FINAL THESIS REPORT

HFS WAREHOUSE AND BAKERY EXPANSION

University Park, PA

JOSEPH RUTT

CONSTRUCTION MANAGMENT

DR CHIMAY ANUMBA

Housing and Food Services
Warehouse and Bakery Expansion
University Park, Pa

Building Information

- Occupant Name – Penn State University
- Occupancy Type – Warehouse and Office Space
- Size – 94,000 SF
- Dates of Construction – March 2015 – March 2016
- Approximate Cost – $13 Million
- Delivery Method – Design Build

Project Team

- Owner – Penn State University
- General Contractor – Kinsley Construction
- Architect – LSC Design Inc.
- Civil Engineer – Sweetland Engineering
- Structural Engineer – Carney Engineering Group
- Mechanical Engineer – Barton Associates
- Food Services – McFarland Kistler & Associates Inc.

Architecture

- 25,000 square-foot freezer space addition
- 20,000 square-foot renovation of ambient storage area
- 5,000 square-foot office space renovations
- Improvements to the baker production area

Structural System

- Substructure – Normal weight concrete (150 pcf)
- Masonry – Concrete Block, Clay Facing Brick, Split Faced Block
- Superstructure – Steel Frame
- Roof Structure – Steel Decking

Mechanical Systems

- Location – Mechanical Room on First Floor
- Roof Top Units – Six VAV Units, Natural Gas
- AHU – Eight Units, Freezer, Cooler, Dry Stock, Offices
- Fire Protection - Early Suppression Fast Response (ESFR) and 75 hp fire pump

Electrical System

- Location – South side of First Floor
- Pad Mounted Utility Transformer
- Main Distribution Panel – 480/277V, 3PH, 4W
- Back Up Power - 2 megawatt emergency generator
- New 3000 amp electrical service

Joseph Rutt

Construction https://www.engr.psu.edu/ae/thesis/portfolios/2016/jxr977/index.html Anumba

EXECUTIVE SUMMARY

In every construction project there are many problematic areas that can be addressed and analyzed to help the project succeed. The Housing and Food Services Warehouse and Bakery expansion is like most projects and has several areas that need to be better analyzed. With extensive research performed in the Fall Semester, I found four analyses that focus on problematic features of The Housing and Food Services Warehouse and Bakery expansion. They are based on areas of schedule and cost reduction using SIPs, implementation of BIM, site safety and occupancy plan, and acquiring a LEED certification.

ANALYSIS 1: SIP ANALYSIS

This analysis focuses on reducing the time to renovate the office space in the Housing and Food Services building. The area of investigation would be to see if implementing a SIP schedule to the renovation of the office space would accelerate the schedule and reduce office downtime.

ANALYSIS 2: BIM UTILIZATION

This analysis focuses on the use of BIM to improve the project. BIM was not used at all on this project but could have been used to improve the project in several ways. BIM could have been used from the start to turn the original building drawings into electronic files. Having an electronic model of the HFS building could be used to show the problems with the as-built. The electronic model will also allow for the use of clash detection software. Both reasons explained above should help to greatly reduce the total amount of RFI's and ASI's. BIM has many more uses, but for this project I recommend implementing BIM at a small scale.

ANALYSIS 3: INDOOR AIR QUALITY

Indoor Air Quality (IAQ) is an important design criteria in today's industry. It is especially important in a facility such as The Housing and Food Service Warehouse and Bakery. Analysis 3 focuses on determining the IAQ of the current system and determining an alternate system through a mechanical breadth. After completing the analysis it was determined that the current system fell somewhat short and a 100% outdoor air system was chosen.

ANALYSIS 4: LEED CERTIFICATION

LEED Certification is the evaluation and qualification of a sustainable project. By taking measures to increase LEED credits, the Housing and Food Services Warehouse and Bakery expansion will benefit in terms of energy efficiency life cycle costs as well as building and user performance.

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ACKNOWLEDGEMENTS

PENNSTATE

PENNSTATE Department of Architectural Engineering

Architectural Engineering Faculty

Dr. Chimay Anumba (Advisor)

KINSLEY CONSTRUCTION

LSCdesign

CEG CARNEY ENGINEERING GROUP

BARTON ASSOCIATES

Sweetland Engineering & ASSOCIATES, INC.

1.0 PROJECT BACKGROUND

The project for my senior thesis is the Housing and Food Services Warehouse and Bakery Expansion for The Pennsylvania State University in University Park, Pennsylvania. Scheduled for completion in March 2016, the project includes increasing freezer, cooler, and dry storage capacity, expanding the bakery, and improving building systems. The current plan will be funded through many sources such as, operational reserves, state funding, self-supporting units, capital investments, and borrowing and debt services. At University Park, its buildings are in need of major renovation and significant changes with 65% of the buildings older than 25 years.

Penn State has hired Architect LSC Design Inc. to design the addition and renovation of the Housing Food and Services Warehouse and Bakery Expansion. LSC Design Inc. was founded in 1980 as Land Survey Consultants, and has since grown to include architecture, interior design, civil engineering, survey management and landscape architecture. They are now known for their ability to listen and advocate for their clients, like Penn State, and to effectively marry design with constructability within a budget and schedule.

The 94,000 square foot existing HFS building will undergo approximately 44,500 square feet of renovations during the three phases of construction. The warehouse will be expanded on the north side by about 25,000 square feet. Starting with phase 1A, the addition to the warehouse will be erected. The renovation of the south side will make the start of phase 1B. Phase 2 marks the start of the existing cooler and freezer renovation, and construction of new racking within the cooler and freezer. Phase 3 starts with the existing freezer. This will be renovated into more dry storage. The first part of phase 3 will start with the southern part of the dry storage area and the offices. As the offices continue to be renovated, the northern part of the dry storage area will start renovations. This expansion will allow Penn State Housing and Food Services to increase the variety and scope of product offerings to meet the culinary needs of students, faculty, staff and visitors. This project also will provide opportunities to capitalize on additional direct manufacturer relationships that will reduce overall food costs.

The goal of this renovation is to increase the capacity of freezer, cooler and dry goods storage, improve workflow and provide more effective use of space. The project will reorganize and expand the warehouse and bakery and replace aging and inefficient building systems.

1.1 CLIENT INFORMATION

Penn State expects to receive quality work from the contractor that is seamless and neat with a minimal loss of services. Another expectation of Penn State is to obtain a crew that strives to be cost-effective, timely, and be a dependable resource to meet the expectations of the project. Safety is one of the upmost concerns when dealing with campus construction. When possible, there will be zero impact to vehicular traffic, and parking. Site fencing will be used to keep pedestrians from entering the construction site. Posting directional, hazard, and caution signs as well as making public notifications is a standard for Penn State OPP. Penn State also ensures the safety of employees by setting mandatory safety training, implementing and enforcing all safety practices and standards, inspecting and repairing equipment, and utilizing appropriate PPE. Penn State conducts a Contractor Performance Evaluation throughout the entire project to ensure the quality of the building. Firms receiving an unsatisfactory mark will be considered for removal from the Pre-qualified Bidders List for a period of no less than six months.

1.2 PROJECT DELIVERY AND STAFFING PLAN

The Housing and Food Services Warehouse and Bakery Expansion is a design build contract between Kinsley Construction and Penn State University. This is chosen because both design and construction is in the hands of a single entity. This creates cost savings and time savings. It also reduces the administrative burden. This means the owner, Penn State, is not required to invest time and money in coordinating between separate design and construction contracts.

Pennsylvania State University	Owner	9 Housing and Food Services Building University Park, PA	814-863-5611
LSC Design Inc.	Architect	320 N. George St. Suite 100 York, PA	717-845-8383
Carney Engineering Group	Structural Engineer	320 N. George St. Suite 120 York, PA	717-852-1260
Barton Associates	Mechanical Engineer	329 Innovation Boulevard, Suite 112 State College, PA	814-237-2180
Sweetland Engineering	Civil Engineer	600 Science Park Road State College, PA	814-237-6518
Kinsley Construction	Contractor	2700 Water Street P.O. Box 2886 York, PA	717-741-3841
McFarland Kistler & Associates Inc.	Food Service	1130 Perry Hwy Pittsburgh, PA	412-367-1905

Figure 1 - Delivery Method

The staff of Kinsley Construction for this project is a team from York, Pennsylvania. Project Manager, Kevin Finke, is the main contact for Kinsley Construction on this project. Below are the details of the staffing plan.

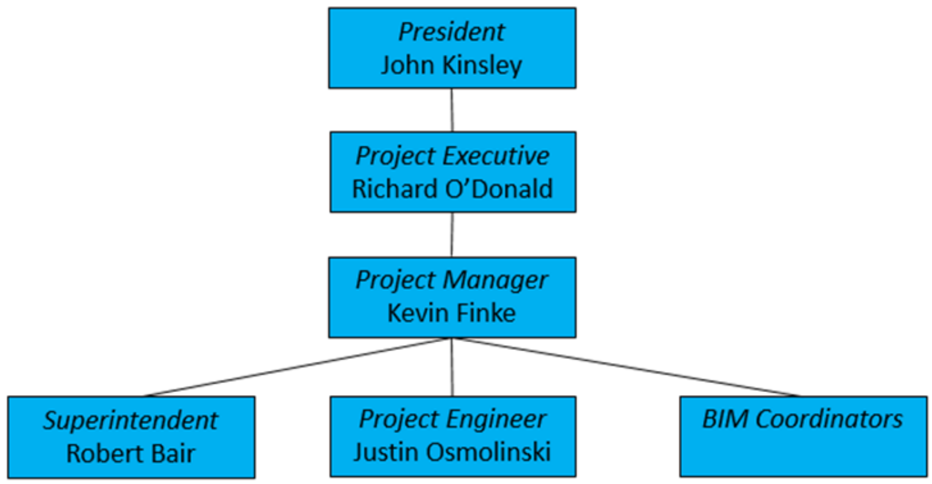


Figure 2 - Staffing Plan

1.3 EXISTING SITE CONDITIONS

On the site for The Housing and Food Services Warehouse and Bakery expansion is set back off Park Ave. To the west of the HFS Warehouse and Bakery is Penn State's Arboretum, and to the east is the Hostetter Business Services building. Directly to the south is the Lewis Katz Law building. North of the HFS Warehouse and Bakery is a parking lot that will be utilized as a material laydown area. The surrounding buildings are not close enough to effect the construction of the Warehouse and Bakery. For the duration of the project, the northern parking lot will be fenced off to store materials and prevent pedestrians from entering the construction site.

Figure 3 – Aerial View of HFS Warehouse and Bakery

2.0 DESIGN AND CONSTRUCTION OVERVIEW

2.1 BUILDING SUMMARY

The 94,000 square foot existing HFS building will undergo approximately 44,500 square feet of renovations during the three phases of construction. The warehouse will be expanded on the north side by about 25,000 square feet. This expansion will allow Penn State Housing and Food Services to increase the variety and scope of product offerings to meet the culinary needs of students, faculty, staff and visitors. This project also will provide opportunities to capitalize on additional direct manufacturer relationships that will reduce overall food costs.

The goal of this renovation is to increase the capacity of freezer, cooler and dry goods storage, improve workflow and provide more effective use of space. The project will reorganize and expand the warehouse and bakery and replace aging and inefficient building systems. Early Suppression Fast Response (ESFR) and 75 hp fire pump will be installed in the ambient storage and cooler/freezer addition.

The structural design of the existing building is primarily structural steel. The addition will continue using structural steel, creating a uniform and continuous building. The design of the electrical system has two power distributions of 208Y/120V, as well as a two megawatt emergency generator for backup power. The HFS building will be in compliance with the ASHRAE 62.1 requirements, and all demolished material will be recycled wherever possible. Hazardous materials will be disposed of in the correct safe manner.

2.2 SCHEDULE OVERVIEW

The existing HFS Warehouse and Bakery Expansion will undergo three phases from the construction start date, March 2nd, 2015, and will be completed for owner occupancy one year later, March 2016. The design phase started in November of 2013. Phase one starts with the excavation and foundation of the warehouse addition located on the north side. The freezer construction is also a part of phase one starting on March 16th, 2015 and continuing for 146 days until October 5th, 2015. New freezer and refrigeration units will be installed to replace the aging and inefficient system currently in place. The office and rear improvements will undergo MEP rough-in for ten days from June 6th, 2015 to June 23rd, 2015. The MEP trim-outs will take about 5 days starting July 27th, 2015. The MEP for the freezer and cooler in the bakery will take 28 days and will start on August 28th, 2015. Renovations of the existing ambient storage area will be included in the third phase starting on December 16th, 2015. The final MEP installation will be located in the new office and consulting room. This will start October 1st, 2015 and end in March 10th, 2016. Some of these phases along with additional scheduled events can be seen in Table 1.

Table 1 - Project Schedule Overview

Project Schedule Overview			
Phase	Duration	Start Date	End Date
Phase 1 - Storm water Management	65	2-Mar-15	29-May-15
Phase 1 - Freezer Construction	146	16-Mar-15	5-Oct-15
Phase 1A - Office & Rear Improvements	158	8-Apr-15	13-Nov-15
Phase 1B - Fire Pump Room & Bakery Area	134	12-May-15	13-Nov-15
Phase 2 - Exterior Improvements	46	15-Jul-15	16-Sep-15
Phase 2 - Renovate Existing Freezer & Cooler	56	29-Sep-15	15-Dec-15
Phase 3A - New Office & Consult Room	116	1-Oct-15	10-Mar-16
Phase 3 - Renovate Existing Ambient	55	16-Dec-15	1-Mar-16

2.3 COST OVERVIEW

The actual cost of construction for the 69,500 GSF addition and renovation for The Housing and Food Service Warehouse and Bakery in State College, Pennsylvania was $9,756,248 or $103.79/SF. This cost takes into account the cost of material, labor, and equipment that is needed to construct the building. When including additional costs like furnishings and equipment, the total project costs rises to $13,209,528 or $140.53/SF. A cost breakdown of the different building systems, including the actual costs, cost per square foot and the percentage of the total cost can be seen below in Table 2.

Table 2 - Cost Summary

Cost Summary			
Building System	Actual Cost	Cost/SF	% Cost
Site Work	$954,161	$10.15	9.78%
Demolition	$512,203	$5.45	5.25%
Concrete	$606,839	$6.46	6.22%
Masonry	$563,911	$6.00	5.78%
Metals	$1,330,752	$14.16	13.64%
Doors, Frames, & Hardware	$378,542	$4.03	3.88%
Windows	$1,102,456	$11.73	11.30%
Flooring	$459,519	$4.89	4.71%
Plumbing	$1,021,479	$10.87	10.47%
HVAC	$1,420,510	$15.11	14.56%
Electrical	$1,405,875	$14.96	14.41%
Total Construction Cost	**$9,756,248**	**$103.79**	**100%**
Overall Project Cost	**$13,209,528**	**$140.53**	**135.40%**

2.4 GENERAL CONDITIONS ESTIMATE

The general conditions estimate performed for The HFS Warehouse and Bakery Addition and Renovation represents the operational costs of the jobsite for the general contractor Kinsley Construction. The estimate was broken down into six different sections which includes supervision/project management, field engineering, administrative, safety, cleanup, and miscellaneous.

Table 3 - General Conditions Summary

General Conditions Summary		
Section	Cost per Month	Total Cost
Project Management	$27,784	$333,412.00
Field Engineering	$2,069	$24,830.00
Administrative	$5,933	$71,195.00
Safety	$79	$950.00
Cleanup	$7,442	$89,300.00
Miscellaneous	$548	$6,580.00
Total	$43,856	$526,267.00

The table above shows the general conditions estimate summary for the six main sections as noted above. The total cost of the project general conditions is $526,267.00 which is 4.05% of the design build contract value for the project at $13,209,528. With the general conditions estimate taking place over a 12 month period I divided the total by each month and found that general conditions cost around $43,856 per month. The prices were found by using a combination of 2013 RS Means Construction Cost Data and actual known costs from previous projects. The most expensive out of the six sections was for project management. This section was 6.3% of the total cost, followed by cleanup at about 17%, administrative at 13.5%, field engineering 4.7%, miscellaneous 1.2% and finally safety at less than 1%.

3.0 SIP ANALYSIS

3.1 PROBLEM IDENTIFICATION

The Housing Food and Services building is undergoing an addition and renovations to the warehouse, bakery and office space. The northern office renovations start from April and end in May 2015, and the southern office renovations take place from December 2015 to January 2016. This makes the office space unusable during these months. The downtime causes congestion and inefficiency within the employees of the HFS Building. There are multiple options to speed the construction up such as increased manpower or working extra days. These options are limited by the size of the site and the owner's requirement that the site only be under construction for a certain period of the day due to the proximity of the campus. Another option could be to change the schedule by focusing on areas in which the project could be optimized. The office renovations have an opportunity to compare and contrast the possible benefits of implementing SIPS. Penn State will want to know if SIPS is beneficial for this project and future construction.

3.2 PROPOSED SOLUTIONS

SIPS will be used to reschedule certain tasks. Initially, the floor plan of the building will be analyzed to determine which spaces to group together. The north and south offices will be renovated at the same time instead of months apart. Next, interior systems will be broken into major construction sequences and attributed certain durations. By involving multiple trades in the schedule, work teams can follow one another throughout the space and minimize unproductive time on site. These offices are relatively small, so it is critical to clear workers out as efficiently as possible. The renovations will take place between the months of April to June.

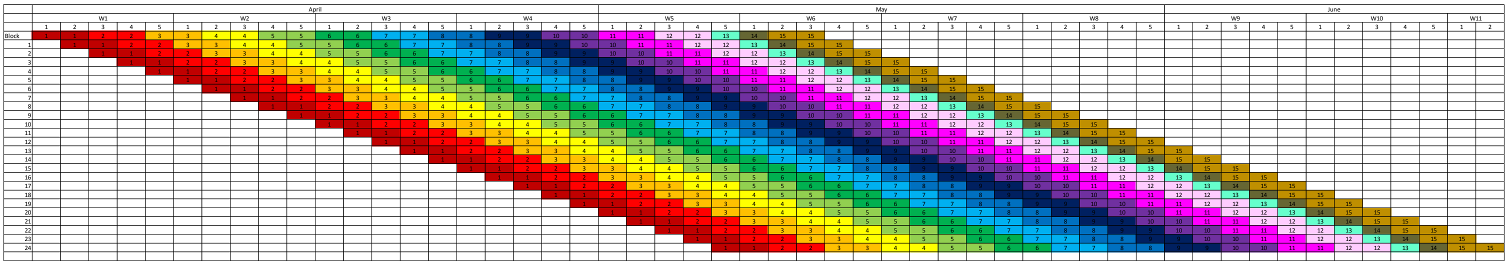
3.3 BACKGROUND RESEARCH

The Short Interval Project Schedule (SIPS) is a method of scheduling that involves a level of detail not commonly found in a project schedule. Short Interval Project Schedule or SIPS is taught as part of the construction management curriculum. The data on the project is provided by the involved parties and allows for an analysis of the building and room layout. There is data showing the effects of detailed schedules, prefabrication, and forward thinking construction methods in the construction industry. It has been shown through the class work on SIPS and the presentations by industry members that SIPS work is better focused on repetitive sections of work, thus the options presented would be the offices, bathrooms, and conference rooms.

3.4 ANALYSIS PROCEDURE

The first step in completing the SIPS analysis is creating a matrix schedule to determine if it is logistically possible to complete the interior finishes. There were a total of 15 different items included in the finishing stage ranging from hanging drywall to final cleanup. Drawing from personal experience and using the CPM schedule for the project the matrix schedule seen in Figure 4 was produced. The matrix schedule will enable the project team to keep track of the work flow through the building and easily determine whether or not progress was on track or not. The room order will follow the path of Figures 5 and 6.

The matrix schedule shows two important things, the flow of work from the first room through the building to the last room and how the work is split up to develop the workday. The different zones are shown in Figure 5 and 6 below. When deciding which trades were to be used during the work shift the main factor was which trades would benefit most from the extra space available during this time. It was decided that the drywall crew, flooring contractors and painters would benefit most in this situation. Each of these subcontractors require a substantial amount of their own space when completing their tasks, and they could work much more efficiently.



Office Renovation Activities	
ID	Activity
1	Hang Drywall
2	Spackle/Finish Drywall
3	Prep, Prime and Paint Walls
4	Prep, Prime and Paint Ceilings
5	Install Casework
6	Install Lighting Fixtures
7	Install Countertops
8	Install Hard Wood Flooring
9	Install Plumbing Fixtures
10	Final Paint
11	Install Door Hardware
12	Final Finish Carpentry
13	Install Carpet
14	Final Electric
15	Cleanup

Figure 4 - Parade of Trades

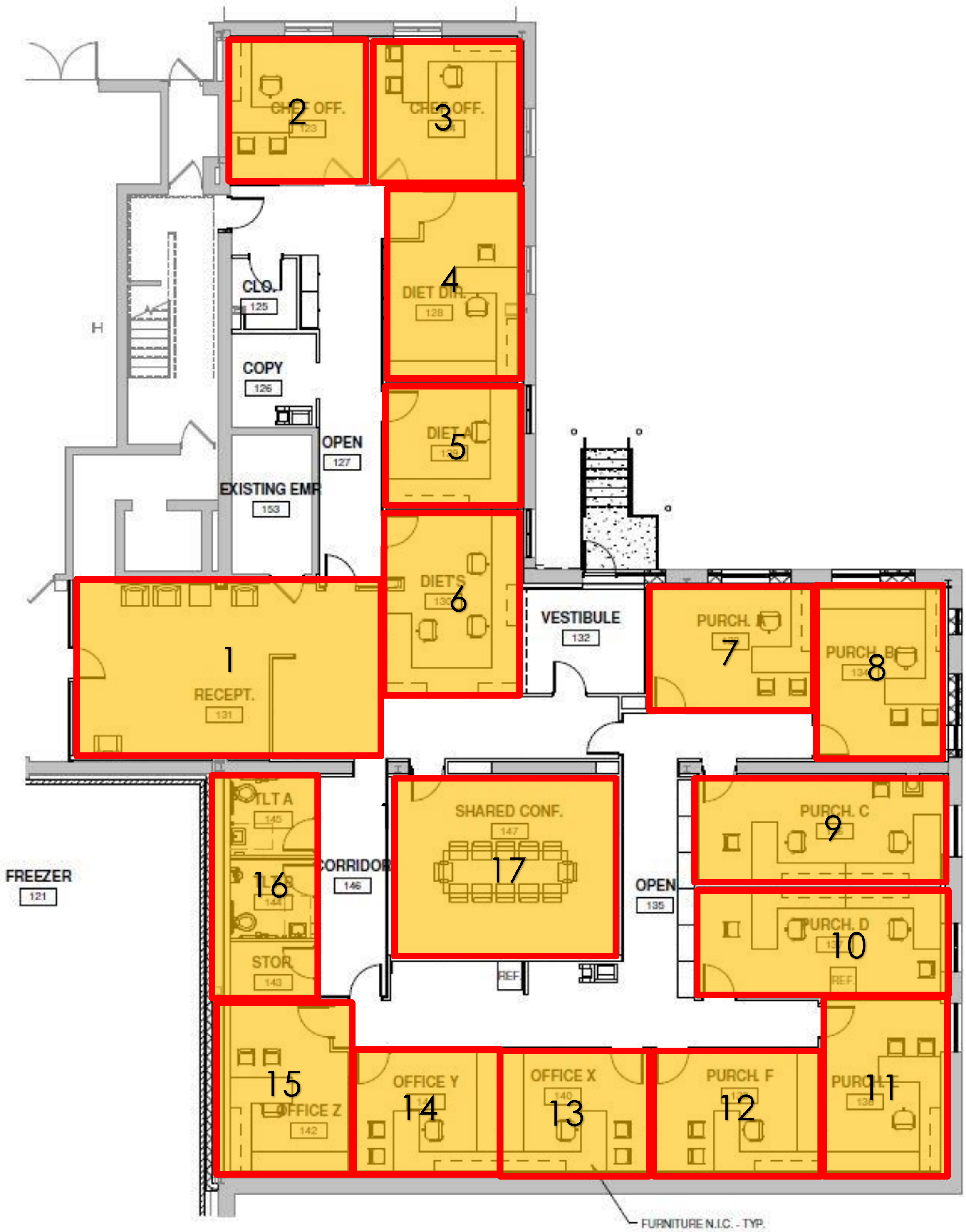


Figure 5 - Order of Renovation

Figure 6 - Order of Renovation cont.

The matrix schedule resulted in an 11 week duration for the interior finishes of the HFS Offices, finishing 5 weeks ahead of the original 16 week schedule and allowing the employees to move back into their office sooner. In order for this schedule to be accelerated enough and for it to be logistically possible to operate, it was necessary to increase manpower for particular trades involved in the finishing process.

3.5 RECOMMENDATIONS

By investigation and applying a SIP Schedule for the interior renovation of the Housing and Food Services office space, the project schedule should be accelerated to alleviate office downtime by about five weeks. A small increase in man power for particular trades was necessary.

4.0 BIM UTILIZATION

4.1 PROBLEM IDENTIFICATION

The schedule is a main concern for the owner. The project needs to finish on time so regular production and storage can occur. One main issue that has held the project up is that there was no as-built drawing for the original warehouse and bakery. There was a lot of wasted time when the project team and the architect were trying to communicate and collaborate. A large contingency was held in case any problems occurred during construction. Many RFI's and ASI's were submitted and take time to get answers, which can cause major schedule delays. The implementation of BIM will also help the owner with operation and maintenance after the building is turned over.

4.2 PROPOSED SOLUTIONS

A possible solution to help with the large contingency and to help with future maintenance could be the use of Building Information Modeling (BIM). It could be used to create 3D models earlier in the project. This will allow for any issues to be corrected before construction starts. A 4D model could also be used to display to the project team the delivery and installation of many aspects of construction. A 4D model will be useful and help demonstrate the procedure to the project team and subcontractors. After completing the analysis there are several potential solutions that could occur.

- The cost of creating the 3D and 4D model is too high and outweighs the costs saved from the use of BIM. If this is the case, BIM will not be utilized.
- The amount of time saved by limiting RFI's is substantial and therefore BIM should be utilized.
- The amount of time added by the creation of the 3D and 4D model is more than the time saved and therefore BIM should not be utilized.

4.3 BACKGROUND RESEARCH

BIM has many uses in the construction industry. BIM can be used for 3D coordination, site utilization planning and analysis, structural analysis, digital fabrication, and facilities management. Since the drawings were never put into 3D format, clash detection could not be used and this resulted in the increased amount of RFI's on the project. My main focus will be utilizing 3D and 4D coordination. BIM could assist in the coordination of the different systems and would have been able to find a lot earlier for the project. The application of BIM could have benefited the overall project costs and schedule. The Pennsylvania State University BIM Execution Planning Guide will be used to facilitate the analysis.

4.4 ANALYSIS PROCEDURE

The following procedure should be completed to successful analysis the use of BIM on The Housing and Food Service Warehouse and Bakery Addition and Renovation.

- Determine the different uses of 3D models for coordination.
- Look into reasons the owner decided to not use BIM initially.
- Evaluate the costs of a 3D and 4D model.
- Look into the estimated costs associated with change orders.
- Evaluate the duration of creating the 3D and 4D model.
- Determine possible schedule savings by limiting the number of RFI's.
- Research facility maintenance scenarios.

4.5 PREDICTED OUTCOME

With the use of 3D coordination the predicted outcome for this analysis is that BIM will be very useful. A 3D model of the existing building will help substantially by preventing RFI's and change orders. With the 3D model complete, clash detection software could be used which will again limit the amount of RFI's and will save time for the project. The use of a 4D model for construction of the warehouse bays is expected to be useful in displaying the procedure and benefits.

4.6 BIM UTILIZATION

Table 4 - BIM Use

X	Plan	X	Design	X	Construct	X	Operate
	Programming		Design Authorizing	X	Site Utilization Plan	X	Building Maintenance
X	Site Analysis	X	Design Reviews	X	Construction System		System Analysis
			3D Coordination		3D Coordination		Asset Management
			Structural Analysis		Digital Fabrication		Space Tracking
			Lighting Analysis		3D Planning		Disaster Planning
			Energy Analysis		Record Modeling		Record Modeling
			Mechanical Analysis				
			Other Analysis				
		X	Sustainability				
			Code Validation				
X	4D Modeling		4D Modeling	X	4D Modeling		4D Modeling
X	Cost Estimation	X	Cost Estimation	X	Cost Estimation	X	Cost Estimation
	Existing Conditions	X	Existing Conditions	X	Existing Conditions	X	Existing Conditions

When looking at BIM for this project, several areas could have been improved with the use of BIM. These areas include 3D coordination, 4D modeling and facility maintenance. Some typical BIM programs used could be programs such as AutoCAD Revit for 3D modeling or a program such as Navisworks could be used for 4D modeling and facility maintenance.

Before implementing BIM on a project, the project team, workers, and owner will need to be able to use the programs to take full advantage of BIM's capabilities. Training sessions can be used on site for the project team and workers, which will allow them to fully understand and use BIM to its fullest extent. This training will not necessarily teach the workers how to draw and model in Revit or Navisworks, but will show them how to properly navigate through the model to find whatever they need. These training programs are extremely beneficial when implementing BIM on a project.

BIM for The HFS Warehouse and Bakery Addition and Renovation was not utilized at all. This does not mean that it could not have been beneficial. These analyzes would benefit from BIM in many ways. Three of the main benefits would be displaying a 3D model to help find the issues with an as-built drawings earlier on in the project and a 4D model to help with the phase planning and the future maintenance required.

If a 3D model was created, the issues with the as-built drawings would have been found much earlier on. When the designer using Revit was comparing the as-built to the actual building when he was making the model, he would have found the issue. The 3D model would have been created before the project even started, so all the issues would have been found before and construction took place. Finding these issues would have limited the amount of RFI's and ASI's greatly.

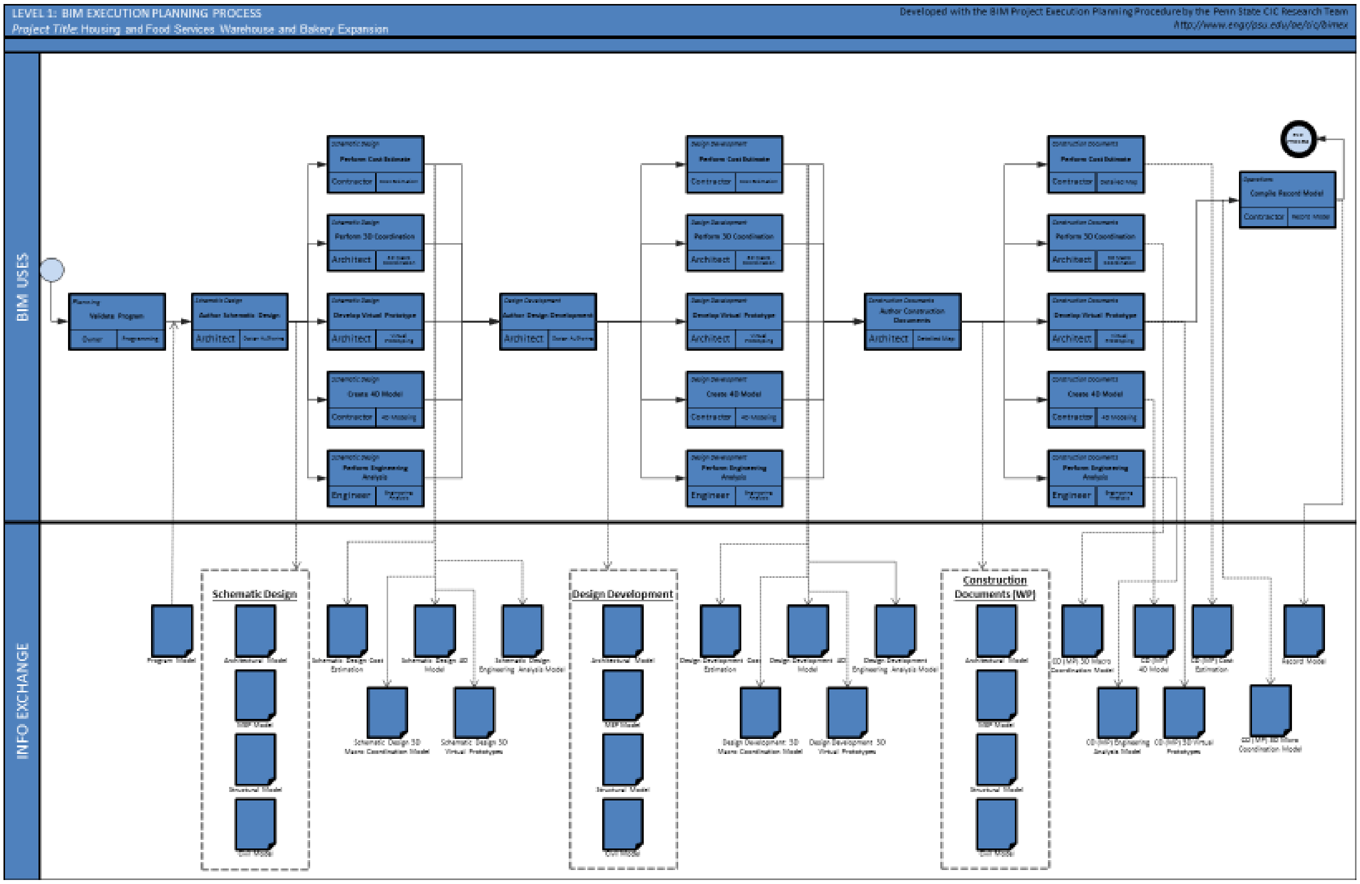


Figure 7 - BIM Use Process Map

A 4D model could have been used to effectively show the construction sequence and the different phases of construction. This would identify space and workspace conflicts and would be able to resolve these issues ahead of the construction process.

A 4D model is a great way to show how the new construction activity will work. Implementing the use of large equipment, new delivery tactics, and installation techniques will improve the overall schedule of the project. This equipment and new delivery method can be displayed accurately and to scale with the use of BIM.

In a 4D model, the equipment needed can clearly be displayed in its exact location and its uses. BIM can be used to show the basic aspects of construction while still explaining how the phase will flow with the rest of the construction activities.

The 4D model can clearly display how construction around the addition proceeds with the use of different colors. The model can also show the locations of the delivery trucks, the equipment needed, the construction trailers and the laydown area for the materials.

The use of a 4D model can also help create maps for each phase of construction that can be set up around the site on the inside of the building and or the exterior of the building. These maps will allow for workers and pedestrians to see which activity is going on and the current traffic plan around the site. This will be beneficial when traffic needs to be closed off for the delivery. These maps can also help keep pedestrians out of danger zones during the entire construction process.

With facilities management the owner has different ways of approaching issues to the building. One option known as Space/Real Estate Management is where all the space is clearly defined and anyone looking at the model can tell exactly what goes in the space and what goes on in the space. The second option is Project Management, which helps future contractors do any renovations that may occur. The last option is Asset Management which helps with the equipment maintenance in the building.

4.7 RECOMMENDATIONS

In conclusion the implementation of BIM has many potential benefits to help with coordination, phasing and facility maintenance. Using BIM can be very useful in limiting the amount of time wasted with RFI's, can help with the phasing and construction activities, and can aid with future maintenance.

5.0 INDOOR AIR QUALITY

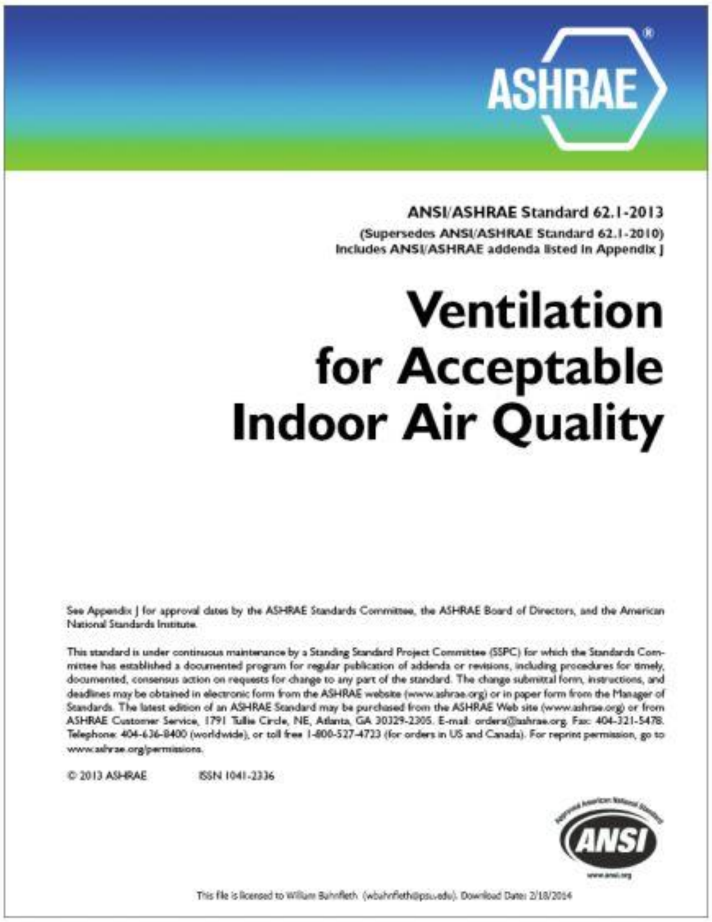
5.1 PROBLEM IDENTIFICATION

Kinsley Construction did not seeking any LEED accreditation for The HFS Warehouse and Bakery Expansion. A significant portion of the LEED credits come from the interior space of the building to ensure that there are efficient systems, recycled materials, and what could be most important, a healthy environment for the building occupants. In today's industry, indoor air quality (IAQ) is an important issue dealing with mechanical systems that supply fresh air and the occupants' health. IAQ is known to effect occupant health in that contaminant concentrations in the environment are an important contributor to the total air pollutant intake that an individual experiences.

The HFS facility's indoor air quality is as especially important issue. When the mechanical ducts were redesigned, it is uncertain that the same amount of outside air to recirculated air fraction was kept consistent.

5.2 PROPOSED SOLUTIONS

For this analysis an IAQ calculation for a single unit will be performed in order to determine how the system performs compared to the IAQ standard. The analysis will be performed in accordance to the ASHRAE Standard 62.1-2013. A definitive standard for this type of facility was not able to be located so the performance of the current system will be compared to the IAQ standard that one must reach in order to achieve the LEED credit using Option 2 for Minimum Indoor Air Quality Performance. After it is determined as to whether or not the current system performed to the standard, a Mechanical Breadth will determine the correct size or system that will meet the standard.


ASHRAE

ANSI/ASHRAE Standard 62.1-2013
(Supersedes ANSI/ASHRAE Standard 62.1-2010)
Includes ANSI/ASHRAE addenda listed in Appendix J

Ventilation for Acceptable Indoor Air Quality

See Appendix J for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE Web site (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

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Figure 8 - ASHRAE Standard 62.1 - 2013

5.3 ANALYSIS PROCEDURE

To begin this analysis a single unit was chosen to analyze. The unit chosen is the largest unit, Unit H, the office space at 3,015 square feet. Each room was broken down into its own zone ASHRAE 62.1 (see Appendix E). The next step in determining the IAQ for this unit was to calculate the zone floor area for each room along with the zone population. With these variables you can calculate the Breathing Zone Outdoor Airflow (Vbz) using equation 6.2.2.1 below.

$$Vbz = Rp \times Pz + Ra \times Az \qquad (6.2.2.1)$$

Where

Az = Zone floor area, the net occupiable floor area of the ventilation zone, ft^2

Pz = Zone population, the number of people in the ventilation zone during typical usage

Rp = Outdoor airflow rate required per person as determined from Table 6.2.2.1

Ra = Outdoor airflow rate required per unit area as determined from Table 6.2.2.1

The next step is to determine the Zone Air Distribution Effectiveness (Ez) (see Appendix E). For this type of air distribution configuration the distribution effectiveness is 1.0. Using this value and the values determined using equation 6.2.2.1, you can determine the Zone Outdoor Airflow using equation 6.2.2.3 below.

$$Voz = Vbz/Ez \qquad (6.2.2.3)$$

Using equation 6.2.2.3 above the next step is to calculate the Zone Outdoor Airflow for each zone in Unit H. After completing this analysis and adding up the Zone Outdoor Airflow for each zone it was determined that an additional 383 CFM of outdoor air needs to be added to the system in order to meet the requirements set by the U.S. Green Building Council in order to reach the Indoor Air Quality requirement. Table 5 on the following page shows the steps taken in this portion of the analysis.

Table 5 - Indoor Air Quality Analysis

Indoor Air Quality Analysis - Unit H					
Zone name	Zone Area Az (ft^2)	Zone Population Pz (people)	Breathing Zone Outdoor Airflow Vbz (cfm)	Zone Air Distribution Effectiveness Ez	Zone Outdoor Airflow Voz (cfm)
Restroom	214	2.00	0	1.00	0
Reception	144	1.44	16	1.00	16
Chef Office	215	4.30	58	1.00	58
Copy Room	152	1.52	17	1.00	17
Shared Confrence Room	488	4.88	54	1.00	54
Break Room	206	10.00	62	1.00	62
Storage	115	0.23	15	1.00	15
Supply Closet	62	0.62	11	1.00	11
Corridor	226	0.00	0	1.00	0
Office A	256	2.56	28	1.00	28
Office B	156	1.56	17	1.00	10
Office C	155	1.55	17	1.00	10
System Area (sq ft)	3,015				
System Population (people)	30.66				
Uncorrected Outdoor Air Intake (cfm)	295				
Outdoor Air Intake Flow (+30%) (cfm)	383				

5.4 RECOMMENDATIONS

Indoor Air Quality (IAQ) is an important design criteria in today's industry. It is especially important in a facility such as The HFS Warehouse and Bakery. Analysis 3 focuses on determining the IAQ of the current system and determining an alternate system through a mechanical breadth. After completing the analysis it was determined that the current system fell somewhat short and a 100% outdoor air system was chosen. It is recommended to use the 100% outdoor air system for The Housing and Food Service Warehouse and Bakery.

6.0 MECHANICAL BREADTH

The main contributor to indoor air quality is the ratio of outside air to recycled air that is used in the system, the more outside air the better the IAQ. With that being the case, for this mechanical breadth, using the outdoor air requirements from the analysis above, a 100% outdoor air unit design will be determined for Unit H.

In order to calculate the cooling and heating loads you first have to determine the design parameters for the location of your building. For this case the building is located in State College, PA and the design parameters for this area can be seen in Figure 9 below. The ASHRAE 1% parameters will be used for both the dry and wet bulb variables for this analysis.

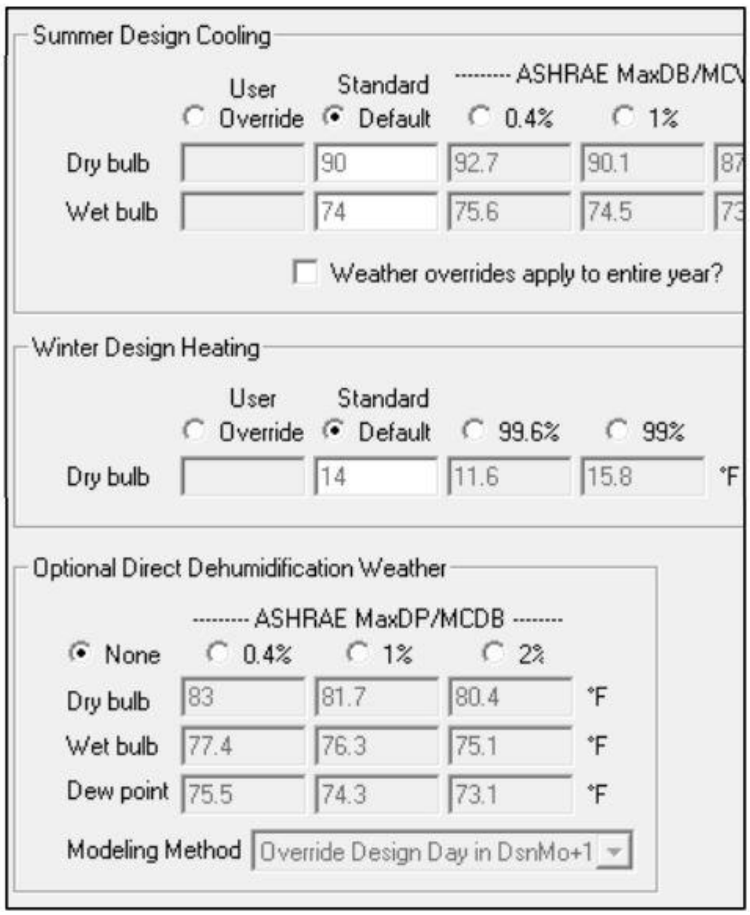


Figure 9 - Design Parameters

The first step will be determining the cooling load for Unit H. When calculating the cooling load, equation 1 below is used.

$\dot{q}(btu) = 4.5\ CFM\ \Delta h$ (Equation 1)

In the equation above, 4.5 is a constant, the CFM refers to the total outdoor air supply from the analysis above and delta h is the difference in enthalpy using a psychrometric chart. For the cooling load the design parameters for Summer Design Cooling are used from Figure 9 above. Those values are 90.1 for the Dry bulb and 74.5 for the Wet bulb. For this analysis a relative humidity of 60% will be used with an indoor temperature of 75° F. The psychrometric chart used to determine the enthalpy change, delta h, can be seen below.

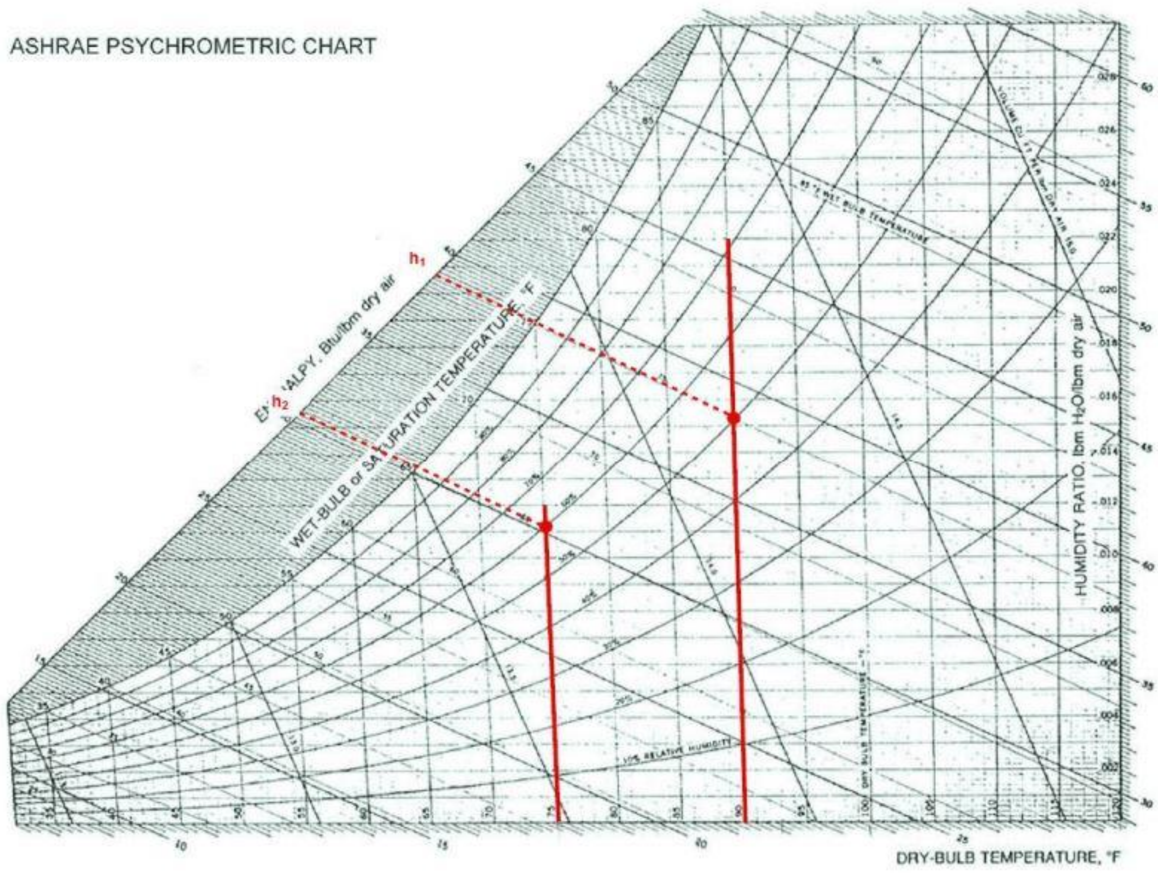


Figure 10 - ASHRAE Psychrometric Chart for Cooling Load

From the chart above you can see that h1 = 38.8 btu/lbm and h2 = 30.4 btu/lbm. Using these values and our previous outdoor air supply of 383 cfm you are left with the equation below.

$\dot{q}(btu) = 4.5\ (383)\ (38.8 - 30.4)$

$\dot{q}(btu) = 14{,}477.4\ btuh = \mathbf{14.5\ mbh}$

The original system for this unit provided 54.9 mbh for cooling, for the 100% outside air system the 14.5 mbh calculated will be added to this amount for a total of 69.4 mbh. A new 100% outdoor air system will need to be able to support this cooling load in order to meet that demand for this unit.

The next part of this analysis is to determine the heating load for Unit H. This is done by finding the sensible load ($\dot{q}$sens) and the latent load ($\dot{q}$lat) for the space. The sensible heat load takes into consideration the difference between the outside temperature and the amount of outside air needed. Equation 2 below shows this relationship.

$\dot{q}\ sens = 1.08\ CFM\ \Delta T$ (Equation 2)

Again using the design parameters for the State College, PA area the heating load was designed with a Dry bulb temperature of 15.8° F. The calculated 383 cfm from the previous analysis is also used along with the indoor temperature of 75° F. This calculation is shown below.

$\dot{q}\ sens = 1.08\ (383)\ (75 - 15.8)$

$\dot{q}\ sens = 24{,}487.5\ btuh = \mathbf{24.5\ mbh}$

The heating load above is added to the current load of 100 mbh for a total of 124.5 mbh load for Unit H

The new 100% outdoor air system will need to be able to supply a cooling load of 69.4 mbh and a heating load of 124.5 mbh.

The next step for this mechanical breadth is to determine the cost implications with changing the mechanical system from its current system to a 100% outdoor air system. Cost information was taken from RS Means 2014 Mechanical Cost Data.

Using the loads from the first part of the analysis, another unit size was chosen and is denoted as the 100% Outdoor Air Cooling/Heating System – Unit H. This system does not differ much from the current system other than the increase in MBH for the heating system. The cost difference, although more than the current system, is also not very substantial at $280.00. This additional price can be offset by the deletion of the return air ducts for the current system; these will no longer be needed with a system using 100% outside air. This could not be as clearly shown for Unit H.

6.1 RECOMMENDATIONS

Following this mechanical breadth and analysis of the indoor air quality it would be recommended to go forth with the 100% outdoor air system. The cost of this change would not negatively affect the overall budget and it would provide residents with a higher quality style of living.

7.0 LEED CERTIFICATION

7.1 PROBLEM IDENTIFICATION

The original project took no considerations to pursue a LEED certification. After reviewing the current design, renovation and addition, it became evident that the project already would be capable of acquiring a LEED certification. With only minor changes, the project is capable of acquiring at least 40 LEED points deeming it suitable for a LEED Certified rating.

7.2 PROPOSED SOLUTIONS

The final analysis is the pursuit of a LEED Certification and a more sustainable project. The current project plans and methods will be evaluated through the LEED Certification process along with rational changes to acquire the most LEED points and highest LEED certification.

Research of the new green buildings systems will evaluate the benefits of a sustainable and LEED certified project. New systems and methods will be researched to maximize energy and cost savings along with construction efficiency.

7.3 BACKGROUND RESEARCH

With the process of a LEED certification comes many other benefits to the construction and lifespan of the project at hand. The process offers rigorous third party commissioning to enhance the design and construction in many different ways. The certification of a sustainable projects lets the owner as well as the users of the building know that effective measures were taken to ensure an environmentally conscientious building was produced.

The decision to pursue a LEED certified and green building can result in many different benefits. Lower operating costs and higher asset value, reduced project waste, energy conservation, a healthier, safer, and more productive environment for all future users, reduced greenhouse gas emissions, and tax rebates are just a few of the incentives to choose a green project.

7.4 ANALYSIS PROCEDURE

To produce a LEED Certified building there are many requirements, but it starts with the LEED Checklist and a targeted level of certification. The LEED Checklist will allow the owner and architect to look for certain points they can reasonably with minimum changes to obtain, and there are others which they will coordinate the projects design to obtain. After analyzing the checklist and even conducting a rough estimate of the cost of the projected points, the owner will then decide on the targeted level of certification.

Through this analysis the targeted LEED points will be evaluated as the owner and General Contractor would after the project was completed. The credits will be tallied and if the project team succeeds the project will be awarded with one of the four LEED Certifications. The LEED Checklist can be found on the USGBC's LEED website, which will provide the guidelines for assessing the degree of sustainability incorporated in the project. The credits awarded will be categorized under six LEED categories.

INTEGRATIVE PROJECT PLANNING AND DESIGN

Integrative Process – 1 point acquired

By integrating the project between multiple facets of the project team the project and obtain this prerequisite the project will have to be integrated between four of the main players in the construction process. This project would most easily be able to integrate the architect, general contractor, civil engineer, and landscape architect, as these are the most prevalent teams in the project's completion.

LOCATION AND TRANSPORTATION

Sensitive Land Protection – 1 point acquired

The first LEED credit available is the Sensitive Land Protection credit, which defines any development footprint not located on a land defined as Prime Farmland, Floodplains, Species, Water Bodies, or Wetlands. These land types are further defined in the LEED v4 Building Design and Construction Addenda. With this criteria filled they can acquire one credit for Sensitive Land Protection.

High Priority Site – 1 point acquired

To encourage project location in areas with development constraints and promote the health of the surrounding area.

Surrounding Density and Diverse Uses – 2 points acquired

Construct or renovate the project on a previously developed site that was used for industrial or commercial purposes.

Access to Quality Transit – 5 points acquired

Locate any functional entry of the project within a ¼-mile (400-meter) walking distance of existing or planned bus, streetcar, or rideshare stops, or within a ½-mile (800-meter) walking distance of existing or planned bus rapid transit stops, light or heavy rail stations, commuter rail stations, or commuter ferry terminals. Planned stops and stations may count if they are sited, funded, and under construction by the date of the certificate of occupancy and are complete within 24 months of that date.

Bicycle Facilities – 1 point acquired

Design or locate the project such that a functional entry or bicycle storage is within a 200-yard (180- meter) walking distance or bicycling distance from a bicycle network that connects to at least one of the following:

- At least 10 diverse uses
- A school or employment center, if the project total floor area is 50% or more residential; or
- A bus rapid transit stop, light or heavy rail station, commuter rail station, or ferry terminal. All destinations must be within a 3-mile (4800-meter) bicycling distance of the project boundary.

SUSTAINABLE SITES

Site Assessment – 1 point acquired

Complete and document a site survey or assessment1 that includes the following information:

- Topography. Contour mapping, unique topographic features, slope stability risks.
- Hydrology. Flood hazard areas, delineated wetlands, lakes, streams, shorelines, rainwater collection and reuse opportunities, TR-55 initial water storage capacity of the site (or local equivalent for projects outside the U.S.).
- Climate. Solar exposure, heat island effect potential, seasonal sun angles, prevailing winds, monthly precipitation and temperature ranges.
- Vegetation. Primary vegetation types, greenfield area, significant tree mapping, threatened or endangered species, unique habitat, invasive plant species.
- Soils. Natural Resources Conservation Service soils delineation, U.S. Department of Agriculture prime farmland, healthy soils, previous development, disturbed soils (local equivalent standards may be used for projects outside the U.S.).
- Human use. Views, adjacent transportation infrastructure, adjacent properties, construction materials with existing recycle or reuse potential.
- Human health effects. Proximity of vulnerable populations, adjacent physical activity opportunities, proximity to major sources of air pollution. The survey or assessment should demonstrate the relationships between the site features and topics listed above and how these features influenced the project design; give the reasons for not addressing any of those topics.

Open Space – 1 point acquired

Provide outdoor space greater than or equal to 30% of the total site area (including building footprint). A minimum of 25% of that outdoor space must be vegetated (turf grass does not count as vegetation) or have overhead vegetated canopy.

Rainwater Management – 1 point acquired

In a manner best replicating natural site hydrology processes, manage on site the runoff from the developed site for the 95th percentile of regional or local rainfall events using low-impact development (LID) and green infrastructure.

WATER EFFICIENCY

Indoor Water Use Reduction – 4 points acquired

All newly installed toilets, urinals, private lavatory faucets, and showerheads that are eligible for labeling must be WaterSense labeled (or a local equivalent for projects outside the U.S.).

Further reduce fixture and fitting water use from the calculated baseline in WE Prerequisite Indoor Water Use Reduction. Additional potable water savings can be earned above the prerequisite level using alternative water sources. Include fixtures and fittings necessary to meet the needs of the occupants. Some of these fittings and fixtures may be outside the tenant space (for Commercial Interiors) or project boundary (for New Construction)

Water Metering – 1 point acquired

Install permanent water meters for two or more of the following water subsystems, as applicable to the project.

ENERGY AND ATMOSPHERE

Optimize Energy Performance – 8 points acquired

Establish an energy performance target no later than the schematic design phase. The target must be established as kBtu per square foot-year (kW per square meter-year) of source energy use.

Enhanced Refrigerant Management – 1 point acquired

Select refrigerants that are used in heating, ventilating, air-conditioning, and refrigeration (HVAC&R) equipment to minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change. The combination of all new and existing base building and tenant HVAC&R equipment that serve the project.

MATERIALS AND RESOURCES

Construction and Demolition Waste Management – 2 points acquired

Develop and implement a construction and demolition waste management plan:

- Establish waste diversion goals for the project by identifying at least five materials (both structural and nonstructural) targeted for diversion. Approximate a percentage of the overall project waste that these materials represent.
- Specify whether materials will be separated or comingled and describe the diversion strategies planned for the project. Describe where the material will be taken and how the recycling facility will process the material.

INDOOR ENVIRONMENTAL QUALITY

Enhanced Indoor Air Quality Strategies – 2 points acquired

Comply with the following requirements, as applicable.

Mechanically ventilated spaces:

- entryway systems
- interior cross-contamination prevention
- filtration.

Naturally ventilated spaces:

- Entryway systems
- natural ventilation design calculations.

Mixed-mode systems:

- Entryway systems
- interior cross-contamination prevention
- filtration
- natural ventilation design calculations
- mixed-mode design calculations

Low-Emitting Materials – 3 points acquired

This credit includes requirements for product manufacturing as well as project teams. It covers volatile organic compound (VOC) emissions in the indoor air and the VOC content of materials, as well as the testing methods by which indoor VOC emissions are determined. Different materials must meet different requirements to be considered compliant for this credit. The building interior and exterior are organized in seven categories, each with different thresholds of compliance. The building interior is defined as everything within the waterproofing membrane. The building exterior is defined as everything outside and inclusive of the primary and secondary weatherproofing system, such as waterproofing membranes and air- and water-resistive barrier materials.

Construction Indoor Air Quality Management Plan – 1 point acquired

Develop and implement an indoor air quality (IAQ) management plan for the construction and preoccupancy phases of the building. The plan must address all of the following.

During construction, meet or exceed all applicable recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd edition, 2007, ANSI/SMACNA 008–2008, Chapter 3.

Protect absorptive materials stored on-site and installed from moisture damage.

Do not operate permanently installed air-handling equipment during construction unless filtration media with a minimum efficiency reporting value (MERV) of 8, as determined by ASHRAE 52.2–2007, with errata (or equivalent filtration media class of F5 or higher, as defined by CEN Standard EN 779–2002, Particulate Air Filters for General Ventilation, Determination of the Filtration Performance), are installed at each return air grille and return or transfer duct inlet opening such that there is no bypass around the filtration media. Immediately before occupancy, replace all filtration media with the final design filtration media, installed in accordance with the manufacturer's recommendations.

Prohibit the use of tobacco products inside the building and within 25 feet (7.5 meters) of the building entrance during construction.

Indoor Air Quality Assessment – 2 points acquired

After construction ends and before occupancy, but under ventilation conditions typical for occupancy, conduct baseline IAQ testing using protocols consistent with the methods listed for all occupied spaces. Use current versions of ASTM standard methods, EPA compendium methods, or ISO methods, as indicated. Laboratories that conduct the tests for chemical analysis of formaldehyde and volatile 126 Updated to reflect the April 5, 2016 LEED v4 Building Design and Construction Addenda organic compounds must be accredited under ISO/IEC 17025 for the test methods they use. Retail projects may conduct the testing within 14 days of occupancy.

Interior Lighting – 1 point acquired

For all shared multioccupant spaces, meet all of the following requirements.

- Have in place multizone control systems that enable occupants to adjust the lighting to meet group needs and preferences, with at least three lighting levels or scenes (on, off, midlevel).
- Lighting for any presentation or projection wall must be separately controlled.
- Switches or manual controls must be located in the same space as the controlled luminaires. A person operating the controls must have a direct line of sight to the controlled luminaires.

INNOVATION

LEED Accredited Professional – 1 point acquired

At least one principal participant of the project team must be a LEED Accredited Professional (AP) with a specialty appropriate for the project.

REGIONAL PRIORITY

Regional Priority – 2 points acquired

Earn up to four of the six Regional Priority credits. These credits have been identified by the USGBC regional councils and chapters as having additional regional importance for the project's region. A database of Regional Priority credits and their geographic applicability is available on the USGBC website

LEED v4 for BD+C: Warehouses and Distribution Centers
Project Checklist

Project Name: Housing and Food Service Warehouse and Bakery
Date: 4/4

Y	?	N			
1			Credit	Integrative Process	1
10	**1**	**5**		**Location and Transportation**	**16**
			Credit	LEED for Neighborhood Development Location	16
1			Credit	Sensitive Land Protection	1
1	1		Credit	High Priority Site	2
2		3	Credit	Surrounding Density and Diverse Uses	5
5			Credit	Access to Quality Transit	5
1			Credit	Bicycle Facilities	1
		1	Credit	Reduced Parking Footprint	1
		1	Credit	Green Vehicles	1
3	**2**	**5**		**Sustainable Sites**	**10**
Y			Prereq	Construction Activity Pollution Prevention	Required
1			Credit	Site Assessment	1
		2	Credit	Site Development - Protect or Restore Habitat	2
1			Credit	Open Space	1
1	2		Credit	Rainwater Management	3
		2	Credit	Heat Island Reduction	2
		1	Credit	Light Pollution Reduction	1
5	**2**	**4**		**Water Efficiency**	**11**
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
		2	Credit	Outdoor Water Use Reduction	2
4		2	Credit	Indoor Water Use Reduction	6
	2		Credit	Cooling Tower Water Use	2
1			Credit	Water Metering	1
9	**12**	**#**		**Energy and Atmosphere**	**33**
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
	6		Credit	Enhanced Commissioning	6
8		10	Credit	Optimize Energy Performance	18
	1		Credit	Advanced Energy Metering	1
		2	Credit	Demand Response	2
	3		Credit	Renewable Energy Production	3
1			Credit	Enhanced Refrigerant Management	1
	2		Credit	Green Power and Carbon Offsets	2

Y	?	N			
2	**2**	**6**		**Materials and Resources**	**13**
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
	2		Credit	Building Life-Cycle Impact Reduction	5
		2	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
		2	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
		2	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit	Construction and Demolition Waste Management	2
9	**1**	**6**		**Indoor Environmental Quality**	**16**
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
2			Credit	Enhanced Indoor Air Quality Strategies	2
3			Credit	Low-Emitting Materials	3
1			Credit	Construction Indoor Air Quality Management Plan	1
2			Credit	Indoor Air Quality Assessment	2
		1	Credit	Thermal Comfort	1
1	1		Credit	Interior Lighting	2
		3	Credit	Daylight	3
		1	Credit	Quality Views	1
		1	Credit	Acoustic Performance	1
1	**2**	**3**		**Innovation**	**6**
	2	3	Credit	Innovation	5
1			Credit	LEED Accredited Professional	1
2	**0**	**2**		**Regional Priority**	**4**
1			Credit	Regional Priority: Specific Credit	1
1			Credit	Regional Priority: Specific Credit	1
		1	Credit	Regional Priority: Specific Credit	1
		1	Credit	Regional Priority: Specific Credit	1
42	**22**	**43**		**TOTALS** Possible Points:	**110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

Figure 11 - LEED Score Card

7.5 PREDICTED OUTCOME

The Housing and Food Services Warehouse and Bakery expansion already has potential LEED points, but with the implementation of the proposed systems; there is even more prospective points to be gained. The evaluation of the project after the changes have been made should result in a least a LEED Certified accreditation.

7.6 RECOMMENDATIONS

In conclusion after implementing all of the previous analyses, it would be almost an obvious decision to pursue a LEED Certification. The certification will not only commemorate the sustainability considerations of this project, but also interconnect all of the sustainable opportunities together. With a LEED score of 42 points, there may be some points that the team didn't intend on achieving and some that they may have already planned on acquiring that didn't work out for them. As a backup there are 22 possible points, which may or may not be achievable, but four of them are guaranteed if the owner is willing to pay for the additions.

Of course the decision to pursue a LEED Certification is predominately up to the owner. Although, there are clear reasons why this is a beneficial decision to the owner. Sustainable buildings are a great representation of the principles and values the owner wants to portray. Sustainable buildings are not only environmentally friendly but also very cost saving in the long run

8.0 ELECTRICAL BREADTH

The existing design of the electrical system have two power distributions of 208Y/120V. The breadth will focus on the possibility of updating the electrical system voltage to 480Y/277V from the existing design of 208Y/120V. For the convenience of comparing system efficiency and cost effectiveness, the impact from the proposing LEED Analysis will not be counted in this analysis; i.e. the addition power from the rooftop wind turbine system will not be included in the LEED analysis. Because the original system is selected based on a preliminary estimate, the exact electrical load that can be provide with the on-site generator is undefined. Thus, in this analysis, the electric loads will be assumed to meet the designed system.

Theoretically, with the rooftop turbine units and the pole mounted wind turbine, power consumption of the building from the main power supply is expect to decrease and thus reduce the building operation cost in long run. A life cycle cost analysis of the updated system compared to the original design will be done in the Value Engineering Analysis.

8.1 EXISTING ELECTRICAL SYSTEM

The existing electrical design for The HFS Warehouse and Bakery utilizes two parallel services entrances connects to the switchgears with incoming service voltage of 208Y/120V.

Table 6 – Switchboard Schedule

POWER STYLE QED-2 SWITCHBOARD													
SECT NO	CKT NO	GMD HEIGHT	DEVICE/FRAME RATING	TRIP AMP	FUSE/ TRIP	#P	DESIGNATION	N/P	LUG INFORMATION				ACCESSORIES
									QTY	PHASE WIRE RANGE	QTY	NEUT. WIRE RANGE	
1	UCT	–	3000A	–	–	–	DUQUESNE LIGHT	No	9	–	9	–	
2	M1	–	NW 3000A Plug A	3000A	A–LSIG	3P	Main Breaker	Yes	–	3/0 – 750 kcmil	–	3/0 – 750 kcmil	OF,SDE1,OF4
3	1	4.5 in	JJ	200A	–	3P	Elevator B	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	2	4.5 in	JJ	200A	–	3P	Elevator A	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	3	4.5 in	JJ	225A	–	3P	Panel M1B	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	4	4.5 in	JJ	225A	–	3P	Panel M2A	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	5	4.5 in	JJ	225A	–	3P	Panel M2B	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	6	7.5 in	LC	600A	–	3P	Motor Control Center	Yes	2	4/0 – 500kcmil	2	4/0 – 500kcmil	
3	7	7.5 in	LC	350A	–	3P	CH – 1	Yes	2	4/0 – 500kcmil	1	#4 – 600 kcmil	
3	8	4.5 in	JJ	225A	–	3P	Panel M1A	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	9	4.5 in	JJ	225A	–	3P	Panel M1C	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	10	4.5 in	JJ	225A	–	3P	DOAS–2	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	11	4.5 in	JJ	225A	–	3P	ATS–LS	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	12	4.5 in	JJ	175A	–	3P	HUMD – 1	Yes	1	1/0 – 4/0 AWG	1	#6 – 350 kcmil	
4	13	4.5 in	HJ	100A	–	3P	Panel LP1B	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	14	4.5 in	HJ	100A	–	3P	Panel LP1D	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	15	4.5 in	HJ	100A	–	3P	Panel MK	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	16	4.5 in	HJ	100A	–	3P	Panel LP2B	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	17	4.5 in	HJ	150A	–	3P	T – KA	Yes	1	#14 – 3/0 AWG	1	#6 – 350 kcmil	
4	18	4.5 in	HJ	150A	–	3P	DOAS – 1	Yes	1	#14 – 3/0 AWG	1	#6 – 350 kcmil	
4	19	4.5 in	HJ	100A	–	3P	Panel LP2A	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	20	4.5 in	HJ	100A	–	3P	ATS – EQ	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	21	4.5 in	HJ	100A	–	3P	Panel LP1C	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	22	4.5 in	HJ	100A	–	3P	Panel LP1G	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	23	4.5 in	HJ	50A	–	3P	EFC – 1	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	24	4.5 in	HJ	70A	–	3P	T – CP1A/CP1D	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	25	4.5 in	HJ	100A	–	3P	SPARE	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	26	4.5 in	HJ	100A	–	3P	Panel M1G	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	27	4.5 in	HJ	100A	–	3P	SPARE	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	28	4.5 in	HJ	100A	–	3P	SPARE	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	29	4.5 in	HJ	100A	–	3P	SPARE	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	30	4.5 in	HJ	100A	–	3P	Panel LP1A	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	31	4.5 in	HJ	60A	–	3P	TVSS	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	32	4.5 in	HJ	50A	–	3P	EFC – 2	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	

The switchboard schedule shown above is used to determine the loads switchboards need to feed for different sets of feeders. All the feeders feed to lighting panels are assumed to be supplied by 480Y/277V system. The calculations of new feeder sizes are demonstrated below. The new proposed sizes exclude the calculation of grounding wire.

Table 7 - Feeder Sizes

SECT NO	CKT NO	GMO HEIGHT	DEVICE/FRAME RATING	TRIP AMP	FUSE/ TRIP	#P	DESIGNATION	Proposed Size Phase Legs	ORIGNINAL Design			
									QTY	PHASE WIRE RANGE	QTY	NEUT. WIRE RANGE
1	UCT	–	3000A	–	–	–	DUQUESNE LIGHT	-	9	–	9	–
2	M1	–	NW 3000A Plug A	3000A	A-LSIG	3P	Main Breaker	2/0	–	3/0 – 750 kcmil	–	3/0 – 750 kcmil
3	1	4.5 in	JJ	200A	–	3P	Elevator B	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	2	4.5 in	JJ	200A	–	3P	Elevator A	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	3	4.5 in	JJ	225A	–	3P	Panel M1B	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	4	4.5 in	JJ	225A	–	3P	Panel M2A	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	5	4.5 in	JJ	225A	–	3P	Panel M2B	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	6	7.5 in	LC	600A	–	3P	Motor Control	2/0	2	4/0 – 500kcmil	2	4/0 - 500kcmil
3	7	7.5 in	LC	350A	–	3P	CH – 1	2/0	2	4/0 – 500kcmil	1	#4 – 600 kcmil
3	8	4.5 in	JJ	225A	–	3P	Panel M1A	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	9	4.5 in	JJ	225A	–	3P	Panel M1C	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	10	4.5 in	JJ	225A	–	3P	DOAS-2	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	11	4.5 in	JJ	225A	–	3P	ATS-LS	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil

New voltage ratings are modified as showed in the previous table. The wire size is much smaller when sized with conservative criteria. The feeder size differences are very significant after the calculation.

8.2 CONCLUSION OF ELECTRICAL BREADTH

Based on the calculations, also given the condition of The HFS Warehouse and Bakery, there will be a benefit if the wires are sized up. The payback periods are relatively short. Thus the upsizing of the wires are recommended.

8.3 RECOMMENDATIONS

Based on the study, cost saving and benefits are reasonable for the improvement of Value Engineering by implementing roof-top wind turbine system. The payback periods are very short assuming the project can obtain funding from the state and industry.

9.0 FINAL RECOMMENDATIONS

ANALYSIS 1: SIPS ANALYSIS

This analysis focuses on reducing the time to renovate the office space in the Housing and Food Services building. The area of investigation would be to see if implementing a SIP schedule to the renovation of the office space would accelerate the schedule and reduce office downtime.

By investigation and applying a SIP Schedule for the interior renovation of the Housing and Food Services office space, the project schedule should be accelerated to alleviate office downtime by about five weeks. A small increase in man power for particular trades was necessary.

ANALYSIS 2: BIM UTILIZATION

The schedule is a main concern for the owner. The project needs to finish on time so regular production and storage can occur. One main issue that has held the project up is that there was no as-built drawing for the original warehouse and bakery. There was a lot of wasted time when the project team and the architect were trying to communicate and collaborate. A large contingency was held in case any problems occurred during construction. Many RFI's and ASI's were submitted and take time to get answers, which can cause major schedule delays. The implementation of BIM will also help the owner with operation and maintenance after the building is turned over.

In conclusion the implementation of BIM has many potential benefits to help with coordination, phasing and facility maintenance. Using BIM can be very useful in limiting the amount of time wasted with RFI's, can help with the phasing and construction activities, and can aid with future maintenance.

ANALYSIS 3: INDOOR AIR QUALITY

Indoor Air Quality (IAQ) is an important design criteria in today's industry. It is especially important in a facility such as The HFS Warehouse and Bakery. Analysis 3 focuses on determining the IAQ of the current system and determining an alternate system through a mechanical breadth. After completing the analysis it was determined that the current system fell somewhat short and a 100% outdoor air system was chosen. It is recommended to use the 100% outdoor air system for The Housing and Food Service Warehouse and Bakery.

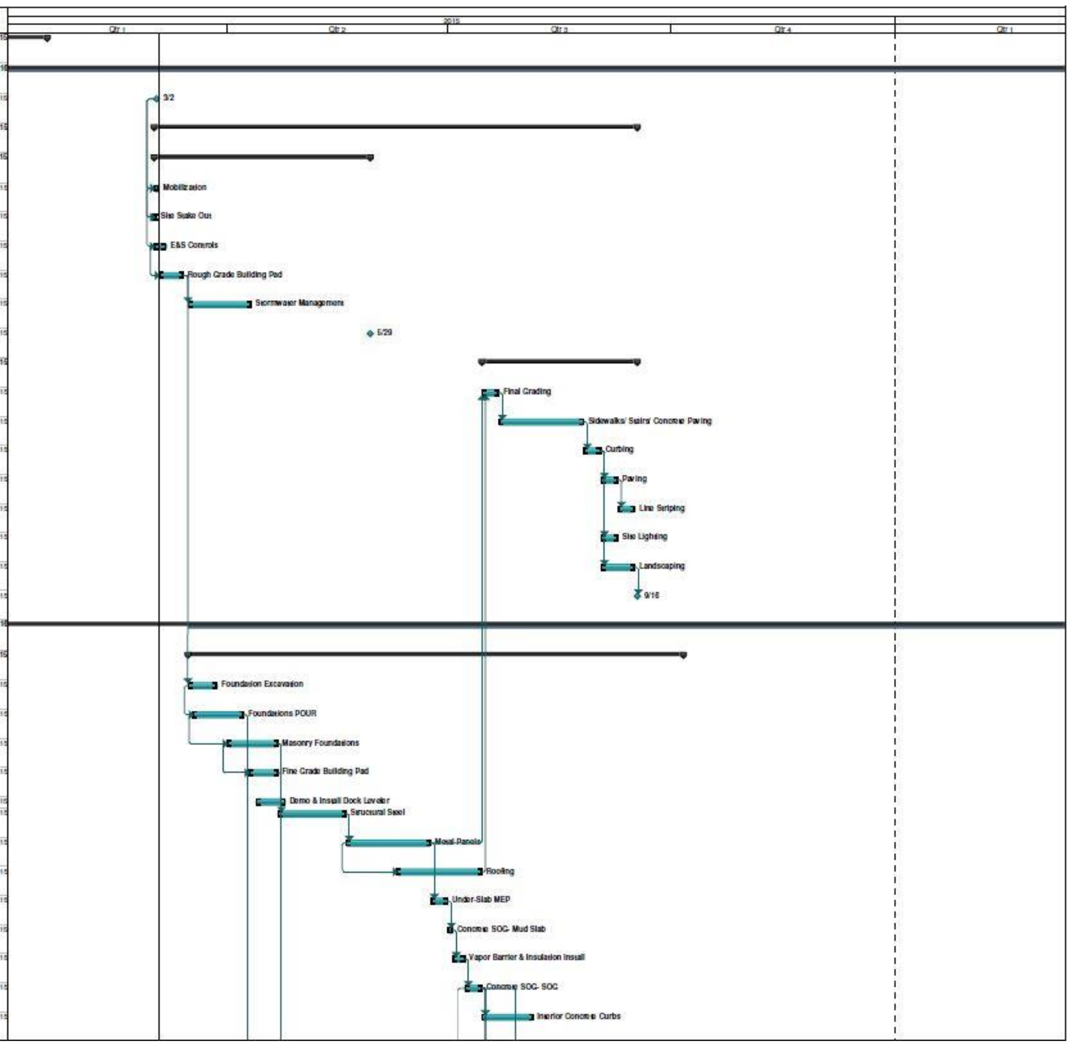
ANALYSIS 4: LEED CERTIFICATION

In conclusion after implementing all of the previous analyses, it would be almost an obvious decision to pursue a LEED Certification. The certification will not only commemorate the sustainability considerations of this project, but also interconnect all of the sustainable opportunities together. With a LEED score of 42 points, there may be some points that the team didn't intend on achieving and some that they may have already planned on acquiring that didn't work out for them. As a backup there are 22 possible points, which may or may not be achievable, but four of them are guaranteed if the owner is willing to pay for the additions.

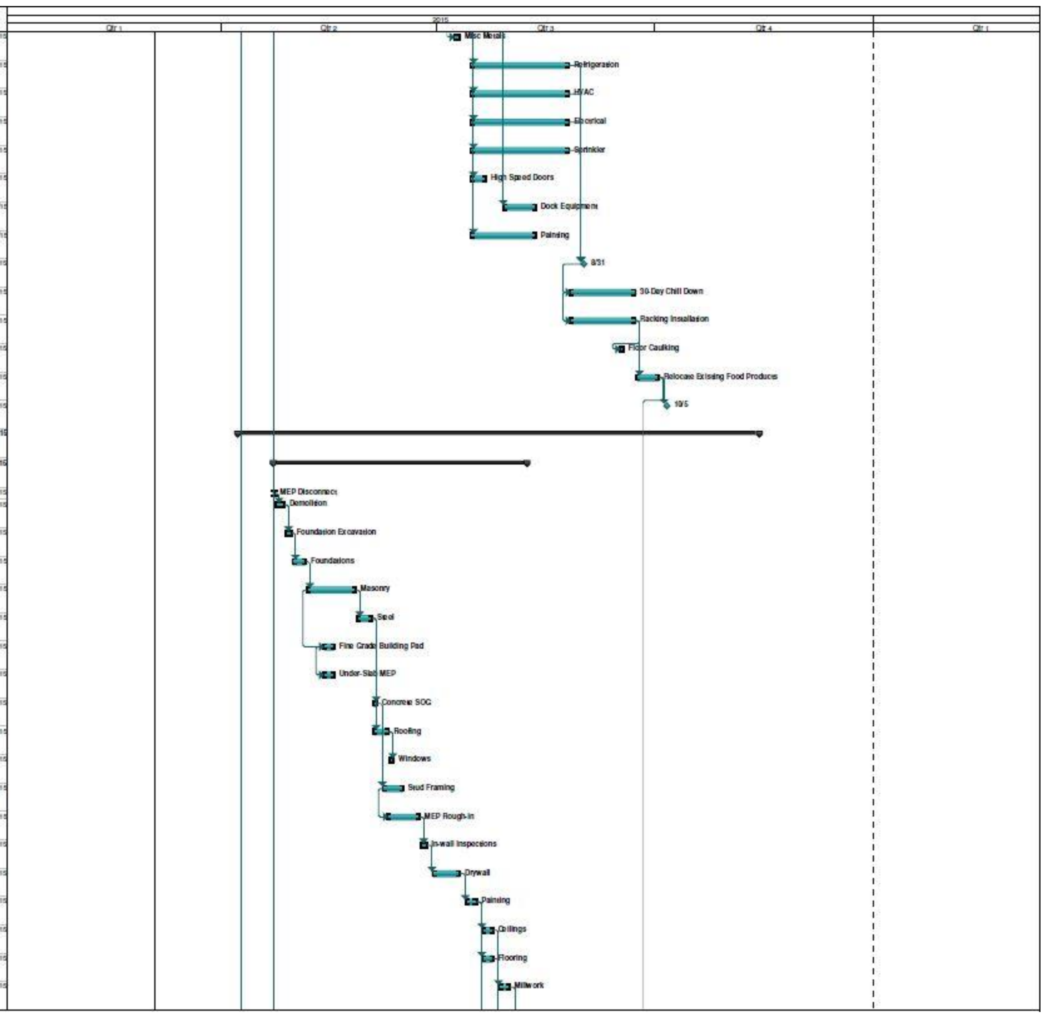
Of course the decision to pursue a LEED Certification is predominately up to the owner. Although, there are clear reasons why this is a beneficial decision to the owner. Sustainable buildings are a great representation of the principles and values the owner wants to portray. Sustainable buildings are not only environmentally friendly but also very cost saving in the long run

APPENDIX A: PROJECT SCHEDULE

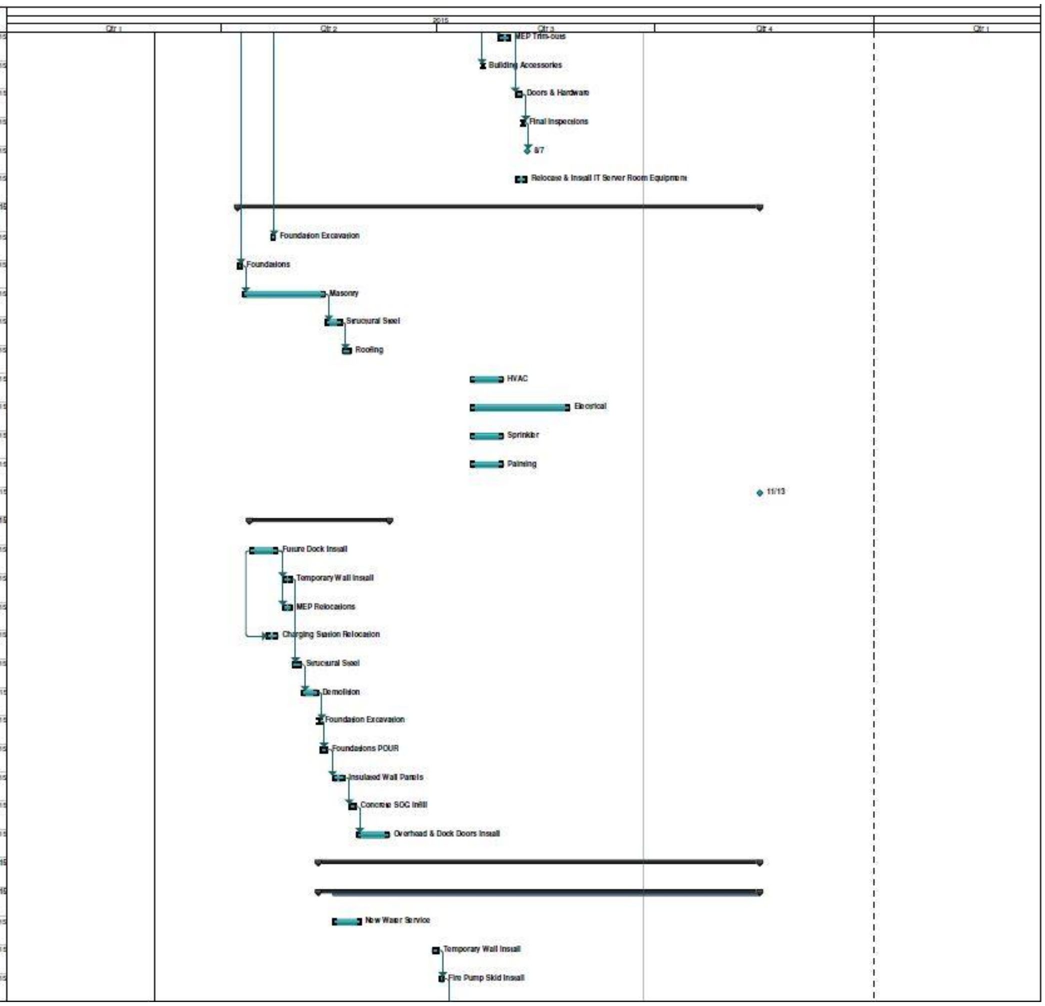
ID	% Complete	Task Name	Duration	Start	Finish
1	51%	**Preconsrucion**	**301 days**	**Fri 11/22/13**	**Fri 1/16/15**
37	0%	**Building Consrucion**	**627 days**	**Thu 10/17/13**	**Fri 3/11/16**
38	0%	Construction Start	1 day	Mon 3/2/15	Mon 3/2/15
39	0%	**Exerior Consrucion**	**143 days**	**Mon 3/2/15**	**Wed 9/16/15**
40	0%	**Phase 1- Sormwaer Managmen**	**65 days**	**Mon 3/2/15**	**Fri 5/29/15**
41	0%	Mobilization	2 days	Mon 3/2/15	Tue 3/3/15
42	0%	Site Stake Out	1 day	Mon 3/2/15	Mon 3/2/15
43	0%	E&S Controls	5 days	Mon 3/2/15	Fri 3/6/15
44	0%	Rough Grade Building Pad	8 days	Wed 3/4/15	Fri 3/13/15
45	0%	Stormwater Management	20 days	Mon 3/16/15	Fri 4/10/15
46	0%	Water Service	10 days	Mon 5/18/15	Fri 5/29/15
47	0%	**Phase 2- Exerior Improvemens**	**46 days**	**Wed 7/15/15**	**Wed 9/16/15**
48	0%	Final Grading	5 days	Wed 7/15/15	Tue 7/21/15
49	0%	Sidewalks/ Stairs/ Concrete Paving	25 days	Wed 7/22/15	Tue 8/25/15
50	0%	Curbing	5 days	Wed 8/26/15	Tue 9/1/15
51	0%	Paving	5 days	Wed 9/2/15	Tue 9/8/15
52	0%	Line Striping	5 days	Wed 9/9/15	Tue 9/15/15
53	0%	Site Lighting	5 days	Wed 9/2/15	Tue 9/8/15
54	0%	Landscaping	10 days	Wed 9/2/15	Tue 9/15/15
55	0%	Exterior Scope Completion	1 day	Wed 9/16/15	Wed 9/16/15
56	0%	**Inerior Consrucion**	**627 days**	**Thu 10/17/13**	**Fri 3/11/16**
57	0%	**Phase 1- Freezer Consrucion**	**146 days**	**Mon 3/16/15**	**Mon 10/5/15**
58	0%	Foundation Excavation	10 days	Mon 3/16/15	Fri 3/27/15
59	0%	Foundations POUR	15 days	Wed 3/18/15	Tue 4/7/15
60	0%	Masonry Foundations	15 days	Wed 4/1/15	Tue 4/21/15
61	0%	Fine Grade Building Pad	8 days	Fri 4/10/15	Tue 4/21/15
62	0%	Demo and install new dock leveler	10 days	Mon 4/13/15	Fri 4/24/15
63	0%	Structural Steel	20 days	Wed 4/22/15	Tue 5/19/15
64	0%	Metal Panels	25 days	Wed 5/20/15	Tue 6/23/15
65	0%	Roofing	25 days	Wed 6/10/15	Tue 7/14/15
66	0%	Under-Slab MEP	5 days	Wed 6/24/15	Tue 6/30/15
67	0%	Concrete SOG- Mud Slab	2 days	Wed 7/1/15	Thu 7/2/15
68	0%	Vapor Barrier & Insulation Install	3 days	Fri 7/3/15	Tue 7/7/15
69	0%	Concrete SOG- SOG	5 days	Wed 7/8/15	Tue 7/14/15
70	0%	Interior Concrete Curbs	15 days	Wed 7/15/15	Tue 8/4/15



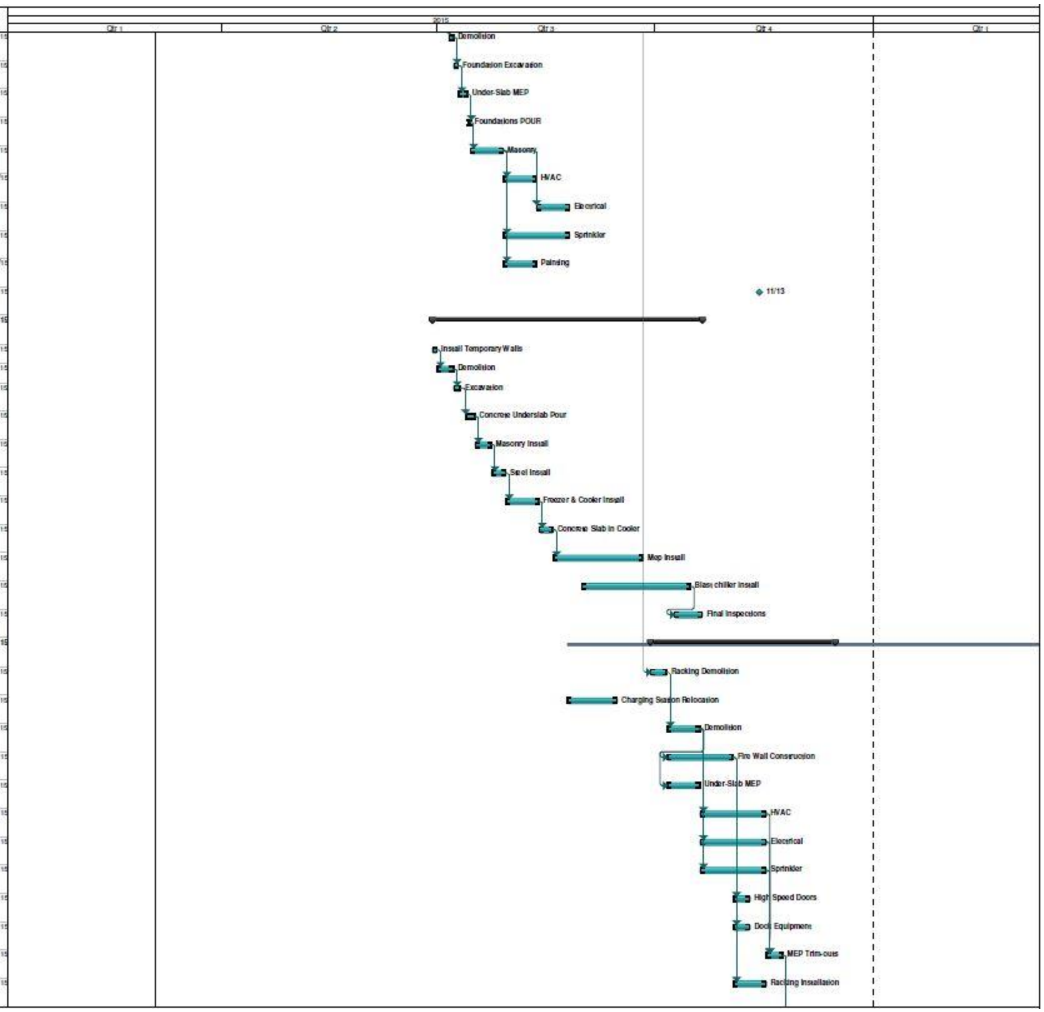
ID	% Complete	Task Name	Duration	Start	Finish
71	0%	Misc Metals	3 days	Wed 7/8/15	Fri 7/10/15
72	0%	Refrigeration	30 days	Wed 7/15/15	Tue 8/25/15
73	0%	HVAC	30 days	Wed 7/15/15	Tue 8/25/15
74	0%	Electrical	30 days	Wed 7/15/15	Tue 8/25/15
75	0%	Sprinkler	30 days	Wed 7/15/15	Tue 8/25/15
76	0%	High Speed Doors	5 days	Wed 7/15/15	Tue 7/21/15
77	0%	Dock Equipment	10 days	Wed 7/29/15	Tue 8/11/15
78	0%	Painting	20 days	Wed 7/15/15	Tue 8/11/15
79	0%	Final Inspections	4 days	Wed 8/26/15	Mon 8/31/15
80	0%	30-Day Chill Down	20 days	Wed 8/26/15	Tue 9/22/15
81	0%	Racking Installation	20 days	Wed 8/26/15	Tue 9/22/15
82	0%	Floor Caulking	2 days	Wed 9/16/15	Thu 9/17/15
83	0%	Relocate Existing Food Products	8 days	Wed 9/23/15	Fri 10/2/15
84	0%	Freezer Complete & Stocked	1 day	Mon 10/5/15	Mon 10/5/15
85	0%	**Phase 1A- Office & Rear Improvements**	**158 days**	**Wed 4/8/15**	**Fri 11/13/15**
86	0%	**OFFICE**	**77 days**	**Thu 4/23/15**	**Fri 8/7/15**
87	0%	MEP Disconnect and Drop	1 day	Thu 4/23/15	Thu 4/23/15
88	0%	Demolition	2 days	Fri 4/24/15	Mon 4/27/15
89	0%	Foundation Excavation	3 days	Tue 4/28/15	Thu 4/30/15
90	0%	Foundations	4 days	Fri 5/1/15	Wed 5/6/15
91	0%	Masonry	15 days	Thu 5/7/15	Wed 5/27/15
92	0%	Steel	5 days	Thu 5/28/15	Wed 6/3/15
93	0%	Fine Grade Building Pad	3 days	Thu 5/14/15	Mon 5/18/15
94	0%	Under-Slab MEP	3 days	Thu 5/14/15	Mon 5/18/15
95	0%	Concrete SOG	2 days	Thu 6/4/15	Fri 6/5/15
96	0%	Roofing	5 days	Thu 6/4/15	Wed 6/10/15
97	0%	Windows	2 days	Thu 6/11/15	Fri 6/12/15
98	0%	Stud Framing	7 days	Mon 6/8/15	Tue 6/16/15
99	0%	MEP Rough-In	10 days	Wed 6/10/15	Tue 6/23/15
100	0%	In-wall Inspections	3 days	Wed 6/24/15	Fri 6/26/15
101	0%	Drywall	10 days	Mon 6/29/15	Fri 7/10/15
102	0%	Painting	5 days	Mon 7/13/15	Fri 7/17/15
103	0%	Ceilings	5 days	Mon 7/20/15	Fri 7/24/15
104	0%	Flooring	5 days	Mon 7/20/15	Fri 7/24/15
105	0%	Millwork	5 days	Mon 7/27/15	Fri 7/31/15



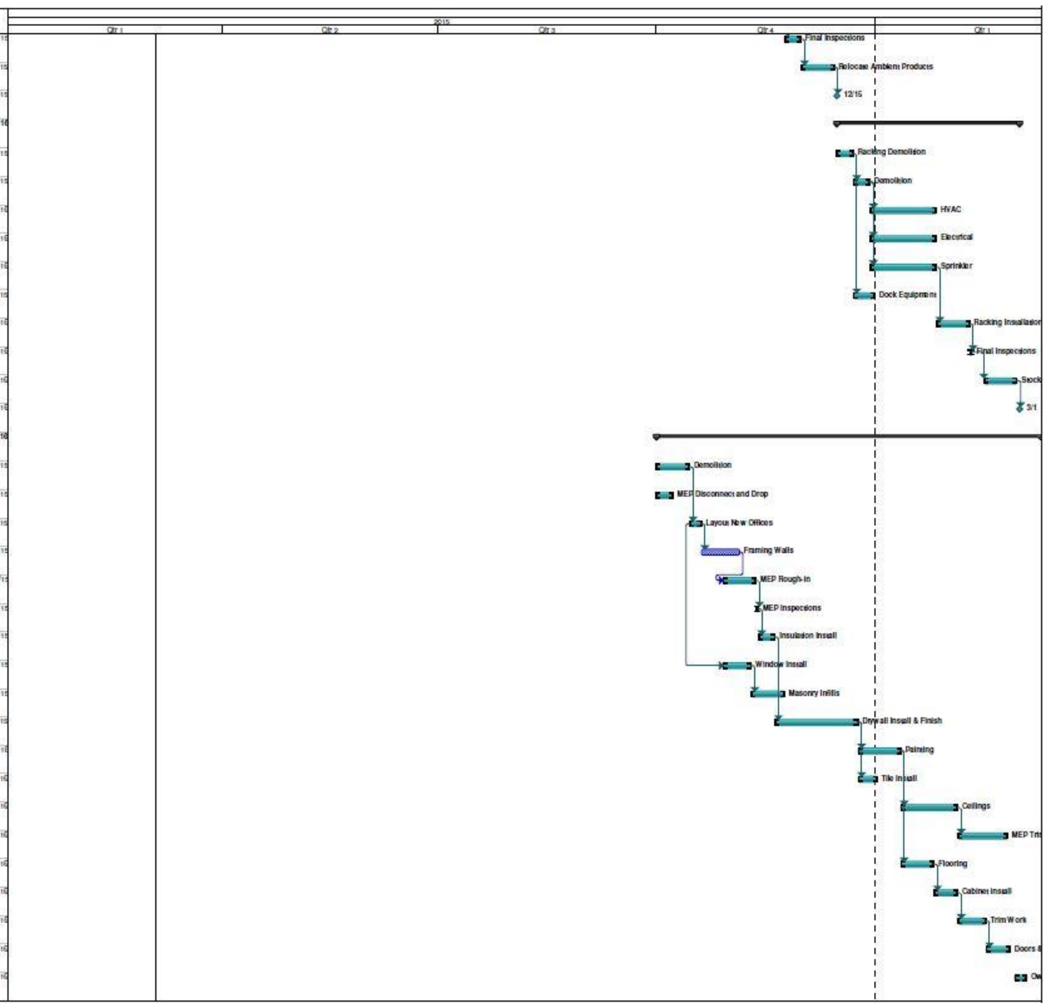
ID	% Comple	Task Name	Duration	Start	Finish
106	0%	MEP Trim-outs	5 days	Mon 7/27/15	Fri 7/31/15
107	0%	Building Accessories	1 day	Mon 7/20/15	Mon 7/20/15
108	0%	Doors & Hardware	3 days	Mon 8/3/15	Wed 8/5/15
109	0%	Final Inspections	1 day	Thu 8/6/15	Thu 8/6/15
110	0%	Office Area Occupancy	1 day	Fri 8/7/15	Fri 8/7/15
111	0%	Relocate & Install IT Server Room Equipment	5 days	Mon 8/3/15	Fri 8/7/15
112	0%	**ELECTRICAL & MAINTENANCE**	**158 days**	**Wed 4/8/15**	**Fri 11/13/15**
113	0%	Foundation Excavation	2 days	Wed 4/22/15	Thu 4/23/15
114	0%	Foundations	2 days	Wed 4/8/15	Thu 4/9/15
115	0%	Masonry	25 days	Fri 4/10/15	Thu 5/14/15
116	0%	Structural Steel	5 days	Fri 5/15/15	Thu 5/21/15
117	0%	Roofing	2 days	Fri 5/22/15	Mon 5/25/15
118	0%	HVAC	10 days	Wed 7/15/15	Tue 7/28/15
119	0%	Electrical	30 days	Wed 7/15/15	Tue 8/25/15
120	0%	Sprinkler	10 days	Wed 7/15/15	Tue 7/28/15
121	0%	Painting	10 days	Wed 7/15/15	Tue 7/28/15
122	0%	Final Inspections	58 days	Wed 8/26/15	Fri 11/13/15
123	0%	**COOLER DOCK**	**43 days**	**Mon 4/13/15**	**Wed 6/10/15**
124	0%	Future Dock Install	10 days	Mon 4/13/15	Fri 4/24/15
125	0%	Temporary Wall Install	4 days	Mon 4/27/15	Thu 4/30/15
126	0%	MEP Relocations	4 days	Mon 4/27/15	Thu 4/30/15
127	0%	Charging Station Relocation	5 days	Mon 4/20/15	Fri 4/24/15
128	0%	Structural Steel	2 days	Fri 5/1/15	Mon 5/4/15
129	0%	Demolition	5 days	Tue 5/5/15	Mon 5/11/15
130	0%	Foundation Excavation	1 day	Tue 5/12/15	Tue 5/12/15
131	0%	Foundations POUR	3 days	Wed 5/13/15	Fri 5/15/15
132	0%	Insulated Wall Panels	5 days	Mon 5/18/15	Fri 5/22/15
133	0%	Concrete SOG Infill	3 days	Mon 5/25/15	Wed 5/27/15
134	0%	Overhead & Dock Doors Install	10 days	Thu 5/28/15	Wed 6/10/15
135	0%	**Phase 1B- Fire Pump Room & Bakery Area**	**134 days**	**Tue 5/12/15**	**Fri 11/13/15**
136	0%	**Fire Pump Room Construction**	**134 days**	**Tue 5/12/15**	**Fri 11/13/15**
137	0%	New Water Service	10 days	Mon 5/18/15	Fri 5/29/15
138	0%	Temporary Wall Install	3 days	Mon 6/29/15	Wed 7/1/15
139	0%	Fire Pump Skid Install	2 days	Thu 7/2/15	Fri 7/3/15



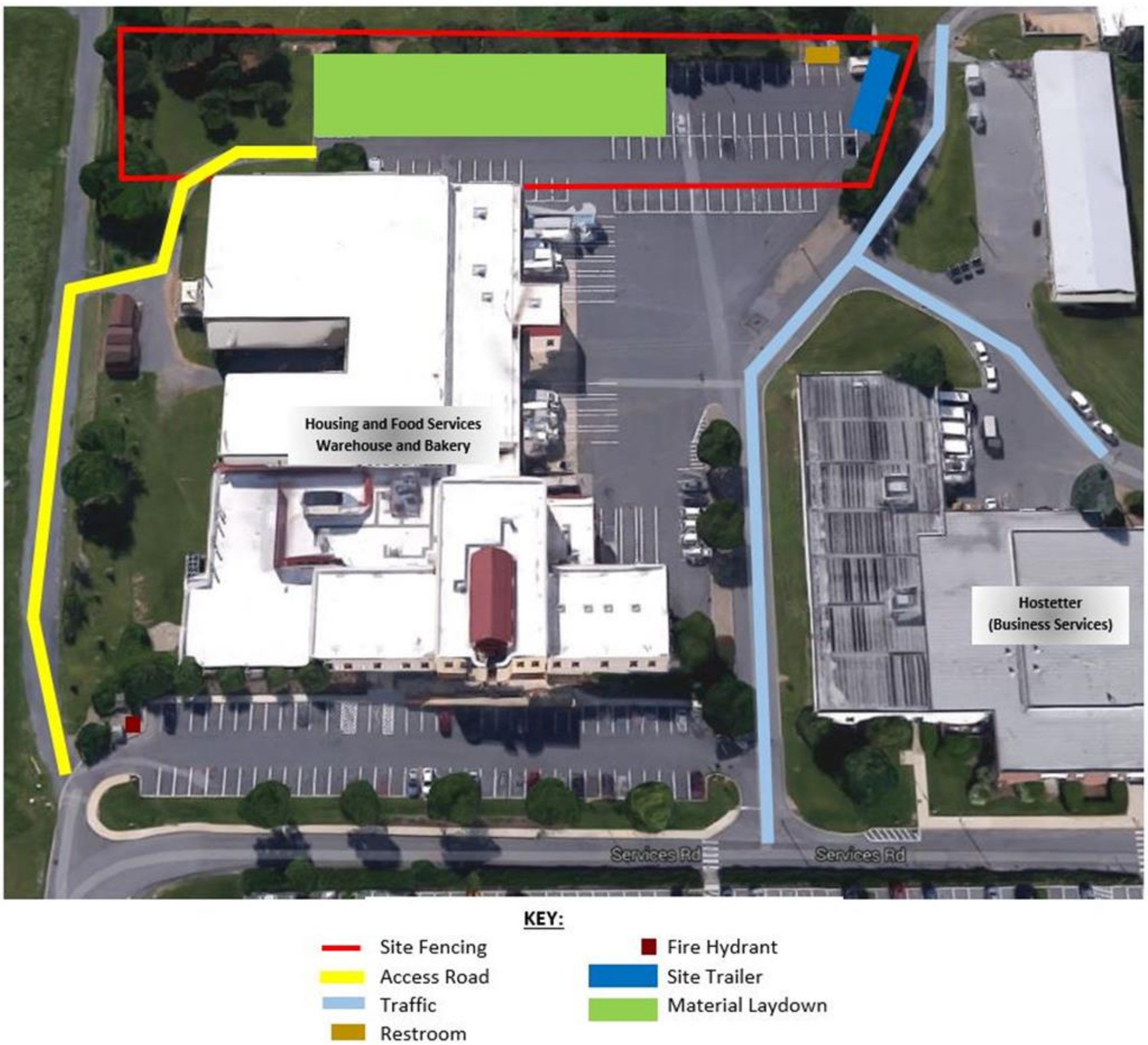
ID	% Complete	Task Name	Duration	Start	Finish
140	0%	Demolition	2 days	Mon 7/6/15	Tue 7/7/15
141	0%	Foundation Excavation	2 days	Wed 7/8/15	Thu 7/9/15
142	0%	Under Slab MEP	2 days	Fri 7/10/15	Mon 7/13/15
143	0%	Foundations POUR	1 day	Tue 7/14/15	Tue 7/14/15
144	0%	Masonry	10 days	Wed 7/15/15	Tue 7/28/15
145	0%	HVAC	10 days	Wed 7/29/15	Tue 8/11/15
146	0%	Electrical	10 days	Wed 8/12/15	Tue 8/25/15
147	0%	Sprinkler	20 days	Wed 7/29/15	Tue 8/25/15
148	0%	Painting	10 days	Wed 7/29/15	Tue 8/11/15
149	0%	Final Inspections	20 days	Mon 10/19/15	Fri 11/13/15
150	0%	**Freezer Cooler Bakery**	**82 days**	**Mon 6/29/15**	**Tue 10/20/15**
151	0%	Temporary Walls	2 days	Mon 6/29/15	Tue 6/30/15
152	0%	Demolition	5 days	Wed 7/1/15	Tue 7/7/15
153	0%	Excavation	3 days	Wed 7/8/15	Fri 7/10/15
154	0%	Concrete Underslab Pour	4 days	Mon 7/13/15	Thu 7/16/15
155	0%	Masonry Install	5 days	Fri 7/17/15	Thu 7/23/15
156	0%	Steel Install	4 days	Fri 7/24/15	Wed 7/29/15
157	0%	Freezer & Cooler Install	10 days	Thu 7/30/15	Wed 8/12/15
158	0%	Concrete Slab in Cooler	4 days	Thu 8/13/15	Tue 8/18/15
159	0%	Mep Install	28 days	Wed 8/19/15	Fri 9/25/15
160	0%	Blast chiller install	34 days	Mon 8/31/15	Thu 10/15/15
161	0%	Final Inspections	8 days	Fri 10/9/15	Tue 10/20/15
162	0%	**Phase 2- Renovate Existing Freezer & Cooler**	**58 days**	**Tue 9/29/15**	**Tue 12/15/15**
163	0%	Racking Demolition	5 days	Tue 9/29/15	Mon 10/5/15
164	0%	Charging Station Relocation	15 days	Tue 8/25/15	Mon 9/14/15
165	0%	Demolition	10 days	Tue 10/6/15	Mon 10/19/15
166	0%	Fire Wall Construction	20 days	Tue 10/6/15	Mon 11/2/15
167	0%	Under-Slab MEP	10 days	Tue 10/6/15	Mon 10/19/15
168	0%	HVAC	20 days	Tue 10/20/15	Mon 11/16/15
169	0%	Electrical	20 days	Tue 10/20/15	Mon 11/16/15
170	0%	Sprinkler	20 days	Tue 10/20/15	Mon 11/16/15
171	0%	High Speed Doors	5 days	Tue 11/3/15	Mon 11/9/15
172	0%	Dock Equipment	5 days	Tue 11/3/15	Mon 11/9/15
173	0%	MEP Trim-outs	5 days	Tue 11/17/15	Mon 11/23/15
174	0%	Racking Installation	10 days	Tue 11/3/15	Mon 11/16/15



ID	% Comple	Task Name	Duration	Start	Finish
175	0%	Final Inspections	5 days	Tue 11/24/15	Mon 11/30/15
176	0%	Relocate Ambient Products	10 days	Tue 12/1/15	Mon 12/14/15
177	0%	Ambient Phase 2 Complete & Stocked	1 day	Tue 12/15/15	Tue 12/15/15
178	0%	**Phase 3- Renovate Exising Ambient**	**55 days**	**Wed 12/16/15**	**Tue 3/1/16**
179	0%	Racking Demolition	5 days	Wed 12/16/15	Tue 12/22/15
180	0%	Demolition	5 days	Wed 12/23/15	Tue 12/29/15
181	0%	HVAC	20 days	Wed 12/30/15	Tue 1/26/16
182	0%	Electrical	20 days	Wed 12/30/15	Tue 1/26/16
183	0%	Sprinkler	20 days	Wed 12/30/15	Tue 1/26/16
184	0%	Dock Equipment	7 days	Wed 12/23/15	Thu 12/31/15
185	0%	Racking Installation	10 days	Wed 1/27/16	Tue 2/9/16
186	0%	Final Inspections	1 day	Wed 2/10/16	Wed 2/10/16
187	0%	Stock New Ambient Product	10 days	Tue 2/16/16	Mon 2/29/16
188	0%	Ambient Phase 3 Complete & Stocked	1 day	Tue 3/1/16	Tue 3/1/16
189	0%	**Phase 3a- New Office & Consult Room**	**116 days?**	**Thu 10/1/15**	**Thu 3/10/16**
190	0%	Demolition	10 days	Thu 10/1/15	Wed 10/14/15
191	0%	MEP Disconnect and Drop	5 days	Thu 10/1/15	Wed 10/7/15
192	0%	Layout New Offices	3 days	Thu 10/15/15	Mon 10/19/15
193	0%	Framing Walls	12 days	Tue 10/20/15	Wed 11/4/15
194	0%	MEP Rough-In	10 days	Thu 10/29/15	Wed 11/11/15
195	0%	MEP Inspections	1 day?	Thu 11/12/15	Thu 11/12/15
196	0%	Insulation Install	5 days	Fri 11/13/15	Thu 11/19/15
197	0%	Window Install	8 days	Thu 10/29/15	Mon 11/9/15
198	0%	Masonry Infills	10 days	Tue 11/10/15	Mon 11/23/15
199	0%	Drywall Install & Finish	25 days	Fri 11/20/15	Thu 12/24/15
200	0%	Painting	12 days	Fri 12/25/15	Mon 1/11/16
201	0%	Tile Install	6 days	Fri 12/25/15	Fri 1/1/16
202	0%	Ceilings	18 days	Tue 1/12/16	Thu 2/4/16
203	0%	MEP Trim-outs	15 days	Fri 2/5/16	Thu 2/25/16
204	0%	Flooring	10 days	Tue 1/12/16	Mon 1/25/16
205	0%	Cabinet Install	8 days	Tue 1/26/16	Thu 2/4/16
206	0%	Trim Work	8 days	Fri 2/5/16	Tue 2/16/16
207	0%	Doors & Hardware	8 days	Wed 2/17/16	Fri 2/26/16
208	0%	Owner Furture Move In	5 days	Mon 2/29/16	Fri 3/4/16



APPENDIX B: EXISTING SITE CONDITIONS



APPENDIX C: GENERAL CONDITIONS ESTIMATE

Code	Work Description	Cost per Unit	Quantity	UOM	Total Estimate
Supervision/Proect Management					
01.21.00	Project Manager Labor	$2,415.00	32	Wk	$76,656.00
01.21.00	1-Project Laborer	$993.00	63	Wk	$63,038.00
01.21.00	1-Project Laborer	$993.00	32	Wk	$31,519.00
01.21.00	Superintendent Labor	$1,250.00	63	Wk	$79,354.00
01.21.00	Asst. Superintendent Labor	$880.00	63	Wk	$55,865.00
01.21.00	Administration Clerical Labor	$425.00	63	Wk	$26,980.00
	Subtotal				**$333,412.00**
Field Engineering					
01.32.23	Survey	$850.00	2	EA	$1,700.00
01.43.39	Mockups	$800.00	1	LS	$800.00
01.45.23	Testing & Allowances (Soils)	$1,200.00	16	LS	$20,069.00
01.45.29	Concrete Testing	$402.00	6	LS	$2,261.00
	Subtotal				**$24,830.00**
Administrative					
01.32.33	Photographic Documentation	$25.00	12	MO	$300.00
01.51.13	Trailer Electric Service Install	$965.00	1	LS	$965.00
01.51.13	Trailer Electric Monthly Cost	$550.00	12	MO	$6,600.00
01.51.13	Temp. Power Installaton	$200.00	2	LS	$400.00
01.51.13	Temp. Power Usage	$300.00	12	MO	$3,600.00
01.51.23	Temp. Heat - Equipment	$120.00	2	Bldg.	$240.00
01.51.29	Temp. Heat Fuel	$3,575.00	2	Bldg.	$7,150.00
01.51.33	Trailer Telephone Monthly Costs	$400.00	12	MO	$4,800.00
01.51.36	Drinking Water & Cups	$50.00	12	MO	$600.00
01.51.36	Temp. Water Installation	$600.00	1	LS	$600.00
01.51.36	Temp. Water Usage	$30.00	12	MO	$360.00
01.52.13	Site Trailer Set-up & Tear-down	$780.00	1	LS	$780.00
01.52.13	Trailer Field Office Rental	$500.00	12	MO	$6,000.00
01.52.13	Storage Containers/Trailers	$250.00	12	MO	$3,000.00
01.52.19	Temp. Toilets (cost per based upon 5 toilets)	$500.00	12	MO	$6,000.00
01.54.19	Rental Equipment	$3,600.00	6	EA	$21,600.00
01.56.26	Temp. Fencing (6mo-1yr rental with RR)	$4.50	1600	LF	$7,200.00
01.58.13	Temp. Project Signage	$1,000.00	1	LS	$1,000.00
	Subtotal				**$71,195.00**
Safety					
01.51.16	Fire Protection (fire extinguisers)	$65.00	10	EA	$650.00
01.52.16	First Aid/Safety Supplies	$150.00	2	LS	$300.00
	Subtotal				**$950.00**
Cleanup					
01.74.13	Final Clean Building	$0.35	94000	SF	$32,900.00
01.74.19	Dumpsters	$600.00	94000	SF	$56,400.00
	Subtotal				**$89,300.00**
Miscellaeous					
01.78.53	Drawing Reprodction	$0.07	94000	SF	$6,580.00
	Subtotal				**$6,580.00**
	General Requirements Total				**$526,267.00**

APPENDIX D: SIPS MATRIX

	April																				May																				June											
	W1					W2					W3					W4					W5					W6					W7					W8					W9					W10					W11	
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2
Block	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15																								
1		1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15																							
2			1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15																						
3				1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15																					
4					1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15																				
5						1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15																			
6							1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15																		
7								1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15																	
8									1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15																
9										1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15															
10											1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15														
11												1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15													
12													1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15												
13														1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15											
14															1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15										
15																1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15									
16																	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15								
17																		1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15							
18																			1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15						
19																				1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15					
20																					1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15				
21																						1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15			
22																							1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15		
23																								1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15	
24																									1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	15	15

Office Renovation Activities	
ID	Activity
1	Hang Drywall
2	Spackle/Finish Drywall
3	Prep, Prime and Paint Walls
4	Prep, Prime and Paint Ceilings
5	Install Casework
6	Install Lighting Fixtures
7	Install Countertops
8	Install Hard Wood Flooring
9	Install Plumbing Fixtures
10	Final Paint
11	Install Door Hardware
12	Final Finish Carpentry
13	Install Carpet
14	Final Electric
15	Cleanup

APPENDIX E: DUCT WORK TABLES

Comments	Sheet Metal Gauge	Sheet Thickness *(inches)*
Welded Ductwork	0	0.312
	1	0.2810
	2	0.2650
	3	0.2500
	4	0.2340
	5	0.2187
	6	0.2030
	7	0.1875
	8	0.1720
	9	0.1560
	10	0.1400
	11	0.1250
	12	0.1090
	13	0.0937
	14	0.0780
	15	0.0700
SMACNA[1)] Ductwork	16	0.0625
	17	0.0560
	18	0.0500
	19	0.0437
	20	0.0375
	21	0.0343
	22	0.0312
	23	0.0280
	24	0.0250
	25	0.0218
	26	0.0187
Not Suited for Ductwork	27	0.0170
	28	0.0156
	29	0.0140
	30	0.0125
	31	0.0109
	32	0.0100
	33	0.0093
	34	0.0085
	35	0.0078
	36	0.0070

Gauge	US Standard Gauge	Sheet Steel		Galvanized Steel		Stainless Steel		Aluminum		Strip & Tubing
	(inches)	Gauge Decimal (inches)	Weight (lb/ft^2)	Gauge Decimal (inches)	Weight (lb/ft^2)	Gauge Decimal (inches)	Weight (lb/ft^2)	Gauge Decimal (inches)	Weight (lb/ft^2)	Gauge Decimal (inches)
44	0.0047									
43	0.0049									
42	0.0051									
41	0.0053									
40	0.0055									
39	0.0059									
38	0.0063	0.0060				0.0062		0.0040		
37	0.0066	0.0064				0.0066		0.0045		
36	0.0070	0.0067				0.0070		0.0050		0.004
35	0.0078	0.0075				0.0078		0.0056		0.005
34	0.0086	0.0082				0.0086		0.0063		0.007
33	0.0094	0.0090				0.0094		0.0071		0.008
32	0.0102	0.0097				0.0102		0.0080		0.009
31	0.0109	0.0105				0.0109		0.0089		0.010
30	0.0125	0.0120	0.500	0.016	0.656	0.0125		0.0100	0.141	0.012
29	0.0141	0.0135	0.563	0.017	0.719	0.0141		0.0113	0.160	0.013
28	0.0156	0.0149	0.625	0.019	0.781	0.0156		0.0126	0.178	0.014
27	0.0172	0.0164	0.688	0.020	0.844	0.0172		0.0142	0.200	0.016
26	0.0188	0.0179	0.750	0.022	0.906	0.0187	0.756	0.0159	0.224	0.018
25	0.0219	0.0209	0.875	0.025	1.031	0.0219		0.0179	0.253	0.020
24	0.0250	0.0239	1.000	0.028	1.156	0.0250	1.008	0.0201	0.284	0.022
23	0.0281	0.0269	1.125	0.031	1.281	0.0281		0.0226	0.319	0.025
22	0.0313	0.0299	1.250	0.034	1.406	0.0312	1.26	0.0253	0.357	0.028
21	0.0344	0.0329	1.375	0.037	1.531	0.0344		0.0285	0.402	0.032
20	0.0375	0.0359	1.500	0.040	1.656	0.0375	1.512	0.0320	0.452	0.035
19	0.0438	0.0418	1.750	0.046	1.906	0.0437		0.0359	0.507	0.042
18	0.0500	0.0478	2.000	0.052	2.156	0.0500	2.016	0.0403	0.569	0.049
17	0.0563	0.0538	2.250	0.058	2.406	0.0562		0.0453	0.639	0.058
16	0.0625	0.0598	2.500	0.064	2.656	0.0625	2.52	0.0508	0.717	0.065
15	0.0703	0.0673	2.813	0.071	2.969	0.0703		0.0571	0.806	0.072
14	0.0781	0.0747	3.125	0.079	3.281	0.0781	3.15	0.0641	0.905	0.083
13	0.0938	0.0897	3.750	0.093	3.906	0.0937		0.0720	1.016	0.095
12	0.1094	0.1046	4.375	0.108	4.531	0.1094	4.41	0.0808	1.140	0.109
11	0.1250	0.1196	5.000	0.123	5.156	0.1250	5.04	0.0907	1.280	0.120
10	0.1406	0.1345	5.625	0.138	5.781	0.1406	5.67	0.1019	1.438	0.134
9	0.1563	0.1495	6.250	0.153	6.406	0.1562		0.1144	1.614	0.148
8	0.1719	0.1644	6.875	0.168	7.031	0.1719	6.93	0.1285	1.813	0.165
7	0.1875	0.1793	7.500			0.1875	7.871	0.1443	2.036	0.180
6	0.2031	0.1943	8.125			0.2031		0.1620	2.286	0.203
5	0.2188	0.2092	8.750			0.2187		0.1819		0.220
4	0.2344	0.2242	9.375			0.2344		0.2043		0.238
3	0.2500	0.2391	10.00			0.2500		0.2294		0.259
2	0.2656					0.2656		0.2576		0.284
1	0.2813					0.2812		0.2893		0.300
1/0 (0)	0.3125					0.3125		0.3249		0.340
2/0 (00)	0.3438					0.3437		0.3648		0.380
3/0 (000)	0.3750					0.3750		0.4096		0.425
4/0 (0000)	0.4063					0.4062		0.4600		0.454
5/0 (00000)	0.4375					0.4375		0.5165		0.500
6/0 (000000)	0.4688					0.4687		0.5800		
7/0 (0000000)	0.5000									

APPENDIX F: LEED SCORE CARD

LEED v4 for BD+C: Warehouses and Distribution Centers
Project Checklist

Project Name: Housing and Food Service Warehouse and Bakery
Date: 4/4

Y	?	N			
1			Credit	Integrative Process	1

10	1	5	**Location and Transportation**		16
			Credit	LEED for Neighborhood Development Location	16
1			Credit	Sensitive Land Protection	1
1	1		Credit	High Priority Site	2
2		3	Credit	Surrounding Density and Diverse Uses	5
5			Credit	Access to Quality Transit	5
1			Credit	Bicycle Facilities	1
		1	Credit	Reduced Parking Footprint	1
		1	Credit	Green Vehicles	1

3	2	5	**Sustainable Sites**		10
Y			Prereq	Construction Activity Pollution Prevention	Required
1			Credit	Site Assessment	1
		2	Credit	Site Development - Protect or Restore Habitat	2
1			Credit	Open Space	1
1	2		Credit	Rainwater Management	3
		2	Credit	Heat Island Reduction	2
		1	Credit	Light Pollution Reduction	1

5	2	4	**Water Efficiency**		11
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
		2	Credit	Outdoor Water Use Reduction	2
4		2	Credit	Indoor Water Use Reduction	6
	2		Credit	Cooling Tower Water Use	2
1			Credit	Water Metering	1

9	12	#	**Energy and Atmosphere**		33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
	6		Credit	Enhanced Commissioning	6
8		10	Credit	Optimize Energy Performance	18
	1		Credit	Advanced Energy Metering	1
		2	Credit	Demand Response	2
	3		Credit	Renewable Energy Production	3
1			Credit	Enhanced Refrigerant Management	1
	2		Credit	Green Power and Carbon Offsets	2

2	2	6	**Materials and Resources**		13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
	2		Credit	Building Life-Cycle Impact Reduction	5
		2	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
		2	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
		2	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit	Construction and Demolition Waste Management	2

9	1	6	**Indoor Environmental Quality**		16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
2			Credit	Enhanced Indoor Air Quality Strategies	2
3			Credit	Low-Emitting Materials	3
1			Credit	Construction Indoor Air Quality Management Plan	1
2			Credit	Indoor Air Quality Assessment	2
		1	Credit	Thermal Comfort	1
1	1		Credit	Interior Lighting	2
		3	Credit	Daylight	3
		1	Credit	Quality Views	1
		1	Credit	Acoustic Performance	1

1	2	3	**Innovation**		6
	2	3	Credit	Innovation	5
1			Credit	LEED Accredited Professional	1

2	0	2	**Regional Priority**		4
1			Credit	Regional Priority: Specific Credit	1
1			Credit	Regional Priority: Specific Credit	1
		1	Credit	Regional Priority: Specific Credit	1
		1	Credit	Regional Priority: Specific Credit	1

42	22	43	**TOTALS**	Possible Points:	110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

APPENDIX G: EXISTING ELECTRICAL SYSTEM

POWER STYLE QED–2 SWITCHBOARD

SECT NO	CKT NO	GMD HEIGHT	DEVICE/FRAME RATING	TRIP AMP	FUSE/TRIP	#P	DESIGNATION	N/P	LUG INFORMATION				ACCESSORIES
									QTY	PHASE WIRE RANGE	QTY	NEUT. WIRE RANGE	
1	UCT	–	3000A	–	–	–	DUQUESNE LIGHT	No	9	–	9	–	
2	M1	–	NW 3000A Plug A	3000A	A–LSIG	3P	Main Breaker	Yes	–	3/0 – 750 kcmil	–	3/0 – 750 kcmil	GF,SDE1,OF4
3	1	4.5 in	JJ	200A	–	3P	Elevator B	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	2	4.5 in	JJ	200A	–	3P	Elevator A	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	3	4.5 in	JJ	225A	–	3P	Panel M1B	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	4	4.5 in	JJ	225A	–	3P	Panel M2A	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	5	4.5 in	JJ	225A	–	3P	Panel M2B	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	6	7.5 in	LC	600A	–	3P	Motor Control Center	Yes	2	4/0 – 500kcmil	2	4/0 – 500kcmil	
3	7	7.5 in	LC	350A	–	3P	CH – 1	Yes	2	4/0 – 500kcmil	1	#4 – 600 kcmil	
3	8	4.5 in	JJ	225A	–	3P	Panel M1A	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	9	4.5 in	JJ	225A	–	3P	Panel M1C	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	10	4.5 in	JJ	225A	–	3P	DOAS–2	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	11	4.5 in	JJ	225A	–	3P	ATS–LS	Yes	1	3/0 – 350 kcmil	1	#6 – 350 kcmil	
3	12	4.5 in	JJ	175A	–	3P	HUMID – 1	Yes	1	1/0 – 4/0 AWG	1	#6 – 350 kcmil	
4	13	4.5 in	HJ	100A	–	3P	Panel LP1B	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	14	4.5 in	HJ	100A	–	3P	Panel LP1D	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	15	4.5 in	HJ	100A	–	3P	Panel MK	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	16	4.5 in	HJ	100A	–	3P	Panel LP2B	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	17	4.5 in	HJ	150A	–	3P	T – KA	Yes	1	#14 – 3/0 AWG	1	#6 – 350 kcmil	
4	18	4.5 in	HJ	150A	–	3P	DOAS – 1	Yes	1	#14 – 3/0 AWG	1	#6 – 350 kcmil	
4	19	4.5 in	HJ	100A	–	3P	Panel LP2A	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	20	4.5 in	HJ	100A	–	3P	ATS – EQ	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	21	4.5 in	HJ	100A	–	3P	Panel LP1C	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	22	4.5 in	HJ	100A	–	3P	Panel LP1G	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	23	4.5 in	HJ	50A	–	3P	EFC – 1	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	24	4.5 in	HJ	70A	–	3P	T – CP1A/CP1D	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	25	4.5 in	HJ	100A	–	3P	SPARE	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	26	4.5 in	HJ	100A	–	3P	Panel M1G	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	27	4.5 in	HJ	100A	–	3P	SPARE	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	28	4.5 in	HJ	100A	–	3P	SPARE	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	29	4.5 in	HJ	100A	–	3P	SPARE	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	30	4.5 in	HJ	100A	–	3P	Panel LP1A	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	31	4.5 in	HJ	60A	–	3P	TVSS	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	
4	32	4.5 in	HJ	50A	–	3P	EFC – 2	Yes	1	#14 – 3/0 AWG	1	#14 – 1/0 AWG	

SECT NO	CKT NO	GMO HEIGHT	DEVICE/FRAME RATING	TRIP AMP	FUSE/ TRIP	#P	DESIGNATION	Proposed Size Phase Legs	ORIGNINAL Design			
									QTY	PHASE WIRE RANGE	QTY	NEUT. WIRE RANGE
1	UCT	–	3000A	–	–	–	DUQUESNE LIGHT	-	9	–	9	–
2	M1	–	NW 3000A Plug A	3000A	A-LSIG	3P	Main Breaker	2/0	–	3/0 – 750 kcmil	–	3/0 – 750 kcmil
3	1	4.5 in	JJ	200A	–	3P	Elevator B	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	2	4.5 in	JJ	200A	–	3P	Elevator A	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	3	4.5 in	JJ	225A	–	3P	Panel M1B	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	4	4.5 in	JJ	225A	–	3P	Panel M2A	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	5	4.5 in	JJ	225A	–	3P	Panel M2B	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	6	7.5 in	LC	600A	–	3P	Motor Control	2/0	2	4/0 – 500kcmil	2	4/0 – 500kcmil
3	7	7.5 in	LC	350A	–	3P	CH – 1	2/0	2	4/0 – 500kcmil	1	#4 – 600 kcmil
3	8	4.5 in	JJ	225A	–	3P	Panel M1A	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	9	4.5 in	JJ	225A	–	3P	Panel M1C	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	10	4.5 in	JJ	225A	–	3P	DOAS-2	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil
3	11	4.5 in	JJ	225A	–	3P	ATS-LS	1/0	1	3/0 – 350 kcmil	1	#6 – 350 kcmil