February 22, 2013

Lighting & Electrical Systems

AEI Team #: 04-2013

ARCHITECTURAL ENGINEERING INSTITUTE

Our one true aim is to enhance the quality of the communities we work with through innovative ideas and an integrated design approach.

Ingenuity | Quality | Enjoyment | Integrity

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1. Executive Summary

As an integrated design team, Architectural Engineering Institute (AEI) Student Competition Team #04-2013 began our building design by creating a list of team, construction and design goals. We focused on creating an integrated building design that would increase community involvement, improve student and teacher environments, and be a leader in safety and security. Some of the goals that applied to the Lighting and Electrical discipline were things like creating an energy efficient design, making building control systems user friendly, and producing an ideal learning environment. We also referenced codes, achieved required design criteria, and integrated design recommendations throughout the building.

During the design process of the Reading Elementary School, we made a conscious effort to meet all goals and create a functional school design. By using things like low wattage, energy efficient fluorescent lamps, energy saving controls, and ideal daylighting systems, we were able to create a school that was 42% below the ASHRAE 2010 Standard 90.1 Space-by-Space lighting requirements. It is confirmed, through thorough documentation, that the total watts used by the lighting system is approximately 50,083 W, well below the allowed 85,871 W.

The total elementary school building load is 714kVA. This load includes all lighting, receptacle, and kitchen loads, as well as building heating and cooling systems such as heat pumps, chiller, and electric hot water heater. This load also includes a 25% growth factor in case of future changes to the school. The pool and clinic renovation in Phase 2 adds approximately 100kVA to the load. There will be a 350 kW diesel generator to supply electricity to the main elementary school, the renovated Clinic space, and adjacent Natatorium for 27 hours.

Overall, the design presented in the project write-up and following appendices validates the proposed building design obtaining or exceeding design criteria. Please visit the project write-ups from the other disciplines for further knowledge of their system designs.

2. Introduction

Figure 1 : Rendering of Elementary School and Phase 2

In the Reading Elementary School pictured in Figure 1, we focused on creating a collection of building systems that enhances the quality of the community through innovative ideas and design. We aimed to design a “high performance” elementary school that functions as a multipurpose space for the community through a collaborative and multi-disciplinary design.

While designing the lighting and electrical systems, the goals were to provide a functional and energy saving solution that provides an enjoyable and secure environment for the students, faculty, and staff.

We started the process by arranging the site and incorporating daylight and shading systems that are most beneficial to the interior of the building. We worked with mechanical students, structural students, and construction management students, in order to integrate the separate disciplines early in the design process. This enabled the creation of the best building façades and site layout solutions. A good façade solution is one that allows a pleasing amount of daylight into the space to create a healthy and productive work environment, while keeping excessive amounts of direct sunlight from affecting the students. It is desirable to obtain this performance while maintaining an aesthetically pleasing design.

After completing the façade design, we moved into the interior lighting and electrical systems while continuing to work with the other disciplines. We strived to provide an integrated and energy efficient solution for the school while encouraging a modern, user friendly design. Throughout this write-up, the design process, research, assumptions, and design conclusions for the lighting and electrical systems will be presented.

3. Site

Within the site design seen in Figure 2, we considered how the electrical and lighting designs would influence the community and our goals, as well as how they should work with other systems and be the most effective solutions.

After extensive research, our team decided that the location of our site would be at the corner of Amity St. and N. 13th St. in Reading, PA. This location provides a safe, public surrounding and an area of easy access for our school.

Figure 2 : Site Layout

3.1 Electrical Design

The site will be supplied with overhead power lines already installed in the area. The power supplier will be the FirstEnergy Company Met-Ed at $0.0667/kWh. They will own the primary step-down transformer from 13.2 kVA to 480 kVA, but it will be located on the school site.

3.2 Building Orientation

After careful consideration, our team decided to change the orientation of the new school. The building footprint was mirrored along the y-axis. This new orientation can also be seen in Figure 2. This change allowed for the main entrance to remain on the front side of the building along Amity St., as well as utilize the site most effectively in respect to parking lot layouts and access to public areas of the school.

3.3 Site Lighting

We designed the exterior lighting such as site, parking lot, and field lighting to meet exterior light level requirements from the IESNA Lighting Handbook. We ensured that there will not be a disturbance to the community due to excess uplight, or site lighting straying into adjacent homes and buildings. It is tied into the main building automation system and is on a timer, as well as controlled by photocells. The parking lot lighting will be 100% output from dusk until 11:00 pm, 50% output from 11:00 pm to 5:00 am and 100% from 5:00 am to dawn. The field lighting will only be on when required by the school or community and will follow the strict time regulations. For the site lighting layout, visit Appendix A in the supporting documentation. For full fixture schedules for exterior lighting, visit Sheet E101 in the attached drawings.

<u>Parking Lot and Pathway Lighting</u>

The fixtures used around the site are a Gardco Gullwing 125W LED fixtures mounted at 18' for the parking lots and driveways and a full cutoff LED bollard for the pathways. The main entries will have Cooper Lighting 37W LED Canopy fixtures mounted under the overhangs and Gardco 10W LED bollards to light pathways.

School Parking		Criteria	As Designed
Horizontal Parking Lot Illuminance	Avg.	0.8	1.88
	Max.	--	3
	Min.	0.2	0.6
	Max:Min	20:1	5:1
Vertical Parking Lot Illuminance @ 5'	Avg.	0.5	0.81
	Max.	--	2.8
	Min.	0.1	0.3
Power Density		0.06	0.053

Figure 3 : School Parking Lot Illuminance and Power Density Criteria

Clinic Parking		Criteria	As Designed
Horizontal Parking Lot Illuminance	Avg.	0.8	1.66
	Max.	--	2.8
	Min.	0.2	0.3
	Max:Min	20:1	9:01
Vertical Parking Lot Illuminance @ 5'	Avg.	0.5	0.9
	Max.	--	2.5
	Min.	0.1	0.2
Power Density		0.06	0.053

Figure 4 : Clinic Parking Lot Illuminance and Power Density Criteria

Main Entry		Criteria	As Designed
Illuminance Values	Avg.	2	2
	Max.	5	4.3
	Min.	0.2	0.5
	Max:Min	10:1	8.5:1
Power Density		0.25	0.07

Figure 5 : Main Entry Illuminance and Power Density Criteria

Baseball Field

In order to achieve the desired light levels and uniformity for an IES Class III sports field, we propose using 450W metal halide GE Powrspot fixtures that reduces glare and uplight on the site. There will be 80 fixtures mounted at 60' on four poles.

Baseball Field		Criteria	As Designed
Infield Illuminance Values	Avg.	50	43.9
	Max.	--	52.7
	Min.	25	29.9
	Max:Min	2:1	1.5:1
Outfield Illuminance Values	Avg.	30	24.6
	Max.	--	45.9
	Min.	12	11.6
	Max:Min	2.5:1	2.2:1
Power Density		1.2	0.79

Figure 6 : Baseball Field Illuminance and Power Density Criteria

3.4 Security

With Reading, PA having a Violent Crime Index of more than twice the national average, building security was one of the issues of most importance in the building design. The school is equipped with card swipe access for faculty and staff to keep the building as safe as possible. The main building entrance will be monitored by faculty and staff during arrival and dismissal times for student entry and exit. There are security cameras around the building controlled by the building security management center in the main office to further monitor both the exterior and interior of the school. All other building access will happen through the main entrance and will be monitored by office personnel by means of a main door intercom system and automatic door locking devices. For building and equipment information see Appendix B.

We also incorporated intrusion protection measures. Glass break acoustic and motion detector sensors will be connected to the building's security management system to alert building personnel if a window or door is broken. Bullet proof glass will be used in the main office to protect the entryway in case of intrusion.

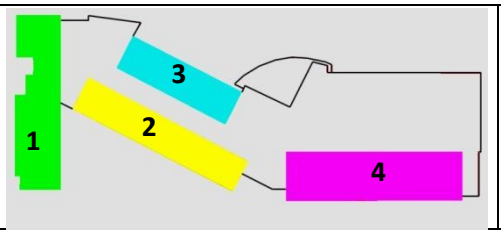
4. Façade

The façade of the building brought together all disciplines and maintained an architectural focus to complete the design.

4.1 Window Design

Calculations were conducted to determine the optimum window size and layout for the building. A ribbon window design was chosen (as opposed to punch out windows), allowing for better views and a more even daylight distribution. In order to determine the height of the windows, 5' vs. 6' windows were tested on each classroom orientation by the mechanical engineers to see how the window height affected cooling loads. The greatest difference in load between a 5' window height and 6' window height was seen on the South facing classrooms. This value was about 3600 BTU/yr, which equals about $102/yr for each South facing classroom. Since sunlight hits the South façade the most throughout the day, all other orientations saw less of a difference in BTUs/yr. The values above apply to windows without a lightshelf. It can be assumed that with a lightshelf, this number would be even smaller. Since the difference is minimal, we chose the 6' high windows giving an open feeling and allow daylight further into the room. In return, this will allow for more energy savings when dimming the electric lighting.

Window glazing was also tested by the mechanical engineers by running three different types of glazing in TRANE Trace to determine how the cooling and heating loads were affected. Factoring their results in with a high visible transmittance for daylighting purposes, the final glazing chosen for all windows was a Double High Performance Tint with an Argon gas fill. This glazing has a visible transmittance of 0.607. More details on these results can be seen in Appendix C.



1. Vertical Fins, Lightshelf
2. Clerestory, Lightshelf
3. **2 Ribbon Windows**, Clerestory
4. Clerestory, Lightshelf

2 Ribbon Window Layout

Figure 7 : Static Shading Devices Tested with Corresponding Orientations

4.2 Shading Devices

Permanent shading devices were also tested throughout the building. Each building orientation benefited from a different static shading device. In Figure 7, a diagram showing which systems were analyzed for each set of classrooms can be seen.

The analysis consisted of creating Daysim models for each scenario. Local, annual metrics were used to look at the daylight distribution of each space. The Daylight Autonomy (DA) at 400 lux was studied. DA is the percentage of hours a certain daylight level is reached throughout the year. For example, DA_{400lux} is how often the space exceeds 400 lux. In this case, the hours analyzed were from 7 AM-4 PM, Monday – Friday, for 180 weeks beginning with the first Monday in September. According to the IESNA Lighting Handbook, DA "provides a measure of how well daylight can replace electric light" when using photosensors to dim the lights. It was also important to ensure that there was not excessive direct sunlight entering the space. Using information output from Daysim, we determined the amount of time direct sunlight was causing a disturbance in the space. Figure 8 below compares a lightshelf to vertical fins for West-facing classrooms. For Daysim runs on every facade orientation and more on permanent shading devices, please refer to Appendix D.

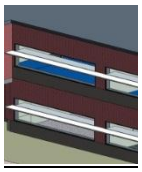
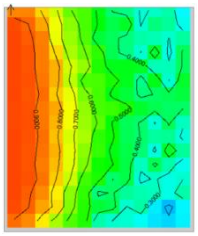
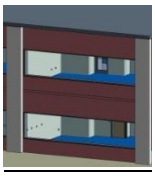
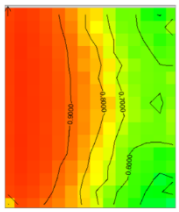
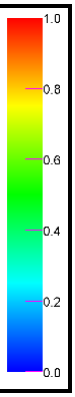
Lightshelf	DA_{400lux}		Fins	DA_{400lux}		
		Hours of Direct Sunlight per School Year 540 hrs/school year **33% of the School Year**			Hours of Direct Sunlight per Year 800 hrs/school year **50% of the School Year**	

Figure 8 : West Facing Classrooms comparing Light Shelves and Fins

In order to determine the dimensions of the lightshelves, a simple profile angle analysis was used. An example of this analysis for the Southwest façade can be seen in Figure 9. The areas highlighted in yellow are the times when the Southwest façade is hit with direct sunlight and reaches further than 4' into the room. The lightshelf, seen on the right, does a significant job blocking the high sun angles in the summer months. An interior shading device will be used in the winter months to stop the penetration.

For the final design, we chose to implement 3' overhangs to keep views open and avoid an overwhelming lightshelf. We will use lightshelves on classroom groups 1, 2 and 4, while also implementing rooftop clerestories on classroom groups 3 and 4.

For internal shading devices, roller shades will be implemented on all perimeter rooms. A bi-color fabric will be used**.** A lighter color will be used on the side facing the window to help reflect light and absorb less heat. A darker color will be used on the classroom side of the shade to allow for clearer views out of the building.

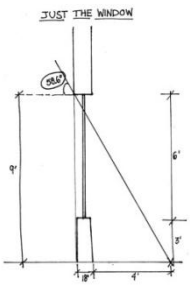
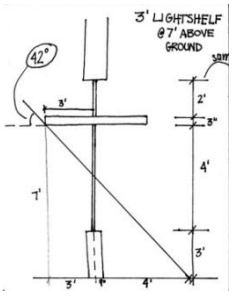
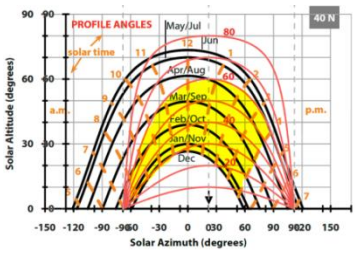
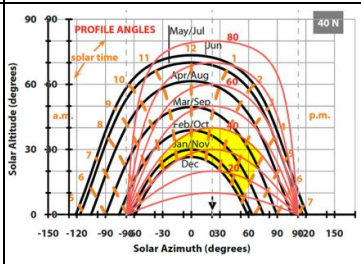
Without Lightshelf	With Lightshelf
	
	

Figure 9 : Profile Angle Analysis for Southwest Facade

4.3 Façade Lighting

The building façade lighting will be a simple, yet intriguing design. We will mount in-ground spot lights to illuminate the landscaping around the building. This will provide a low level of light for garden areas and the playground that will typically not be occupied at night. Dark Sky requirements were taken into consideration with the in-ground lighting analysis and less than 2% of the site's total exterior lumen output is uplight. There will also be spot lighting mounted on the north building façade over the entryway canopy. This will provide light to the building name, as seen in Figure 10.

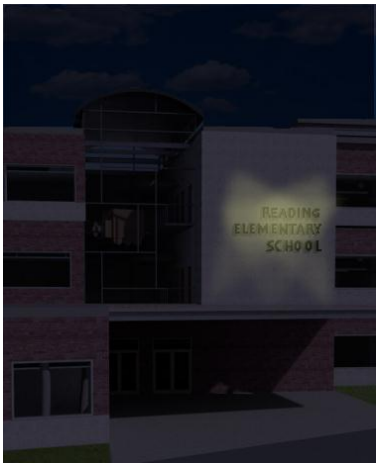


Figure 10 : Illuminated Building Facade

To light the entryways, RAB LED canopy lights will be mounted over all doors. This will provide adequate illumination meeting the required light levels for building entries. There will also be RAB 18W LED wall pack fixtures mounted on the exterior of the building to illuminate entrances and exits for egress purposes. For more information about the specific fixtures and illuminance values, see Appendix A.

5. Roof

The roof design began by deciding which sections of the roof should need to be flat to accommodate the necessary mechanical equipment on the roof and which sections could be sloped for roof drainage, and possible clerestory and photovoltaic panel installation.

5.1 Photovoltaic System

Although PV Panels proved to not be a feasible cost vs. energy savings strategy, we started the analysis by performing a study for both the best slope for a photovoltaic system on the roof and the best slope for daylight optimization from the clerestories. We decided that about a 15° slope would be best to accommodate both systems.

We researched multiple options for a photovoltaic panel layout and type for this roof. Using the chart in Figure 11, the total energy savings per year per system is calculated with the help of an online solar calculator called PVWatts. The payback periods proved to be so high, and rebate/stimulus money so low, that the system will not be ideal for this project. Unless more funding can be found in the future, the solar panel design will not be implemented.

Solar Panel Type	Max Power	Tilt Angle	Azimuth	Net Annual Energy (kW)	Cost/ Panel	# Panels	Cost of Panels	Total kW	Total Ouput/year	Total Energy Savings/Year	Unit	Cost/kWh	Energy Savings / Year	Payback Period
Uni-solar	68W	15°	180°	773	$120	362	$43,440	246	279826	32,518	kWh	$0.06601	$2,146.51	20.2
Uni-solar	68W	15°	150°	761	$120	448	$53,760	305	340928	32,518	kWh	$0.06601	$2,146.51	25.0
Uni-solar	144W	15°	180°	1636	$250	188	$47,000	271	307568	35,900	kWh	$0.06601	$2,369.76	19.8
Uni-solar	144W	15°	150°	1610	$250	233	$58,250	336	375130	44,610	kWh	$0.06601	$2,944.71	19.8
Sharp	235W	15°	180°	2670	$400	247	$98,800	580	659490	76,500	kWh	$0.06601	$5,049.77	19.6
Sharp	235W	15°	150°	2623	$400	306	$122,400	719	802638	92,500	kWh	$0.06601	$6,105.93	20.0
Sanyo	225W	15°	180°	2557	$650	332	$215,800	747	848924	96,900	kWh	$0.06601	$6,396.37	33.7
Sanyo	225W	15°	150°	2511	$650	399	$259,350	898	1001889	113,000	kWh	$0.06601	$7,459.13	34.8

Figure 11: Photovoltaic Cost vs Payback Calculations

5.2 Clerestories

Another daylighting scenario that influenced the structural system was the use of clerestory windows on the upper classroom level. We ran a number of simulations using Daysim to calculate the cost benefit of the electricity savings from implementing 2.5' clerestory windows.

Clerestory Calculations	Without Clerestory	With Clerestory
Energy Savings (kWh)	485	720
Cost Savings ($)	$32.50	$48.24

Figure 12 : Clerestory Cost vs Payback Calculations

Figure 12 shows the energy and cost saving results, from dimming the electric lights, with and without a clerestory. We chose to move forward with North-facing clerestories on the Level 3 classrooms facing Northeast and South. Based on

Daysim results, the addition of a clerestory will only save about $16 dollars per year due to dimming the electric lights. While these savings are not significant enough to support this decision alone, there are other benefits that you cannot necessarily put a price tag on. These benefits include a more even light distribution and a more productive work environment due to higher daylight levels which can help contribute to the students' and teachers' health and happiness in the long run.

6. Atrium

Another design element that we will be implementing is an atrium in the lobby of the building. Images of the atrium design can be seen in Figure 13 and Figure 14. This system will allow for a significant amount of daylight to enter into the lobby and transition spaces on all three levels. The atrium will allow for less electric light to be used in the space and focus on natural light. It will also create a spacious and inviting entryway to appeal to students, faculty, and guests. It will house an intriguing piece of sculpture work made by a local Reading artist, Robert Ian Pepper. This piece of artwork will be the center of attention in the space.

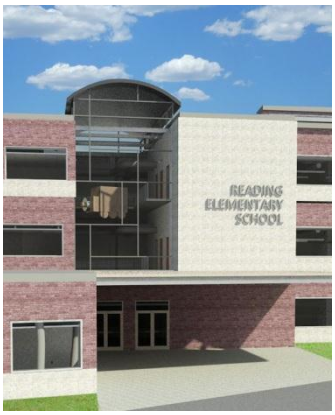


Figure 13 : Exterior Façade Rendering

Figure 14 : 3D Section View of Atrium

We originally intended to use Kalwall to construct the roof of the atrium. After further evaluation by the mechanical engineers, the glazing and Kalwall in the atrium space were negatively affecting the heating and cooling loads. In order to correct this, daylight level calculations were run in AGi32 with an opaque roof. If adequate daylight levels were reached with a solid roof material, then there was no reason for the Kalwall roof. The daylight levels in the atrium area were much greater than the recommended 10 footcandles, therefore the transparent roof is unnecessary. Our final design implements an opaque roof. For more detailed information and calculation grids, reference Appendix E

6.1 Lighting Design

Lobbies			Criteria	As Designed
Lobbies : Daytime	25-65 yrs	Avg.	10	11
		Avg:Min	4:1	4:1
Lobbies : Nighttime	25-65 yrs	Avg.	5	5.4
		Avg:Min	4:1	4:1
Power Density			0.9	0.86

Figure 17: Lobby Illuminance and Power Density Criteria

For the lighting design of this space, we wanted to focus the attention on the artwork that will be suspended from the ceiling. Illuminating this piece of art will allow it to be enjoyed by the occupants. At night it can be easily visible, from the street, though the glass façade of the atrium. It is a good way to help bring together the school and the community. In order to do this, we will use LED spotlight fixtures and illuminate the center piece from above and the front (from the floor below). More specifically, we will be using a Philips CANLYTE Spot LED. Decorative pendants will also be used to provide correct light levels on the walkways

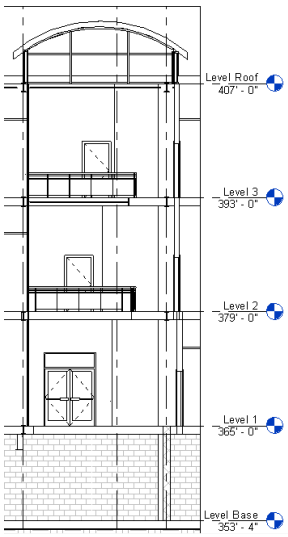


Figure 15 : Atrium Section with Floor-to-Floor Dimensions

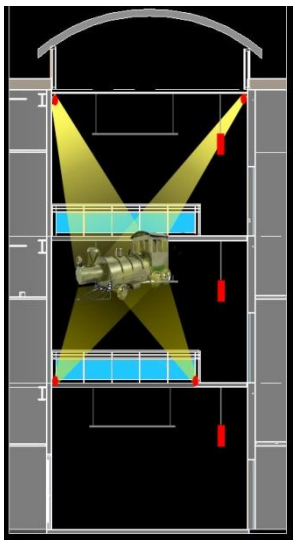


Figure 16 : Atrium Schematic Lighting Design

leading to the bathrooms. For the complete lighting layout and fixtures used, please refer to the Third Floor Lighting Plan or Appendix E.

7. Classrooms

7.1 Design Criteria

Classrooms			Criteria	As Designed
Classroom	25-65 yrs	Avg.	40	38
		Avg:Min	2:1	2:1
Whiteboard	25-65 yrs	Avg (Vert.)	30	27.2
		Avg:Min	3:1	2.2:1
Power Density			1.24	1.15

Figure 18 : Classroom Illuminance and Power Density Criteria

When designing a typical classroom, we wanted to maintain a user friendly system that created an ideal teaching and learning space. We achieved required design criteria, and created a space that each teacher could control at the touch of a button. The ceilings in the school will be exposed ceilings at 14' high with fixtures mounted at 8' AFF. This allows the students interaction with the systems and for the teachers to use them as a teaching tool. We also analyzed the surfaces in the space that would have specific lighting requirements including desk surfaces, counter-tops, computer screens, and vertical white boards.

7.2 Lamps and Ballasts

Before choosing a specific fixture or design, a lamp comparison study was conducted. Figure 20 shows a rough lifetime cost analysis of T5, T8, and LED fixtures. We chose a T8 system to keep up-front purchasing costs lower, as well as to provide a more efficient system to include both uplight and downlight in the space. We will be also implementing T8 fixtures throughout the office, hallway, and common spaces.

	Fixtures/ Room	Watts/ Lamp	Hours/ Year	kWh/ Year	Room Energy Usage/Year	Maintenance Costs/Lamp/Year	Ballast Costs	Lamp Costs	Lamp Lifespan	Fixture Cost	Fixture Lifespan	Initial Fixture Cost	Lifetime Cost
T5 (4ft)	12	28	2600	72.8	$58.53	$5.00	$52.00	$4.75	9.2	$150.00	20	$2,169.00	**$4,918.12**
T8 (4ft)	12	32	2600	83.2	$66.89	$5.00	$46.00	$2.75	9.2	$120.00	20	$1,749.00	**$4,601.36**
LED (4ft)	8	60	2600	156	$83.62	$2.00	$0.00	$0.00	20.0	$260.00	20	$2,080.00	**$4,072.32**

Figure 20 : Classroom Lamp Comparison

Lamp and Ballast Selection	
Lamp	Philips F28T8/ADV835 XEW ALTO
Ballast	ADVANCE TRANSFORMER Electronic Dimming Ballast (2 lamp)

Figure 19 : Classroom Lamp and Ballast Selection

7.3 Fixtures

For the classrooms, an even light distribution throughout the space was essential. Linear pendants with different uplight/downlight distributions were tested. An 80% uplight/20% downlight fixture was chosen because it gave an even distribution throughout the room and allowed for a visually appealing fixture layout. Linear LED undercabinet fixtures will also be used. The fixtures used in the classrooms can be seen in the lighting fixture schedule on Sheet E101 or Appendix F.

7.4 Typical Classroom Layout

Figure 21 and Figure 22 show a typical classroom layout and section.

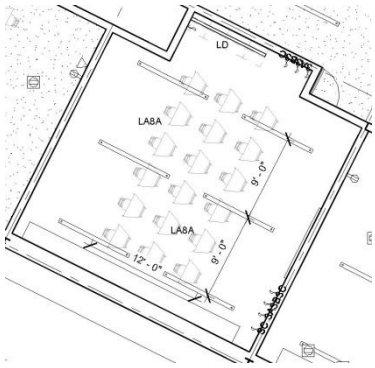


Figure 21 : Classroom Ceiling Plan

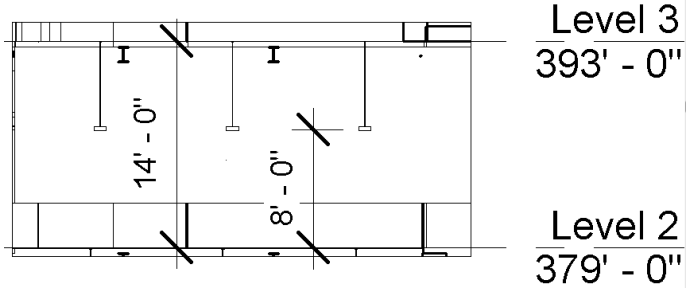


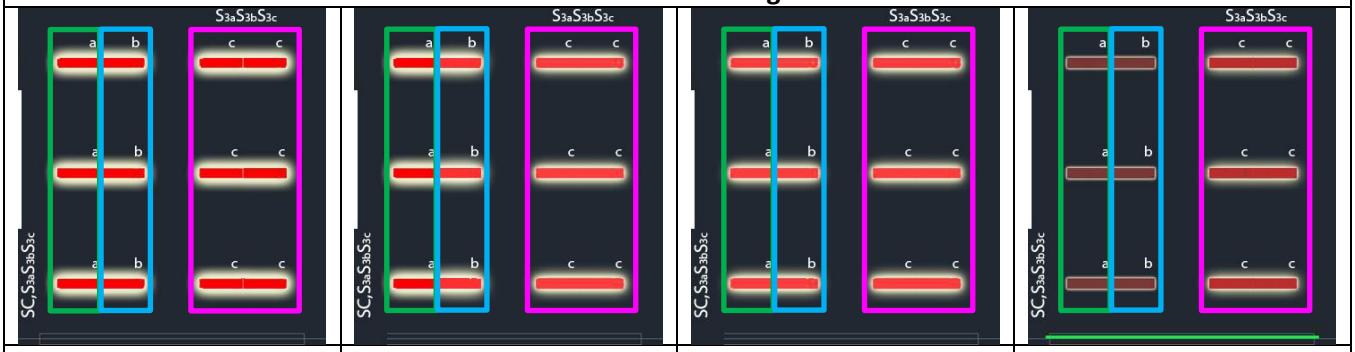
Figure 22 : Classroom Section

7.5 Daylight and Switching Controls

Each classroom will have a scene control device mounted at the teaching board, along with individual switching and dimming controls for each zone. For a specific zoning diagram, see Figure 23. This system will allow for intuitive use for the teachers and students, as well as fulfilling the ASHRAE 2010 Standard 90.1 controls requirement. These will all be connected to a WattStopper DLM system providing individual room control from the central controller. The different scene settings can be seen below. Dual Technology vacancy sensors are implemented in each classroom.

Daylight sensors will also be implemented in the classrooms to control the two rows of fixtures closest to the windows. With these controls used in all 36 main classrooms, a total of approximately 28,360 kWh of energy per year can be saved in daylight alone. This is approximately $1,900 per year in daylight savings (this value does not include savings from occupancy sensor). These results were calculated in Daysim

Classroom Settings



Full Output	Teaching Mode	50% Light Output	AV Mode
100%, 100%, 100%	100%, 75%, 50%	50%, 50%, 50%	10%, 10%, 50%

Figure 23 : Zoning Diagram

8. Administration and Public Spaces

8.1 Design Criteria

Administration			Criteria	As Designed
Principal's Office	25-65 yrs	Avg.	30	33
		Avg:Min	2:1	2:1
Power Density			1.11	0.93
Clerical Space	25-65 yrs	Avg.	30	32
		Avg:Min	2:1	2.2:1
Power Density			0.98	0.79
Reception/Waiting Area	25-65 yrs	Avg.	20	21
		Avg:Min	3:1	2.6:1
Power Density			0.73	0.68
Community Office	25-65 yrs	Avg.	50	32
		Avg:Min	2:1	2:1
Power Density			1.11	0.89

Figure 24 : Administration Illuminance and Power Density Criteria

Library			Criteria	As Designed
Book Stacks : General @ Floor	<25 yrs	Avg.	10	13.1
		Avg:Min	2:1	2:1
Book Stacks : Shelving @ 2.5' AFF	<25 yrs	Avg.	15	18.5
		Avg:Min	2:1	2:1
Lending Desk : Staffed Area	25-65 yrs	Avg.	50	55
		Avg:Min	2:1	1.2:1
Reading Areas	<25 yrs	Avg.	25	26
		Avg:Min	2:1	1.7:1
Power Density			0.93	0.57

Figure 25 : Library Illuminance and Power Density Criteria

8.2 Lamps and Ballasts

Following the recommendations of the study done for classrooms, the rest of the building fixtures use mostly T8s. The lamps remain 28W T8 linear fluorescent or a 28W T8 U tube with electronic dimming ballasts. The other lamping options seen throughout the building are LED downlights, and our LED under cabinet fixtures.

8.3 Fixtures and Layout

The fixtures used throughout the administration and public spaces can be seen in the lighting fixture schedule on Sheet E101 and in the lighting plans in the attached drawings.

8.4 Daylight and Switching Controls

The building corridors will incorporate daylighting controls in the curtain wall areas and in the atrium. The public spaces such as bathrooms, corridors, and the library will also be controlled by a Building Management System. There will be no occupancy sensors in these spaces. Individual offices and conference rooms will have switching and dimming controls, as well as occupancy/vacancy sensors. All public space requirements were followed as per the ASHRAE 2010 Standard 90.1 requirements.

9. Multipurpose Room

9.1 Design Criteria

When designing the gym and multipurpose space, we wanted to implement a the same user friendly interface as seen throughout the entire school. This aids in creating a functional multipurpose space to include: sporting events, gym classes, lunch periods, and minor theater productions. We made sure to achieve all of these functions while still achieving the required design criteria seen in Figure 26.

Multi-Purpose Room			Criteria	As Designed
Assembly : A/V No Notes	<25 yrs	Avg.	0.5	3.2
		Avg:Min	2:1	1.3:1
Assembly : Speaker/Panel	<25 yrs	Avg.	0:00	32
		Avg:Min	3:1	2.3:1
Phys. Ed	<25 yrs	Avg.	25	32
		Avg:Min	3:1	2.3:1
Cafeteria	<25 yrs	Avg.	7.5	14
		Avg:Min	3:1	
Basketball - Class 3	25-65 yrs	Avg.	50	49
		Avg:Min	3:1	1.3:1
Power Density			1.2	0.97

Figure 26 : Multipurpose Room Illuminance and Power Density Criteria

Note: Design criterion is based off of 25-65 year old age range because the gym will also be used by the community during out of school hours. We needed to make sure the light levels were high enough.

9.2 Lamps and Ballasts

A study comparing lamp types was also conducted, similar to those for the classrooms. Figure 27 shows a rough lifetime cost analysis of T5, T8, MH, and LED system. We choose to implement the six lamp T5HO system for the cheapest lifespan cost. The T5HO implementation still maintains a relatively low start-up cost. The longer life lamps also do not

need changed nearly as frequently as a metal halide system. The user friendly T5HO system provides dimming capabilities and eliminates the startup time of comparable metal halides.

	Fixtures/ Room	Watts/ Lamp	Hours/ Year	kWh/ Year	Room Energy Usage/Year	Maintenance Costs/Year	Ballast Cost	Lamp Costs	Lamp Lifespan	Fixture Cost	Fixture Lifespan	Initial Fixture Cost	Lifetime Cost
6LT5	15	324	2600	842.4	$846.61	$15.00	$23.00	$4.75	9.2	$160.00	20	$3,862.50	**$26,832**
6LT8	24	190	2600	494	$794.35	$15.00	$21.00	$2.75	9.2	$120.00	20	$4,788.00	**$29,849**
250W MH	20	275	2600	715	$958.10	$10.00	$32.00	$28.00	7.7	$140.00	20	$8,080.00	**$29,338**
350W LED	24	350	2600	910	$1,463.28	$2.00	$0.00	$0.00	19.2	$450.00	20	$10,800.00	**$41,026**

Figure 27 : Gymnasium Lamp Comparison

Lamp and Ballast Selection	
Lamp	Philips F54WT5/841/HO-ALTO
Ballast	ADVANCE TRANSFORMER Electronic Ballast (2 lamp)

Figure 28 : Multipurpose Room Lamp and Ballast Selection

9.3 Fixtures

For the multipurpose space, it was important to get an even light distribution across the entire gymnasium. We choose T5HO high bay fixtures and discovered that a six lamp fixture will provide the most even distribution with the least amount of fixtures. It will be a pendant mounted fixture aligned with the gymnasium trusses. They will be mounted at 24' high and have an all downlight distribution. The fixtures are protected by metal cages. Additional layers of light will be provided by PAR lamp spotlights with a wide distribution, mounted along a track. More details can be found in Appendix G.

In the stage area we will implement a sloped ceiling that can be seen in Figure 30, to help with acoustics. Recessed can fixtures will also be mounted for general stage lighting. To assist with theater and stage productions, a track mounted theater lighting system will be installed. The equipment can be removed from the track to avoid damage if necessary. For specific fixture selection, see the lighting schedule on Sheet E101.

9.4 Layout

The multipurpose room lighting layout can be seen in Figure 29. The downlights are mounted over the stage area and the theater track lighting will be mounted along the stage line at ceiling height. Implementing the fixtures in this layout allowed us to meet all recommended design criteria listed in Figure 26 above.

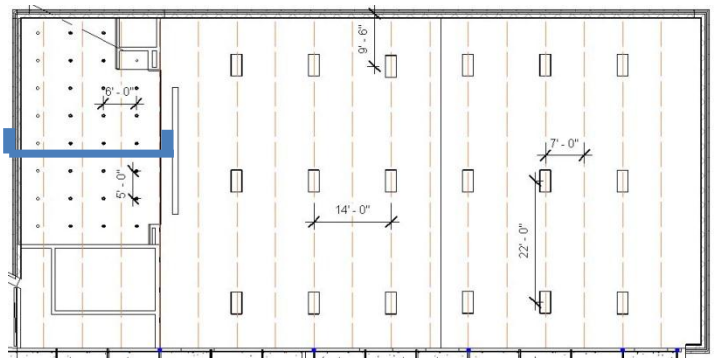


Figure 29 : Multipurpose Room Lighting Layout

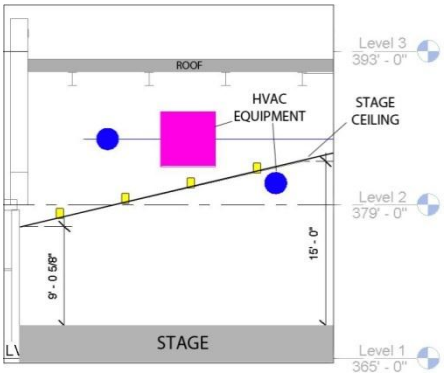


Figure 30 : Multipurpose Room Section

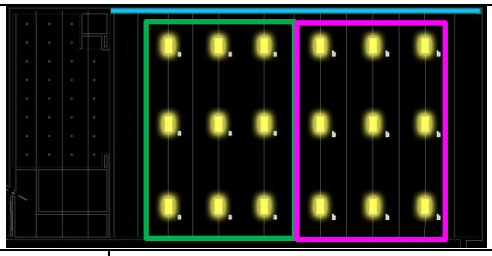
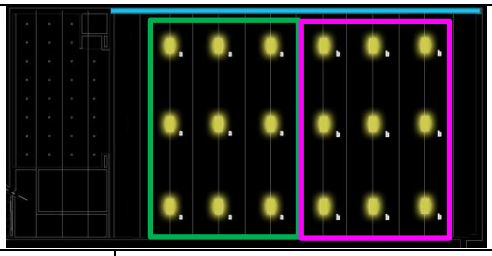
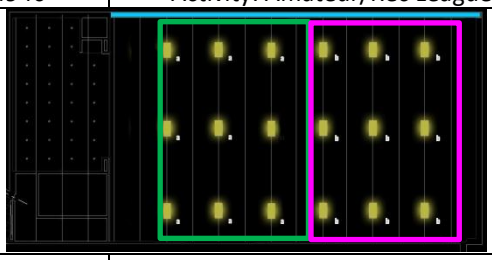
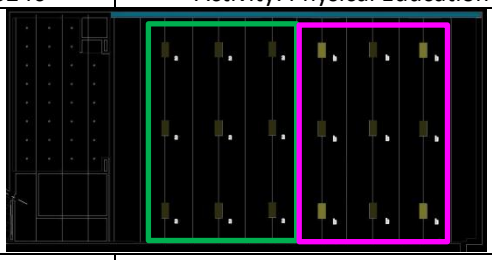
			
Light Levels: 49 fc	All 6 Lamps On Activity: Amateur/Rec Leagues	Light Levels: 32 fc	4 Lamps On Activity: Physical Education
			
Light Levels: 14 fc	2 Lamps On Activity: Cafeteria Lunch	Light Levels: 3.2 fc	2 Lamps On in 4 Fixtures, Shades Down Activity: A/V Presentation

Figure 31 : Multipurpose Room Scene Settings

9.5 Daylight and Switching Controls

The controls for the gym will be based on a stepped dimming system seen in Figure 31. This will allow for two, four, or six lamps per fixture to be on to create a dimming effect. Each half of the gym will have its own scene control panel with the same scenes. This will allow for separate control in the event that two different activities are going on simultaneously with a room divider. The different settings can be seen below. The pink and green circles indicate the separate zones. These areas will also be on daylighting sensors to limit the amount that the lamps need to be on with the same stepped dimming effect.

The stage lights will be controlled on an adjacent system but the individual lamps can be dimmed. This will allow for easy adjustments and no need for an AV/Equipment room.

9.6 Skylight System

Once the façade design was completed, the natural lighting in the gym was not evenly distributed across the space. As an add/alternate, we recommend skylights over the gym area. The proposed layout can be seen in Figure 32.

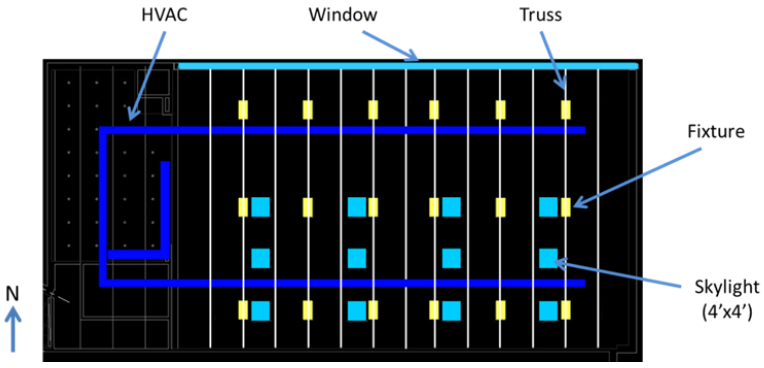


Figure 32 : Multipurpose Room Ceiling Plan

In Figure 33, the Illuminance Levels from Daysim for the gym with and without skylights can be seen. Please note that these values were tested for each season, but we are only presenting one trial. The skylights help evenly distribute the light throughout the space and almost double the light levels. This will allow us to turn the lights off more frequently. Upon original analysis, the energy savings from dimming the electric light in Daysim were only about $120/yr. Based on the energy savings alone, it is hard to justify paying such a high upfront cost for installing 12 skylights. After a detailed analysis, skylights are being proposed as an Add/Alternate to the multi-purpose room roof. If the owner chooses to move forward

with this Add/Alternate the additional cost would be around $2,000 per skylight according to RSMeans Cost Data. This number does not include the motorized shading system that will need to be installed. While the cost is rather high, occupants will benefit greatly from higher daylight levels and a more even distribution. They would also allow for energy savings because the electric light could be turned completely off for a certain percentage of hours in the year.

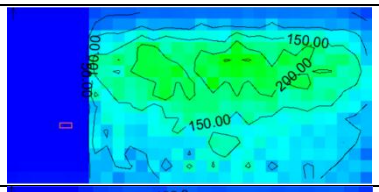
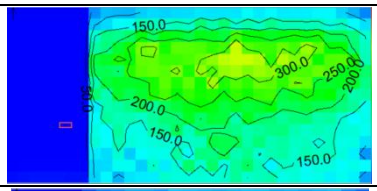
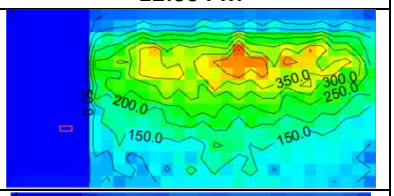
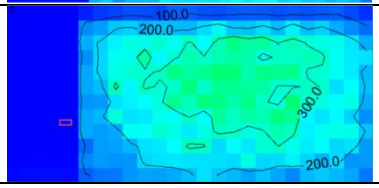
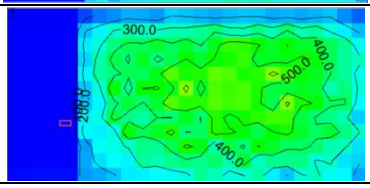
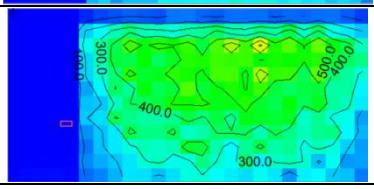
Fall (September 21st)			
Time	**8:00 AM**	**10:00 AM**	**12:00 PM**
Without Skylights			
With Skylights			

Figure 33 : Daysim Illuminance Levels for Multipurpose Room Skylight System

10. Electrical Design

10.1 Receptacle Layout

Because of the high demand for new and hands on technology, a large load for computers, speaker systems, projectors, televisions, etc. must be planned for. Generally, classrooms were provided 7 under floor duplex receptacles, 2 GFCI receptacles over the sink area, 2 convenience receptacles, and a receptacle/cable outlet for a wall mounted television. Under floor receptacles were chosen to avoid placing receptacles in the pre-cast exterior wall panels. The projector ports will be hard wired into the ceiling.

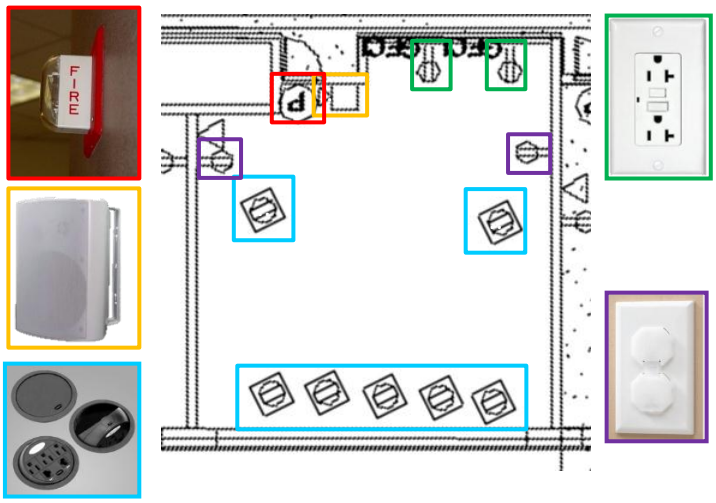


Figure 34 : Typical Classroom Receptacle and Fire Alarm Layout

In the corridors convenience receptacles will be provided every 50'. In offices, under floor data and receptacle outlets will be provided at known desk spaces and other receptacles will be provided every 20' along walls. The MDF and IDF rooms will have 6 GFCI Quad receptacles each. All kitchen and theatre equipment will be accounted for with individual permanent receptacles. An example layout and more information about the electrical design can be found in the appendices.

10.2 Fire Alarm Layout

The fire alarm layout will adhere to the 2011 NFPA code requirements of fire alarm visual and speaker devices. Each classroom and office will have a visual device as well as a speaker. Visual devices and speakers will be mounted through the hallways, in bathrooms and throughout the multipurpose room.

The building speaker system will also serve as a public announcement system. It will be on emergency power and be controlled from the main office. This speaker system will announce bells, morning announcements, and emergency tones. For fire alarm layouts and a fire alarm riser diagram see the Appendix L and the Fire Alarm Plans in the attached drawings.

10.3 Electrical Room Layout

The electrical room will be located in the basement of the elementary school. It will house the main distribution panels, 480 to 120/208Y regular and emergency step down transformers, fire alarm panels, automatic transfer switches, and emergency distribution panels.

The main elementary school load is calculated at about 715KVA. This includes all lighting, receptacle, and kitchen equipment, as well as an electric hot water heater, rooftop air handlers, and individual heat pumps throughout the building. These loads will be distributed from a Met-Ed owned transformer to the main building switchboard. From there, the power will be distributed throughout the building through main distribution panels in the electrical room. 480 to 120/208Y volt transformers will also be placed in the main electrical room. From there, electrical feed will distribute to predetermined Main Distribution Frame (M.D.F.) and Intermediate Distribution Frame (I.D.F.) rooms throughout the building. The multipurpose room and kitchen will be fed from the theater storage room. For the building riser diagram please see Sheet E108.

10.4 Emergency Generator

The two buildings on the site will be equipped with one building generator. This generator will be a 350kW Generac Gemini and located on the north side of the existing building between the pool and clinic sections. It will be equipped with a 693 gal tank to supply the building for a minimum of 27 hours. Because of the implementation of a 24 hour clinic space, we wanted to ensure that the school could be used as a shelter in case of a community or city wide emergency.

The generator will be available to provide immediate life safety power for egress lighting. It will also provide power to the entire first floor of the elementary school including multipurpose room, kitchen, and first floor classrooms. In case of emergency these can be used to shelter community members. The 24 hour clinic will also be fully supplied. This will allow for the clinic to also be used in case of an emergency.

WEATHERPROOF ENCLOSURE

RUN TIME HOURS	USABLE CAPACITY (GAL)	L	W	H	WT	dBA*
NO TANK	-	175	58	78	8106	85
7	183	175	58	91	9054	
17	438	175	58	103	9366	
27	693	175	58	115	9669	
37	946	208	58	118	11313	
52	1325	278	58	118	12146	

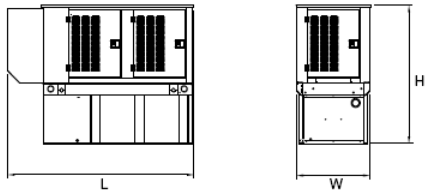


Figure 35 : Generator Capacity Data

11. Phase 2

The second phase of this project will specifically repurpose the existing elementary school to house the indoor pool and 24 hour health clinic. It will also include reserve office/classroom spaces for future school or administration growth. We will be demolishing and rebuilding the east half of the existing school to build a new natatorium. The west side of the building will be renovated to house the 24 hour clinic. This will allow the school to be separated from the 24 hour clinic for safety reasons, but still allow it to be incorporated with the new school design and construction.

Pool		Criteria	As Designed
Water Surface	Avg.	30	31
	Avg:Min	3:1	2:1
Power Density		1.2	
Deck Surface	Avg.	10	22
	Avg:Min	4:1	2.5:1
Power Density		1.2	
Turning Lanes	Avg.	50	48
	Avg:Min	1.7:1	1.3:1
Power Density		1.2	

Figure 36 : Pool Illuminance and Power Density Criteria

11.1 Natatorium

Design Criteria

The design criteria for the pool area was very specific. The general lighting will provide sufficient light to all pool spaces, as well as the second level seating area above the pool deck.

Lamps, Ballasts, and Controls

The Natatorium lighting fixtures will follow the same criteria as the gym high bay study. We will be implementing a 6 lamp wide distribution T5HO high bay system with watertight fixtures to keep dry and prevent corrosion. This system will have an on/off switching system with no dimming or daylight control. Because the design criterion is so specific, we wanted to ensure that all lighting was kept at appropriate levels.

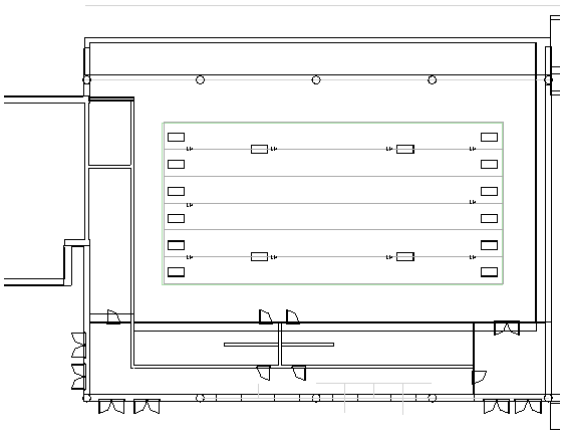


Figure 37 : Natatorium Lighting Layout

Layout

A Natatorium lighting layout can be seen in Figure 37. The fixtures are pendant mounted above the pool. To provide enough light for the turning lane, a majority of the fixtures are positioned over the ends of the pool. A lift will be required to access fixtures and change lamps and ballasts. For lighting calculations for the Natatorium see Appendix M.

11.2 Clinic

Design Criteria

The design criteria for the clinic can be seen in the figures below.

Clinic		Criteria	As Designed
Individual Patient Rooms	Avg.	50	50
	Avg:Min	2:1	1.7:1
Power Density		1.66	0.99
Double Patient Rooms	Avg.	50	50.5
	Avg:Min	2:1	1.7:1
Power Density		1.66	1.17
Toilets	Avg.	15	18
	Avg:Min	2:1	1.4:1
Power Density		0.98	0.55
X-Ray	Avg.	50	50
	Avg:Min	2:1	1.7:1
Power Density		1.11	0.5
Nurses Station	Avg.	10	19
	Avg:Min	2:1	1.5:1
Power Density		0.87	0.44

Clinic		Criteria	As Designed
Waiting Room	Avg.	10	
	Avg:Min	3:1	
Power Density		1.07	
Medical Supply	Avg.	20	17.5
	Avg:Min	3:1	1.5:1
Power Density		0.63	0.38
Clean Supply	Avg.	10	15.7
	Avg:Min	2:1	2:1
Power Density		0.6	0.46
Soiled Area	Avg.	30	32
	Avg:Min	2:1	1.4:1
Power Density		0.6	0.76
Office Supply	Avg.	10	13.4
	Avg:Min	2:1	1.4:1
Power Density		0.63	0.38

Clinic		Criteria	As Designed
Office	Avg.	30	25
	Avg:Min	2:1	1.4:1
Power Density		1.11	0.5
Janitor Closet	Avg.	10	12
	Avg:Min	2:1	1.5:1
Power Density		0.63	0.3
Administration	Avg.	30	31
	Avg:Min	2:1	1.9:1
Power Density		0.98	0.5
Break Room	Avg.	10	16
	Avg:Min	2:1	1.7:1
Power Density		0.73	0.34

Figure 38 : Clinic Illuminance and Power Density Criteria

Lamps, Ballasts, and Controls

The clinic lighting will be a linear fluorescent T8 lamp with a typical electronic ballast. Each room will have vacancy sensors and manual on/auto off to accommodate all of the offices and patient rooms.

Fixtures

The clinic fixtures are recessed 2x2 and 2x4 linear fluorescent fixtures. These will be the same Pinnacle Adeo fixture used in the school building. For more information on each fixture, see Appendix M.

Layout

A clinic lighting layout can be seen in Figure 39. The fixtures are recessed into a drop ceiling. For more information about the lighting layout, see the attached drawings.

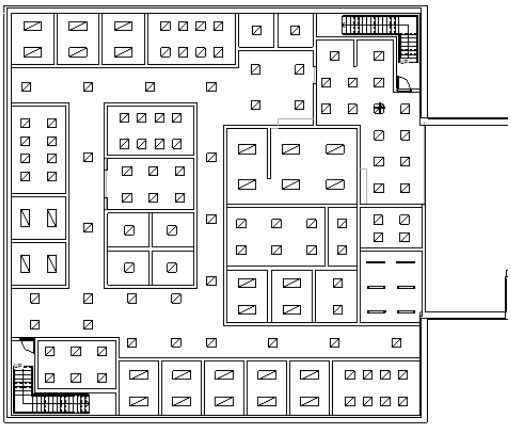


Figure 39 : Clinic Lighting Layout

12. LEED

LEED design is a very important aspect of modern, high technology, high efficiency, sustainable buildings. It takes collaboration from an entire design team to integrate and reach the LEED design qualifications. Although lighting and electrical systems do not have many points they are able to achieve specifically, there are a few that are very important to the design. These points will help allow us to reach a LEED Silver Certification.

Light Pollution Reduction – 1 Point: All exterior lighting is placed for the least amount of light trespass off of the site and a minimum amount of uplight. All fixtures will have dimming capability for 11:00PM to 5:00AM. They will be controlled by a building automated timer, as well as photocells on the fixtures.

Green Power – 2 Points: This score requires that the annual electricity consumption of more than 35% of the building's electricity will be renewable energy. By purchasing through Washington Gas Energy Services, suggested by the Center for Resources Solutions/Green-e Energy, we can receive a rate for $0.0930/kWh for 50% Green-e Energy Certified.

Controllability of Systems – 1 Point: The elementary school design will have occupant controls for all of the required lighting in the building. There will be scene controls for all classrooms and dimming switches for all office spaces.

Daylight & Views (Views) – 1 Point: To achieve this LEED point we will be using lower partition heights, interior shading devices and glazing, as well as photocell controls to maximize the views from the interior of the building.

13. Conclusion

By working as an integrated design team, we feel that our design has met our project goals in many ways. Although we encountered changes in approach and design as we worked through the project, it allowed us to learn and create the best system possible by overcoming differences and issues.

Throughout this building design, we provided a user friendly and extremely energy efficient lighting system. The simple integration principle throughout the building allows for easy growth and change. As the project continues, we hope the building raises attendance, improves teacher satisfaction, and provides an above average learning environment for everyone in the community.

List of Appendices

Appendix A: Site Lighting Calculations

<table>
<tr><th colspan="3"><u>Parking Lot and Pathway Lighting</u></th></tr>
<tr><th>Philips Gardco GL18 LED Area Light</th><th>Gardco Full Cutoff LED Bollard</th><th>Cooper Lighting Canopy Light</th></tr>
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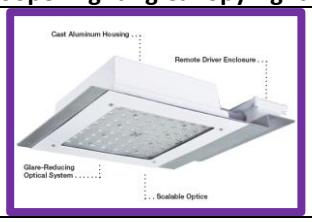
<td>  </td>
<td> 
</td>
</tr>
<tr>
<td>• Type 3 and Type 5 used
• 125W, 18’ Mounting Height
• Neutral White
• 0-10V Dimming</td>
<td>• 10 W
• Neutral White
• 0-10V Dimming
• 3’ Height</td>
<td>• 37W Canopy Light
• Neutral White
• Recessed in Overhang
• 0-10V Dimming</td>
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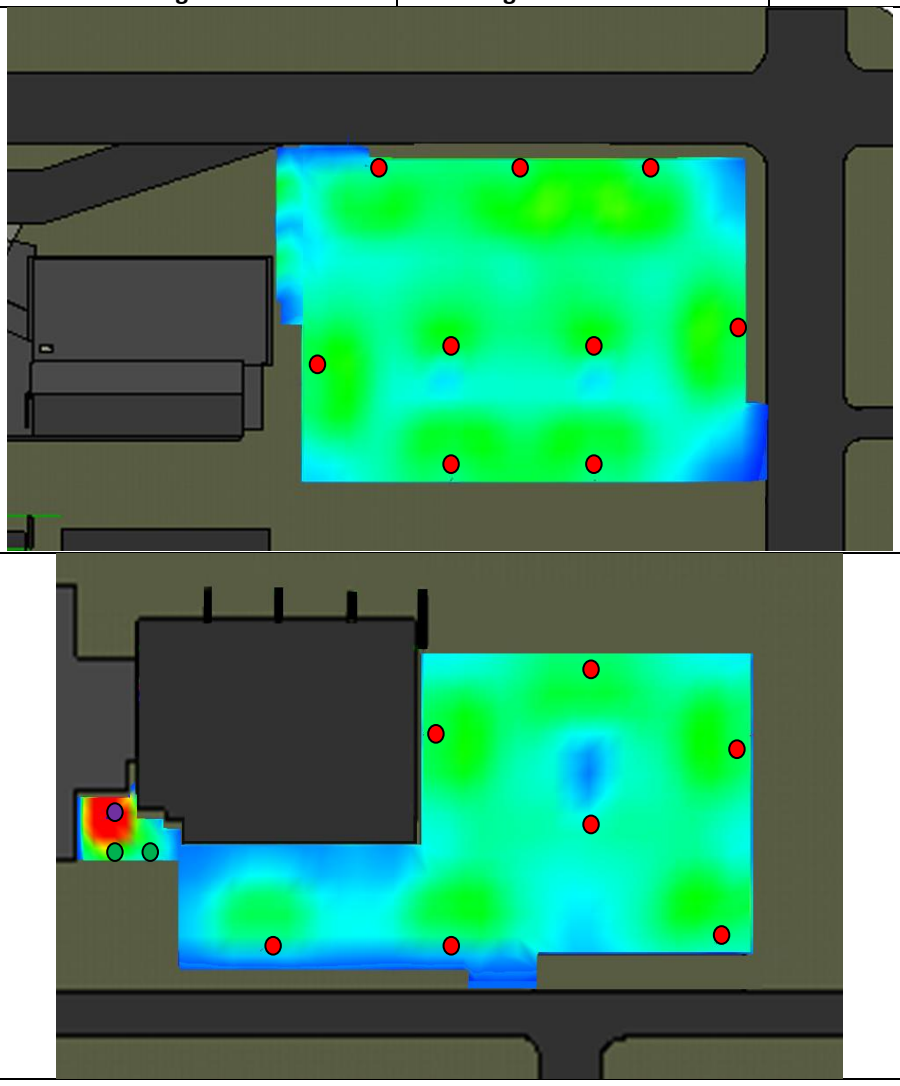
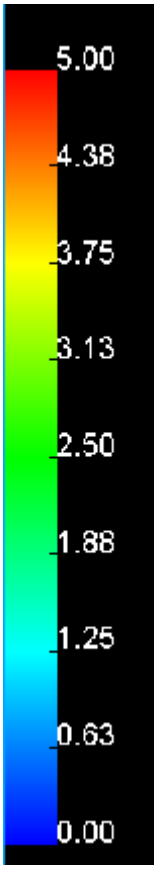
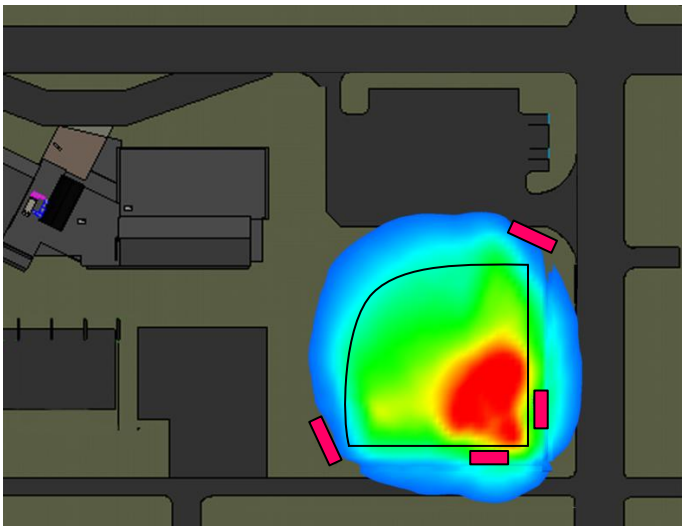
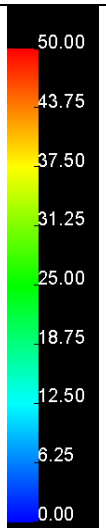
<td colspan="2">  </td>
<td> 
</td>
</tr>
</table>

Baseball Field Lighting

GE Powr-Spot Floodlight – Glare Reduction

- 400W MH
- Fields for all Levels
- Reduces Glare and Uplight
- 80 Fixtures
- 60’ Mounting Height

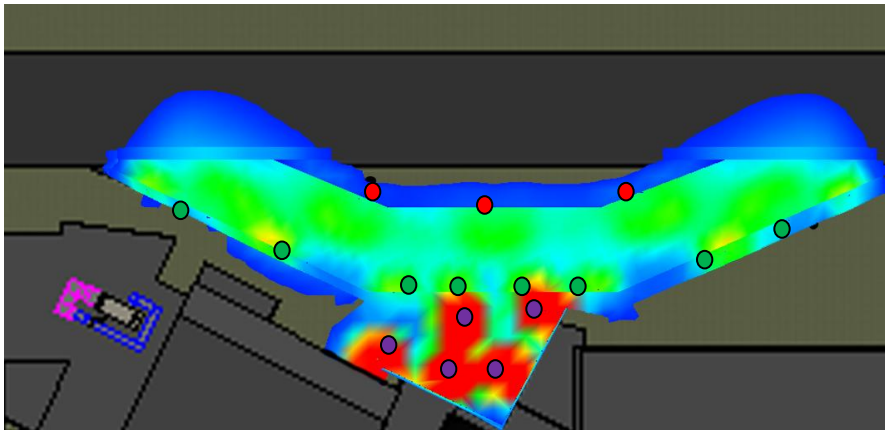


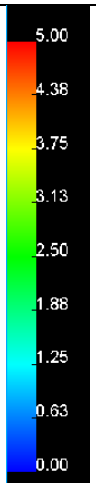


Illuminance (fc)

Façade Lighting

Philips Gardco GL18 LED Area Light	Cooper Lighting Canopy Light	Gardco Full Cutoff LED Bollard	RAB 26W LED Wallpack	Bega Lighting In Ground Spot
				
• 89W, 13’ Mntg Ht • Neutral White • 0-10V Dimming	• 37W Canopy Light • Neutral White • 0-10V Dimming	• 10 W • Neutral White • 0-10V Dim	• 26W • 68 CRI 4000K • Bldg Exterior	• 9W MH Adjustable • Around Site





Illuminance (fc)

Appendix B: Security

Visitor entrance, guests must be buzzed in and sign in at front desk

Unlocked for public access

Locked; faculty card swipe access only

Locked; emergency exit only

These security measures will help to keep the Reading students safe. There will also be a K-rated security fence around the perimeter of the property. At the building Visitor Entrance, bulletproof glass will be installed to prevent forced entry through the main doors.

Daytime (6:00 am – 5:00 pm)

Figure 2 : Building Access Locations During School Hours

Evenings / Weekends (access to public spaces only)

Figure 1 : Building Access Locations Evenings and Weekends

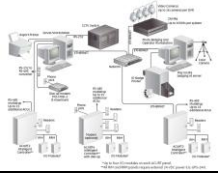
Security Cameras	Topaz Access Control	Card Readers	Glass Break Sensor
			
Vandal Resistant Security Cameras	Building Control System	Building Access Control	Acoustic and PIR Glass Break Sensor and Transmitter

Table 1 : Main Security Devices to Implement

Building Security Devices				
Location	**Type**	**Quantity**	**Manufacturer**	**Description**
Building Surveillance	Building Security Integrator	1	GE Security	Topaz System
	Door Swipes	6	GE Security	Transition, Mini Mullion Card Readers
	Video Cameras	47	ultraView	Rugged Dome Cameras
	Glass Break Sensors	75	Sentrol	ShatterPro, Plus Motion Sensor, Shock Sensor, Acoustic Sensor Glass Break Alarm
	Glass Break Transmittors	25	Sentrol	Glassbreak Sensor Analyzer
	Building Access Intercom	1	GE Security	Topaz Audio and Video Intercom Entry System
Fire Protection	Fire Control Panel	1	GE Security	fireworX Integrated Control Panel
	Smoke Detectors	21	GE Security	Ceiling Smoke Detectors
	Pull Stations	19	GE Security	Wall Mounted Pull Stations
	Visual Devices	60	GE Security	Strobes
	Combination Devices	80	GE Security	Wall and Ceiling Mounted Combination Devices
	Call Stations	21	GE Security	Wall Mounted Call Stations
Building Alert	Speaker Devices	45	Visiplex	Building Announcement, Bell, and Speaker System
	Clocks	85	Visiplex	Integrated Digital Clock and Announcement System

Table 2: Summary of Building Security Devices

Appendix C: Glazing Selection

ASHRAE Standard 90.1 Building Envelope Requirements		
Vertical Glazing Type	**Assembly Max. U**	**Assembly Max SHGC**
Non-metal Framing (all)	0.35	0.40
Metal Framing (Curtain Wall)	0.45	0.40
Metal Framing (all other)	0.55	0.40

Table 1 : 2010 ASHRAE Standard 90.1 Requirements

Glazing Types	Assembly U-Value	Assembly SHGC	VT
Double High Performance Tint (Argon)	0.54	0.390	0.607
Double Low Solar Low-E Clear (Air)	0.40	0.382	0.701
Double Glazed Triple Silver Low-E (Argon)	0.35	0.272	0.638

Table 2 : Selection of Glazing Types

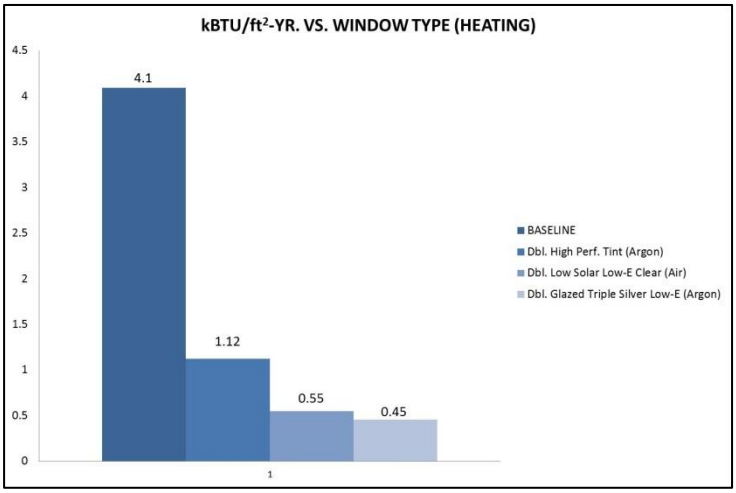


Figure 1 : kBTU/ft2/yr vs. Window Type (Heating)

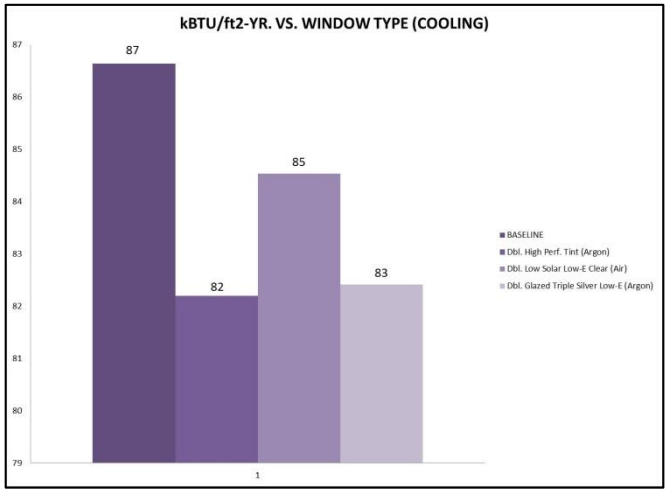


Figure 2 : kBTU/ft2/yr vs. Window Type (Cooling)

Glazing Prices		
Type	**Price per SF**	**Total Cost of Glazing**
Double High Performance Tint (Argon)	$6.85	$82,384.95
Double Low Solar Low-E Clear (Air)	$9.10	$109,445.70
Double Glazed Triple Silver Low-E (Argon)	>> $9.10	>> $109,445.70

* Low volume pricing; does not include mark-up, framing, triple silver coating, etc

Table 3 : Glazing Prices

Three types of glazing were selected for further observation. Table 1 shows the ASHRAE Standard 90.1 requirements for glazing. All three options tested meet these requirements and also have a good visible transmittance (VT) for daylighting and views, shown in Table 2. Figures 1 and 2 compare the effects of each glazing on the heating and cooling loads, respectively. Since the elementary school will be in cooling mode for a majority of the year, it was important to choose a glazing that least negatively affected the cooling load. Cost also impacted the final decision. Table 3 shows the cost break down. Double High Performance Tint with an Argon fill was selected for the final glazing.

It is required by ASHRAE that the Window-to-Wall Ratio is no greater than 40%, as seen in Table 4. After the façade design was finalized, our Window-to-Wall Ratio is about 29.5%. This is also ideal for daylighting purposes, where the Window-to-Wall Ratio should typically fall above 20% or 25%.

Design Criteria	
Window-to-Wall Ratio	< 40%
Our Facade	
Window-to-Wall Ratio	**29.5%**

Table 4 : Window-to-Wall Design Criteria

Appendix D: Permanent Shading Devices

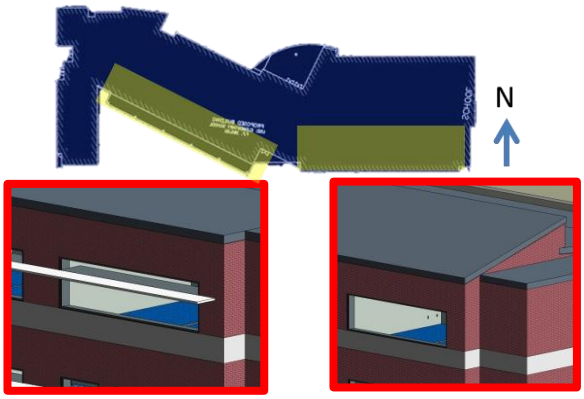


Figure 1: Lightshelf

Figure 2: Clerestory

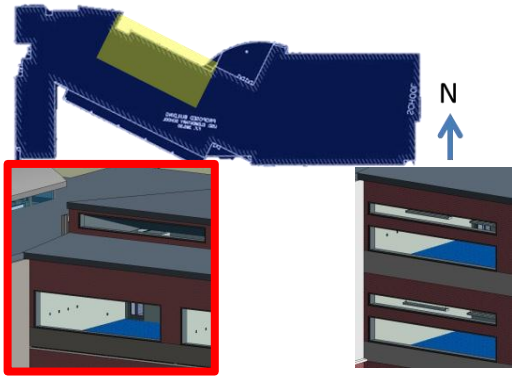


Figure 7: Clerestory

Figure 8: Double Ribbon

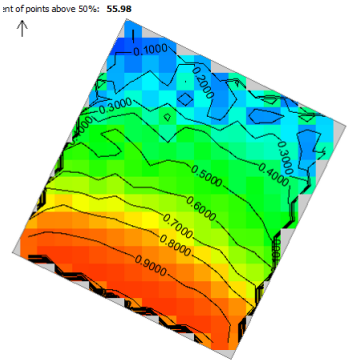


Figure 3: DA_{400lux}

Hours of Direct Sunlight per School Year
950 hours
55% of the School Year

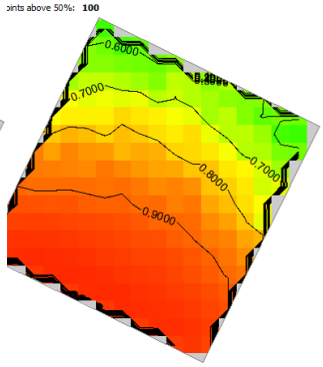
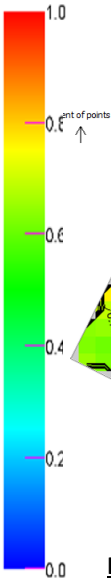


Figure 4: DA_{400lux}

Hours of Direct Sunlight per School Year
1464 hours
90% of the School Year



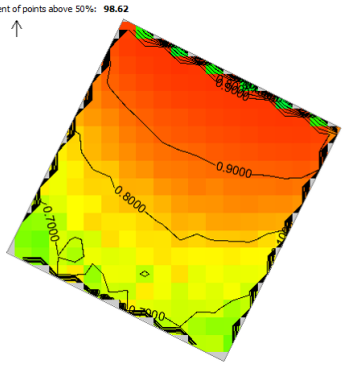


Figure 9: DA_{400lux}

Hours of Direct Sunlight per School Year
141 hours
9% of the School Year

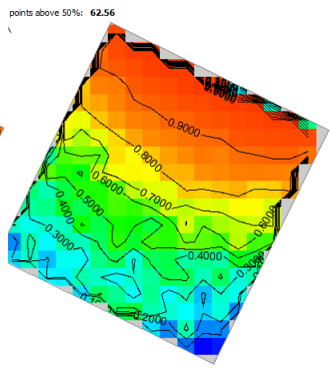


Figure 10: DA_{400lux}

Hours of Direct Sunlight per School Year
142 hours
9% of the School Year

The red box denotes apertures used in final design. No shading devices were tested for Northeast facing classrooms because they do not receive direct sunlight during hours of operation (8 am – 5pm). The "Hours of Direct Sunlight per School Year" includes any hour where at least one point in the room receives an illuminance above 1000 lux. It has been decided to implement both lightshelves and clerestories to the South and Southwest facing classrooms. The lightshelves help block about 35% more direct sunlight and the clerestory helps through light further back into the space. Since this clerestory will be facing North, this will not bring in direct sunlight.

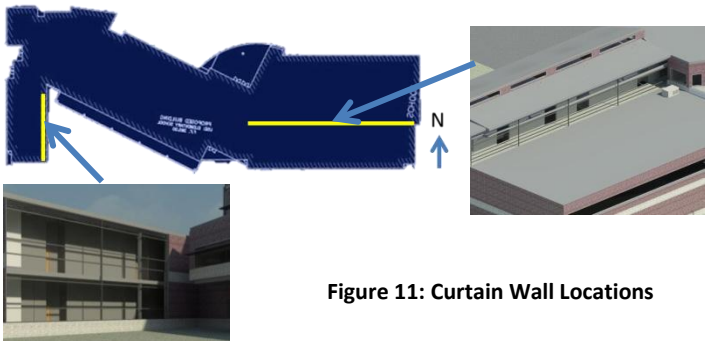
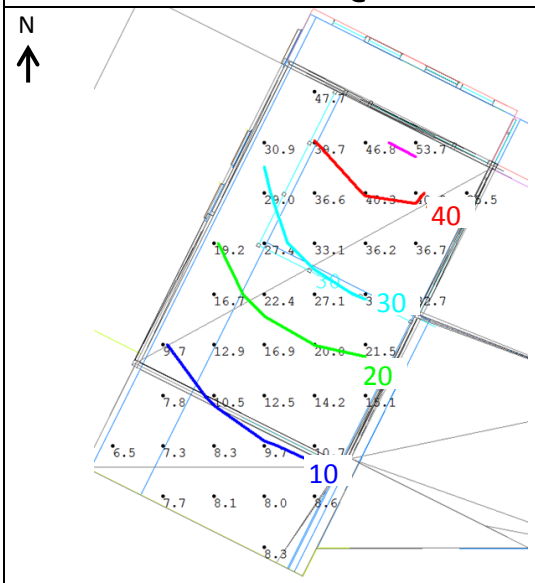
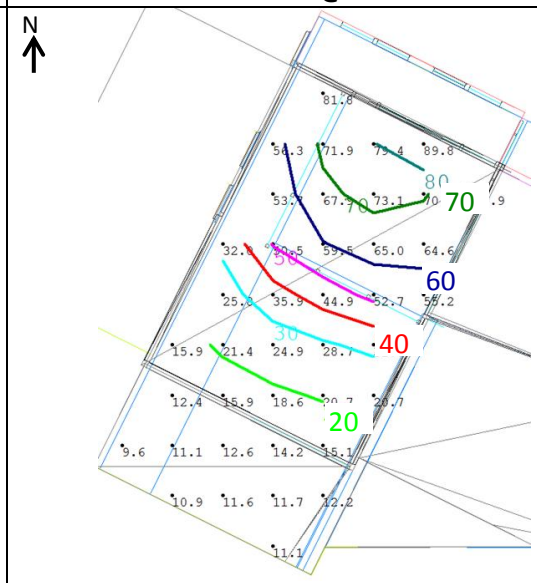


Figure 11: Curtain Wall Locations

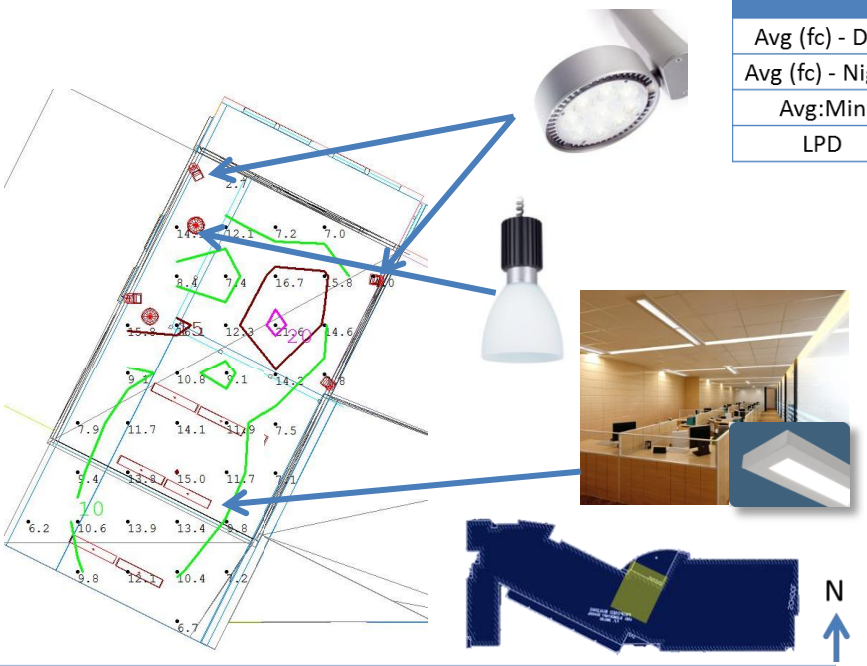
While most of the façade of the building takes shape based upon the window design of the classrooms, there are a few areas of the buiding where we wanted to implement a curtain wall. Figure 11 shows these locations. A custom frit pattern (in the design of the school mascot, or something representative of Reading, PA) will be implemented. Internal roller shades will also have to be available in both areas.

Appendix E: Atrium Daylighting, Lighting, & Controls

Daylight Levels in Atrium (with Opaque Roof) – Partly Cloudy Sky	
December 21st @ Noon	**June 21st @ Noon**
	
Average Illuminance: 25 fc	Average Illuminance: 53 fc

The figures above are showing AGi32 calculations (daylight only) in December and June with an opaque roof material. The design criterion for an atrium is 10 fc. Therefore, these calculations show that even without the Kalwall roof, the daylight levels are well above what is recommended. This will still allow for all lights in the atrium to be off during the day.

	Rec./Required	Actual
Avg (fc) - Day	10 fc	10.93 fc
Avg (fc) - Night	5 fc	5.42 fc
Avg:Min	4:1	4.05:1
LPD	0.90	0.86



The **Pendalyte LED** pendants are suspended 8' AFF. The **Lytespan Spot LED** fixtures are mounted on the wall at various levels. While they will be providing accent lighting for the piece of artwork suspended in the center of the space, they will also provide some of the ambient light for the space.

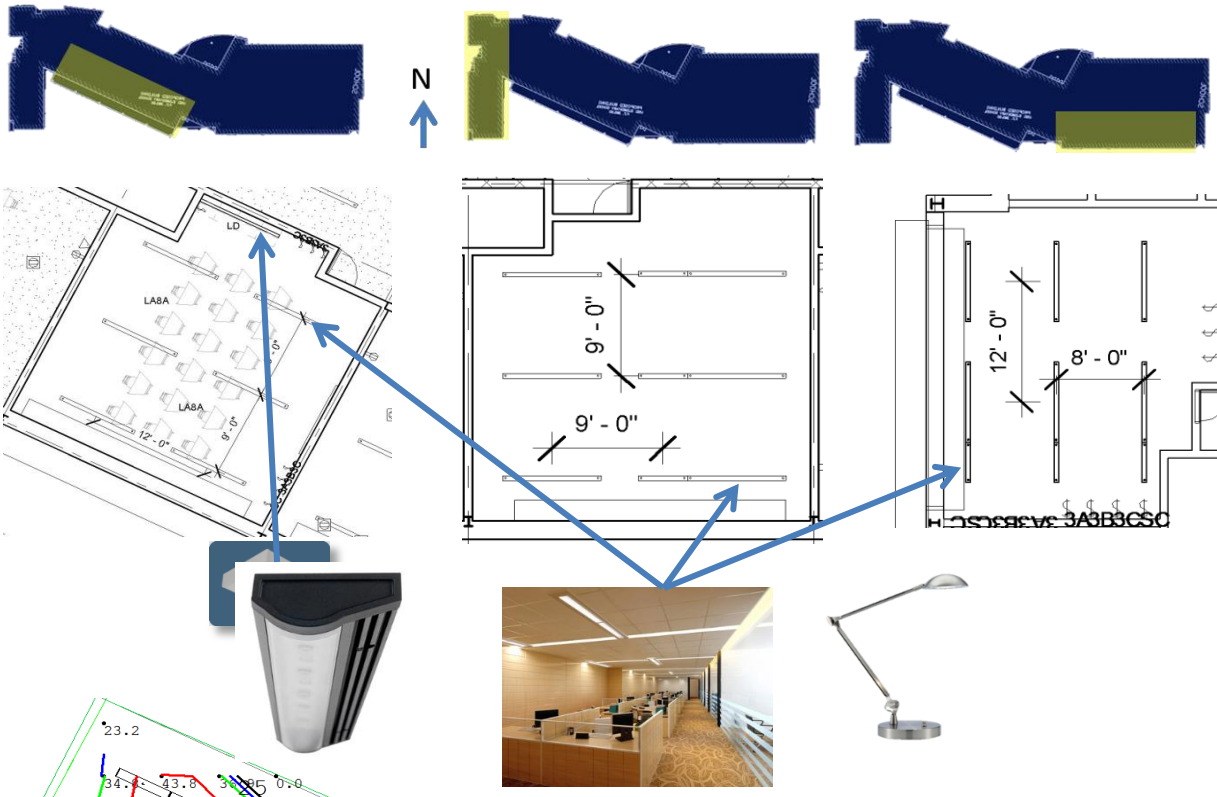
Controls

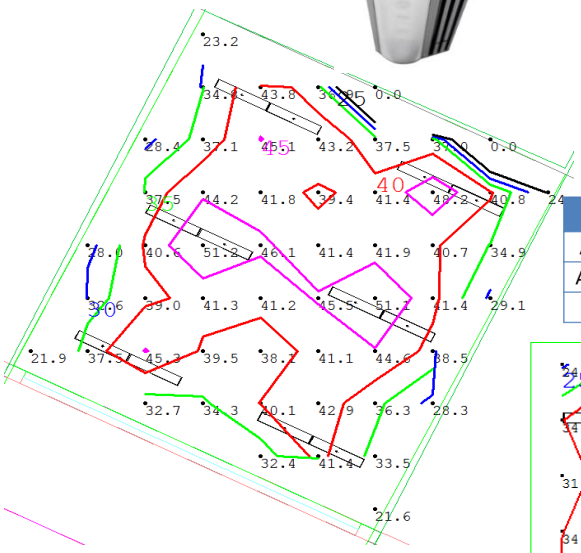
All lighting controls in the atrium abide by the ASHRAE Standard 90.1 Section 9.4.1. These include occupancy sensors, manual override switch and a photosensor control. All atrium lights will be attached to the Building Management System.

Company	Fixture Series	Mounting	Lamp
Philips LIGHTOLIER	Pendalyte LED – 9"	Suspended	20W LED
Philips LIGHTOLIER	Lytespan Spot LED	Surface	15W LED

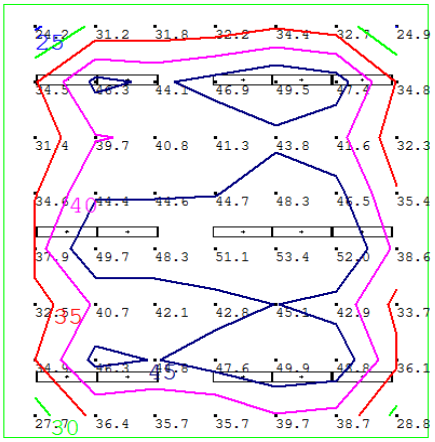
Appendix F: Classroom Lighting Calculations

The images below depict a number of different classroom layouts throughout the school. Both layouts and lighting calculations with required illuminance and power density values are listed as well.

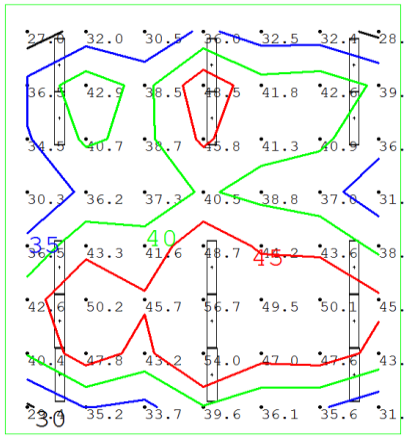




	Rec./Required	Actual
Avg (fc)	40 fc	39.9 fc
Avg:Min	2:1	2.07:1
LPD	1.24	1.05



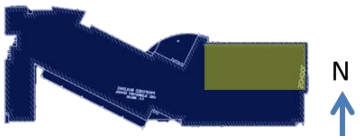
	Rec./Required	Actual
Avg (fc)	40 fc	38 fc
Avg:Min	2:1	1.94:1
LPD	1.24	1.15



	Rec./Required	Actual
Avg (fc)	40 fc	39.8 fc
Avg:Min	2:1	2.89:1
LPD	1.24	1.13

Company	Fixture Series	Mounting	Lamp
Pinnacle	Linero 8 – 4' & 8'	Suspended	T8
Lightolier	LED Micro Undercabinet	Surface	10W/LF LED
LUCEPLAN	BAP LED	Surface	10W LED

Appendix G: Multipurpose Room Lighting Calculations



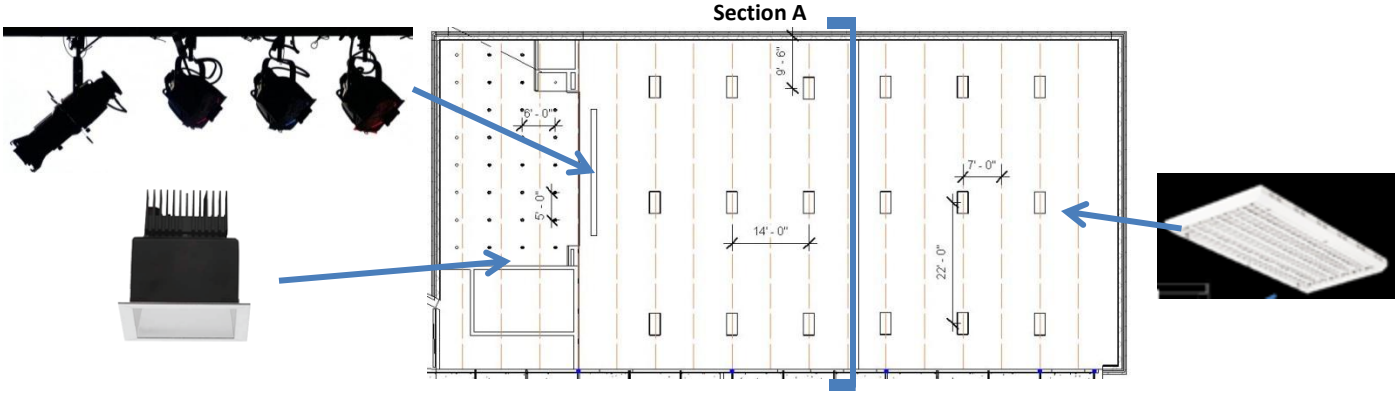


Figure 1 : Multipurpose Room and Stage Lighting Layout

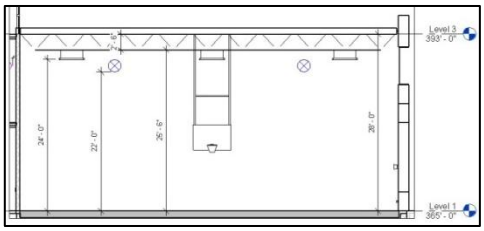


Figure 1 : Multipurpose Room Section A

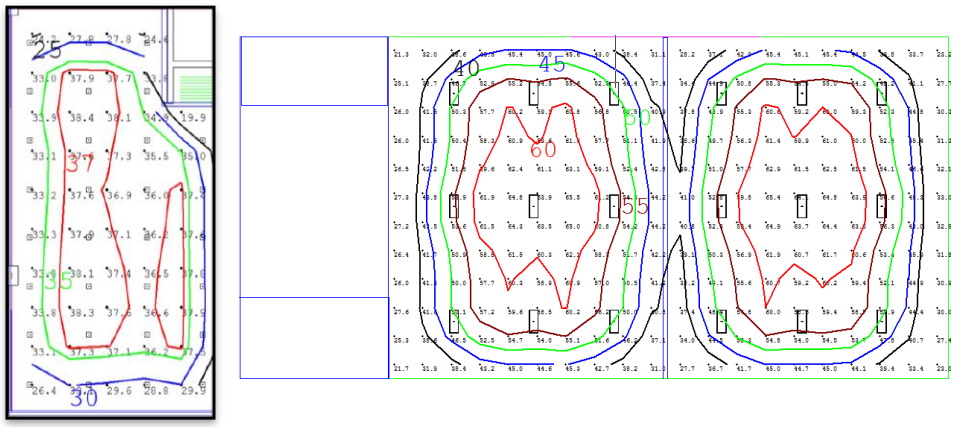


Figure 2 : Stage and Multipurpose Room AGI Calculations

Stage		
	Rec./Required	Actual
Avg (fc)	30 @ 5' AFF	32.62
Avg:Min	1.5:1	1.7:1

Table 1 : Stage Illuminance Requirements

LPD	
Maximum	1.20
Actual	0.89

Table 2 : Stage Lighting Power Density

	A/V No Notes (<25 yrs)		Speaker/ Panel (<25 yrs)		Phys. Ed (<25 yrs)		Cafeteria (<25 yrs)		Basketball–Class 3 (25-65 yrs)	
	Rec.	Actual	Rec.	Actual	Rec.	Actual	Rec.	Actual	Rec.	Actual
Avg (fc)	0.5	3.2	25	32	25	32	7.5	14	50	48.76
Avg:Min	2:1	1.26:1	3:1	2.29:1	3:1	2.29:1	3:1	2.22:1	3:1	1.26:1

Table 3 : Multipurpose Room Illuminance Requirements

Company	Fixture Series	Mounting	Lamp
Philips Day-Brite	Gym Luminaire	Suspended	(6) 54W T5HO
Acculite	IS1 & IS2 Series	Suspended	97 W LED
(For Stage) Philips LIGHTOLIER	Calculite	Recessed	27W LED

Table 4 : Multipurpose Room and Stage Lighting Fixture Details

Stage Lighting

LED downlights will provide ambient lighting for the stage, while a theatrical lighting strip will be specified for lighting effects.

Additional Lighting

It is important to provide a second layer of light in the gym in addition to the standard gymnasium fixtures. At this point in time we are looking into implementing track lighting throughout the space that consists of wide distribution PAR lamp spotlights. This will allow for a warmer color temperature and a different feel for banquets or other special community events. It was important to try and use fixtures other than high bay, in order to create this new atmosphere. The track lighting will be protected by metal cages.

Appendix H: Multipurpose Room Daylighting Calculations

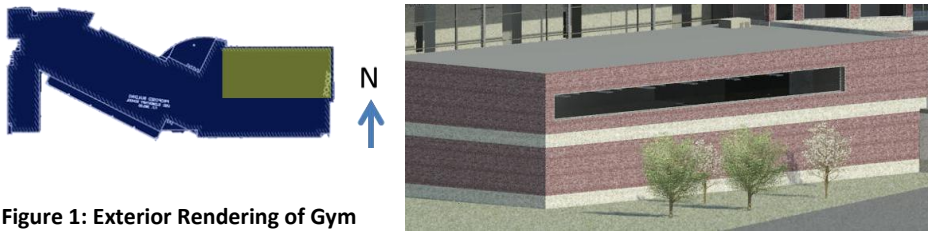


Figure 1: Exterior Rendering of Gym

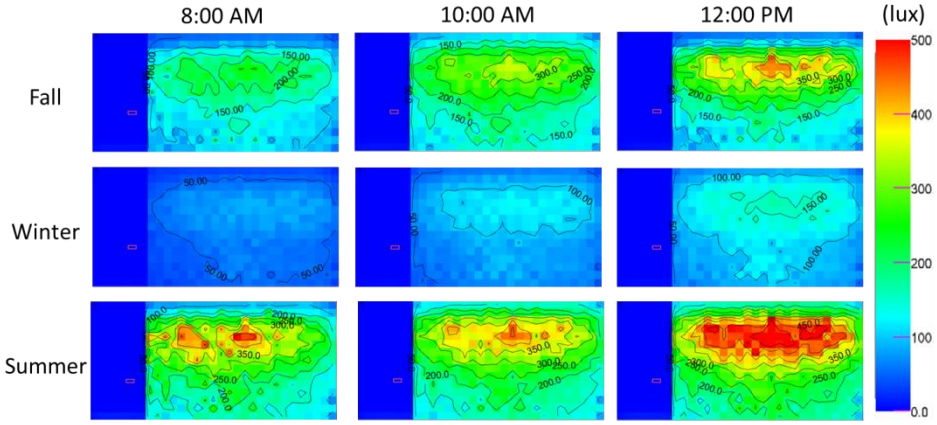


Figure 2: Illuminance contours *without* skylights

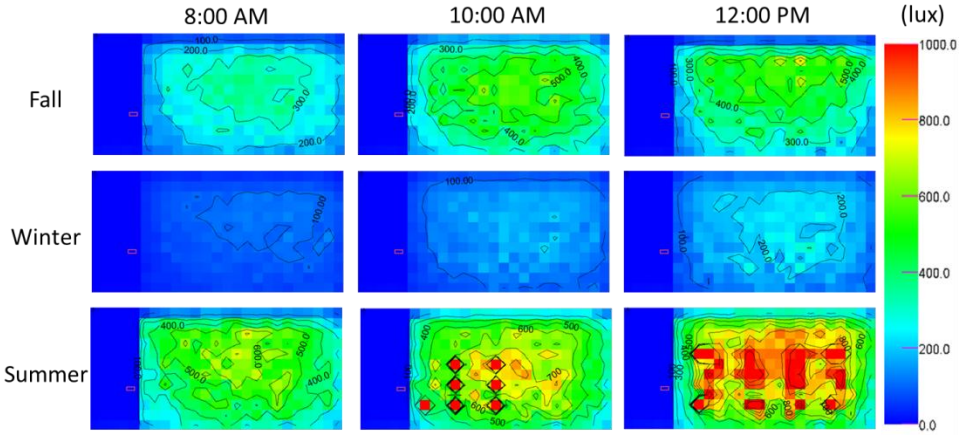
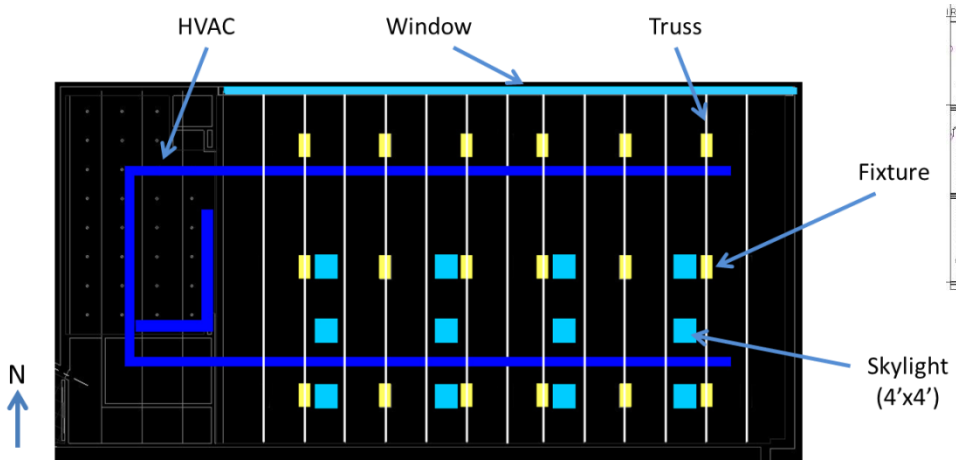


Figure 3: Illuminance contours *with* skylights

Daysim was used to analyze the daylight levels in the multi-purpose room. To the left are illuminance contours for the multi-purpose room with and without skylights. Figure 2 shows that without skylights (and only the window on the north façade) the daylight distribution is not very even across the space. The images in Figure 3 show a more uniform daylight distribution. Skylights also double daylight levels, this will allow for reduction of electric light levels throughout the day.

Figure 4 is a plan of our systems layout, showing coordination between all systems.

If the owner choses to move forward with skylights, our team suggests implementing fixed skylights flush with the roof line as opposed to a skylight well. While you can get efficient skylight wells, the most efficient skylight is a fixed skylight. The daylight will have the ability to come right in without taking bounces off of skylight well walls.



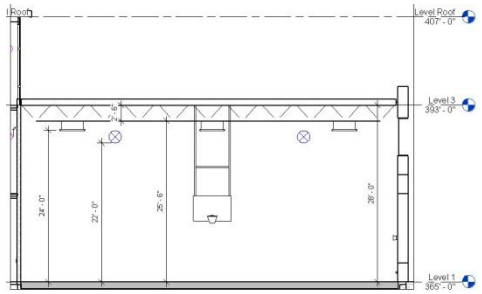
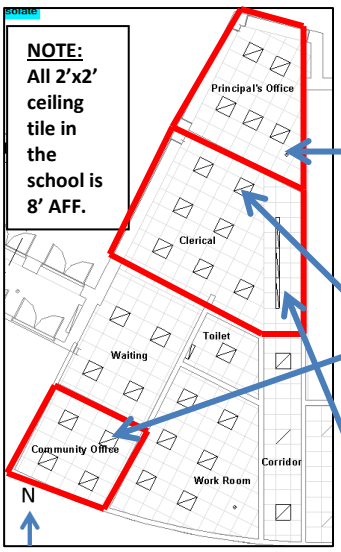
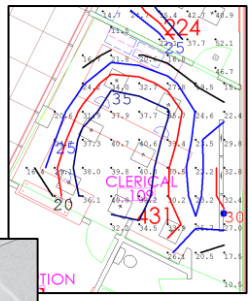


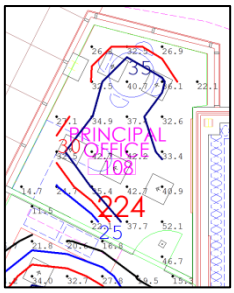
Figure 4 (Left): Systems Layout
Figure 5 (Above): Section View of Gym

Appendix I: Administration & Public Spaces Lighting Calculations

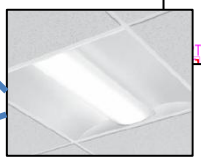


Lightolier Calculite 27W



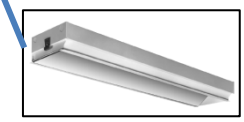


Community Office (25-65 yrs)		
	Recommended/Req.	Actual
Avg. (fc)	30	31.77
Avg:Min	2:1	2.01:1
LPD	1.11	1.04

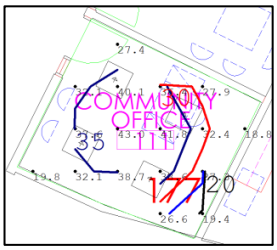


Pinnacle Adeo – (2) T8

Principal's Office (25-65 yrs)		
	Recommended/Req.	Actual
Avg. (fc)	30	33.01
Avg:Min	2:1	1.91:1
LPD	1.11	1.01

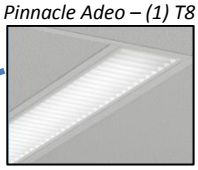


Lightolier Walmaster Wall Wash – (1) T8

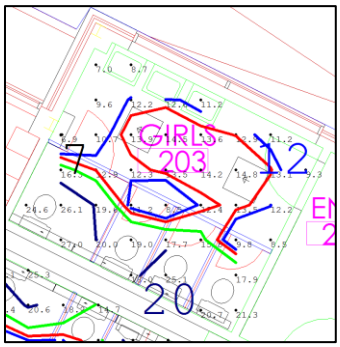


Clerical (25-65 yrs)		
	Recommended/Req.	Actual
Avg. (fc)	30	28.68
Avg:Min	2:1	2.16:1
LPD	0.98	0.92

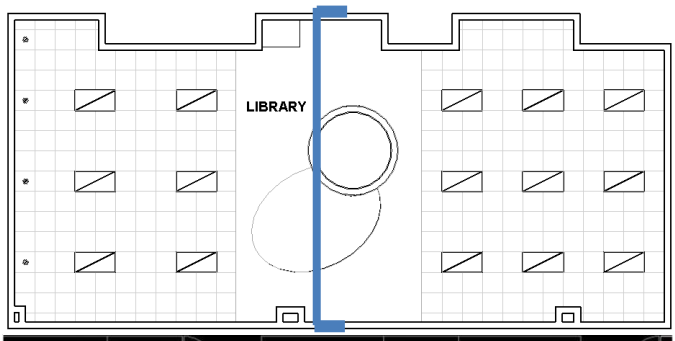
Pinnacle Adeo – (1) T8



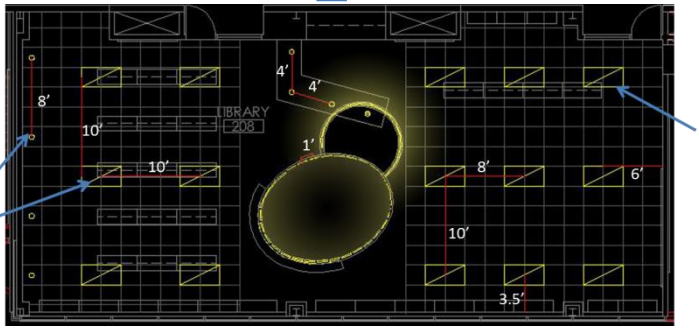
AXIS Beam4 – T8

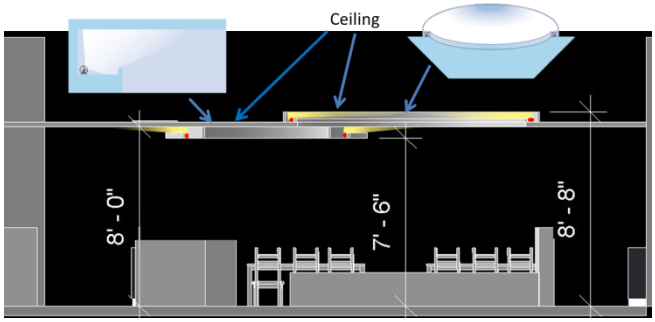


Restrooms (25-65 yrs)		
	Recommended/Req.	Actual
Avg. (fc)	15	14.64
Avg:Min	2:1	2.1:1
LPD	0.98	0.87



Illuminance Criteria (from IESNA Lighting Handbook)				
	Rec. Avg.	Actual Avg.	Rec. Avg:Min	Actual Avg:Min
Book Stacks (<25 yrs.)				
General @ Floor	10	13.1	2:1	1.98:1
Shelving @ 2.5' AFF	15	18.5	2:1	1.98:1
Lending Desk – Staffed (25-65 yrs.)	50	55	2:1	1.18:1
Reading Areas (<25 yrs.)	25	26.31	2:1	1.70:1





Appendix J: Building Controls

Table 1 : Watt Stopper Digital Lighting Management System								
Image	**Model**	**Type of Device**	**Image**	**Model**	**Type of Device**	**Image**	**Model**	**Type of Device**
	LMRC-310	Room Controller		LMLS-400	Photosensor		LMSM	Digital Network Segment Manager
	LMDC-100	Occupancy Sensor		LMSW-105	Digital 5-Button Scene Switch Engraved		DLM	Computer Interface Tools and Software
	LMDM-101	On/Off Switch						

The building controls are designed as a WattStopper DLM system. This digital lighting management system allows for easy adjustments to building controls such as typical scenes, vacancy sensor delay times, and building automation systems, as well as easy installation.

Each classroom will be controlled with a scene selector for easy control. A typical classroom can be seen in Figure 1. The lighting in each classroom is separated into three zones as scene in the Lighting and Electrical Option paper. Each zone will have its own on/off switch. This will allow for teachers to override the scene

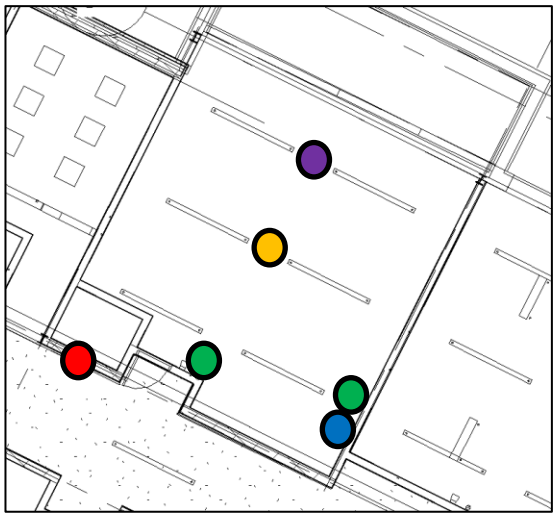


Figure 1 : Typical Classroom Controls Layout

The multipurpose room, seen in Figure 2, will also have scene controls, as well as individual zone controls and separate controls for the stage lighting.

The offices and conference rooms will have dimming/on/off switches for each individual zone. The main hallways and exterior spaces will be on the building automation system and turn on or off based on a timer schedule designated by the school.

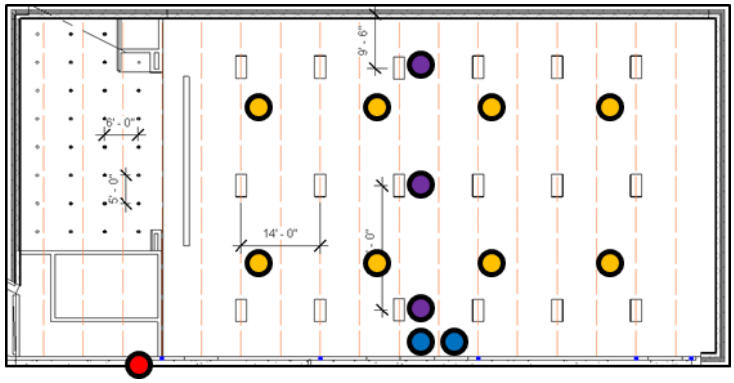
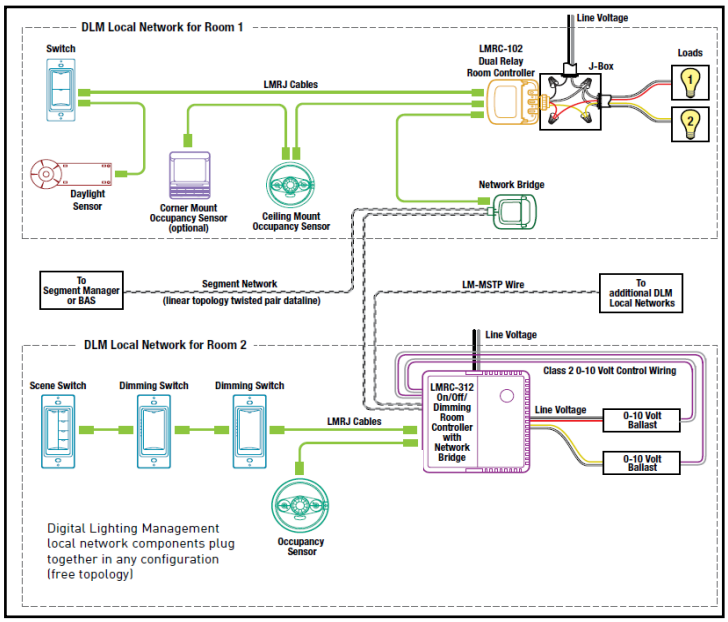


Figure 2 : Multipurpose Room Controls Layout

Wattstopper Controls		
Room	**Type**	**Code**
Classrooms	Room Controller	LMRC-210
	Emergency Lighting Control Unit	ELCU-200
	HVAC Integration	LMRL-100
	Occupancy Sensor	LMDC-100
	Dimmer Switch	LMDM-101
	Digital 5-Button Scene Switch Engraved	LMSW-105
	Photosensor	LMLS-400
	Network Bridge	LMBC-300
Offices	Room Controller	LMRC-210
	Emergency Lighting Control Unit	ELCU-200
	HVAC Integration	LMRL-100
	Occupancy Sensor	LMDC-100
	Dimmer Switch	LMDM-101
	Photosensor	LMLS-400
	Network Bridge	LMBC-300
Hallway	Occupancy Sensor	LMDC-100
	Emergency Lighting Control Unit	ELCU-100
	Remote Test Switch	EMTS-100
Building Control System	Computer Interface Tools and Software	DLM
	Segment Manager / BAS	LMSM-201



Appendix K: Kitchen Design

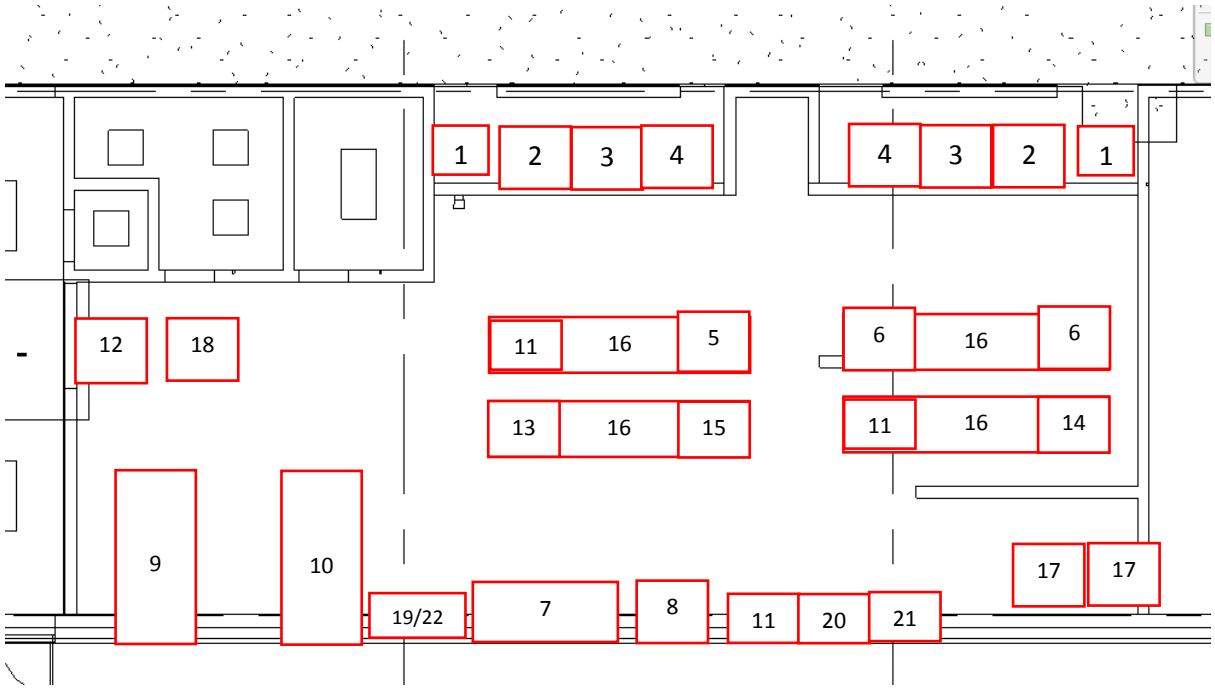


Figure 1 : Kitchen Equipment Layout

Kitchen Equipment								
Label	**Type**	**Quantity**	**Manufacturer**	**Plug Type**	**Horsepower**	**Voltage**	**Amperage**	**Wattage**
1	Milk Cooler	2	Beverage-Air	5-15P	1/2	120	8.4	100.8
2	Heated Well	2	Delfield	14-30P	-	120/208	20	1000
3	Counter	2	Delfield	-	-	-	-	-
4	Cashier Station	2	Delfield	5-15R	-	120	15	180
5	Electric Range	1	Garland	HW	-	208	75	1600
6	Griddle	2	Garland	HW	-	208	58	1200
7	Roll-in Oven	1	Nu-Vu	HW	-	208	105	2184
8	Convection Oven	1	Nu-Vu	HW	-	208	40	832
9	Roll-in Refridgerator	1	Beverage-Air	HW	1/2	120	12	144
10	Roll-in Freezer	1	Beverage-Air	HW	1	208	10.5	218.4
11	Garbage Disposal	3	In-sink-erator	HW	1.5	208	3.2	66.56
12	Ice Machine	1	Ice-O-Matic	5-15R	-	120	9.7	116.4
13	Food Processor	1	Omcan	5-15R	3/4	120	15	180
14	Mixer	1	Omcan	5-15R	-	120	15	180
15	Slicer	1	Omcan	5-15R	0.2	120	15	180
16	Countertops	4	Delfield	-	-	-	-	-
17	Dishwasher	2	Champion	HW	1	208	70	1456
18	Blast Chiller	1	Beverage-Air	HW	-	208	6.1	1167
19	Microwave Oven	4	Sharp	5-15R	-	208	14	1000
20	Bun Steamer	2	Adcraft	5-15R	-	120	8.3	1000
21	Toaster: Conveyor	2	Adcraft	5-15R	-	120	18	2200
22	Broiler	2	Adcraft	5-15R	-	208	14	3100

Table 1 : Kitchen Equipment Description

Appendix L: Electrical Design

A typical Classroom electrical layout can be seen here. Each classroom has two GFCI receptacles over the countertop, two convenience receptacles, and seven designated poke-through computer receptacles. All hardware such as televisions and projectors will have individual receptacles and data ports at installation points.

Each classroom will also be equipped with a speaker for fire alarm and building announcements, as well as a visual fire alarm. These will be tied into the fire control panel on each floor.

For specific building lighting, mechanical, and power loads, please see attached drawings.

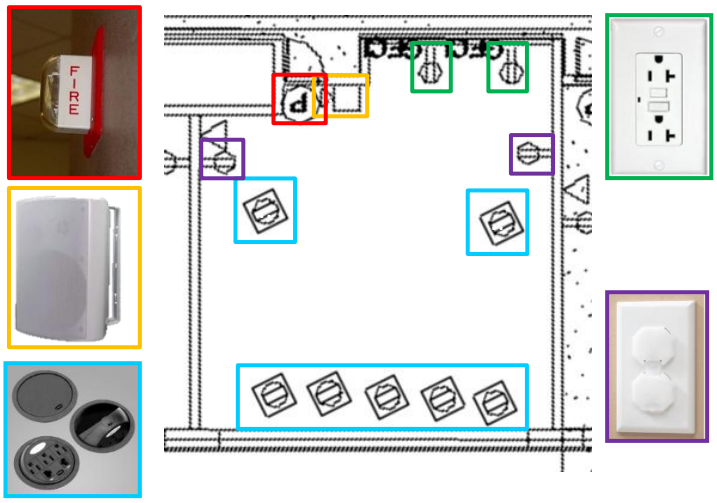


Figure 1 : Typical Classroom Electrical Layout

Teaching Equipment				
Type	**Quantity**	**Manufacturer**	**Voltage**	**Wattage**
Computer	42	Dell	120	200
Projector	42	In Focus	120	230
Television	48	Sony	120	158
Screen	48	In Focus	n/a	n/a
Motorized Shades	130	MechoShades	n/a	n/a
Printer/Copy/Fax Machine	4	Cannon	120	1104
Phone	48	Panasonic	n/a	n/a
Window Break Devices	130	GE	n/a	n/a

Table 1 : Typical Teaching Equipment in Classrooms and Offices

For more information about the locations and details of the electrical equipment, as well as wire and conduit sizing, please see the riser diagram in the attached drawings.

Figure 2 : Typical Electrical Equipment Images

Electrical Equipment				
Type	**Manufacturer**	**Number**	**Specification**	**Voltage**
Panelboard	GE Industrial	16	100A, 42 Pole	480/277V
Panelboard	GE Industrial	2	225A, 42 Pole	480/277V
MDP	GE Industrial	1	400A, 42 Pole	480/277V
Panelboard	GE Industrial	1	100A, 42 Pole	208/120V
Panelboard	GE Industrial	10	225A, 42 Pole	208/120V
MDP	GE Industrial	3	400A, 42 Pole	208/120V
In-Switchboard Breaker	GE Industrial	1	20A CB	208V
In-Switchboard Breaker	GE Industrial	1	30A CB	208V
In-Switchboard Breaker	GE Industrial	1	225A CB	208V
In-Switchboard Breaker	GE Industrial	1	300A CB	208V
Switchboard	GE Industrial	1	Switchboard	480/277V
Automatic Transfer Switch	GE Industrial	1	1000A ATS	480/277V
Automatic Transfer Switch	GE Industrial	1	225A ATS	480/277V
Automatic Transfer Switch	GE Industrial	2	100A ATS	480/277V
Generator	Generac	1	350KW	480/277V
Transformer	GE Industrial	3	150 KVA	480V to 120/208V
Transformer	GE Industrial	1	112.5 KVA	480V to 120/208V

Table 2 : Typical Electrical Equipment Schedule

Appendix M: Phase 2

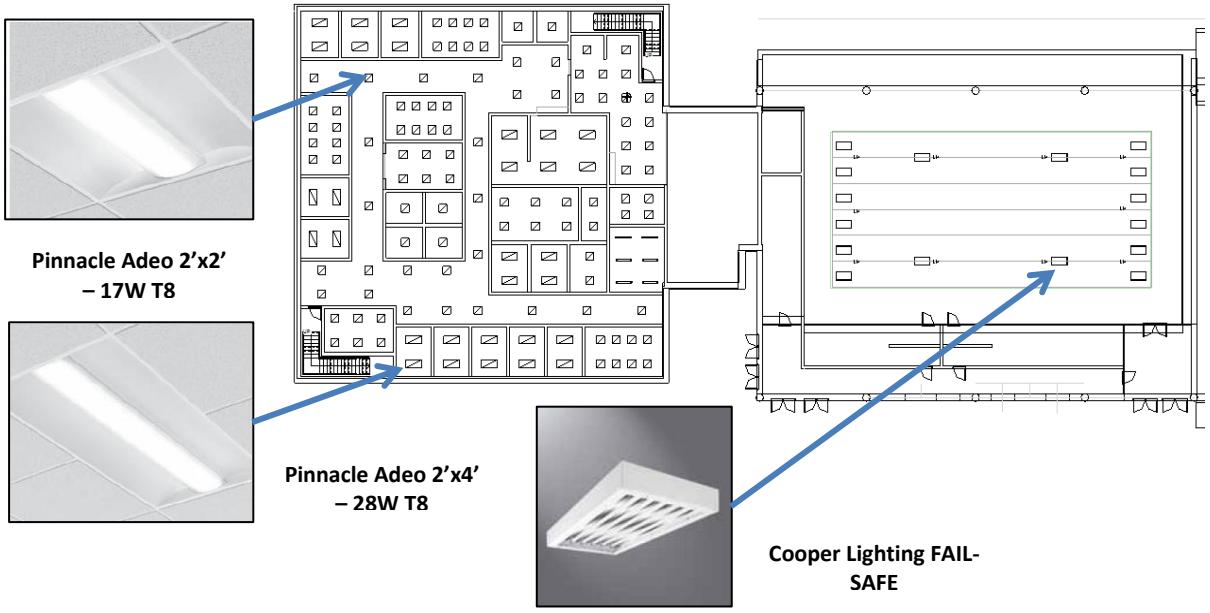


Figure 1 : Clinic and Natatorium Lighting Layout

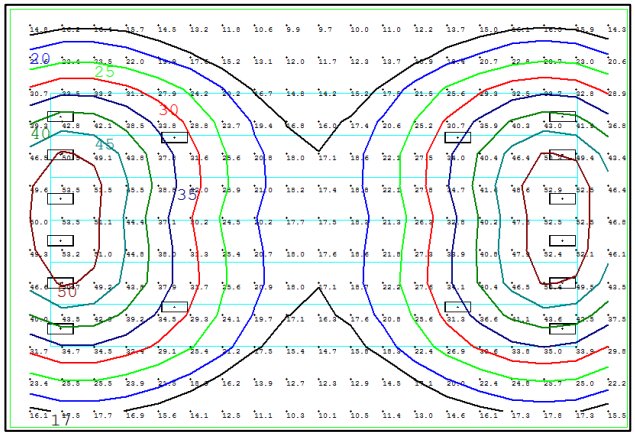


Figure 2 : PoolAGI Lighting Calculation

Pool		Criteria	As Designed
Water Surface	Avg.	30	31
	Avg:Min	3:1	2:1
Power Density		1.2	
Deck Surface	Avg.	10	22
	Avg:Min	4:1	2.5:1
Power Density		1.2	
Turning Lanes	Avg.	50	48
	Avg:Min	1.7:1	1.3:1
Power Density		1.2	

Table 1 : Pool Lighting Requirements

Clinic		Criteria	As Designed
Individual Patient Rooms	Avg.	50	50
	Avg:Min	2:1	1.7:1
Power Density		1.66	0.99
Double Patient Rooms	Avg.	50	50.5
	Avg:Min	2:1	1.7:1
Power Density		1.66	1.17
Toilets	Avg.	15	18
	Avg:Min	2:1	1.4:1
Power Density		0.98	0.55
X-Ray	Avg.	50	50
	Avg:Min	2:1	1.7:1
Power Density		1.11	0.5
Nurses Station	Avg.	10	19
	Avg:Min	2:1	1.5:1
Power Density		0.87	0.44

Clinic		Criteria	As Designed
Waiting Room	Avg.	10	
	Avg:Min	3:1	
Power Density		1.07	
Medical Supply	Avg.	20	17.5
	Avg:Min	3:1	1.5:1
Power Density		0.63	0.38
Clean Supply	Avg.	10	15.7
	Avg:Min	2:1	2:1
Power Density		0.6	0.46
Soiled Area	Avg.	30	32
	Avg:Min	2:1	1.4:1
Power Density		0.6	0.76
Office Supply	Avg.	10	13.4
	Avg:Min	2:1	1.4:1
Power Density		0.63	0.38

Clinic		Criteria	As Designed
Office	Avg.	30	25
	Avg:Min	2:1	1.4:1
Power Density		1.11	0.5
Janitor Closet	Avg.	10	12
	Avg:Min	2:1	1.5:1
Power Density		0.63	0.3
Administration	Avg.	30	31
	Avg:Min	2:1	1.9:1
Power Density		0.98	0.5
Break Room	Avg.	10	16
	Avg:Min	2:1	1.7:1
Power Density		0.73	0.34

Table 2, 3, &4 : Clinic Lighting Requirements

Appendix N: References

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SHEET LIST

Lighting Fixture Schedule

Type	Description	Manufacturer	Series	Catalog No.	Lamp Type	CCT (K)	Ballast	Load (VA)	Mounting	Comments
AA	6"x6" LED Square Downlight Aperture include a reflector cone with a clear finish; Suitable for wet locations	Philips Lightolier	Calculite	C6X6L1520DL35KWHW	27W LED	3500		27	Recessed	
FA	2'x4' Recessed Volumetric Fixture with a Satine Lens and a powder-coat white painted finish on trim	Pinnacle	Adeo	AD24A-1T8-G1-120-1E-W	(1) 28W T8	4100	Elec. Dim.	30.8	Recessed	
FB	2'x4' Recessed Volumetric Fixture with a Satine Lens and a powder-coat white painted finish on trim	Pinnacle	Adeo	AD24A-2T8-G1-120-1E-W	(2) 28W T8	4100	Elec. Dim.	61.6	Recessed	
FC	2'x4' Recessed Volumetric Fixture with a Satine Lens and a powder-coat white painted finish on trim	Pinnacle	Adeo	AD24A-3T8-G1-120-1E-W	(3) 28W T8	4100	Elec. Dim.	92.4	Recessed	
FD	2'x2' Recessed Volumetric Fixture with a Satine Lens and a powder-coat white painted finish on trim	Pinnacle	Adeo	AD22A-1T8-G1-120-1E-W	(1) 17W T8	4100	Elec. Dim.	18.7	Recessed	
FE	2'x2' Recessed Volumetric Fixture with a Satine Lens and a powder-coat white painted finish on trim	Pinnacle	Adeo	AD22A-2T8-G1-120-1E-W	(2) 17W T8	4100	Elec. Dim.	37.4	Recessed	
FF	2'x4' Fluorescent Gymnasium Luminaire; UL listed for damp locations; white flat reflector	Philips Day-Brite	FGL	FGL654HO-UNV-WF-3/2-EBH	(6) 54W T5HO	4100	Electronic	324	Suspended	
LA4	4' Fluorescent Linear Pendant with a Satine Micro Diffuse Lens; white finish; adjustable aircraft cable	Pinnacle	Linero 8	L8A-1T8-4-AC48G1-120V-1E-W	(1) 28W T8	4100	Electronic	28	Suspended	
LA4A	4' Fluorescent Linear Pendant with a Satine Micro Diffuse Lens; white finish; adjustable aircraft cable	Pinnacle	Linero 8	L8A-1T8-4-AC48G1-120V-1D-W	(1) 28W T8	4100	Elec. Dim.	30.8	Suspended	
LA8	8' Fluorescent Linear Pendant with a Satine Micro Diffuse Lens; white finish; adjustable aircraft cable	Pinnacle	Linero 8	L8A-2T8-8-AC48G1-120V-1E-W	(4) 28W T8	4100	Electronic	112	Suspended	
LA8A	8' Fluorescent Linear Pendant with a Satine Micro Diffuse Lens; white finish; adjustable aircraft cable	Pinnacle	Linero 8	L8A-2T8-8-AC48G1-120V-1D-W	(4) 28W T8	4100	Elec. Dim.	123.2	Suspended	
LA8B	8' Fluorescent Linear Pendant with a Satine Micro Diffuse Lens; white finish; adjustable aircraft cable	Pinnacle	Linero 8	L8A-1T8-8-AC48G1-120V-1E-W	(2) 28W T8	4100	Electronic	56	Suspended	
LB	4' Fluorescent Stairwell Fixture with a vandal proof lens and a built in infrared sensor	Philips Lightolier	Stairwell Luminaire	SF48V232120MT-OC	(2) 28W T8	4100	Elec. Dim.	61.6	Wall Mounted	
LC	4' Recessed Linear Fluorescent Wall Washer with a low iridescent semi-specular reflective system; white finish	Philips Lightolier	Wallmaster	WMRL143UNVHI	(1) 28W T8	4100	Electronic	28	Recessed	
LD	LED Undercabinet Fixture with a matte black finish and a clear polycarbonate lens	Philips Lightolier	Micro Undercabinet	MIC100BK	10W/LF LED	3500		Varies	Surface Mounted	Varies; Verify lengths with cabinet layout on lighting plans
LE	1' Linear LED Cove	GE	LED Cove Lighting System	73093 with 73107 Mounting Track	6.8W/LF LED	4100		6.8	Surface Mounted	To be layed out for a circular cove; see lighting plans
LF	4' Industrial Strip Light with a Symetric Reflector and a high-gloss, baked white enamel finish	Lithonia	Z-Series	Z 1 32 120 GEB10IS	(1) 28W T8	4100	Electronic	28	Ceiling Surface	
LG	Recessed Fluorescent Linear Perimeter Fixture; Custom Lengths; Satin Lens with flush optics positioning; staggared lamping	AXIS	Beam 4	BBRSFLS#NLT8+S-W120EITG3	28W T8	4100	Electronic	28	Recessed	Refer to lighting plans for exact fixture lengths
LH	2'x4' Linear Fluorescent High Bay Wet Location Fixture with a clear acrylic lens and aluminum	Cooper	FAIL-SAFE	2HBHD-654T5-CL-UNV	(6) 54W T5HO	4100	Electronic	324	Suspended	
TA	2'x2' Recessed Fluorescent, 3", 9 Cell Parabolic Louver with a low iridescence, semi-specular finish	Philips Lightolier	Deepcel	DPS2G9LS22UUNVSO	(2) 25W U-T8	4100	Electronic	50	Recessed	
TB	2'x2' Recessed Fluorescent, 3", 9 Cell Parabolic Louver with a low iridescence, semi-specular finish	Philips Lightolier	Deepcel	DPS2G9LS22UUNVSO	(2) 25W U-T8	4100	Electronic	50	Recessed	
X	Red LED Edge-lit Exit Sign, Double Face, Self-Powered with a nickel metal hydride battery, Clear panel color and self-testing ability	Philips Lightolier	EX2 Series	EX22R3SCCNSD2T	4.80W			Self-Powered	Ceiling Surface	Verify chevron direction with lighting plans
SA	6"D LED Spot Light with a powder coated aluminum finish; 10 degree beam spread; option for color	Philips Lightolier	Lytespan LED	LLAB030RSAL	15W	3500		15	Surface Mounted	
SB	9"D LED Pendant with a White Glass Diffuser and 9" gray power head	Philips Lightolier	Pendalyte LED	40471L2TU	20W	3500		20	Suspended	
SC	10W LED Desk Lamp with a white finish and a glass-reinforced nylon head; blue polycarbonate filter	LUCEPLAN	BAP LED	1D19LL000002	10W	2700		10	Surface Mounted	
WA	Sports Lighting Fixture, Full Cutoff Sheild, 60' MH	GE SportsLighting	Powr-Spot	PSFA400E4A	400W	3500K		412	Pole Mounted	
WB	Site Lighting Fixture, 18' Mounting Height, Square Pole, Silver finish, LED, Photocell included	Philips Gardco	Gulwing LED	GL13-DIM	71.2W	4000K		71.2	Pole Mounted	
WC	Full-Cutoff LED Bollard, Silver finish, 3' mounting, Photocell included	Philips Gardco	Bollard LED	BR840-36-DIM	10W	4000K		10	Bollard	
WD	Canopy light for covered entries. White finish, glare sheild	Cooper Lighting	Concise LED	CNC-C01-LED-E1-SQ-TW	27W	4000K		27	Canopy	
WE	LED Wall Pack, Black Finish, Solar Collector included, 3' mounting height	RAB Lighting	SLIM LED	SLIM18N/PC2	18W	4000K		18	Wallpack	
WF	In Ground Lighting, Decorative, LED, Adjustable	Bega Lighting	In Ground Slim	8638LED	1.5W	4000K		1.5	In Ground	

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Reading Elementary School

Schedules

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Scale

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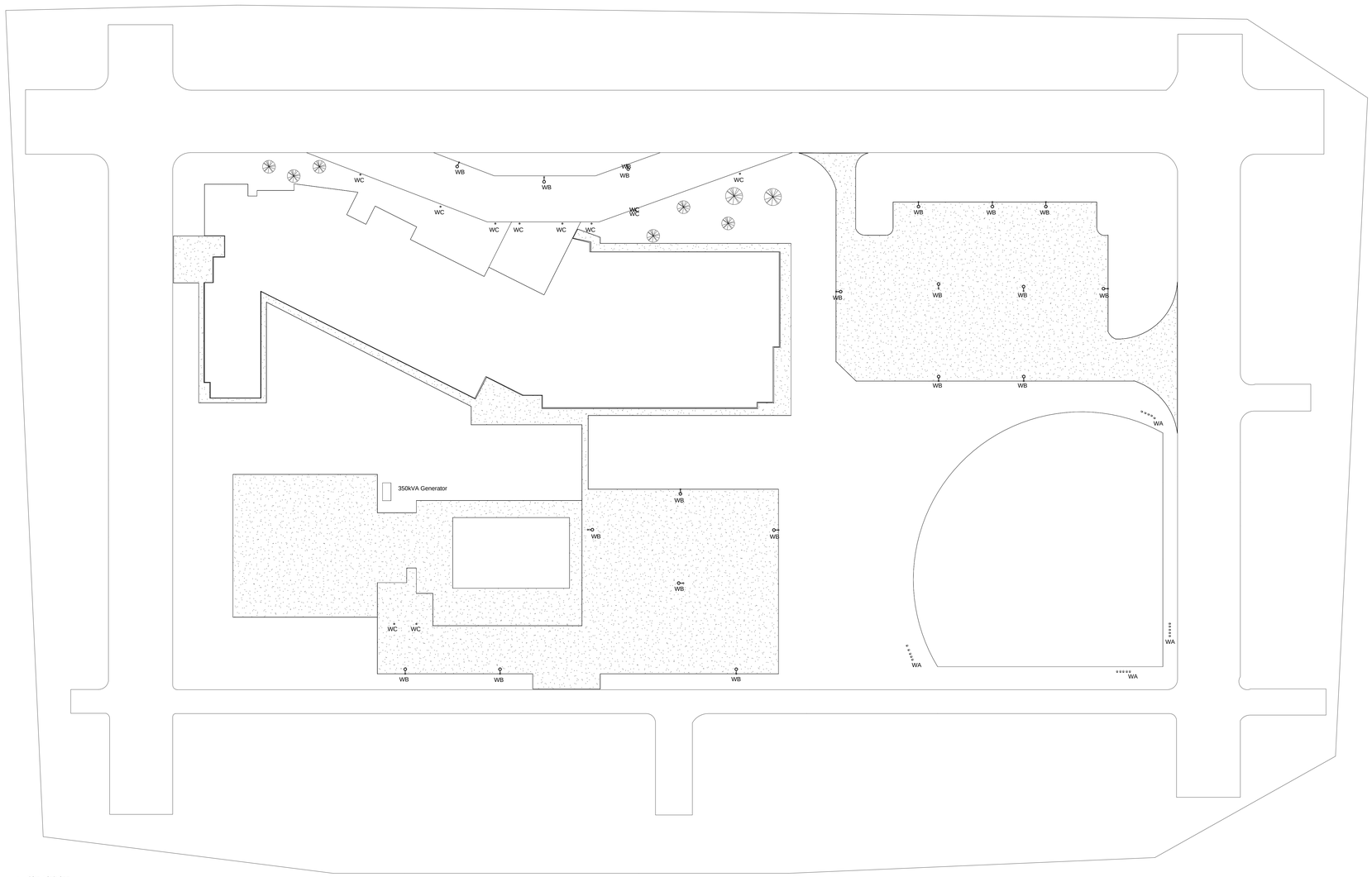

1 Site Lighting
1" = 30'-0"

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No.	Description	Date

AEI Team #04-2013

Reading Elementary School

Site Lighting Layout

Project Number	04-2013
Date	22 February 2013
Drawn By	Author
Checked By	Checker

E102

Scale 1" = 30'-0"

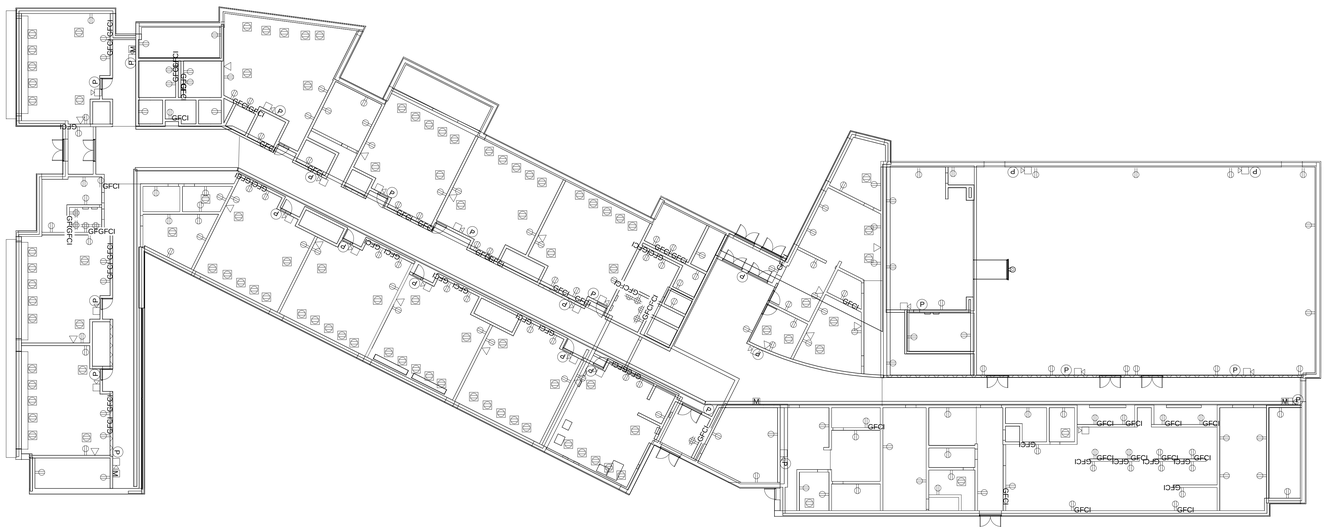
2/20/2013 10:21:24 AM

1 First Floor Lighting Layout
1/16" = 1'-0"

GENERAL NOTES

A. ALL OVERHEAD CABINETS IN BACK OF CLASSROOMS ARE EQUIPPED WITH UNDERCABINET LED FIXTURES OF THE APPROPRIATE LENGTH.

B. EACH UNDERCABINET FIXTURE HAS ITS OWN SINGLE POLE SWITCH.



2 First Floor Power and Fire Alarm Layout
1/16" = 1'-0"

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No.	Description	Date

AEI Team #04-2013

Reading Elementary School

1st Floor Lighting, Power & FA Plans

Project Number	04-2013
Date	22 February 2013
Drawn By	Team #04-2013
Checked By	Team #04-2013

E103

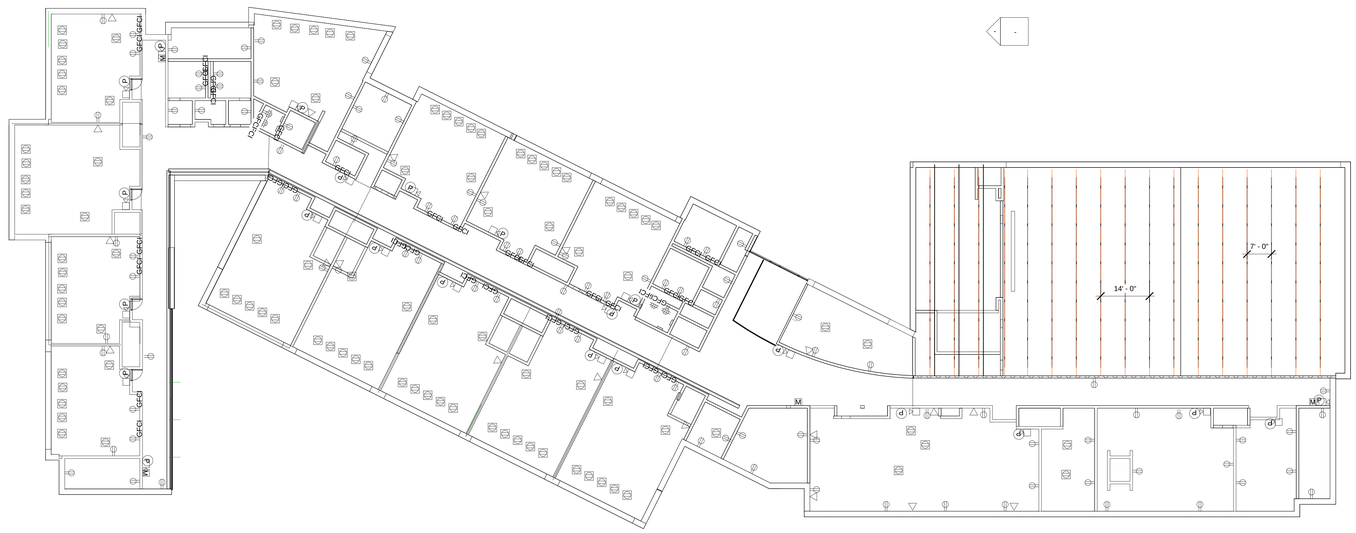
Scale 1/16" = 1'-0"

2/20/2013 10:21:30 AM

1 Second Floor Lighting Layout
1/16" = 1'-0"

GENERAL NOTES

A. ALL OVERHEAD CABINETS IN BACK OF CLASSROOMS ARE EQUIPPED WITH UNDERCABINET LED FIXTURES OF THE APPROPRIATE LENGTH.
B. EACH UNDERCABINET FIXTURE HAS ITS OWN SINGLE POLE SWITCH.



2 Second Floor Power and Fire Alarm Layout
1/16" = 1'-0"

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No.	Description	Date

AEI Team #04-2013

Reading Elementary School

2nd Floor Lighting, Power, & FA Plans

Project Number	04-2013
Date	22 February 2013
Drawn By	Author
Checked By	Checker

E104

Scale 1/16" = 1'-0"

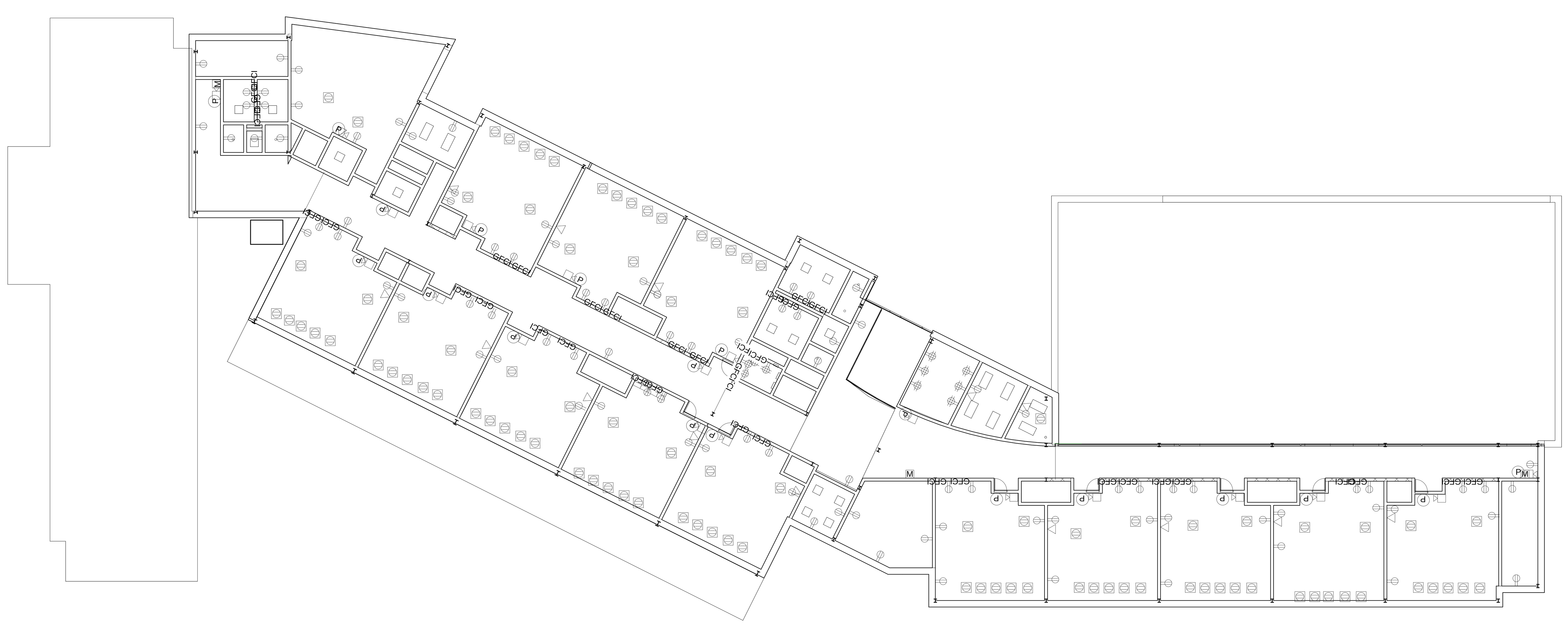
2/20/2013 10:21:36 AM

1 Third Floor Lighting Layout
1/16" = 1'-0"

GENERAL NOTES

A. ALL OVERHEAD CABINETS IN BACK OF CLASSROOMS ARE EQUIPPED WITH UNDERCABINET LED FIXTURES OF THE APPROPRIATE LENGTH.

B. EACH UNDERCABINET FIXTURE HAS ITS OWN SINGLE POLE SWITCH.



2 Third Floor Power and Fire Alarm Layout
1/16" = 1'-0"

No.	Description	Date

AEI Team #04-2013

Reading Elementary School

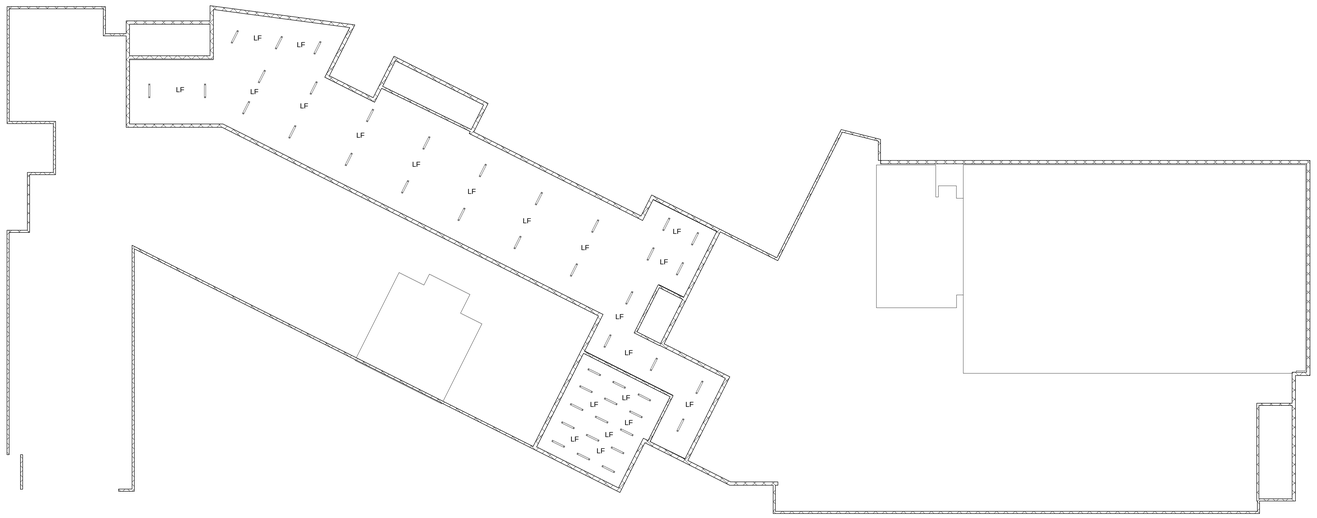
3rd Floor Lighting, Power & FA Plans

Project Number	04-2013
Date	22 February 2013
Drawn By	Author
Checked By	Checker

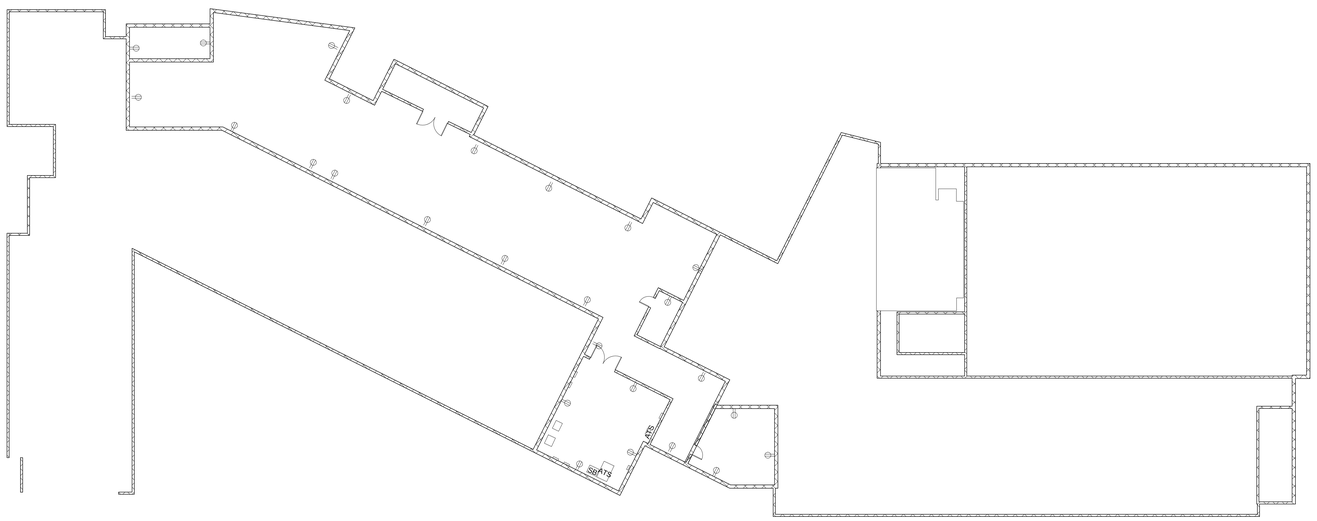
E105

Scale 1/16" = 1'-0"

2/20/2013 10:21:41 AM



1 Basement Lighting Layout
1/16" = 1'-0"



2 Basement Power and Fire Alarm Layout
1/16" = 1'-0"

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No.	Description	Date

AEI Team #04-2013

Reading Elementary School

Basement Lighting, Power, & FA Plans

Project Number	04-2013
Date	22 February 2013
Drawn By	Author
Checked By	Checker

E106

Scale	1/16" = 1'-0"

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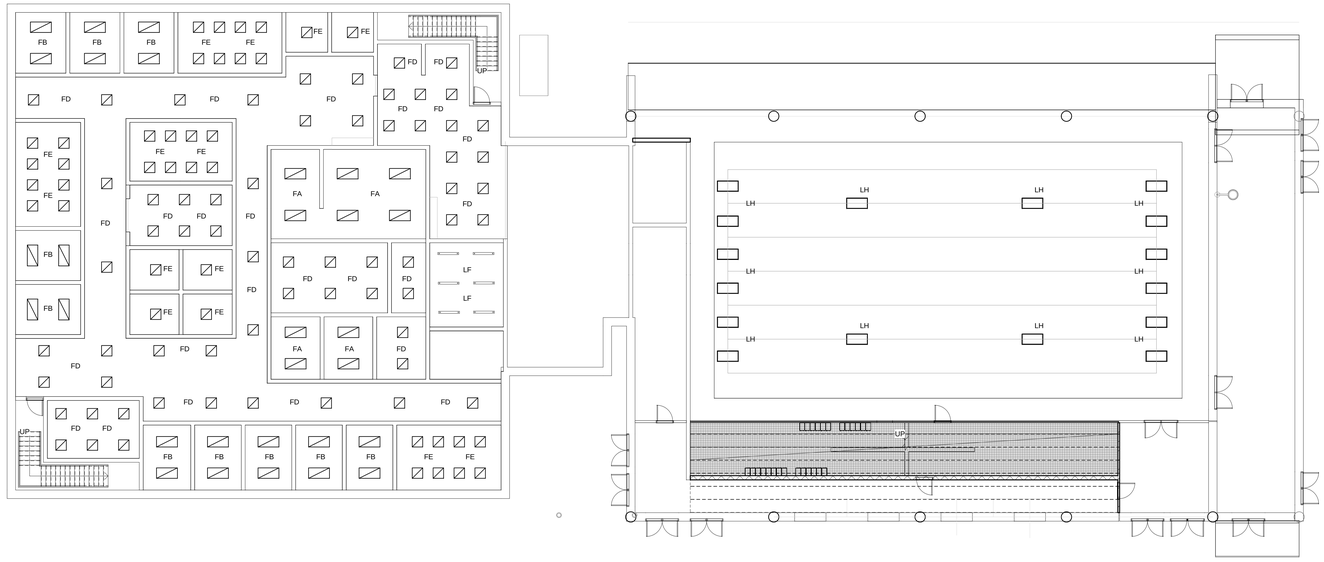
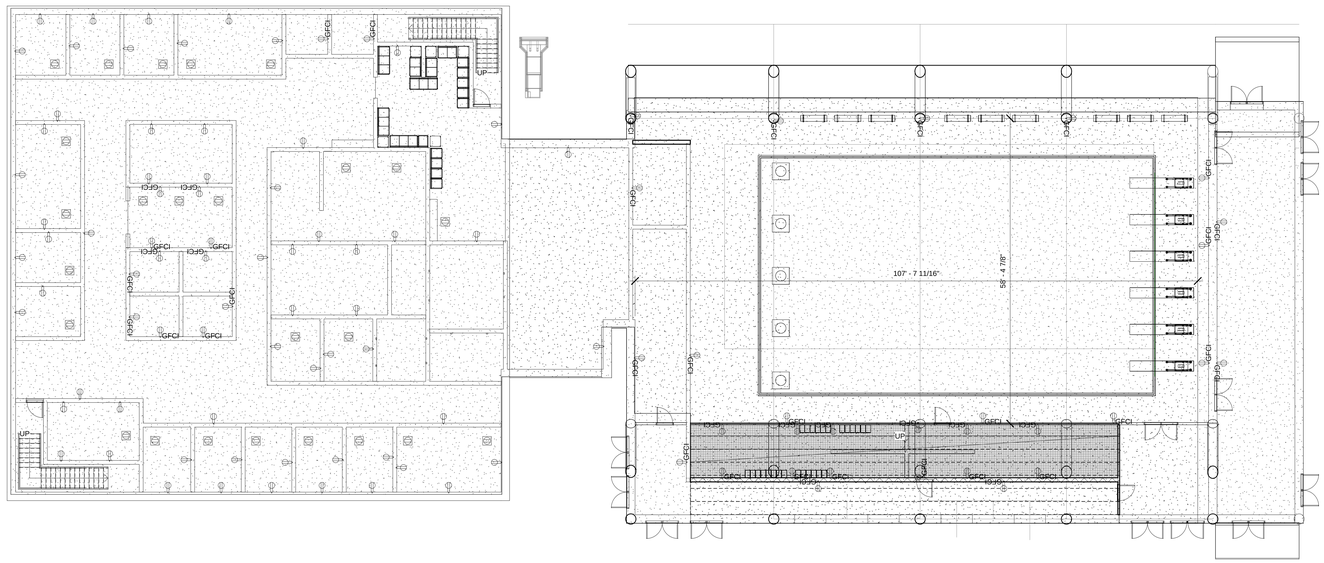


1 Phase 2 Lighting Layout
3/32" = 1'-0"



2 Phase 2 Power and Fire Alarm Layout
3/32" = 1'-0"

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No.	Description	Date

AEI Team #04-2013

Reading Elementary School

Phase 2 Lighting & Power Plans

Project Number	04-2013
Date	22 February 2013
Drawn By	Author
Checked By	Checker

E107

Scale	3/32" = 1'-0"

2/20/2013 10:22:03 AM

Basement	Purpose	Load (VA)	Total Amps	Growth	Panelboard Size
277V	Lighting	1641	3.4	4.3	100
120/208V	Pow/Mech	4377	12.2	15.2	100

Level 1 Gym	Purpose	Load (VA)	Total Amps	Growth	Panelboard Size
277V	Lighting	14479	30.2	37.8	100
120/208V	Pow/Mech	56132.16	156.0	195.0	225

Level 1 Central	Purpose	Load (VA)	Total Amps	Growth	Panelboard Size
277V	Lighting	8304	17.3	21.7	100
120/208V	Pow/Mech	28639	79.6	99.5	225

Level 1 Wing	Purpose	Load (VA)	Total Amps	Growth	Panelboard Size
277V	Lighting	5985	12.5	15.6	100
120/208V	Pow/Mech	23934	66.5	83.1	225

Level 2 Central	Purpose	Load (VA)	Total Amps	Growth	Panelboard Size
277V	Lighting	7655	16.0	20.0	100
120/208V	Pow/Mech	29550	82.1	102.6	225

Level 2 Wing	Purpose	Load (VA)	Total Amps	Growth	Panelboard Size
277V	Lighting	11780	24.6	30.7	100
120/208V	Pow/Mech	35410	98.4	123.0	225

Level 3 Central	Purpose	Load (VA)	Total Amps	Growth	Panelboard Size
277V	Lighting	9337	19.5	24.4	100
120/208V	Pow/Mech	30151	83.8	104.7	225

Level 3 Wing	Purpose	Load (VA)	Total Amps	Growth	Panelboard Size
277V	Lighting	6329	13.2	16.5	100
120/208V	Pow/Mech	28033	77.9	97.4	225

Building Totals	Purpose	Load (VA)
With Emergency Lighting	Lighting	65510
With Receptacle Reduction	Pow/Mech	242777.7
Total Load	**714533.2**	

Elementary School

Life Safety Loads

Location	V	VA
Level 1 Gym	277/480	1752.2
Level 1 Central	277/480	1347.4
Level 1 Wing	277/480	971.8
Level 2 Central	277/480	1375.6
Level 2 Wing	277/480	2056.4
Level 3 Central	277/480	1314
Level 3 Wing	277/480	1422.8

Level 1	V	Total VA	Amp	Growth
Combined:	277/480	4071.4	8.5	10.6
Level 2	**V**	**Total VA**	**Amp**	**Growth**
Combined:	277/480	3432	7.2	9.0
Level 3	**V**	**Total VA**	**Amp**	**Growth**
Combined:	277/480	2736.8	5.7	7.1

Critical Emergency Loads

Location	V	VA
Level 1 Gym	120/208	71842.16
Level 1 Central	120/208	100639
Level 1 Wing	120/208	23934
Level 1 Gym	277/480	12726.8
Level 1 Central	277/480	6956.6
Level 1 Wing	277/480	5013.2

Location	V	Total VA	Amp	Growth
Level 1	120/208	196415.2	409.9	512.3
Level 1	277/480	24696.6	51.5	64.4

Basement

Receptacles	No.	V	VA/device	VA
Under Floor	0	120	168	0
TV	0	120	158	0
Projector	0	120	230	0
Computer	0	120	168	0
Convenience	16	120	180	2880
GFCI	0	120	180	0
MDF (quad)	4	120	360	1440
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
Exhaust Fan	5	208	11.4	57
Total 120/208			**4377**	

Lighting	V	VA
All Lighting	277	1641
Total 277/480	**1641**	

Large Building Units	No.	V	VA
DOA 005	1	208 3P	5320
DOA 010	1	208 3P	10390
DOA 030	1	208 3P	72000
DOA 050	2	208 3P	180000
Hot Water Heater	1	208 3P	30000
Elevator	1	480 3P	29894.4
Total to Switchboard			**327604.4**

Level 1 Multipurpse Room

Receptacles	No.	V	VA/device	VA
Under Floor	10	120	168	1680
TV	1	120	158	158
Projector	0	120	230	0
Computer	0	120	168	0
Convenience	58	120	180	10440
GFCI	4	120	180	720
MDF (quad)	0	120	360	0
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
Size 7	7	208 1P	812	5684
Size 36	3	208 3P	5040	15120
Kitchen Equipment	**No.**	**V**	**VA/device**	**VA**
Milk Cooler	2	120	8.4	100.8
Heated Well	2	120/208	20	1000
Counter	2	n/a	n/a	n/a
Cashier Station	2	120	15	180
Electric Range	1	208	75	1600
Griddle	2	208	58	1200
Roll-in Oven	1	208	105	2184
Convection Oven	1	208	40	832
Roll-in Refridgerator	1	120	12	144
Roll-in Freezer	1	208	10.5	218.4
Garbage Disposal	3	208	3.2	66.56
Ice Machine	1	120	9.7	116.4
Food Processor	1	120	15	180
Mixer	1	120	15	180
Slicer	1	120	15	180
Countertops	4	n/a	n/a	n/a
Dishwasher	2	208	70	1456
Blast Chiller	1	208	6.1	1167
Microwave Oven	4		14	1000
Hot Serving Cabinet	6	208	4.7	975
Bun Steamer	2	120	8.3	1000
Toaster: Conveyor	2	120	18	2200
Fryer	1	120	4.5	1750
Broiler	2	208	14	3100
Dishwasher	2	208		1500
Total 120/208			**56132.16**	

Lighting	V	VA
All Lighting	277	11501
Corridor	277	478
Exterior Lighting	277	2500
Total 277/480		**14479**

Level 1 Central

Receptacles	No.	V	VA/device	VA
Under Floor	8	120	168	1344
TV	8	120	158	1264
Projector	8	120	230	1840
Computer	40	120	168	6720
Convenience	26	120	180	4680
GFCI	18	120	180	3240
MDF (quad)	6	120	360	2160
Printer	2	120	1104	2208
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
Size 7	3	208 1P	812	2436
Size 9	1	208 1P	957	957
Size 15	1	208 1P	1790	1790
Total 120/208			**28639**	

Lighting	V	VA
All Lighting	277	7827
Corridor	277	477
Total 277/480		**8304**

Level 1 Wing

Receptacles	No.	V	VA/device	VA
Under Floor	6	120	168	1008
TV	4	120	158	632
Projector	5	120	230	1150
Computer	20	120	168	3360
Convenience	26	120	180	4680
GFCI	9	120	180	1620
MDF (quad)	6	120	360	2160
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
Size 7	6	208 1P	812	4872
Size 9	1	208 1P	957	957
Size 12	3	208 1P	1165	3495
Total 120/208			**23934**	

Lighting	V	VA
Corridor	277	477
All Lighting	277	5508
Total 277/480		**5985**

Level 2 Central

Receptacles	No.	V	VA/device	VA
Under Floor	19	120	168	3192
TV	4	120	158	632
Projector	4	120	230	920
Computer	5	120	168	840
Convenience	32	120	180	5760
GFCI	22	120	180	3960
MDF (quad)	6	120	360	2160
Printer	1	120	1104	1104
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
Size 7	5	208 1P	812	4060
Size 9	1	208 1P	957	957
Size 12	2	208 1P	1165	2330
Size 24	1	208 3P	3635	3635
Total 120/208			**29550**	

Lighting	V	VA
All Lighting - No Library Pendants	277	6944
Corridor	277	711
Total 277/480		**7655**

Level 2 Wing

Receptacles	No.	V	VA/device	VA
Under Floor	11	120	168	1848
TV	10	120	158	1580
Projector	10	120	230	2300
Computer	30	120	168	5040
Convenience	27	120	180	4860
GFCI	49	120	180	8820
MDF (quad)	6	120	360	2160
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
Size 7	3	208 1P	812	2436
Size 9	3	208 1P	957	2871
Size 12	3	208 1P	1165	3495
Total 120/208			**35410**	

Lighting	V	VA
All Lighting	277	11069
Corridor	277	711
Total 277/480		**11780**

Level 3 Central

Receptacles	No.	V	VA/device	VA
Under Floor	8	120	168	1344
TV	8	120	158	1264
Projector	8	120	230	1840
Computer	40	120	168	6720
Convenience	26	120	180	4680
GFCI	16	120	180	2880
MDF (quad)	6	120	360	2160
Printer	1	120	1104	1104
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
Size 7	6	208 1P	812	4872
Size 9	1	208 1P	957	957
Size 12	2	208 1P	1165	2330
Total 120/208			**30151**	

Lighting	V	VA
All Lighting	277	8766
Corridor	277	571
Total 277/480		**9337**

Level 3 Wing

Receptacles	No.	V	VA/device	VA
Under Floor	9	120	168	1512
TV	6	120	158	948
Projector	6	120	230	1380
Computer	30	120	168	5040
Convenience	23	120	180	4140
GFCI	12	120	180	2160
MDF (quad)	12	120	360	4320
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
Size 7	4	208 1P	812	3248
Size 12	3	208 1P	1165	3495
Size 15	1	208 1P	1790	1790
Total 120/208			**28033**	

Lighting	V	VA
All Lighting	277	5758
Corridor	277	571
Total 277/480		**6329**

Phase 2 Totals

Pool	Purpose	Load	Total Amps	Growth	Panelboard Size
277V	Lighting	44280	92.4	115.5	225
120/208V	Pow/Mech	33483	93.0	116.3	225

Clinic	Purpose	Load	Total Amps	Growth	Panelboard Size
277V	Lighting	1974	4.1	5.1	100
120/208V	Pow/Mech	30036	83.5	104.3	225

Phase 2 Emergency

Life Safety Loads

Location	V	VA
Pool	277/480	1780
Clinic	277/480	1342

Location	V	Total VA	Amp	Growth
Pool	277/480	1780	3.7	4.6
Clinic	277/480	1342	2.8	3.5

Critical Emergency Loads

Location	V	VA
Clinic	120/208	1974
Clinic	277/480	28694

Location	V	Total VA	Amp	Growth
Clinic	120/208	1974	4.1	5.1
Clinic	277/480	28694	59.9	74.8

Natatorium

Receptacles	No.	V	VA/device	VA
Under Floor	1	120	168	168
TV	4	120	158	632
Projector	0	120	230	0
Computer	1	120	168	168
Convenience	0	120	180	0
GFCI	38	120	180	6840
MDF (quad)	10	120	360	3600
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
AHU	1	208 3P	10075	10075
General Hot Water Heater	1	208 1P	12000	12000
Total 120/208			**33483**	

Lighting	V	VA
All Lighting	277	6280
Exterior Lighting	277	38000
Total 277/480		**44280**

Clinic

Receptacles	No.	V	VA/device	VA
TV	3	120	158	474
Projector	1	120	230	230
Computer	25	120	168	4200
Convenience	60	120	180	10800
GFCI	13	120	180	2340
MDF (quad)	10	120	360	3600
Mechanical Equipment	**No.**	**V**	**VA/device**	**VA**
FXM 07	4	208 1P	125	500
FXM12	3	208 1P	125	375
FXM18	2	208 1P	334	668
FXM30	2	208 1P	479	958
FXZ07	4	208 1P	167	668
FXF09	1	208 1P	63	63
RWEY72	1	208 1P	4660	4660
Heat Recovery	1	208 1P	500	500
Total 120/208			**30036**	

Lighting	V	VA
All Lighting	277	1974
Total 277/480		**1974**

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No.	Description	Date

AEI Team #04-2013

Reading Elementary School

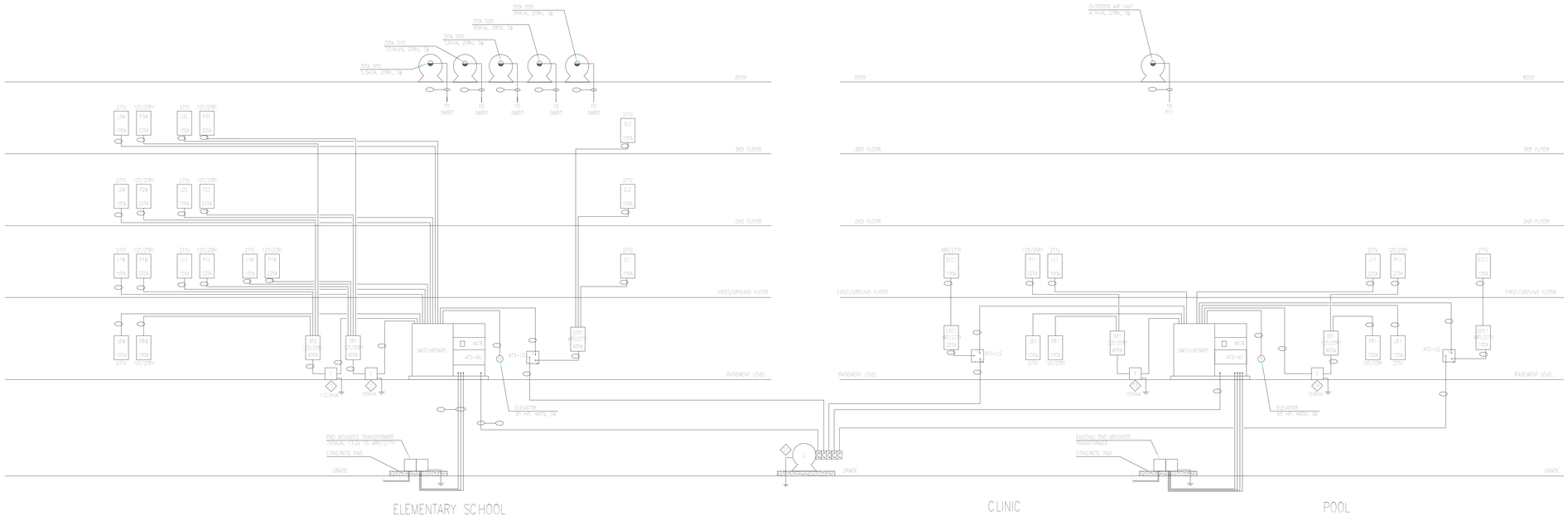
Electrical Loads

Project Number	04-2013
Date	22 February 2013
Drawn By	Author
Checked By	Checker

E108

Scale

2/20/2013 10:22:08 AM

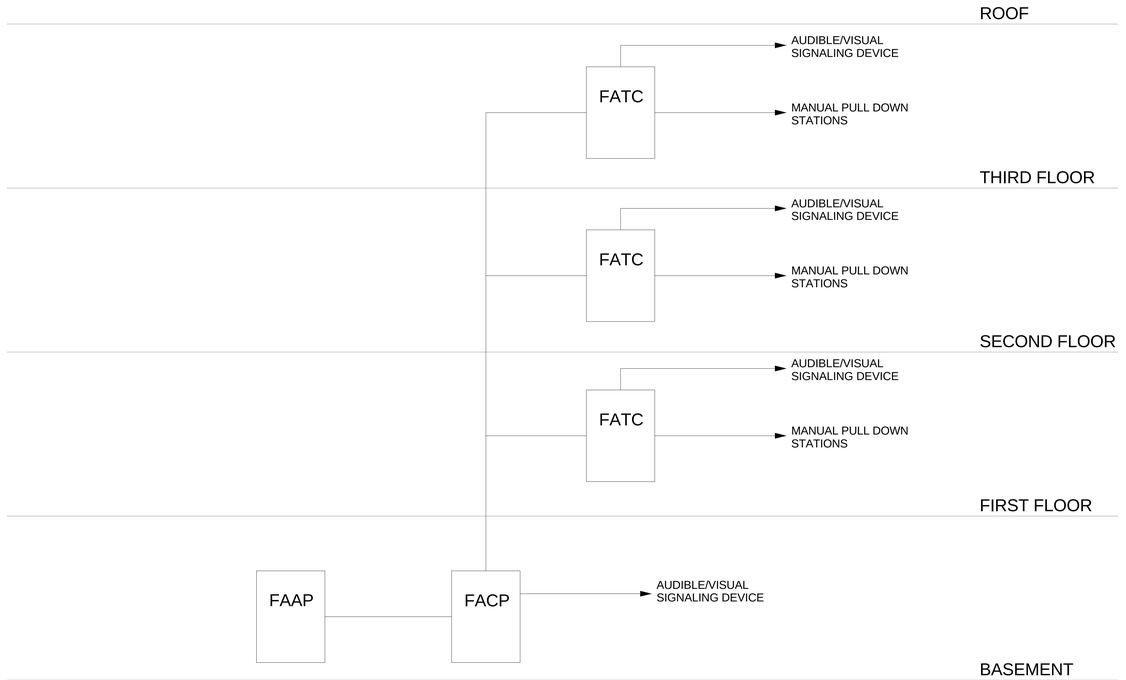


POWER RISER DIAGRAM – ELEMENTARY SCHOOL AND PHASE 2

GENERATOR SCHEDULE			
TAG	KW	VOLTAGE	NOTES: PAD MOUNTED, BUILDING EXTERIOR, FEEDS TO BOTH BUILDINGS
T1	350	480/277V	

DRY TYPE TRANSFORMER SCHEDULE					
TAG	KVA	PRIMARY V	PRIMARY AMPS	SECONDARY V	SECONDARY AMPS
T1	150	480V	301A	120/208Y	402A
T2	112.5	480V	176.5	120/208Y	235.4
T3	150	480V	36.2	120/208Y	83.5
T4	150	480V	40.3	120/208Y	93.0

BRANCH CIRCUIT AND FEEDER SCHEDULE – EMT CONDUIT		
TAG	COPPER WIRE 75° RATING	CIRCUIT RATING
1	3#3, 1#8GRD, 1-1/4"C	100A
2	3#4/0, 1#4GRD, 2"C	225A
3	3#8, 1#10, 3/4"C	40A
4	3#500KCM, 1#3GRD, 4"C	400A
5	3#300KCM, 1#4GRD, 2-1/2"C	275A
6	TWO SETS: 3#250KCM, 1#2GRD, 2-1/2"C	500A
7	THREE SETS: 3#350KCM, 1#4GRD, 2-1/2"C	900A
8	3#350KCM, 1#4GRD, 2-1/2"C	300A



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No.	Description	Date

AEI Team #04-2013

Reading Elementary School

Power & Fire Alarm Riser Diagrams

Project Number	04-2013
Date	22 February 2013
Drawn By	Author
Checked By	Checker

E109

Scale

2/20/2013 10:23:56 AM

1st Floor			Energy Usage		Power Density		
Rm. No.	Name	Area (SF)	Allowed W	Total Watts	ASHRAE Rm. Type	Max. LPD	Actual LPD
104	Multi-Purpose	6000	7200	5832	Court Sports Arena - Class 3	1.20	0.97
100	Vestibule	154	139	83	Lobby	0.90	0.54
101	Lobby	318	286	272	Lobby	0.90	0.86
102	Vestibule	178	160	112	Lobby	0.90	0.63
105	Stage	994	1223	891	Conference/Meeting/Multipurpose	1.23	0.90
106	Storage	210	132	56	Storage	0.63	0.27
107	Ramp	239	158	51	Corridor/Transition	0.66	0.21
108	Principal	211	234	214	Office (Enclosed)	1.11	1.01
109	Clerical	410	402	375.8	Office (Open)	0.98	0.92
110	Reception (Waiting)	220	161	149.6	Lounge/Recreation	0.73	0.68
111	Community Office	153	170	159.6	Office (Enclosed)	1.11	1.04
112	Toilet	68	67	51	Restrooms	0.98	0.75
113	Work Room	302	335	243.1	Office (Enclosed)	1.11	0.80
114	Corridor	133	88	51	Corridor/Transition	0.66	0.38
115	Girls	169	166	135	Restrooms	0.98	0.80
116	Cust.	63	40	34	Storage	0.63	0.54
117	Boys	144	141	118	Restrooms	0.98	0.82
118	MDF	102	97	84	Electrical/Mechanical	0.95	0.82
119	Treating/Waiting	309	513	569	Exam/Treatment	1.66	1.84
120	Office	95	105	143.2	Office (Enclosed)	1.11	1.51
121	Exam	130	216	244.8	Exam/Treatment	1.66	1.88
122	Cots	209	153	56.1	Lounge/Recreation	0.73	0.27
123	Toilet	82	80	34	Restrooms	0.98	0.41
124	PE Office/Storage	370	411	256.4	Office (Enclosed)	1.11	0.69
125	Trash	149	94	68	Storage	0.63	0.46
126	Lockers	76	57	34	Locker Room	0.75	0.45
127	Shower	114	112	81	Restrooms	0.98	0.71
128	Corridor	222	147	56	Corridor/Transition	0.66	0.25
129	Office	80	89	92.4	Office (Enclosed)	1.11	1.16
130	Storage	93	59	51	Storage	0.63	0.55
131	Cust.	28	18	17	Storage	0.63	0.61
132	Kitchen	1352	1338	1288	Food Preperation	0.99	0.95
133	Table/Chair Storage	408	257	84	Storage	0.63	0.21
134	Classroom	760	942	869.2	Classroom/Lecture/Training	1.24	1.14
135	Classroom	760	942	869.2	Classroom/Lecture/Training	1.24	1.14
136	Classroom	760	942	869.2	Classroom/Lecture/Training	1.24	1.14
137	Instruct. Storage	225	142	102	Storage	0.63	0.45
138	Toilet	81	79	51	Restrooms	0.98	0.63
140	Special Ed	908	1126	1146.3	Classroom/Lecture/Training	1.24	1.26

1st Floor Continued			Energy Usage		Power Density		
Rm. No.	Name	Area (SF)	Allowed W	Total Watts	ASHRAE Rm. Type	Max. LPD	Actual LPD
141	Classroom	809	1003	869.2	Classroom/Lecture/Training	1.24	1.07
142	Classroom	756	937	869.2	Classroom/Lecture/Training	1.24	1.15
143	Classroom	761	944	869.2	Classroom/Lecture/Training	1.24	1.14
144	Classroom	764	947	869.2	Classroom/Lecture/Training	1.24	1.14
145	SGI/Community Room	739	916	869.2	Classroom/Lecture/Training	1.24	1.18
146	Boys	116	114	107	Restrooms	0.98	0.92
147	Cust.	70	44	34	Storage	0.63	0.49
148	Girls	114	112	107	Restrooms	0.98	0.94
151	Conference	233	287	182.6	Conference/Meeting/Multipurpose	1.23	0.78
152	Security	78	87	68	Office (Enclosed)	1.11	0.87
155	Classroom	775	961	1054	Classroom/Lecture/Training	1.24	1.36
156	Vestibule	110	99	83	Lobby	0.90	0.75
157	Maintenance	191	120	136	Storage	0.63	0.71
158	IDF	78	74	56	Electrical/Mechanical	0.95	0.72
159	Classroom	768	952	1054	Classroom/Lecture/Training	1.24	1.37
160	Classroom	782	970	1054	Classroom/Lecture/Training	1.24	1.35
161	Conference	93	114	91.3	Conference/Meeting/Multipurpose	1.23	0.98
115A	Entry	63	42	27	Corridor/Transition	0.66	0.43
117A	Entry	34	22	27	Corridor/Transition	0.66	0.79
140A	Special Ed Toilet	75	74	34	Restrooms	0.98	0.45
146A	Entry	65	43	27	Corridor/Transition	0.66	0.42
148A	Entry	57	38	27	Corridor/Transition	0.66	0.47
S1	Stair	283	195	123.2	Stairway	0.69	0.44
S2	Stair	503	347	184.8	Stairway	0.69	0.37
S3	Stair	247	170	123.2	Stairway	0.69	0.50
S4	Stair	240	166	123.2	Stairway	0.69	0.51
	Entrance Canopy		0		Stairway	0.69	#DIV/0!
	Corridor	4711	3109	1432	Corridor/Transition	0.66	0.30

2nd Floor			Energy Usage		Power Density		
Rm. No.	Name	Area (SF)	Allowed W	Total Watts	ASHRAE Rm. Type	Max. LPD	Actual LPD
121	Kiln Room	47	58	84	Classroom/Lecture/Training	1.24	1.79
202	Planning/Conference	600	738	535	Conference/Meeting/Multip	1.23	0.89
203	Girls	161	158	118	Restrooms	0.98	0.73
204	Cust.	59	43	34	Lounge/Recreation	0.73	0.58
205	Boys	136	133	118	Restrooms	0.98	0.87
206	IDF	84	80	56	Electrical/Mechanical	0.95	0.67
207	Assistant Principal	178	198	159.6	Office (Enclosed)	1.11	0.90
208	Library	1800	1674	1034.5	Reading Area (Library)	0.93	0.57
209	Library Support	440	317	437.2	Card File and Cataloging	0.72	0.99
212	Art Classroom	1020	1265	839.2	Classroom/Lecture/Training	1.24	0.82
213	Faculty Dining	520	380	304.8	Lounge/Recreation	0.73	0.59
216	Classroom	800	992	819.2	Classroom/Lecture/Training	1.24	1.02
217	Classroom	800	992	819.2	Classroom/Lecture/Training	1.24	1.02
218	Classroom	800	992	819.2	Classroom/Lecture/Training	1.24	1.02
219	Teacher Workroom	200	222	224	Office (Enclosed)	1.11	1.12
221	Toilet	70	69	51	Restrooms	0.98	0.73
222	Special Ed	907	1125	1146.3	Classroom/Lecture/Training	1.24	1.26
223	Classroom-K	975	1209	1004	Classroom/Lecture/Training	1.24	1.03
224	Classroom-K	975	1209	1004	Classroom/Lecture/Training	1.24	1.03
225	Classroom-K	975	1209	1004	Classroom/Lecture/Training	1.24	1.03
226	Classroom-K	975	1209	1004	Classroom/Lecture/Training	1.24	1.03
227	Classroom-K	975	1209	1004	Classroom/Lecture/Training	1.24	1.03
228	Boys	115	113	115	Restrooms	0.98	1.00
229	Cust.	55	35	34	Storage	0.63	0.62
230	Girls	115	113	115	Restrooms	0.98	1.00
233	Classroom	800	992	1054	Classroom/Lecture/Training	1.24	1.32
234	Classroom-K	1050	1302	1168.8	Classroom/Lecture/Training	1.24	1.11
235	Classroom	800	992	1054	Classroom/Lecture/Training	1.24	1.32
236	Classroom	800	992	1054	Classroom/Lecture/Training	1.24	1.32
237	Closet	15	9	0	Storage	0.63	0.00

2nd Floor			Energy Usage		Power Density		
Rm. No.	Name	Area (SF)	Allowed W	Total Watts	ASHRAE Rm. Type	Max. LPD	Actual LPD
203A	Entry	62	41	27	Corridor/Transition	0.66	0.44
205A	Entry	36	24	27	Corridor/Transition	0.66	0.75
222A	Special Ed Toilet	80	78	34	Restrooms	0.98	0.43
223A	Toilet	50	49	17	Restrooms	0.98	0.34
224A	Toilet	50	49	17	Restrooms	0.98	0.34
225A	Toilet	50	49	17	Restrooms	0.98	0.34
226A	Toilet	50	49	17	Restrooms	0.98	0.34
227A	Toilet	50	49	17	Restrooms	0.98	0.34
228A	Entry	50	33	27	Corridor/Transition	0.66	0.54
230A	Entry	50	33	27	Corridor/Transition	0.66	0.54
234A	Toilet	67	66	17	Restrooms	0.98	0.25
S1	Stair	294	203	123.2	Stairway	0.69	0.42
S2	Stair	533	368	184.8	Stairway	0.69	0.35
S3	Stair	254	175	123.2	Stairway	0.69	0.49
S4	Stair	252	174	123.2	Stairway	0.69	0.49
	Corridor	4805	3171	1422	Corridor/Transition	0.66	0.30

3rd Floor			Energy Usage		Power Density		
Rm. No.	Name	Area (SF)	Allowed W	Total Watts	ASHRAE Rm. Type	Max. LPD	Actual LPD
302	Psych Office	150	167	101.3	Office (Enclosed)	1.11	0.68
304	Conference	280	344	123.2	Conference/Meeting/Multipurpose	1.23	0.44
303	IST	230	255	184.8	Office (Enclosed)	1.11	0.80
305	Girls	161	158	147	Restrooms	0.98	0.91
306	Cust.	66	42	34	Storage	0.63	0.52
307	Boys	136	133	130	Restrooms	0.98	0.96
308	IDF	84	80	56	Electrical/Mechanical	0.95	0.67
309	Guidance	178	198	149.6	Office (Enclosed)	1.11	0.84
310	Classroom	824	1022	1004	Classroom/Lecture/Training	1.24	1.22
311	Classroom	824	1022	1004	Classroom/Lecture/Training	1.24	1.22
312	Classroom	824	1022	1004	Classroom/Lecture/Training	1.24	1.22
313	Classroom	824	1022	1004	Classroom/Lecture/Training	1.24	1.22
314	Classroom	824	1022	1004	Classroom/Lecture/Training	1.24	1.22
317	Classroom	751	931	819.2	Classroom/Lecture/Training	1.24	1.09
318	Classroom	751	931	819.2	Classroom/Lecture/Training	1.24	1.09
319	Classroom	751	931	819.2	Classroom/Lecture/Training	1.24	1.09
320	Instruct. Storage	210	132	56	Storage	0.63	0.27
321	Elec. Closet	53	50	34	Electrical/Mechanical	0.95	0.64
322	Toilet	80	78	51	Restrooms	0.98	0.64
324	Special Ed	907	1125	1146.3	Classroom/Lecture/Training	1.24	1.26
325	Classroom	725	899	819.2	Classroom/Lecture/Training	1.24	1.13
326	Classroom	725	899	819.2	Classroom/Lecture/Training	1.24	1.13
327	Classroom	725	899	819.2	Classroom/Lecture/Training	1.24	1.13
328	Special Ed	725	899	819.2	Classroom/Lecture/Training	1.24	1.13
329	Classroom	725	899	819.2	Classroom/Lecture/Training	1.24	1.13
330	Boys	85	83	73	Restrooms	0.98	0.86
331	Cust.	22	14	17	Storage	0.63	0.77
332	Girls	85	83	73	Restrooms	0.98	0.86
305A	Entry	64	42	27	Corridor/Transition	0.66	0.42
307A	Entry	40	26	27	Corridor/Transition	0.66	0.68
324A	Special Ed toilet	80	78	34	Restrooms	0.98	0.43
330A	Entry	45	30	27	Corridor/Transition	0.66	0.60
332A	Entry	42	28	27	Corridor/Transition	0.66	0.64
S1	Stair	756	522	123.2	Stairway	0.69	0.16
S2	Stair	450	311	184.8	Stairway	0.69	0.41
S3	Stair	240	166	123.2	Stairway	0.69	0.51
	Corridor	4202	2773	1142	Corridor/Transition	0.66	0.27

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AEI Team #04-2013

Reading Elementary School

Building Lighting Power Densities

Project Number	04-2013
Date	22 February 2013
Drawn By	Author
Checked By	Checker

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