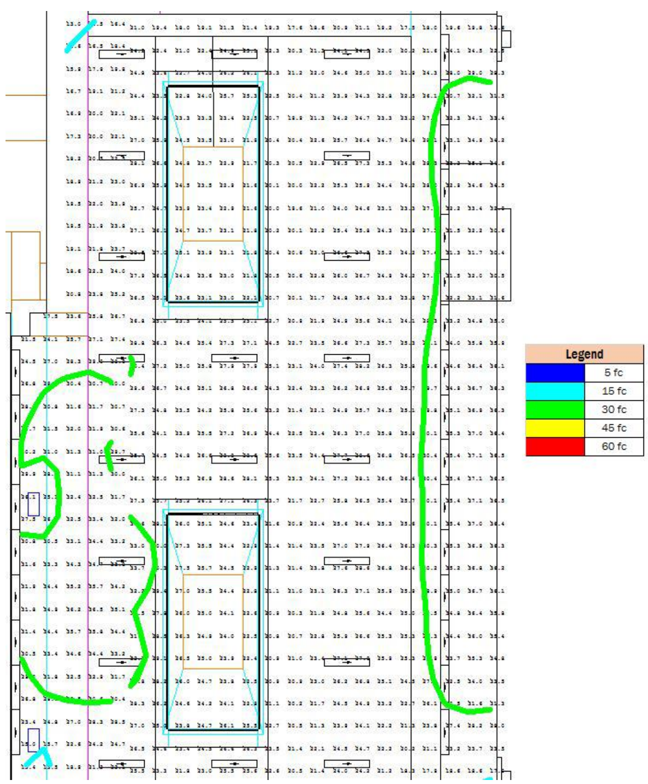


Figure 60 | Office Contour Plot | AGi32

With the inclusion of more natural light in the open office, the lighting design explained above effectively coincides with the large skylight wells. The mixture of all three types of fixtures creates both direct, indirect, and accent lighting for the Office. The cove lighting creates an accent on the wells, the pendants and wall-mounted fixtures provide direct and indirect lighting to the majority of the space, and the wall-mounted fixtures create the glow on the translucent glass for the Light Court.

Electrical Depth

The following Electrical Depth will focus on three topics: a branch circuit redesign for the five spaces discussed in the Lighting Depth, a short circuit analysis of one of the new load paths, and a photovoltaic array study for the roof area above the Office.

Branch Circuit Redesign

The new electrical loads for each of the five redesigned spaces were calculated and the appropriate panels were updated to match the new designs. The new lighting loads will affect the following panels.

Table 35 | Modified Panelboards

Panel	Type	Voltage
RP-LN2	Normal	208Y/120V
RP-LN3	Normal	208Y/120V
RP-LS1	Normal	208Y/120V
RP-1N1	Normal	208Y/120V
RP-2N1	Normal	208Y/120V
RP-2N2	Normal	208Y/120V
ERL-LN	Emergency	208Y/120V
ERL-1N	Emergency	208Y/120V
ERL-LN2	Emergency	208Y/120V
DP-LN2	Dimming	208Y/120V
DP-1N1	Dimming	208Y/120V
EDP-LN	EM Dimming	208Y/120V

For each updated panel, the original panel appears first, with the affected loads highlighted in orange; any spare circuits affected will not be highlighted. The updated panel will follow with the new loads in red.

RP-LN2

208 Y/120V						RP-LN2							BUS: 225 AMP		
65K AIC		3Ø-4W											MAIN: 150 AMP CB		
	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA						POLE	TRIP	WIRE SIZE	LOAD SERVED	
					ØA		ØB		ØC						
1	SITE LTG. - FCA-1/FBB	2#10+G-3/4"C.	20	1	0.75	1.14					1	20	2#10+G-3/4"C.	SITE LTG. - FBC	2
3	SITE LTG. - FBE-1	2#10+G-3/4"C.	20	1			1.07	0.42			1	20	2#10+G-3/4"C.	SITE STOR. LTG.	4
5	SITE STOR. RECEPTS.	2#10+G-3/4"C.	20	1					0.36	0.36	1	20	2#10+G-3/4"C.	SITE STOR. RECEPTS.	6
7	RECEPTACLES	2#12+G-3/4"C.	20	1	0.50	0.72					1	20	2#12+G-3/4"C.	RECEPTACLES	8
9	RECEPTACLES	2#12+G-3/4"C.	20	1			0.72	0.90			1	20	2#12+G-3/4"C.	RECEPTACLES	10
11	POWERED SIGN	2#12+G-3/4"C.	20	1					0.60	0.00	1	20		SPARE	12
13	SPARE		20	1	0.00	0.00					1	20		SPARE	14
15	SPARE		20	1			0.00	0.00			1	20		SPARE	16
17	SPARE		20	1					0.00	0.00	1	20		SPARE	18
19	SPARE		20	1	0.00	0.00					1	20		SPARE	20
21	SPARE		20	1			0.00	0.00			1	20		SPARE	22
23	SPARE		20	1					0.00	0.00	1	20		SPARE	24
25	SPARE		20	1	0.00	0.00					1	20		SPARE	26
27	SPARE		20	1			0.00	0.00			1	20		SPARE	28
29	SPARE		20	1					0.00	0.00	1	20		SPARE	30
31	SPARE		20	1	0.00	0.00					1	20		SPARE	32
33	SPARE		20	1			0.00	0.00			1	20		SPARE	34
35	SPARE		20	1					0.00	0.00	1	20		SPARE	36
37	SPARE		20	1	0.00	0.00					1	20		SPARE	38
39	SPARE		20	1			0.00	0.00			1	20		SPARE	40
41	SPARE		20	1					0.00	0.00	1	20		SPARE	42
	LOAD PER PHASE				3.11		3.11		1.32						
	TOTAL =						7.54 kVA					21 AMPS		A = AFI BREAKER	

NOTES: ☐ FEED THROUGH LUGS ☐ FLUSH ☐ 600KCM LUGS ☐ ISOLATED GROUND BUS G = GFI BREAKER

1.

2.

65K AIC		208Y/120V 3P-4W			**RP-LN2**								Bus: 225A Main: 150A CB		
Ckt. #	Description	Wire Size	Trip	Pole	Load (kVA) A		B		C		Pole	Trip	Wire Size	Description	Ckt. #
1	Site Ltg. - FCA-1/FBB	2#10+G-3/4"C.	20	1P	0.75	1.14					1P	20	2#10+G-3/4"C.	Site Ltg. - FBC	2
3	Site Ltg. - FBE-1	2#10+G-3/4"C.	20	1P			1.07	0.42			1P	20	2#10+G-3/4"C.	Site Stor. Ltg.	4
5	Site Stor. Recepts.	2#10+G-3/4"C.	20	1P					0.36	0.36	1P	20	2#10+G-3/4"C.	Site Stor. Recepts.	6
7	Receptacles	2#12+G-3/4"C.	20	1P	0.50	0.72					1P	20	2#12+G-3/4"C.	Receptacles	8
9	Receptacles	2#12+G-3/4"C.	20	1P			0.72	0.90			1P	20	2#12+G-3/4"C.	Receptacles	10
11	Powered Sign	2#12+G-3/4"C.	20	1P					0.60	0.96	1P	20	2#12+G-3/4"C.	Lobby - FG	12
13	Lobby - FH,FJ	2#12+G-3/4"C.	20	1P	0.18	0.00					1P	20		Spare	14
15	Spare		20	1P			0.00	0.00			1P	20		Spare	16
17	Spare		20	1P					0.00	0.34	1P	20	2#12+G-3/4"C.	Lobby - FG	18
19	Spare		20	1P	0.00	0.00					1P	20		Spare	20
21	Spare		20	1P			0.00	0.00			1P	20		Spare	22
23	Spare		20	1P					0.00	0.25	1P	20	2#12+G-3/4"C.	Lobby - FH,FJ,FK	24
25	Spare		20	1P	0.00	0.00					1P	20		Spare	26
27	Spare		20	1P			0.00	0.00			1P	20		Spare	28
29	Spare		20	1P					0.00	0.00	1P	20		Spare	30
31	Spare		20	1P	0.00	0.00					1P	20		Spare	32
33	Spare		20	1P			0.00	0.00			1P	20		Spare	34
35	Spare		20	1P					0.00	0.00	1P	20		Spare	36
37	Spare		20	1P	0.00	0.00					1P	20		Spare	38
39	Spare		20	1P			0.00	0.00			1P	20		Spare	40
41	Spare		20	1P					0.00	0.00	1P	20		Spare	42
				Load Per Phase:	3.29		3.11		2.87						

Load Summary			D.F.	Demand Loads
Lighting	5.11	kVA	1.25	6.38 kVA
Receptacle (First)	3.56	kVA	1.00	3.56 kVA
Receptacle (Excess)	0	kVA	0.50	0 kVA

Demand Loads	D.F.	Load Summary		
0 kVA	1.25	kVA	0	Largest Motor
0 kVA	1.00	kVA	0	Other Motors
0 kVA	0.80	kVA	0	Appliances
0.6 kVA	1.00	kVA	0.60	Equipment

	Connected Load		Demand Load
Total Load (kVA)	9.27	kVA	10.54 kVA
Total Load (A)	25.74	A	29.28 A
Design Load (A)			225 A
Spare (A)			195.72 A

RP-LN3

208 Y/120V | **65K AIC** | **3Ø-4W**

RP-LN3

BUS: 225 AMP | **MAIN: 150 AMP CB**

	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA						POLE	TRIP	WIRE SIZE	LOAD SERVED	
					ØA		ØB		ØC						
1	RECEPTACLES	2#12+G-3/4"C.	20	1	0.72	0.72					1	20	2#12+G-3/4"C.	RECEPTACLES	2
3	EWC	2#12+G-3/4"C.	20	1			0.50	0.50			1	20	2#12+G-3/4"C.	EWC	4
5	COAT RACK	2#12+G-3/4"C.	20	1					1.20	1.08	1	20	2#12+G-3/4"C.	RECEPTACLES	6
7	COAT RACK	2#12+G-3/4"C.	20	1	1.20	0.72					1	20	2#12+G-3/4"C.	RECEPTACLES	8
9	RECEPTACLES	2#12+G-3/4"C.	20	1			0.54	1.20			1	20	2#12+G-3/4"C.	LIGHTING (R3,R4)	10
11	RECEPTACLES (R2)	2#12+G-3/4"C.	20	1					0.36	0.54	1	20	2#12+G-3/4"C.	RECEPTACLES (R3)	12
13	RECEPTACLES (R1)	2#12+G-3/4"C.	20	1	0.54	0.71					1	20	2#10+G-3/4"C.	SITE LTG. - FC/FC-1/FBB	14
15	SITE LTG. - FC	2#10+G-3/4"C.	20	1			0.82	0.84			1	20	2#10+G-3/4"C.	SITE LTG. - FBB/FBC	16
17	POWERED SIGN	2#10+G-3/4"C.	20	1					0.80	1.80	1	20	2#10+G-3/4"C.	CHARGING STATION	18
19	CHARGING STATION	2#10+G-3/4"C.	20	1	1.80	1.80					1	20	2#10+G-3/4"C.	CHARGING STATION	20
21	SITE LTG. - FBX	2#10+G-3/4"C.	20	1			0.20	0.36			1	20	2#12+G-3/4"C.	RECEPTACLES	22
23	SPARE		20	1					0.00	0.00	1	20		SPARE	24
25	SPARE		20	1	0.00	0.00					1	20		SPARE	26
27	SPARE		20	1			0.00	0.00			1	20		SPARE	28
29	SPARE		20	1					0.00	0.00	1	20		SPARE	30
31	SPARE		20	1	0.00	0.00					1	20		SPARE	32
33	SPARE		20	1			0.00	0.00			1	20		SPARE	34
35	SPARE		20	1					0.00	0.00	1	20		SPARE	36
37	SPARE		20	1	0.00	0.00					1	20		SPARE	38
39	SPARE		20	1			0.00	0.00			1	20		SPARE	40
41	SPARE		20	1					0.00	0.00	1	20		SPARE	42
	LOAD PER PHASE				**8.21**		**4.96**		**5.78**						

TOTAL = 18.95 kVA | **53 AMPS** | A = AFI BREAKER

NOTES:☐ FEED THROUGH LUGS☐ FLUSH☐ 600KCM LUGS☐ ISOLATED GROUND BUS G = GFI BREAKER

1.

2.

65K AIC	208Y/120V 3P-4W					RP-LN3							Bus: 225A Main: 100A CB		
Ckt. #	Description	Wire Size	Trip	Pole	Load (kVA) A		B		C		Pole	Trip	Wire Size	Description	Ckt. #
1	Receptacles	2#12+G-3/4"C.	20	1P	0.72	0.72					1P	20	2#12+G-3/4"C.	Receptacles	2
3	EWC	2#12+G-3/4"C.	20	1P			0.50	0.50			1P	20	2#12+G-3/4"C.	EWC	4
5	Coat Rack	2#12+G-3/4"C.	20	1P					1.20	1.08	1P	20	2#12+G-3/4"C.	Receptacles	6
7	Coat Rack	2#12+G-3/4"C.	20	1P	1.20	0.72					1P	20	2#12+G-3/4"C.	Receptacles	8
9	Receptacles	2#12+G-3/4"C.	20	1P			0.54	1.20			1P	20	2#12+G-3/4"C.	Lighting (R3, R4)	10
11	Receptacles (R2)	2#12+G-3/4"C.	20	1P					0.36	0.54	1P	20	2#12+G-3/4"C.	Receptacles (R3)	12
13	Receptacles (R1)	2#12+G-3/4"C.	20	1P	0.54	0.23					1P	20	2#10+G-3/4"C.	Site Ltg. - FC-1/FBB	14
15	Site Ltg. - FC	2#10+G-3/4"C.	20	1P			0.16	0.84			1P	20	2#10+G-3/4"C.	Site Ltg. - FBB/FBC	16
17	Powered Sign	2#10+G-3/4"C.	20	1P					0.80	1.80	1P	20	2#10+G-3/4"C.	Charging Station	18
19	Charging Station	2#10+G-3/4"C.	20	1P	1.80	1.80					1P	20	2#10+G-3/4"C.	Charging Station	20
21	Site Ltg. - FBX	2#10+G-3/4"C.	20	1P			0.20	0.00			1P	20	2#12+G-3/4"C.	Receptacles	22
23	Site - XFD,XFF	2#10+G-3/4"C.	20	1P					0.48	0.00	1P	20		Spare	24
25	Spare		20	1P	0.00	0.00					1P	20		Spare	26
27	Site - XFE,XFH	2#10+G-3/4"C.	20	1P			0.19	0.32			1P	20	2#10+G-3/4"C.	Site - XFE,XFH	28
29	Spare		20	1P					0.00	0.00	1P	20		Spare	30
31	Spare		20	1P	0.00	0.00					1P	20		Spare	32
33	Site - XFG,XFH	2#10+G-3/4"C.	20	1P			0.19	0.16			1P	20	2#10+G-3/4"C.	Site - XFC	34
35	Spare		20	1P					0.00	0.00	1P	20		Spare	36
37	Spare		20	1P	0.00	0.00					1P	20		Spare	38
39	Spare		20	1P			0.00	0.00			1P	20		Spare	40
41	Spare		20	1P					0.00	0.00	1P	20		Spare	42
				Load Per Phase:	7.73		4.80		6.26						

Load Summary			D.F.	Demand Loads
Lighting	3.97	kVA	1.25	4.96 kVA
Receptacle (First 10)	5.58	kVA	1.00	5.58 kVA
Receptacle (Excess)	0	kVA	0.50	0 kVA

Demand Loads	D.F.	Load Summary		
0.625 kVA	1.25	kVA	0.5	Largest Motor
0.5 kVA	1.00	kVA	0.5	Other Motors
0 kVA	0.80	kVA	0	Appliances
7.8 kVA	1.00	kVA	7.8	Equipment

	Connected Load		Demand Load
Total Load (kVA)	18.35	kVA	19.47 kVA
Total Load (A)	50.97	A	54.07 A
Design Load (A)			225 A
Spare (A)			170.93 A

RP-LS1

208 Y/120V		65K AIC	3Ø-4W	RP-LS1	BUS: 225 AMP	MAIN: 225 AMP CB

	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA ØA		ØB		ØC		POLE	TRIP	WIRE SIZE	LOAD SERVED	
1	RECEPTACLES	2#12+G-3/4"C.	20	1	1.08	0.00					1	20	2#12+G-3/4"C.	RECEPTACLES	2
3	RECEPT., FCU-3	2#12+G-3/4"C.	20	1			0.79	0.70			1	20	2#12+G-3/4"C.	FCU-14	4
5	RECEPTACLES	2#12+G-3/4"C.	20	1					0.72	0.50	1	20	2#12+G-3/4"C.	UC REFRIG.	6
7	MICROWAVE	2#12+G-3/4"C.	20	1	1.00	0.75					1	20	2#12+G-3/4"C.	HW HEATER	8
9	COFFEE MAKER	2#12+G-3/4"C.	20	1			0.50	0.20			1	20	2#12+G-3/4"C.	RECEPTACLES	10
11	RECEPTACLES	2#12+G-3/4"C.	20	1					0.72	0.90	1	20	2#12+G-3/4"C.	RECEPTACLES	12
13	RECEPTACLES	2#12+G-3/4"C.	20	1	0.72	0.72					1	20	2#12+G-3/4"C.	RECEPTACLES	14
15	RECEPTACLES	2#12+G-3/4"C.	20	1			0.72	0.20			1	20	2#12+G-3/4"C.	RECEPTACLES	16
17	RECEPTACLES	2#12+G-3/4"C.	20	1					0.90	0.90	1	20	2#12+G-3/4"C.	RECEPTACLES	18
19	RECEPTACLES	2#12+G-3/4"C.	20	1	1.08	0.90					1	20	2#12+G-3/4"C.	RECEPTACLES	20
21	HOLDING CABINET	2#12+G-3/4"C.	20	1			1.80	1.80			1	20	2#12+G-3/4"C.	HOLDING CABINET	22
23	HOLDING CABINET	2#12+G-3/4"C.	20	1					1.80	1.80	1	20	2#12+G-3/4"C.	HOLDING CABINET	24
25	REACH-IN REFRIG	2#12+G-3/4"C.	20	1	1.06	3.80									26
27	RECEPTACLES	2#12+G-3/4"C.	20	1			0.54	3.80			3	50	3#8+G-1"C.	AIRPOT COFFEE MAKER	28
29	LIGHTED CABINET	2#12+G-3/4"C.	20	1					0.24	3.80					30
31	UC ICE MAKER	2#12+G-3/4"C.	20	1	0.62	0.00					1	20		SPARE	32
33	SITE LTG. - FBA	2#10+G-3/4"C.	20	1			0.99	0.70			1	20	2#10+G-3/4"C.	SITE LTG. - FC	34
35	POWERED SIGN	2#10+G-3/4"C.	20	1					1.00	0.20	1	20	2#10+G-3/4"C.	POWERED SIGN	36
37	SITE RECEPTACLES	2#10+G-3/4"C.	20	1	0.36	0.36					1	20	2#10+G-3/4"C.	SITE RECEPTACLES	38
39	PROJ. SCREEN	2#12+G-3/4"C.	20	1			1.50	0.00			1	20		SPARE	40
41	SPARE		20	1					0.00	0.00	1	20		SPARE	42
		LOAD PER PHASE			12.45		14.24		13.48						
		TOTAL =					40.17 kVA				112 AMPS			A = AFI BREAKER	

NOTES: ☐ FEED THROUGH LUGS ☐ FLUSH ☐ 600KCM LUGS ☐ ISOLATED GROUND BUS G = GFI BREAKER

1.

2.

RP-LS1

65K AIC | 208Y/120V 3P-4W | Bus: 225A | Main: 225A CB

Ckt. #	Description	Wire Size	Trip	Pole	Load (kVA) A		B		C		Pole	Trip	Wire Size	Description	Ckt. #
1	Receptacles	2#12+G-3/4"C.	20	1P	1.08	0.00					1P	20	2#12+G-3/4"C.	Receptacles	2
3	Recept., FCU-3	2#12+G-3/4"C.	20	1P			0.79	0.70			1P	20	2#12+G-3/4"C.	FCU-14	4
5	Receptacles	2#12+G-3/4"C.	20	1P					0.72	0.50	1P	20	2#12+G-3/4"C.	UC Refrig.	6
7	Microwave	2#12+G-3/4"C.	20	1P	1.00	0.75					1P	20	2#12+G-3/4"C.	HW Heater	8
9	Coffee Maker	2#12+G-3/4"C.	20	1P			0.50	0.20			1P	20	2#12+G-3/4"C.	Receptacles	10
11	Receptacles	2#12+G-3/4"C.	20	1P					0.72	0.90	1P	20	2#12+G-3/4"C.	Receptacles	12
13	Receptacles	2#12+G-3/4"C.	20	1P	0.72	0.72					1P	20	2#12+G-3/4"C.	Receptacles	14
15	Receptacles	2#12+G-3/4"C.	20	1P			0.72	0.20			1P	20	2#12+G-3/4"C.	Receptacles	16
17	Receptacles	2#12+G-3/4"C.	20	1P					0.90	0.90	1P	20	2#12+G-3/4"C.	Receptacles	18
19	Receptacles	2#12+G-3/4"C.	20	1P	1.08	0.90					1P	20	2#12+G-3/4"C.	Receptacles	20
21	Holding Cabinet	2#12+G-3/4"C.	20	1P			1.80	1.80			1P	20	2#12+G-3/4"C.	Holding Cabinet	22
23	Holding Cabinet	2#12+G-3/4"C.	20	1P					1.80	1.80	1P	20	2#12+G-3/4"C.	Holding Cabinet	24
25	Reach-In Refrig.	2#12+G-3/4"C.	20	1P	1.06	3.80									26
27	Receptacles	2#12+G-3/4"C.	20	1P			0.54	3.80			1P	20	3#8+G-1"C.	Airpot Coffee Maker	28
29	Lighted Cabinet	2#12+G-3/4"C.	20	1P					0.24	3.80					30
31	UC Ice Maker	2#12+G-3/4"C.	20	1P	0.62	0.00					1P	20		Spare	32
33	Site Ltg. - FBA	2#10+G-3/4"C.	20	1P			0.99	0.00			1P	20		Spare	34
35	Powered Sign	2#10+G-3/4"C.	20	1P					1.00	0.20	1P	20	2#10+G-3/4"C.	Powered Sign	36
37	Site Receptacles	2#10+G-3/4"C.	20	1P	0.36	0.36					1P	20	2#10+G-3/4"C.	Site Receptacles	38
39	Proj. Screen	2#12+G-3/4"C.	20	1P			1.50	0.00			1P	20		Spare	40
41	Spare		20	1P					0.00	0.00	1P	20		Spare	42
				Load Per Phase:	12.45		13.54		13.48						

Load Summary			D.F.	Demand Loads
Lighting	1.23	kVA	1.25	1.5375 kVA
Receptacle (First)	10	kVA	1.00	10 kVA
Receptacle (Excess)	1.81	kVA	0.50	0.905 kVA

Demand Loads	D.F.	Load Summary		
0.875 kVA	1.25	kVA	0.70	Largest Motor
0.7 kVA	1.00	kVA	0.7	Other Motors
17.824 kVA	0.80	kVA	22.28	Appliances
2.7 kVA	1.00	kVA	2.70	Equipment

	Connected Load		Demand Load
Total Load (kVA)	39.42	kVA	34.54 kVA
Total Load (A)	109.50	A	95.95 A
Design Load (A)			225 A
Spare (A)			129.05 A

RP-1N1

The following panel is an 84 pole panel, the remaining half of the panel has only spare circuits.

208 Y/120V | 65K AIC | 3Ø-4W

RP-1N1

BUS: 225 AMP | MAIN: 225 AMP CB

	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA ØA		ØB		ØC		POLE	TRIP	WIRE SIZE	LOAD SERVED	
1	ROLL UP DOOR OPENER	2#12+G-3/4"C.	25	1	1.65	0.86					1	20	2#12+G-3/4"C.	ROLL UP DOOR OPENER	2
3	SPARE		20	1			0.00	0.86			1	20	2#12+G-3/4"C.	ROLL UP DOOR OPENER	4
5	RECEPTACLES	2#12+G-3/4"C.	20	1					1.06	0.90	1	20	2#12+G-3/4"C.	RECEPTACLES	6
7	RECEPTACLES	2#12+G-3/4"C.	20	1	0.60	0.72					1	20	2#12+G-3/4"C.	RECEPTACLES	8
9	RECEPTACLES	2#12+G-3/4"C.	20	1			0.72	0.90			1	20	2#12+G-3/4"C.	RECEPTACLES	10
11	RECEPTACLES	2#12+G-3/4"C.	20	1					0.54	0.90	1	20	2#12+G-3/4"C.	RECEPTACLES	12
13	RECEPTACLES	2#12+G-3/4"C.	20	1	0.36	0.54					1	20	2#12+G-3/4"C.	RECEPTACLES	14
15	RECEPTACLES	2#12+G-3/4"C.	20	1			1.26	0.54			1	20	2#12+G-3/4"C.	RECEPTACLES	16
17	RECEPTACLES	2#12+G-3/4"C.	20	1					1.08	0.54	1	20	2#12+G-3/4"C.	RECEPTACLES	18
19	RECEPTACLES	2#12+G-3/4"C.	20	1	0.72	0.36					1	20	2#12+G-3/4"C.	RECEPTACLES	20
21	FCU-5	2#12+G-3/4"C.	20	1			0.70	0.86			1	20	2#12+G-3/4"C.	EF-2	22
23	EF-3	2#12+G-3/4"C.	20	1					0.70	0.86	1	20	2#12+G-3/4"C.	EF-5	24
25	EF-6	2#12+G-3/4"C.	20	1	0.86	1.06					1	20	2#12+G-3/4"C.	ENTRY LIGHTS RELAY	26
27	CAFÉ ENTRY RELAY	2#12+G-3/4"C.	20	1			0.10	0.00			1	20		SPARE	28
29	LOADING RELAY	2#12+G-3/4"C.	20	1					0.80	0.00	1	20		SPARE	30
31	SPARE		20	1	0.00	0.00					1	20		SPARE	32
33	SPARE		20	1			0.00	0.00			1	20		SPARE	34
35	SPARE		20	1					0.00	0.00	1	20		SPARE	36
37					0.00	0.00									38
39	SPECIAL EVENTS DISCONNECT #1	4#10 + #10G	30	3			0.00	0.00			3	30	4#10 + #10G	SPECIAL EVENTS DISCONNECT #2	40
41									0.00	0.00					42
	LOAD PER PHASE				7.73		5.94		7.38					SECTION #1	

TOTAL = 21.06 kVA 58 AMPS A = AFI BREAKER

NOTES: ☐ FEED THROUGH LUGS ☐ FLUSH ☐ 600KCM LUGS ☐ ISOLATED GROUND BUS G = GFI BREAKER

1.

2.

65K AIC	208Y/120V 3P-4W				RP-1N1								Bus: 225A Main: 225A CB		
Ckt. #	Description	Wire Size	Trip	Pole	Load (kVA) A		B		C		Pole	Trip	Wire Size	Description	Ckt. #
1	Roll Up Door Opener	2#12+G-3/4"C.	20	1P	1.65	0.86					1P	20	2#12+G-3/4"C.	Roll Up Door Opener	2
3	Spare		20	1P			0.00	0.86			1P	20	2#12+G-3/4"C.	Roll Up Door Opener	4
5	Receptacles	2#12+G-3/4"C.	20	1P					1.06	0.90	1P	20	2#12+G-3/4"C.	Receptacles	6
7	Receptacles	2#12+G-3/4"C.	20	1P	0.60	0.72					1P	20	2#12+G-3/4"C.	Receptacles	8
9	Receptacles	2#12+G-3/4"C.	20	1P			0.72	0.90			1P	20	2#12+G-3/4"C.	Receptacles	10
11	Receptacles	2#12+G-3/4"C.	20	1P					0.54	0.90	1P	20	2#12+G-3/4"C.	Receptacles	12
13	Receptacles	2#12+G-3/4"C.	20	1P	0.36	0.54					1P	20	2#12+G-3/4"C.	Receptacles	14
15	Receptacles	2#12+G-3/4"C.	20	1P			1.26	0.54			1P	20	2#12+G-3/4"C.	Receptacles	16
17	Receptacles	2#12+G-3/4"C.	20	1P					1.08	0.54	1P	20	2#12+G-3/4"C.	Receptacles	18
19	Receptacles	2#12+G-3/4"C.	20	1P	0.72	0.36					1P	20	2#12+G-3/4"C.	Receptacles	20
21	FCU-5	2#12+G-3/4"C.	20	1P			0.70	0.86			1P	20	2#12+G-3/4"C.	EF-2	22
23	EF-3	2#12+G-3/4"C.	20	1P					0.70	0.86	1P	20	2#12+G-3/4"C.	EF-5	24
25	EF-6	2#12+G-3/4"C.	20	1P	0.86	1.06					1P	20	2#12+G-3/4"C.	Entry Lights Relay	26
27	Café Entry Relay	2#12+G-3/4"C.	20	1P			0.10	0.47			1P	20	2#12+G-3/4"C.	Light Court - FB,FE,FJ	28
29	Loading Relay	2#12+G-3/4"C.	20	1P					0.80	0.00	1P	20		Spare	30
31	Spare	2#12+G-3/4"C.	20	1P	0.00	0.00					1P	20		Spare	32
33	Light Court - FB,FE	2#12+G-3/4"C.	20	1P			0.44	0.45			1P	20	2#12+G-3/4"C.	Light Court - FE,FF	34
35	Spare		20	1P					0.00	0.00	1P	20		Spare	36
37	Special Events Disconnect #1	4#10+#10G	30	3P	0.00	0.00					3P	30	4#10+#10G	Special Events Disconnect #2	38
39							0.00	0.00							40
41									0.00	0.00					42
43	Spare		20	1P	0.00	0.00					1P	20		Spare	44
45	Spare		20	1P			0.00	0.00			1P	20		Spare	46
47	Spare		20	1P					0.00	0.00	1P	20		Spare	48
49	Spare		20	1P	0.00	0.00					1P	20		Spare	50
51	Spare		20	1P			0.00	0.00			1P	20		Spare	52
53	Spare		20	1P					0.00	0.00	1P	20		Spare	54
55	Spare		20	1P	0.00	0.00					1P	20		Spare	56
57	Spare		20	1P			0.00	0.00			1P	20		Spare	58
59	Spare		20	1P					0.00	0.00	1P	20		Spare	60
61	Spare		20	1P	0.00	0.00					1P	20		Spare	62
63	Spare		20	1P			0.00	0.00			1P	20		Spare	64
65	Spare		20	1P					0.00	0.00	1P	20		Spare	66
67	Spare		20	1P	0.00	0.00					1P	20		Spare	68
69	Spare		20	1P			0.00	0.00			1P	20		Spare	70
71	Spare		20	1P					0.00	0.00	1P	20		Spare	72
73	Spare		20	1P	0.00	0.00					1P	20		Spare	74
75	Spare		20	1P			0.00	0.00			1P	20		Spare	76
77	Spare		20	1P					0.00	0.00	1P	20		Spare	78
79	Spare		20	1P	0.00	0.00					1P	20		Spare	80
81	Spare		20	1P			0.00	0.00			1P	20		Spare	82
83	Spare		20	1P					0.00	0.00	1P	20		Spare	84
				Load Per Phase:	7.73		7.30		7.38						

Load Summary			D.F.	Demand Loads
Lighting	1.36	kVA	1.25	1.70 kVA
Receptacle (First)	10	kVA	1.00	10 kVA
Receptacle (Excess)	1.74	kVA	0.50	0.87 kVA

Demand Loads	D.F.	Load Summary		
0 kVA	1.25	kVA	0	Largest Motor
0 kVA	1.00	kVA	0	Other Motors
0 kVA	0.80	kVA		Appliances
9.31 kVA	1.00	kVA	9.31	Equipment

	Connected Load		Demand Load
Total Load (kVA)	22.41205	kVA	21.88 kVA
Total Load (A)	62.26	A	60.78 A
Design Load (A)			225 A
Spare (A)			164.22 A

RP-2N1

The following panel is an 84 pole panel, the remaining half of the panel has only spare circuits.

	208 Y/120V						RP-2N1						BUS: 225 AMP		
	65K AIC	3Ø-4W											MAIN: 225 AMP CB		
	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA						POLE	TRIP	WIRE SIZE	LOAD SERVED	
					ØA		ØB		ØC						
1	EF-11	2#12+G-3/4"C.	20	1	0.70	0.54					1	20	2#12+G-3/4"C.	RECEPTACLES	2
3	EWC	2#12+G-3/4"C.	20	1			0.53	0.53			1	20	2#12+G-3/4"C.	EWC	4
5	RECEPTACLES	2#12+G-3/4"C.	20	1					1.08	0.54	1	20	2#12+G-3/4"C.	RECEPTACLES	6
7	RECEPTACLES	2#12+G-3/4"C.	20	1	0.72	0.54					1	20	2#12+G-3/4"C.	WORK STATION RECS.	8
9	WORK STATION RECS.	2#12+G-3/4"C.	20	1			0.54	0.54			1	20	2#12+G-3/4"C.	WORK STATION RECS.	10
11	WORK STATION RECS.	2#12+G-3/4"C.	20	1					0.54	0.80	1	20	2#12+G-3/4"C.	WORK STATION LTG.	12
13	WORK STATION LTG.	2#12+G-3/4"C.	20	1	0.80	0.54					1	20	2#12+G-3/4"C.	WORK STATION RECS.	14
15	RECEPTACLES	2#12+G-3/4"C.	20	1			0.72	0.54			1	20	2#12+G-3/4"C.	WORK STATION RECS.	16
17	RECEPTACLES	2#12+G-3/4"C.	20	1					0.90	0.80	1	20	2#12+G-3/4"C.	WORK STATION LTG.	18
19	RECEPTACLES	2#12+G-3/4"C.	20	1	0.72	0.90					1	20	2#12+G-3/4"C.	RECEPTACLES	20
21	RECEPTACLES	2#12+G-3/4"C.	20	1			0.72	0.72			1	20	2#12+G-3/4"C.	RECEPTACLES	22
23	RECEPTACLES	2#12+G-3/4"C.	20	1					0.72	0.72	1	20	2#12+G-3/4"C.	RECEPTACLES	24
25	LCD	2#12+G-3/4"C.	20	1	0.72	0.72					1	20	2#12+G-3/4"C.	RECEPTACLES	26
27	RECEPTACLES	2#12+G-3/4"C.	20	1			0.72	0.00			1	20		SPARE	28
29	LTG. OUTDOOR EVENTS	2#12+G-3/4"C.	20	1					1.08	1.08	1	20	2#12+G-3/4"C.	LTG. OUTDOOR EVENTS	30
31	LTG. OUTDOOR EVENTS	2#12+G-3/4"C.	20	1	0.48	1.17					1	20	2#12+G-3/4"C.	LTG. OUTDOOR EVENTS	32
33	LTG. CORRIDOR 201,220	2#12+G-3/4"C.	20	1			1.37	1.05			1	20	2#12+G-3/4"C.	LTG. RM. 218-226	34
35	LTG. RM. 218, 219	2#12+G-3/4"C.	20	1					0.75	0.55	1	20	2#12+G-3/4"C.	LTG. RM. 223	36
37	LTG. RM. 229, 231	2#12+G-3/4"C.	20	1	0.35	1.85					1	20	2#12+G-3/4"C.	LTG. RM. 234	38
39	LTG. RM. 234	2#12+G-3/4"C.	20	1			1.82	1.01			1	20	2#12+G-3/4"C.	LTG. RM. 234	40
41	SPARE		20	1					0.00	0.00	1	20		SPARE	42
	LOAD PER PHASE				10.74		10.80		9.56					SECTION #1	
	TOTAL =				31.10 kVA						86 AMPS			A = AFI BREAKER	

NOTES: ☑ FEED THROUGH LUGS ☐ FLUSH ☐ 600KCM LUGS ☐ ISOLATED GROUND BUS G = GFI BREAKER

1. REFER TO SECTION #2 FOR TOTAL PANEL LOAD
2.

65K AIC		208Y/120V 3P-4W			RP-2N1								Bus: 225A Main: 225A CB		
Ckt. #	Description	Wire Size	Trip	Pole	Load (kVA) A		B		C		Pole	Trip	Wire Size	Description	Ckt. #
1	EF-11	2#12+G-3/4"C.	20	1P	0.70	0.54					1P	20	2#12+G-3/4"C.	Receptacles	2
3	EWC	2#12+G-3/4"C.	20	1P			0.53	0.53			1P	20	2#12+G-3/4"C.	EWC	4
5	Receptacles	2#12+G-3/4"C.	20	1P					1.08	0.54	1P	20	2#12+G-3/4"C.	Receptacles	6
7	Receptacles	2#12+G-3/4"C.	20	1P	0.72	0.54					1P	20	2#12+G-3/4"C.	Work Station Recs.	8
9	Work Station Recs.	2#12+G-3/4"C.	20	1P			0.54	0.54			1P	20	2#12+G-3/4"C.	Work Station Recs.	10
11	Work Station Recs.	2#12+G-3/4"C.	20	1P					0.54	0.80	1P	20	2#12+G-3/4"C.	Work Station Ltg.	12
13	Work Station Ltg.	2#12+G-3/4"C.	20	1P	0.54	0.54					1P	20	2#12+G-3/4"C.	Work Station Recs.	14
15	Receptacles	2#12+G-3/4"C.	20	1P			0.72	0.54			1P	20	2#12+G-3/4"C.	Work Station Recs.	16
17	Receptacles	2#12+G-3/4"C.	20	1P					0.90	0.80	1P	20	2#12+G-3/4"C.	Work Station Ltg.	18
19	Receptacles	2#12+G-3/4"C.	20	1P	0.72	0.90					1P	20	2#12+G-3/4"C.	Receptacles	20
21	Receptacles	2#12+G-3/4"C.	20	1P			0.72	0.72			1P	20	2#12+G-3/4"C.	Receptacles	22
23	Receptacles	2#12+G-3/4"C.	20	1P					0.72	0.72	1P	20	2#12+G-3/4"C.	Receptacles	24
25	LCD	2#12+G-3/4"C.	20	1P	0.72	0.72					1P	20	2#12+G-3/4"C.	Receptacles	26
27	Receptacles	2#12+G-3/4"C.	20	1P			0.72	0.00			1P	20		Spare	28
29	Light Box - XFA	2#12+G-3/4"C.	20	1P					0.54	0.72	1P	20	2#12+G-3/4"C.	Light Box - XFB	30
31	Light Box - XFB	2#12+G-3/4"C.	20	1P	0.71	1.17					1P	20	2#12+G-3/4"C.	Ltg. Outdoor Event	32
33	Ltg. Corridor 201, 220	2#12+G-3/4"C.	20	1P			1.37	1.05			1P	20	2#12+G-3/4"C.	Ltg. Rm - 218-226	34
35	Ltg. Rm - 218, 219	2#12+G-3/4"C.	20	1P					0.75	0.55	1P	20	2#12+G-3/4"C.	Ltg. Rm - 223	36
37	Ltg. Rm - 229, 231	2#12+G-3/4"C.	20	1P	0.35	1.85					1P	20	2#12+G-3/4"C.	Ltg. Rm - 234	38
39	Ltg. Rm - 234	2#12+G-3/4"C.	20	1P			1.82	1.01			1P	20	2#12+G-3/4"C.	Ltg. Rm - 234	40
41	Spare		20	1P					0.00	0.00	1P	20		Spare	42
43	Spare		20	1P	0.00	0.00					1P	20		Spare	44
45	Spare		20	1P			0.00	0.00			1P	20		Spare	46
47	Spare		20	1P					0.00	0.00	1P	20		Spare	48
49	Spare		20	1P	0.00	0.00					1P	20		Spare	50
51	Spare		20	1P			0.00	0.00			1P	20		Spare	52
53	Spare		20	1P					0.00	0.00	1P	20		Spare	54
55	Spare		20	1P	0.00	0.00					1P	20		Spare	56
57	Spare		20	1P			0.00	0.00			1P	20		Spare	58
59	Spare		20	1P					0.00	0.00	1P	20		Spare	60
61	Spare		20	1P	0.00	0.00					1P	20		Spare	62
63	Spare		20	1P			0.00	0.00			1P	20		Spare	64
65	Spare		20	1P					0.00	0.00	1P	20		Spare	66
67	Spare		20	1P	0.00	0.00					1P	20		Spare	68
69	Spare		20	1P			0.00	0.00			1P	20		Spare	70
71	Spare		20	1P					0.00	0.00	1P	20		Spare	72
73	Spare		20	1P	0.00	0.00					1P	20		Spare	74
75	Spare		20	1P			0.00	0.00			1P	20		Spare	76
77	Spare		20	1P					0.00	0.00	1P	20		Spare	78
79	Spare		20	1P	0.00	0.00					1P	20		Spare	80
81	Spare		20	1P			0.00	0.00			1P	20		Spare	82
83	Spare		20	1P					0.00	0.00	1P	20		Spare	84
			Load Per Phase:		10.72		10.81		8.66						

Load Summary			D.F.	Demand Loads
Lighting	14.03	kVA	1.25	17.53 kVA
Receptacle (First)	10	kVA	1.00	10 kVA
Receptacle (Excess)	3.68	kVA	0.50	1.84 kVA

Demand Loads	D.F.	Load Summary		
0 kVA	1.25	kVA	0	Largest Motor
0 kVA	1.00	kVA	0	Other Motors
0.576 kVA	0.80	kVA	0.72	Appliances
1.76 kVA	1.00	kVA	1.76	Equipment

	Connected Load		Demand Load
Total Load (kVA)	30.185	kVA	31.71 kVA
Total Load (A)	83.85	A	88.08 A
Design Load (A)			225 A
Spare (A)			136.92 A

RP-2N2

The following panel is an 84 pole panel, the remaining half of the panel has only spare circuits.

208 Y/120V 65K AIC 3Ø-4W					RP-2N2									BUS: 225 AMP MAIN: 225 AMP CB		
	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA						POLE	TRIP	WIRE SIZE	LOAD SERVED	
					ØA		ØB		ØC						
1	WORK STATION RECS.	2#12+G-3/4"C.	20	1	0.54	0.54					1	20	2#12+G-3/4"C.	WORK STATION RECS.	2
3	WORK STATION RECS.	2#12+G-3/4"C.	20	1			0.54	0.54			1	20	2#12+G-3/4"C.	WORK STATION RECS.	4
5	WORK STATION LTG.	2#12+G-3/4"C.	20	1					0.80	0.80	1	20	2#12+G-3/4"C.	WORK STATION LTG.	6
7	WORK STATION RECS.	2#12+G-3/4"C.	20	1	0.54	0.54					1	20	2#12+G-3/4"C.	WORK STATION RECS.	8
9	WORK STATION RECS.	2#12+G-3/4"C.	20	1			0.54	0.54			1	20	2#12+G-3/4"C.	WORK STATION RECS.	10
11	WORK STATION LTG.	2#12+G-3/4"C.	20	1					0.80	0.80	1	20	2#12+G-3/4"C.	WORK STATION LTG.	12
13	WORK STATION RECS.	2#12+G-3/4"C.	20	1	0.54	0.54					1	20	2#12+G-3/4"C.	WORK STATION RECS.	14
15	WORK STATION RECS.	2#12+G-3/4"C.	20	1			0.54	0.80			1	20	2#12+G-3/4"C.	WORK STATION LTG.	16
17	WORK STATION LTG.	2#12+G-3/4"C.	20	1					0.80	0.72	1	20	2#12+G-3/4"C.	RECEPTACLES	18
19	RECEPTACLES	2#12+G-3/4"C.	20	1	1.08	0.72					1	20	2#12+G-3/4"C.	RECEPTACLES	20
21	RECEPTACLES	2#12+G-3/4"C.	20	1			0.36	0.18			1	20	2#12+G-3/4"C.	RECEPTACLES	22
23	RECEPTACLES	2#12+G-3/4"C.	20	1					0.72	0.72	1	20	2#12+G-3/4"C.	RECEPTACLES	24
25	LTG. OUTDR. EVENT	2#12+G-3/4"C.	20	1	1.89	1.89					1	20	2#12+G-3/4"C.	LTG. OUTDR. EVENT	26
27	LTG. OUTDR. EVENT	2#12+G-3/4"C.	20	1			1.47	1.47			1	20	2#12+G-3/4"C.	LTG. OUTDR. EVENT	28
29	LTG. OUTDR. EVENT	2#12+G-3/4"C.	20	1					1.05	1.26	1	20	2#12+G-3/4"C.	LTG. OUTDR. EVENT	30
31	LTG. RM. 204-216	2#12+G-3/4"C.	20	1	1.44	0.83					1	20	2#12+G-3/4"C.	LTG. RM. 204	32
33	LTG. RM. - 211-216	2#12+G-3/4"C.	20	1			0.30	1.26			1	20	2#12+G-3/4"C.	LTG. RM. STAIR-2	34
35	SPARE		20	1					0.00	0.00	1	20		SPARE	36
37	SPARE		20	1	0.00	0.00					1	20		SPARE	38
39	SPARE		20	1			0.00	0.00			1	20		SPARE	40
41	SPARE		20	1					0.00	0.00	1	20		SPARE	42
	LOAD PER PHASE				11.09		8.54		8.47					SECTION #1	
	TOTAL =				28.10 kVA						78 AMPS			A = AFI BREAKER	

NOTES: ☑ FEED THROUGH LUGS ☐ FLUSH ☐ 600KCM LUGS ☐ ISOLATED GROUND BUS G = GFI BREAKER

1. REFER TO SECTION #2 FOR TOTAL PANEL LOAD
2.

	65K AIC	208Y/120V 3P-4W					**RP-2N2**						Bus: 225A Main: 225A CB	
Ckt. #	Description	Wire Size	Trip	Pole	Load (kVA) A		B		C		Pole	Trip	Wire Size	Description	Ckt. #
1	Work Station Recs.	2#12+G-3/4"C.	20	1P	0.54	0.54					1P	20	2#12+G-3/4"C.	Work Station Recs.	2
3	Work Station Recs.	2#12+G-3/4"C.	20	1P			0.54	0.54			1P	20	2#12+G-3/4"C.	Work Station Recs.	4
5	Work Station Ltg.	2#12+G-3/4"C.	20	1P					0.80	0.80	1P	20	2#12+G-3/4"C.	Work Station Ltg.	6
7	Work Station Recs.	2#12+G-3/4"C.	20	1P	0.54	0.54					1P	20	2#12+G-3/4"C.	Work Station Recs.	8
9	Work Station Recs.	2#12+G-3/4"C.	20	1P			0.54	0.54			1P	20	2#12+G-3/4"C.	Work Station Recs.	10
11	Work Station Ltg.	2#12+G-3/4"C.	20	1P					0.80	0.80	1P	20	2#12+G-3/4"C.	Work Station Ltg.	12
13	Work Station Recs.	2#12+G-3/4"C.	20	1P	0.54	0.54					1P	20	2#12+G-3/4"C.	Work Station Recs.	14
15	Work Station Recs.	2#12+G-3/4"C.	20	1P			0.54	0.80			1P	20	2#12+G-3/4"C.	Work Station Ltg.	16
17	Work Station Ltg.	2#12+G-3/4"C.	20	1P					0.80	0.72	1P	20	2#12+G-3/4"C.	Receptacles	18
19	Receptacles	2#12+G-3/4"C.	20	1P	1.08	0.72					1P	20	2#12+G-3/4"C.	Receptacles	20
21	Receptacles	2#12+G-3/4"C.	20	1P			0.36	0.18			1P	20	2#12+G-3/4"C.	Receptacles	22
23	Receptacles	2#12+G-3/4"C.	20	1P					0.72	0.72	1P	20	2#12+G-3/4"C.	Receptacles	24
25	Light Court - FA	2#12+G-3/4"C.	20	1P	0.30	0.25					1P	20	2#12+G-3/4"C.	Light Court - FA	26
27	Spare		20	1P			0.00	0.76			1P	20	2#12+G-3/4"C.	Office - FH,FM	28
29	Spare		20	1P					0.00	0.42	1P	20	2#12+G-3/4"C.	Office - FL	30
31	Ltg. Rm - 205-216	2#12+G-3/4"C.	20	1P	0.89	0.53					1P	20	2#12+G-3/4"C.	Office - FH,FM	32
33	Ltg. Rm - 211-216	2#12+G-3/4"C.	20	1P			0.30	1.26			1P	20	2#12+G-3/4"C.	Ltg. Rm - Stair-2	34
35	Spare		20	1P					0.00	0.00	1P	20		Spare	36
37	Spare		20	1P	0.00	0.00					1P	20		Spare	38
39	Spare		20	1P			0.00	0.00			1P	20		Spare	40
41	Spare		20	1P					0.00	0.00	1P	20		Spare	42
43	Spare		20	1P	0.00	0.00					1P	20		Spare	44
45	Spare		20	1P			0.00	0.00			1P	20		Spare	46
47	Spare		20	1P					0.00	0.00	1P	20		Spare	48
49	Spare		20	1P	0.00	0.00					1P	20		Spare	50
51	Spare		20	1P			0.00	0.00			1P	20		Spare	52
53	Spare		20	1P					0.00	0.00	1P	20		Spare	54
55	Spare		20	1P	0.00	0.00					1P	20		Spare	56
57	Spare		20	1P			0.00	0.00			1P	20		Spare	58
59	Spare		20	1P					0.00	0.00	1P	20		Spare	60
61	Spare		20	1P	0.00	0.00					1P	20		Spare	62
63	Spare		20	1P			0.00	0.00			1P	20		Spare	64
65	Spare		20	1P					0.00	0.00	1P	20		Spare	66
67	Spare		20	1P	0.00	0.00					1P	20		Spare	68
69	Spare		20	1P			0.00	0.00			1P	20		Spare	70
71	Spare		20	1P					0.00	0.00	1P	20		Spare	72
73	Spare		20	1P	0.00	0.00					1P	20		Spare	74
75	Spare		20	1P			0.00	0.00			1P	20		Spare	76
77	Spare		20	1P					0.00	0.00	1P	20		Spare	78
79	Spare		20	1P	0.00	0.00					1P	20		Spare	80
81	Spare		20	1P			0.00	0.00			1P	20		Spare	82
83	Spare		20	1P					0.00	0.00	1P	20		Spare	84
				Load Per Phase:	**7.01**		**6.36**		**6.58**						

Load Summary			D.F.	Demand Loads
Lighting	9.50	kVA	1.25	11.88 kVA
Receptacle (First)	10	kVA	1.00	10 kVA
Receptacle (Excess)	0.44	kVA	0.50	0.22 kVA

Demand Loads	D.F.		Load Summary	
0 kVA	1.25	kVA	0	Largest Motor
0 kVA	1.00	kVA	0	Other Motors
0 kVA	0.80	kVA	0	Appliances
0 kVA	1.00	kVA	0	Equipment

	Connected Load		Demand Load
Total Load (kVA)	19.94	kVA	22.10 kVA
Total Load (A)	55.39	A	61.38 A
Design Load (A)			225 A
Spare (A)			163.63 A

ERL-LN

65K AIC		208Y/120V 3P-4W			ERL-LN								Bus: 100A Main: 100A CB		
Ckt. #	Description	Wire Size	Trip	Pole	Load (kVA)						Pole	Trip	Wire Size	Description	Ckt. #
					A		B		C						
1	Bldg. Site Ltg.	2#10+G-3/4"C.	20	1P	0.45	0.94					3P	20	3#12+G-3/4"C.	Sprinkler Air Compressor	2
3	Guard House Site Ltg	2#10+G-3/4"C.	20	1P			0.25	0.94							4
5	Catering Lighting	2#10+G-3/4"C.	20	1P					0.50	0.94					6
7	Catering Lighting	2#10+G-3/4"C.	20	1P	0.20	0.00					1P	20		Spare	8
9	Spare		20	1P			0.00	0.00			1P	20		Spare	10
11	EM Lobby - FG,FJ	2#12+G-3/4"C.	20	1P					0.19	0.07	1P	20	2#10+G-3/4"C.	EM Site - XFD	12
13	Spare		20	1P	0.00	0.00					1P	20		Spare	14
15	Spare		20	1P			0.00	0.00			1P	20		Spare	16
17	Spare		20	1P					0.00	0.00	1P	20		Spare	18
19	Spare		20	1P	0.00	0.00					1P	20		Spare	20
21	Spare		20	1P			0.00	0.00			1P	20		Spare	22
23	Spare		20	1P					0.00	0.00	1P	20		Spare	24
25	Spare		20	1P	0.00	0.00					1P	20		Spare	26
27	Spare		20	1P			0.00	0.00			1P	20		Spare	28
29	Spare		20	1P					0.00	0.00	1P	20		Spare	30
31	Spare		20	1P	0.00	0.00					1P	20		Spare	32
33	Spare		20	1P			0.00	0.00			1P	20		Spare	34
35	Spare		20	1P					0.00	0.00	1P	20		Spare	36
37	EDP-LN		20	1P	0.30	0.50					3P	20		EDP-AUD	38
39							0.20	1.40							40
41									0.05	0.60					42
				Load Per Phase:	2.39		2.79		2.347						

Load Summary			D.F.	Demand Loads
Lighting	1.59	kVA	1.25	1.99 kVA
Receptacle (First)	0	kVA	1.00	0 kVA
Receptacle (Excess)	0	kVA	0.50	0 kVA

Demand Loads	D.F.	Load Summary		
0 kVA	1.25	kVA	0	Largest Motor
0 kVA	1.00	kVA	0	Other Motors
0 kVA	0.80	kVA	0	Appliances
5.87 kVA	1.00	kVA	5.87	Equipment

	Connected Load		Demand Load
Total Load (kVA)	7.46	kVA	7.86 kVA
Total Load (A)	20.72	A	21.83 A
Design Load (A)			100 A
Spare (A)			78.17 A

ERL-1N

208 Y/120V 65K AIC 3Ø-4W					ERL-1N									BUS: 100 AMP MAIN: 100 AMP CB		
	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA						POLE	TRIP	WIRE SIZE	LOAD SERVED	
					ØA		ØB		ØC						
1	FACP	2#12+G-3/4"C.	20	1	1.00	1.00					1	20	2#12+G-3/4"C.	AREA OF RESCUE	2
3	FACP	2#12+G-3/4"C.	20	1			1.00	1.45			1	20	2#12+G-3/4"C.	EM. OUTDR. EVNT LTG	4
5	EM. OUTDR. EVNT LTG	2#12+G-3/4"C.	20	1					0.63	0.30	1	20	2#12+G-3/4"C.	SMALL OFFICE LTS	6
7	CAFÉ ENTRY RELAY	2#12+G-3/4"C.	20	1	0.15	0.72					1	20	2#12+G-3/4"C.	ENTRY LIGHTS RELAY	8
9	LOADING RELAY	2#12+G-3/4"C.	20	1			0.80	0.56			1	20	2#12+G-3/4"C.	EM. LTG. CORR. 201,220	10
11	EM. LTG. RM. 218, 219	2#12+G-3/4"C.	20	1					0.45	0.35	1	20	2#12+G-3/4"C.	EM. LTG. RM. 228	12
13	EM. LTG. RM. 229, 231	2#12+G-3/4"C.	20	1	0.45	1.18					1	20	2#12+G-3/4"C.	EM. LTG. RM. 234	14
15	SPARE		20	1			0.00	0.00			1	20		SPARE	16
17	SPARE		20	1					0.00	0.00	1	20		SPARE	18
19	SPARE		20	1	0.00	0.00					1	20		SPARE	20
21	SPARE		20	1			0.00	0.00			1	20		SPARE	22
23	SPARE		20	1					0.00	0.00	1	20		SPARE	24
25	SPARE		20	1	0.00	0.00					1	20		SPARE	26
27	SPARE		20	1			0.00	0.00			1	20		SPARE	28
29	SPARE		20	1					0.00	0.00	1	20		SPARE	30
31	SPARE		20	1	0.00	0.00					1	20		SPARE	32
33	SPARE		20	1			0.00	0.00			1	20		SPARE	34
35	SPARE		20	1					0.00	0.00	1	20		SPARE	36
37	SPARE		20	1	0.00	0.00					1	20		SPARE	38
39	SPARE		20	1			0.00	0.00			1	20		SPARE	40
41	SPARE		20	1					0.00	0.00	1	20		SPARE	42
	LOAD PER PHASE				4.50		3.81		1.73						

TOTAL = 10.04 kVA 28 AMPS A = AFI BREAKER

NOTES:☐ FEED THROUGH LUGS☐ FLUSH☐ 600KCM LUGS☐ ISOLATED GROUND BUS G = GFI BREAKER

1.

2.

65K AIC	208Y/120V 3P-4W	ERL-1N	Bus: 100A Main: 100A CB

Ckt. #	Description	Wire Size	Trip	Pole	Load (kVA) A		B		C		Pole	Trip	Wire Size	Description	Ckt. #
1	FACP	2#12+G-3/4"C.	20	1P	1.00	1.00					1P	20	3#12+G-3/4"C.	Area of Rescue	2
3	FACP	2#12+G-3/4"C.	20	1P			1.00	0.00			1P	20		Spare	4
5	EM. Outdr. Event Ltg.	2#12+G-3/4"C.	20	1P					0.63	0.30	1P	20	3#12+G-3/4"C.	Small Office Lts.	6
7	Café Entry Relay	2#12+G-3/4"C.	20	1P	0.15	0.72					1P	20	3#12+G-3/4"C.	Entry Lights Relay	8
9	Loading Relay	2#12+G-3/4"C.	20	1P			0.80	0.56			1P	20	3#12+G-3/4"C.	EM. Ltg. Corr. 201, 220	10
11	EM. Ltg. Rm - 218, 219	2#12+G-3/4"C.	20	1P					0.45	0.35	1P	20	3#12+G-3/4"C.	EM. Ltg. Rm - 228	12
13	EM. Ltg. Rm - 229, 231	2#12+G-3/4"C.	20	1P	0.45	1.18					1P	20	3#12+G-3/4"C.	EM. Ltg. Rm - 234	14
15	Spare		20	1P			0.00	0.00			1P	20		Spare	16
17	Spare		20	1P					0.00	0.00	1P	20		Spare	18
19	Spare		20	1P	0.00	0.00					1P	20		Spare	20
21	Spare		20	1P			0.00	0.00			1P	20		Spare	22
23	Spare		20	1P					0.00	0.00	1P	20		Spare	24
25	Spare		20	1P	0.00	0.00					1P	20		Spare	26
27	Spare		20	1P			0.00	0.00			1P	20		Spare	28
29	Spare		20	1P					0.00	0.00	1P	20		Spare	30
31	Spare		20	1P	0.00	0.00					1P	20		Spare	32
33	Spare		20	1P			0.00	0.00			1P	20		Spare	34
35	Spare		20	1P					0.00	0.00	1P	20		Spare	36
37	Spare		21	1P	0.00	0.00					1P	21		Spare	38
39	Spare		22	1P			0.00	0.00			1P	22		Spare	40
41	Spare		23	1P					0.00	0.00	1P	23		Spare	42
				Load Per Phase:	4.50		2.36		1.73						

Load Summary			D.F.	Demand Loads
Lighting	3.92	kVA	1.25	4.9 kVA
Receptacle (First)	0	kVA	1.00	0 kVA
Receptacle (Excess)	0	kVA	0.50	0 kVA

Demand Loads	D.F.	Load Summary		
0 kVA	1.25	kVA	0	Largest Motor
0 kVA	1.00	kVA	0	Other Motors
0 kVA	0.80	kVA	0	Appliances
4.67 kVA	1.00	kVA	4.67	Equipment

	Connected Load		Demand Load
Total Load (kVA)	8.59	kVA	9.57 kVA
Total Load (A)	23.86	A	26.58 A
Design Load (A)			100 A
Spare (A)			73.42 A

ERL-2N

	208 Y/120V 65K AIC 3Ø-4W				**ERL-2N**							BUS: 100 AMP MAIN: 100 AMP CB			
	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA ØA		ØB		ØC		POLE	TRIP	WIRE SIZE	LOAD SERVED	
1	EM. LTG. OUTDR. EVENT	2#12+G-3/4"C.	20	1	1.16	1.79					1	20	2#12+G-3/4"C.	EM. LTG. OUTDR. EVENT	2
3	EM. LTG. OUTDR. EVENT	2#12+G-3/4"C.	20	1			1.47	0.50			1	20	2#12+G-3/4"C.	EM. LTG. 205-216	4
5	EM. LTG. RM. 204&216	2#12+G-3/4"C.	20	1					1.03	0.00	1	20		SPARE	6
7	SPARE		20	1	0.00	0.00					1	20		SPARE	8
9	SPARE		20	1			0.00	0.00			1	20		SPARE	10
11	SPARE		20	1					0.00	0.00	1	20		SPARE	12
13	SPARE		20	1	0.00	0.00					1	20		SPARE	14
15	SPARE		20	1			0.00	0.00			1	20		SPARE	16
17	SPARE		20	1					0.00	0.00	1	20		SPARE	18
19	SPARE		20	1	0.00	0.00					1	20		SPARE	20
21	SPARE		20	1			0.00	0.00			1	20		SPARE	22
23	SPARE		20	1					0.00	0.00	1	20		SPARE	24
25	SPARE		20	1	0.00	0.00					1	20		SPARE	26
27	SPARE		20	1			0.00	0.00			1	20		SPARE	28
29	SPARE		20	1					0.00	0.00	1	20		SPARE	30
31	SPARE		20	1	0.00	0.00					1	20		SPARE	32
33	SPARE		20	1			0.00	0.00			1	20		SPARE	34
35	SPARE		20	1					0.00	0.00	1	20		SPARE	36
37	SPARE		20	1	0.00	0.00					1	20		SPARE	38
39	SPARE		20	1			0.00	0.00			1	20		SPARE	40
41	SPARE		20	1					0.00	0.00	1	20		SPARE	42
	LOAD PER PHASE				2.94		1.97		1.03						
	TOTAL =						5.94 kVA					16 AMPS		A = AFI BREAKER	
	NOTES: ☐ FEED THROUGH LUGS ☐ FLUSH ☐ 600KCM LUGS ☐ ISOLATED GROUND BUS													G = GFI BREAKER	
	1.														
	2.														

ERL-2N

65K AIC | 208Y/120V 3P-4W | Bus: 100A | Main: 100A CB

Ckt. #	Description	Wire Size	Trip	Pole	Load (kVA) A		B		C		Pole	Trip	Wire Size	Description	Ckt. #
1	EM. Light Court - FC	2#10+G-3/4"C.	20	1P	1.44	0.00					1P	20		Spare	2
3	Spare		20	1P			0.00	0.50			1P	20	2#10+G-3/4"C.	EM. Ltg. Rm - 205-216	4
5	EM. Ltg. Rm - 204&216	2#10+G-3/4"C.	20	1P					0.28	0.00	1P	20		Spare	6
7	Spare		20	1P	0.00	0.00					1P	20		Spare	8
9	Spare		20	1P			0.00	0.00			1P	20		Spare	10
11	Spare		20	1P					0.00	0.00	1P	20		Spare	12
13	Spare		20	1P	0.00	0.00					1P	20		Spare	14
15	Spare		20	1P			0.00	0.00			1P	20		Spare	16
17	Spare		20	1P					0.00	0.00	1P	20		Spare	18
19	Spare		20	1P	0.00	0.00					1P	20		Spare	20
21	Spare		20	1P			0.00	0.00			1P	20		Spare	22
23	Spare		20	1P					0.00	0.00	1P	20		Spare	24
25	Spare		20	1P	0.00	0.00					1P	20		Spare	26
27	Spare		20	1P			0.00	0.00			1P	20		Spare	28
29	Spare		20	1P					0.00	0.00	1P	20		Spare	30
31	Spare		20	1P	0.00	0.00					1P	20		Spare	32
33	Spare		20	1P			0.00	0.00			1P	20		Spare	34
35	Spare		20	1P					0.00	0.00	1P	20		Spare	36
37	Spare		20	1P	0.00	0.00					1P	20		Spare	38
39	Spare		20	1P			0.00	0.00			1P	20		Spare	40
41	Spare		20	1P					0.00	0.00	1P	20		Spare	42
				Load Per Phase:	1.44		0.50		0.28						

Load Summary			D.F.	Demand Loads
Lighting	2.2	kVA	1.25	2.78 kVA
Receptacle (First)	0	kVA	1.00	0 kVA
Receptacle (Excess)	0	kVA	0.50	0 kVA

Demand Loads	D.F.	Load Summary		
0 kVA	1.25	kVA	0	Largest Motor
0 kVA	1.00	kVA	0	Other Motors
0 kVA	0.80	kVA	0	Appliances
0 kVA	1.00	kVA	0	Equipment

	Connected Load		Demand Load
Total Load (kVA)	2.22	kVA	2.78 kVA
Total Load (A)	6.17	A	7.71 A
Design Load (A)			100 A
Spare (A)			92.29 A

DP-LN2

208V Y/ 120 65000 A.I.C. 3 PHASE 4 WIRE		DIMMER PANEL DP-LN2											GP24 MAIN LUGS ONLY	
ROOM/AREA	DESCRIPTION	CIRCUIT # NORM.		ZONE	CONTROLS	Phase A WATTS	Phase B WATTS	Phase C WATTS	IN	LV	ND	FL	WIRE & CONDUIT	REMARKS
Lower Lobby 024	(52') FJ	1		B2	-	1920			X				2#12+G-3/4"C.	
Lower Lobby 024	(52') FJ	2		B2	-	1920			X				2#12+G-3/4"C.	
Lower Lobby 024	(52') FJ	3		B3	-		1920				X		2#12+G-3/4"C.	
Lower Lobby 024	(52') FJ	4		B3	-		1920				X		2#12+G-3/4"C.	
S. Garden Corr. 063	(12') FJ	5		B5	-			450	X				2#12+G-3/4"C.	
S. Garden Corr. 063	(12') FJ	6		B6	-			450			X		2#12+G-3/4"C.	
S. Garden Corr. 063	2-FN	7		B8	-	100				X			2#12+G-3/4"C.	
Seminar 025A	4-FN	8		C1	-	200				X			2#12+G-3/4"C.	
Seminar 025A	4-FN	9		C4	-		200			X			2#12+G-3/4"C.	
Seminar 025A	FAK	10		C2	-		700			X			2#12+G-3/4"C.	
Seminar 025A	FAK	11		C5	-			350		X			2#12+G-3/4"C.	
Seminar 025B	FN	12		C7	-			50		X			2#12+G-3/4"C.	
Seminar 025B	FN	13		C10	-	50				X			2#12+G-3/4"C.	
Seminar 025B	FAK	14		C11	-	200				X			2#12+G-3/4"C.	
Seminar 025B	FAK	15		C8	-		100			X			2#12+G-3/4"C.	
Spare	-	16		-	-		0				X		-	
Spare	-	17		-	-			0			X		-	
Spare	-	18		-	-			0			X		-	
Spare	-	19		-	-	0					X		-	
Spare	-	20		-	-	0					X		-	
Spare	-	21		-	-		0				X		-	
Spare	-	22		-	-		0				X		-	
Spare	-	23		-	-			0			X		-	
Spare	-	24		-	-			0			X		-	
NORMAL INPUT FROM	SDP-N3			TOTAL LOAD PER PHASE IN kVA:		4.39	4.84	1.30						
					TOTAL LOAD:	10.53	kVA	kVA						
						29.25	Amps	Amps						

65K AIC	208Y/120V 3P-4W	DP-LN2				GP36 MAIN LUGS ONLY
Room/Area	Description	Circuit #	Load (kVA) A	B	C	Wire Size
Spare	-	1	0.00			
Spare	-	2	0.00			
Spare	-	3		0.00		
Spare	-	4		0.00		
S. Garden Corr. 063	(12') FJ	5			0.45	2#12+G-3/4"C.
S. Garden Corr. 063	(12') FJ	6			0.45	2#12+G-3/4"C.
S. Garden Corr. 063	2-FN	7	0.10			2#12+G-3/4"C.
Seminar 025A	4-FN	8	0.20			2#12+G-3/4"C.
Seminar 025A	4-FN	9		0.20		2#12+G-3/4"C.
Seminar 025A	FAK	10		0.70		2#12+G-3/4"C.
Seminar 025A	FAK	11			0.35	2#12+G-3/4"C.
Seminar 025B	FN	12			0.05	2#12+G-3/4"C.
Seminar 025B	FN	13	0.05			2#12+G-3/4"C.
Seminar 025B	FAK	14	0.20			2#12+G-3/4"C.
Seminar 025B	FAK	15		0.10		2#12+G-3/4"C.
Spare	-	16		0.00		2#12+G-3/4"C.
Spare	-	17			0.00	2#12+G-3/4"C.
Spare	-	18			0.00	2#12+G-3/4"C.
Spare	-	19	0.00			2#12+G-3/4"C.
Spare	-	20	0.00			2#12+G-3/4"C.
Spare	-	21		0.00		2#12+G-3/4"C.
Spare	-	22		0.00		2#12+G-3/4"C.
Spare	-	23			0.00	2#12+G-3/4"C.
Spare	-	24			0.00	2#12+G-3/4"C.
		Load Per Phase:	**0.55**	**1.00**	**1.30**	

Load Summary		DF	Demand Load
Lighting (kVA)	2.85	1.25	3.56
Total Amps (A)	7.92	-	9.90

DP-1N1

208V Y/ 120 65000 A.I.C. 3 PHASE 4 WIRE		DIMMER PANEL DP-1N1											GP36 MAIN LUGS ONLY	
ROOM/AREA	DESCRIPTION	CIRCUIT # NORM.		ZONE	CONTROLS	Phase A WATTS	Phase B WATTS	Phase C WATTS	IN	LV	ND	FL	WIRE & CONDUIT	REMARKS
Light Court - 105	(42') FJ	1		Z5	-	1575			X				2#12+G-3/4"C.	
Light Court - 105	(42') FJ	2		Z5	-	1575			X				2#12+G-3/4"C.	
Light Court - 105	(42') FJ	3		Z5	-		1575		X				2#12+G-3/4"C.	
Light Court - 105	(42') FJ	4		Z5	-		1575		X				2#12+G-3/4"C.	
Light Court - 105	(42') FJ	5		Z5	-			1575	X				2#12+G-3/4"C.	
Light Court - 105	(42') FJ	6		Z5	-			1575	X				2#12+G-3/4"C.	
Light Court - 105	(42') FJ	7		Z5	-	1575			X				2#12+G-3/4"C.	
Light Court - 105	(42') FJ	8		Z5	-	1575			X				2#12+G-3/4"C.	
Light Court - 105	(42') FJ	9		Z5	-		1575		X				2#12+G-3/4"C.	
Light Court - 105	(42') FJ	10		Z6	-		1575				X		2#12+G-3/4"C.	
Light Court - 105	(42') FJ	11		Z6	-			1575			X		2#12+G-3/4"C.	
Light Court - 105	(42') FJ	12		Z6	-			1575			X		2#12+G-3/4"C.	
Light Court - 105	(42') FJ	13		Z6	-	1575					X		2#12+G-3/4"C.	
Light Court - 105	(42') FJ	14		Z6	-	1575					X		2#12+G-3/4"C.	
Light Court - 105	(42') FJ	15		Z6	-		1575				X		2#12+G-3/4"C.	
Light Court - 105	(42') FJ	16		Z6	-		1575				X		2#12+G-3/4"C.	
Light Court - 105	(42') FJ	17		Z6	-			1575			X		2#12+G-3/4"C.	
Light Court - 105	(42') FJ	18		Z6	-			1575			X		2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	19		M1	-	1125			X				2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	20		M1	-	1125			X				2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	21		M1	-		1125		X				2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	22		M1	-		1125		X				2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	23		M1	-			1125	X				2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	24		M1	-			1125	X				2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	25		M1	-	1125			X				2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	26		M1	-	1125			X				2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	27		M1	-		1125		X				2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	28		M2	-		1125				X		2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	29		M2	-			1125			X		2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	30		M2	-			1125			X		2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	31		M2	-	1125					X		2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	32		M2	-	1125					X		2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	33		M2	-		1125				X		2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	34		M2	-		1125				X		2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	35		M2	-			1125			X		2#12+G-3/4"C.	
Special Exhibits - 104	(30') FAU	36		M2	-			1125			X		2#12+G-3/4"C.	
NORMAL INPUT FROM SDP-N2				TOTAL LOAD PER PHASE IN kVA:		16.20	16.20	16.20						
					TOTAL LOAD:	48.60	kVA	kVA						
						135.00	Amps	Amps						

65K AIC	208Y/120V 3P-4W	DP-1N1				GP36 MAIN LUGS ONLY
Room/Area	Description	Circuit #	Load (kVA) A	B	C	Wire Size
Light Court - 105	(36') FC	1	0.36			2#12+G-3/4"C.
Light Court - 105	(36') FC	2	0.36			2#12+G-3/4"C.
Light Court - 105	(36') FC	3		0.36		2#12+G-3/4"C.
Light Court - 105	(36') FC	4		0.36		2#12+G-3/4"C.
Spare	-	5				
Spare	-	6				
Spare	-	7				
Spare	-	8				
Spare	-	9				
Spare	-	10				
Spare	-	11				
Spare	-	12				
Spare	-	13				
Spare	-	14				
Spare	-	15				
Spare	-	16				
Spare	-	17				
Spare	-	18				
Special Exhibits - 104	(30') FAU	19	1.13			2#12+G-3/4"C.
Special Exhibits - 105	(30') FAU	20	1.13			2#12+G-3/4"C.
Special Exhibits - 106	(30') FAU	21		1.13		2#12+G-3/4"C.
Special Exhibits - 107	(30') FAU	22		1.13		2#12+G-3/4"C.
Special Exhibits - 108	(30') FAU	23			1.13	2#12+G-3/4"C.
Special Exhibits - 109	(30') FAU	24			1.13	2#12+G-3/4"C.
Special Exhibits - 110	(30') FAU	25	1.13			2#12+G-3/4"C.
Special Exhibits - 111	(30') FAU	26	1.13			2#12+G-3/4"C.
Special Exhibits - 112	(30') FAU	27		1.13		2#12+G-3/4"C.
Special Exhibits - 113	(30') FAU	28		1.13		2#12+G-3/4"C.
Special Exhibits - 114	(30') FAU	29			1.13	2#12+G-3/4"C.
Special Exhibits - 115	(30') FAU	30			1.13	2#12+G-3/4"C.
Special Exhibits - 116	(30') FAU	31	1.13			2#12+G-3/4"C.
Special Exhibits - 117	(30') FAU	32	1.13			2#12+G-3/4"C.
Special Exhibits - 118	(30') FAU	33		1.13		2#12+G-3/4"C.
Special Exhibits - 119	(30') FAU	34		1.13		2#12+G-3/4"C.
Special Exhibits - 120	(30') FAU	35			1.13	2#12+G-3/4"C.
Special Exhibits - 121	(30') FAU	36			1.13	2#12+G-3/4"C.
		Load Per Phase:	7.47	7.47	6.75	

Load Summary		DF	Demand Load
Lighting (kVA)	21.69	1.25	27.11
Total Amps (A)	60.25	-	75.31

EDP-LN

208V Y/ 120 65000 A.I.C. 3 PHASE 4 WIRE		DIMMER PANEL EDP-LN											GP12 MAIN LUGS ONLY	
ROOM/AREA	DESCRIPTION	CIRCUIT #	EMERG.	ZONE	CONTROLS	Phase A WATTS	Phase B WATTS	Phase C WATTS	IN	LV	ND	FL	WIRE & CONDUIT	REMARKS
S. Garden Corr. 063	3-FN	1		B8	-	150				X			2#12+G-3/4"C.	
Seminar 025A	3-FN	2		C1	-	150				X			2#12+G-3/4"C.	
Seminar 025A	3-FN	3		C4	-		150			X			2#12+G-3/4"C.	
Seminar 025B	FN	4		C7	-		50			X			2#12+G-3/4"C.	
Seminar 025B	FN	5		C10	-			50		X			2#12+G-3/4"C.	
Spare	-	6		-	-			0			X		-	
Spare	-	7		-	-	0					X		-	
Spare	-	8		-	-	0					X		-	
Spare	-	9		-	-		0				X		-	
Spare	-	10		-	-		0				X		-	
Spare	-	11		-	-			0			X		-	
Spare	-	12		-	-			0			X		-	
NORMAL INPUT FROM	ERL-LN			TOTAL LOAD PER PHASE IN kVA:		0.30	0.20	0.05						
					TOTAL LOAD:	0.55	kVA	kVA						
						1.53	Amps	Amps						

65K AIC	208Y/120V 3P-4W	EDP-LN				GP36 MAIN LUGS ONLY
Room/Area	Description	Circuit #	Load (kVA) A	B	C	Wire Size
S. Garden Corr. 063	3-FN	1	0.15			2#12+G-3/4"C.
Seminar 025A	3-FN	2	0.15			2#12+G-3/4"C.
Seminar 025A	3-FN	3		0.15		2#12+G-3/4"C.
Seminar 025B	FN	4		0.05		2#12+G-3/4"C.
Seminar 025B	FN	5			0.05	2#12+G-3/4"C.
Light Court - 105	(36') FC	6			0.36	2#12+G-3/4"C.
Light Court - 105	(36') FC	7	0.36			2#12+G-3/4"C.
Spare	-	8	0.00			2#12+G-3/4"C.
Light Court - 105	(36') FC	9		0.36		2#12+G-3/4"C.
Spare	-	10		0.00		2#12+G-3/4"C.
Light Court - 105	(36') FC	11			0.36	2#12+G-3/4"C.
Spare	-	12			0.00	2#12+G-3/4"C.
		Load Per Phase:	0.66	0.56	0.77	

Load Summary		DF	Demand Load
Lighting (kVA)	1.99	1.25	2.49
Total Amps (A)	5.53	-	6.91

Due to the oversized panels there were plenty of spare amps for the new loads associated with the designs shown in the Lighting Depth. All new circuits were designed to 20A circuit breakers and to have either 2#12 wires or 2#10 wires in ¾" conduit, based on distance from the panel.

Short Circuit Analysis

A point-to-point short circuit analysis was conducted for one branch of the one line diagram to one Panel RP-LN1 mentioned in the previous Branch Circuit Redesign section. The following line and locations will be analyzed.

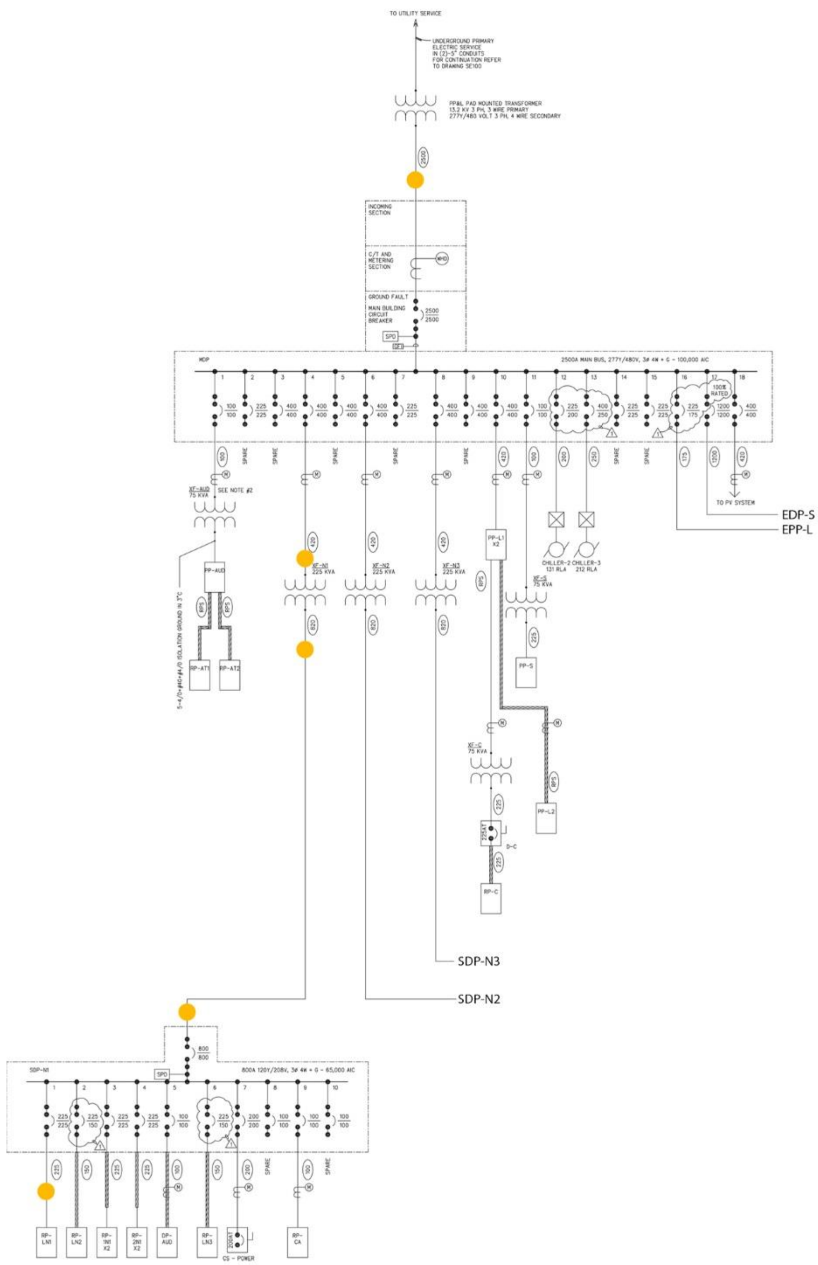


Figure 61 | One-Line Diagram

The calculations for the point-to-point analysis are shown below. When compared to the AIC ratings of each device, it was found that each device exceeded the short circuit requirement calculated, proving it is a sufficient design.

Fault Point	Panel/XFMR	E (Volts)	L (ft)	Wire/Bus		'C' Value	XFMR (%Z)	I_{FLA}	Multiplier	ISC	f	M	ISC
				#	Size								
1	MDP	480	240	24	600KCM	22965	5.75	3608.44	17.39	62755.46	0.098606	0.910244	57122.8
2	XF-N1 (Before)	480	13	4	600KCM	22965	-	-	-	57122.80	0.029171	0.971656	55503.72
3	XF-N1 (After)	208	-	-	-	-	1.20	-	83.33	55503.72	2.461063	0.288929	37007.57
4	SDP-N1	208	4	8	600KCM	22965	-	-	-	37007.57	0.00671	0.993335	36760.92
5	RP-LN1	208	27	4	250KCM	16483	-	-	-	36760.92	0.125358	0.888606	32665.98

Photovoltaic Array Study

As will be mention in the Structural Breadth, the green roof that was initially located above the open office area was removed. However, to continue the utilization of the roof area, photovoltaic arrays were studied to decrease the overall power usage of the building. As seen in figure 62, The Barnes Foundation has a PV Array located on the roof of the Light Box currently. The purpose of this study will be to analyze the additional PV Array and compare the energy savings of the initial design to the new one.

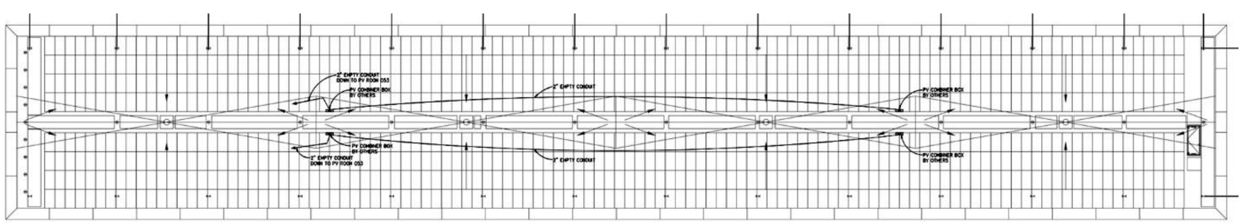


Figure 62 | Current PV Array

The first step in this analysis was to find the average amount of solar energy on the roof over the year; to do this, DIVA for Rhino was used. Other than calculating the irradiation on the roof, this study was also used to observe the shaded area caused by the Light Box on the roof. As shown below, the average irradiation on the desired roof area was considered to be 1400 kWh/m^2 per year; furthermore, it was deemed that the entire roof area above the open office could be used regardless of the shade caused by the Light Box.

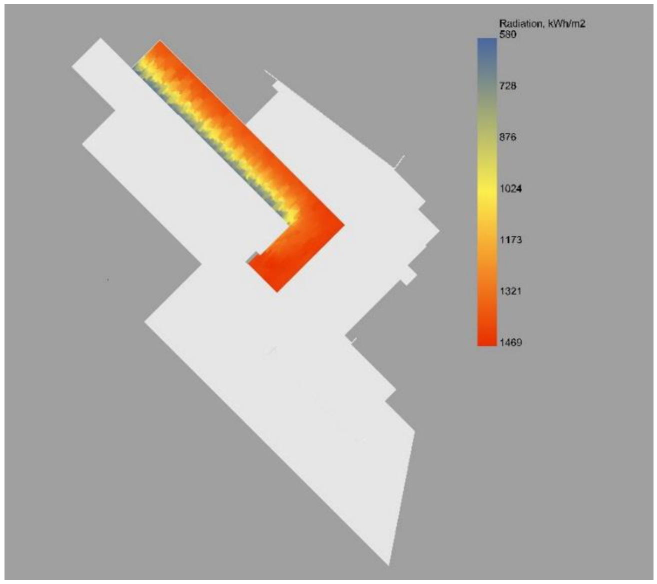


Figure 63 | Irradiation Simulation | Diva for Rhino

The next step was to maximize the amount of panels that will be placed on the Office roof while avoiding drains, the newly designed skylights, and ensuring the most amount of sun would be hitting the panels. After much analysis it was decided to have a total of 135 panel placed on the roof as shown in figure 64. A South-East orientation was chosen to maximize the amount of panels while also allowing for more solar energy to be captured during the day before the Light Box affects the array.

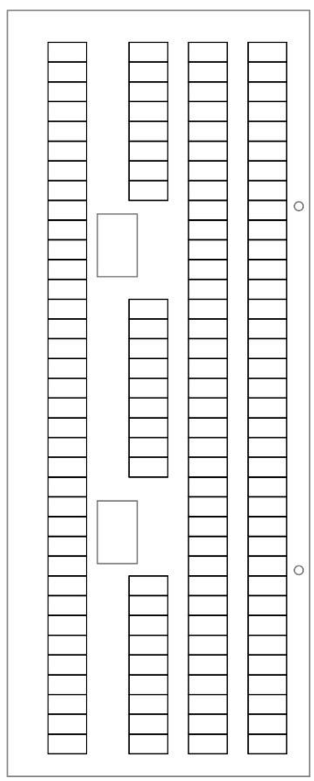


Figure 64 | Office Roof PV Array Layout

System Advisor Model (SAM) was then used to analyze the amount of energy created with the use of PV arrays on the Light Box and Office roof. A Sunpower 225 solar panel was chosen as the desired panel as stated in the building specifications along with a Satcon inverter. Different inverters were tested within the program until a DC-AC ratio close to 1.0 could be achieved. Using the 1400 kWh/m^2 previously calculated, the total amount of energy on the Light Box and Office roof panels were calculated, finding 176 kW on the Light Box roof and 27 kW on the Office roof. The SAM software allows the user to input the desired amount of DC energy for the array and the program calculated the array size and amount of inverters necessary. The array size recommended by SAM was then compared to the panel layouts to ensure the arrays matched what was designed.

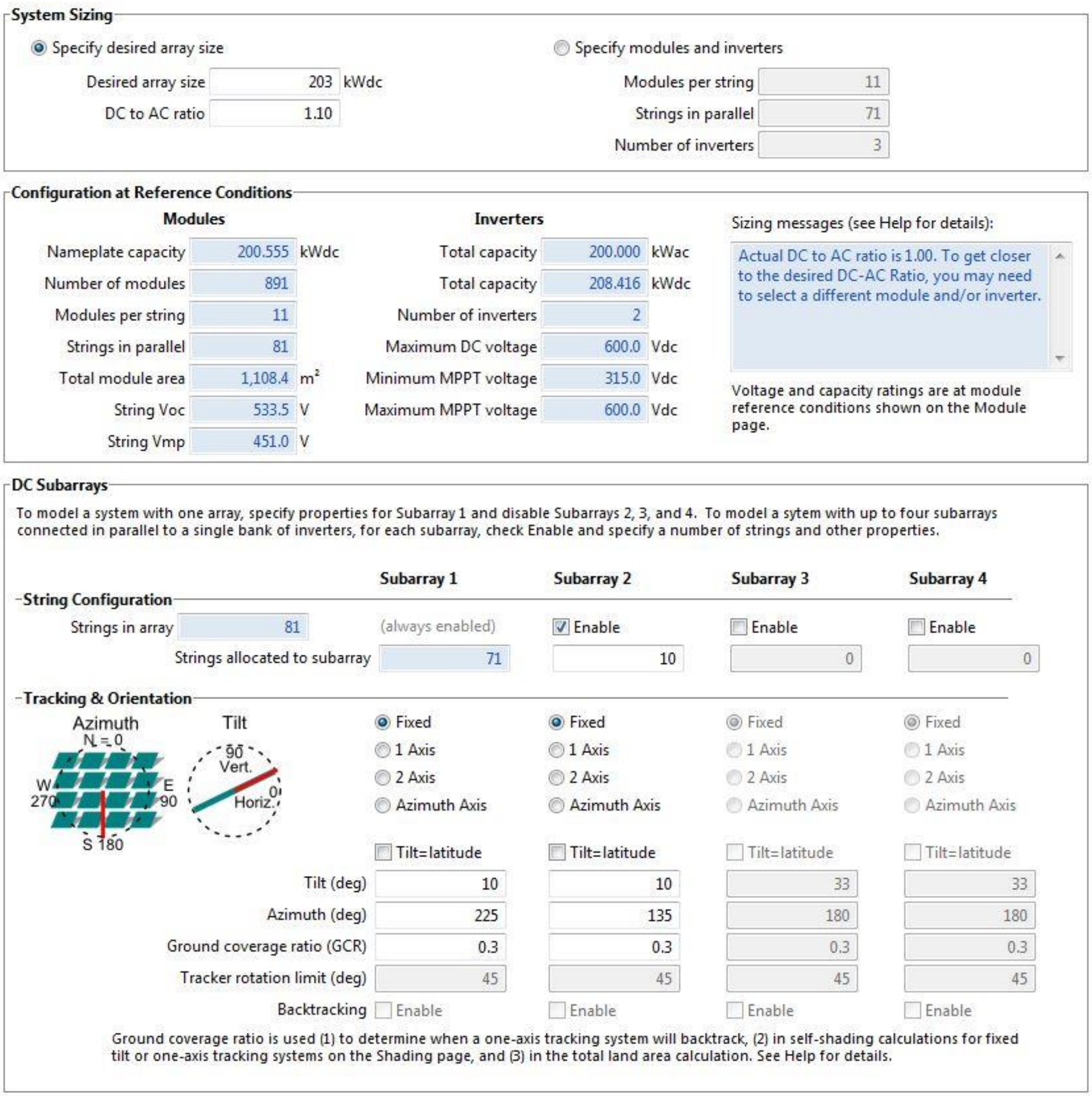


Figure 65 | New Array Design | SAM

Also included in the simulation were federal and state incentives and the proper PECO High Tension electricity rates associated with the building. The results of the analysis are shown below.

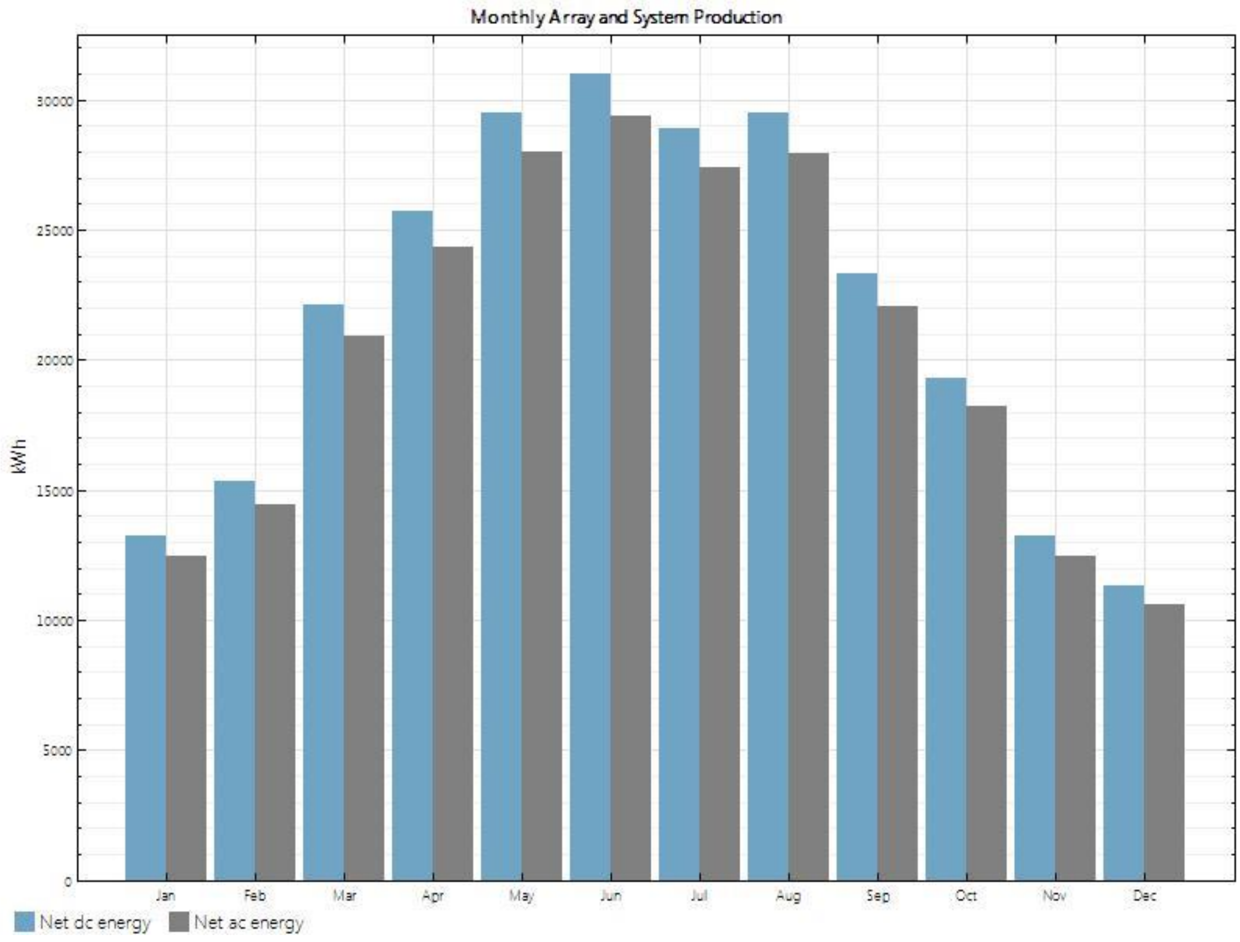


Figure 66 | DC vs. AC Energy Production | SAM

Table 36 | Current vs. New PV Array Comparison

Metric	Current	New	Difference
Annual energy	217095 kWh	248065 kWh	30970 kWh
Net savings with system	$16,345	$18,623	$2,278
Payback period	35.6 years	35.7 years	0.1 years
Initial cost	$447,925	$511,013	$63,088

With a slightly longer payback period, the additional PV array is capable of creating an extra 31,000 kWh of AC power into the building. This design efficiently reduces the facility's carbon footprint while also utilizing the open roof area.

Structural Breadth

As discussed in the Office portion of the Lighting Depth, a structural redesign of the roof area above the East office area was required to place skylights into the room. To do this, a steel structure was designed to replace the cambered concrete structure as originally designed; furthermore, the green roof located on the roof area above was removed in order to reduce the dead load.

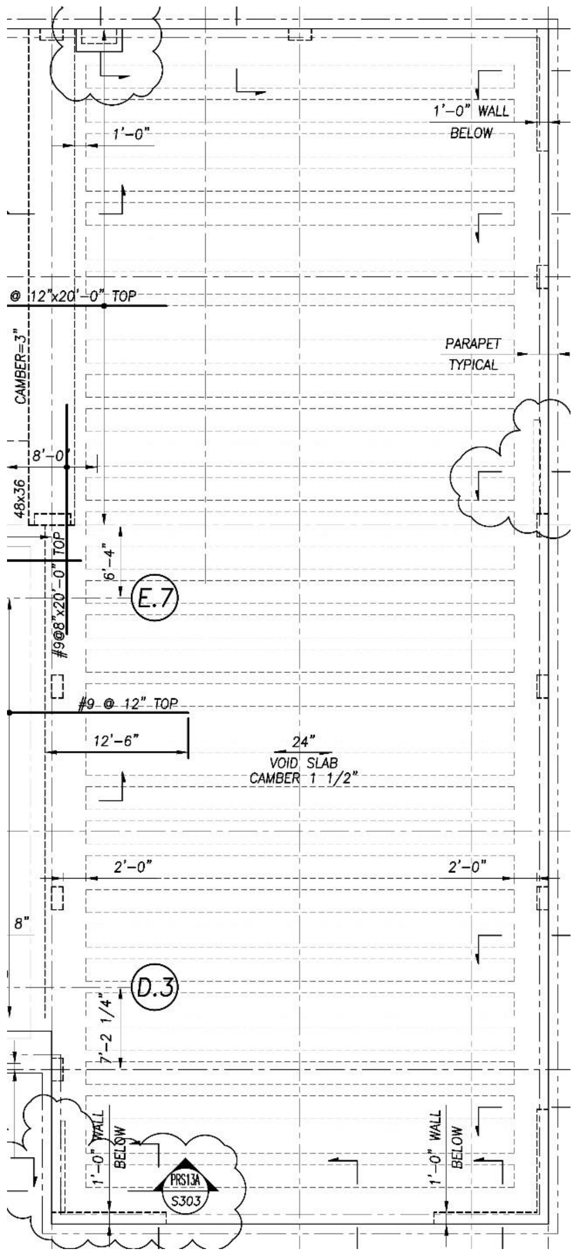


Figure 67 | Current Concrete Structure

To begin designing the new roof system, column placement was first decided. Due to the special exhibit area, on the first level, and the auditorium, on the lower level, being located directly below the office space it was not possible to place columns down the center of the room without disrupting the levels below. This resulted in keeping columns being placed along the perimeter length of the space. The exact locations of the columns were decided based on symmetry and existing floor plan. It should be noted that the column marked in figure 68 will cause a closet to be decreased in size and it comes down in a portion of the special exhibit area and the restrooms. This was deemed the best option although an architectural study was not done to correct these collisions.

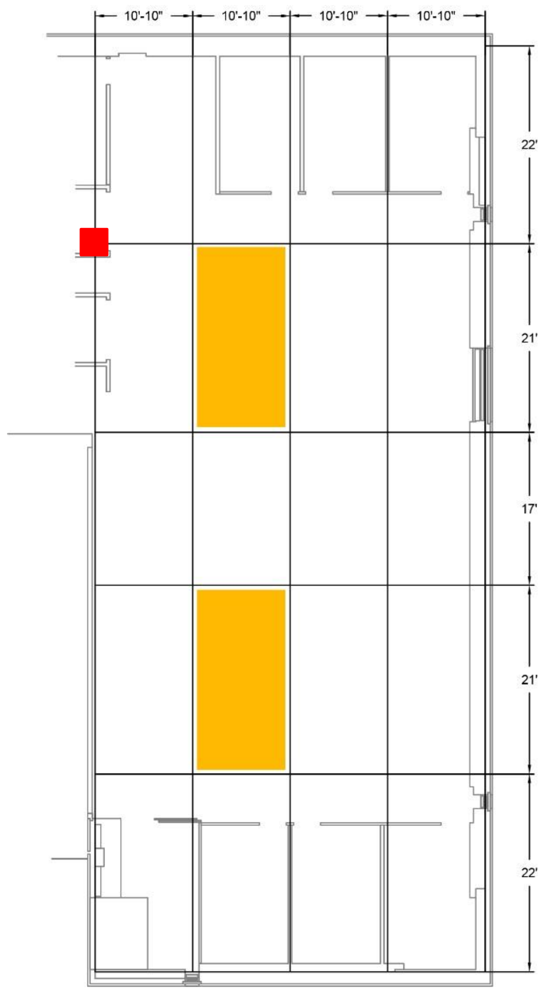


Figure 68 | Proposed Structural Layout

In order to create the desired skylight wells it was decided to divide the space into 4 sections, each 10'-10" wide, to be able to place the wells along the center of the open office portion of the room. The roof deck was then designed based on the materials of the roof. The dead load, live load, and snow load of the roof was found to be 62psf, 20psf, and 30psf, respectively. Since the snow load is greater than the live load, 30psf will be used instead of the 20psf previously stated for the live load. The following equations were then used to calculate the total weight on the metal deck.

$$w_u = 1.2(DL) + 1.6(LL) = 122.43\ psf$$

It was found that a 1.5B16 metal deck would be needed throughout the space. The dead load of the roof was then calculated based on the psf values shown in table 37. While the total dead load of the roof was found to be roughly 50psf, the loads of the skylighting and PV array were estimated to be 15psf and 2psf, respectively. However, for the purpose of these calculations and to ensure any unforeseen loads were accounted for, the total dead load for the structure was set at 100 psf.

Table 37 | Roof Dead Loads

Material	PSF
Lightweight Concrete, 4"	38.33
PVC Membrane	1
Rigid Roof Insulation	3
Protective Sheathing	1.7
Vapor Retarder	1
Deck - 1.5B16, 3 Span	3.54
Skylights	15
PV Array	2
Total	65.57

To design the beams and girders of the steel system the following equations were used. For a more detailed analysis of each beam and girder, please refer to Y:\Brenner\Senior Thesis\Structural/Structural.xlsx.

$$w_{DL} = \frac{L_{Section} \times DL}{1000}$$

$$w_{LL} = \frac{L_{Section} \times LL}{1000}$$

$$w_u = 1.2(w_{DL}) + 1.6(w_{LL})$$

$$M_u = \frac{w_u \times L^2}{8}$$

$$I = \frac{5 \times {}^{w_u}/_{12} \times (L \times 12)^4}{{}^{L}/_{360} \times 384 \times 29000}$$

From here, various infill-beams were tested to ensure that $M_n > M_u$ and $I_x > I$, then each were tested for deflection until one was found to be less than L/360.

$$w_u = 1.2\left(w_{DL} + w_{self-weight}\right) + 1.6(w_{LL})$$

$$M_u = \frac{w_u \times L^2}{8}$$

$$\delta = \frac{5 \times {}^{w_u}/_{12} \times (L \times 12)^4}{I_x \times 384 \times 29000} < {}^{L}/_{360}$$

Beams were then sized using the same equations and tests. Finally, the girders were designed based on the point loads from each beam and the moment that they create in the girder. Various girders were then tested to ensure that M_n was greater than the moment calculated. From here, the process above was conducted to test for deflection. These calculations resulted in the following structural layout.

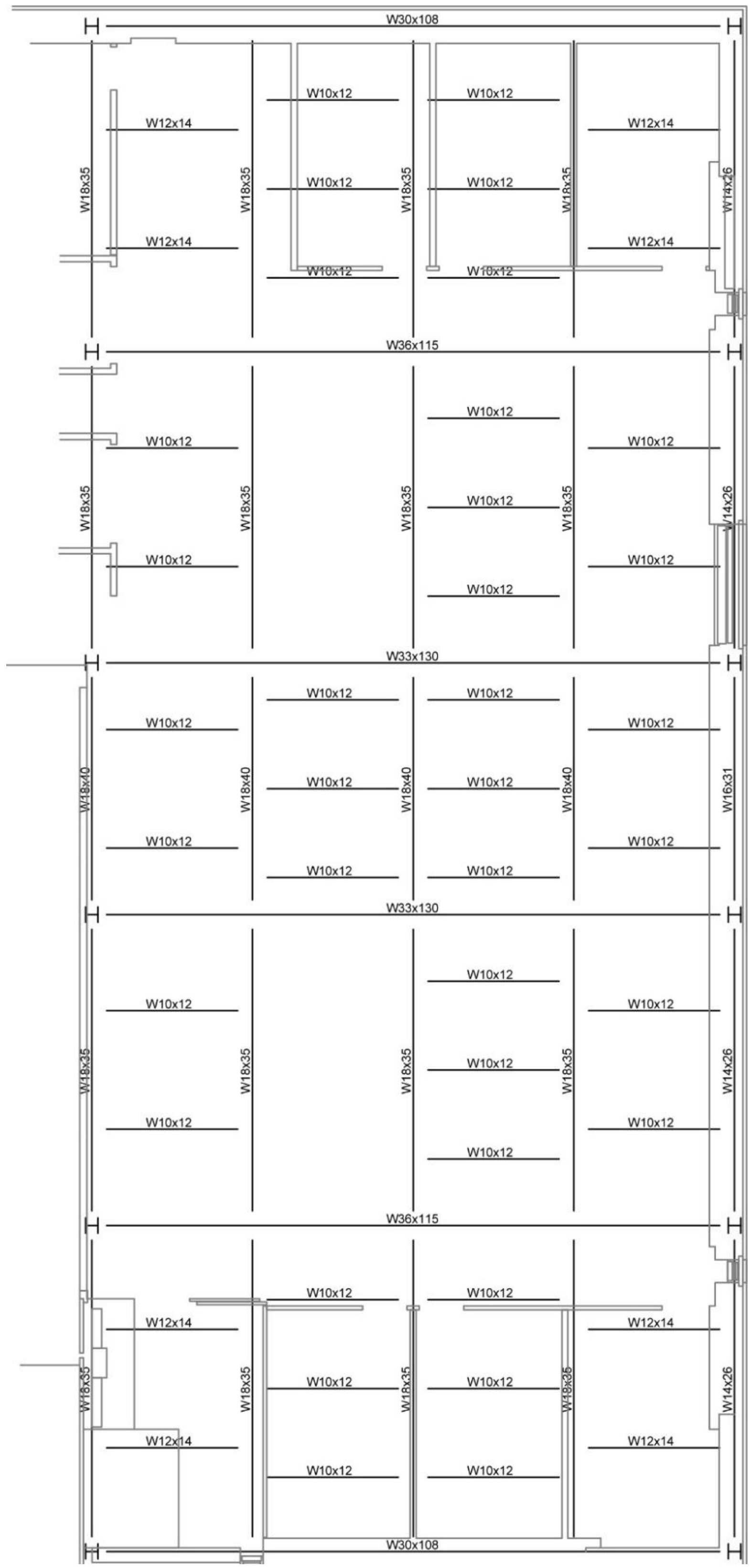


Figure 69 | Designed Steel Structural Layout

MAE Daylighting Breadth

Located on the second level of the East end of the building, the open office has natural daylight entering the space through only three windows. This created the desire to include more daylight in the space and to give the occupants a better connection with the surrounding city, to reinforce circadian rhythm, and to reduce the use of electric light.

In designing the skylight wells for the space, the galleries of The Barnes Foundation were looked at. In many of the galleries there are large roof monitors to allow daylight into the space; these roof monitors are massive in size, taking up the entire ceiling area of a gallery.

Figure 70 | Gallery & Roof Monitor Photo | ©Michael Moran

These roof monitors were used as inspiration for the skylight well design of the open office. The size of the bottom of the well was based off of the structural grid created, the size of the well was offset from the steel girders to avoid any collisions. The well was then extruded two feet up and then splayed to the desired skylight size to resemble the gallery roof monitors.The skylight chosen has a triple glazed, poly/acrylic/acrylic, glass with a 0.6 visible light transmittance.

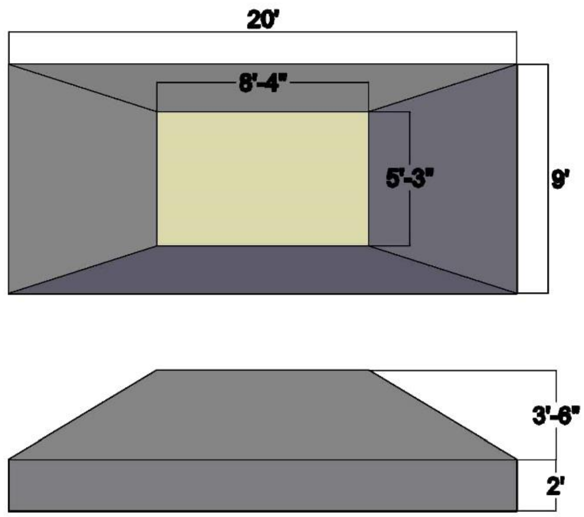


Figure 71 | Skylgiht Well Dimensions

With the placement and size of the wells set, a model was created and analyzed in Daysim to observe its performance. For this analysis, the space was divided into three zones as shown in figure 72. Zone 1 consists of the fixtures that are affected by the skylights, Zone 2 consists of the fixtures affected by the window, and Zone 3 consists of the fixtures that will remain on. Although it was possible to add shades to the window, it was decided to solely observe the effects of the skylights on the space for the analysis.

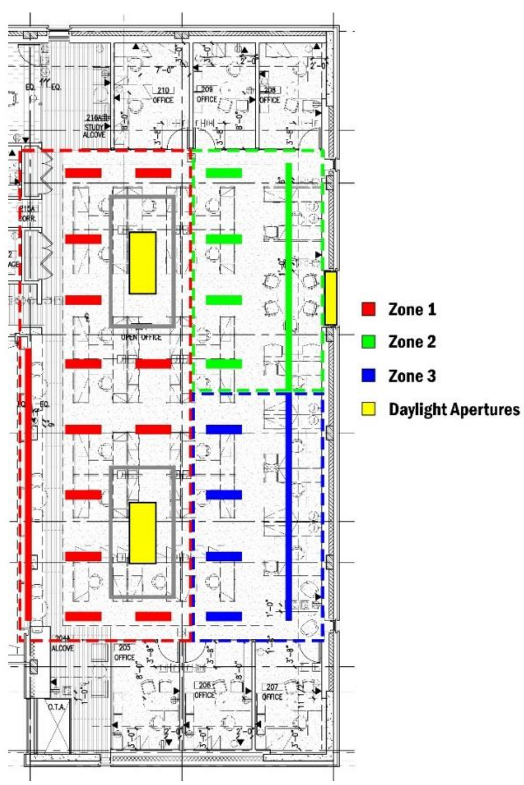


Figure 72 | Office Lighting Daylight Zones

The critical point was then chosen based on the lowest area of illuminance within the proximity of the skylights.

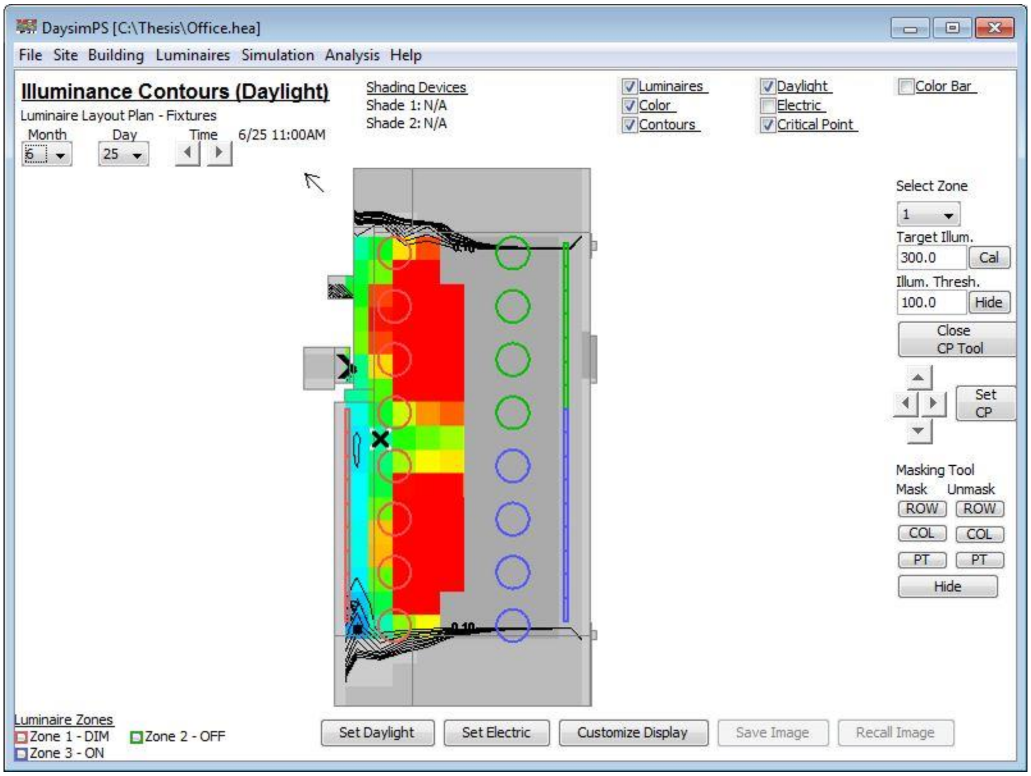


Figure 73 | Critical Point Location | Daysim

A closed loop proportional system with target illuminances of 300 lux was then used to calibrate the "cos" photosensor.

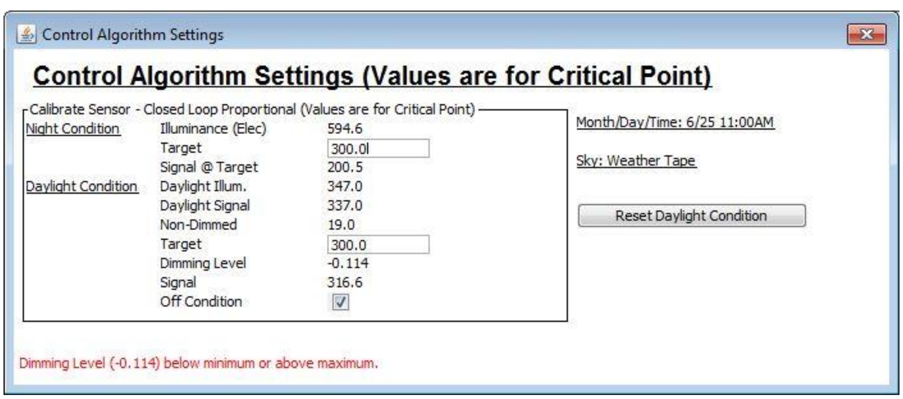


Figure 74 | Closed Loop Control Algorithm

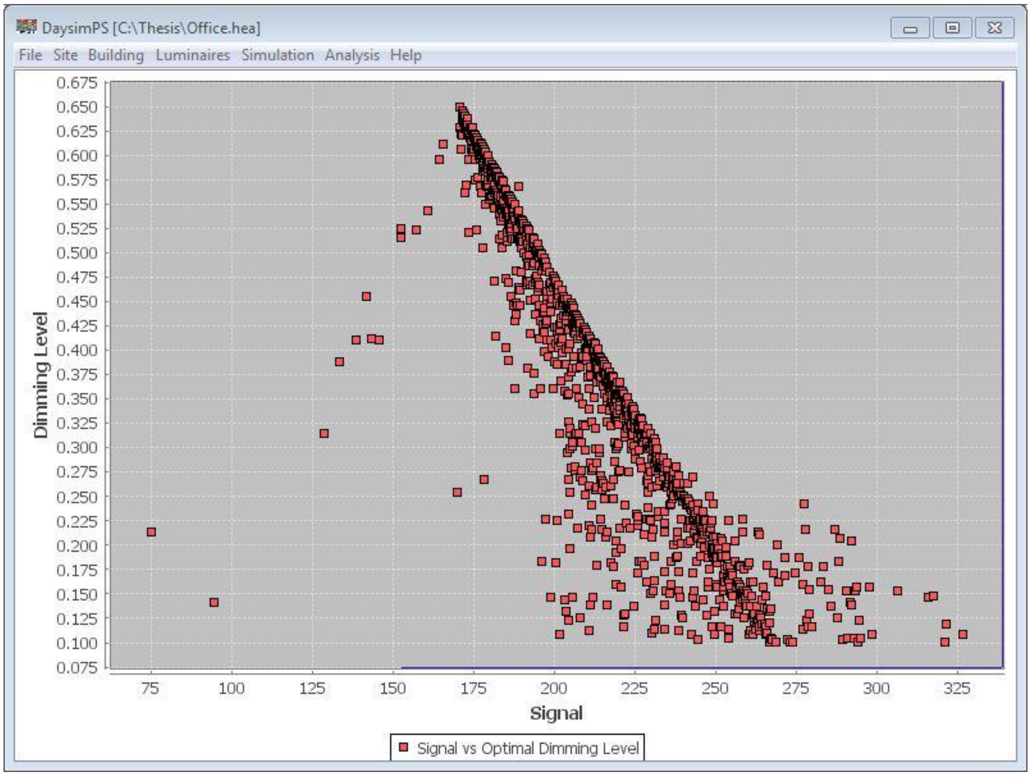


Figure 75 | Signal vs. Optimal Dimming Level | Daysim

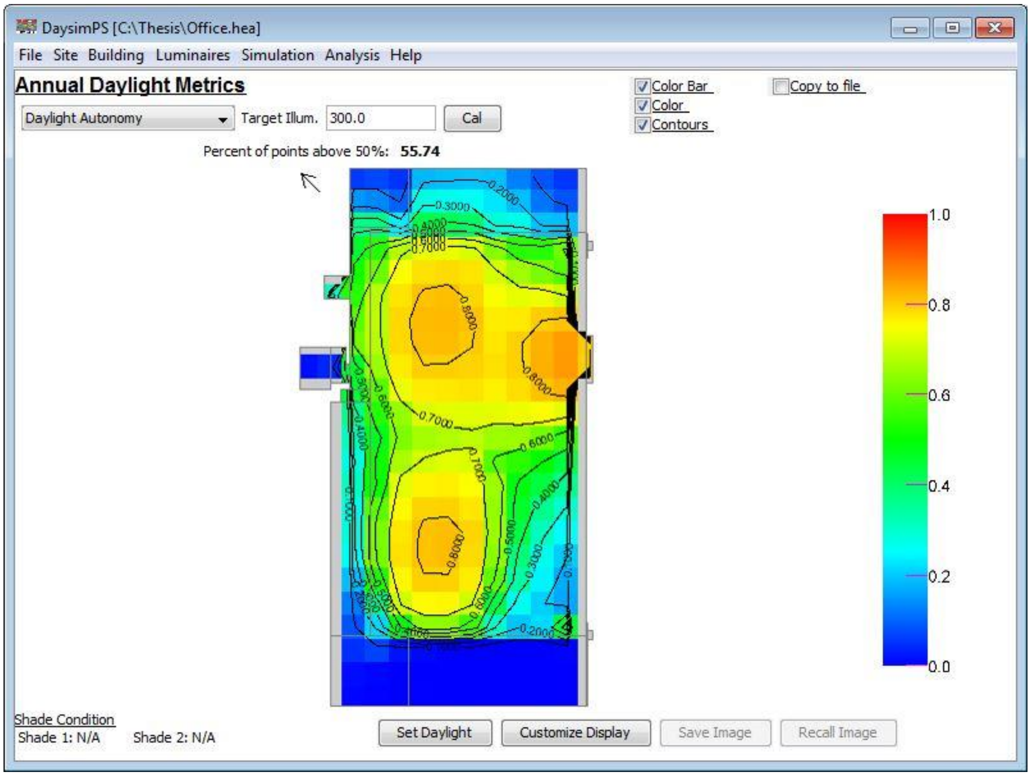


Figure 76 | Daylight Autonomy | Daysim

Per LEED standards, a daylight autonomy of 55% for at least 50% of the floor area is required. Shown in figure 76 there is a daylight autonomy of 55.74% achieved. It can be noted that at both ends of the space are private offices that were not analyzed for this breadth, although their floor area was a portion of this calculation. If these areas were to be removed it would result in a higher daylight autonomy for the space.

As a result of this daylighting a total savings of 3473.82 kWh was achieved with the use of integrated daylight controls in the electric lighting.

Energy Tables (KWh)

Controlled Zone | Grand Total

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Base	569.16	514.08	569.16	550.8	569.16	550.8	569.16	569.16	550.8	569.16	550.8	569.16	6701.4
Optimal	288.63	253.1	262.14	234.39	240.68	222.99	232.98	232.35	238.12	255.75	271.16	298.33	3030.67
Algorithm	316.44	274.27	281.33	246.73	250.59	229.01	239.7	239.79	251.74	275.51	294.76	327.64	3227.57
Savings	252.71	239.8	287.82	304.06	318.56	321.78	329.45	329.36	299.05	293.64	256.03	241.51	3473.82

Figure 77 | Total Energy Results | Daysim

The splayed well efficiency was then calculated based on the form factors of the well. For the purpose of these calculations, the splayed portion of the well was assumed to go the entire height of the well rather than 3'-6" previously defined. It was found that the well had an efficiency of 89%.

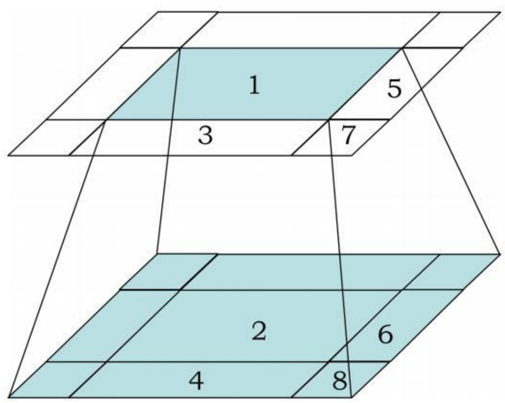


Figure 78 | Form Factor Well

$$F_{t-b} = \frac{A_{(1+3+5+7)}F_{(1+3+5+7)-(2+4+6+8)} + A_7F_{7-8} - A_{(3+7)}F_{(3+7)-(4+8)} - A_{(5+7)}F_{(5+7)-(6+8)}}{A_1}$$

$$R_w = \frac{A_{walls}}{A_{top}}$$

$$R_b = \frac{A_{bottom}}{A_{top}}$$

$$\eta'_{well} = F_{t-b} + \frac{\rho_w(R_b - F_{t-b})(1 - F_{t-b})}{R_w - \rho_w(R_w - R_b + 2F_{t-b} - 1)}$$

The well efficiency and energy savings were then taken into SkyCalc to provide a cost analysis of the space. Although the skylights resulted in a slight increase in heating energy for the area, there was a decrease of energy usage for both lighting and cooling. This is partially a result of the, near optimal, Skylight to Floor Ratio of the design.

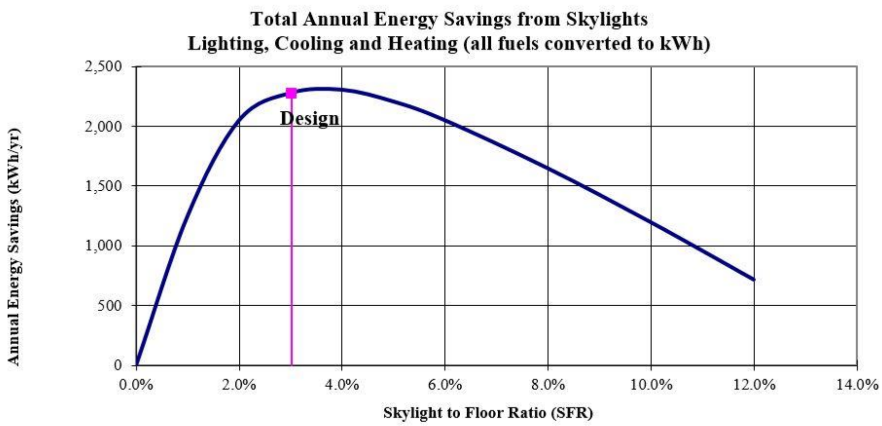


Figure 79 | Annual Energy Savings vs. Skylight to Floor Ratio | SkyCalc

Table 38 | Skylight Well Savings

Savings from Functioning Photocontrol System		
Savings	**Annual Energy Savings (kWh/yr)**	**Annual Cost Savings ($/yr)**
Lighting	3473.82	$521.073
Cooling	382.64	$57.40
Heating	-60.92	$-2.11
Total	3795.53	$576.36

Mechanical Breadth

Due to the newly added skylights and the removal of the green roof above, it was necessary to rearrange the mechanical layout of the open office and to evaluate if the equipment needed to be resized. To begin this analysis, the U-values of the initial and newly designed roofs were calculated, these values can be found in table 39. The new roof was designed with R-23 insulation to achieve a total roof R-value of 30.

Table 39 | Roof U-Values

Material		R-Value
Green Roof System	Sedum	2.325
	Growth Media, 3"	1.5
	Drainage Mat	1
	Protection Layer	6
PVC Membrane		6
Rigid Roof Insulation, R-11		11.4
0.5" Protection Board		0.45
Continuous Vapor Retarder		0.16
NW Concrete, 2'		1.68
LW Concrete, 4"		0.52
New Rigid Roof Insulation, R-23		23.6
U-Value (With Green Roof)		0.03277
U-Value (No Green Roof)		0.03254

The original design capacity of the office space was 6.6 tons based on the chilled beam schedule provided. This was calculated using the following equation and the information found in table 40.

$$\frac{5300\ BTUs \times 15\ units}{12000\ \frac{BTUs}{Ton}} = 6.6\ Tons$$

After performing an analysis through Trane TRACE 700 the newly designed room load was found to be roughly 4 tons. The addition of skylights resulted in an extra 1.2 tons of cooling in the space; however, because of the over-designed chilled beams, there was no need to resize the system. The Train TRACE 700 results can be found in Appendix E.

Table 40 | Active Chilled Beam Schedule

ACTIVE CHILLED BEAMS																	
UNIT NO	LOCATION	SERVES	CFM	SIZE		INLET	NOZZLE SIZE	HEATING/COOLING COIL								MAKE/MODEL	REMARKS
				WIDTH	LENGTH			MBH	EAT	LAT	PD	EWT	LWT	GPM	PD		
ACB-A	LEVEL 2 OFFICES	LEVEL 2 OFFICES	65	24"	48"	5"ø	–	5.6	65°F	92.2°F	0.46 IN WG	125°F	110°F	0.8	0.9 FT WG	TROX / DID632	HEATING
ACB-A	LEVEL 2 OFFICES	LEVEL 2 OFFICES	65	24"	48"	5"ø	–	3.5	52°F	62.4°F	0.46 IN WG	58°F	66°F	0.5	1.1 FT WG	TROX / DID632	COOLING
ACB-B	OFFICE 204	OFFICE 204	110	24"	72"	5"ø	–	7.0	65°F	91.7°F	0.23 IN WG	125°F	110°F	1.05	1.9 FT WG	TROX / DID632	HEATING
ACB-B	OFFICE 204	OFFICE 204	110	24"	72"	5"ø	–	5.3	52°F	60.6°F	0.23 IN WG	58°F	62°F	0.66	2.5 FT WG	TROX / DID632	COOLING
ACB-C	OFFICE 223	OFFICE 223	85	24"	72"	5"ø	–	7.7	65°F	93.3°F	0.36 IN WG	125°F	110°F	1.1	2.0 FT WG	TROX / DID632	HEATING
ACB-C	OFFICE 223	OFFICE 223	85	24"	72"	5"ø	–	4.9	52°F	61.8°F	0.36 IN WG	58°F	62°F	0.7	2.8 FT WG	TROX / DID632	COOLING

The initial mechanical design consisted of 15 active chilled beams, by using the information above it was decided to rearrange the mechanical layout while maintaining the amount of chilled beams in the space. Due to the location of the skylights, it was necessary to relocate the chilled beams shown below.

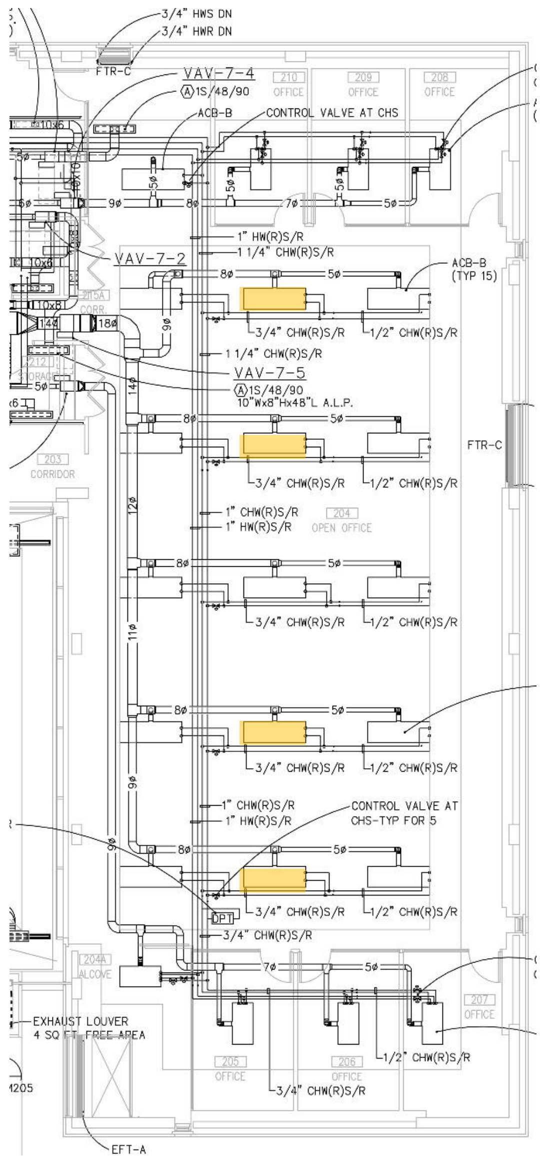


Figure 80 | Current Mechanical System Layout

After rearranging the chilled beams, the ducts and return piping were then resized. This resulted in the following mechanical layout and sizes. This layout was also designed to avoid the lighting in the space for complete integration.

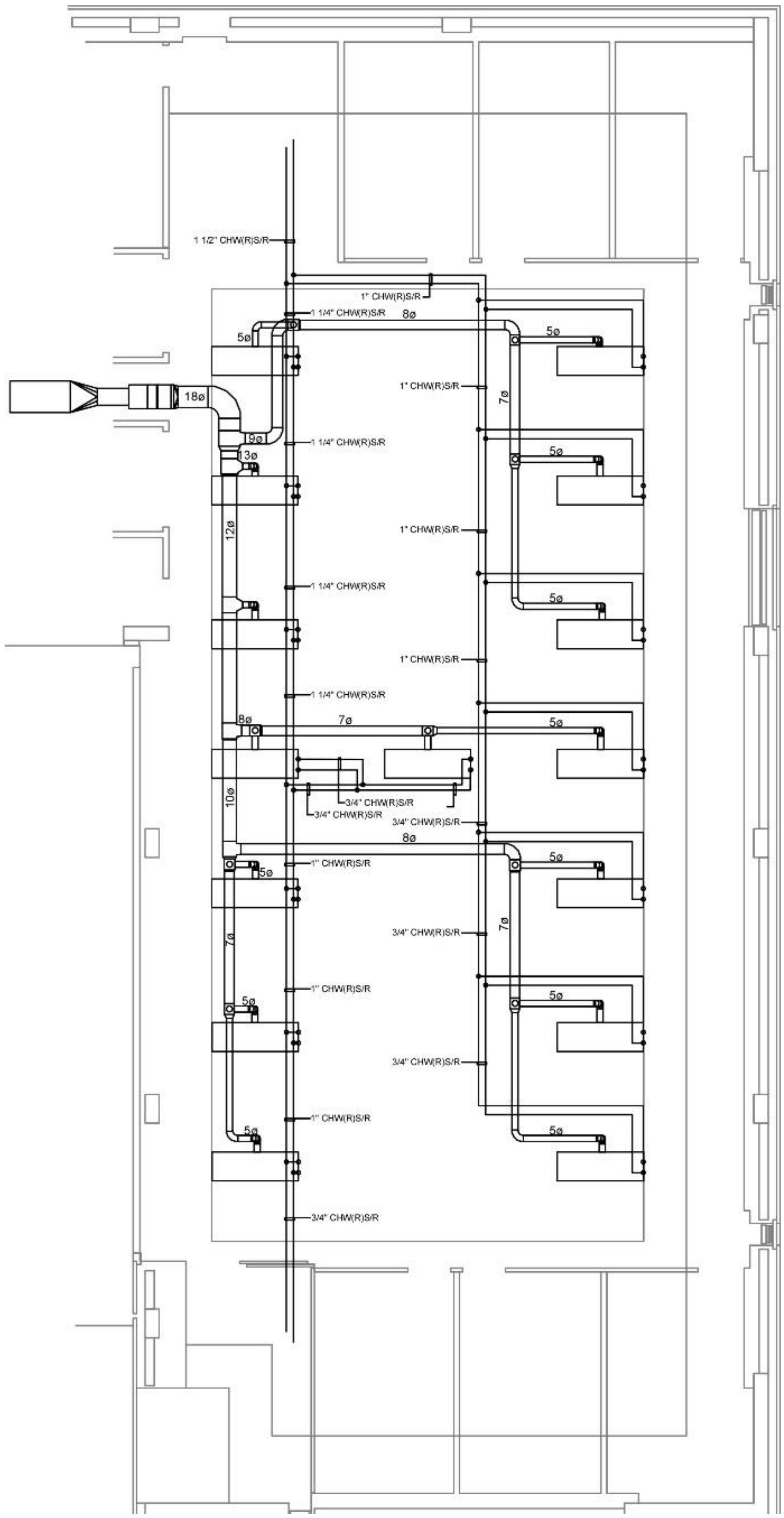


Figure 81 | New Mechanical System Layout

To view the Train TRACE 700 model, please refer to Y:\Brenner\Senior Thesis\Mechanical\Office 204.trc.

Conclusion

Over the course of five years, the knowledge gained in that time, in the field of Architectural Engineering, was used to develop this report. With an understanding in the lighting/electrical, structural, and mechanical options of AE, the goal of this senior thesis was to show the integration of various disciplines within The Barnes Foundation with the focus in redesigning the lighting and electrical systems. Using research, performance analyses, and several studies, this goal was achieved and resulted in the enhanced aesthetics and performance of the building.

The Lighting Depth properly analyzed the needs of each space and resulted in new lighting schemes that helped to connect The Barnes to the city of Philadelphia and aided in establishing an iconic and energetic look for the building at night. The Electrical Depth effectively took the new lighting designs and ensured that the current electrical system could handle the altered loads. The Structural Breadth, MAE Daylighting Breadth, and Mechanical Breadth conveyed how the integration of various systems affect each other. The Structural Breadth developed a new steel system to allow for the placement of skylights. The Daylighting Breadth analyzed the newly designed skylights to ensure they were providing enough light to LEED standards. And the Mechanical Breadth used the changes based on the new structural design, lighting design, and daylighting design to generate an appropriate mechanical layout. A photovoltaic array was created on the roof to utilize the space that once was occupied by a green roof. After design was complete, the weight of the array was calculated and included in the dead load of the structural design to ensure the strength of the system with this new load and to create an integrated design.

Acknowledgements

I would like to thank the following people for their support through the entire thesis process. With their help and encouragement, I was able to complete my senior thesis and create the report that you say you "read" but let's admit it, you skimmed.

| Dr. Richard Mistrick
| Shawn Good
| Gary Golasziewski
| Dr. Thomas Boothby

I would also like to thank Fisher Marantz Stone for their great deal of effort in helping me find a building to center my senior thesis around.

A giant thank you to Paula Martinez-Nobles for all of your advice and support through this entire thesis ordeal.

Thank you to Vincent D'Antonio of The Barnes Foundation for providing me with direct support from the facility and for giving me a tour of The Barnes to get a first-hand look at the subject of my senior thesis.

Café 210 West for being my home away from home away from home away from home. You come right after my parent's house, my house in State College, and the third floor of Sackett; but you have provided me with so much love and inspiration over this year when all I wanted to do was quit.

To my friends in and out of the major that dealt with my complaining throughout the year, thank you for the memories and the boosts of energy when I needed it the most.

And finally to my family, I thank you with all of me. It is thanks to you that I am where I am today. You have supported me whole-heartedly throughout the years and for that I love you.

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