TECHNICAL ASSIGNMENT 2

October 16, 2013

SOUTH HALLS RENOVATION: EWING-CROSS

UNIVERSITY PARK, PA

Quaid Spearing| Ewing-Cross Renovation

Construction Option

Advisor: Dr. Anumba

SOUTH HALLS RENOVATION: EWING-CROSS

EXECUTIVE SUMMARY

Technical Assignment 2 focuses on the key attributes of the Ewing-Cross Renovation that affect project execution. The Analyses performed look at the critical aspects of the project during construction. These include: the project schedule, structural and MEP estimates, general conditions estimate, site planning, constructability challenges, and the Building Information Modeling use.

The detailed project schedule shows an in depth look at the sequencing of work and durations of each activity. The construction start date is set at May 17, 2013, and is expected to hit final completion on January 14, 2014. This translates to a construction schedule of seven months, or approximately 176 working days. The MEP rough in and interior finishes drives the schedule as each floor takes approximately 73 days to complete, with work occurring simultaneously on several floors.

A detailed structural systems estimate and assemblies MEP estimates were performed to further analyze the cost of Ewing-Cross. The MEP assemblies estimate was found to be $2,951,000 which is significantly lower than the actual cost of $4,087,000. This can be attributed to the fact that RSMeans does not have a comparable item for the ERV systems and their ductwork. The detailed structural estimate includes the primary structural steel, the restroom slabs, roof framing, and the exterior elevated slabs. The concrete cost was estimated to be $354,000, compared to the actual cost $414,900. The cost difference can be accounted to the fact that the excavation for foundations was not included in the estimated cost. The metals estimate was approximately $299,000. This was significantly lower than the $413,950 actual cost, but is attributed to not including interior metal railings and the various other nonstructural metals.

The site layout planning was analyzed to gain a better understanding of how the site is utilized during each phase of construction. Site plans for the Demolition, Superstructure, and Enclosure phases were created.

The general conditions estimate for phase 1 of the South Halls Renovation came to approximately $2,760,000 or $138,000 per month. The largest portion of this being the staffing costs at 49% of the total GC costs, with insurance and contingency making up the next largest portions at 19% and 21% respectively.

The main constructability challenges faced by the project team at South Halls include the MEP coordination, site constraints/location, and the existing floor slabs.

Finally, the Building Information Modeling use for South Halls was analyzed to understand how BIM was actually being used. It was found that BIM is being used for a wide variety of purposes including: design review, 3D coordination, sustainability evaluation, existing conditions modeling, and record modeling. Overall, the BIM use is very good, but there is some room for improvement in regards to 4D modeling and cost estimation.

TABLE OF CONTENTS

PROJECT SCHEDULE

The South Halls Construction and Renovation Project started in 2009 when Penn State had a feasibility study performed to look into the potential construction activities that could be performed for the dormitory complex. The construction began approximately 2 years later, with the construction of the new dormitory, Chace, and the renovation of Haller-Lyons. As Ewing-Cross is nearly identical to the other three renovations, the detailed project schedule created focuses on the construction activities of Ewing-Cross.

***See Appendix A for the full detailed project schedule.**

Table 1: Project Phase Overview

Phase	Start	Finish	Duration
Design	5/30/2011	7/30/2012	306
Procurement/Earlier Construction Phases	11/4/2011	6/1/2013	411
Ewing-Cross Construction Start	5/14/2013	4/14/2013	0
Site Work	5/20/2013	11/14/2013	129
Abatement	5/24/2013	6/19/2013	19
Demolition	5/14/2013	7/3/2013	37
Above Grade Structure	5/28/2013	8/14/2013	57
Enclosure	5/17/2013	9/16/2013	87
Framing and Rough In	5/24/2013	8/23/2013	66
Finishes	7/26/2013	11/25/2013	87
Closeout	11/1/2013	1/14/2014	53
Final Completion	1/14/2013	1/14/2014	0

DESIGN AND PROCUREMENT

After the initial feasibility study performed in 2009, Penn State requested proposals from prequalified contractors. Barton Malow and Clark Nexsen were selected, and the design phase for the South Halls Renovation began at the end of May, 2011. 100 % construction documents were completed in July of 2012, early after the beginning of construction on Chace and the Haller-Lyons renovation. Design-Assist specialty contractors were chosen in November of 2011, around the same time that the construction documents phase began, and were able to providing valuable input to Clark Nexsen's MEP engineers. Barton Malow's GMP contract with Penn State was finalized on March 17, 2012 and they were given Notice to Proceed on May 1st, 2012. The construction of Chace and renovation of Haller-Lyons ran until June of 2013, with the Ewing-Cross renovation beginning in May of 2013.

CONSTRUCTION

The construction phase for Ewing-Cross is unique in that a majority of the existing structure will remain. There will be very little excavation work necessary, and most of the existing brick façade enclosure will remain. The project is on an aggressive seven month construction schedule, leading to a lot of work occurring simultaneously. Overall, the construction schedule was divided by the work occurring in Ewing and the work in Cross.

INITIAL SITE WORK

Barton Malow mobilized at the close of the spring 2013 semester, beginning with the demolition of sidewalks and installation of proper tree protection. Due to the age of the existing structure, asbestos abatement was necessary, which took about one calendar month to complete. The abatement work began on the fourth and third floors of both Ewing and Cross, and then moved to the lower two floors. The demolition of MEP and finishes followed closely behind, beginning with the fourth and third floors, as soon as abatement work was complete on those floors. While the interior demolition was occurring, the demolition of several existing spread and continuous footings took place. This work paves the way for the excavation and pouring of new columns footers, which will support the North side walkway and South side wrap around porch. The exterior site work is broken down into the North and South side work; this includes the meeting rooms on the North and South sides, as well as the North side walkway and the South side wrap around porch. The North and South site work occurs simultaneously, througout the duration of construction. Figure 1 shows how the work is broken down in the detailed project schedule.

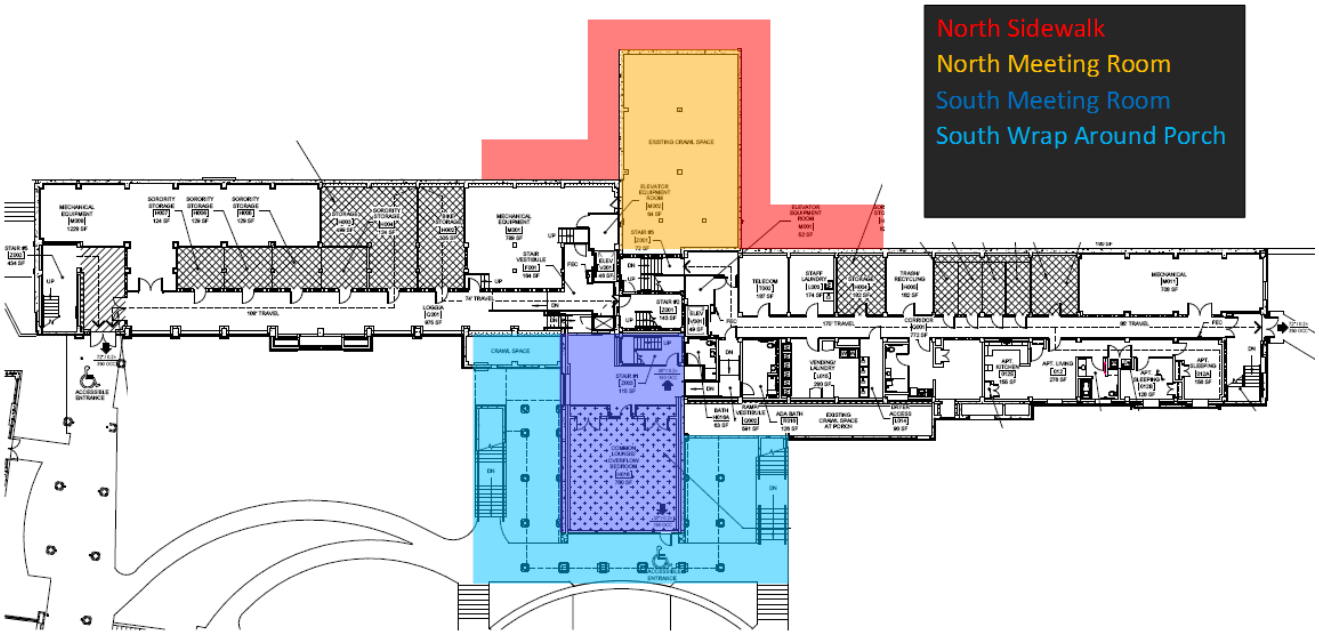


Figure 1: Site Work and Demo |Quaid Spearing

STRUCTURE

Besides the concrete slab and steel columns, the North walkway and South wrap around porch, the only structural work occurring at Ewing-Cross is the replacement of the restroom concrete slabs. The slabs experienced delamination, due to the separation of the concrete above and below the steel reinforcement. The sequencing follows a bottom up flow, which can be seen in figure 2. The slab replacement begins in Cross with the demolition of the existing floor slab 2. Floor 2 F/R/P then occurs and the shoring for floor slab 3 is immediately erected. The existing floor slab 3 is demolished, and once floor slab 2 has reached sufficient strength, floor slab 3 is poured. This process then repeats for floor slab 4. In total, the Cross restroom slabs take 39 days to complete. The Ewing restroom slabs follow the same sequencing, beginning approximately a week later and taking 49 days to complete. Each floor averages about 15 days for demolition, shoring, and F/R/P for the new slab. This work completes the major structural work that needs to occur for Ewing-Cross.

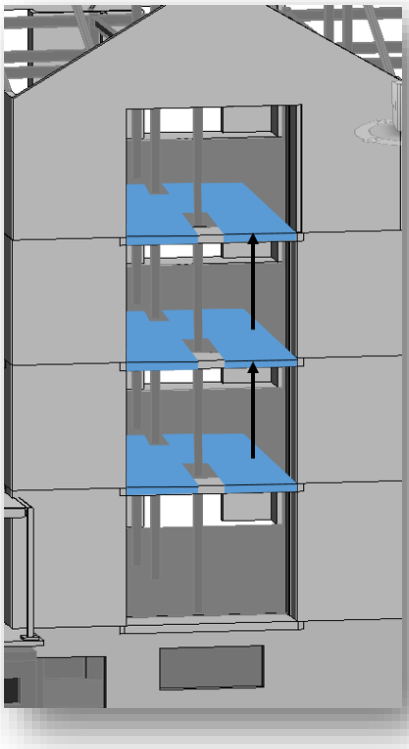


Figure 2: Restroom Slab Sequence Quaid Spearing

ENCLOSURE

The enclosure work begins towards the start of the project and is divided into 6-7 sequences each for Ewing and Cross. The majority of this work involves enclosing the stone panel projections and the roofing for the gabled ends. Cross takes 87 days to enclose and Ewing takes 84 days, with Ewing starting about one week after Cross. The work flow for the large stone panel projections sequence is: wall panels → roof trusses →windows & shingles →stone panels. Each large projection sequence takes about 22 days. The work flow for the small stone panel projections is: windows & shingles → stone panels and this sequence takes approximately 10 days for each small projection. The enclosure work for Ewing follows the same work flow as Cross. The enclosure work flow can be seen in Appendix C: Construction Site Plans – Enclosure.

FRAMING AND ROUGH IN

Within both Ewing and Cross, there are four main areas for framing and rough in, as determined by the schedule: Floors 4/3, Floors 2/1, Restrooms, and Ground Floor (Mechanical Rooms). Looking at figure 3, framing and rough in begins on the ground floor of Cross. Although the interior work generally follows a top down sequencing, the ground floors were started earlier because they house primarily the mechanical and electrical equipment and take longer to complete than other floors. As each trade finishes their work on Cross ground floor, they move to Ewing ground floor. The framing, mechanical room fit out, and MEP rough in takes approximately 57 days for both Ewing and Cross, with Ewing finishing about one week after Cross. The upper floors, consisting of primarily bedrooms and sorority suites, follow a top down construction for framing and MEP rough in. Work begins on the fourth and third floors concurrently, and each trade moves to the second and first floors as they finish their work. Framing and rough in for each floor takes about 22 days, with Ewing and Cross on the same durations. The restroom framing and rough in begins after all the new restroom floor slabs have been poured. As

each trade finishes their work on the first floor, they begin the framing/rough in for the restrooms, with all four floors in Cross starting at the same time. The framing and rough in for each floor takes approximately 20 days. As each trade finishes the framing and rough in for Cross, they move to the Ewing restrooms.

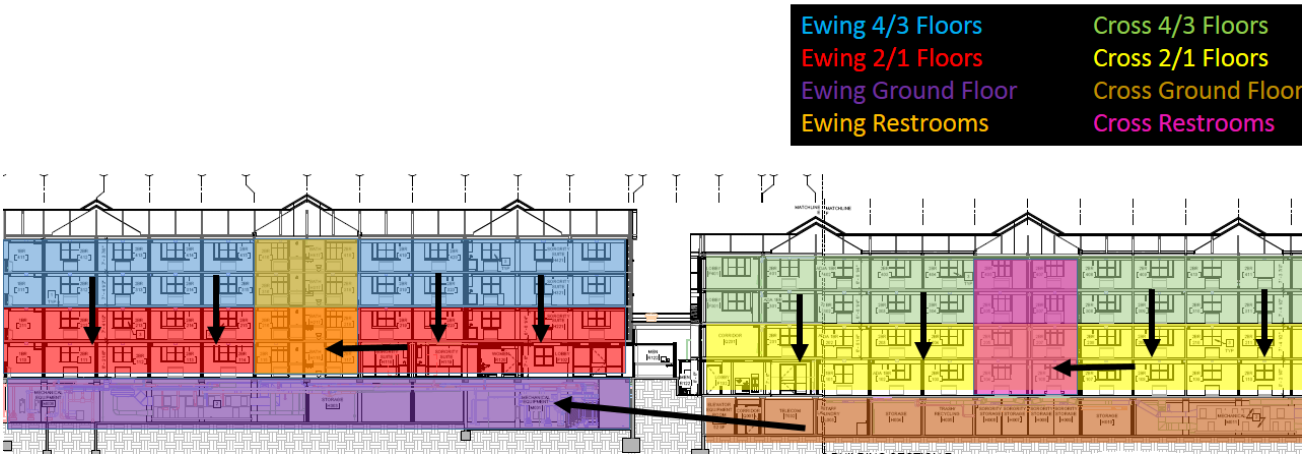


Figure 3: Interior Work Sequencing | Quaid Spearing

FINISHES

Following the sequencing set by the framing and rough in, the finishes are again best understood by dividing each building into the three major areas of: ground floor (mechanical rooms), restrooms, and floors 1-4. The finish work includes: hanging and finishing drywall, MEP and equipment trim out, door installation, flooring, and final paint. The finishes for the Ewing and Cross ground floor takes approximately 46 days each. Finish work is about 56 days per floor for both Ewing and Cross, and the restroom finish work is roughly 25 days per floor. To simplify the detailed schedule, only the fourth floor for both Ewing and Cross was detailed with each rough in and finish activity. This is typical for the restroom schedule as well, because all four floors of restrooms are scheduled in parallel, with the same durations.

CLOSEOUT

As the construction comes to completion, each floor proceeds through typical punch list items and is closed out to be turned over to the owner. The building is scheduled to be turned over in phases, with the 4th, 3rd, and 2nd floors being turned over early, to allow Penn State to begin moving in furniture and student items from Cooper – Hoyt, in anticipation of the next phase of construction. All testing and balancing occurs during the closeout, and Owner FF&E will also begin during this period. Final completion is scheduled to occur in January of 2014.

ASSEMBLIES ESTIMATE

Table 2: RSMeans MEP Assemblies Cost

MEP Assemblies Estimate					SF Estimate	
System	Cost $	Cost $/SF	Actual Cost	Actual Cost $/SF	SF Estimate Cost $	Cost $/SF
Mechanical	$ 1,428,451	$ 19.84	$2,782,950	$ 38.65	$ 2,579,000	$ 36.32
Electrical	$ 1,150,490	$ 15.98	$1,304,000	$ 18.11	$ 1,305,000	$ 18.38
Plumbing	$ 372,301	$ 5.17	-	-	-	-
Total	$ 2,951,242	$ 40.99	$4,086,950	$ 56.76	$ 3,884,000	$ 54.70

An MEP assemblies estimate was created utilizing RSMeans Costworks. The total MEP assemblies cost was found to be $2,951,242 at $40.99 per square foot. Compared to the actual systems cost of $4,086,950 at $56.76 per square foot, there is a $1,135,708 difference. Upon further analysis, several factors were identified that could account to the difference in cost.

Looking at the electrical assemblies estimate, the actual electrical is $153,500 more than the estimated assembly. The electrical assemblies estimate is fairly accurate because all the major feeders were taken off, and each panel board was accounted for. The small difference of approximately 12% can be attributed to the subcontractor markup.

Looking at the assemblies estimate compared to the square foot estimate costs found in technical report 1, the SF estimate is actually closer to the actual costs than the MEP assemblies estimate. The actual MEP cost is broken down into two main categories: mechanical/plumbing as one, and the electrical as the other; fire protection is not included within the mechanical/plumbing costs. The actual mechanical/plumbing system costs is $982,200 more than the assemblies estimate. This is largely contributed to the fact that RS Means does not have an accurate assembly to represent the two energy recovery ventilation units; and there were no assemblies to properly account for the lineal feet of ductwork that accompanies the two ERV units. When taking the ERV units and ductwork into consideration, the difference between the estimated assemblies and the actual cost is justifiable.

***See Appendix B-1 for a full estimate summary for the mechanical, electrical, and plumbing systems**

DETAILED STRUCTURAL ESTIMATE

Table 3: Material Take off Summary

System	Quantity
Concrete (CY)	375.1
Rebar (tons)	19.0
Steel Membrs (Tons)	7.3

A detailed structural estimate was performed to fully understand the structural system being utilized for Ewing-Cross. Due to the fact that a majority of the building's structure is existing to remain, it was difficult to pick a typical bay and extrapolate the quantities. Therefore, a majority of the takeoffs performed accounted for all of the structural system. The new structural work for Ewing-Cross consists of primarily cast-in-place concrete, with hollow structural sections steel. The stone panel wall projections structure was estimated, as well as the foundation and superstructure for the north and south porches. The projection footings and foundations, porch concrete slabs and steel were all accounted for individually as it was difficult to extrapolate one section as representative for the entire building. To calculate the restroom floor slabs, the second level slab in Ewing was used to represent all six slabs to be replaced. Quantities of materials were obtained by utilizing a combination of structural drawings and a Revit model of the building's structure. Costs from RSMeans CostWorks were then combined with the quantities to find an overall cost for the structural system. Projects for Penn State that have contract amounts in excess of $25,000 are required to use prevailing wages for labor. For this reason, the RSMeans labor cost were adjusted accordingly to reflect prevailing wages and provide a more accurate detailed structural estimate.

***See Appendix B-2 for the Detailed Structural Systems Estimate**

FOOTINGS

This portion of the estimate included the concrete column footings, concrete piers, and the projection footings. There were four types of column footings which consisted of 3000psi concrete and Grade 60 reinforcing steel running full length in both the longitudinal and transversal directions. There are three different types of concrete piers at varying heights that also utilize 3000psi concrete and Grade 60 rebar, running full length horizontally and vertically. Also, there are four types of wall footings, varying in size, depending on the height and load of the foundation wall they support.

FOUNDATION WALLS

There are four types of foundation walls, ranging in thickness from 8" to 14" and of varying heights, depending upon the

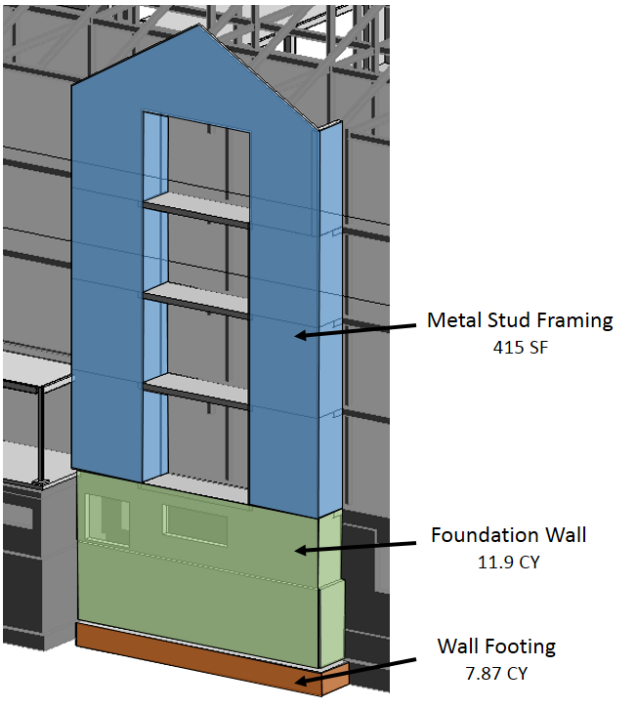


Figure 4: Estimated Structure
Quaid Spearing

location. Similar to the footings, the foundation walls consist of 3000psi concrete and Grade 60 reinforcing steel. Each foundation wall was estimated because nearly each wall was unique, in respect to height and cubic yards of concrete. Figure 4 shows the components estimated in each bumpout.

CONCRETE BEAMS AND COLUMNS

The concrete beams and columns primarily support the south wrap around porch and consist of 3000psi concrete and Grade 60 rebar. There are two types of concrete columns, with a typical height of 13'-4"; the typical beam length is 8'-9". The porch structural components estimated can be seen in figure 5.

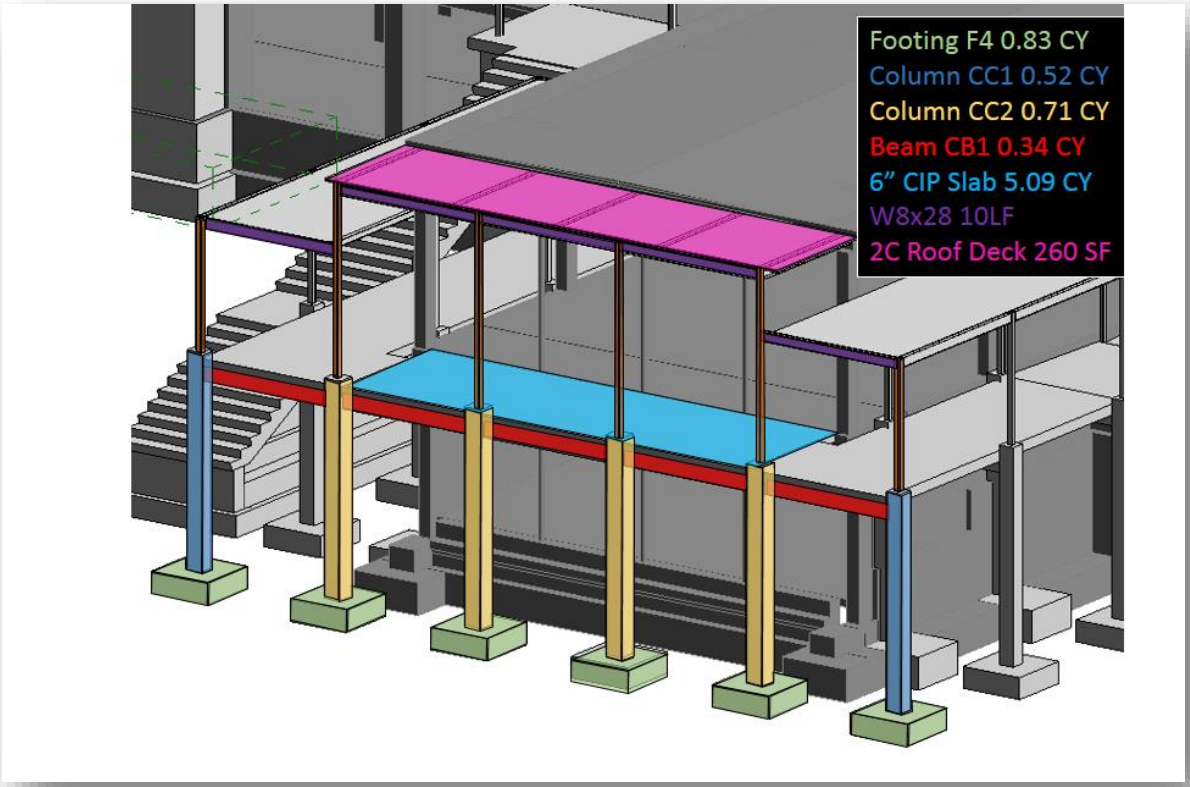


Figure 5: South Porch Estimated Structure | Quaid Spearing

CONCRETE SLABS

A large portion of the concrete estimate consists of the six identical restroom slabs (see figure 2), the elevated porch slab, and the slab on grade. The slabs consist of 4000psi concrete with Grade 60 reinforcing steel. In total there are 6 different thicknesses of slabs, ranging from 3 ¼" to 8". The concrete slabs account for $133,000 of the concrete costs.

STEEL

The metals portion of the estimate includes the HSS steel columns and beams, the cold formed roof trusses, and the roof decking. Upon further inspection of the metals portion of the actual estimate, it was determined that the exterior metal railings for porches and walkways was included in the actual cost. Metal railings were included in the estimate to better reflect the project cost and accounted for

nearly $100,000. The most common steel members are HSS 4x4x1/4 and 4x4x1/2 steel members, and the porch roof decking 2" 2C Conform deck and covers approximately 3700SF.

COST ANALYSIS

Table 4: Detailed Structural System Cost Totals

System	Estimated Cost	Actual Cost	SF Estimate
Concrete	$ 354,376	$ 414,900	$ 1,787,900
Metals	$ 299,073	$ 413,950	-

Looking at Table 3, the detailed estimated costs more accurately reflect the actual cost than the original square foot estimate did. The SF estimate assumed that the entire building was new construction. In addition, the SF estimate only accounted for a concrete structure, with no structural steel members.

Comparing the detailed estimate to the actual costs, both the concrete and metals estimate are lower than the actual cost; ideally, a detailed estimate is within 5% of the actual cost. After looking at the detailed takeoff quantities, there are several factors that could contribute to the cost differences.

When the actual cost breakdown for concrete is analyzed, it is apparent that there are several items that were not included in the detailed estimate. Excavation and backfill were not included in the detailed estimate for concrete, and account for approximately $46,000 of the actual concrete costs. Taking out the excavation costs would bring the actual costs down to $368,900; the concrete detailed estimate would be within 5% of the actual costs. With all of this considered, the concrete estimate is believed to be reasonable.

In regards to the metals estimate, the difference can be accounted to various metals that were not included in the structural estimate. The actual metals package for Phase 1, primarily consists of a steel fabrication lump sum design assist proposal; this proposal not only includes the structural steel for the exterior porches, but also includes the porch railing, interior railing, staircase railing, and metal brackets. The porch metal railing was included to better reflect the actual metals cost; however, the other various non-structural metal was not included in the steel estimate, which would make up some of the deficit in the metals cost. Taking in account all of these factors, the estimate is believed to accurate within the limits.

SITE LAYOUT PLANNING

The site layout plans for the demolition, superstructure, and enclosure phases can be seen in Appendix C and should be referenced for a full understanding of the work involved during each stage of the project. Throughout the course of the project, several items remain in the same location; these include the field office in Redifer, the dumpsters, toilets, and material storage sheds.

DEMOLITION PHASE

The demolition phase includes all of the demolition and abatement necessary to ready the site and building for future phases. Dumpsters are located at both North entrance gates for easy pickup of trash and recyclables. Due to the tight site constraints and sloped site (in the north-south direction), one way traffic is not achievable.

Looking at the demolition plan, there are several major areas of demolition. The north exterior walkway and south wrap around porch are demoed from west to east, in preparation for the new foundation and superstructure. The enclosure at the large projections will be removed to allow for the new bumpouts to be erected. The restroom slabs will also be cut out, once the abatement work in this area is complete. The interior demolition follows a top down sequencing and includes removal of all FF&E (see figure 3 for sequencing of interior trades). As the demolition work is completed, the site and building are prepared for the superstructure phase.

SUPERSTRUCTURE PHASE

The site setup for the superstructure phase is very similar to the demolitions phase, with dumpsters remaining near the site entrance gates. This phase adds more equipment than the demolition phase and will require a higher level of coordination, with the exterior structure occurring simultaneously with the restroom slab structure. The exterior concrete and steel columns for the exterior porch and walkway follow the flow set by the demolition. A mobile truck crane is utilized for placement of members on the south side of Ewing-Cross, and a crawler crane is used on the north side. Material stockpiles for steel members are located within close proximity of the cranes. The restroom slabs begin during the superstructure phase, beginning with the second floor slabs, once shoring is in place. Ready mixed concrete is delivered to the site and pump directly into place, as seen on the superstructure plan.

ENCLOSURE PHASE

Following the superstructure phase, the enclosure phase consists of enclosing the four large projections that were removed in the demolition phase, and also installing the new façade for the small projections. Site traffic flow remains the same as the previous phases, and there are limestone panel material stockpiles located on the southwest and northeast side of the site. Mobile man lifts are utilized for the installation of the limestone panels; because the panels are lightweight, a crane is not necessary to lift them into place. Hydraulic scaffolding is also used for placement of limestone panels; the hydraulic scaffolding helps to reduce the time required to mobilize and demobilize that traditional scaffolding would need. The hydraulic scaffolding also helps to reduce site congestion by only having scaffolding in the location that is immediately required. The sequencing of building enclosure does not follow a traditional flow, as observed in the enclosure plan. There are two main reasons for this: time constraints

and other site activities. Because the total project duration for Ewing-Cross is only seven months, many construction activities overlap, resulting in the enclosure sequencing bouncing around the site to avoid delaying other activities. Similar to the majority of other phases, the enclosure is divided between work occurring on Ewing and the work on Cross; the small projections are finished first, with large projections being completed shortly after. Once the limestone panel systems are installed on each sequence, the enclosure phase is complete.

***See Appendix C for the Site Layout Plans**

GENERAL CONDITIONS ESTIMATE

The South Halls Renovation was broken into three major phases, with Haller-Lyons and Ewing-Cross comprising Phase 1. As a result, the general conditions estimate was calculated for both buildings, with a total duration of twenty months. As can be seen in table 5, the general conditions estimate came to $2,760,448 at $138,022 per month. Included in the general conditions estimate are the: Staffing, Field Office, Quality and Testing, Insurance, Temporary Facilities and Utilities, Cleaning and Waste Management, and the Contingency. The pricing is a combination of actual cost data and RSMeans.

The Staffing costs include all of the Barton Malow employees on the project. The staffing plan created for Technical Assignment 1 includes (1) project executive, (1) project director, (1) senior project manager, (1) 1 senior project engineer, (1) project engineer, (1) senior superintendent, (2) superintendents, (1) intern, and (1) project technician. Staff durations were taken directly from the actual staffing plan. As can be seen in figure 6, the staffing costs account for the largest portion of the general conditions costs, due to the high level of supervision required to manage the project. The staffing costs estimated are slightly higher than the original actual costs, because the construction manager staffing is slightly larger than the one originally priced in the GMP contract.

The insurance makes up a sizeable portion of the general conditions at 19% of the total cost. This includes the Builder's Risk Insurance, Liability Insurance, and the Payment & Performance Bond. The insurance costs are based off the entire phase cost ($28.8M).

The Cleaning and Waste Management costs are significant because of the level of recycling that Penn State requires in respect to construction waste. There are different dumpsters for the various recyclables produced from the construction process, and tipping fees significantly add up over the twenty month project period.

A unique aspect of the South Halls Project can be seen through the small cost of temporary facilities. Barton Malow's field office is located in a sectioned off corridor within Redifer Hall. There are no job trailers on site, as the design assist subcontractors are located in Redifer as well. As such, not having cost incurred for temporary job trailers is reflected in the general conditions estimate. The temporary utilities cost are also very low because Penn State has extensive utilities already in place that could be accessed for construction purposes.

There is a 2% construction contingency included to account for any unforeseen conditions that may occur. This is especially important with a design-build project that involves renovating a 50 year old building within a seven month time frame. Unforeseen conditions that could arise include existing underground utilities that were not correctly mapped on drawings, asbestos material, or differing site conditions.

Delays in work being completed or outside factors, such as new owner requests or redesign, would impact the project schedule. In turn, schedule growth would be reflected in the general conditions. Even a one month delay would increase the general conditions cost by nearly $140,000. This does not include the implications of the project not finishing on time, such as liquidated damages and actual damages due to a delay in turning over the building to Penn State. If the project were to run over into the spring

2014 semester, the cost to temporarily house a few hundred students in hotel rooms would be significant.

***See Appendix D for the full General Conditions Estimate**

Table 5: General Conditions Estimate Breakdown

Category	Total Cost	Cost Per Month*
Personnel/Staff	$ 1,359,685	$ 67,984
Field Office	$ 75,425	$ 3,771
Quality and Testing	$ 6,026	$ 301
Insurance	$ 530,528	$ 26,526
Temporary Facilities & Utilites	$ 53,986	$ 2,699
Cleaning and Waste Management	$ 152,098	$ 7,605
Contingency	$ 582,700	$ 29,135
Total	$ 2,760,448	$ 138,022

*Based on a 20 month duration project

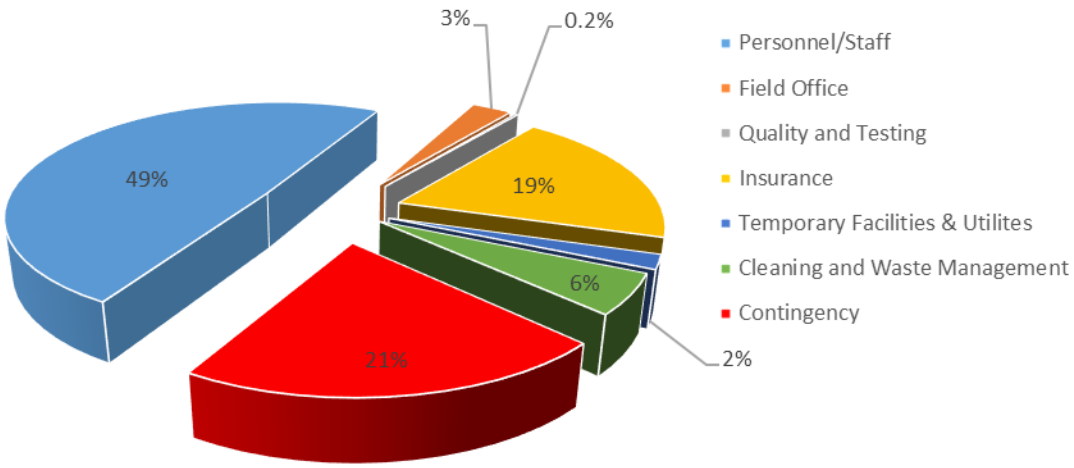


Figure 6: General Conditions Breakdown by Percentage | Quaid Spearing

CONSTRUCTABILITY CHALLENGES

There are several constructability challenges that are of concern during the renovation of Ewing-Cross. Most of the constructability issues that occur on Ewing-Cross also occurred during the renovation of Haller-Lyons, so there is a learning curve that was achieved through the repetition of similar buildings. After discussion with the Barton Malow project team, it was determined that the MEP coordination, site constraints/location, and the floor slabs were the three main constructability challenges.

MEP COORDINATION

Since Ewing-Cross is a renovation project, there were extensive utilities, equipment, and electrical conduit already in place. Initially, the project team wanted to salvage and reuse as much of the conduit as possible. Barton Malow made use of a 3D scanner to try and map the conduit in the ground floor mechanical/electrical rooms, which should have allowed them to coordinate the existing conduit with new conduit and other MEP systems. However, there were still coordination issues amongst new and existing MEP runs, which resulted in eventually removing the existing conduit altogether.

MEP coordination was also a challenge on the upper floors, for student rooms and corridors. At 7' – 4 ½", the floor to ceiling heights are extremely low, by today's standards. During the initial feasibility study phase for South Halls, it was believed that energy recovery would not be possible because the low floor to ceiling heights would not allow for outside air to be supplied to student rooms. Clark Nexsen resolved this by using wide, shallow ductwork for the duct runs to student rooms. In addition, the main ductwork chases were fed through the large stone panel projections. The ductwork, along with the fire protection and electrical runs are hidden in the bulkheads, which can be seen in figures 7 & 8 below. Having a large amount of bulkheads creates a challenge, with respect to drywall finishing because bulkheads are more labor intensive than a typical wall; there becomes an intricate link between the MEP rough in and bulkhead work.

Figure 7: MEP coordination and bulkhead in typical corridor | Quaid Spearing

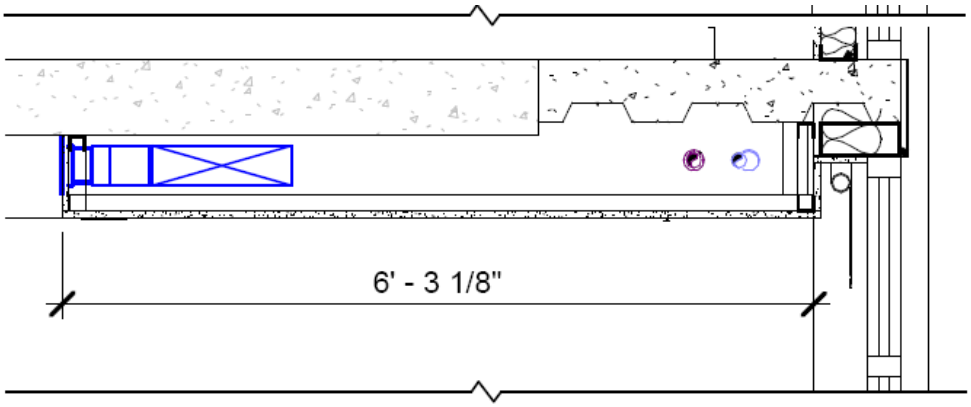


Figure 8: Typical Bulkhead and MEP in student rooms | Drawing AE322

SITE CONSTRAINTS/LOCATION

The second challenge for the Ewing-Cross renovation involves the site constraints and location. By State College standards, the South Halls site is very tight, with neighboring buildings in close proximity. With housing on Penn State's campus reaching maximum capacity each semester, there was no room for all of South Halls to be unoccupied during the entire project. Therefore, the project was phased so that three of the four dormitories could be occupied, with the fourth under construction. As observed in figure 9, Redifer Commons, Cooper-Hoyt, and Young Hall enclose the Ewing-Cross site on the West, South, and East respectively.

With students occupying Cooper – Hoyt to the south of Ewing-Cross and a main pedestrian thoroughfare to Redifer along the south of the site, maintaining site security and safe pedestrian walkways is crucial through all phases of the project. Along with the safety of students, there is also a strict construction start time of 8:00 AM, which is typical of projects on Penn State's main campus. This means that no exterior or particularly noisy construction can begin before 8:00 AM. This ensures that disruption to the student residents near construction is minimized. This can prove to be a challenge is terms of scheduling, as most contractors typically prefer to start at 7:00 AM or even earlier. Barton Malow overcame the time constraint by scheduling noisier work to start later in the morning and mainly interior or prep work occurring before 8:00 AM.

There are significant traffic concerns during construction, with daily deliveries to the various restaurants in Redifer; with many of these deliveries occurring on the North side of the site, sometimes blocking the site entrance gate. This means that deliveries for construction materials not only need to be coordinated among trades, but also with the surrounding facilities deliveries. There are also truck wash racks as both North entrances to minimize the dirt and mud tracked onto the local roads; a truck wash station is not needed at the East entrance gate because it leads onto a paved site road.

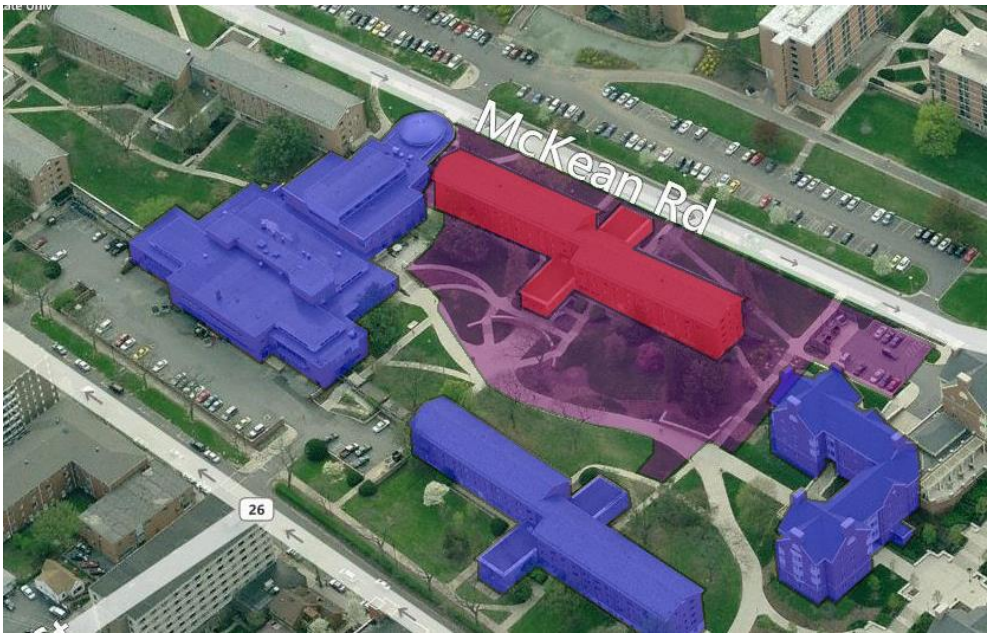


Figure 9: 3D Site Location and Surrounding Buildings | Bing Maps

EXISTING FLOOR SLABS

The third challenge that the project team faced during the renovation of Ewing-Cross was the existing floor slabs. There was a delamination of the floor slabs in the restrooms, meaning that the concrete began to separate away from the reinforcing bars. Barton Malow determined that the best solution was to cut out the restroom slabs. Portions of the existing rebar were left exposed to tie into the new slab and overlap with new reinforcing bar (see figure 10). Tying in new structure to existing structure can be challenging because proper load distribution has to be achieved. Due to the restroom slabs needing replaced, the entire schedule for the restroom was effectively put on its own critical path.

During the demolition of the second floor, it was determined that there was significant separation of the topping slab and aggregate, resulting in a rough uneven slab surface. To remedy this, the project team grinded down the floor slabs and placed a topping slab to provide a smooth enough finish for the laminate vinyl tile.

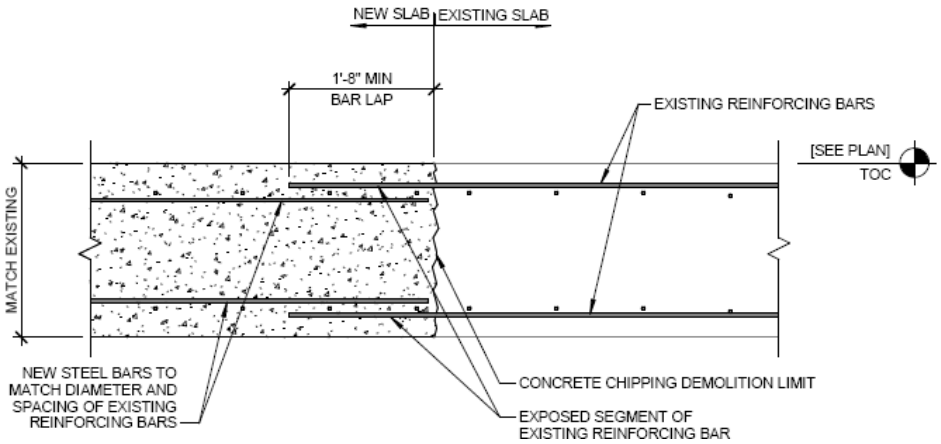


Figure 10: Typical New to Existing Slab at Bathroom | Drawing SF 503

BUILDING INFORMATION MODELING USE EVALUATION

Building Information Modeling (BIM) is being heavily implemented for the South Halls Renovation Project. Clark Nexsen built models, including: architecture, structure, mechanical, electrical, and plumbing models. The models were used to create the 2D drawings utilized in the field. The models and drawings are constantly updated and shared via Dropbox, ensuring that the entire project team has the most up-to-date information. The 3D models and electronic file sharing also allows for the project team to reduce the amount of paper drawings needed on site, because each Superintendent has the latest information on his tablet.

Table 6: Actual BIM Use List | Courtesy of Barton Malow

X	PLAN	X	DESIGN	X	CONSTRUCT	X	OPERATE
	PROGRAMMING	X	DESIGN AUTHORING		SITE UTILIZATION PLANNING		BUILDING MAINTENANCE SCHEDULING
	SITE ANALYSIS	X	DESIGN REVIEWS		CONSTRUCTION SYSTEM DESIGN		BUILDING SYSTEM ANALYSIS
		X	3D COORDINATION	X	3D COORDINATION	X	ASSET MANAGEMENT
			STRUCTURAL ANALYSIS		DIGITAL FABRICATION	X	SPACE MANAGEMENT / TRACKING
			LIGHTING ANALYSIS	X	3D CONTROL AND PLANNING		DISASTER PLANNING
			ENERGY ANALYSIS	X	RECORD MODELING	X	RECORD MODELING
			MECHANICAL ANALYSIS				
			OTHER ENG. ANALYSIS				
		X	SUSTAINABLITY (LEED) EVALUATION				
			CODE VALIDATION				
	PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)
	COST ESTIMATION		COST ESTIMATION		COST ESTIMATION		COST ESTIMATION
	EXISTING CONDITIONS MODELING	X	EXISTING CONDITIONS MODELING	X	EXISTING CONDITIONS MODELING	X	EXISTING CONDITIONS MODELING

Table 6 shows the actual BIM uses for the South Halls project. Being that this is a Penn State project, Barton Malow and Clark Nexsen employed the Penn State approach for BIM execution planning. The black X's indicate the actual BIM uses. It can be seen that there are a wide variety of BIM uses actually employed. Models from the design phase were directly transferred to Barton Malow for the construction phase, and these models are planned to be turned over to Penn State at the project's completion. Penn State will then utilize the models to add in any facility management info they deem necessary.

There is also a heavy focus on 3D coordination and modeling of the existing conditions. The 3D coordination focused on the mechanical, electrical, and plumbing systems. 3D MEP coordination was especially crucial with the low floor to floor heights, because there is little room for error in the layout of these systems. Modeling the existing conditions is essential, considering how much of the structure will remain. In the structural model, the existing structure is shaded a lighter gray, to differentiate what part of the structure will be new.

Table 7: Proposed BIM Use List | Quaid Spearing

X	PLAN	X	DESIGN	X	CONSTRUCT	X	OPERATE
	PROGRAMMING	X	DESIGN AUTHORING		SITE UTILIZATION PLANNING		BUILDING MAINTENANCE SCHEDULING
	SITE ANALYSIS	X	DESIGN REVIEWS		CONSTRUCTION SYSTEM DESIGN		BUILDING SYSTEM ANALYSIS
		X	3D COORDINATION	X	3D COORDINATION	X	ASSET MANAGEMENT
			STRUCTURAL ANALYSIS		DIGITAL FABRICATION	X	SPACE MANAGEMENT / TRACKING
			LIGHTING ANALYSIS	X	3D CONTROL AND PLANNING		DISASTER PLANNING
			ENERGY ANALYSIS	X	RECORD MODELING	X	RECORD MODELING
			MECHANICAL ANALYSIS				
			OTHER ENG. ANALYSIS				
		X	SUSTAINABLITY (LEED) EVALUATION				
			CODE VALIDATION				
	PHASE PLANNING (4D MODELING)	X	PHASE PLANNING (4D MODELING)	X	PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)
	COST ESTIMATION	X	COST ESTIMATION	X	COST ESTIMATION		COST ESTIMATION
	EXISTING CONDITIONS MODELING	X	EXISTING CONDITIONS MODELING	X	EXISTING CONDITIONS MODELING	X	EXISTING CONDITIONS MODELING

In addition to the actual BIM uses, Table 7 shows the proposed BIM use plan. The Red X's identify suggestions for other BIM uses, which include Phase Planning (4D modeling) and Cost Estimation. 4D modeling could prove to be beneficial because of the project's short construction duration of seven months. A 4D model for a typical student room, detailing the sequencing and duration of interior trades, could be used to help reduce schedule delays and better understand the interconnectivity among trades. As there are numerous activities occurring simultaneously, a 4D model could also be useful in planning out the various exterior trade work and material laydown, especially for the bumpout enclosures.

BIM could also be used for cost estimating purposes. Normally, it is difficult to put trust in the fact that the architect, or model creator, accurately modeled and dimensioned all the components. However, the 2D drawings were directly created from the 3D models. In addition, the project delivery method (Design-Build/IPD-like) lends itself to create a joint vested interest between Clark Nexsen and Barton Malow. If the models are accurately labeled, quantities could be derived directly from the 3D models, cutting down on the time invested in estimating, and budget tracking.

CRITICAL EVALUATION

When compared to other projects which employ BIM, the South Halls Renovation Project makes good use of BIM. The implementation of BIM has attributed to the success of the South Halls renovation project thus far. BIM was utilized from early during the design phase to assist in many aspects of the project. It would be very difficult to deliver a 70,000SF renovation in seven months without proper planning and coordination. The project team saw the value in implementing a large amount of BIM; having a sophisticated owner, like Penn State, is also invaluable because they can see the benefits that BIM can provide to a project and they push the contractors they employ to make use of it.

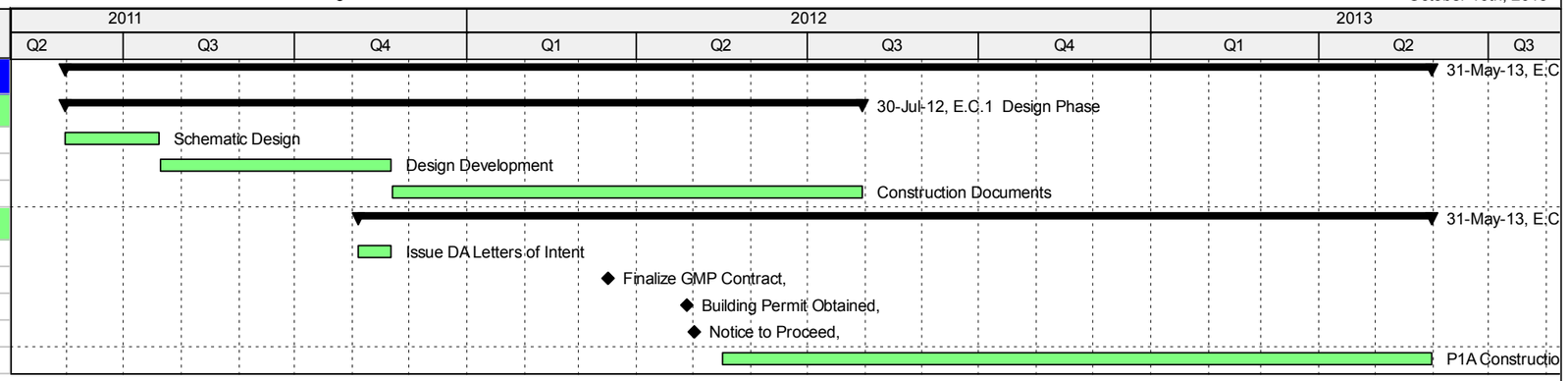
Another aspect that has played into the successful implementation of BIM at South Halls is co-location. Normally, there would be weekly coordination meetings, and any issues that arise may have to wait for several days. Having the construction manager and key subcontractors co-located allows for any issues that may arise to be immediately resolved.

Overall, BIM is implemented appropriately at South Halls. The use at South Halls is a good example of how BIM can be incorporated into a Design-Build project. The key to any successful project is ensuring that the end user is kept in mind. The BIM use process that Barton Malow has chosen will benefit Penn State by providing a record model. The use of 3D coordination is also crucial for clash detection, especially with the existing and unknown conditions that can arise with a renovation project. There is potential room for improvement, and a good starting point would be the employment of phase planning and cost estimation using the model.

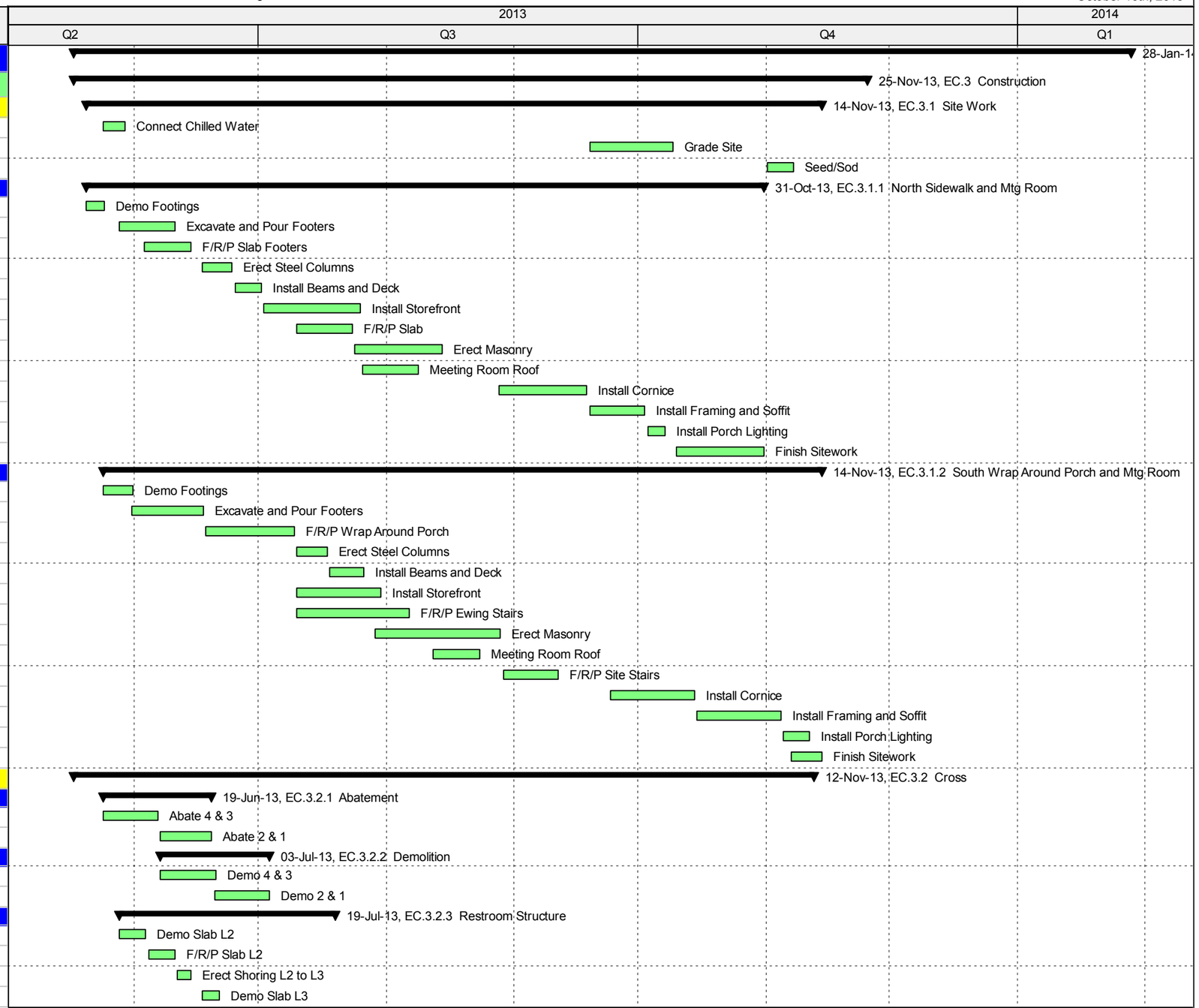
***See Appendix E for the BIM Level 1 Process Map**

APPENDIX A: DETAILED PROJECT SCHEDULE

Activity ID	Activity Name	Original Duration	Start	Finish
E.C Design and Procurement		512	31-May-11	31-May-13
E.C.1 Design Phase		298	31-May-11	30-Jul-12
A1000	Schematic Design	36	31-May-11	20-Jul-11
A1010	Design Development	87	21-Jul-11	21-Nov-11
A1020	Construction Documents	175	22-Nov-11	30-Jul-12
E.C.2 Procurement		401	04-Nov-11	31-May-13
A1030	Issue DA Letters of Intent	12	04-Nov-11	21-Nov-11
A1040	Finalize GMP Contract	0		16-Mar-12
A1050	Building Permit Obtained	0		27-Apr-12
A1060	Notice to Proceed	0		01-May-12
A1070	P1A Construction	265	17-May-12	31-May-13

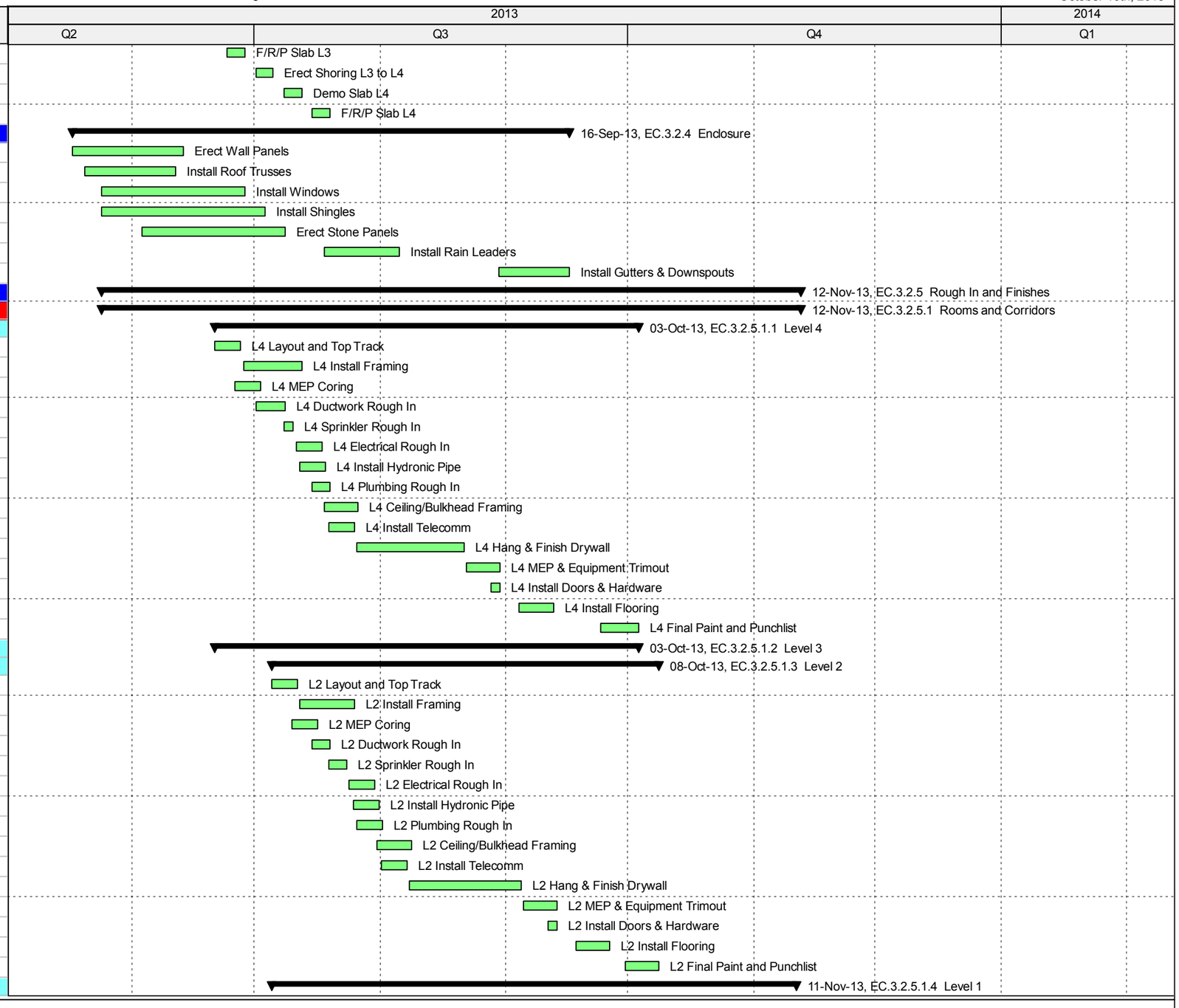


Activity ID	Activity Name	Original Duration	Start	Finish
EC Ewing-Cross Detailed Schedule		178	17-May-13	28-Jan-14
EC.3 Construction		134	17-May-13	25-Nov-13
EC.3.1 Site Work		126	20-May-13	14-Nov-13
A1080	Connect Chilled Water	3	24-May-13	29-May-13
A1090	Grade Site	15	19-Sep-13	09-Oct-13
A1100	Seed/Sod	5	01-Nov-13	07-Nov-13
EC.3.1.1 North Sidewalk and Mtg Room		116	20-May-13	31-Oct-13
A1110	Demo Footings	5	20-May-13	24-May-13
A1120	Excavate and Pour Footers	10	28-May-13	10-Jun-13
A1130	F/R/P Slab Footers	10	03-Jun-13	14-Jun-13
A1140	Erect Steel Columns	6	17-Jun-13	24-Jun-13
A1150	Install Beams and Deck	5	25-Jun-13	01-Jul-13
A1160	Install Storefront	17	02-Jul-13	25-Jul-13
A1170	F/R/P Slab	10	10-Jul-13	23-Jul-13
A1180	Erect Masonry	16	24-Jul-13	14-Aug-13
A1190	Meeting Room Roof	10	26-Jul-13	08-Aug-13
A1200	Install Cornice	15	28-Aug-13	18-Sep-13
A1210	Install Framing and Soffit	10	19-Sep-13	02-Oct-13
A1220	Install Porch Lighting	3	03-Oct-13	07-Oct-13
A1230	Finish Sitework	16	10-Oct-13	31-Oct-13
EC.3.1.2 South Wrap Around Porch and Mt		122	24-May-13	14-Nov-13
A1240	Demo Footings	5	24-May-13	31-May-13
A1250	Excavate and Pour Footers	12	31-May-13	17-Jun-13
A1260	F/R/P Wrap Around Porch	15	18-Jun-13	09-Jul-13
A1270	Erect Steel Columns	6	10-Jul-13	17-Jul-13
A1280	Install Beams and Deck	7	18-Jul-13	26-Jul-13
A1290	Install Storefront	15	10-Jul-13	30-Jul-13
A1300	F/R/P Ewing Stairs	20	10-Jul-13	06-Aug-13
A1310	Erect Masonry	23	29-Jul-13	28-Aug-13
A1320	Meeting Room Roof	10	12-Aug-13	23-Aug-13
A1325	F/R/P Site Stairs	9	29-Aug-13	11-Sep-13
A1330	Install Cornice	15	24-Sep-13	14-Oct-13
A1340	Install Framing and Soffit	15	15-Oct-13	04-Nov-13
A1350	Install Porch Lighting	5	05-Nov-13	11-Nov-13
A1360	Finish Sitework	6	07-Nov-13	14-Nov-13
EC.3.2 Cross		125	17-May-13	12-Nov-13
EC.3.2.1 Abatement		18	24-May-13	19-Jun-13
A1370	Abate 4 & 3	9	24-May-13	06-Jun-13
A1380	Abate 2 & 1	9	07-Jun-13	19-Jun-13
EC.3.2.2 Demolition		19	07-Jun-13	03-Jul-13
A1390	Demo 4 & 3	10	07-Jun-13	20-Jun-13
A1400	Demo 2 & 1	10	20-Jun-13	03-Jul-13
EC.3.2.3 Restroom Structure		38	28-May-13	19-Jul-13
A1410	Demo Slab L2	5	28-May-13	03-Jun-13
A1420	F/R/P Slab L2	5	04-Jun-13	10-Jun-13
A1430	Erect Shoring L2 to L3	4	11-Jun-13	14-Jun-13
A1440	Demo Slab L3	5	17-Jun-13	21-Jun-13



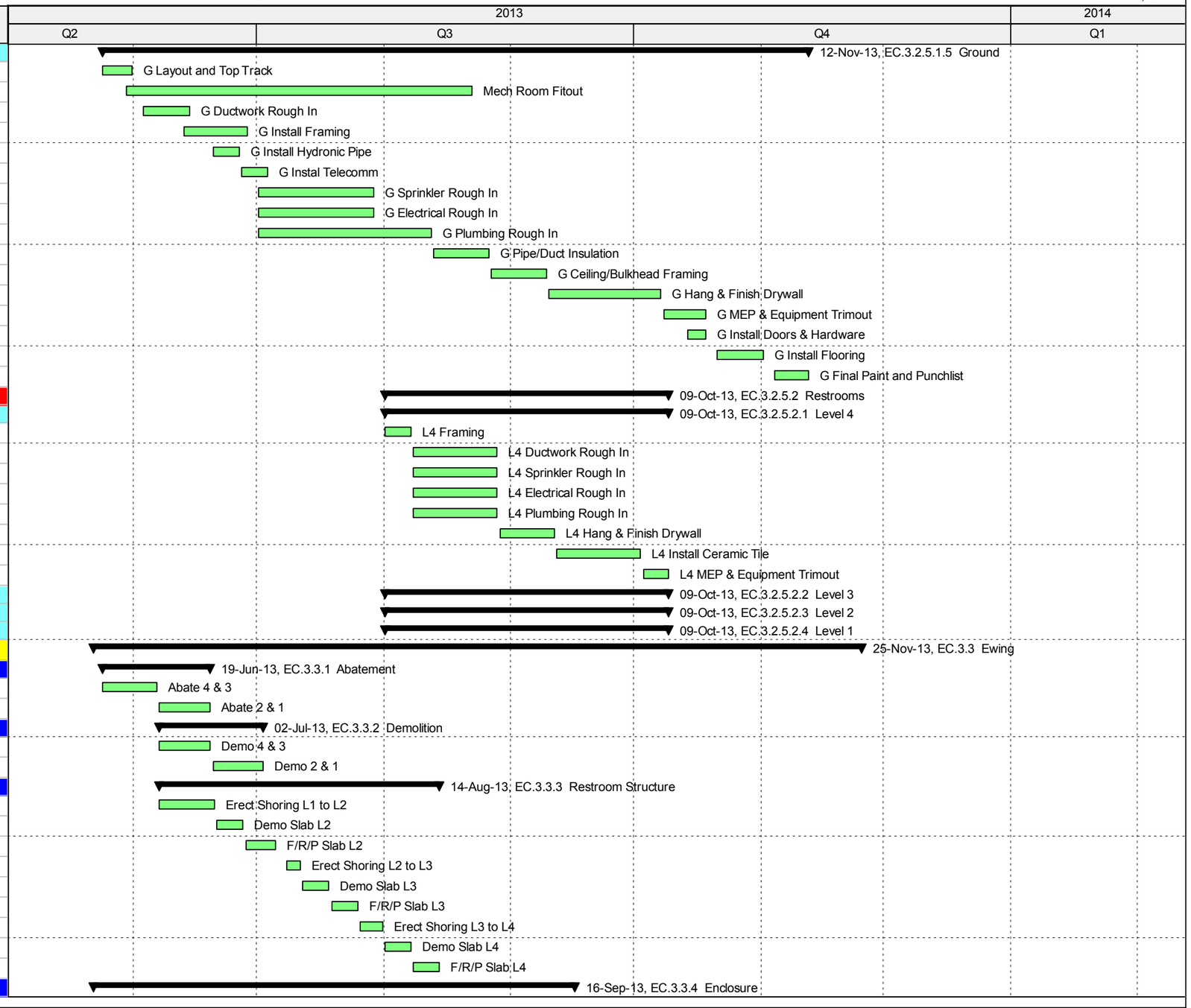
Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

Activity ID	Activity Name	Original Duration	Start	Finish
A1450	F/R/P Slab L3	5	24-Jun-13	28-Jun-13
A1460	Erect Shoring L3 to L4	4	01-Jul-13	05-Jul-13
A1470	Demo Slab L4	5	08-Jul-13	12-Jul-13
A1480	F/R/P Slab L4	5	15-Jul-13	19-Jul-13
EC.3.2.4 Enclosure		84	17-May-13	16-Sep-13
A1490	Erect Wall Panels	19	17-May-13	13-Jun-13
A1500	Install Roof Trusses	16	20-May-13	11-Jun-13
A1510	Install Windows	25	24-May-13	28-Jun-13
A1520	Install Shingles	28	24-May-13	03-Jul-13
A1530	Erect Stone Panels	25	03-Jun-13	08-Jul-13
A1540	Install Rain Leaders	13	18-Jul-13	05-Aug-13
A1550	Install Gutters & Downspou	11	30-Aug-13	16-Sep-13
EC.3.2.5 Rough In and Finishes		120	24-May-13	12-Nov-13
EC.3.2.5.1 Rooms and Corridors		120	24-May-13	12-Nov-13
EC.3.2.5.1.1 Level 4		73	21-Jun-13	03-Oct-13
A1560	L4 Layout and Top Track	5	21-Jun-13	27-Jun-13
A1570	L4 Install Framing	10	28-Jun-13	12-Jul-13
A1580	L4 MEP Coring	5	26-Jun-13	02-Jul-13
A1590	L4 Ductwork Rough In	5	01-Jul-13	08-Jul-13
A1600	L4 Sprinkler Rough In	3	08-Jul-13	10-Jul-13
A1610	L4 Electrical Rough In	5	11-Jul-13	17-Jul-13
A1620	L4 Install Hydronic Pipe	5	12-Jul-13	18-Jul-13
A1630	L4 Plumbing Rough In	5	15-Jul-13	19-Jul-13
A1640	L4 Ceiling/Bulkhead Framir	7	18-Jul-13	26-Jul-13
A1650	L4 Install Telecomm	5	19-Jul-13	25-Jul-13
A1660	L4 Hang & Finish Drywall	19	26-Jul-13	21-Aug-13
A1670	L4 MEP & Equipment Trimc	7	22-Aug-13	30-Aug-13
A1680	L4 Install Doors & Hardwar	3	28-Aug-13	30-Aug-13
A1690	L4 Install Flooring	7	04-Sep-13	12-Sep-13
A1700	L4 Final Paint and Punchlis	8	24-Sep-13	03-Oct-13
EC.3.2.5.1.2 Level 3		73	21-Jun-13	03-Oct-13
EC.3.2.5.1.3 Level 2		67	05-Jul-13	08-Oct-13
A1710	L2 Layout and Top Track	5	05-Jul-13	11-Jul-13
A1720	L2 Install Framing	10	12-Jul-13	25-Jul-13
A1730	L2 MEP Coring	5	10-Jul-13	16-Jul-13
A1740	L2 Ductwork Rough In	5	15-Jul-13	19-Jul-13
A1750	L2 Sprinkler Rough In	3	19-Jul-13	23-Jul-13
A1760	L2 Electrical Rough In	5	24-Jul-13	30-Jul-13
A1770	L2 Install Hydronic Pipe	5	25-Jul-13	31-Jul-13
A1780	L2 Plumbing Rough In	5	26-Jul-13	01-Aug-13
A1790	L2 Ceiling/Bulkhead Framir	7	31-Jul-13	08-Aug-13
A1800	L2 Install Telecomm	5	01-Aug-13	07-Aug-13
A1810	L2 Hang & Finish Drywall	19	08-Aug-13	04-Sep-13
A1820	L2 MEP & Equipment Trimc	7	05-Sep-13	13-Sep-13
A1830	L2 Install Doors & Hardwar	3	11-Sep-13	13-Sep-13
A1840	L2 Install Flooring	7	18-Sep-13	26-Sep-13
A1850	L2 Final Paint and Punchlis	7	30-Sep-13	08-Oct-13
EC.3.2.5.1.4 Level 1		91	05-Jul-13	11-Nov-13



Actual Level of Effort | Actual Work | Remaining Work | Critical Remaining Work | Milestone | summary

Activity ID	Activity Name	Original Duration	Start	Finish
EC.3.2.5.1.5	**Ground**	120	24-May-13	12-Nov-13
A1860	G Layout and Top Track	5	24-May-13	31-May-13
A1865	Mech Room Fitout	60	30-May-13	22-Aug-13
A1866	G Ductwork Rough In	10	03-Jun-13	14-Jun-13
A1870	G Install Framing	12	13-Jun-13	28-Jun-13
A1880	G Install Hydronic Pipe	5	20-Jun-13	26-Jun-13
A1890	G Instal Telecomm	5	27-Jun-13	03-Jul-13
A1900	G Sprinkler Rough In	20	01-Jul-13	29-Jul-13
A1910	G Electrical Rough In	20	01-Jul-13	29-Jul-13
A1920	G Plumbing Rough In	30	01-Jul-13	12-Aug-13
A1930	G Pipe/Duct Insulation	10	13-Aug-13	26-Aug-13
A1940	G Ceiling/Bulkhead Framin	9	27-Aug-13	09-Sep-13
A1950	G Hang & Finish Drywall	20	10-Sep-13	07-Oct-13
A1960	G MEP & Equipment Trimo	9	08-Oct-13	18-Oct-13
A1970	G Install Doors & Hardware	5	14-Oct-13	18-Oct-13
A1980	G Install Flooring	10	21-Oct-13	01-Nov-13
A1990	G Final Paint and Punchlist	7	04-Nov-13	12-Nov-13
EC.3.2.5.2	**Restrooms**	49	01-Aug-13	09-Oct-13
EC.3.2.5.2.1	**Level 4**	49	01-Aug-13	09-Oct-13
A2000	L4 Framing	5	01-Aug-13	07-Aug-13
A2010	L4 Ductwork Rough In	15	08-Aug-13	28-Aug-13
A2020	L4 Sprinkler Rough In	15	08-Aug-13	28-Aug-13
A2030	L4 Electrical Rough In	15	08-Aug-13	28-Aug-13
A2040	L4 Plumbing Rough In	15	08-Aug-13	28-Aug-13
A2050	L4 Hang & Finish Drywall	9	29-Aug-13	11-Sep-13
A2060	L4 Install Ceramic Tile	15	12-Sep-13	02-Oct-13
A2070	L4 MEP & Equipment Trimc	5	03-Oct-13	09-Oct-13
EC.3.2.5.2.2	**Level 3**	49	01-Aug-13	09-Oct-13
EC.3.2.5.2.3	**Level 2**	49	01-Aug-13	09-Oct-13
EC.3.2.5.2.4	**Level 1**	49	01-Aug-13	09-Oct-13
EC.3.3	**Ewing**	131	22-May-13	25-Nov-13
EC.3.3.1	**Abatement**	18	24-May-13	19-Jun-13
A2080	Abate 4 & 3	9	24-May-13	06-Jun-13
A2090	Abate 2 & 1	9	07-Jun-13	19-Jun-13
EC.3.3.2	**Demolition**	18	07-Jun-13	02-Jul-13
A2100	Demo 4 & 3	9	07-Jun-13	19-Jun-13
A2110	Demo 2 & 1	9	20-Jun-13	02-Jul-13
EC.3.3.3	**Restroom Structure**	48	07-Jun-13	14-Aug-13
A2115	Erect Shoring L1 to L2	10	07-Jun-13	20-Jun-13
A2120	Demo Slab L2	5	21-Jun-13	27-Jun-13
A2130	F/R/P Slab L2	5	28-Jun-13	05-Jul-13
A2140	Erect Shoring L2 to L3	4	08-Jul-13	11-Jul-13
A2150	Demo Slab L3	5	12-Jul-13	18-Jul-13
A2160	F/R/P Slab L3	5	19-Jul-13	25-Jul-13
A2170	Erect Shoring L3 to L4	4	26-Jul-13	31-Jul-13
A2180	Demo Slab L4	5	01-Aug-13	07-Aug-13
A2190	F/R/P Slab L4	5	08-Aug-13	14-Aug-13
EC.3.3.4	**Enclosure**	81	22-May-13	16-Sep-13

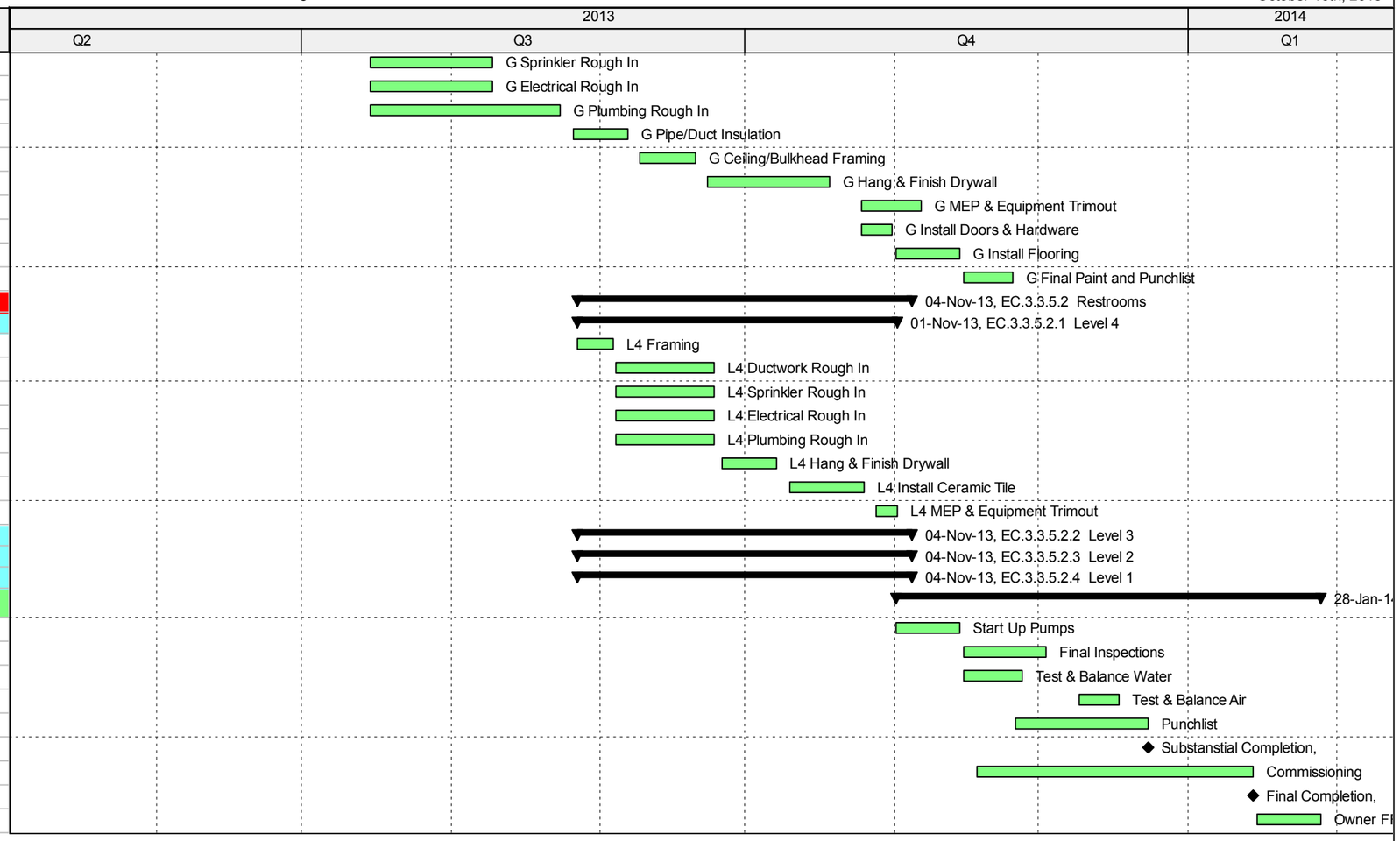


Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

Activity ID	Activity Name	Original Duration	Start	Finish
A2200	Erect Wall Panels	21	22-May-13	20-Jun-13
A2210	Install Roof Trusses	14	24-May-13	13-Jun-13
A2220	Install Windows	25	24-May-13	28-Jun-13
A2230	Install Shingles	28	24-May-13	03-Jul-13
A2240	Erect Stone Panels	25	03-Jun-13	08-Jul-13
A2260	Install Gutters & Downspou	11	30-Aug-13	16-Sep-13
EC.3.3.5 Rough In and Finishes		120	07-Jun-13	25-Nov-13
EC.3.3.5.1 Rooms and Corridors		120	07-Jun-13	25-Nov-13
EC.3.3.5.1.1 Level 4		73	20-Jun-13	02-Oct-13
A2270	L4 Layout and Top Track	5	20-Jun-13	26-Jun-13
A2280	L4 Install Framing	10	27-Jun-13	11-Jul-13
A2290	L4 MEP Coring	5	25-Jun-13	01-Jul-13
A2300	L4 Ductwork Rough In	5	28-Jun-13	05-Jul-13
A2310	L4 Sprinkler Rough In	3	05-Jul-13	09-Jul-13
A2320	L4 Electrical Rough In	5	10-Jul-13	16-Jul-13
A2330	L4 Install Hydronic Pipe	5	11-Jul-13	17-Jul-13
A2340	L4 Plumbing Rough In	5	12-Jul-13	18-Jul-13
A2350	L4 Ceiling/Bulkhead Framir	7	17-Jul-13	25-Jul-13
A2360	L4 Install Telecomm	5	18-Jul-13	24-Jul-13
A2370	L4 Hang & Finish Drywall	19	25-Jul-13	20-Aug-13
A2380	L4 MEP & Equipment Trimc	7	21-Aug-13	29-Aug-13
A2390	L4 Install Doors & Hardwar	3	27-Aug-13	29-Aug-13
A2400	L4 Install Flooring	7	03-Sep-13	11-Sep-13
A2410	L4 Final Paint and Punchlis	8	23-Sep-13	02-Oct-13
EC.3.3.5.1.2 Level 3		75	20-Jun-13	04-Oct-13
EC.3.3.5.1.3 Level 2		71	03-Jul-13	11-Oct-13
A2420	L2 Layout and Top Track	5	03-Jul-13	10-Jul-13
A2430	L2 Install Framing	10	11-Jul-13	24-Jul-13
A2440	L2 MEP Coring	5	09-Jul-13	15-Jul-13
A2450	L2 Ductwork Rough In	5	12-Jul-13	18-Jul-13
A2460	L2 Sprinkler Rough In	3	18-Jul-13	22-Jul-13
A2470	L2 Electrical Rough In	5	23-Jul-13	29-Jul-13
A2480	L2 Install Hydronic Pipe	5	24-Jul-13	30-Jul-13
A2490	L2 Plumbing Rough In	5	25-Jul-13	31-Jul-13
A2500	L2 Ceiling/Bulkhead Framir	7	30-Jul-13	07-Aug-13
A2510	L2 Install Telecomm	5	31-Jul-13	06-Aug-13
A2520	L2 Hang & Finish Drywall	19	07-Aug-13	03-Sep-13
A2530	L2 MEP & Equipment Trimc	7	04-Sep-13	12-Sep-13
A2540	L2 Install Doors & Hardwar	3	10-Sep-13	12-Sep-13
A2550	L2 Install Flooring	7	17-Sep-13	25-Sep-13
A2560	L2 Final Paint and Punchlis	7	03-Oct-13	11-Oct-13
EC.3.3.5.1.4 Level 1		89	03-Jul-13	06-Nov-13
EC.3.3.5.1.5 Ground		120	07-Jun-13	25-Nov-13
A2570	G Layout and Top Track	5	07-Jun-13	13-Jun-13
A2580	Mech Room Fitout	60	12-Jun-13	05-Sep-13
A2590	G Install Framing	10	14-Jun-13	27-Jun-13
A2600	G Install Hydronic Pipe	33	26-Jun-13	12-Aug-13
A2610	G Instal Telecomm	5	11-Jul-13	17-Jul-13

Actual Level of Effort | Actual Work | Remaining Work | Critical Remaining Work | Milestone | summary

Activity ID	Activity Name	Original Duration	Start	Finish
A2620	G Sprinkler Rough In	20	15-Jul-13	09-Aug-13
A2630	G Electrical Rough In	20	15-Jul-13	09-Aug-13
A2640	G Plumbing Rough In	30	15-Jul-13	23-Aug-13
A2650	G Pipe/Duct Insulation	9	26-Aug-13	06-Sep-13
A2660	G Ceiling/Bulkhead Framing	10	09-Sep-13	20-Sep-13
A2670	G Hang & Finish Drywall	20	23-Sep-13	18-Oct-13
A2680	G MEP & Equipment Trimo	9	25-Oct-13	06-Nov-13
A2690	G Install Doors & Hardware	5	25-Oct-13	31-Oct-13
A2700	G Install Flooring	10	01-Nov-13	14-Nov-13
A2710	G Final Paint and Punchlist	7	15-Nov-13	25-Nov-13
EC.3.3.5.2 Restrooms		49	27-Aug-13	04-Nov-13
EC.3.3.5.2.1 Level 4		48	27-Aug-13	01-Nov-13
A2720	L4 Framing	5	27-Aug-13	03-Sep-13
A2730	L4 Ductwork Rough In	15	04-Sep-13	24-Sep-13
A2740	L4 Sprinkler Rough In	15	04-Sep-13	24-Sep-13
A2750	L4 Electrical Rough In	15	04-Sep-13	24-Sep-13
A2760	L4 Plumbing Rough In	15	04-Sep-13	24-Sep-13
A2770	L4 Hang & Finish Drywall	8	26-Sep-13	07-Oct-13
A2780	L4 Install Ceramic Tile	12	10-Oct-13	25-Oct-13
A2790	L4 MEP & Equipment Trimo	5	28-Oct-13	01-Nov-13
EC.3.3.5.2.2 Level 3		49	27-Aug-13	04-Nov-13
EC.3.3.5.2.3 Level 2		49	27-Aug-13	04-Nov-13
EC.3.3.5.2.4 Level 1		49	27-Aug-13	04-Nov-13
EC.4 Closeout and Final Completic		61	01-Nov-13	28-Jan-14
A2800	Start Up Pumps	10	01-Nov-13	14-Nov-13
A2810	Final Inspections	11	15-Nov-13	02-Dec-13
A2820	Test & Balance Water	9	15-Nov-13	27-Nov-13
A2830	Test & Balance Air	7	09-Dec-13	17-Dec-13
A2840	Punchlist	19	26-Nov-13	23-Dec-13
A2850	Substanstial Completion	0		23-Dec-13
A2860	Commissioning	40	18-Nov-13	14-Jan-14
A2870	Final Completion	0		14-Jan-14
A2880	Owner FF&E	10	15-Jan-14	28-Jan-14



APPENDIX B: ASSEMBLIES MEP ESTIMATES & DETAILED STRUCTURAL SYSTEMS ESTIMATE

Penn State

University Park, Pennsylvania, 16802
Date: 07-Sep-13

Ewing-Cross Mechanical
Year 2013 Quarter 3
Assembly Detail Report

Prepared By:
quaid spearing
penn state

Assembly Number		Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
D Services						
D30105301960		Commercial building heating systems, terminal unit heaters, forced hot water, 100,000 SF bldg, 1mil CF, total, 3 floors	71,002.00	S.F.	$3.57	$253,477.14
D30203301010		Pump, base mounted with motor, end-suction, 2-1/2" size, 3 HP, to 150 GPM	4.00	Ea.	$14,681.50	$58,726.00
D30203301020		Pump, base mounted with motor, end-suction, 3" size, 5 HP, to 225 GPM	3.00	Ea.	$16,201.10	$48,603.30
D30203301030		Pump, base mounted with motor, end-suction, 4" size, 7-1/2 HP, to 350 GPM	4.00	Ea.	$19,071.50	$76,286.00
D30401061010		AHU, field fabricated, built up, cool/heat coils, filters, constant volume, 40,000 CFM	2.00	Ea.	$87,857.80	$175,715.60
D30401101010		AHU, central station, cool/heat coils, constant volume, filters, 2,000 CFM	2.00	Ea.	$21,785.75	$43,571.50
D30401181010		Fan coil A/C system, cabinet mounted, controls, 2 pipe, 1/2 ton	155.00	Ea.	$2,219.25	$343,983.75
D30401181020		Fan coil A/C system, cabinet mounted, controls, 2 pipe, 1 ton	8.00	Ea.	$2,608.45	$20,867.60
D30401181050		Fan coil A/C system, cabinet mounted, controls, 2 pipe, 3 ton	3.00	Ea.	$4,699.45	$14,098.35
D30401281010		Fan coil A/C system, horizontal with cabinet, controls, 4 pipe, 1/2 ton	5.00	Ea.	$5,723.05	$28,615.25
D30401281030		Fan coil A/C system, horizontal with cabinet, controls, 4 pipe, 1-1/2 ton	2.00	Ea.	$8,888.55	$17,777.10
D30401281040		Fan coil A/C system, horizontal with cabinet, controls, 4 pipe, 2 ton	2.00	Ea.	$10,209.10	$20,418.20
D30401281050		Fan coil A/C system, horizontal with cabinet, controls, 4 pipe, 3 ton	1.00	Ea.	$13,043.75	$13,043.75
D30401281070		Fan coil A/C system, horizontal with cabinet, controls, 4 pipe, 4 ton	1.00	Ea.	$15,463.75	$15,463.75
D30402201010		Fan system, in-line centrifugal, 500 CFM	3.00	Ea.	$5,188.60	$15,565.80
D30402201020		Fan system, in-line centrifugal, 1300 CFM	2.00	Ea.	$7,507.55	$15,015.10
D30402401010		Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 500 CFM	2.00	Ea.	$2,936.70	$5,873.40
D30406101010		Plate heat exchanger, 400 GPM	4.00	Ea.	$65,337.40	$261,349.60
D Services Subtotal						**$1,428,451.19**

Penn State

University Park, Pennsylvania, 16802
Date: 08-Sep-13

Ewing-Cross Electrical
Year 2013 Quarter 3
Assembly Detail Report

Prepared By:
quaid spearing
penn state

Assembly Number	Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
D Services					
D50101301550	Underground service installation, includes excavation, backfill, and compaction, 100' length, 4' depth, 3 phase, 4 wire, 277/480 volts, 600 A w/switchboard	1.00	Ea.	$26,024.68	$26,024.68
D50102300240	Feeder installation 600 V, including RGS conduit and XHHW wire, 100 A	50.00	L.F.	$25.94	$1,297.00
D50102300280	Feeder installation 600 V, including RGS conduit and XHHW wire, 200 A	600.00	L.F.	$48.77	$29,262.00
D50102300320	Feeder installation 600 V, including RGS conduit and XHHW wire, 400 A	50.00	L.F.	$97.42	$4,871.00
D50102300360	Feeder installation 600 V, including RGS conduit and XHHW wire, 600 A	50.00	L.F.	$169.98	$8,499.00
D50102400240	Switchgear installation, incl switchboard, panels & circuit breaker, 120/208 V, 600 A	1.00	Ea.	$12,831.60	$12,831.60
D50102400520	Switchgear installation, incl switchboard, panels & circuit breaker, 277/480 V, 600 A	1.00	Ea.	$20,698.73	$20,698.73
D50102501040	Panelboard, 4 wire w/conductor & conduit, NQOD, 120/208 V, 100 A, 5 stories, 50' horizontal	1.00		$5,403.98	$5,403.98
D50102502020	Panelboard, 4 wire w/conductor & conduit, NQOD, 120/208 V, 225 A, 5 stories, 50' horizontal	17.00		$10,567.05	$179,639.85
D50201100600	Receptacles incl plate, box, conduit, wire, 16.5 per 1000 SF, 2.0 watts per SF	71,002.00	S.F.	$3.51	$249,217.02
D50201300360	Wall switches, 5.0 per 1000 SF	71,002.00	S.F.	$1.20	$85,202.40
D50201450200	Motor installation, single phase, 115 V, 1/3 HP motor size	5.00	Ea.	$1,523.72	$7,618.60
D50201450280	Motor installation, single phase, 115 V, 2 HP motor size	2.00	Ea.	$1,651.86	$3,303.72
D50201451960	Motor installation, three phase, 460 V, 2 HP motor size	2.00	Ea.	$1,851.59	$3,703.18
D50201452000	Motor installation, three phase, 460 V, 5 HP motor size	5.00	Ea.	$1,988.22	$9,941.10
D50201452040	Motor installation, three phase, 460 V, 10 HP motor size	3.00	Ea.	$2,157.86	$6,473.58
D50201550360	Motor feeder systems, three phase, feed to 200 V 3 HP, 230 V 5 HP, 460 V 10 HP, 575 V 10 HP	500.00	L.F.	$10.19	$5,095.00
D50202100520	Fluorescent fixtures recess mounted in ceiling, 1.6 watt per SF, 40 FC, 10 fixtures @32watt per 1000 SF	71,002.00	S.F.	$5.14	$364,950.28
D50309200106	Internet wiring, 6 data/voice outlets per 1000 S.F.	71.00	M.S.F.	$1,781.09	$126,457.39
D Services Subtotal					**$1,150,490.11**

Penn State

University Park, Pennsylvania, 16802
Date: 07-Sep-13

Ewing-Cross Plumbing
Year 2013 Quarter 3
Assembly Detail Report

Prepared By:
quaid spearing
penn state

Assembly Number		Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
D Services						
D20103102300		Lavatory w/trim, wall hung, vitreous china, 20" x 27", handicap	22.00	Ea.	$1,735.97	$38,191.34
D20104101960		Kitchen sink w/trim, countertop, stainless steel, 33" x 22" double bowl	11.00	Ea.	$2,197.67	$24,174.37
D20104404260		Service sink w/trim, PE on CI, corner floor, 28" x 28", w/rim guard	8.00	Ea.	$3,333.66	$26,669.28
D20108201880		Water cooler, electric, wall hung, dual height, 14.3 GPH	4.00	Ea.	$1,917.47	$7,669.88
D20109222240		Bathroom, lavatory & water closet, 1 wall plumbing, share common plumbing wall*	2.00	Ea.	$2,546.75	$5,093.50
D20109262160		Bathroom, three fixture, 2 wall plumbing, lavatory, water closet & bathtub, stand alone	1.00	Ea.	$4,841.85	$4,841.85
D20109266120		Bathroom, three fixture, 2 wall plumbing, water closet, stall shower & lavatory, stand alone	10.00	Ea.	$5,594.80	$55,948.00
D20109267100		Bathroom, three fixture, 2 wall plumbing, lavatory, corner stall shower & water closet, short plumbing wall common *	32.00	Ea.	$4,371.95	$139,902.40
D20908101220		Copper tubing, hard temper, solder, type K, 1/2" diameter	300.00	L.F.	$12.28	$3,684.00
D20908101260		Copper tubing, hard temper, solder, type K, 3/4" diameter	500.00	L.F.	$17.36	$8,680.00
D20908101280		Copper tubing, hard temper, solder, type K, 1" diameter	200.00	L.F.	$21.87	$4,374.00
D20908101300		Copper tubing, hard temper, solder, type K, 1-1/4" diameter	50.00	L.F.	$26.70	$1,335.00
D20908101320		Copper tubing, hard temper, solder, type K, 1-1/2" diameter	650.00	L.F.	$33.45	$21,742.50
D20908101340		Copper tubing, hard temper, solder, type K, 2" diameter	220.00	L.F.	$48.54	$10,678.80
D20908101360		Copper tubing, hard temper, solder, type K, 2-1/2" diameter	275.00	L.F.	$70.24	$19,316.00
D Services Subtotal						**$372,300.92**

03 Concrete Estimate

RS Means Code	Description	Crew	Daily Output	Labor Hours	Unit	Quantity 1	Quantity 2	Material $/Unit	Labor $/Unit	Equipment $/Unit	Material $	Labor $	Equipment $	Total Cost $
Division 03	**Concrete**													
	Concrete Column Footings													
	Footing F3					18 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.47	8.38	$ 83.91	$ -	$ -	$ 703.08	$ -	$ -	$ 703.08
031113450020	Formwork Plywood	C1	305	0.1	SFCA	17.56	316.01	$ 5.53	$ 4.66	$ -	$ 1,747.52	$ 1,472.60	$ -	$ 3,220.12
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.02	0.30	$ 1,409.81	$ 824.60	$ -	$ 416.87	$ 243.83	$ -	$ 660.69
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	0.47	8.38	$ -	$ 47.33	$ 13.64	$ -	$ 396.58	$ 114.29	$ 510.87
	Footing F3.2					2 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.70	1.40	$ 83.91	$ -	$ -	$ 117.47	$ -	$ -	$ 117.47
031113450020	Formwork Plywood	C1	305	0.1	SFCA	26.40	52.80	$ 5.53	$ 4.66	$ -	$ 291.98	$ 246.05	$ -	$ 538.03
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.02	0.05	$ 1,409.81	$ 824.60	$ -	$ 66.70	$ 39.01	$ -	$ 105.72
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	0.70	1.40	$ -	$ 47.33	$ 13.64	$ -	$ 66.26	$ 19.10	$ 85.36
	Footing F4					11 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.83	9.10	$ 83.91	$ -	$ -	$ 763.84	$ -	$ -	$ 763.84
031113450020	Formwork Plywood	C1	305	0.1	SFCA	23.41	257.49	$ 5.53	$ 4.66	$ -	$ 1,423.91	$ 1,199.89	$ -	$ 2,623.80
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.04	0.42	$ 1,409.81	$ 824.60	$ -	$ 586.98	$ 343.33	$ -	$ 930.31
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	0.83	9.10	$ -	$ 47.33	$ 13.64	$ -	$ 430.85	$ 124.17	$ 555.02
	Footing F4.2					7 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	1.24	8.71	$ 83.91	$ -	$ -	$ 730.95	$ -	$ -	$ 730.95
031113450020	Formwork Plywood	C1	305	0.1	SFCA	35.20	246.40	$ 5.53	$ 4.66	$ -	$ 1,362.59	$ 1,148.22	$ -	$ 2,510.82
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.04	0.31	$ 1,409.81	$ 824.60	$ -	$ 435.79	$ 254.89	$ -	$ 690.68
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	1.24	8.71	$ -	$ 47.33	$ 13.64	$ -	$ 412.30	$ 118.82	$ 531.12

RS Means Code	Description	Crew	Daily Output	Labor Hours	Unit	Quantity 1	Quantity 2	Material $/Unit	Labor $/Unit	Equipment $/Unit	Material $	Labor $	Equipment $	Total Cost $
Division 03	**Concrete**													
	Concrete Wall Footings													
	Wall Footing CF2.0/C-SE					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	3.63	3.63	$ 83.91	$ -	$ -	$ 304.55	$ -	$ -	$ 304.55
031113450020	Formwork Plywood	C1	375	0.09	SFCA	111.45	111.45	$ 5.53	$ 4.66	$ -	$ 616.33	$ 519.37	$ -	$ 1,135.70
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.06	0.06	$ 1,409.81	$ 824.60	$ -	$ 91.09	$ 53.28	$ -	$ 144.37
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	3.63	3.63	$ -	$ 47.33	$ 13.64	$ -	$ 171.78	$ 49.51	$ 221.29
	Wall Footing CF4.0/C-SC					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	7.87	7.87	$ 83.91	$ -	$ -	$ 660.20	$ -	$ -	$ 660.20
031113450020	Formwork Plywood	C1	375	0.09	SFCA	129.80	129.80	$ 5.53	$ 4.66	$ -	$ 717.79	$ 604.87	$ -	$ 1,322.66
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.25	0.25	$ 1,409.81	$ 824.60	$ -	$ 353.17	$ 206.57	$ -	$ 559.75
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	7.87	7.87	$ -	$ 47.33	$ 13.64	$ -	$ 372.39	$ 107.32	$ 479.71
	Wall Footing CF4.0/E-SC					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	8.61	8.61	$ 83.91	$ -	$ -	$ 722.33	$ -	$ -	$ 722.33
031113450020	Formwork Plywood	C1	375	0.09	SFCA	139.35	139.35	$ 5.53	$ 4.66	$ -	$ 770.59	$ 649.36	$ -	$ 1,419.96
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.27	0.27	$ 1,409.81	$ 824.60	$ -	$ 386.41	$ 226.01	$ -	$ 612.42
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	8.61	8.61	$ -	$ 47.33	$ 13.64	$ -	$ 407.44	$ 117.42	$ 524.86
	Wall Footing CF4.0/C-NE, E-NW					2 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	14.52	29.03	$ 83.91	$ -	$ -	$ 2,435.95	$ -	$ -	$ 2,435.95
031113450020	Formwork Plywood	C1	375	0.09	SFCA	138.60	277.20	$ 5.53	$ 4.66	$ -	$ 1,532.92	$ 1,291.75	$ -	$ 2,824.67
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.41	0.81	$ 1,409.81	$ 824.60	$ -	$ 1,144.08	$ 669.17	$ -	$ 1,813.25
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	14.52	29.03	$ -	$ 47.33	$ 13.64	$ -	$ 1,374.02	$ 395.98	$ 1,769.99
	Wall Footing CF4.0/C-NC, E-NC					2 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	25.82	51.64	$ 83.91	$ -	$ -	$ 4,333.49	$ -	$ -	$ 4,333.49
031113450020	Formwork Plywood	C1	375	0.09	SFCA	174.55	349.10	$ 5.53	$ 4.66	$ -	$ 1,930.50	$ 1,626.79	$ -	$ 3,557.29
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.61	1.22	$ 1,409.81	$ 824.60	$ -	$ 1,713.24	$ 1,002.08	$ -	$ 2,715.32
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	25.82	51.64	$ -	$ 47.33	$ 13.64	$ -	$ 2,444.33	$ 704.43	$ 3,148.76
	Wall Footing CF2.0/E-SE					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	5.25	5.25	$ 83.91	$ -	$ -	$ 440.53	$ -	$ -	$ 440.53
031113450020	Formwork Plywood	C1	375	0.09	SFCA	157.30	157.30	$ 5.53	$ 4.66	$ -	$ 869.87	$ 733.02	$ -	$ 1,602.89
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.09	0.09	$ 1,409.81	$ 824.60	$ -	$ 130.27	$ 76.19	$ -	$ 206.46
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	5.25	5.25	$ -	$ 47.33	$ 13.64	$ -	$ 248.48	$ 71.61	$ 320.09
	Wall Footing CF2.0/Stairs					2 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	3.93	7.86	$ 83.91	$ -	$ -	$ 659.36	$ -	$ -	$ 659.36
031113450020	Formwork Plywood	C1	375	0.09	SFCA	112.20	224.40	$ 5.53	$ 4.66	$ -	$ 1,240.93	$ 1,045.70	$ -	$ 2,286.64
032110600500	Reinforcing, Grade 60	4 Rodm	2.1	15.24	Ton	0.11	0.21	$ 1,409.81	$ 824.60	$ -	$ 296.06	$ 173.17	$ -	$ 469.23
033105702450	Placement, Pumped	C20	65	0.98	C.Y.	3.93	7.86	$ -	$ 47.33	$ 13.64	$ -	$ 371.91	$ 107.18	$ 479.10

RS Means Code	Description	Crew	Daily Output	Labor Hours	Unit	Quantity 1	Quantity 2	Material $/Unit	Labor $/Unit	Equipment $/Unit	Material $	Labor $	Equipment $	Total Cost $
Division 03	**Concrete**													
	Concrete Foundation Walls													
	Concrete Wall/C-SE					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	1.59	1.59	$ 83.91	$ -	$ -	$ 133.10	$ -	$ -	$ 133.10
031113852000	Formwork Plywood to 8' high	C2	370	0.13	SFCA	123.94	123.94	$ 2.29	$ 4.89	$ -	$ 283.82	$ 606.05	$ -	$ 889.87
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	0.14	0.14	$ 1,409.81	$ 575.05	$ -	$ 197.01	$ 80.36	$ -	$ 277.36
033105704950	Placement, Pumped 8" thick	C20	100	0.64	C.Y.	1.59	1.59	$ -	$ 26.80	$ 8.83	$ -	$ 42.51	$ 14.01	$ 56.52
	Concrete Wall/C-SE					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	6.56	6.56	$ 83.91	$ -	$ -	$ 550.40	$ -	$ -	$ 550.40
031113852400	Formwork Plywood 8-16' high	C2	280	0.17	SFCA	512.71	512.71	$ 2.52	$ 6.47	$ -	$ 1,292.03	$ 3,317.23	$ -	$ 4,609.26
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	0.44	0.44	$ 1,409.81	$ 575.05	$ -	$ 613.88	$ 250.40	$ -	$ 864.28
033105704950	Placement, Pumped 8" thick	C20	100	0.64	C.Y.	6.56	6.56	$ -	$ 26.80	$ 8.83	$ -	$ 175.79	$ 57.92	$ 233.71
	Concrete Wall/C-SC					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	8.72	8.72	$ 83.91	$ -	$ -	$ 731.44	$ -	$ -	$ 731.44
031113852000	Formwork Plywood to 8' high	C2	370	0.13	SFCA	471.23	471.23	$ 2.29	$ 4.89	$ -	$ 1,079.11	$ 2,304.31	$ -	$ 3,383.42
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	0.83	0.83	$ 1,409.81	$ 575.05	$ -	$ 1,171.31	$ 477.77	$ -	$ 1,649.08
033105705100	Placement, Pumped 12" thick	C20	110	0.58	C.Y.	8.72	8.72	$ -	$ 26.80	$ 8.04	$ -	$ 233.61	$ 70.08	$ 303.70
	Concrete Wall/C-SC					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	3.18	3.18	$ 83.91	$ -	$ -	$ 267.16	$ -	$ -	$ 267.16
031113852000	Formwork Plywood to 8' high	C2	370	0.13	SFCA	275.96	275.96	$ 2.29	$ 4.89	$ -	$ 631.94	$ 1,349.43	$ -	$ 1,981.37
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	0.22	0.22	$ 1,409.81	$ 575.05	$ -	$ 312.31	$ 127.39	$ -	$ 439.70
033105704950	Placement, Pumped 8" thick	C20	100	0.64	C.Y.	3.18	3.18	$ -	$ 26.80	$ 8.83	$ -	$ 85.33	$ 28.11	$ 113.44
	Concrete Wall/E-SC					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	4.67	4.67	$ 83.91	$ -	$ -	$ 391.58	$ -	$ -	$ 391.58
031113852000	Formwork Plywood to 8' high	C2	370	0.13	SFCA	253.00	253.00	$ 2.29	$ 4.89	$ -	$ 579.37	$ 1,237.17	$ -	$ 1,816.54
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	0.33	0.33	$ 1,409.81	$ 575.05	$ -	$ 461.92	$ 188.41	$ -	$ 650.34
033105705100	Placement, Pumped 12" thick	C20	110	0.58	C.Y.	4.67	4.67	$ -	$ 26.80	$ 8.04	$ -	$ 125.07	$ 37.52	$ 162.59
	Concrete Wall/C-NE, E-NW					2 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	2.20	4.39	$ 83.91	$ -	$ -	$ 368.48	$ -	$ -	$ 368.48
031113852000	Formwork Plywood to 8' high	C2	370	0.13	SFCA	176.00	352.00	$ 2.29	$ 4.89	$ -	$ 806.08	$ 1,721.28	$ -	$ 2,527.36
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	0.18	0.36	$ 1,409.81	$ 575.05	$ -	$ 513.07	$ 209.28	$ -	$ 722.35
033105705100	Placement, Pumped 12" thick	C20	110	0.58	C.Y.	2.20	4.39	$ -	$ 26.80	$ 8.04	$ -	$ 117.69	$ 35.31	$ 152.99
	Concrete Wall/C-NC, E-NC					2 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	5.13	10.27	$ 83.91	$ -	$ -	$ 861.45	$ -	$ -	$ 861.45
031113852000	Formwork Plywood to 8' high	C2	370	0.13	SFCA	277.75	555.50	$ 2.29	$ 4.89	$ -	$ 1,272.10	$ 2,716.40	$ -	$ 3,988.49
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	0.44	0.87	$ 1,409.81	$ 575.05	$ -	$ 1,233.25	$ 503.03	$ -	$ 1,736.29
033105705100	Placement, Pumped 12" thick	C20	110	0.58	C.Y.	5.13	10.27	$ -	$ 26.80	$ 8.04	$ -	$ 275.14	$ 82.54	$ 357.68
	Concrete Wall/E-SE					1 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	10.91	10.91	$ 83.91	$ -	$ -	$ 915.19	$ -	$ -	$ 915.19
031113852400	Formwork Plywood 8-16' high	C2	280	0.17	SFCA	940.74	940.74	$ 2.52	$ 4.89	$ -	$ 2,370.67	$ 4,600.23	$ -	$ 6,970.90
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	1.19	1.19	$ 1,409.81	$ 575.05	$ -	$ 1,675.49	$ 683.42	$ -	$ 2,358.91
033105704950	Placement, Pumped 8" thick	C20	100	0.64	C.Y.	10.91	10.91	$ -	$ 26.80	$ 8.83	$ -	$ 292.30	$ 96.31	$ 388.61
	Concrete Wall/E-SE													
033105350150	Concrete Material 3000psi		0	0	C.Y.	1.61	1.61	$ 83.91	$ -	$ -	$ 135.32	$ -	$ -	$ 135.32
031113852000	Formwork Plywood to 8' high	C2	370	0.13	SFCA	87.48	87.48	$ 2.29	$ 4.89	$ -	$ 200.34	$ 427.79	$ -	$ 628.13
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	0.10	0.10	$ 1,409.81	$ 575.05	$ -	$ 136.26	$ 55.58	$ -	$ 191.84
033105705100	Placement, Pumped 12" thick	C20	110	0.58	C.Y.	1.61	1.61	$ -	$ 26.80	$ 8.04	$ -	$ 43.22	$ 12.97	$ 56.19
	Concrete Wall/Stairs					2 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	2.15	4.30	$ 83.91	$ -	$ -	$ 360.45	$ -	$ -	$ 360.45
031113852000	Formwork Plywood to 8' high	C2	370	0.13	SFCA	115.50	231.00	$ 2.29	$ 4.89	$ -	$ 528.99	$ 1,129.59	$ -	$ 1,658.58
032110600700	Reinforcing, Grade 60	4 Rodm	3	10.67	Ton	0.08	0.16	$ 1,409.81	$ 575.05	$ -	$ 229.45	$ 93.59	$ -	$ 323.04
033105705100	Placement, Pumped 12" thick	C20	110	0.58	C.Y.	2.15	4.30	$ -	$ 26.80	$ 8.04	$ -	$ 115.12	$ 34.54	$ 149.66

RS Means Code	Description	Crew	Daily Output	Labor Hours	Unit	Quantity 1	Quantity 2	Material $/Unit	Labor $/Unit	Equipment $/Unit	Material $	Labor $	Equipment $	Total Cost $
Division 03	**Concrete**													
	Concrete Piers													
	16x16; 10.88' height					2.00								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.75	1.50	$ 83.91	$ -	$ -	$ 125.57	$ -	$ -	$ 125.57
031113256000	Formwork Plywood 16x16	C1	185	0.17	SFCA	63.67	127.34	$ 2.38	$ 7.70	$ -	$ 303.06	$ 980.49	$ -	$ 1,283.55
032110600200	Reinforcing, Grade 60	4 Rodm	1.5	21.33	Ton	0.07	0.13	$ 1,409.81	$ 1,139.25	$ -	$ 186.25	$ 150.51	$ -	$ 336.76
033105700600	Placement, Pumped	C20	90	0.71	C.Y.	0.75	1.50	$ -	$ 31.78	$ 9.85	$ -	$ 47.56	$ 14.74	$ 62.30
	16x16; 6' height					8.00								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.41	3.32	$ 83.91	$ -	$ -	$ 278.54	$ -	$ -	$ 278.54
031113256000	Formwork Plywood 16x16	C1	185	0.17	SFCA	35.31	282.48	$ 2.38	$ 7.70	$ -	$ 672.30	$ 2,175.10	$ -	$ 2,847.40
032110600200	Reinforcing, Grade 60	4 Rodm	1.5	21.33	Ton	0.05	0.40	$ 1,409.81	$ 1,139.25	$ -	$ 559.55	$ 452.17	$ -	$ 1,011.72
033105700600	Placement, Pumped	C20	90	0.71	C.Y.	0.41	3.32	$ -	$ 31.78	$ 9.85	$ -	$ 105.50	$ 32.70	$ 138.19
	24x24; 6' height					4.00								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.93	3.73	$ 83.91	$ -	$ -	$ 313.26	$ -	$ -	$ 313.26
031113256500	Formwork Plywood 24x24	C1	190	0.17	SFCA	52.80	211.20	$ 2.65	$ 7.70	$ -	$ 559.68	$ 1,626.24	$ -	$ 2,185.92
032110600200	Reinforcing, Grade 60	4 Rodm	1.5	21.33	Ton	0.09	0.34	$ 1,409.81	$ 1,139.25	$ -	$ 485.44	$ 392.28	$ -	$ 877.72
033105700600	Placement, Pumped	C20	90	0.71	C.Y.	0.93	3.73	$ -	$ 31.78	$ 9.85	$ -	$ 118.65	$ 36.77	$ 155.42
	24x24; 3' height					6.00								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.47	2.80	$ 83.91	$ -	$ -	$ 234.95	$ -	$ -	$ 234.95
031113256500	Formwork Plywood 24x24	C1	190	0.17	SFCA	26.40	158.40	$ 2.65	$ 7.70	$ -	$ 419.76	$ 1,219.68	$ -	$ 1,639.44
032110600200	Reinforcing, Grade 60	4 Rodm	1.5	21.33	Ton	0.04	0.26	$ 1,409.81	$ 1,139.25	$ -	$ 364.15	$ 294.27	$ -	$ 658.42
033105700600	Placement, Pumped	C20	90	0.71	C.Y.	0.47	2.80	$ -	$ 31.78	$ 9.85	$ -	$ 88.98	$ 27.58	$ 116.56

RS Means Code	Description	Crew	Daily Output	Labor Hours	Unit	Quantity 1	Quantity 2	Material $/Unit	Labor $/Unit	Equipment $/Unit	Material $	Labor $	Equipment $	Total Cost $
Division 03	**Concrete**													
	Concrete Columns													
	Columns CC1					14.00								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.52	7.26	$ 83.91	$ -	$ -	$ 608.97	$ -	$ -	$ 608.97
031113255500	Formwork Plywood 12x12	C1	180	0.18	SFCA	58.65	821.13	$ 2.44	$ 7.91	$ -	$ 2,003.55	$ 6,495.12	$ -	$ 8,498.67
032110600200	Reinforcing, Grade 60	4 Rodm	1.5	21.33	Ton	0.09	1.20	$ 1,409.81	$ 1,139.25	$ -	$ 1,698.04	$ 1,372.16	$ -	$ 3,070.20
033105700600	Placement, Pumped	C20	90	0.71	C.Y.	0.52	7.26	$ -	$ 31.78	$ 9.85	$ -	$ 230.64	$ 71.49	$ 302.13
	Columns CC2					4.00								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.71	2.82	$ 83.91	$ -	$ -	$ 236.91	$ -	$ -	$ 236.91
031113255500	Formwork Plywood 14x14	C1	180	0.18	SFCA	68.42	273.68	$ 2.44	$ 7.91	$ -	$ 667.78	$ 2,164.81	$ -	$ 2,832.59
032110600200	Reinforcing, Grade 60	4 Rodm	1.5	21.33	Ton	0.09	0.34	$ 1,409.81	$ 1,139.25	$ -	$ 485.15	$ 392.05	$ -	$ 877.20
033105700600	Placement, Pumped	C20	90	0.71	C.Y.	0.71	2.82	$ -	$ 31.78	$ 9.85	$ -	$ 89.73	$ 27.81	$ 117.54

RS Means Code	Description	Crew	Daily Output	Labor Hours	Unit	Quantity 1	Quantity 2	Material $/Unit	Labor $/Unit	Equipment $/Unit	Material $	Labor $	Equipment $	Total Cost $
Division 03	**Concrete**													
	Concrete Beams													
	Beam CB1					11 ea								
033105350150	Concrete Material 3000psi		0	0	C.Y.	0.34	3.74	$ 83.91	$ -	$ -	$ 314.08	$ -	$ -	$ 314.08
031113200500	Formwork Plywood	C2	225	0.21	SFCA	29.70	326.70	$ 2.65	$ 8.05	$ -	$ 865.76	$ 2,629.94	$ -	$ 3,495.69
032110600100	Reinforcing, Grade 60	4 Rodm	1.6	20	Ton	0.04	0.40	$ 1,409.81	$ 1,079.58	$ -	$ 561.20	$ 429.75	$ -	$ 990.95

RS Means Code	Description	Crew	Daily Output	Labor Hours	Unit	Quantity 1	Quantity 2	Material $/Unit	Labor $/Unit	Equipment $/Unit	Material $	Labor $	Equipment $	Total Cost $
Division 03	**Concrete**													
	Slab on Grade													
	Concrete Slab/North Walkway					1 ea								
033053404700	slab on grade, 4000 psi	C14E	92	0.957	C.Y.	46.18	46.18	$ 98.61	$ 28.69	$ 0.41	$ 4,554.25	$ 1,325.03	$ 18.94	$ 5,898.22
033529300200	Finish, bull float and manual float	C10	1265	0.02	S.F.	1187.60	1187.60	$ -	$ 0.53	$ -	$ -	$ 629.43	$ -	$ 629.43
030130620010	Slab on Grade Patching	1 Cert	100	0.08	S.F.	2100.00	2100.00	$ 7.71	$ 2.88		$ 16,191.00	$ 6,048.00	$ -	$ 22,239.00
	Elevated Concrete Slab													
	4" Slab/South Porch					2.00								
033105350300	Concrete Material 4000psi		0	0	C.Y.	4.34	8.69	$ 88.23	$ -	$ -	$ 766.32	$ -	$ -	$ 766.32
031113351000	Formwork Plywood, 1 use	C2	470	0.102	S.F.	467.50	935.00	$ 3.18	$ 3.85	$ -	$ 2,973.30	$ 3,599.75	$ -	$ 6,573.05
032110600400	Reinforcing, Grade 60	4 Rodm	2.9	11.03	Ton	0.30	0.60	$ 1,374.17	$ 596.75	$ -	$ 827.58	$ 359.39	$ -	$ 1,186.96
033105701400	Placement, Pumped, < 6"	C20	140	0.46	C.Y.	4.34	8.69	$ -	$ 19.14	$ 6.34	$ -	$ 166.24	$ 55.07	$ 221.31
032205500200	WWF W2.1xW2.1	2 Rodm	31	0.52	C.S.F.	3.52	7.04	$ 16.27	$ 27.67	$ -	$ 114.46	$ 194.66	$ -	$ 309.12
033529300200	Finish, bull float and manual float	C10	1265	0.02	S.F.	335.00	670.00	$ -	$ 0.78	$ -	$ -	$ 522.60	$ -	$ 522.60
	6" Slab/South Porch					1.00								
033105350300	Concrete Material 4000psi		0	0	C.Y.	5.09	5.09	$ 88.23	$ -	$ -	$ 449.48	$ -	$ -	$ 449.48
031113351000	Formwork Plywood, 1 use	C2	470	0.102	S.F.	327.80	327.80	$ 3.18	$ 3.85	$ -	$ 1,042.40	$ 1,262.03	$ -	$ 2,304.43
032110600400	Reinforcing, Grade 60	4 Rodm	2.9	11.03	Ton	0.23	0.23	$ 1,374.17	$ 596.75	$ -	$ 313.10	$ 135.97	$ -	$ 449.07
033105701500	Placement, Pumped 6"-10"	C20	160	0.4	C.Y.	5.09	5.09	$ -	$ 16.75	$ 5.54	$ -	$ 85.33	$ 28.22	$ 113.56
032205500300	WWF W2.5xW2.5	2 Rodm	29	0.55	C.S.F.	2.76	2.76	$ 21.11	$ 29.84	$ -	$ 58.30	$ 82.40	$ -	$ 140.70
033529300200	Finish, bull float and manual float	C10	1265	0.02	S.F.	263.00	263.00	$ -	$ 0.78	$ -	$ -	$ 205.14	$ -	$ 205.14
	8" Slab/South Porch					4.00								
033105350300	Concrete Material 4000psi		0	0	C.Y.	9.48	37.91	$ 88.23	$ -	$ -	$ 3,344.84	$ -	$ -	$ 3,344.84
031113351000	Formwork Plywood, 1 use	C2	470	0.102	S.F.	508.86	2035.44	$ 3.18	$ 3.85	$ -	$ 6,472.70	$ 7,836.44	$ -	$ 14,309.14
032110600400	Reinforcing, Grade 60	4 Rodm	2.9	11.03	Ton	0.50	2.01	$ 1,374.17	$ 596.75	$ -	$ 2,757.70	$ 1,197.57	$ -	$ 3,955.27
033105701500	Placement, Pumped 6"-10"	C20	160	0.4	C.Y.	9.48	37.91	$ -	$ 16.75	$ 5.54	$ -	$ 635.00	$ 210.02	$ 845.02
033529300200	Finish, bull float and manual float	C10	1265	0.02	S.F.	366.00	1464.00	$ -	$ 0.78	$ -	$ -	$ 1,141.92	$ -	$ 1,141.92
	Restroom Slab					6.00								
033105350300	Concrete Material 4000psi		0	0	C.Y.	6.61	39.67	$ 88.23	$ -	$ -	$ 3,499.79	$ -	$ -	$ 3,499.79
032110600400	Reinforcing, Grade 60	4 Rodm	2.9	11.03	Ton	0.74	4.42	$ 1,374.17	$ 596.75	$ -	$ 6,067.88	$ 2,635.05	$ -	$ 8,702.93
033105701500	Placement, Pumped 6"-10"	C20	160	0.4	C.Y.	6.61	39.67	$ -	$ 16.75	$ 5.54	$ -	$ 664.42	$ 219.75	$ 884.17
033529300200	Finish, bull float and manual float	C10	1265	0.02	S.F.	310.00	1860.00	$ -	$ 0.53	$ -	$ -	$ 985.80	$ -	$ 985.80
031113351100	Formwork & Shoring, 3 use	C2	545	0.09	S.F.	310.00	620.00	$ 1.28	$ 3.32	$ -	$ 793.60	$ 2,058.40	$ -	$ 2,852.00
	Slab on Composite Deck													
033116100820	LW 3 1/4" Concrete				C.Y.	1.84	14.75	$ 121.97			$ 1,799.60	$ -	$ -	$ 1,799.60
053113505900	3" deep 28 ga. Decking	E4	2850	0.011	SF	183.75	1470.00	$ 3.00	$ 0.70	$ 0.06	$ 4,410.00	$ 1,029.00	$ 88.20	$ 5,527.20
033105701500	Placement, Pumped 6"-10"	C20	160	0.4	C.Y.	1.84	14.75	$ -	$ 16.75	$ 5.54	$ -	$ 247.14	$ 81.74	$ 328.88
032205500300	WWF W2.5xW2.5	2 Rodm	29	0.55	C.S.F.	1.84	14.70	$ 21.11	$ 29.84	$ -	$ 310.32	$ 438.65	$ -	$ 748.97
033529300200	Finish, bull float and manual float	C10	1265	0.02	S.F.	183.75	1470.00	$ -	$ 0.53	$ -	$ -	$ 779.10	$ -	$ 779.10
	Topping Slab													
033529300600	1" Topping Restroom Slabs	C10B	750	0.053	S.F.	6000.00	6000.00	$ 0.78	$ 2.60	$ 0.60	$ 4,680.00	$ 15,600.00	$ 3,600.00	$ 23,880.00
	Concrete Stairs													
033053406800	South Porch Stairs	C14H	750	0.053	S.F.	340	340	$ 6.58	$ 40.00	$ 5.54	$ 2,237.20	$ 13,600.00	$ 1,883.60	$ 17,720.80
	Equipment													
015433102120	Concrete Truck with Pump		0	0	Week	10	10	$ 27.56	$ 984.84	$ 4,051.26	$ 275.60	$ 9,848.40	$ 40,512.60	$ 50,636.60

Concrete Estimate Summary								
Item		**Material**		**Labor**		**Equipment**		**Total**
Subtotal		$ 126,183.72		$ 139,041.65		$ 49,363.63		$ 314,588.99
Tax (6%)		$ 7,571.02						$ 7,571.02
O & P (10%)		$ 13,375.47		$ 13,904.16		$ 4,936.36		$ 32,216.00
Grand Total		$ 147,130.21		$ 152,945.81		$ 54,299.99		**$ 354,376.02**

05 Metals Estimate

RS Means Code	Description	Crew	Daily Output	Labor Hours	Unit	Quantity 1	Quantity 2	Material $/Unit	Labor $/Unit	Equipment $/Unit	Material $	Labor $	Equipment $	Total Cost $
Division 05	**Metals**													
	Structural Steel Columns													
051223174500	Column C1, 4x4x1/4 w/ baseplate	E2	58	0.97	Ea.	30.00	30.00	$ 200.38	$ 57.24	$ 30.00	$ 6,011.40	$ 1,717.20	$ 900.00	$ 8,628.60
051223174500	Column C2, 4x4x1/2 w/ baseplate	E2	58	0.97	Ea.	15.00	15.00	$ 200.38	$ 57.24	$ 30.00	$ 3,005.70	$ 858.60	$ 450.00	$ 4,314.30
051223174600	Column C3, 8x8x3/8 w/ baseplate	E2	50	1.12	Ea.	5.00	5.00	$ 708.32	$ 66.28	$ 34.53	$ 3,541.60	$ 331.40	$ 172.65	$ 4,045.65
051223175600	Column C4, 8x4x3/8 w/ baseplate	E2	54	1.04	Ea.	10.00	10.00	$ 442.70	$ 61.46	$ 31.70	$ 4,427.00	$ 614.60	$ 317.00	$ 5,358.60
051223174500	Column C5, 4x4x1/4 w/ baseplate	E2	58	0.97	Ea.	5.00	5.00	$ 200.38	$ 57.24	$ 30.00	$ 1,001.90	$ 286.20	$ 150.00	$ 1,438.10
	Structural Steel Roof Members													
051223175600	HSS 7x4x3/8; 12' lengths	E2	54	1.04	Ea.	35.00	35.00	$ 442.70	$ 61.46	$ 31.70	$ 15,494.50	$ 2,151.10	$ 1,109.50	$ 18,755.10
051223174500	HSS 4 1/2x4 1/2x3/8; 12' lengths	E2	58	0.97	Ea.	50.00	50.00	$ 200.38	$ 57.24	$ 30.00	$ 10,019.00	$ 2,862.00	$ 1,500.00	$ 14,381.00
051223176850	W8x28	E2	1080	0.05	L.F.	136.00	136.00	$ 41.47	$ 3.06	$ 1.60	$ 5,639.92	$ 416.16	$ 217.60	$ 6,273.68
051223201200	C6x13	E4	255	0.13	L.F.	20.00	20.00	$ 12.63	$ 7.65	$ 0.63	$ 252.60	$ 153.00	$ 12.60	$ 418.20
051223201300	C8x11.5	E4	225	0.14	L.F.	25.00	25.00	$ 17.43	$ 8.68	$ 0.72	$ 435.75	$ 217.00	$ 18.00	$ 670.75
051223200300	L4x4x1/4	E4	275	0.12	L.F.	35	35	$ 12.63	$ 7.11	$ 0.59	$ 442.05	$ 248.85	$ 20.65	$ 711.55
	Roof Decking													
053123503450	2" 2C Conform Roof Decking	E4	3400	0.01	S.F.	3752.58	3752.58	$ 3.47	$ 0.59	$ 0.05	$ 13,021.47	$ 2,214.02	$ 187.63	$ 15,423.12
	Cold Formed Roof Trusses					8 ea								
054413602120	18 ga. 16' spans	2 Carp	8	2	Ea.	7.00	56.00	$ 85.93	$ 109.44	$ -	$ 4,812.08	$ 6,128.64	$ -	$ 10,940.72
054413602130	18 ga. 20' spans	2 Carp	7	2.29	Ea.	4.00	32.00	$ 107.42	$ 125.25	$ -	$ 3,437.44	$ 4,008.00	$ -	$ 7,445.44
054413602140	18 ga. 24' spans	2 Carp	7	2.29	Ea.	5.00	40.00	$ 128.90	$ 125.25	$ -	$ 5,156.00	$ 5,010.00	$ -	$ 10,166.00
	Metal Railing													
055213502010	Metal Railing 4 1/2" OC at 42" high	E4	120	0.27	L.F.	538.01	538.01	$ 167.33	$ 16.02	$ 1.36	$ 90,025.13	$ 8,618.91	$ 731.69	$ 99,375.73
	Equipment													
015419500100	12-ton truck-mounted hydraulic crane	A3H	1	8	Day	40.00	40.00		$ 370.50	$ 967.86	$ -	$ 14,820.00	$ 38,714.40	$ 53,534.40

Metals Estimate Summary

Item	Material	Labor	Equipment	Total
Subtotal	$ 166,724	$ 50,656	$ 44,502	$ 261,881
Tax (6%)	$ 10,003			$ 10,003
O & P (10%)	$ 17,673	$ 5,066	$ 4,450	$ 27,188
Grand Total	$ 194,400	$ 55,721	$ 48,952	**$ 299,073**

Concrete Columns and Footings									
Item	Concrete					Horiztonal Rebar		Vertical Rebar	
Column Footings	Quantity	Width	Length	Thickness	Volume (CF)	Length	Type	Length	Type
F3	18	3	3	1.33	11.97	30	#5	-	-
F3.2	2	3	3	2	18	30	#6	-	-
F4	11	4	4	1.33	21.28	48	#6	-	-
F4.2	7	4	4	2	32	56	#6	-	-
Concrete Columns	**Quantity**	**Width**	**Length**	**Height**	**Volume (CF)**	**Length**	**Type**	**Length**	**Type**
CC1	14	12	12	13.33	13.33	53.32	#7	80	#4
CC2	4	14	14	13.33	18.15	53.32	#7	80	#4
Concrete Piers	**Quantity**	**Width**	**Length**	**Height**	**Volume (CF)**	**Length**	**Type**	**Length**	**Type**
16x16	2	16	16	10.88	19.24	87.0	#6	58.6	#4
16x16	1	16	16	6.03	10.67	48.3	#6	32.0	#4
16x16	2	16	16	5.03	8.89	40.2	#6	26.7	#4
16x16	3	16	16	4.02	7.11	32.2	#6	21.3	#4
16x16	2	16	16	3.01	5.33	24.1	#6	16.0	#4
24x24	1	24	24	6.00	24	48.0	#7	96.0	#4
24x24	2	24	24	5.00	20	40.0	#7	80.0	#4
24x24	4	24	24	3.00	12	24.0	#7	48.0	#4
16x24	1	16	24	1.38	3.67	11.0	#7	32.0	#4
16x24	1	16	24	4.88	12.97	39.0	#7	80.0	#4
16x24	1	16	24	1.69	4.5	13.5	#7	32.0	#4

Stone Panel Projections Structure																	
Name	Quantity	Height	Length	Thickness	Area	Volume	Horiztontal Rebar				Vertical Rebar				Dowels	
							Length	Type	Length	Type	Length	Type	Length	Type	Length	Type
Wall Footing CF2.0 C-SE	1	2	23.33	2	46.67	93.33	70	#5	-	-	48	#5	-	-	-	-
Concrete Wall C-SE	1	2.63	20.67	0.75	54.38	40.79	81.7	#5	-	-	110.5	#5	-	-	63	#5
Concrete Wall C-SE	1	10.88	20.67	0.75	225.04	168.67	338.2	#5	-	-	457.0	#5	-	-	-	-
Wall Footing CF4.0 C-SC	1	4	25.29	2	50.58	202.32	177	#6	126.5	#5	136	#5	76.1	#5	-	-
Concrete Wall C-SC	2	6.67	31.03	1.083	206.9701	224.1486	434.42	#5	-	-	413.54	#5	-	-	280	#6
Concrete Wall C-SC	1	4.3	28.416	0.67	122.1888	81.8665	284.16	#5	-	-	120.4	#5	-	-	-	-
Wall Footing CF4.0 E-SC	1	4	27.67	2	55.34	221.36	193.7	#6	138.4	#5	147.6	#5	83.2	#5	-	-
Concrete Wall E-SC	1	3.89	28.468	1.083	110.81	120	227.744	#5	-	-	225.62	#5	-	-	145	#5
Wall Footing CF4.0 C-NE, E-NW	1	8	23.33	2	186.64	373.28	163.31	#6	116.65	#5	248.8533333	#5	140.3308	#5	-	-
Concrete Wall C-NE, E-NW	1	3.66	20.67	1.167	75.66	56.46	153.72	#5	-	-	115.5789474	#5	-	-	63	#5
Wall Footing CF4.0 C-NC, E-NC	1	12	27.67	2	332	664	193.69	#6	138.35	#5	442.72	#5	249.6541	#5	-	-
Concrete Wall C-NC, E-NC	1	4	30.47	1.083	121.88	131.996	243.76	#5	-	-	248	#5	-	-	310	#5
Wall Footing CF2.0 E-SE	1	2	33.75	2	67.5	135	101.25	#5	-	-	67.5	#5	-	-	-	-
Concrete Wall E-SE	1	12.7	32.96	0.67	418.592	280.4566	856.96	#5	-	-	838.2	#5	-	-	330	#6
Concrete Wall E-SE	1	1.51	25.25	1.083	38.28	41.47	101	#5	-	-	75.5	#5	-	-	-	-

Wrap Around Porch Structure

South Porch	Quantity	Height	Length	Thickness	SF	CF	Longitudinal Rebar		Top Transverse Rebar		Bot Transverse Rebar		WWF		
							Length	Type	Length	Type	Length	Type	Area	Type	Perimeter
Slab 1st Floor Right	1	9.75	24	0.33	233.56	77.85	344	#4	240	#4	-	-	233.56	2.1x2.1	69
Slab 1sr Floor Left	1	9.75	34.36	0.33	335.01	111.67	492.4933	#4	343.6	#4	-	-	335.01	2.1x2.1	97.83
8" Structural	1	8.92	32.43	0.67	289.25	192.83	217.5005	#4	291.87	#4	389.16	#5	-	-	68.583
6" Structural	1	11.46	22.95	0.5	263.04	131.52	316.8759	#4	316.8759	#4	-	-	263.04	2.5x25	76.083
8" Structural	1	8.92	40.98	0.67	365.57	243.71	274.8433	#4	368.82	#4	491.76	#5	-	-	105.17
8" Structural	1	8.92	10.24	0.67	91.35	60.9	68.67729	#4	92.16	#4	122.88	#5	-	-	40.583
8" Structural	1	9.75	24.97	0.67	243.42	162.28	183.0508	#4	224.73	#4	299.64	#5	-	-	8.75
Concrete Beam CB1	11		8.75			8.75	52.5	#4	47.97	#4	-	-	-	-	

Bathroom Slab Structure

Bathroom Slab	Perimeter	Quantity	Width	Length	Thickness	SF	CF	Top Long. Rebar		Bot Long. Rebar		Top Trans. Rebar		Bot Trans. Rebar	
								Length	Type	Length	Type	Length	Type	Length	Type
Concrete	90	6	15.75	20.67	0.52	308.56	160.71	336	#4	336	#5	336	#4	336	#4

South Stairs Structure

South Stairs	Quantity	Height	Length	Thickness	SF	CF	Horiz. Top Rebar		Horiz. Bot Rebar		Vert. Top Rebar		Vert. Bot Rebar	
							Length	Type	Length	Type	Length	Type	Length	Type
Footing CF2.0a	2	2	37.9825	1.33	50.52	101.03	-	-	113.94	#5	-	-	76	#5
Concrete Wall	2	1.49	37.066	1.083	59.81	55.23	-	-	111	#5	-	-	41.154	#5
Concrete Stairs	1	-	8	20 Risers	-	-	-	-	-	-	-	-	-	-
Concrete Stairs	1	-	11	7 Risers	-	-	-	-	-	-	-	-	-	-

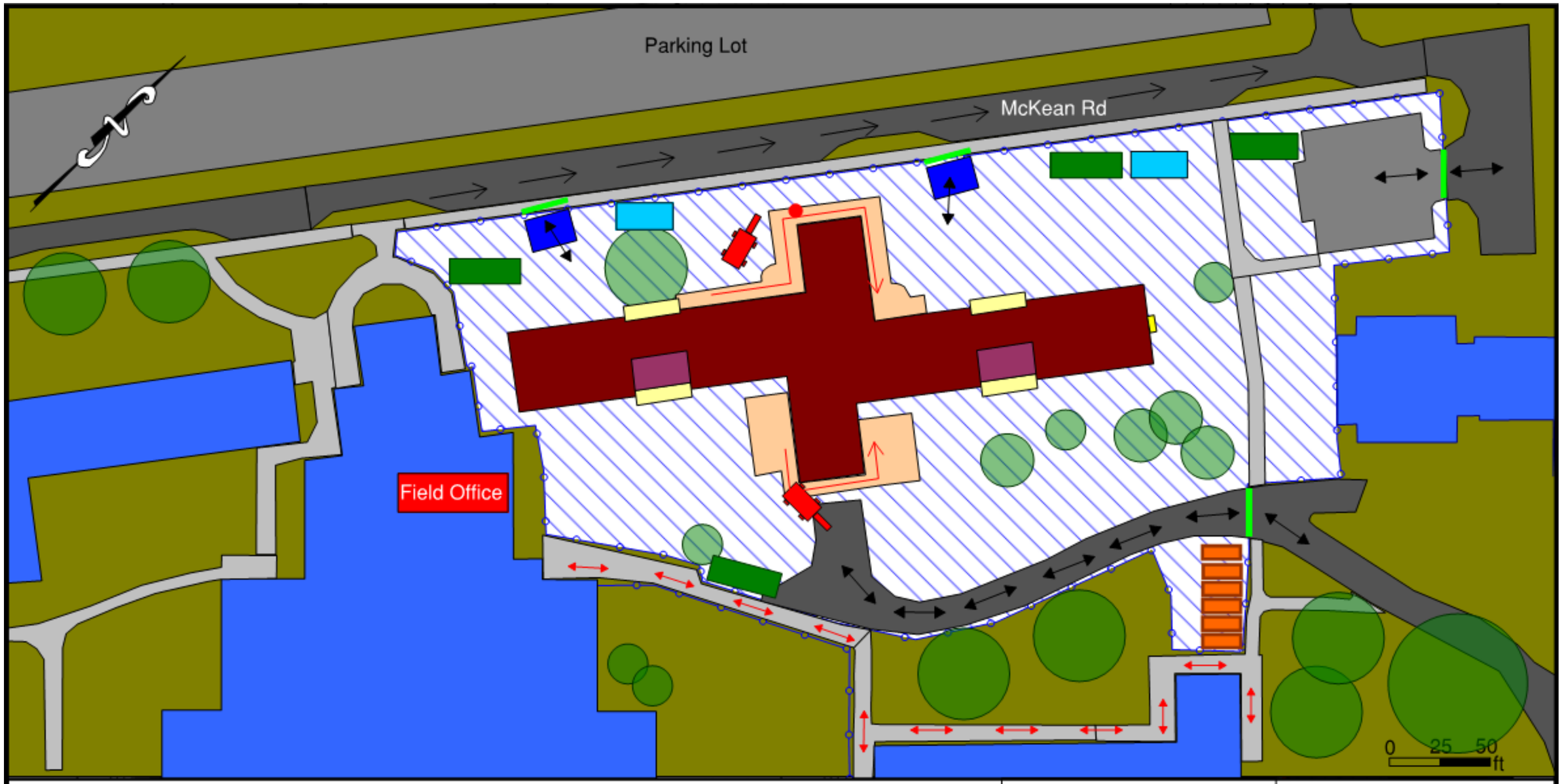
North Slab on Grade

North Walkway	Thickness	Volume	Area	Perimeter
Slab on Grade	0.4167	1187.595	2850	70.5

Structural Steel		
Porch Roof Members	**Quantity ea**	**Length**
HSS 7x4x3/8	4	9.75
HSS 7x4x3/8	25	12.33
HSS 7x4x3/8	1	7
HSS 7x4x3/8	3	10.33
HSS 4 1/2x4 1/2x3/8	13	12.58
HSS 4 1/2x4 1/2x3/8	16	10.33
HSS 4 1/2x4 1/2x3/8	8	9.75
HSS 4 1/2x4 1/2x3/8	3	8.67
HSS 6x4x3/8	8	12.33
W8x28	13	10.042
C6x13	1	17
C6x13	2	12.33
C8x11.5	2	10
L4x4x1/4	1	30.17
Small Projection Roof Members	**(8 total)**	
Steel Trusses	2	11.95
Steel Trusses	2	9.45
Steel Trusses	2	7.78
Steel Trusses	2	6.15
Steel Trusses	2	4.48
Steel Trusses	2	2.84
Steel Trusses	1	14.45
Large Projection Roof Members	**(4 total)**	
Steel Trusses	4	14.2
Steel Trusses	2	12.72
Steel Trusses	2	11.2
Steel Trusses	2	9.57
Steel Trusses	2	7.78
Steel Trusses	2	6.15
Steel Trusses	2	4.48
Steel Trusses	2	2.84
Steel Trusses	1	20

Porch Roof Decking	Perimeter	Area
2" 2C Conform	143	528.4
2" 2C Conform	84	294.67
2" 2C Conform	80.75	264.21
2" 2C Conform	85.75	301.75
2" 2C Conform	62	171.89
2" 2C Conform	141.17	462.66
2" 2C Conform	96.33	474.09
2" 2C Conform	82.83	298.07
2" 2C Conform	127.583	604.75
2" 2C Conform	62.33	173.4
Exterior Metal Railings	**Quantity LF**	
South Porch	512	

APPENDIX C: SITE LAYOUT PLANNING

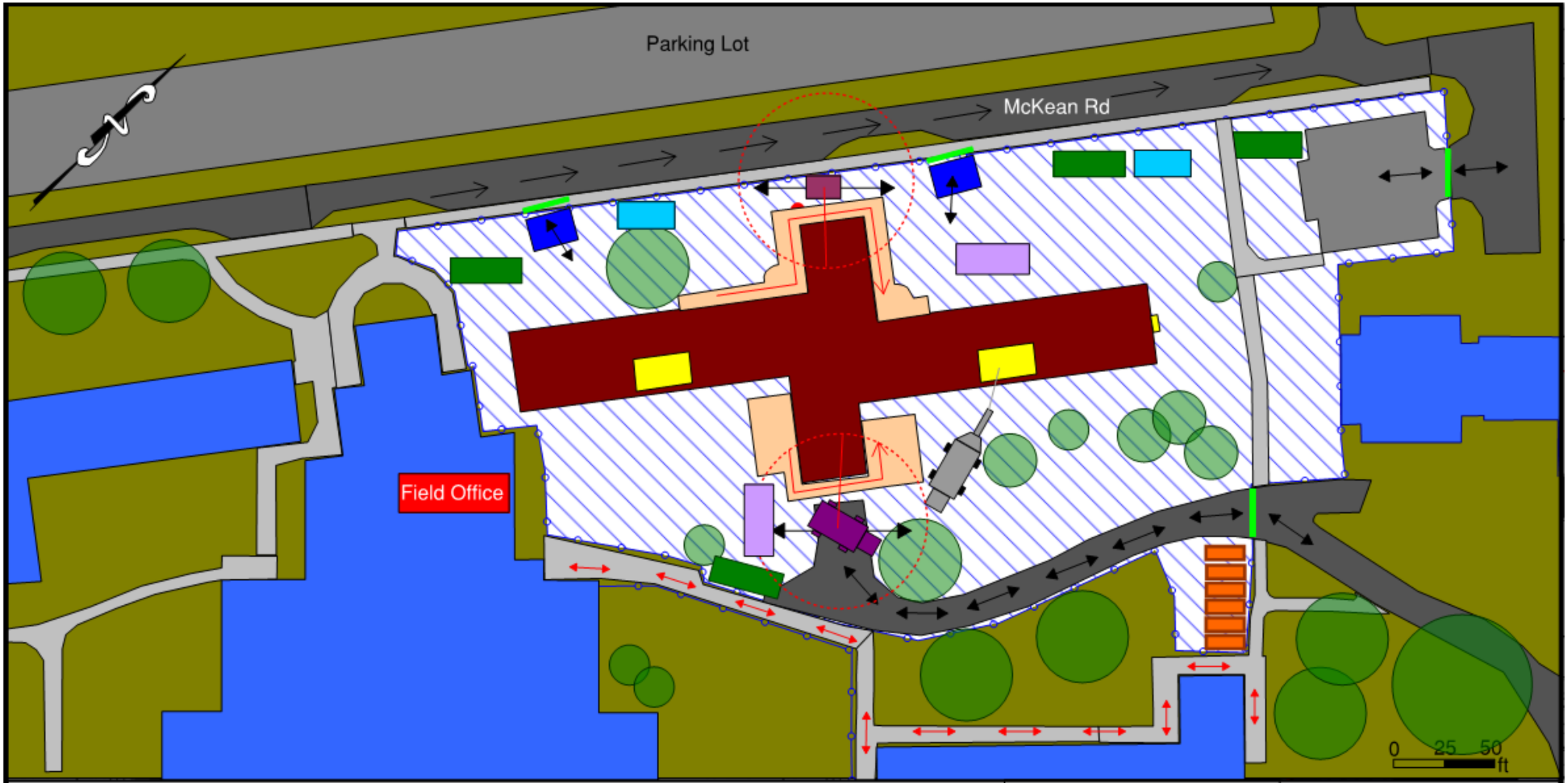


LEGEND

- Pedestrian Traffic
- Site Traffic Flow
- Demolition Flow
- Road Traffic
- Site Fence
- Sidewalk
- Road
- Parking Lot
- Protected Tree
- Fire Hydrant
- Gate
- Const. Site
- Site Demo
- Facade Demo
- Slab Demo
- Porta Johns
- Dumpsters
- Wash Rack
- Demo Equipment
- Mat'l Storage
- Adj. Building
- Project Building

Author: Quaid Spearing
Tech #2
Date: October 16th, 2013
Advisor: Dr. Anumba

South Halls: Ewing-Cross
University Park, PA
Demo Plan

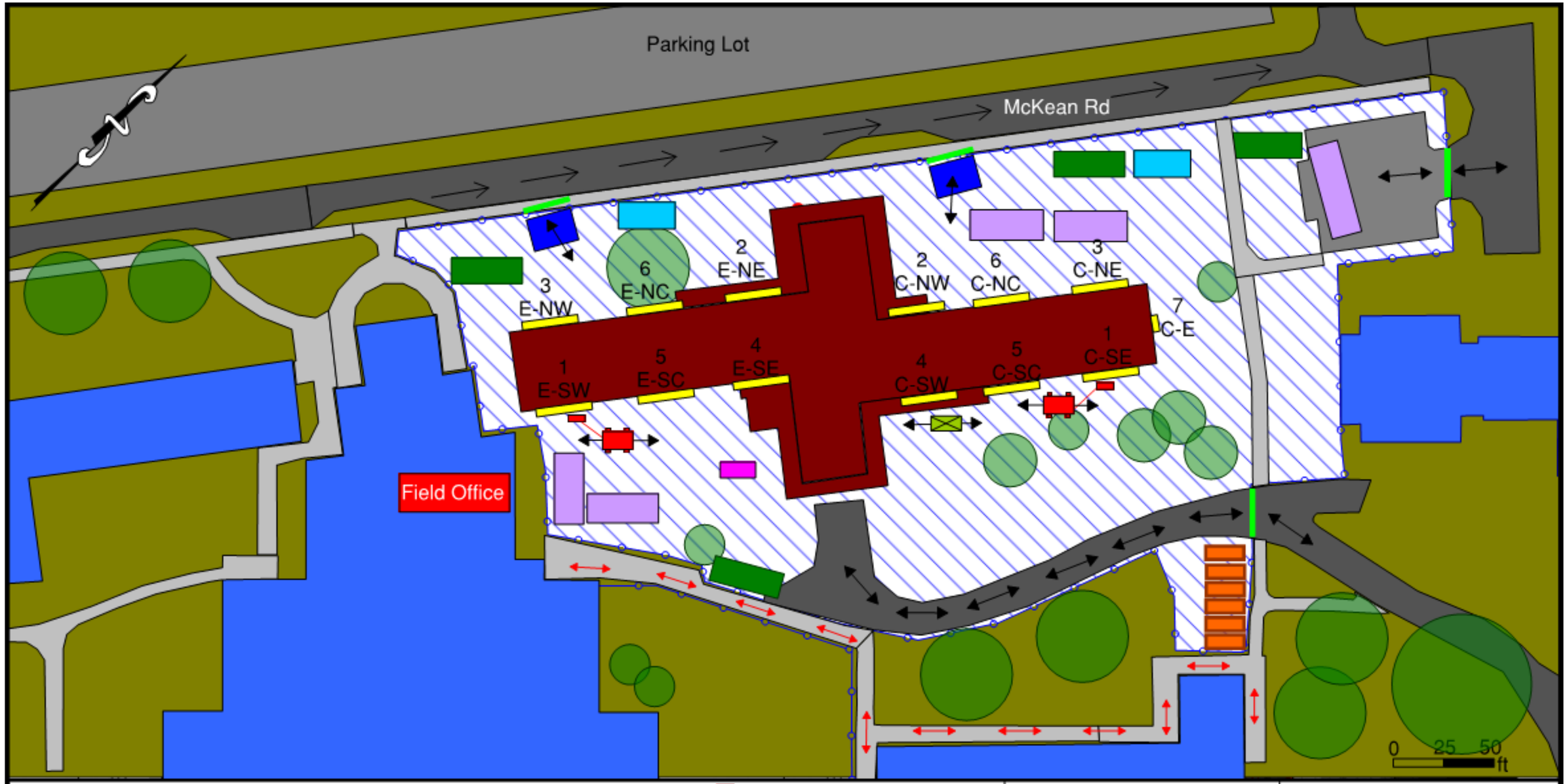


LEGEND

- Pedestrian Traffic
- Site Traffic Flow
- Super. Flow
- Road Traffic
- Site Fence
- Sidewalk
- Road
- Parking Lot
- Protected Tree
- Fire Hydrant
- Gate
- Const. Site
- Porch Structure
- Restroom Slabs
- Mat'l Staging
- Porta Johns
- Dumpsters
- Wash Rack
- Mobile Truck Crane
- Crawler Crane
- Concrete Truck
- Mat'l Storage
- Adj. Building
- Project Building

Author: Quaid Spearing
Tech #2
Date: October 16th, 2013
Advisor: Dr. Anumba

South Halls: Ewing-Cross
University Park, PA
Superstructure Plan



LEGEND

- Pedestrian Traffic
- Site Traffic Flow
- Road Traffic
- Site Fence
- Sidewalk
- Road
- Parking Lot
- Protected Tree
- Fire Hydrant
- Gate
- Const. Site
- 1,2,3 Sequence
- Enclosure
- Mat'l Staging
- Porta Johns
- Dumpsters
- Wash Rack
- Man Lift
- Hydraulic Scaffold
- Mortar Mixer
- Mat'l Storage
- Adj. Building
- Project Building

Author: Quaid Spearing
Tech #2
Date: October 16th, 2013
Advisor: Dr. Anumba

South Halls: Ewing-Cross
University Park, PA
Enclosure Plan

APPENDIX D: GENERAL CONDITIONS ESTIMATE

General Conditions Estimate					
Cost Code	**Description**	**Quantity**	**Unit**	**Labor/Unit**	**Labor Total**
	Personnel/Staff				
013113200220	Project Executive	18	Week	3825	$ 68,850
013113200200	Project Director	44	Week	3350	$ 147,400
013113200180	Senior Project Manager	87	Week	2900	$ 252,300
013113200120	Senior Project Engineer	87	Week	2050	$ 178,350
013113200100	Project Engineer	87	Week	1575	$ 137,025
013113200260	Senior Superintendent	87	Week	3100	$ 269,700
013113200240	Field Superintendent	43	Week	2825	$ 121,475
013113200240	Field Superintendent	43	Week	2825	$ 121,475
013113200010	Intern	13	Week	1040	$ 13,520
013113200020	Project Technician	87	Week	570	$ 49,590
	Field Office				
015213400100	Equipment	20	Month	217.8	$ 4,356
015213400120	Supplies	20	Month	100	$ 2,000
015213400140	Telephone	20	Month	88.11	$ 1,762
015213400160	Lights and HVAC	20	Month	165.33	$ 3,307
015213400010	Computer Equipment/Software	1	LPSM	50000	$ 50,000
015213400010	Furniture	1	LPSM	10000	$ 10,000
015213400010	Postage/Packaging	20	Month	200	$ 4,000
	Quality & Testing				
014523505570	Testing (1/month)	20	Each	301.32	$ 6,026
	Temporary Utilities				
015113500140	Temporary Electrical Power	1	Each	3268.25	$ 3,268
	Temporary Facilities				
015626500250	Site Fencing	2700	LF	7.43	$ 20,061
015813500020	Signage	200	SF	37.13	$ 7,426
015433406410	Temporary Toilets (4)	80	Month	227.88	$ 18,230
	Small Tools				
015433400010	Small Tools/Equipment	1	LPSM	5000	$ 5,000
	Cleaning and Waste Management				
024119190600	Dumpsters (2)	174	Week	505	$ 87,870
017413200010	Final Cleaning	710.02	MSF	90.46	$ 64,228
	General Conditions Subtotal				**$ 1,647,220**
	Insurance				
013113300020	Builders Risk	$ 28,833,020	Job	0.0024	$ 69,199
013113300600	Liability	$ 28,833,020	Job	0.01	$ 288,330
013113900010	Payment & Performance Bond	$ 28,833,020	Job	0.006	$ 172,998
	Insurance				
013113300020	Contingency	$ 28,833,020	Job	0.02	$ 582,700
	General Conditions Total				**$ 2,760,448**

APPENDIX E: BIM USE EVALUATION

LEVEL 1: BIM EXECUTION PLANNING PROCESS

Project Title

Developed with the BIM Project Execution Planning Procedure by the Penn State CIC Research Team

http://www.engr/psu.edu/ae/cic/bimex

BIM USES

Planning
Validate Program
Owner | Programming

Schematic Design
Author Schematic Design
Clark Nexsen | Design Authoring

Schematic Design
Perform Cost Estimate
BMC | Cost Estimation

Schematic Design
Perform 3D Coordination
Clark Nexsen | 3D Macro Coordination

Schematic Design
Create 4D Model
BMC | 4D Modeling

Design Development
Author Design Development
Clark Nexsen | Design Authoring

Design Development
Perform Cost Estimate
BMC | Cost Estimation

Design Development
Perform 3D Coordination
Clark Nexsen | 3D Macro Coordination

Design Development
Create 4D Model
BMC | 4D Modeling

Construction Documents
Author Construction Documents
Clark Nexsen | Detailed Map

Construction Documents
Perform Cost Estimate
BMC | Detailed Map

Construction Documents
Perform 3D Coordination
Clark Nexsen | 3D Macro Coordination

Construction Documents
Create 4D Model
BMC | 4D Modeling

Operations
Compile Record Model
BMC | Record Model

END PROCESS

INFO EXCHANGE

Schematic Design
- Architectural Model
- MEP Models
- Structural Model
- Civil Model

Schematic Design Cost Estimation

Schematic Design 4D Model

Schematic Design 3D Macro Coordination Model

Design Development
- Architectural Model
- MEP Models
- Structural Model
- Civil Model

Design Development Cost Estimation

Design Development 4D Model

Design Development 3D Macro Coordination Model

Construction Documents (WP)
- Architectural Model
- MEP Models
- Structural Model
- Civil Model

CD (MP) 3D Macro Coordination Model

CD (MP) 4D Model

CD (MP) Cost Estimation

CD (MP) 3D Micro Coordination Model

Record Model

APPENDIX F: REFERENCES

Detailed Structural Estimate

"Rebar-Info." *Rebar Info*. Web. 02 Oct. 2013.
<http://www.rebar-info.com/rebar-info-sizes.html>

"RSMeans Online." *RSMeans Online*. Web. 26 Sept. 2013.
<http://www.rsmeansonline.com/>

Steel Tube Institute of North America. *"Hollow Structural Sections."* Steel Tube Institute. Web. 05 Oct. 2013.
<http://steeltubeinstitute.org/>

Constructability Challenges

"Concrete Knowledge Center - Troubleshooting Surface Imperfections." *Delamination*. Web. 30 Sep. 2013.
<http://www.concrete.org/Technical/CKC/troubleshooting/articles/053.htm>

BIM Use Evaluation

"PROJECT." *BIM Execution Planning*. Web. 11 Oct. 2013.
<http://bim.psu.edu/Project/resources/default.aspx>